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Mapping the Scale and Scope of the Creative Industries in Yorkshire and the Humber

Final Report

Dr Jon Swords and Dr Nathan Townsend

xR StOries

XR Stories - Innovation in Screen Storytelling in the Age of Interactivity and Immersion

XR Stories supports research and development for companies working in cutting-edge digital technologies in the Yorkshire and Humber region. We do this through a programme of funding, research collaboration and connection. We work across film, TV, games, media arts, heritage, advertising and technology to champion a new future in storytelling.

XR Stories is putting the innovative and dynamic digital storytelling community of our region at the front of the global creative and cultural landscape. We draw together the University of York's research excellence and a strong business focus. We are finding new ways to tell new stories to new audiences.

XR Stories is a £15M investment by AHRC, ERDF, the University of York, the British Film Institute and Screen Yorkshire.

Report written Summer, 2019

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1. Executive Summary

XR Stories is a £15 million investment by AHRC, the University of York, BFI and Screen Yorkshire – along with a wide range of creative and cultural industries partners and universities in the Yorkshire and Humber region. XR Stories is set up to provide research and development funding to push forward the potential of immersive and interactive technologies for digital storytelling. The project's overarching ambition is to make the region the UK's centre of expertise in digital screen storytelling. With its funding, the project is committed to bring together world-leading research and creative digital expertise, shaping the future of storytelling.

For XR Stories to achieve its objectives, we need to understand the region's creative industries. In this report we begin by examining the scale and scope of the sector for two interconnected reasons.

- To understand the scale and scope of the creative and screen industries
- To begin to map the creative immersive sector

1.1 The scale and scope of Yorkshire and the Humber's Creative Industries

1.1.1 Employment

In 2017, the ONS estimated there were about 1.35 million people working in Great Britain's creative industries[1] which amounts to 4.6% of the working population. Around 67,000 (5%) of these people were based in Yorkshire and the Humber which is 2.7% of the total employment in the region (ONS 2018). This puts the region 8th in terms of creative industries employment with a profile similar to that of Scotland.

Five sub-sectors of the creative industries have above expected concentrations: advertising and marketing; architecture; design; IT, software and computer services; and museums, galleries and libraries. Almost 56% of the region's creative industries employment is found in Leeds (33%), Sheffield (12%) and Bradford (11%) as one might expect given the size of these cities. Sheffield has significant employment in 'crafts' and Bradford does well for 'publishing'.

Looking at employment in creative occupations, within and beyond the creative industries, we find more than half of in the region are in 'IT, software and computer services' (29%) and 'adverting and marketing' (26%).

[1] The Business Register and Employment Survey does not include Northern Ireland.

There is limited data available for employment and gender, but with what is available we can identify there are no occupations where women are the majority of workers. The biggest disparity – where data is available – is for 'marketing and sales directors' with a 77-23 split.

1.1.2 Enterprises

The ONS estimates there were approximately 289,000 enterprises in the creative industries in 2018. This includes businesses, charities and community interest companies. Yorkshire and the Humber accounts for 4.55% or 13,190 of these enterprises and this represents 7.2% of the region's total enterprises (ONS 2019). The spread of enterprises correlates with the profile of the UK.

Leeds is the region's main centre for creative industry enterprises with the highest share the region's creative business for 'advertising and marketing', 'design', 'film, TV, video and photography', 'IT, software and computer services' and 'publishing' . Sheffield has particular specialism in 'craft' and 'music, performing and visual arts', and North Yorkshire has relatively high proportions of enterprises operating in 'architecture' and 'museums, galleries and libraries'.

The region's creative industries are supported by higher education institutions who produce graduates who can work in the sector; postgraduate students and staff undertake research about, with and for the creative industries; many academics are creative practitioners who produce art; writing, music and other cultural products; and universities operate museums, galleries, archives and music venues.

1.2 Scale and Scope of the Screen Industries

Employment in Yorkshire and the Humber's screen industries is 6,365 and there are 865 enterprises in the sector, half of which are in film, TV and video-related activities (ONS 2019).

Employment in Yorkshire and the Humber's screen industries have grown significantly faster than Great Britain as a whole. Between 2015 and 2018 the region saw an increase of 116% compare to 11% nationally.

A much smaller percentage of workers in the region screen industries are full-time industries (63.8%) compared to the creative industries as a whole (73.6%). The highest proportion of full-time employees can be found in TV programming and broadcasting (93%) and radio broadcasting (81.6%).

Turnover in the 'motion picture, video and television production activities' has increased 434% from 2008 to 2017.

The region is well-served for location shooting with a huge range of location types available including: urban and neighbourhood locations in the major towns and cities; rural landscapes including the Yorkshire Dales, North Yorkshire Moors and coast; natural features including Brimham Rocks, Malham Cove and Humber Estuary; and historic locations for period filming including country houses, traditional villages and industrial landscapes.

The region's screen industries are supported by vibrant stakeholder organisations including Screen Yorkshire, Games Republic and York Mediale.

1.3 The Nascent Creative Immersive Sector

It is difficult to map an area as new and dynamic as the creative immersive sector but drawing on experimental social network analysis and insights from our funded R&D projects we can begin to characterise it. Companies, together with experts and practitioners, operating in the emergent creative immersive sector are found across the creative industries. Given the range of ways in which immersive storytelling is exhibited, the technologies used to consume it, the variety of stories being told and the different narrative forms, it is not surprising to find expertise and companies opera

In using social network analysis to understand the creative immersive sector, we find a new way to map the creative industries which provides more flexibility than the DCMS approach. Doing so reveal some of the DCMS grouping do not align with self-defined activities from creative industries enterprises. Moreover, it highlight activities undertake by creative companies which do not fit neatly within orthodox definitions of the creative industries but reach beyond them.

1.4 Next Steps

The research presented here is a foundation upon which we will build. The insights we provide in this report are an overview and headline figures, but more work is needed to better understand the dynamics of Yorkshire and the Humber's creative, screen and immersive industries. This knowledge will help inform the work of XR Stories and new work as part of Creat:KE. The latter is a three-year project funded by Research England and the University of York. The programme is designed to generate knowledge exchange, innovation and business development. The programme is aimed at freelancers, micro-businesses and SMEs in Yorkshire's screen-based industries and directly associated supply chain. It brings together researchers and policy advisors to better understand and shape the future of visual entertainment, storytelling and more. Creat:KE was developed and will be delivered in partnership with the British Film Institute and Screen Yorkshire.

2. Introduction

1.5 Creative Industries Partnerships

XR Stories is one of nine creative industries R&D partnerships (CIRDPs) funded from the UK Government's industrial strategy through the AHRC's creative economy programme. The nine CIRDPs bring together higher education institutions, businesses, policymakers and other stakeholders to support the development of creative industries activities through funding, knowledge exchange and collaboration.

XR Stories is a £15 million investment by AHRC, the University of York, BFI and Screen Yorkshire – along with a wide range of creative and cultural industries partners and universities in the Yorkshire and Humber region. XR Stories is set up to provide research and development funding to push forward the potential of immersive and interactive technologies for digital storytelling. The project's overarching ambition is to make the region the UK's centre of expertise in digital screen storytelling. With its funding, the project is committed to bring together world-leading research and creative digital expertise, shaping the future of storytelling.

The other eight funded projects are:

Bristol & Bath R&D is focusing on improving the creative industries in the Bristol and Bath area. It is led by UWE Bristol with the Universities of Bath, Bristol and Bath Spa along with industry partners including Watershed.

Business of Fashion, Textiles and Technology is focusing on innovation in the fashion and textiles industries. It led by University of the Arts London with UCL, Loughborough University, University of Cambridge, University of Leeds and Queen Mary University London along with industry partners including ASOS and the V&A.

Clwstwr is focusing on collaboration and innovation to create a sustainable media production sector in Wales. It is led by Cardiff University in partnership with University of South Wales and Cardiff Metropolitan University together with Welsh broadcasters and production companies.

Creative Informatics is innovating with data for the creative industries. It is led by Edinburgh University alongside Edinburgh Napier University, Codebase and Creative Edinburgh.

Future Fashion Factory is seeking to transform innovation in fashion industry. It is led by the University of Leeds with the Royal College of Art and a range of partners including Burberry, the British Fashion Council, Yorkshire Textiles and Camira Fabrics.

Future Screens NI is exploring ways to enhance the skills and growth of film, TV, animation, games and immersive media. It is led by Ulster University and Queens University Belfast together with some of Northern Ireland's key creative organisations, including NI Screen, RTE and the BBC.

InGAME is helping the games industry innovate. It is led by Abertay University with the University of Dundee and the University of St Andrews. Industry partners include BBC, Beano Studios, Microsoft, and Sony Interactive Entertainment Europe.

StoryFutures focuses on innovations for storytelling through engagement with immersive technologies, AI and data. It is led by Royal Holloway University of London and brings together partners including Immerse UK, Pinewood Studios and Heathrow.

1.6 Understanding Yorkshire and the Humber's Creative Industries

For XR Stories to achieve its objectives, we need to understand the region's creative industries. In this report we begin by examining the scale and scope of the sector for two interconnected reasons. First, although immersive and interactive digital storytelling has been part of the economy since at least the 1980s, the past 5-10 years has seen increasingly expansion of the field as technology allows more to be produced and consumed. Paralleling this development, and in part spurring it, various initiatives and funding has emerged in the past few years to support its growth. Thus, the field is emergent, dynamic and difficult to pin down as many enterprises operating in this area are new. Second, the skills and competencies required for immersive and interactive digital storytelling don't come from single areas of the creative industries. The screen industries are crucial players in this field, but, as we demonstrate below there are intersections with many other areas of the wider creative economy. This is borne out in who has applied for research and development funding so far (see chapter 6 for more details).

The report has two aims:

- To understand the scale and scope of the creative and screen industries
- To begin to map the creative immersive sector

To understand the creative industries we take the DCMS definition (see Table 2) and for the screen industries we adopt Screen Yorkshire's approach which included film, television, interactive media and radio (these are discussed more below in chapters 3 and

5. The scale of our focus is Yorkshire and the Humber, and where possible we break this down to sub-regions using the NUTS3 geography[2]. The scoping we present here begins by adopting an orthodox approach that draw on data from the Office of National Statistics. There are drawbacks of this dataset which we discuss in the next chapter, but we use it for two reasons. First, the data is consistent across the country and time, and the methodologies are transparent meaning geographical and temporal comparisons are straightforward to make. It also allows us to compare the latest statistics with previous research, such as the Screen Yorkshire Growth Plan. Second, the comparability of the data allows us to establish a baseline from which we can build in subsequent phases of the research.

In the next chapter we outline our understanding of the creative industries in the context of previous research in this area. The nature of this document means it is not a full literature review, but it does draw on a series of academic and policy sources to illustrate the perspectives being used in our work. Chapter 4 then highlights key sets of statistics about the creative industries in Yorkshire and the Humber. These focus on employment, enterprises and region's the higher education sector. Chapter 5 we narrow our focus from the creative industries to those sub-sectors which make up the screen industries. In so doing we demonstrate the size and scope of the sector drawing on ONS data and outline the physical infrastructure the region has and key industry stakeholders. In chapter 6 we move away from established methods for mapping the creative industries by undertaking social network analysis of Yorkshire and the Humber's creative sector. In so doing we avoid some of the drawbacks of the DCMS economic estimates to allow analysis the multiple types of work creative industries enterprises undertake. Chapter 7 draws together the insights from previous chapters to try and begin to understand the region's creative immersive sector, particularly in relation to immersive and interactive storytelling.

[2] NUTS level 3 splits the region into the following geographical units: Barnsley, Doncaster and Rotherham; Bradford; Calderdale and Kirklees; East Riding of Yorkshire; City of Kingston upon Hull; Leeds; North Yorkshire CC; North and North East Lincolnshire; Sheffield; Wakefield; York.

3. Defining the Sector for XR Stories

1.7 Introduction

In this chapter we discuss how one might go about defining the creative economy and in turn, how we can understand their scale and scope in Yorkshire and the Humber. The aim is to briefly outline how similar work has been done in the past to provide a context for this report and the research XR Stories is undertaking to help the region's immersive and interactive storytelling sector develop. The nature of the funding for XR Stories and its geographical focus on an English region means most of the context is from the UK. We acknowledge this is a partial picture and it is important not to solely focus on the UK. We recognise there are insights and best practice to be learned from places beyond the UK and in the next phase of the research, particularly in horizon scanning activities, we will examine non-UK contexts in more detail. Indeed, in the next phase of the research we will adopt more sophisticated techniques overall, including qualitative methods, to understand the dynamics of the region's sector in comparison to activity elsewhere.

1.8 Defining the Creative Industries

The term 'creative industries' came into popular usage at the end of the 1990s under the influence the New Labour Government and their economic development policy[3]. The Department for Culture, Media and Sport's (DCMS) definition and mapping of the newly labelled creative industries marked an important shift in policy for arts and culture, placing it centre stage for a new government seeking to think differently about the economic value of cultural activities (see Smith 1998 for insights from the time). For O'Connor (2011), this different approach can be traced back to work of the Great London Council and UNESCO in the early 1980s, and Luckman (2019) has argued Australia's Department of Communications and the Arts 'Creative Nation' report is an important precursor to the DCMS work. Nevertheless, the DCMS's 1998 and 2001 mapping documents, and subsequent policy, have become the epoch-making interventions which cemented the creative industries as key economic activities in the UK and beyond.

The shift from policy focus on arts and culture - under the remit of the Minister for the Arts and Department of National Heritage - to creative industries was made through simultaneously re-conceptualising the value of creative activities and redefining what might be considered as 'creative'. The original 1998 DCMS definition focused on 13 sets of core activities:

[3] For a longer history, see O'Connor, J. (2011) The cultural and creative industries: A critical history. *Ekonomiaz: Revista Vasca de Economia*, *78*, pp. 24-47

- advertising
- art and antiques markets
- architecture
- crafts
- design
- fashion
- film
- leisure software (i.e. computer games)
- music
- performing arts
- publishing
- software
- TV and radio

The mapping work also identified ‘related industries’, ‘related activities’ and ‘peripheral activities’ alongside these core areas and reported portraits of each using economic measures such as revenue, employment levels and industry structure. The 2001 mapping document provided slightly more sophisticated definitions of the 13 sectors, but most importantly began to highlight the sector’s growth (Table 1) which has become a key headline for the creative industries.

Table 1 - Change in UK Creative Industries Revenue and Employment, 1998-2001

	Revnue (£bn)				Employment ('000s)			
	1998	2001	Change	% change	1998	2001	Change	% change
advertising	4	3	-1	-25%	96	93	-3	-3%
art and antiques markets	1.5	1.7	0.2	13%	30	21	-9	-30%
architecture	2.2	3.5	1.3	59%	40	37	-3	-8%
crafts	0.4	0.4	0	0%	25	24	-1	-4%
design	12	26.7	14.7	123%	23	76	53	230%
fashion	0.6	0.6	0	0%	12	12	0	0%
film and video	0.9	3.6	2.7	300%	33	45	12	36%
leisure software (i.e. computer games)	1.2	1	-0.2	-17%	27	21	-6	-22%
music	3.6	4.6	1	28%	160	122	-38	-24%
performing arts	0.9	0.5	-0.4	-44%	60	74	14	23%
publishing	16.3	18.5	2.2	13%	125	141	16	13%
software	7.5	36.4	28.9	385%	272	555	283	104%
TV and radio	6.4	12.1	5.7	89%	64	102	38	59%
	57.5	112.5	55	96%	966	1322	356	37%

(source: DCMS, 2001)

The DCMS approach uses Standard Industrial Classification (SIC) and Standard Occupational Classification (SOC) codes to define the sectors (Table 2). These codes are what enterprises select when they summit their accounts to Companies House.

The UK definition has changed over the last 20 years, in part, due to continued critique of original definitions from academics, practitioners, policymakers and industry groups.

Roodhouse (2006), for example, has highlighted the inconsistency of definitions over time and between places. In recent research has highlighted the differences between the UK and US definitions of the creative industries, with occupations such as florists included in the US definition but not the UK set (Kemeny et al. 2019). In the current UK set of SIC codes, organisations classified as '91020 – Museum Activities' are included, but those classified as '91030 - Operation of historical sites and buildings and similar visitor attractions' are left out, even though many activities of the latter overlap with the former.

The inclusion of software in the 1998 report, and what is now called 'IT, software and computer services', has perhaps caused the greatest controversy. For Miller (2009), the inclusion of computing and IT is symptomatic of an economistic approach reproducing ideals of neoliberalism at the expense of artistic and aesthetic values[4]. This sub-sector also accounts for a disproportionate share of the sector compared to other areas. The figures in Table 1 show that software accounted for 32% of total revenue and 42% of total employment in the creative industries in 2001. In 2018 IT, software and computer services accounted for 40% of the creative industries' contribution to GVA (£40.6bn of £101.6bn) and 35.9% of employment (733,000 of 2 million people). In contrast, crafts make up a tiny proportion of the creative industries (0.3% of GVA and 0.4% of employment). This is due, in part, to the methodologies used to measure the creative industries, something the Crafts Council has highlighted as problematic (Crafts Council et al. 2012). Indeed, the only SIC code used for the craft sub-sector of the DCMS definitions is 'manufacture of jewellery and related articles'. Other craft activities will be captured under 'Artistic Creation' if practitioners select that SIC code. While parts of 'IT, software and computer services' resemble other areas of the creative industries (computer games companies employ artists, and software companies use designers), it could be argued computer consultancy activities bear more resemblance to management professional services than creative activities.

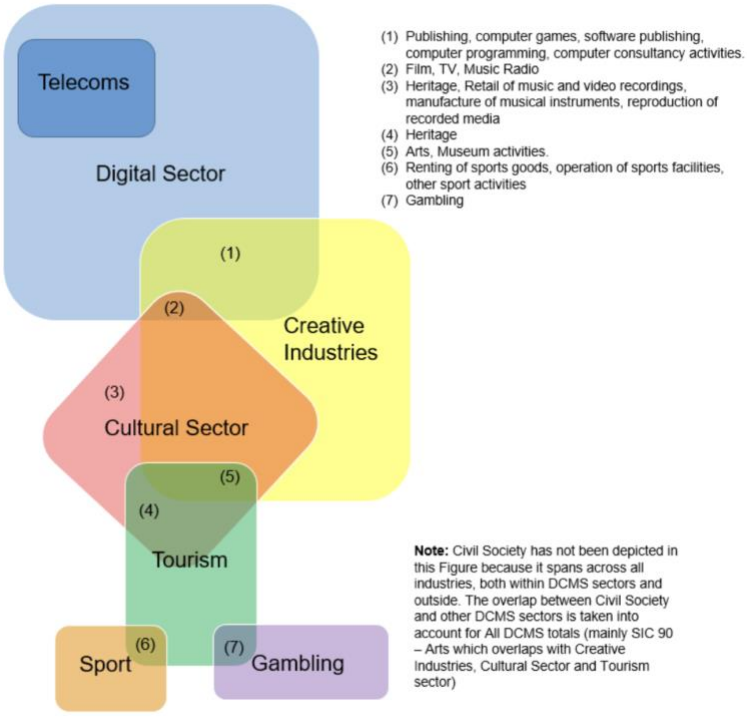
1.8.1 Redefinitions

Since the early DCMS work, their approach to defining which sectors are included in their creative industries economic estimates, and therefore policy, has shifted in two key ways. First, they now highlight overlaps with other sectors under the Department's remit (Figure 1). Second, they combine data on enterprises (using SIC codes) with data on occupations (using Standard Occupational Classification codes) to highlight areas of the economy with the greatest 'creative intensity'. Creative intensity is "[t]he proportion of creative jobs for each industry was calculated (creative intensity)…[and]

[4] The latter are hard to quantify, and thus consistently tracking their value of time is impossible. Moreover, such a process is not necessarily desirable to do.

[i]ndustries with creative intensity above a specified threshold are considered Creative Industries" (DCMS 2016: 21). In doing this they acknowledge that creative workers are found across the economy (e.g. designers work in manufacturing companies, musicians work in the hospitality sector, architects work in local authorities and public relations professionals work in pharmaceuticals).

Figure 1 - Overlap of DCMS sectors



The current definitions used by the DCMS stem from the latest calculations of creative intensity and are shown in Table 2. While this table is the latest definition, the codes used date to 2007 so are out of date. Updates are complex and costly, so no criticism is levelled at the ONS or Companies House, but it is worth noting that some activities which have emerged since 2007 are not accurately captured and rely on the interpretation of enterprises, accountants and statisticians to capture them as best as is possible.

Table 2 - DCMS Creative Industries Definition

Creative Industries Sub-Sector	**4-digit SIC code**		**4-digit SOC code**
Advertising and Marketing	7021 Public relations and communication activities		1132 Marketing and sales directors
	7311 Advertising agencies		1134 Advertising and public relations directors
	7312 Media representation		3543 Marketing associate professionals
			2472 Public relations professionals

			2473 Advertising accounts managers and creative directors
Architecture	7111 Architectural activities		2431 Architects
			2432 Town planning officers
			2435 Chartered architectural technologists
			3121 Architectural and town planning technicians
Crafts	3212 Manufacture of jewellery and related articles		5211 Smiths and forge workers
			5411 Weavers and knitters
			5441 Glass and ceramics makers, decorators and finishers
			5442 Furniture makers and other craft woodworkers
			5449 Other skilled trades n.e.c.
Design: product, graphic and fashion design	7410 Specialised design activities		3421 Graphic designers
			3422 Product, clothing and related designers
Film, TV, video, radio and photography	6010 Radio broadcasting		3416 Arts officers, producers and directors
	6020 Television programming and broadcasting activities		3417 Photographers, audio-visual and broadcasting equipment operators
	7420 Photographic activities		
	5911 Motion picture, video and television programme production activities		
	5912 Motion picture, video and television programme post-production activities		
	5913 Motion picture, video and television programme distribution activities		
	5914 Motion picture projection activities		
IT, software and computer services	6201 Computer programming activities		2135 IT business analysts, architects and systems designers
	6202 Computer consultancy activities		1136 Information technology and telecommunications directors
	5821 Publishing of computer games		2136 Programmers and software development professionals
	5829 Other software publishing		2137 Web design and development professionals
Museums, galleries and libraries	9101 Library and archive activities		2451 Librarians
	9102 Museum activities		2452 Archivists and curators
Music, performing and visual arts	5920 Sound recording and music publishing activities		3411 Artists
	8552 Cultural education		3413 Actors, entertainers and presenters
	9001 Performing arts		3414 Dancers and choreographers

	9002 Support activities to performing arts		3415 Musicians
	9003 Artistic creation		
	9004 Operation of arts facilities		
Publishing	5811 Book publishing		2471 Journalists, newspaper and periodical editors
	5812 Publishing of directories and mailing lists		3412 Authors, writers and translators
	5813 Publishing of newspapers		
	5814 Publishing of journals and periodicals		
	5819 Other publishing activities		
	7430 Translation and interpretation activities		

Source: DCMS (2019)

Beyond the work of the DCMS, various other redefinitions of the creative industries have been offered by governance organisations overseas, academics, consultancies, charities and other stakeholders. There are too many to summarise here, but we will briefly touch on some of the reasons why redefinitions have been suggested.

First, the DCMS approach has been critiqued for being too economistic and erasing the cultural value of the activities creative companies undertake (Kong 2005; Walmsley 2013). Second, the economistic discourse is used for boosterist neo-liberal agendas which silences, or at least overlooks some of the negative aspects of the creative industries. For instance, Ekinsmyth (2002) has highlighted exploitation faced by freelancers in the magazine industry; Brook et al. (2018) have drawn attention to how social class excludes people from the creative industries; the Creative Diversity Network (2018) has drawn attention to the low numbers of people who identify as disabled and/or transgender in the UK broadcasting industry; Bhavnani's (2007) report for the BFI draws attention to barriers faced by women, ethnic minorities and LGBTQ+ workers in the film industry.

Third, the influence of the DCMS definition, and the relatively large amount of research undertaken into the UK and US creative industries means there is an Anglo-American bias to research in the field. Fahmi et al. (2015), for example, argue that Western conceptualisations of the creative economy are difficult for developing countries to adopt and Kong et al. (2006) have drawn attention to the variegated adoption of Western policy ideas in Asia. Fourth, and in some ways related to the first and third factors, there is also an urban-centric bias to a lot of policy for the creative industries (particularly towards very large cities) which draws on ideas of city-led agglomeration economies (Rantisi et al. 2006). But work from Australia (Mayes 2010), Canada (Bain 2013) and Norway (Lysgård 2016) highlights not only the need to recognise creative

economies in rural and peripheral locations, but also the different forms policy can and might take.

Finally, the politics of which sub-sectors are included, and how they are defined, has led to alternative ways of thinking about the creative industries. The Work Foundation (2007), for instance, proposed a layered typology based on different types of value produced by cultural and creative activities. The aim of this report is not to examine these issues in great detail, not least as regional data is very limited for issues of equality, diversity and inclusion, but these are areas of interest and will inform the next phases of research.

In the next chapter we outline key sets of statistics for the creative industries in Yorkshire and the Humber. Our approach is to follow the conventional approach, using the DCMS definitions, to allow for straightforward comparisons. Chapters 6 and 7 take different approaches using social network analysis to provide an alternative perspective.

4. The Creative Industries in Yorkshire and the Humber

In this chapter we highlight key sets of statistics about the creative industries in Yorkshire and the Humber. The majority of these are drawn from the Office of National Statistics (ONS) which collect and collate data at the national level. Regional and sub-regional scale data is sometimes limited and roundings are often used to avoid disclosing organisation- or individual-level data. Other data are unavailable and some requires bespoke requests which the ONS charges for. At the time of writing the latter was unavailable due to resource constraints. Even with those caveats, we still get a good idea of the scope and scope of the region's creative industries and wherever possible these are presented in comparison to national figures and those of those regions.

At the scale we're examining, it is important to recognise that numbers can only go so far to understand the activities in the region's creative industries. We would note, therefore, that just because there is a low concentration of an activity, or the absolute numbers are relatively small, that should not be taken as an indication of low quality or low value work being done by those employed in the sector.

1.9 Employment

Understanding employment figures for the creative industries is notoriously hard given the large number of freelancers working in the sector. This is compounded by many freelancers having a primary or secondary job outside the creative industries because creative practice does not pay enough to support them completely, or because it is a side job that complements their main work.

In 2017, the ONS estimated there were about 1.35 million people working in Great Britain's creative industries[5] which amounts to 4.6% of the working population. Around 67,000 (5%) of these people were based in Yorkshire and the Humber which is 2.7% of the total employment in the region (ONS 2018). This puts the region 8th in terms of creative industries employment with a profile similar to that of Scotland. Using location quotients, we can take into account differences in overall employment levels to give a better idea of the concentration of jobs in different parts of Great Britain[6]. In Table 3 we can see London and the South East are the only regions with scores above one, but this is unexpected as they dominate the creative industries, accounting for more than 50% of total employment. If we remove these regions, we see a much less skewed picture indicating a relatively even spread of jobs around the country with Wales and the East of England highest.

[5] The Business Register and Employment Survey does not include Northern Ireland.
[6] all other things being equal, a location quotient over 1 indicates a higher than expected concentration of employment

Table 3 - Regional Employment in the Creative Industries (2017)

Region	Employment	%	% of regional employment in CIs	Location Quotient	Location Quotient without London and South East
London	501000	37.1	9.5	2.15	
South East	216000	16.0	5.1	1.15	
East	105000	7.8	3.7	0.83	1.23
North West	103000	7.6	3.0	0.69	1.01
South West	88000	6.5	3.4	0.78	1.14
West Midlands	72000	5.3	2.7	0.61	0.90
Scotland	69000	5.1	2.7	0.60	0.89
Yorkshire and The Humber	67000	5.0	2.7	0.62	0.91
East Midlands	54000	4.0	2.5	0.57	0.83
Wales	50000	3.7	3.8	0.86	1.26
North East	26000	1.9	2.4	0.54	0.79
Total	**1351000**				

Source: Calculated using the Business Register and Employment Survey ONS (2018)

Table 4 illustrates Yorkshire and the Humber's creative industries employment by sub-sector grouping compared to the rest of Great Britain. The sector is dominated by 'IT, software the computer services' at the national level (45.3%) and this is reflected at the regional scale (46.5%). The only other area with a similar proportion to the national picture is 'crafts', with all other sub-sections differing from 49% less than the national average ('music, performing and visual arts') to 73% more than the national average ('museums, galleries and libraries'). This is in part due to relatively small numbers in some sub-sectors, the dominance of London and the South East, but also regional specialisms (see Table 6 for more details on Yorkshire and the Humber).

Table 4 - Creative Industries Employment in Great Britain and Yorkshire and the Humber by Sub-Sector (2017)

Sub-sector	National CI Employment Total	Sub-sector %	Yorks & Humb. CI Employment Total	**Sub-sector %**	Y&H as % of national	Location Quotient
Advertising and Marketing	151000	11.20	8315	12.5	5.5	1.12
Architecture	81000	6.01	4925	7.4	6.1	1.23
Crafts	5000	0.37	230	0.3	4.6	0.93

Design: product, graphic and fashion design	54000	4.00	3850	5.8	7.1	1.44
Film, TV, video, radio and photography	159000	11.79	4575	6.9	2.9	0.58
IT, software and computer services	611750	45.36	30955	46.5	5.1	1.03
Museums, galleries and libraries	59000	4.37	5040	7.6	8.5	1.73
Music, performing and visual arts	115000	8.53	2920	4.4	2.5	0.51
Publishing	113000	8.38	6660	10.0	5.9	0.10
Total	1348750	100	67470	101[7]		

Source: Business Register and Employment Survey ONS (2018)

Location quotients can again provide a more useful picture with five sub-sectors having above expected concentrations: advertising and marketing; architecture; design; IT, software and computer services; and museums, galleries and libraries.

The regional scale only gives part of the picture and Table 5 shows the distribution of employment within Yorkshire and the Humber. Almost 56% of the region's creative industries employment is found in Leeds (33%), Sheffield (12%) and Bradford (11%) as one might expect given the size of these cities.

Table 5 - Creative Industries Employment in Yorkshire and the Humber (2017)

NUTS3 Region	**Totals**	**%**
Leeds	21865	32.84
Sheffield	7810	11.73
Bradford	7275	10.93
North Yorkshire CC	6630	9.96
Calderdale and Kirklees	5840	8.77
Barnsley, Doncaster and Rotherham	4510	6.77
York	3980	5.98
East Riding of Yorkshire	2745	4.12
Wakefield	2460	3.70
Kingston upon Hull, City of	2315	3.48
North and North East Lincolnshire	1145	1.72

[7] Doesn't sum due to roundings in BRES methodology.

Total	**66575**	**100**

Source: Business Register and Employment Survey ONS (2018)

If we delve deeper still, we can identify areas of concentration within different parts of the region (areas shaded grey in Table 6). Most of the region has a greater than expected concentration of employment in the 'museums, galleries and libraries' and 'design' sector which is not surprising given the importance of tourism to the region and the history of manufacturing. Sheffield has significant employment in 'crafts' and Bradford does well for 'publishing'. North and North East Lincolnshire has five areas of employment higher than expected, but this is likely due to relatively low numbers skewing the data.

Table 6 – Employment Location Quotients for Sub-Regions of Yorkshire and the Humber

	Advertising and Marketing	Architecture	Crafts	Design	Film, TV, video, radio and photography	IT, software and computer services	Museums, galleries and libraries	Music, performing and visual arts	Publishing
Kingston upon Hull, City of	1.60	1.21	0.00	0.78	1.27	0.81	1.90	0.24	0.77
East Riding of Yorkshire	0.99	1.33	0.00	1.33	0.53	1.13	1.63	0.79	0.42
North and North East Lincolnshire	1.43	0.70	2.27	1.05	1.18	0.71	3.66	0.35	0.85
York	0.79	1.62	0.33	1.06	0.48	1.06	3.47	0.36	0.28
North Yorkshire CC	1.49	2.13	0.19	2.13	0.51	0.86	1.87	0.53	0.23
Barnsley, Doncaster and Rotherham	0.87	0.89	0.87	1.20	0.41	1.28	0.98	0.31	0.83
Sheffield	0.76	1.67	5.08	1.57	0.65	0.97	1.29	0.68	1.02
Bradford	0.38	0.66	0.36	1.16	0.28	0.44	0.99	0.33	6.41
Leeds	1.39	0.92	0.24	0.99	0.60	1.15	1.46	0.53	0.34
Calderdale and Kirklees	0.96	1.10	0.67	2.88	0.52	1.01	1.60	0.50	0.67

Note: location quotients calculated compared to national scale

Source: calculated using Business Register and Employment Survey ONS (2018)

1.9.1 Employment Type

We can breakdown the employment figures into full-time and part-time positions. As

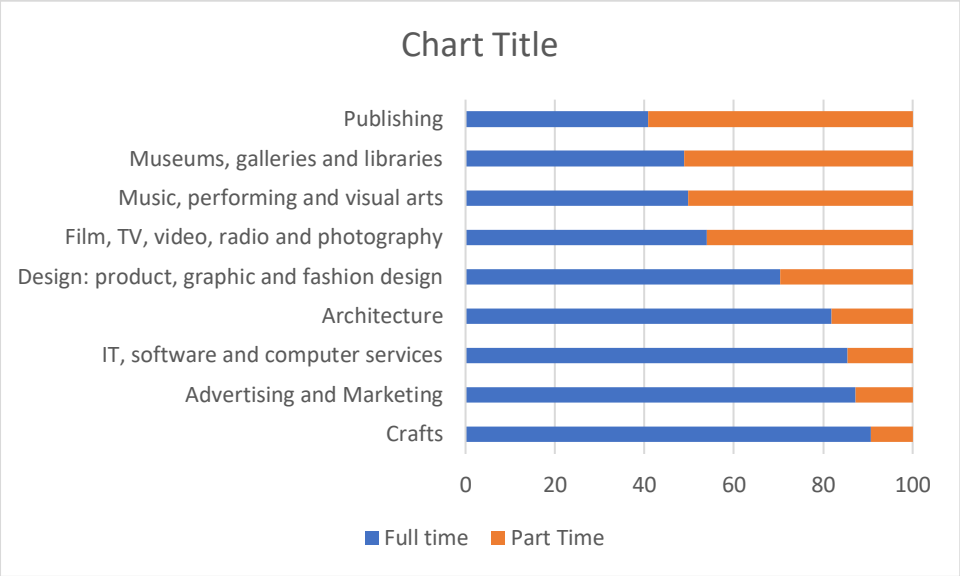
Figure 2 and Table 7 illustrate, there is a marked difference in the balance of full- and part-time positions in different sub-sectors. 'Crafts', 'advertising and marketing', 'IT, software and computer services' and 'architecture' all have more than twice the proportion of full-time employees than 'publishing'. Three sub-sectors have more part-time employment than full-time: 'publishing'; 'museums, galleries and libraries'; and 'music, performing and visual arts'. These broad sub-sectors hide some interesting differences between SIC codes. For instance, within 'music, performing and visual arts', three areas have more full-time post than part-time: 'artistic creation' (76.1%), 'support activities for the performing arts' (62.5%) and 'cultural education' (51.1%). Only three areas have full-time employment above 90%: 'motion picture, video and television programme distribution activities' (100%); 'television programming and broadcasting activities' (98.2%); and 'manufacture of jewellery and related articles' (90.7%).

Table 7 - Full-time and part-time posts in the Y&H creative industries (2017)

	Full-time posts	**% full-time**	**Part-time posts**	**% part-time**
Advertising and Marketing	7180	87.2	1050	12.8
Architecture	3750	81.9	830	18.1
Crafts	195	90.7	20	9.3
Design: product, graphic and fashion design	2765	70.4	1165	29.6
Film, TV, video, radio and photography	2325	54.0	1980	46.0
IT, software and computer services	25205	85.4	4315	14.6
Museums, galleries and libraries	2355	48.9	2465	51.1
Music, performing and visual arts	1305	49.8	1315	50.2
Publishing	2795	40.8	4050	59.2
Total	**47875**	73.6	**17190**	26.4

Source: BRES (2019)

Figure 2 - Employment type percentages



Source: BRES (2019)

1.9.2 Creative Occupations

Not all creative workers work in the creative industries. Some designers, for example, will be employed by manufacturing companies and large accountancy firms may have in-house marketing people. It is worth, therefore, understanding the wider labour pool of creative talent. We can do this using SOC codes.

Table 8 illustrates the variance in composition of creative occupations between the UK's regions. In the South East's creative workforce (within and beyond the creative industries), for instance, 'advertising and marketing' makes up 31.7% compare to Scotland's 21%. For 'craft', 9.6% of the Scottish creative workforce is craftworkers, but in the North West of England it is only 4.7%. In Wales, 12.9% of creative workers are in 'publishing' compared to 5.3% in the West Midlands.

Table 8 - Creative Employment by Region (%) (2019)

	North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East	London	South East	South West	Wales	Scotland	Northern Ireland
Advertising and Marketing	31.4	30.1	25.5*	26.3*	30.4	29.6	25.5	31.7	22.4	19.2*	21.0	22.2*
Architecture	5.9*	3.7*	5.6	2.8*	4.3*	6.7	5.8*	3.3*	5.8	5.9*	5.7	8.0*
Crafts	6.0*	4.7	7.8*	7.1	8.0*	3.7*	1.2*	2.7*	7.0*	8.0*	9.6	7.1*
Design: product, graphic and fashion design	8.4	8.9	9.9	13.5	6.7	8.1	9.0	7.0	9.7	6.8	6.2	7.1
Film, TV, video, radio and photography	5.2	7.1	6.8	4.9	4.6	5.4	11.4	5.2	7.8	8.9	9.7	6.0
IT, software and computer services	27.9	27.3	29.0	30.3	32.6	32.6	26.8	34.3	29.8	24.7	31.9	31.1*
Museums, galleries and libraries	5.7	7.0	6.9	4.3	5.2	6.9	10.1	7.0*	5.4*	11.1	5.2	5.7
Music, performing and visual arts	0*	2.2	2.3	2.5*	2.9	1.2	1.1	1.5	0.5	2.5*	3.6	3.7*
Publishing	9.5	8.9	6.3	8.2	5.3	5.8	9.2	7.3	11.8	12.9	7.2	9.1

Source: Annual Labour Force Survey (2019)

*Includes occupations where no figure is reported by the ONS as it is estimated at less than 500 and/or numbers are disclosed

Table 9 - Occupational Composition of Yorkshire and the Humber's Creative Workforce (2019)

	Occupation	number	Confidence interval	Male	conf	%	Female	conf	%
Advertising and Marketing	Marketing and sales directors	13,700	3,700	10,200	3,100	77	3,100	4,400	23
	Advertising and public relations directors	3,600	1,900	~	!		!	1,900	
	Marketing associate professionals	12,800	3,600	3,900	2,300	67	1,900	7,200	33
	Public relations professionals	3,300	1,800	1,700	2,500		*	~	
	Advertising accounts managers and creative directors	1,300	*	700	3,600		*	1,100	
Architecture	Architects	4,400	2,100	3,200	2,000	65	1,700	1,000	35
	Town planning officers	1,700	*	700	1,700		*	700	
	Chartered architectural technologists	!	!	~	*		!	!	
	Architectural and town planning technicians	1,500	*	~	!		!	900	
Crafts	Smiths and forge workers	~	!	~	!		!	!	
	Weavers and knitters	1,300	*	700	!		!	!	
	Glass and ceramics makers, decorators and finishers	~	!	~	*		!	!	
	Furniture makers and other craft woodworkers	3,900	2,000	4,400	*		2,000	~	
	Other skilled trades n.e.c.	5,400	2,300	5,000	*	69	2,200	700	31
Design: product, graphic and fashion design	Graphic designers	6,700	2,600	3,100	!	65	1,700	1,800	35
	Product, clothing and related designers	6,800	2,600	2,400	*		*	2,500	
Film, TV, video, radio and photography	Arts officers, producers and directors	3,800	1,900	2,600	*	62	1,600	1,200	38
	Photographers, audio-visual and broadcasting equipment operators	5,400	2,300	4,000	*	68	1,900	2,400	32
IT, software and computer services	IT business analysts, architects and systems designers	7,500	2,700	6,800	!	73	2,500	700	27

	Information technology and telecommunications directors	6,700	2,600	5,500	*	71	2,300	1,800	29
	Programmers and software development professionals	21,300	4,600	13,700	1,600	79	3,600	2,100	21
	Web design and development professionals	3,900	2,000	4,200	1,900	68	2,000	1,400	32
Museums, galleries and libraries	Librarians	2,400	*	800	1,700		!	1,600	
	Archivists and curators	700	*	~	*		!	500	
Music, performing and visual arts	Artists	3,100	1,800	700	1,900		*	500	
	Actors, entertainers and presenters	2,900	1,700	1,800	!		*	1,400	
	Dancers and choreographers	1,200	*	!	!		!	1,300	
	Musicians	1,300	*	2,800	!		*	~	
Publishing	Journalists, newspaper and periodical editors	2,800	1,700	2,500	2,000		*	1,100	
	Authors, writers and translators	6,600	2,600	1,300	2,200		*	3,900	

Source: Annual Population Survey/Labour Force Survey (2019)

! Estimate and confidence interval not available since the group sample size is zero or disclosive (0-2).

* Estimate and confidence interval unreliable since the group sample size is small (3-9).

~ Estimate is less than 500.

Table 9 show the composition of Yorkshire and the Humber's creative workforce based on the DCMS list of creative industries SOC codes. The statistics are incomplete due to figure less than 500 not being disclosed and unreliable confidence intervals, and due to roundings and confidence intervals the figures for males and females don't total the same as overall figures. We can still gain some value by analysing the data. For instance, more than half of creative occupations in the region are in 'IT, software and computer services' (29%) and 'adverting and marketing' (26%), with the lowest proportions with 6% of the region's creative workforce are 'museums, galleries and libraries' and 'music, performing and visual arts'. The amount of missing data for occupations split between male and female groupings means analysis is limited with this data, but with the data available there are no occupations where women are the majority of workers. The biggest disparity – where data is available – is for 'marketing and sales directors' with a 77-23 split.

Regional labour market data on age and ethnicity is collected by the ONS but aggregated at a level which makes it impossible to draw out information for the creative industries. A series of ongoing projects are seeking to gather data in these areas such as a UK Games Industry Diversity Census commissioned by UK Interactive Entertainment and run by the University of Sheffield. It will be interesting to see the results and build on them to develop the sector.

1.10 Enterprises

The ONS estimates there were approximately 289,000 enterprises in the creative industries in 2018. This includes businesses, charities and community interest companies. Yorkshire and the Humber accounts for 4.55% or 13,190 of these enterprises and this represents 7.2% of the region's total enterprises (ONS 2019). Almost 20% of London's total enterprises are in the creative industries. As discussed above, Yorkshire and the Humber's profile is similar to Scotland (Table 10).

Table 10 - Regional Distribution of Creative Industries Enterprises (2018)

	Enterprises	% of UK CIs	CIs as % of regional total
London	97855	33.7	19.3
South East	55085	19.0	13.6
East	27475	9.5	10.4
South West	21105	7.3	9.1
North West	19710	6.8	7.4
West Midlands	16395	5.7	7.7
Scotland	13260	4.6	7.6
Yorkshire and The Humber	13190	4.5	7.2

East Midlands	12690	4.4	7.1
Wales	5835	2.0	5.6
North East	4405	1.5	6.3
Northern Ireland	2950	1.0	4.0
Total	289955		

Source: calculated using UK Business Counts (ONS 2019)

Table 11 illustrates Yorkshire and the Humber's enterprise profile correlates to that of the UK. 'Advertising and 'architecture' make up a higher proportion of enterprises compared to the national average with 'Film, TV, Video, Radio and photography' and 'Music, performing and visual arts' representing smaller proportions.

Table 11 - Creative Industries Enterprises by Sub-Sector for UK and Y&H (2018)

	UK	Sub-sector % (UK)	Y&H	sub-sector % (Y&H)	**Y&H as % of national**
Advertising	24450	8.4	1275	9.7	5.2
Architecture	16355	5.6	960	7.3	5.9
Crafts	1300	0.4	80	0.6	6.2
Design	23295	8.0	1180	9.0	5.1
Film, TV, Video, Radio and photography	32900	11.3	1105	8.4	3.4
IT, software and computer services	145065	50.0	6600	50.0	4.5
Museums, galleries and libraries	990	0.3	60	0.5	6.1
Music, performing and visual arts	34765	12.0	1425	10.8	4.1
Publishing	10820	3.7	505	3.8	4.7
	289940		13190		

Data is available for the sub-regional distribution of creative industries enterprises and we could use this data to generate location quotients to understand geographical concentrations of firms within the region (as we did for employment in Table 6), but due to relatively low numbers it would not give robust results. Furthermore, the results would need to be interpreted with caution as there is no differentiation between a company with 3 employees and one with 20 (data about company size is presented below and in Table 13). Table 12, however, shows the percentage of enterprises in different areas of the region. The highlighted cells indicate the highest percentage in each sub-sector and

illustrates the significance of Leeds as the region's main centre for creative industry enterprises. Sheffield has particular specialism in 'craft' and 'music, performing and visual arts', and North Yorkshire has relatively high proportions of enterprises operating in 'architecture' and 'museums, galleries and libraries'.

Table 12 - Proportion of creative industries by Y&H sub-region

% of sub-sector	Advertising and Marketing	Architecture	Craft	Design	Film, TV, video, radio and photography	IT, Software and Computer Services	Museums, galleries and libraries	Music, performing and visual arts	Publishing	% of all Y&H creative industries
Kingston upon Hull	2.4	2.6	0.0	2.5	2.3	2.0	0.0	2.1	1.0	**2.1**
East Riding of Yorkshire	7.1	8.3	0.0	5.5	6.4	4.9	0.0	5.7	4.0	**5.6**
North and North East Lincolnshire	2.8	4.2	6.7	3.0	2.3	2.6	0.0	3.6	3.0	**2.9**
York	5.1	6.8	6.7	4.7	6.0	5.6	20.0	5.0	5.1	**5.6**
North Yorkshire	16.2	18.8	13.3	17.8	15.6	12.9	40.0	15.3	16.2	**14.8**
Barnsley, Doncaster and Rotherham	8.3	8.9	6.7	9.7	9.2	8.9	0.0	8.9	10.1	**8.9**
Sheffield	9.9	11.5	33.3	10.6	13.8	10.8	10.0	18.1	14.1	**12.0**
Bradford	7.1	7.3	6.7	7.6	6.9	9.1	10.0	7.5	9.1	**8.3**
Leeds	25.7	17.7	13.3	18.6	22.0	24.7	20.0	17.1	19.2	**22.4**

Reflecting the wider pattern in the UK's creative industries enterprises, Yorkshire and the Humber's are predominantly micro enterprises (94.5%). Of these micro enterprises, 88% have 0-4 employees and 12% have 5-9 employees. Small enterprises (10-49 people) account for 4.9% of the total and medium-sized enterprises account for 0.9% (50-249 people). There are 10 enterprises with more than 250 people in the data. It should be noted, however, the Office of National Statistics round figures to avoid disclosure of data which may make it possible to identify individual organisations (ONS, 2019). This includes rounding down to zero and up to ten (so not all zeros are true zeros). Half of the medium-sized enterprises are in 'IT, software and computer services' with a further ten in 'advertising and marketing', ten in 'architecture' and five in 'music, visual and performing arts'.

There are approximately 530 enterprises in the creative industries in the UK turning over more than £50m a year in the UK. Of these, 44% (235 enterprises) can be found in London with a further 10% (55 enterprises) in the South East. The East of England has 15 such companies and the North West, Scotland and West Midlands have five each, while every other region has zero. We should, again, be careful to interpret these zeros as roundings mean some zeros are not zeros. What is clear, however, is London and South East dominate on another measure. This is reinforced if we compare the figures for the creative industries with data for the economy as a whole. Accounting for all enterprises turning over more than £50m a year, only 29% are found in London and 16% in the South East.

Table 13 shows the turnover of different kinds of creative businesses based in Yorkshire and the Humber. More than 50% turnover less than £100,000 a year which is slightly greater than the UK average 48%. Of the region's creative industries enterprises, 3.1% are turning over more than £1m.

Table 13 - Businesses in Yorkshire and the Humber's Creative Industries by Turnover (2018)

%	£0-49,000	£50,000-99,000	£100,000-199,000	£200,000-499,000	£500,000-999,000	£1,000,000-1,999,000	£2,000,000-4,999,000	£5,000,000-9,999,999	£10,000,000-49,000,000	£50,000,000 and over
Advertising and marketing	18.5	20.9	32.1	14.1	7.6	4.4	1.2	0.8	0.4	0.0
Architecture	9.7	37.8	35.7	9.2	4.1	1.5	1.5	0.5	0.0	0.0
Crafts	9.1	27.3	54.5	9.1	0.0	0.0	0.0	0.0	0.0	0.0
Design	19.7	35.0	26.5	9.4	6.0	2.1	0.9	0.4	0.0	0.0
Film, TV, video, radio and photography	28.2	31.1	32.0	6.3	1.0	1.0	0.0	0.0	0.5	0.0
IT, software and computer services	14.3	36.9	38.8	4.0	2.8	1.6	1.0	0.3	0.2	0.0
Museums, libraries and galleries	25.0	0.0	25.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0
Music, performing and visual arts	22.5	25.8	38.7	9.6	3.0	0.0	0.4	0.0	0.0	0.0
Publishing	25.0	36.8	26.3	3.9	6.6	1.3	0.0	0.0	0.0	0.0
Y&H Total	**17.1**	**33.6**	**35.9**	**6.6**	**3.7**	**1.7**	**0.9**	**0.3**	**0.2**	**0.0**
UK Total	**16.4**	**31.4**	**36.8**	**6.5**	**3.7**	**2.3**	**1.6**	**0.6**	**0.6**	**0.2**

(Source: NOMIS, 2019)

1.11 Research and Education

Higher education institutions (HEIs) have an important role to play in relation to XR Stories and the creative industries more broadly. HEIs produce graduates who can work in the creative industries; postgraduate students and staff undertake research about; with and for the creative industries; many academics are creative practitioners who produce art; writing, music and other cultural products; and universities operate museums, galleries, archives and music venues. In this section we outline the research and higher education landscape which relates to the aims of XR Stories. Again, we start broadly before narrowing the focus.

There are eleven HEIs in the Yorkshire and the Humber region, spread across all constituent counties (Table 14).

Table 14 - Yorkshire and the Humber's higher education institutions

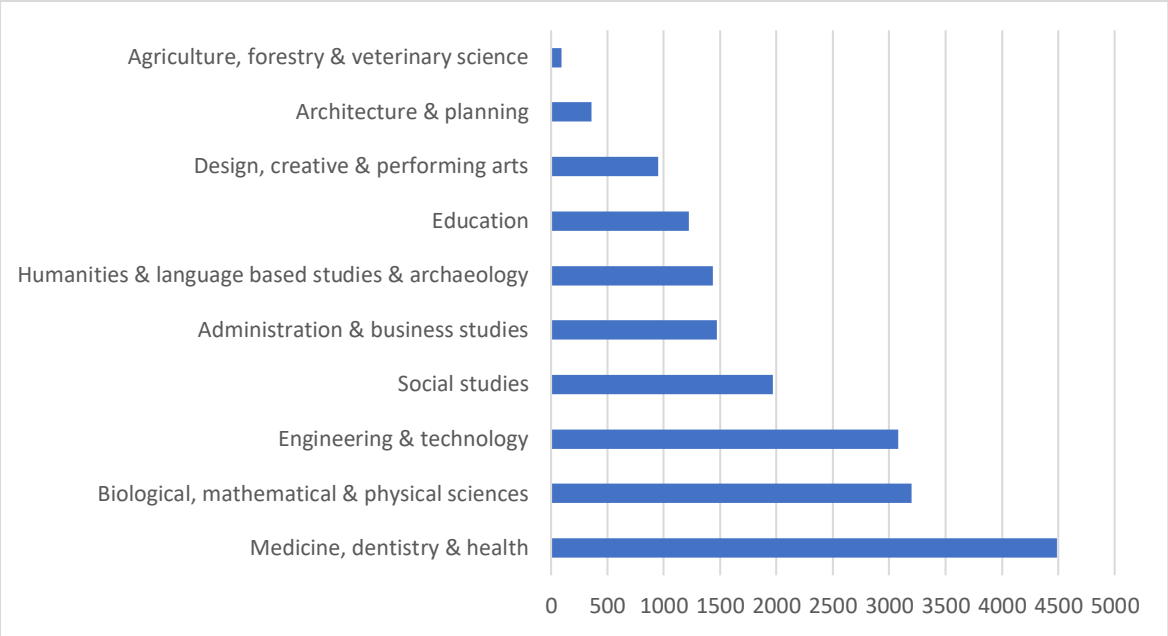
Higher Education Institution	Number of Academic Staff	Number of Undergraduate Students	Number of Postgraduate Students
University of Bradford	575	7,695	2,420
University of Huddersfield	920	14,165	4,080
University of Hull	1,025	13,390	2,200
University of Leeds	3,500	25,430	8,990
Leeds Beckett University	1375	18,615	4,995
Leeds Trinity University	175	2,725	640
Leeds Arts University	160	1,570	35
Sheffield University	3,280	19,760	9915
Sheffield Hallam University	2,025	24,320	6,410
University of York	1,860	13,810	5,010
York St John University	340	5,460	785

Source: HESA (2019)

Figure 3 shows the number of staff employed at Yorkshire and Humber HEI by ‘Cost Centre’. The medical, biological and engineering sciences each have over 3,000 employees, while the social and administrative sciences, together with the humanities

and education have between 1,000 and 2,000. Design, architecture and agriculture have the fewest employees, ranging between 90 and 950.

Figure 3 - Number of FTE Academic Staff at Y&H Universities by Cost Centre Group (2017/18)

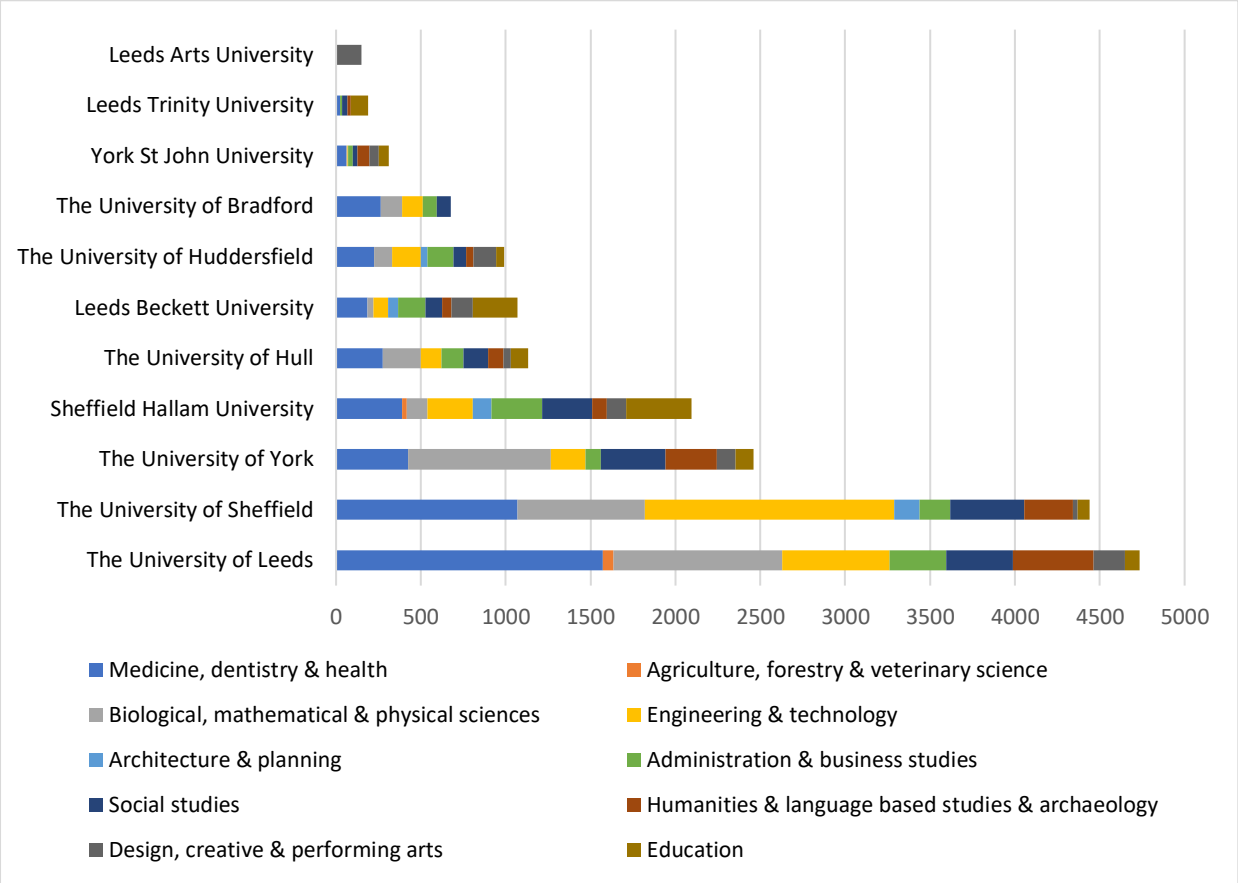


Source: HESA (2019)

Figure 4 shows the number of academic staff at Yorkshire and Humber HEI by provider and cost centre group. Only Sheffield Hallam is represented in all of the ten recognised 'cost centre groups', however, Leeds, Sheffield, Leeds Beckett and Huddersfield are represented in nine groups and Hull and York in eight. Some providers are, in contrast, highly specialised, and largely or entirely dedicated to specific cost centres (e.g. Leeds Arts University for design, creative and performing arts, Leeds Trinity for education).

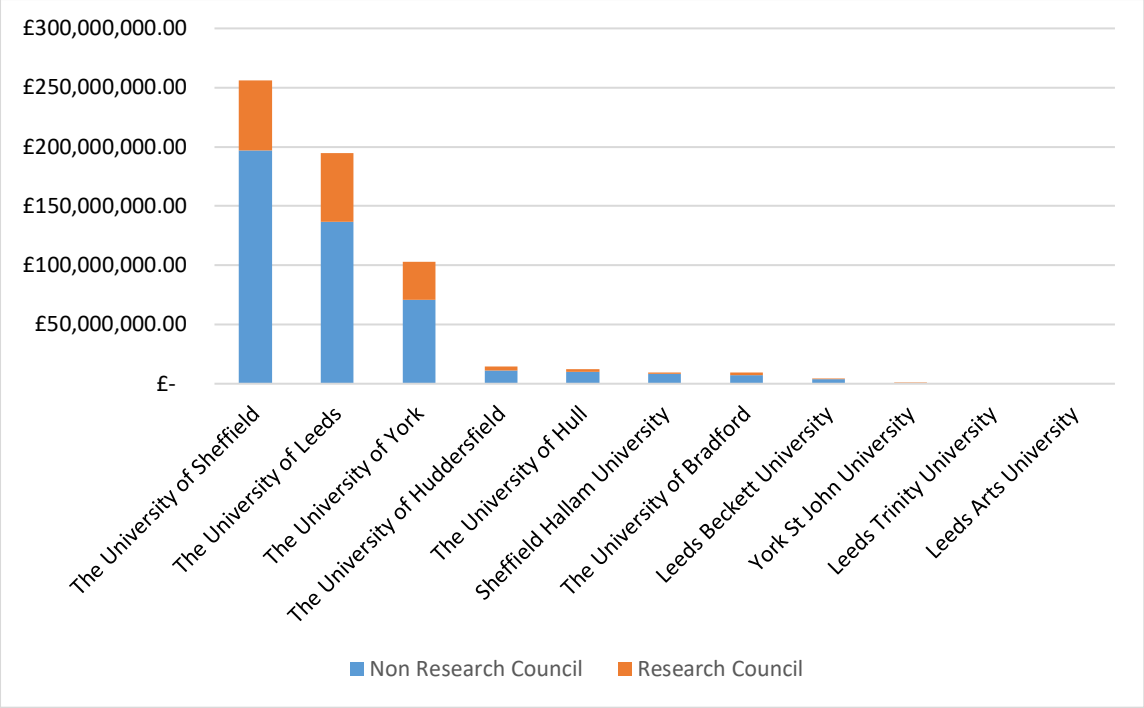
Figure 5 shows total research grants and contracts (for all academic departments) received by Yorkshire and Humber HEI. The three exceptional providers are Sheffield, Leeds and York which all secured grants that totalled between £256,288,000 and £103,215,000 in 2017/18. Every other provider received grants between £14,536,000 (Huddersfield) and £0 (Leeds Arts).

Figure 4 - Number of FTE Academic Staff at Y&H Universities by Provider and Cost Centre Group (2017/18)



Source: HESA (2019)

Figure 5 - Research Grants and Contracts Received by Y&H Universities (2017/2018)



Source: HESA (2019)

The size and strength of the region's HEIs provides an excellent foundation upon which the screen industries can draw. Screen Yorkshire identify there are approximately 2000 students enrolled on 23 screen-related courses at 23 higher and further education institutions. Given the scope of the skills required for XR media and technology development, it is important to note that disciplines such as computer science and the arts, provide an even wider potential labour pool.

We can also identify where HEI provide specific research expertise which can feed into the emergent immersive sector.

1.11.1 Immersive-related research centres at Y&H HEIs

Fourteen research groups can be identified at HEI's in the region that are directly relevant to the activities of XR Stories. Seven HEIs in the region (Leeds Trinity, Sheffield Hallam, University of Bradford, University of Huddersfield, University of Leeds, University of Sheffield, University of York) have at least one relevant research centre. The outlines below are taken from each centre's own descriptions.

Leeds Trinity University

International Research Centre for Interactive Storytelling (IRIS)

The International Research Centre for Interactive Storytelling (IRIS) has been formed to explore new and emerging methods of storytelling through media and technology. Based upon the research of its Director and Associate Director into

interactive media storytelling, our activities will involve both film production and academic research. Hence, we aim to promote dialogue between creative practice and theoretical knowledge as related forms of research work and will provide the conditions for students and researchers to realise a wide range of possible interactive projects.

Sheffield Hallam University

Cultural Communication and Computing Research Institute (C3RI)

The C3RI is all about making connections - bringing together specialisms in art, design, media production, communication studies, computing and engineering into the University's largest community of researchers. The Institute includes two Research Centres, the Art and Design Research Centre and the Communication and Computing Research Centre. The C3RI provides a business focussed consultancy and research service in communications and computing to businesses through our dedicated Knowledge Transfer team. The C3RI is also home to Design Futures, a discrete unit within C3RI delivering packaging and product design research to industry … Design Futures contributes significantly to the research delivery of the institute. Core specialist research clusters with the institute include Lab4Living and CENTRIC.

Virtual Reality Prosthetics

This exciting project, funded by the Wellcome Trust, is designed to engage the public with emerging technologies and cutting-edge multi-disciplinary research linking Biomedical Science, Psychology, Physiotherapy and Virtual Reality. We will create interactive and VR resources which enable the public to improve their understanding of joint physiology and how our brains control movements, even when using prosthetic limbs, stimulating debate about limb loss versus views of ‘normality’.

University of Bradford

Centre for Visual Computing

World-class research and development in visual image data processing, bridging the business and academic worlds. The Centre has a unique dual focus. Our research projects change the way we compute visual image data; our commercial projects address real business problems and deliver practical applications for our industry partners. With a strong interdisciplinary focus, our research activity brings together three areas of expertise – computational, physiological and psychological – in order to make advances in fields as diverse as visual media, biometrics, security and computer gaming.

Communication, Culture and Media (CCM) Research Group

A particular strength of the work of the CCM Research group is that it takes place within the Faculty of Engineering and Informatics. The fact that researchers at Bradford in the field of culture, communication and media studies work so closely with colleagues in mobile telecommunications and computing is relatively unusual in UK institutions but is more common at institutions in the US and Europe. This arrangement enables and encourages innovative research in the field of new, interactive and mobile media, already showcased in research funding awarded by the European Community, UK Research Councils and the Arts Council. We believe that this close relationship between theory and

technology is strategically vital to future research in the rapidly changing field of digital media.

University of Huddersfield

Centre for Visual and Immersive Computing

The Centre for Visual and Immersive Computing (CVIC) focuses on regional and international dimensions of knowledge/technology innovation, application and practice development, academic networking, and social service innovation. It investigates research concepts, algorithms and systems in VIV domains for the development of seamless communication mechanisms between humans and computer systems. Examples include the use of image processing to detect security threats from CCTV and the application of cognitive and engineering psychology to facilitate human behaviour in socio-technical systems.

University of Leeds

Centre for Immersive Technologies

The Centre for Immersive Technologies works with partners from the public and private sectors to drive innovation. We work across a range of disciplines to help companies and organisations use virtual reality and augmented reality for maximum benefit and competitive edge. Our evidence-based approach helps organisations to see the advantages and potential pitfalls of immersive technologies, enabling them to make informed choices.

University of Sheffield

Sheffield Robotics

The world is standing on the verge of a revolution in robotics. The kind of life-changing innovations we've been dreaming about for decades are now only steps away. Sheffield is taking those steps: through responsible, ethical research, we are pioneering new products and processes that will transform the world by changing manufacturing, healthcare, infrastructure and our understanding of the human condition. The age of academics working in isolation is over. To make amazing things happen, we have to work together in teams that cross traditional boundaries. Our interdisciplinary approach makes us faster, more flexible, and better informed. Our research involved investigators in every faculty at both the University of Sheffield and Sheffield Hallam University.

Visual Computing

The Visual Computing group includes computer graphics and animation, vision computing, and complex systems simulation allied to rendering and visualisation. In computer graphics and animation, we mix programming, mathematics and visual creativity, with interests in simulating the human face, with its intimate link between modelling and animation, the processing and visualisation of point cloud data and its associated meshes, and the production of interactive experiences in augmented and virtual reality. In the simulation area, we utilize graphics hardware (GPUs) to provide

scalable software solutions for science and engineering problems, for example simulating pedestrians and traffic in a city area.

University of York

Centre for Digital Heritage

The objectives of the Centre are to undertake research and knowledge exchange in: data and information management and preservation of digital data; the use of digital media (including Internet and computer games technologies, and video and sound) for the dissemination and publication of cultural heritage; data mining and information extraction, including natural language processing, to analyse, index and interpret cultural heritage texts; mobile applications for cultural heritage recording and presentation; augmented reality and virtual reality modelling, including both acoustic and 3D modelling, of cultural heritage resources; the impact of digital media on the public interaction with the cultural heritage, both tangible and intangible.

Centre for the Study of Christianity and Culture

Many people are fascinated by the rich cultural heritage to be discovered in art, literature, music and historic buildings. However the fact that so much of this heritage has been substantially shaped by Christian belief and practice can pose a major problem of access and understanding for those who lack familiarity with Christian concepts or biblical themes … CSCC undertakes large research projects and is recognised as a leading centre in the area of 3D digital visualisation which it employs as both as a research tool and in working with important historic churches to bring recent research to life through innovative interpretation schemes.

Human Computer Interaction Group

HCI@York is a dynamic, collaborative community that conducts world-class research and teaching in how diverse groups of users interact with technology. We draw from computer science, psychology and design to investigate how to create positive user experiences, and to drive forward the research methods of our field. HCI@York prides itself on its diversity in both research topic and the users groups with whom we work. In the group, we have specialists working across the topics of usability, user experience and accessibility. In many of our projects we are not only pushing forward in how to design and evaluate systems, but also in the validity of the methods used in Human Computer Interaction. Within our research portfolio, we have projects across a range of domains including: inclusive design, player experience in digital games, design for health and well-being, usable security, design for heritage and design for heritage.

Digital Creativity (DC) Labs

Digital Creativity Labs brings together over 100 partners and 30 researchers from multiple disciplines to deliver impact from research in the games and media industries. Building on a major (£18 million) investment by three UK research councils, four universities, and over 80 collaborative partner organisations from industry, government and the third sector, we bring together over 30 world-class researchers across creative and scientific

disciplines and take a multidisciplinary approach to tackling research challenges with a focus on real-world impact. We provide our partners with new perspectives, leading to highly innovative ideas, technologies and solutions. Engaging with us provides a valuable opportunity for organisations to access valuable resources to address business concerns, empowering them to build technologies which drive new user experiences, interact with customers in new ways, reach new markets, gain customer insights, and make better decisions using techniques from Artificial Intelligence, Data Analytics, User Experience Design, Psychology, Sociology and other areas of the sciences, arts and humanities.

WEAVR

The Weavr Consortium has answered UK Research and Innovation's call to look at Audiences of the Future, with a groundbreaking demonstrator project exploring a cross-reality, data driven, highly personalised viewing experience for esports. The consortium consisting of ESL, York University, dock10, Cybula, Focal Point VR & Rewind will operate a £5.8M project over two years, £4M of which is funded by UK Research and Innovation. UK Research and Innovation (UKRI), the UK Government's non-departmental public body for innovation and research, has awarded the Weavr Consortium a two-year demonstrator grant that focuses on esports broadcasting, as part of the Industry Strategy Challenge Fund (ISCF). The ISCF's "Audience of the Future" challenge looks to bring the UK's creative businesses, researchers and technologists together to create the next generation of highly immersive experiences.

In chapter 7 we highlight how the region's HEIs have contributed to XR Stories through the first round of collaborative research and development grants, as we begin to examine what we define as Yorkshire and the Humber's immersive sector.

5. Screen Industries

The focus of XR Stories is on digital storytelling using immersive media and technology. Storytelling is central to human activity, a key way humans make sense of the world and the screen industries are the latest in a long line of technologies and cultural practices committed to the creation of stories. Film, TV, video, computer games and other interactive media increasingly tell stories digitally, but such technologies are changing rapidly, enabling new modes of creation, new approaches to storytelling, and new experiences for audiences and users. The future of the screen industries, then, requires individuals and organisations to keep pace with changing technologies and innovations in storytelling to make the most of the opportunities of immersive media and technologies can afford.

The screen industries are central players in the development of digital storytelling and in this section we narrow our focus from the creative industries to those sub-sectors which make up the screen industries.

1.12 Yorkshire and the Humber's Screen Industries

The screen industries are broadly defined as film, TV, computer games and interactive media. Various organisations in the UK are tasked with developing the screen industries and the precise definition of which activities and products count as 'screen' differs between them. The British Film Institute, for instance, focuses on film, TV and computer games with animation activities stretching across these areas. Screen Yorkshire include these areas plus radio activities. Screen Skills, the UK's skills body for what they label as "screen-based creative industries", focuses on animation, film, games, television, VFX and immersive technology (ScreenSkills 2019). The differences are, in part, due to the evolving nature of the creative industries and the need for new areas to be represented by stakeholder bodies, and for established areas to maintain representation. Local, national and internal industry politics, and the historical evolution of activities in difference places also play a part.

Taking Screen Yorkshire's broad definition, employment in Yorkshire and the Humber's screen industries is 6,365 with almost half of those. There are 865 enterprises in the sector, half of which are in film, TV and video-related activities (ONS 2019). These figures are a useful starting point but limited in explanatory value as they only include people employed by enterprises and employment in the sector is dominated by freelancers. Furthermore, it only counts enterprises based in Yorkshire and the Humber and thus cannot capture the geographically flexible nature of work in the production of film and TV productions and the mobility of staff. In addition, the production of computer games does not exhibit agglomeration in the same way as many other areas of the creative economy due to the nature of its production and the timescales involved (Vallance 2011; Vallance

2014). Examining clusters of employment for the screen industries, therefore, provides only limited understanding of value created by Yorkshire and the Humber companies with production networks stretching beyond the region.

Screen Yorkshire have measured the financial value of the region's screen industries and estimate film and TV companies to have an annual turnover of over £420m in 2015 (Screen Yorkshire 2017). They have also estimated the growth of the sector between 2009 and 2015 was the fastest growing in the UK: gross value added increased 242% (compared to 120% for the UK); employment grew 56 percentage points more than the UK average (88% vs 32%); and the number of enterprises increased 10 percentage points more than the UK trend (57% vs 47%).

At the time of writing the Office of National Statistics could not provide detailed regional turnover figures due to resource constraints, but Table 15 gives an indication of key areas relating to screen-related activities. This data indicates there has been significant, if fluctuating, growth since Screen Yorkshire's estimate to 2015. SIC codes 59.1, 58.2, 74.2 and 90 group together a series of sub-codes, some of which are not directly part of the screen industries as defined by Screen Yorkshire or BFI, but likely overlap with work in this sector (see Annex 1 for details). It should also be noted that 'Ready-made interactive leisure and entertainment software development' (SIC 62011), which encompasses computer games companies, is not included as in the data made available to us it is aggregated into SIC 62 which includes general software programming, IT consultancy and computing facilities management. These other areas have very high turnover figures and would skew the data.

Table 15 - Turnover of screen and screen-related activities in Yorkshire and the Humber

SIC Code		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
59.1	Motion picture, video and television production activities	90	122	*	276	330	348	350	419	382	434
60.2	Television programming and broadcasting activities	*	*	6	8	15	12	80	130	*	*
58.2	Software publishing	62	32	44	55	117	*	*	102	98	101
74.2	Photographic activities	98	80	70	56	61	52	56	64	75	60
60.1	Radio broadcasting	*	*	*	46	58	38	44	42	*	*
90	Creative, arts and entertainment activities	240	*	145	163	150	155	178	138	172	143

* indicates information suppressed by the Office of National Statistics to avoid disclosure.
(Source: ONS, 2019)

1.13 Employment

There were just over 160,000 people employed in the UK screen industries in 2018. Nearly 55% of these were in London with Yorkshire and the Humber accounting for 4% of this or 6365 people (Table 16). Above we compared Yorkshire and the Humber's employment profile to Scotland, but for the screen industries it diverges. This is likely because of the production apparatus that comes with national broadcasting responsibilities.

Table 16 - Regional Employment in the Screen Industries (2018)

	Number	%
London	86,950	54.3
South East	16,100	10.0
North West	14,375	9.0
East	8,220	5.1
Scotland	7,355	4.6
South West	7,000	4.4
Yorkshire and The Humber	6,365	4.0
West Midlands	4,920	3.1
Wales	4,790	3.0
East Midlands	2,585	1.6
North East	1,540	1.0
Great Britain	**160200**	

Source: BRES (2019)

If we look more closely at the activities which constitute the region's screen industries we can see 'motion picture projection activities' is the largest employer, followed closely by 'television programming and broadcasting activities' and 'radio broadcasting' (Table 17). The figures for all the television-related activities will likely see an increase over the next few years with Channel 4's move to Leeds and related investment from Sky Studios. To understand employment in computer games it is sensible to combine 'publishing of computer games' with 'ready-made interactive leisure and entertainment software development' given the overlap with these SIC codes.

Table 17 - Employment in Great Britain's and Yorkshire and the Humber's Screen Industries (2018)

Screen Industries Activity	Great Britain	Yorkshire and The Humber	Y&H as a percentage of GB
Motion picture production activities	23640	600	2.5%
Motion picture, video and television programme post-production activities	10495	125	1.2%
Motion picture distribution activities	5840	15	0.3%
Motion picture projection activities	21500	1,500	7.0%
Video production activities	6725	250	3.7%
Video distribution activities	500	10	2.0%
Television programming and broadcasting activities	24670	1,250	5.1%

Television programme distribution activities	1805	0	0.0%
Television programme production activities	35475	1,000	2.8%
Radio broadcasting	14875	1,250	8.4%
Publishing of computer games	2125	15	0.7%
Ready-made interactive leisure and entertainment software development	12550	350	2.8%
Total	**160200**	**6,365**	

Source: BRES (2019)

If we look at the growth of employment in the region, we can see the screen industries have grown significantly faster than the country as a whole with employment more than doubling between 2015 and 2018 (Table 18). Six areas of activity have grown more than 200%: TV programming and broadcasting (614%), video production (400%), post-production (257%), film production (243%), radio (213%) and film distribution (200%). It should be noted that the numbers fluctuate in this period

Table 18 - Employment change in the Great Britain and Yorkshire and the Humber Screen Industries

	GB 2015	GB 2018	% change	Y&H 2015	Y&H 2018	% change
Motion picture distribution activities	5,000	6,000	20%	5	15	200%
Motion picture production activities	23,000	24,000	4%	175	600	243%
Motion picture projection activities	20,000	22,000	10%	1,250	1,500	20%
Motion picture, video and television programme post-production activities	13,000	11,000	-15%	35	125	257%
Publishing of computer games	1,500	2,250	50%	10	15	50%
Radio broadcasting	11,000	14,000	27%	400	1,250	213%
Ready-made interactive leisure and entertainment software development	10,000	13,000	30%	150	350	133%
Television programme distribution activities	700	1,750	150%	0	0	
Television programme production activities	30,000	36,000	20%	700	1,000	43%
Television programming and broadcasting activities	26,000	24,000	-8%	175	1,250	614%
Video distribution activities	700	500	-29%	0	10	
Video production activities	5,000	7,000	40%	50	250	400%
	145,900	**161,500**	**11%**	**2,950**	**6,365**	**116%**

As we did above, we can use ONS data to understand the status of employees in the screen industries (Table 19). A much smaller percentage of workers in the region are full-time in the screen industries (63.8%) compared to the creative industries as a whole (73.6%). The highest proportion of full-time employees can be found in TV programming and broadcasting (93%) and radio broadcasting (81.6%).

Table 19 - Status of Screen Industry Employees in Yorkshire and the Humber (2018)

	Full-time	%	Part-time	%
Motion picture production activities	350	53.8	300	46.2
Motion picture, video and television programme post-production activities	50	40.0	75	60.0
Motion picture distribution activities	5	33.3	10	66.7
Motion picture projection activities	350	25.9	1000	74.1
Video production activities	100	40.0	150	60.0
Video distribution activities	5	50.0	5	50.0
Television programming and broadcasting activities	1000	93.0	75	7.0
Television programme distribution activities	0		0	
Television programme production activities	700	73.7	250	26.3
Radio broadcasting	1000	81.6	225	18.4
Publishing of computer games	5	50.0	5	50.0
Ready-made interactive leisure and entertainment software development	300	75.0	100	25.0
Total	**3865**	**63.8**	**2195**	**36.2**

Source: BRES (2019)

1.13.1 Freelancers

The screen industries rely on a large number of freelancer workers. BFI analysis of ONS Annual Population Survey Data shows that in 2018, 45% of those engaged in film and video production, a total of more than 31,000 people, were self-employed (Table 6). In comparison, only 15% of the total UK workforce was self-employed in 2018 (BFI Statistical Yearbook 2019: Education and Employment). However, at the moment there are no national statistics available for earnings of the freelance workforce as they are not covered by the Annual Survey of Hours and Earnings (ASHE). More granular details and breakdowns of the use of freelancers is an area that will require more in-depth exploration as data is presently scant.

An indication can be ascertained, however, from the ScreenSkills Employer Survey (2019). The numbers at a regional level for Yorkshire and the Humber are small so should be treated with an element of caution however they do provide some useful insights. It showed that 86% of organisations working in the screen sector in Yorkshire and the Humber work with freelancers. Of those that use freelancers 78% of organisations reported using them Very Frequently (28%) or Frequently (50%). Freelancers were used for grades that were reported as Experienced (83%) or Expert (78%) showing that it was mostly for more established/ later career individuals that are called upon. Key reasons for the use of freelancers were that they provide greater flexibility (78%), they are a good fit for short term projects (78%), they provide talent that is not available in the organisations own work force (61%). The reason by freelancers are used by companies relate to the flexibility of a contingent workforce and being able to bring in people with particular specialisms on a temporary basis that an organisation does not have in-house.

Whilst this gives an indication of the use of freelancers in Yorkshire and the Humber it is worth reiterating that this is based on a small sample of companies, and due to the flexible nature of freelance workers, many may work across regions and this activity would not be captured by looking exclusively at organisations based in Y&H. Indeed, it is widely recognised there is a shortage of skilled freelancers in film and TV which contributes to their mobility, which itself is differentiated by role and the kinds of productions on which they work. For example, Hollywood films and high-end television with large budgets can afford to employ the most experienced and/or most talented people and can pay for accommodation and travel to ensure they are where they are needed. In contrast, serial dramas such as soaps are more likely to use local crew in the production phase. Moreover, the type of personnel required on different productions varies.

This is an area in which further research will be required to get a fuller picture of activity. A conclusion from the Annual ScreenSkills Assessment 2018-19 was that further research was needed to better understand the working patterns and earnings of freelancers, as well as any challenges they might face. While research of this kind is already undertaken in for instance broadcast TV, future research on freelance work should be undertaken for each of the subsectors of the industry.

1.14 Businesses

Using screen SIC codes, we can identify 27,820 enterprises in the UK. Following the pattern identified above, almost 50% of these are based in London with the South East having a further 16.5%. Yorkshire and the Humber has 3.1% of the sector, placing it 7th in the UK with 865 enterprises (Table 20).

Table 20 - Screen Industries in the UK's Regions (2019)

	N	%
London	13425	48.3
South East	4580	16.5
East	2095	7.5
South West	1695	6.1
North West	1460	5.2
Scotland	945	3.4
Yorkshire and The Humber	865	3.1
West Midlands	855	3.1
Wales	720	2.6
East Midlands	655	2.4
Northern Ireland	270	1.0
North East	260	0.9

United Kingdom	**27820**	**100**

Source: UK Business Counts (2019)

In section Enterprises1.10 we highlighted how the profile of enterprises in Yorkshire and the Humber's creative industries corresponds to that of the UK. Table 21 illustrates the region, again, correlates to the UK profile. There are important differences, however, with Yorkshire and the Humber having no enterprises defining themselves as undertaking television distribution. The region also has a much higher proportion of computer games companies with 11% of the sector working in 'Ready-made interactive leisure and entertainment software development'. Only the North East (13.5%), West Midlands (12.3%) and East Midlands (11.5%) have higher proportions. Nearly 6% of the region's screen industries enterprises defining themselves as 'television programming and broadcasting activities', and this is the second highest proportion in the UK (only the West Midlands has a higher proportion).

Table 21 - Screen Industries Enterprises by Sub-Sector for UK and Y&H (2018)

	United Kingdom	**%**	**Yorkshire and The Humber**	**%**
Motion picture production activities	8415	30.2	225	26.0
Motion picture, video and television programme post-production activities	2965	10.7	65	7.5
Motion picture distribution activities	430	1.5	5	0.6
Motion picture projection activities	275	1.0	15	1.7
Video production activities	4185	15.0	170	19.7
Video distribution activities	105	0.4	5	0.6
Television programming and broadcasting activities	1155	4.2	50	5.8
Television programme distribution activities	160	0.6	0	0.0
Television programme production activities	7400	26.6	180	20.8
Radio broadcasting	795	2.9	40	4.6
Publishing of computer games	320	1.2	15	1.7
Ready-made interactive leisure and entertainment software development	1615	5.8	95	11.0
	27820		**865**	

Source: UK Business Counts (2019)

1.15 Physical infrastructure

The region is well-served for location shooting with a huge range of location types available including: urban and neighbourhood locations in the major towns and cities;

rural landscapes including the Yorkshire Dales, North Yorkshire Moors and coast; natural features including Brimham Rocks, Malham Cove and Humber Estuary; and historic locations for period filming including country houses, traditional villages and industrial landscapes. One drawback is that many of the urban landscapes' unique vernacular style means they cannot double for other cities. The ability to look like other places is one of the factors which has made Vancouver a successful filming location.

Yorkshire and the Humber has reasonable studio facilities. Northern Film and TV Studios, located near Doncaster, offers the largest single production stage in Northern England with 48,000 sq. feet plus a neighbouring stage of 30,000 sq. feet. The complex also has workshops, meeting rooms and external spaces for scenery assembly and filming. Church Fenton, a former RAF base between Leeds and York, has almost 100,000 sq. feet of space in three hangars. It also has over 400 acres of land which can be used for filming, plus workshops and offices. Prime Studios in central Leeds offers four sound stages totalling 11,500 sq. feet for smaller scale film, TV and commercial shoots, together with offices, makeup, wardrobe and screen facilities. Channel 4's new headquarters is currently being built in Leeds, and this has spurred development of new studio space nearby (LEP 2019). Higher and Further education institutions also have production space and equipment available for hire. For example, The Department of Theatre, Film, Television and Interactive Media at the University of York has industry standard studio and production facilities available for use by the screen industries. Their facilities include two TV studios, visual and audio editing suites, rehearsal space and a multi-purpose 'black box' sound stage. Selby College has facilities available and the Leeds Trinity has production spaces available for hire.

1.16 Industry Stakeholders

There are a series of industry stakeholders working in the Yorkshire and Humber Region or at a national level that are actual or potential project partners. Some of the key ones are outlined below in their own words.

Game Republic

Game Republic Ltd runs the two largest networks in the North of England – Game Republic and GaMaYo – and is backed by more than two decades of games industry experience from Managing Director Jamie Sefton and 20 years of project, research and events industry experience from Jackie Mulligan. Game Republic Ltd specialises in four areas. Events: From brief to content, planning, research and delivery, Game Republic Ltd has a successful track record in producing and programming games content for games, tech and digital conferences, expos and festivals that entertain, educate, deliver audiences and gain media interest.

Immerse Sheffield

Immerse Sheffield is a meetup for those working, or simply interested in the growing immersive technologies sector in the Sheffield City Region. Sheffield is home to a hotbed of innovative companies and businesses that are exploring the application of Virtual and Augmented Reality technology in fields ranging from data analysis to medicine to entertainment. We wanted to create a space where people can come together and learn from each other, discuss challenges they've overcome in exploring how to interact in the virtual world.

Screen Yorkshire

Screen Yorkshire's ambition is to grow a world-class screen industries hub of international significance in the Yorkshire & Humber region. We deliver this vision by investing financially in productions; developing talent to create a skilled workforce; building best-in-class studios and fostering Yorkshire's global reputation as an outstanding location for creatives. Established as one of nine regional screen agencies by the UK Film Council in 2002, we've been around for almost two decades. We launched our first production fund in 2003 which went on to invest in iconic British films like the BAFTA-award-winning This is England. In 2011 Screen Yorkshire became a stand-alone private company specialising in commercial content investment and establishing the Yorkshire Content Fund (YCF), which to date has brought over 40 productions to Yorkshire and Humber.

York Meidale

York Mediale is an international media arts festival which celebrates York as the UK's first and only UNESCO Creative City of Media Arts. We are an independent, not for profit arts organisation founded in 2014 to celebrate the designation of York as the UK's first and only UNESCO Creative City of Media Arts. Every two years, we deliver an international media arts festival, the first of which took place in October 2018. With audiences of 65,000 and a further 91 million reached online, we soon became the UK's largest media arts festival. As well as bringing new commissions from leading artists to the city for the festival, we provide opportunities for the best emerging talent to showcase their art. Through incorporating technologies into their works, artists of all kinds will challenge, provoke, interrogate and celebrate our cities, our landscapes and our lives.

Immerse UK

Immerse UK brings together industry, researchers and research organisations, the public sector, entrepreneurs, innovators and end users to support the UK in becoming the global leader in applications of immersive technologies: high-end visualisation, virtual, mixed, and augmented reality, haptics and other sensory interfaces with data. It is free to join and by signing up you become part of our Immerse UK members directory and community and are featured on our UK website so others can find out more about what you do.

Digital Catapult

Advanced digital technologies can accelerate growth and increase productivity across the UK economy. To help reach this full potential Digital Catapult, in 2017 alone, has had meaningful engagements with 638 startups and scaleups, 42 new industrial collaborations and 31 new academic engagements to drive innovation and adoption of advanced digital technologies. To make this happen, Digital Catapult delivers three core technology programmes, across two industry sectors, driven by three regional centres and a national centre in London.

Creative XR

CreativeXR developed by Digital Catapult and Arts Council England, is designed to help content creators develop more ambitious prototypes and explore new ways of storytelling enabled by immersive technologies. Since its inception CreativeXR has supported selected teams in two phases of the programme, from prototype funding through to funded projects. CreativeXR gives creative talent the opportunity to experiment with immersive technologies to create new experiences that inspire audiences. Focused on the creative industries, particularly the arts and culture sector, the programme gives the best creative teams the opportunity to develop concepts and prototypes of immersive content (virtual, augmented and mixed reality). The programme offers access to early stage finance, facilities, industry leaders and commissioning bodies, and the opportunity to pitch for further development funding.

UKIE

UKIE (UK Interactive Entertainment) is the only trade body for the UK's games and interactive entertainment industry. We are a not-for-profit and represent businesses of all sizes from small start-ups to large multinational developers, publishers and service companies, working across online, mobile apps, consoles, PC, eSports, VR and AR. Meet the team members who are at your service. Everything we do helps to support, grow and promote our members' businesses and the wider UK games and interactive entertainment industry by making sure we have the right economic, cultural, political and social environment needed for businesses to thrive.

Creative Industries Federation

The Creative Industries Federation is the membership body which represents, champions and supports the UK’s creative industries. Through our unique network of creative organisations, our influential policy and advocacy work and our extensive, UK-wide events programme we support and celebrate the work of our members. Our membership network comprises more than 10,000 individuals from creative organisations, businesses and educational institutions throughout the UK. We are influential advocates on the issues that matter most to our creative community; creative careers and skills, the impact of Brexit and the importance of entrepreneurship and growth. We bring together our members to facilitate valuable connections and collaborations that generate new ideas and foster both artistic and commercial successes. By protecting the success of our

sector, the fastest growing in the UK, we contribute to the strength of the UK economy as a whole. Independent. Authoritative. Fearless.

Film Hub North

Film Hub North is network of organisations committed to fostering a vibrant, flourishing film culture in the North of England. Led in partnership by HOME, Manchester, Showroom Cinema, Sheffield and Tyneside Cinema, Newcastle upon Tyne, we support and represent a wide-ranging group of exhibitors and filmmakers throughout the region. Working across Cheshire, County Durham, Cumbria, Greater Manchester, Lancashire, Merseyside, Northumberland, North Lincolnshire, Tyne & Wear and Yorkshire, we distribute National Lottery funds on behalf of the BFI Film Audience Network and BFI NETWORK. We provide funding and training that helps exhibitors expand their reach, develops local filmmaking talent and, ultimately, ensures that audiences in the North have access to a rich variety of cinema.

6. Social Network Analysis of the Creative Industries

1.17 Introduction

The screen industries are crucial to the development of immersive and interactive storytelling, but it is important any consideration of people and enterprises involved in immersive media and technologies does not focus simply on screen-oriented media, technologies and expertise. Visuals are powerful elements for immersive experiences, but sound, touch, smell, taste and motion all play key roles, whether on their own or in combination with other dimensions. Focusing solely on physical screens could also be detrimental to achieving presence within immersive experiences. Moreover, we should not ignore non-digital technologies in the generation of immersive media and development of immersive technologies which interact with the physical world. Many of the competencies to develop and combine these elements exist within the screen industries, but more can be found in other areas of the creative industries and even beyond them. As seek to understand more about the immersive and interactive storytelling sector, we are open to these other areas of work.

One way to try and identify areas which might relate to a nascent creative immersive sector, it to understand more about the creative industries themselves, particularly the interrelationships therein. This is something the DCMS and ONS data outlined above fails to capture as organisations and individuals are classified into single categories. In this section we use social network analysis (SNA) to delve into the interrelationships inherent in the creative industries.

1.18 Using Social Network Analysis

Using SNA we can learn more about the interrelationships within Yorkshire and the Humber's creative industries. SNA is an approach which creates networks that can be analysed to reveal insights about the nature of the network and its constituent elements. To understand the creative industries this can be done in a number of ways, including using buyer-supplier relationships and collaborations to trace production networks. This kind of data is difficult to find in secondary sources beyond credits for films and TV programmes (via the Internet Movie Database), and generating it is a costly process. In contrast, data is readily available about how enterprises define themselves in relation to SIC codes and graphing this in social network analysis software can reveal communities of activity without transactional data. For this we can use the FAME (Financial Analysis Made Easy) database that draws information from Companies House returns made by enterprises when they must select up to four SIC codes to identify what they do.

This information is not always reliable, however, for a number of reasons. First, the codes can go out of date as the economy evolves and new activities emerge. For instance, FAME (like the DDCMS) uses the 2007 codes and thus are least 12 years old at the time of writing. Second, the reliability of the data depends on accurate reporting and updating of codes by companies. Third, using filter must be done carefully. For instance, FAME allows you to filter by location, using the registered address of an enterprise to define particular geographies. Three options are available when filtering by location: a) where an enterprise is registered (usually the address of its head/main office, b) the primary trading address of an enterprise or c) trading addresses. Using trading addresses reveals the places in which an enterprise has a presence, but this can be misleading as the level of activity undertaken at a trading address is unknown. Moreover, large companies have trading addresses in many locations which means unpicking the geography of those companies is difficult. Finally, the results from FAME can fluctuate day-to-day depending on the status of enterprises in the Companies House API. These changes are minor and don't impact the analysis significantly, but we should be aware of them.

Despite these drawbacks, the data is still a very useful resource to understand activities of enterprises. For this analysis, we downloaded data from FAME for enterprises with a registered and/or primary trading address in the Yorkshire and the Humber region that have at least one creative industries SIC codes. The data was downloaded in mid-October 2019 and returned information for 19,575 enterprises. This is a greater number than shown in Table 11, a consequence of the different methodologies used by FAME and the ONS, and how we filtered the data. The result is that the data from FAME captures companies that might be considered on the periphery of the creative industries as they have one or more SIC code beyond the DCMS creative industries definition. The reliability of correctly identifying SIC codes discussed above can lead to some confusing allocations due to errors or misfilings. For example, there is a company which is registered as 'Production of Electricity' and 'Business and domestic software development'. Some online research reveals the company doesn't produce electricity but provides electrical engineering solutions.

What is more interesting are the code combinations which don't appear to be mistakes as these reveal the overlaps the creative industries have with other parts of the economy. For instance, there is a company in Leeds is registered as 'non-scheduled passenger air transport' and 'support activities to performing arts' – based on their website this doesn't appear to be a misfiling because they are a music management company who also organise tours for their artists. There is a Ripon-based charity who are registered as 'Cultural Education' and 'Plant Propagation'. Again, this does not appear to be a mistake as they are a garden and sculpture park whose purpose is to provide education. To draw on Michael Porter's competitive diamond which is so popular with policy-makers, but less so with academics (Martin and Sunley 2003; Swords 2013), these non-creative industries codes indicate 'related and supporting industries' and can be informative for regional

development strategies. This is not the focus of this report but will form part of ongoing XR Stories research.

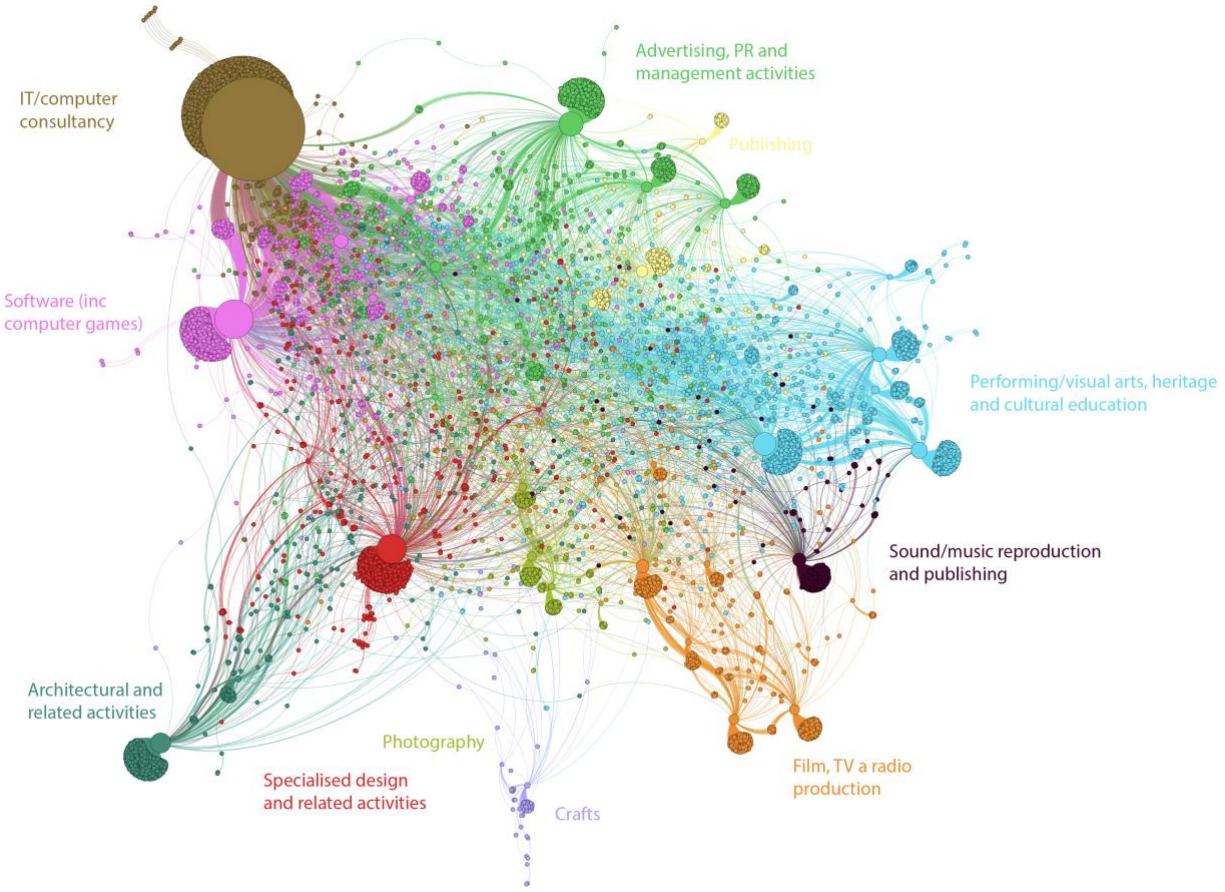
Using this data we created a network which connects enterprises to their SIC codes and visually represent this using Gephi, a social network analysis program. Gephi plots nodes (in this case enterprises and SIC codes) and connections (or edges) between them (in this case an enterprise's connection to a SIC code). The software allows you to statistically analyse and manipulate networks based on the network's properties using a series of calculations and algorithms. Figure 6 was created using a combination of these. First, the number of connections for each nodes was calculated and this information was used to change the size of nodes with the large ones having more connections. Second, a modularity calculation was performed to detect communities within the network based on the connectedness of nodes. Nodes with similar sets of connections are identified as within the same community and this information is represented with colours. Finally, the network layout was determined using an algorithm called ForceAtlas 2 which simulates a kind of gravity based on shared connections. Nodes (e.g. companies) with the same connections to other nodes (e.g. SIC codes) are attracted to one another.

The result of the manipulations explained above is a visual representation of the region's creative industries and the relatedness of enterprises based on their reported SIC codes. Beyond the direct connection between an enterprise and SIC codes, the position and colour of a node in the network can be read as its relationship to other nodes. Nodes which are near one another and/or are the same coloured indicates a degree of similarity. Position in the overall network indicates membership of a community of similar activities or distance from other communities. It should be noted that peripherality in the network can be a result of an enterprise's specialism in that they only connect to one SIC code so is only pulled in one direction by the ForceAtlas 2 algorithm.

1.19 Results of Social Network Analysis

The SNA graph can be seen in Figure 6. The communities identified by the software have been labelled based on the key creative industries activities found within them.

Figure 6 - Social Network Analysis of Yorkshire and the Humber's Creative Industries



The SNA test of modularity identifies eleven different communities which resemble much of the DCMS categorisation but there is some separation. Table 22 illustrates where there is alignment between the communities identified in the SNA and DCMS groupings. There is complete alignment for ‘advertising and marketing’, ‘architecture’, ‘crafts’ and ‘design’ but divergence in the others. Codes found in the DCMS ‘film, TV, video, radio and photography’ grouping split into three communities: ‘film, TV and radio’; ‘photography’; and ‘performing/visual arts, heritage & cultural education’. The DCMS ‘IT, software and computer services’ grouping split two: ‘software (including computer games)’ and ‘IT/computer consultancy’. All the codes in ‘museums, galleries and libraries’ and ‘music, performing and visual arts’ are found in a single community except sound recording and music publishing activities which forms a community on its own. Part of the DCMS ‘publishing’ grouping (two SIC codes) is found in the ‘advertising, PR & management activities’ community with the rest forming a general ‘publishing’ one.

Table 22 – DCMS Creative Industries Sub-sectors and SIC Code Groupings

DCMS Category	5-digit SIC Code Description	Community identified in SNA	% of SIC code to enterprise connections in key community
Advertising and Marketing	Advertising agencies	Advertising, PR & management activities	91.1
	Media representation	"	88.4
	Public relations and communication activities	"	90.7
Architecture	Architectural activities	Architectural & related activities	94.6
	Urban planning and landscape architectural activities	"	93.6
Crafts	Manufacture of jewellery and related articles	Crafts	94.2
Design: product, graphic and fashion design	Specialised design activities	Specialised design and related activities	84.3
Film, TV, video, radio and photography	Film processing	Photography	96.6
	Motion picture distribution activities	Film, TV & radio	95.0
	Motion picture production activities	"	95.6
	Motion picture projection activities	"	94.1
	Motion picture, television and other theatrical casting	Performing/visual arts, heritage & cultural education	100.0
	Motion picture, video and television programme post-production activities	Film, TV & radio	92.8
	Other photographic activities (not including portrait and other specialist photography and film processing) n.e.c.	Photography	88.0
	Other specialist photography (not including portrait photography)	Photography	88.0
	Portrait photographic activities	Photography	93.1
	Radio broadcasting	Film, TV & radio	85.6
	Television programme distribution activities	"	100.0
	Television programme production activities	"	94.7
	Television programming and broadcasting activities	"	86.3
	Video distribution activities	"	79.4
	Video production activities	"	79.2
IT, software and computer services	Business and domestic software development	Software (inc computer games)	86.4
	Computer consultancy activities	IT/computer consultancy	81.7
	Other software publishing	Software (inc computer games)	88.1

	Publishing of computer games	"	95.1
	Ready-made interactive leisure and entertainment software development	"	92.3
Museums, galleries and libraries	Archive activities	Performing/visual arts, heritage & cultural education	90.9
	Library activities	"	95.2
	Museum activities	"	96.3
Music, performing and visual arts	Artistic creation	"	88.0
	Cultural education	"	93.1
	Operation of arts facilities	"	95.3
	Performing arts	"	93.7
	Sound recording and music publishing activities	Sound/music reproduction & publishing	84.6
	Support activities to performing arts	Performing/visual arts, heritage & cultural education	89.7
Publishing	Book publishing	Publishing	80.5
	Other publishing activities	"	80.3
	Publishing of consumer, business and professional journals and periodicals	"	91.2
	Publishing of directories and mailing lists	Advertising, PR & management activities	91.7
	Publishing of learned journals	"	100.0
	Publishing of newspapers	"	92.5
	Translation and interpretation activities	Advertising, PR & management activities	89.3

The graph as a whole there are 381 SIC codes, 43 (or 11%) of which are creative industries codes. Despite the relatively low proportion of creative industries SIC codes in the graph, 83% of connections from companies are to creative industries codes. These connections are also highly clustered with the fourth column in Table 22 illustrating the high degree of concentration. This data indicates the proportion of connections from enterprises to creative industries SIC codes which are found in their primary community. For example, 95.1% of connections to 'publishing of computer games' come from nodes in the community in which that SIC code is found.

In chapter 7 we use this graph to understand where immersive companies might be found based on who applied for the first round of XR Stories R&D funding.

7. Mapping the Immersive Creative Sector

The aim of the report so far has been to outline the scale and scope of the creative and then screen industries. This has been done because the emergent nature of the immersive sector means it is difficult to map. As discussed above mapping newer parts of the creative economy is problematic. With no SIC or SOC codes, it lacks the established methods for measuring employment, turnover and business counts. For instance, animation has no specific codes with firms and workers found in film, TV, computer games and advertising, amongst others. What we do know, however, is that a great deal of immersive media production, technological development and exhibition and distribution of immersive experiences happens through the creative industries. In this section, we explore some ways of understanding and defining the creative immersive sector.

There has been research into defining the immersive sector undertaken, for example Innovate UK's report from 2018. NESTA produced the report (in collaboration with consultancies MTM and glass.ai) and estimated there were about 1000 companies specialising in immersive activities and approximately 4500 people working in the sector. They also estimated the sector was worth £660m in sales in 2017. Reflecting the range of applications for immersive media and technologies, the companies NESTA surveyed identified markets beyond the creative industries including advanced manufacturing and energy. This matches the work being undertaken in Yorkshire and the Humber by HEI research centres such as the Centre for Immersive Technologies at University of Leeds, whose work focuses on design, education and health and wellbeing, as well as cultural engagement. The report also highlights the sector relies on public funding of different kinds, with £160m of research funding for immersive projects identified.

Perhaps the most useful element of NESTA's report is their working definition of the immersive sector which they suggest centres on:

> "organisations (including businesses, university researchers and communities of developers and practitioners) developing or applying immersive technologies to create economic, social and cultural value. These technologies transcend traditional formats for interacting with digital information (screens), immersing users in digitally generated or enhanced realities"
>
> (NESTA, 2018: 11)

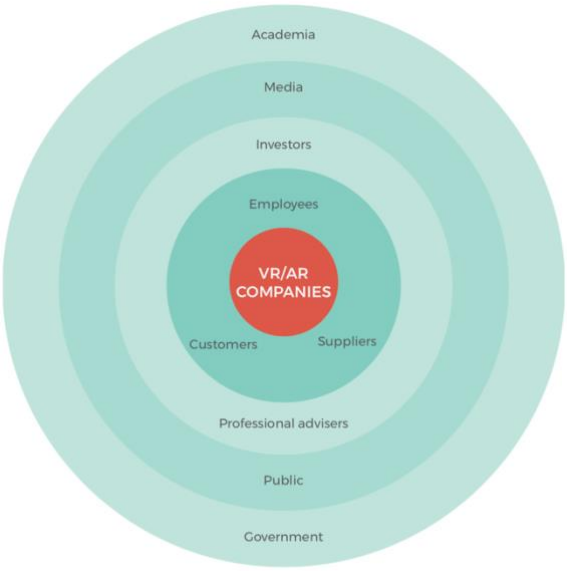
This definition allows us to consider the kinds of 'digitally generated or enhanced realities' being produced and therefore the kinds of companies producing them.

In a report about specifically growing VR and AR companies, Digital Catapult and PWC (2018: 10) outline three types of VR/AR company:

> "*Content* companies develop VR/AR content to sell to enterprise clients or directly to the consumer market. *Service* companies use their time and expertise to provide a valuable outcome to VR/AR oriented customers. *Technology* companies create the platforms, tools, plugins and other solutions that provide value to the VR/AR industry."
>
> (original emphasis)

They also highlight the range of stakeholders involved in the sector (Figure 7). While the concentric circles imply distance from company's activities which is not borne out in reality, and the general descriptors hide a multitude of activities (even in the supplementary table provided in the Digital Catapult report), this list of additional actors allows us more insight to understand the immersive sector. Indeed, it provides us with an imperative to understand it more as it is not dissimilar to many other parts of the economy.

Figure 7 - Stakeholders in the VR/AR industry



(Source: Digital Catapult, 2018)

We can also gain insights into this sector from who is applying immersive research funding. Recent calls of most relevance to the focus of XR Stories are the Audience of the Future programme funded by the Industrial Strategy Challenge Fund delivered by UK Research and Innovation (with the first demonstrator projects awarded in 2018 and running for two years) and AHRC-EPSRC Immersive Experiences programme (with projects awarded in 2017 and running in 2018 for up to nine months).

Audience of the Future awarded four demonstrator projects focusing on esports, performance, visitor experience and moving image[8]. *Weavr* focuses on e-sports and brings together ESL, an esports company, with academics and data, AI, VR/AR and media production companies. *Immersive Performances of the Future* is exploring "what it means to perform live using emerging technologies such as virtual reality (VR), augmented reality (AR), and mixed reality (MR)" (RSC, 2018: online) by bringing together

[8] For full details, see: https://www.immerseuk.org/demonstrator-beneficiaries/

the Royal Shakespeare Company, technology companies, universities, festival organisers and music organisations. *Dinosaurs & Robots* is led by Factory 42 an immersive and television production company and involves national museums and a theatre company. The four project focuses on *Wallace and Gromit*, bringing together Aardman, Tiny Rebel Games, Potato, Sugar Potato and the University of South Wales.

The Immersive Experiences programme funded 32 projects which included a broader range of fields including museums and heritage, design standards and working practices, authoring and design methodologies, performance, content-driven experiences, social media, partnership building, children's experiences and the role of built and natural environments in immersion. The application of immersive media and technologies were similar broad, with the use of 360° video, immersive audio, VR, AR, games and AI generated content. Together, these funding streams illustrate the wide range of fields and applications involved in creative immersive activity.

Part of the research being undertaken as part of the XR Stories project is to help delineate the creative immersive sector, but with particular reference to digital storytelling. Immediately this narrows our focus and removes the need to examine XR developments for manufacturing, medical and, to some extent, educational uses. There is, of course, some overlap in these fields with storytelling and thus they are not excluded entirely from the research programme. This report is the start of this process and with early insights from the work undertaken by and with XR Stories, we can begin the process of delineating Yorkshire and the Humber's immersive storytelling sector. The next section begins this work.

1.19.1 Collaborative R&D funding

XR Stories is funding collaborative research and development projects which bring together SMEs and academics based in Yorkshire and the Humber (other actors can be involved, but the benefits need to be focused on SMEs in the region). The first round of applications for funding were made in late summer 2019 with results announced in mid-October. These applications provide a useful insight into the kinds of companies working in the immersive field.

There were 25 eligible applications which fit the funding criteria of: storytelling focus; at least one industry and one academic partner; co-created R&D; co-funding; shared IP. Thirty SMEs were on the bids working in the following areas:

- TV and Film Production
- Games Development
- Multimedia Arts Production
- Performing Arts
- Creative Design Consultancy
- Digital innovation and R&D Practice
- Marketing
- Creative Technology Consultancy
- Digital Design Studio
- Visual Effects
- Journalism

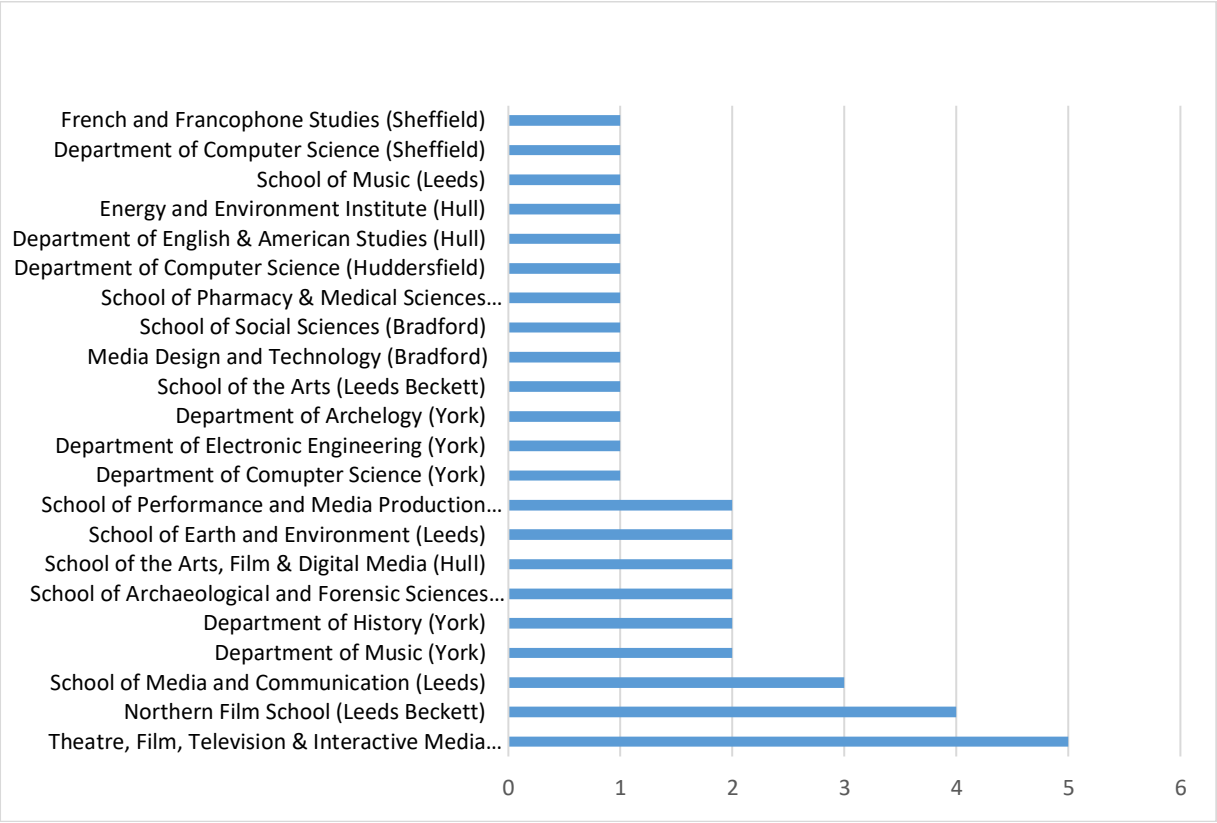
These areas fit neatly within orthodox definitions of the creative sector but reach beyond the screen industries. Applications also involved five major regional 'vehicle' organisations which: National Railway Museum; National Science and Media Museum; Northern Ballet Ltd; Northern Rail; and Opera North. Academic partners came from eight of the eleven HEIs in the region, plus two elsewhere in the UK (Table 23). In total, 89 people were named on applications with a ratio of approximately 60:40 male to female.

Table 23 - Applications from higher education institutions

Higher Education Institution	**Applications**
University of York	9
University of Leeds	4
Leeds Beckett University	4
University of Bradford	4
University of Hull	4
University of Sheffield	4
York St John University	4
University of Huddersfield	1
Sheffield Hallam University	0
Leeds Arts University	0
Leeds Trinity University	0
University of Nottingham	*1*
King's College London	*1*

Figure 8 shows the total number of HEI academic staff that were associated with all 25 applications by department/school and institution. These 37 staff were associated with 22 departments/schools across the eight HEIs and we begin to see involvement of expertise from beyond the creative industries emerging.

Figure 8 - R&D project applications by university department/school



This is reinforced by Figure 9 which shows the total number of academic staff that were associated with all applications by the Cost Centre Group classification of their department/school used by HESA. In total 20 applications were received from academics working in 'Design, Creative & Performing Arts', eight working in 'Humanities & Language Based Studies & Archeology', four from 'Engineering and Technology' subject areas, three from 'Biological, Mathematical & Physical Sciences', and one from 'Medicine, Dentistry & Health' and 'Social Studies'.

Figure 9 - Small Collaborative R&D Projects: Number of Applicants by Cost Centre Group

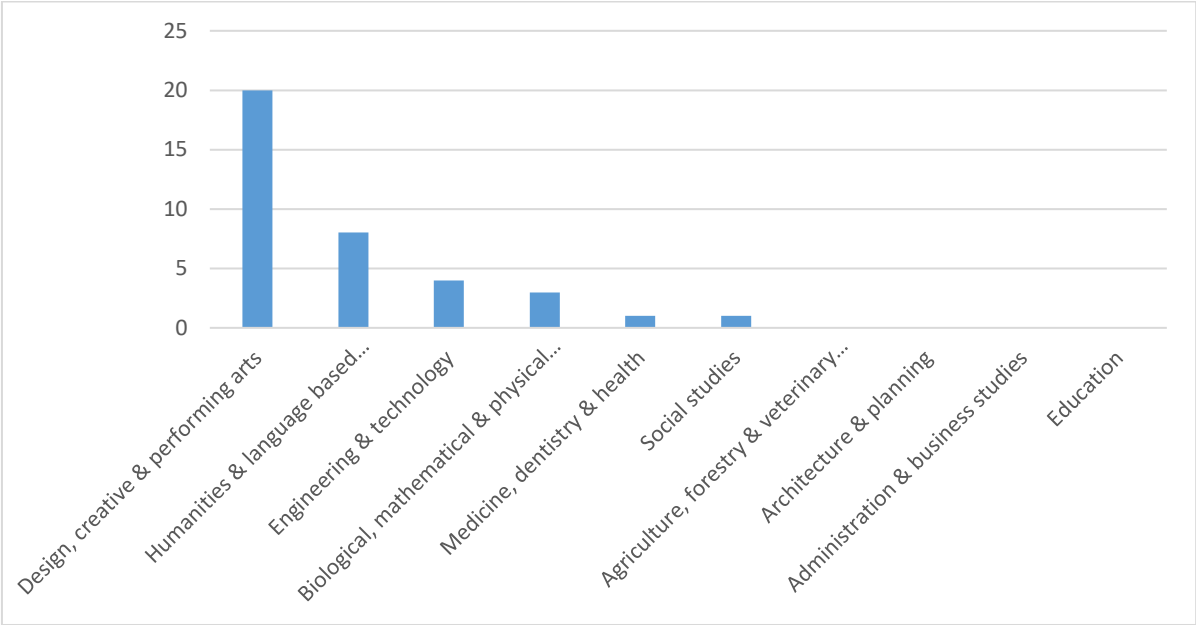


Figure 10 shows the number of applicants involved in particular research group at HEIs (see above Figure 3). The largest group are members of both Digital Creativity Labs and the Centre for Digital Heritage (University of York) with four applicants, while all other research group affiliations had only one application.

Figure 10 - Applications by Research Centre

Research Centre	Higher Education Institution	Applications
DC Labs/Centre for Digital Heritage	University of York	4
Centre for Digital Heritage	University of York	1
Centre for Digital Heritage/Centre for the Study of Christianity & Culture	University of York	1
Centre for Visual & Immersive Computing	University of Huddersfield	1
Communication, Culture and Media Research Group	University of Bradford	1
DC Labs	University of York	1
The Centre for Immersive Technologies	University of Leeds	1
Visual Computing	University of Sheffield	1
WEAVR	University of York	1

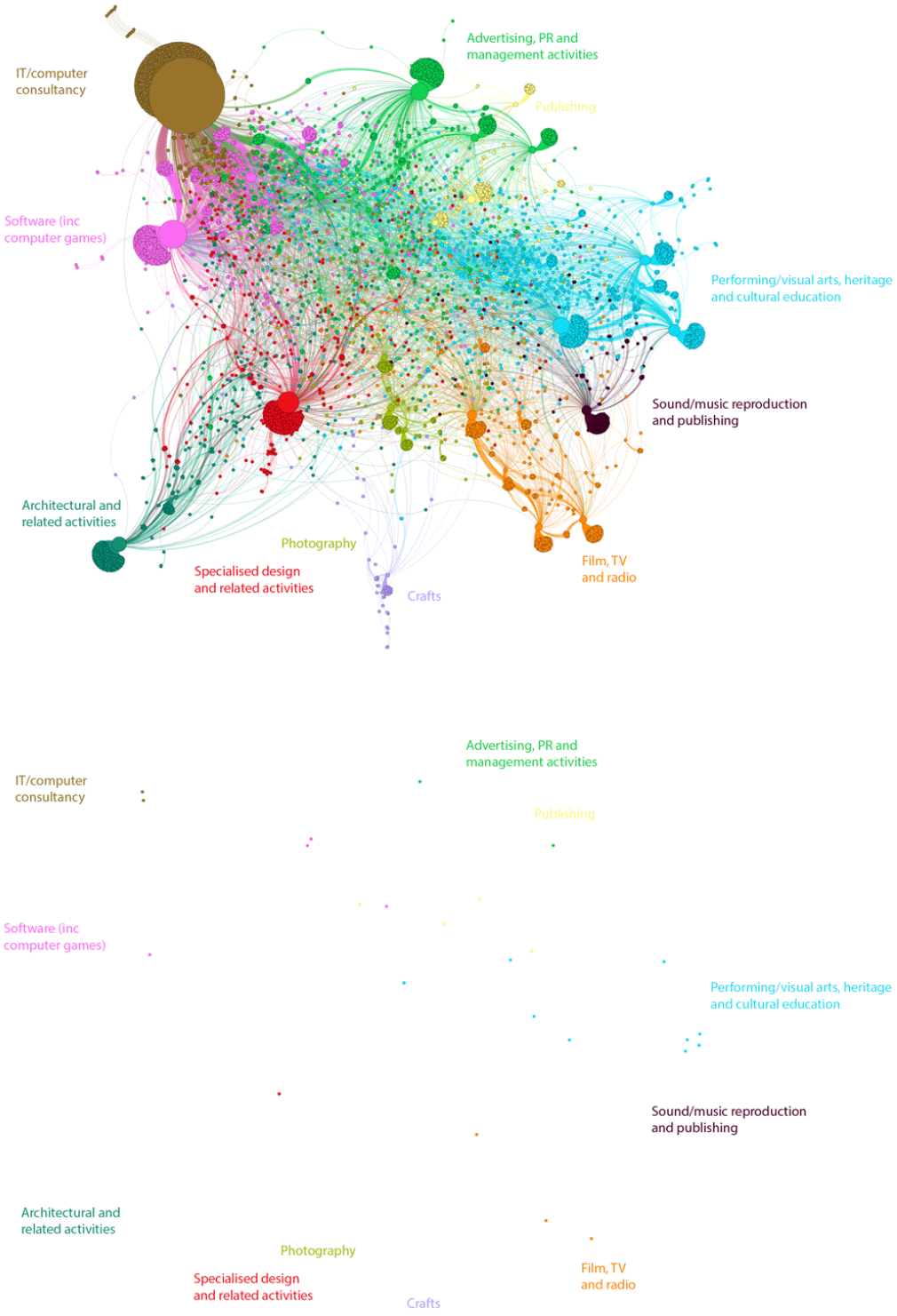
The profile of the departments from which people are applying for XR Stories R&D funding are predominantly arts and humanities subjects, mostly film and media or performance, but also history and music, for example, rather than science departments such as computing or engineering.

1.20 Using Social Network Analysis to Understand the Immersive Sector

We can learn more about from which parts of the creative industries the immersive sector is drawing expertise by using social network graph of the region's sector (see section

1.19). And we can use the organisations who applied for the first round of R&D as they are companies working in the immersive field (**Error! Reference source not found.**).

Figure 11 - R&D funding applicants in the region's creative industries network



Identifying them in the graph reveals the organisations are spread across the network. The organisations are found in the ‘performing/visual arts, heritage and cultural education’

(n=9), ‘software (inc computer games)’ (n=4), ‘publishing’ (n=4), ‘film, TV and radio’ (n=3), ‘advertising, PR and management activities’ (n=2), ‘IT/computer consultancy’ (n=2) and ‘specialised design and related activities’ (n=1). Some organisations involved in the bids are not shown in the network because they are either based outside of Yorkshire and the Humber or don’t have at least one creative industries SIC code associated with their activity (e.g. Northern Rail).

The spread of organisations reinforces the insights gleaned from analysing the academics involved to illustrate that the immersive sector is multi- and inter-disciplinary in nature. This is just a small sample and more data is required to firm up this conceptualisation, but given the range of ways in which immersive storytelling is exhibited, the technologies used to consume it, the variety of stories being told and the different narrative forms, it is not surprising to find this spread of companies. As more data is gathered, and as the sector evolves, we hope to be able to identify sub-fields within the creative immersive sector which draw on particular specialisms, target certain markets and use different technologies in the production, distribution and exhibition of immersive and interactive stories.

This methodology needs refining but it is potentially very useful to understand more about the work done by creative industries companies, how they fit within different communities and what boundary-spanning activities are undertaken alongside creative industries work.

8. Annex 1

59.1 Motion picture, video and television production activities includes:

- Motion picture, video and television programme production activities
- Motion picture, video and television programme post-production
- Motion picture, video and television programme distribution
- Motion picture projection activities

58.2 Software publishing includes:

- Publishing of computer games
- Other software publishing

74.2 Photographic activities includes:

- Portrait photographic activities
- Other specialist photography
- Film processing
- Other photographic activities not elsewhere classified

90 Creative, arts and entertainment activities includes:

- Performing arts
- Support activities to performing arts
- Artistic creation
- Operation of arts facilities

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