This is a repository copy of *Using social network analysis to understand the creative and cultural industries*.

White Rose Research Online URL for this paper:
https://eprints.whiterose.ac.uk/id/eprint/184106/

Version: Accepted Version

Book Section:

Swords, Jon orcid.org/0000-0003-2318-9566 (2022) Using social network analysis to understand the creative and cultural industries. In: Comunian, Roberta, Faggian, Alessandra, Heinonen, Jarna and Wilson, Nick, (eds.) A Modern Guide to Creative Economies. Edward Elgar Publishing.

Using social network analysis to understand the creative and cultural industries

Jon Swords, Department of Theatre, Film, Television and Interactive Media, University of York, UK

Abstract

This chapter explores the ways in which social network analysis can be used to understand the creative industries. Networks are crucial to the effective functioning of the creative and cultural industries (CCIs) and decades of research have highlighted this importance for activities across the value chain. Social network analysis allows researchers to schematically trace connections between different agents in the CCIs to understand the composition of networks, relationships between individuals and groups of nodes, and statistically identify communities. The chapter outlines the range of ways in which   social network analysis has been applied to the CCIs by reviewing a range of literature which reports its use. A more detailed application of social network research is provided that uses data on UK creative companies to explore how they define their activities using Standard Industrial Classification codes. In so doing the chapter highlights some of the drawbacks inherent in applying social network analysis to the CCIs.

1. Introduction

This chapter explores the ways in which social network analysis (SNA) can be used to understand the creative and cultural industries (CCIs). Social network analysis allows researchers to schematically trace connections between different agents and understand the characteristics of networks through statistical and visual analysis. Networks are crucial to the effective functioning of the CCIs and decades of research has highlighted this importance for activities across the value chain. Networks are conceptualised in two broad ways in this work. First, they are discussed in general terms to describe: the social and business networks through which people find work (Bielby & Bielby, 1996); how networks are used to create, and emerge from project teams (Grabher, 2002); how firms are embedded in local/regional networks forming agglomerations (Crewe, 1996); and the role of global production networks in transnational creative economies (Wu, 2017), amongst others.

The second way in which networks are conceptualised is to trace linkages schematically to allow systematic analysis and exploration. This involves generating datasets of network actors

and connections between them, and then visualising and/or testing the network statistically. In the CCIs, this might be transactional data in supply chains or employment records. Most often this is done using social network analysis and it is this approach this chapter focuses on. It is this approach this chapter focuses on by undertaking analysis of companies in the UK which are defined as part of the creative industries. SNA is done on a dataset of almost 450,000 enterprises and their connections to Standard Industrial Classification (SIC) codes they select when submitting yearly accounts. The SNA allows communities of companies which undertake similar activities to be identified and reveals the work they do which is not defined as part of the creative industries by the UK's Department for Culture Media and Sport. The chapter, therefore, highlights the blurriness of the boundary between the CCIs and the rest of the economy, the limitations of the SIC system used to identify and focus policy on creative enterprises and highlights areas for further research.

After the introduction (section 1), this chapter begins by outlining the origins of social network analysis in mathematics and sociology before providing some ways to ensure it is used appropriately and in a way that does not overstate the results it produces (section 2). Section 3 outlines the range of ways that social network analysis has been applied to the CCIs by reviewing a range of literature which reports its use. In section 4 a more detailed application of social network is provided that uses data on UK creative companies to explore how they define their activities using Standard Industrial Classification codes. This research highlights the work creative industries companies do outside the standard UK definition of the creative industries and critiques the way the UK's Dept for Digital, Culture, Media and Sport defines work in this sector.

2. Social Network Analysis

For Carrington, Scott, and Wasserman (2005) the origins of social network analysis (hereafter SNA) can be traced back to the 1930s but its use took off rapidly in the 1990s[1]. In this time SNA has been applied to a huge range of social and scientific contexts where networks form. The field has developed drawing insights from areas as diverse as physics, organisational studies, economics, epidemiology, sociology and geography.

At the heart of SNA, however, is graph theory. Graph theory is a field of mathematics which studies linkages (also called edges or lines) between nodes (also called vertices or points) which form a graph, or in more common parlance: a network (Gera et al., 2018). Nodes can represent many things including people, organisations, documents, events, media products, animals, diseases and places. The connection between them might indicate collaborations,

---

[1] For the avoidance of doubt, then, while SNA can be used to understand connections manifest on social network platforms such as Twitter and Facebook, the term predates them by decades.

buyer-supplier relations, employment, citations in document, involvement or attendance at events, ownership etc. (Sucar, 2015). Graph theory provides mathematical approaches for defining networks and their characteristics by analysing elements such as their size, distance between nodes and how completely connected a network is. More sophisticated analyses provide ways of generating insights about a network's characteristics and prompting further questions for investigation. For example, tests of modularity allow the statistical detection of modules or communities within networks based on shared connections and the identification of divisions between groups of nodes (Newman, 2006). While measures of centrality provide indications of which nodes are most 'important' based on how well connected they are (see Scott, 2017 for an overview)

Drawing on these approaches, SNA emerged from sociology as people's lives were translated into network models to "understand how individual actions turn into an emergent behaviour of society as a whole" (Zweig, 2016: 27). For Zweig (2016) this was an important moment because it allowed social action to be quantified, but the fundamentals of graph theory are to abstract entities into mathematical formulae. The field, therefore, has been criticised for overlooking qualitative factors that cannot be abstracted into quantitative form or simplified into vertices and edges (see Knox et al., 2006 for more). Nevertheless, SNA can provide a useful starting point to understand the nature of networks, particularly when they are very large. For instance, it can help identify communities or groupings for deeper analysis using modularity tests (see below) and tests for centrality can help highlight significant nodes to concentrate on (e.g. highly cited documents or people connected to lots of projects).

2.1 Getting the most from SNA

For statistical approaches to work best, the bigger the network you can build the better. With the rise of big data, and online platforms which harness huge datasets about their users, there has been a tendency for people to search for an n=all approach in SNA, where researchers try to capture entire populations rather than samples, because size is seen as a way to overcome some of the shortcomings of abstracted data (see also Comunian, 2011). In such applications the results which can be gleaned from graph theory allow data-rich platforms to perfect their algorithms, particularly where they lead to recommendations. For instance, SNA analysis can help identify similarly connected people on Twitter or Facebook to make suggestions about who else to follow or 'friend'. On media platforms, SNA data can be used to recommend what else to watch or listen to next based on people's overlapping watch histories. The biggest drawbacks with using SNA in this way, however, are the quality of the data you begin with and the assumptions you make about it. In the context of media platforms, Gerlitz and Helmond (2013: 1358), highlight that simply watching something online, liking something or being connected to another person hides "a variety of affective responses such as excitement,

agreement, compassion, understanding, but also ironic and parodist liking". The abstraction required for SNA misses these things.

We must, therefore, be careful and reflexive in the way we generate datasets for SNA and the analysis we undertake. For example, whether drawing on primary or secondary data it is crucial classifications and sampling methods are understood so existing abstractions are clear before further ones are made. For example, using LinkedIn data to trace business networks needs to acknowledge 'connections' may not reflect real business relationships. Or if a web platform such as Crunchbase adds characteristics to company profiles, it is important to understand the reliability of this data and potential errors. Understanding the underlying assumptions, data collection methods and coding will help produce robust insights from any SNA done using this data. For primary data, automated collection is often the most straightforward way to quickly build large datasets and many organisations offer APIs to facilitate this. When APIs are not available or data is not straightforwardly accessible, data scraping can be used to gather it. Here, we must be clear about how data is coded, and ethical considerations are central to these methods to ensure data is collected, analysed and disseminated in responsible ways so as not to cause harms. As Fiesler and Proferes (2018) have argued, just because data is public in some way, it does not mean it can or should be straightforwardly used for research purposes.

If data has been pseudonymised, SNA may remove some of that anonymity by revealing associations that identify actors in a network. Users need to be careful to avoid unintentionally revealing more about the data than is necessary. Finally, when presenting findings from SNA, it is important to be clear about the data collection, the shortcomings of this and any caveats which come with results. Being careful and reflexive in undertaking SNA provides ways to avoid the pitfall of implied authority which comes from 'scientific' and quantitative approaches and the relative ontological stability these fields denote (Swords & Liu, 2015). As Knox et al. (2006) put it, "[mathematical] methodological expertise has made it possible for SNA writers to claim a monopoly on 'scientific' network thinking, by providing them with a means of going beyond 'loose', metaphorical approaches to networks, and providing a range of formal tools for 'precisely' mapping networks." (p116).

3. Social Network and the Cultural-Creative Industries

There is a small but growing field of research which uses SNA to understand the CCIs industries, which this section explores, some of which focuses on people and organisations while other work concentrates on documents, artifacts and socio-technical devices. Relating to the first area, Taylor (2019) has used information about trustees and directors of cultural and creative organisations to examine the makeup of boards of national portfolio

organisations funded by Arts Council England. His analysis reveals the dominance of male decisionmakers on these boards and the interconnections between boards through their members. Similar work has been undertaken by Mould and Joel (2010) on board members of London-based advertising companies. By graphing the networks they reveal key gatekeepers through whom knowledge is transferred and companies connected together. As these authors acknowledge, the SNA models can only reveal so much and the complex manifestation of power within the networks they examine needs qualitative research to be better understood.

Granger and Hamilton (2010) have examined relationships between key individuals and organisations in the creative economy of Coventry, UK. They argue relational mapping such as this offers a "richer, more nuanced way of research and developing policy for the creative industries" (p.57). A similar application is used by Morelli and Gunes (2012) in their analysis of the videogames industry. Using data about which developers and publishers work together to produce games over five generations of major games consoles,   they highlight the variance in publishing communities around different consoles and decreasing volatility over time as the videogames industry's structure stabilised. In film, cast and crew directories can be graphed to highlight the connections and reconnections throughout people's careers. Senekal and Stemmet (2014) have used SNA to trace the central role of director Jamie Uys in the Afrikaans film industry, highlighting the films through which other celebrated film personnel collaborated. Miller (2011) uses a similar methodology, but connecting studios which   have collaborated on different types of film. They examine networks around 'high grossing' and 'highly lauded' productions to understand more about the outcomes of co-productions. Miller argues that the structural differences in networks of production offer different ways to organise how studios and production companies might collaborate. These examples, again, illustrate useful insights but the level of abstraction to individual actors (whether companies or individuals) leave further questions about the nature of relationships unanswered. These questions should be seen as opportunities, however, not drawbacks and ways of iterating research questions as scholars move from extensive to intensive approaches.

The second approach is to examine linkages between a broader range of objects, artefacts, documents and agents. Joel (2009) has used SNA to map connections between design firms and other parts of the creative industries. They did this using a sample of companies from which further information was gathered to allow linkages to creative sub-sectors to be drawn. This is similar to the work presented in section   4 below, but the sample used here is much larger and a wider range of SNA tools were used in the analysis. In the heritage field, SNA has been used to help catalogue cultural heritage artefacts, documents and other objects (Hampson et al., 2012). de Miguel Molina et al (2006) have used SNA   to explore the study

of gastronomy in work on intangible heritages. All this work provides useful insights about their subjects, but they recognise abstraction means some details can be lost along the way.

4. Using Social Network Analysis to Understand Creative Industries Definitions

In this section I present a more in-depth application of SNA to understand differences between how the UK's Department for Culture, Media and Sport (DCMS) delineate enterprises in the creative industries and how enterprises define themselves. In so doing I try to follow the advice in section 2 to be clear about the limits of such an approach. The term 'creative industries' came into popular usage at the end of the 1990s under the influence of the   New Labour Government and their economic development policy (for a longer history, see   O'Connor, 2011). The   DCMS's   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 (Garnham, 1990) and UNESCO (Girard, 1982) in the 1980s, while Luckman (2019) and Granger and Hamilton (2010) have argued Australia's Department of Communications and the Arts 'Creative Nation' report is an important precursor to the DCMS work (Department of Communications and the Arts, 1994). 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. We can see this as such approaches spread around the world (Fahmi, McCann, & Koster, 2015; Kong, Gibson, Khoo, & Semple, 2006; Restrepo & Márquez, 2013).

The original 1998 DCMS definition of creative industries focused on 13 sets of core activities: 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 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. There is not sufficient space here to interrogate each of these critiques to a level which does them justice *[cross-ref to another chapter in this book??]*.

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. 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] [i]ndustries with creative intensity above a specified threshold are considered Creative Industries" (DCMS, 2016: 21). The current threshold for an industry to be included is a minimum of 6.000 jobs, more than 30% are defined as creative (see Bakhshi et al., 2013, for more on the origins of the creative intensity approach and a critique). Using this approach they acknowledge that creative workers are found across the economy.

These definitions are used to calculate the size of the creative industries using various measures. The current definitions used by the DCMS stem from the latest calculations of creative intensity and are shown in Table 1.

Table 1 - 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)

There are, however, a series of drawbacks to this approach. Both SOC and SIC codes are amended about every 10 years, but as soon as the codes are released, they are out of date and new economic activities are not accurately captured. There is also an issue with reporting as enterprises are required to select codes when they register accounts with Companies House, but misreporting is a problem. This could be the result of rolling over outdated codes from previous accounts, not understanding the coding system or not considering accuracy a priority. Typos can also have an impact with a number of enterprises sampled here appearing to have a digit missing.

Correct reporting also relies on the interpretation of enterprises, accountants and statisticians to capture activities as best as is possible, but some codes are difficult to differentiate. For instance, in the current UK set of creative industries 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. This is partly a result of the DCMS approach starting with occupations (SOC codes) to determine sectors (SIC codes), rather than focusing on whether the products and services an enterprise produces are 'creative'. This means that some of the multi- and interdisciplinary work in the creative industries is captured, but others are obscured in reporting. This is seen in the division of sub-sectors and the aggregation of these sub-sectors into groupings which may not resemble connected activities in the economy (seen in the leftmost column of Table 1). Moreover, no account is taken of the other activities these enterprises undertake outside of the creative industries.

It is these latter critiques the remainder of this chapter focuses on to explore how SNA can reveal more about the CCIs. It does so by taking into account the multifaceted activities of enterprises working in this, and related sectors. In what follows I argue using SNA can help achieve two things:

- help better understand communities of activity within the CCIs;
- help identify areas of activity which are complementary   to and supporting of CCI activities.

In so doing, the DCMS groupings are unpicked to provide a more nuanced approach to creative and cultural industries activities based on self-selected SIC codes.

4.1 Methodology

For this research data from Financial Analysis Made Easy database (FAME) was used. The database draws from UK Companies House returns made by enterprises and includes a range of information about a company's financials. It   includes some charities and community interest companies, but not all. It also has some freelancers who work as a ltd company, but by no means all do this. Data was downloaded by selecting enterprises which had at least one creative industries SIC code and are based in the UK. The data presented below was downloaded in early 2020 so includes data from returns made in 2018 and 2019. A wide range of company characteristics was gathered to allow analysis beyond what is presented below. As well as SIC codes, the data download included information about a company's establishment date, gender of directors, location information, turnover, employee numbers, and legal status. The data was cleaned and coded for use in Gephi, a social network analysis program. Cleaning the was necessary to remove data entry errors left over from Companies House submissions, FAME's own data entry, or Excel mis-formatting data which limited the type of analysis which could be undertaken, e.g. incorrect characters on company names, removing duplicates and correcting date formats. A random sample of companies was

checked to identify potential miscoding of SIC codes at some point from entry to the download. This was done by comparing information about companies online with data from FAME and helped identify common mistakes which were then corrected throughout he whole dataset. This also identified issues I mistakenly believed to be errors but where interesting insights into what creative companies do. This is discussed further in section 4.3.

The data were also coded to allow comparisons between regions, analyse the limited gender data in the database, examination of types of companies (e.g. Ltd vs community interest companies – see Butt et al, 2017 for an example), but mainly to prepare it for use in Gephi. This involved creating two new datasets:

1. a list of nodes consisting of a) 449 945 companies, their characteristics and unique identifiers and b) 652 SIC codes associated with the companies
2. a list of edges indicating connections between companies and SIC codes

These new datasets allowed Gephi to understand and graph the companies and their connections to SIC codes. Once in Gephi a series of functions were applied to produce the network in Figure 1. First, the number of connections for each node was calculated and this information was used to change the size of nodes. The larger the node the more connections it has going into it. Second, a modularity calculation was performed to detect communities within the network based on the connectedness of nodes and the detection of divisions between groups 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 (Jacomy, Venturini, Heymann, & Bastian, 2014) 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 same analysis was done for just companies registered in the Yorkshire and the Humber region in northern England for a different project and this allowed some sub-national comparison (Swords, forthcoming).

The network shown below consists of 449 945 enterprises connected to the 652 different 5-digit SIC codes they list to reflect the activities they undertake, including the 42 creative industries codes defined by the DCME. In total the network contains 625 744 edges between nodes which is the number of SIC codes against companies in the dataset. There is a 1.39 average degree of connection. The dataset is for the UK as a whole and the regional distribution of the dataset represents what we know from other mapping exercises about the distribution of the creative and cultural industries in the UK (Butt et al, 2017; DCMS, 2019; Siepel et al, 2020)

4.2 Results

The network shown here consists of 449 945 enterprises connected to the 652 different 5-digit SIC codes they list to reflect the activities they undertake, including the 42 creative industries codes defined by the DCME. In total the network contains 625 744 edges between nodes which is the number of SIC codes against companies in the dataset. There is a 1.39 average degree of connection. The dataset is for the UK as a whole with more than 50% of companies having a registered address in London or the South East. The regional distribution of the dataset represents what we know from other mapping exercises about the distribution of the creative and cultural industries in the UK (Butt et al, 2017; Siepel et al, 2020).

Table 2 shows the SIC codes with the most connections, that is the most frequently listed codes by the companies in the dataset. The top 30 accounts for 82.6% of all connections with IT and software related activities (both those in the DCMS list of creative industries companies and those outside it) accounting for 36.8% of the total.

Rank	SIC Code Description	%	Count	Rank	SIC Code Description	%	Count
1	Information technology consultancy activities	22.76	142 697	16	Management consultancy activities other than financial management	1.84	11 560
2	Business and domestic software development	7.79	48 837	17	Photographic activities not elsewhere classified	1.75	10 948
3	Artistic creation	5.25	32 893	18	Operation of arts facilities	1.38	8656
4	specialised design activities	5.09	31 923	19	Media representation services	1.36	8496
5	Advertising agencies	3.96	24 853	20	Book publishing	1.17	7343
6	Architectural activities	3.41	21 394	21	Other software publishing	0.94	5923
7	Motion picture production activities	2.44	15 288	22	Ready-made interactive leisure and entertainment software development	0.92	5761
8	Performing arts	2.44	15 272	23	Cultural education	0.91	5702
9	Other information technology service activities	2.34	14 691	24	Other specialist photography	0.85	5348
10	Video production activities	2.27	14 227	25	Motion picture, video and television programme post-production activities	0.78	4905
11	Television programme production activities	2.03	12 750	26	Other business support service activities n.e.c.	0.72	4529
12	Sound recording and music publishing activities	1.99	12 447	27	Data processing, hosting and related activities	0.69	4309
13	Support activities to performing arts	1.97	12 333	28	Other service activities n.e.c.	0.61	3834
14	Public relations and communications activities	1.87	11 730	29	Web portals	0.60	3756
15	Other publishing activities	1.85	11 578	30	Translation and interpretation activities	0.56	3534

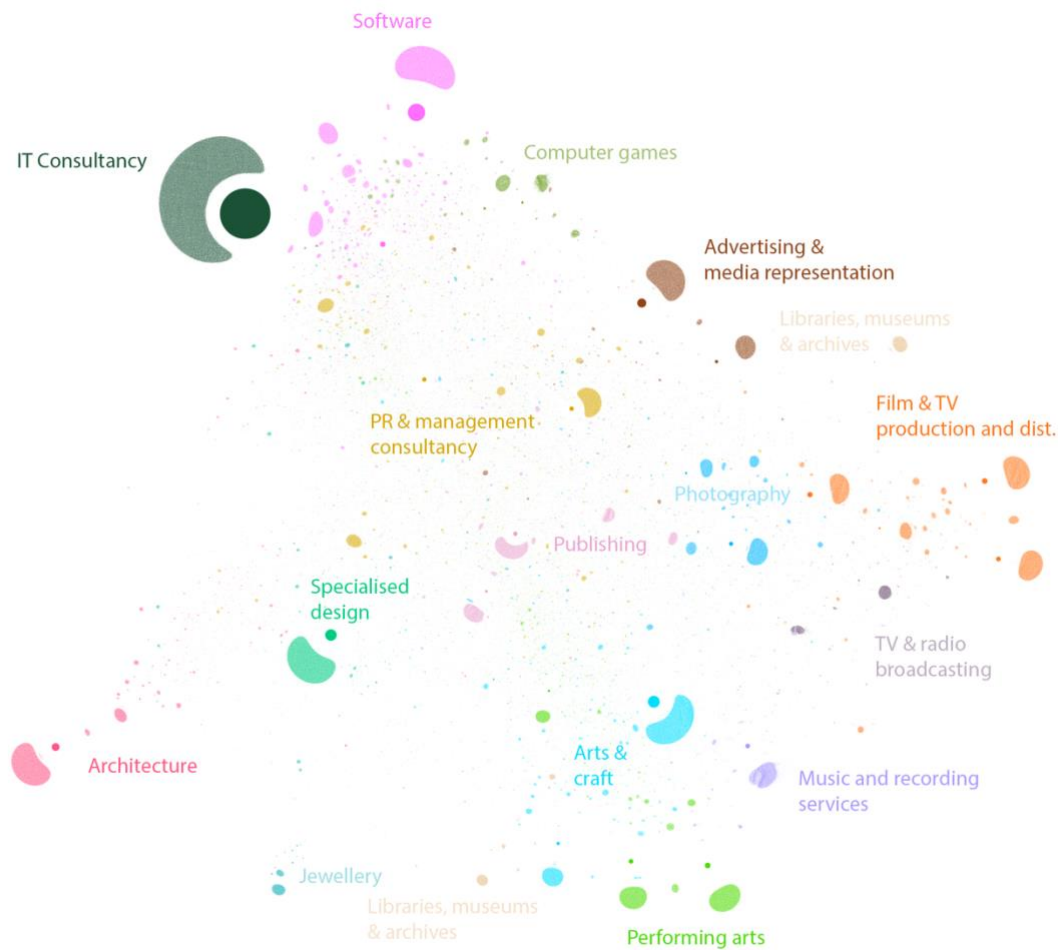*Table 2 - Connections to the top 30 SIC codes*

Figure 1 - Social Network Analysis of the UK's Creative Industries (edges removed for ease of viewing)

4.2.1 SNA Communities vs DCMS Groupings

The SNA test of modularity identifies 16 different communities in the network. These groupings vary in size with large variances in the number of enterprise nodes and SIC code nodes they contain. The character of each community can be determined by examining the activities enterprises undertake and the SIC code nodes with the highest number of connections. This examination was used to produce the necessarily broad labels in Figure 1 and used below. The variety of SIC codes found in each community also varies with the *IT Consultancy* community only containing five different codes while *Specialised Design* has 119 different SIC codes. These ranges are dependent on the likelihood of an enterprise selecting more than one SIC code which in itself is an   indication of how well the codes represent what a business does. For example, there are numerous and highly detailed SIC codes for manufacturing activities but very few for artists and craft practitioners.

The communities resemble many of the DCMS groupings but there is important divergence. Table 2 illustrates where there is alignment, or otherwise, between the communities identified in the SNA and DCMS groupings. There is complete alignment for 'architecture', 'crafts' (renamed to *Jewellery* here to more accurately reflect the activities undertaken by firm in this community), 'specialised design' and the 'museums, galleries and archives' grouping is consistent, although relabelled to highlight many galleries are found in the *Art and Craft* community. With the exception of 'translation and interpretation activities', the DCMS 'publishing' grouping is consistent with what was found in the SNA. The DCMS grouping of 'Advertising and marketing' splits into two communities: *PR & Management Consultancy* and *Advertising & Media Representation*. Public relations activities join with 'translation and interpretation activities' to form a community where we also find a relatively high number of management consultancy enterprises (not a DCMS creative industries sub-sector). The latter accounts for 13.3% of enterprises in this community and 67.6% of all management consultancy firms in the dataset are found here.

As one might expect, the DCMS grouping of 'Film, TV, video, radio and photography' splits to reflect differences in specialism, production processes and markets for this range of activity. Photographic activities come together into one community (*Photography*) and broadcasting of TV and radio form another (*TV & Radio Broadcasting*). The rest of this grouping is found in a community which encompasses *Film and TV production and distribution activities* that encompasses activities along this value chain except broadcasting.

The DCMS groups together 'IT, software and computer services' but this splits three ways. *IT consultancy activities* is a very distinct community. A second community is made up of activities relating to the production of *Computer Games*, while the third is general *Software*.

Finally, the DCMS grouping of 'music, performing and visual arts' splits into three, as one might have predicted. 'Artistic creation' and the 'Operation of arts facilities' are together in the SNA community labelled *Art and Craft*. This community also includes many craft activities found within 'artistic creation' itself, plus 'specialised design activities' and 'other manufacturing n.e.c.'. Music-related activities form their own community along with SIC codes from outside the DCMS definition which reflect the business models of music businesses: 'Retail sale via mail order houses or via Internet' and 'Other retail sale not in stores, stalls or markets'. The final community from this grouping is *Performing arts* which includes 80% of connections to the 'cultural education' SIC code from the DCMS list, but also 81% of the connections to 'Other human health activities'. This provides an indication of the range of activities performing arts organisations do, a point I return to below.

Table 2 - DCMS Creative Industries Sub-sectors and SIC Code Groupings

DCMS Category	5-digit SIC Code Description	Community identified in SNA
Advertising and Marketing	Advertising agencies	Advertising & Media Rep
	Media representation	Advertising & Media Rep
	Public relations and communication activities	PR & Management Consultancy
Architecture	Architectural activities	Architecture
	Urban planning and landscape architectural activities	Architecture
Crafts	Manufacture of jewellery and related articles	Jewellery
Design: product, graphic and fashion design	Specialised design activities	Specialised design
Film, TV, video, radio and photography	Film processing	Photography
	Motion picture distribution activities	Film & TV production and distribution
	Motion picture production activities	Film & TV production and distribution
	Motion picture projection activities	Film & TV production and distribution
	Motion picture, video and television programme post-production activities	Film & TV production and distribution
	Other photographic activities (not including portrait and other specialist photography and film processing) n.e.c.	Photography
	Other specialist photography (not including portrait photography)	Photography
	Portrait photographic activities	Photography
	Radio broadcasting	TV & Radio Broadcasting
	Television programme distribution activities	Film & TV production and distribution
	Television programme production activities	Film & TV production and distribution
	Television programming and broadcasting activities	TV & Radio Broadcasting
	Video distribution activities	Film & TV production and distribution
	Video production activities	Film & TV production and distribution
IT, software and computer services	Business and domestic software development	Software
	Information technology consultancy activities	IT Consultancy
	Other software publishing	Software
	Publishing of computer games	Computer Games
	Ready-made interactive leisure and entertainment software development	Computer Games
Museums, galleries and libraries	Archive activities	Libraries, museums & archives
	Library activities	Libraries, museums & archives
	Museum activities	Libraries, museums & archives
Music, performing and visual arts	Artistic creation	Art & Craft
	Cultural education	Performing arts
	Operation of arts facilities	Art & Craft
	Performing arts	Performing arts

	Sound recording and music publishing activities	Music & Recording Services
	Support activities to performing arts	Performing arts
Publishing	Book publishing	Publishing
	Other publishing activities	Publishing
	Publishing of consumer, business and professional journals and periodicals	Publishing
	Publishing of directories and mailing lists	Publishing
	Publishing of learned journals	Publishing
	Publishing of newspapers	Publishing
	Translation and interpretation activities	PR & Management Consultancy

4.3 Discussion

This section the key findings from the SNA are discussed and areas for further research are highlighted. This analysis brings into question the usefulness of the DCMS groupings. On one level it may not seem important, but the discursive work these groupings do can feed into how policymakers and others understand the creative and cultural industries. A more accurate picture of how different activities relate to each other, or don't, is important for targeted and effective policy interventions. Understanding this detail is crucial at the national scale as well as regional and local levels as the groupings diverge in different ways in different places. In Yorkshire and the Humber, for example, all the codes in the DCMS groupings of '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. This is different to the UK-wide picture, but separation is, again, unsurprising given the technical and organisational specialisms required to produce music and take it to market. The amalgamation of the other codes is likely due to a series of interconnected factors which operate differently at the local and regional scales compared to the nation's creative   economy. For example, enterprises involved in the performance arts, performance of music, exhibition of visual arts, and museum operations are similarly organised, often share facilities, receive funding from allied sources and may have historic connections. Much of the activity undertaken by these organisations (perhaps with the exception of museums) are best captured under the 'artistic creation' SIC code which is very broad and overlaps with a lot of similar activity. At a regional level there may not be the diversity of other connected activities to create separation into distinct communities in the SNA. Moreover, many enterprises in this field undertake 'cultural education' activities as part of career and organisational development and as part of outreach activities which links them. There are likely other local reasons such as the evolution of the arts sectors in the major cities in Yorkshire and the Humber through the impact of previous policy and/or funding interventions, governance of the arts sector, the presence of key institutions and long-

running festivals, amongst others. These factors will differ across the UK and are worthy of further study.

One of the reasons for the new set of groupings created by the SNA is because 652 different 5-digit SIC codes are included and only 6% of them are creative industries codes. The other codes are shared by enterprises and are a major factor in the new communities which form. These figures also demonstrate that the activities undertaken by companies we could define as part of the creative industries is wide and varied. Examining the breadth of work undertaken by enterprises we could define as part of the CCIs is worthy of further research but too large a task for this chapter, so instead let us highlight some interesting insights which illustrate that the boundary between the CCIs and the rest of the economy is not as clear as the DCMS approach might suggest.

We can see the blurring of the boundary at different scales. At the sub-sector level, for example, the SIC code for 'Other human health activities' has a relatively small number of connections to it (c. 1100), but 81% of these are concentrated in the *Performing Arts* community. Enterprises identifying as undertaking this code are most frequently also doing 'Artistic creation' and 'Cultural education' suggesting there is a crossover between performing arts activities and health benefits. We can see this with increasing recognition of the benefits of social prescribing where health agencies can refer patients for activities which will benefit their health, including engaging with cultural events and institutions (Romer, 2018).

Looking at the company scale, we can identify businesses whose work bridges across the CCIs and the rest of the economy. For example, there is a company in Leeds 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. In Ripon there is a 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 with a purpose is to provide education. There is a company in London who build ships but also undertake IT consultancy because they handle the electronics as well as superstructure and interior design of boats. There is an international corporation whose activities include 'Pre-primary education' and 'Child day-care activities' as well as 'Business and domestic software' and 'Leasing of intellectual property and similar products'. This is because they run nurseries which include bespoke coding classes. Around the country there are hotels and B&Bs included because they offer art-based retreats. Toy companies appear in the network because they also publish books. Call centre companies are included because they undertake advertising and marketing work. We can also identify companies using old SIC codes for new activities. For example, there are enterprises

producing and publishing computer games which also register as 'other sports activities' which reflects the rise of e-sports.

At the individual scale, there is evidence of the other work people do alongside activities defined as in the creative industries. This comes through for sole traders who put primary and secondary jobs under the same limited company. Interesting combinations include, 'freight rail transport' and 'sound recording and music publishing'; 'Butter and cheese production' and 'Information technology consultancy activities'; 'buying and selling real estate' and 'artistic creation'; 'specialists medical practice activities' and 'artistic creation'. Understanding the ways in which these non-CCI activities complement, supplement and/or constrain creative work is a further area which needs deeper appreciation by policymakers.

These examples from the SNA help illustrate the diversity of work undertaken by creative industries companies and creative practitioners, which are not captured in the headlines about the sector. The boundary between the creative industries and the rest of the economy is porous and the interdependencies strong. It is important researchers and policymakers do not overlook these connections in the formation of interventions as they vary between places, and because these connections highlight where skillsets are complementary and where learning and cross-sector innovation might occur.

5. Conclusions

This chapter has sought to explore the ways in which SNA can be used to understand the CCIs. In so doing it has highlighted some of the drawbacks inherent in such work. The level of abstraction required for SNA, for example, requires information about nodes to be stripped out and actors treated in a way which can't acknowledge their complexity. This limits the detail which can be gleaned from SNA and necessitates further work to be undertaken to triangulate findings, delve deeper in the nature of relationships within networks and to understand how broader factors contribute to a node's position in its ecology. This is especially important when using SNA to research the CCIs as they are characterised by a range of longstanding exclusions and exploitations which need to be highlighted and addressed.

This chapter has revealed the connections CCI enterprises do with other companies and work which is not defined as part of the creative industries by the UK's Department for Culture Media and Sport. The blurriness of the boundary between the CCIs and the rest of the economy, together with the limitations of the SIC system used to identify and focus policy on creative enterprises and highlights areas for further research. Moreover, the blurriness has implications for policy which needs to better appreciate the interconnections between the

CCIs and activities which fall into different spheres of economic, social and cultural development policy.

References

Bakhshi, H., Freeman, A., & Higgs, P. (2013). *A dynamic mapping of the UK creative industries*. London: NESTA.

Bielby, D. D., & Bielby, W. T. (1996). Women and Men in Film: Gender Inequality among Writers in a Culture Industry. *Gender and Society, 10*(3), 248-270. Retrieved from www.jstor.org/stable/189696

Butt, M., Cross, E., Holliman, N., Kempton, L., Legget, J., Mackenzie, E., Ross, H., Sapsed, J., Swords, J., Vallance, P. and Whitehurst, F. (2017) *Creative FUSE Initial Report*. Creative FUSE North East: Newcastle upon Tyne.

Carrington, P. J., Scott, J., & Wasserman, S. (2005). *Models and Methods in Social Network Analysis*. Cambridge, UNITED KINGDOM: Cambridge University Press.

Central Statistical Office. (1974). *Standard industrial classification (revised 1968)*. London: HM Stationary Office.

Comunian, R. (2011). "Social network analysis", *Regions*, 2(2), 3.

Crewe, L. (1996). Material Culture: Embedded Firms, Organizational Networks and the Local Economic Development of a Fashion Quarter. *Regional Studies, 30*(3), 257-272. doi:10.1080/00343409612331349618

Department of Communications and the Arts (1994). Creative Nation: Commonwealth cultural policy. Asutralia: Department of Communications and the Arts.

DCMS. (2016). *Creative Industries Economic Estimates*. London: DCMS.

DCMS. (2019). *DCMS sector economic estimates*. London: DCMS.

de Miguel Molina, M., de Miguel Molina, B., Santamarina Campos, V., & del Val Segarra Oña, M. (2016). Intangible Heritage and Gastronomy: The Impact of UNESCO Gastronomy Elements. *Journal of Culinary Science & Technology, 14*(4), 293-310. doi:10.1080/15428052.2015.1129008

Ekinsmyth, C. (2002). Project Organization, Embeddedness and Risk in Magazine Publishing. *Regional Studies, 36*(3), 229-243. doi:10.1080/00343400220122043

Fahmi, F. Z., McCann, P., & Koster, S. (2015). Creative economy policy in developing countries: The case of Indonesia. *Urban Studies, 54*(6), 1367-1384. doi:10.1177/0042098015620529

Fiesler, C., & Proferes, N. (2018). "Participant" Perceptions of Twitter Research Ethics. *Social Media + Society, 4*(1), 2056305118763366. doi:10.1177/2056305118763366

Garnham, N. (1990). *Capitalism and Com- munication: Global Culture and the Economics of Information*, London: Sage.

Gera, R., T. W. Haynes and S. T. Hedetniemi (2018). <u>Graph Theory: Favorite Conjectures and Open Problems - 2</u>. Cham. Springer.

Gerlitz, C., & Helmond, A. (2013). *New Media and Society, 15*(8), 1348.

Girard, A. (1982). Cultural industries: a han- dicap or a new opportunity for cultural deve- lopment? in UNESCO (1982): *Cultural In- dustries: A Challenge for the Future of Culture*. Paris: UNESCO.

Grabher, G. (2002). The Project Ecology of Advertising: Tasks, Talents and Teams. *Regional Studies, 36*(3), 245-262. doi:10.1080/00343400220122052

Granger, R. C., & Hamilton, C. (2010). Re-spatializing the creative industries: a relational examination of underground scenes, and professional and organizational lock-in. *Creative Industries Journal, 3*(1), 47-60. doi:10.1386/cij.3.1.47_1

Hampson, C., Lawless, S., Bailey, E., Yogev, S., Zwerdling, N., Carmel, D., . . . Wade, V. (2012, 2012//). *CULTURA: A Metadata-Rich Environment to Support the Enhanced Interrogation of Cultural Collections.* Paper presented at the Metadata and Semantics Research, Berlin, Heidelberg.

Jacomy, M., Venturini, T., Heymann, S., & Bastian, M. (2014). ForceAtlas2, a Continuous Graph Layout Algorithm for Handy Network Visualization Designed for the Gephi Software. *PLOS ONE, 9*(6), e98679. doi:10.1371/journal.pone.0098679

Joel, S. (2009). A social network analysis approach to a social model of the creative industries: the design sub-sector. *Creative Industries Journal, 2*(2), 191-201. doi:10.1386/cij.2.2.191/1

Kemeny, T., Nathan, M., & O'Brien, D. (2020). Creative differences? Measuring creative economy employment in the United States and the UK. *Regional Studies, 54*(3), 377-387. doi:10.1080/00343404.2019.1625484

Knox, H., Savage, M., & Harvey, P. (2006). Social networks and the study of relations: networks as method, metaphor and form. *Economy and Society, 35*(1), 113-140. doi:10.1080/03085140500465899

Kong, L., Gibson, C., Khoo, L.-M., & Semple, A.-L. (2006). Knowledges of the creative economy: Towards a relational geography of diffusion and adaptation in Asia. *Asia Pacific Viewpoint, 47*(2), 173-194. doi:10.1111/j.1467-8373.2006.00313.x

Kribs, K. (2016). The artist-as-intermediary: Musician labour in the digitally networked era. *ISCS, null*(null), 1.

Luckman, S. (2019). *Craft Entrepreneurialism and Sustainable Scale: Resistance to and disavowal of the creative industries as champions of capitalist growth*. Paper presented at the CAMEo Conference - Re-Futuring Creative Economies, Leicester, UK.

McFall, L. (2014). The problem of cultural intermediaries in the economy of the qualities. In Smith Maguire, J. and Matthews, J. (eds) The cultural intermediaries reader. London: Sage.

Miller, J. (2011). Producing quality: A social network analysis of coproduction relationships in high grossing versus highly lauded films in the US Market. *International Journal of Communication, 5*, 1014–1033.

Morelli, T., & Gunes, M. H. (2012, 26-29 Aug. 2012). *Video Game Industry as a Social Network.* Paper presented at the 2012 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining.

Mould, O., & Joel, S. (2010). Knowledge networks of 'buzz' in London's advertising industry: a social network analysis approach. *Area, 42*(3), 281-292. Retrieved from www.jstor.org/stable/40890882

Newman, M. E. J. (2006). "Modularity and community structure in networks." Proceedings of the National Academy of Sciences 103(23): 8577.

O'Connor, J. (2011). The Cultural and Creative Industries: A Critical History. *EKONOMIAZ. Revista vasca de Economía, 78*(3), 24-47.

Ozimek, A. M. (2019). The 'grey area' of employment relations in the Polish videogame industry. *International Journal of Cultural Studies, 22*(2), 298-314. doi:10.1177/1367877918821238

Potts, J., Cunningham, S., Hartley, J., & Ormerod, P. (2008). Social network markets: a new definition of the creative industries. *Journal of cultural economics*, *32*(3), 167-185.

Restrepo, F. B., & Márquez, I. D. (2013). *The Orange Economy - An Infinite Opportunity*. Online: Inter-American Development Bank.

Romer, C. (2018). Doctors supported to prescribe arts through new £4.5m scheme. Retrieved from https://www.artsprofessional.co.uk/news/doctors-supported-prescribe-arts-through-new-ps45m-scheme

Roodhouse, S. (2006). The Creative Industries: Definitions, Quantification and Practice. In C. Eisenberg, R. Gerlach, & C. Handke (Eds.), *Cultural Industries: The British Experience in International Perspective* (pp. 13-32). Online: University Berlin, Edoc-Server.

Scott, J. (2017). *Social Network Analysis* (Fourth ed.). 55 City Road.

Senekal, B. A., & Stemmet, J.-A. (2014). The gods must be connected: An investigation of Jamie Uys' connections in the Afrikaans film industry using social network analysis. *Communicatio, 40*(1), 1-19. doi:10.1080/02500167.2014.888361

Siepel, J., Camerani, R., Masucci, M., Valez Ospina, J., Casadei, P. and Bloom, M. (2020) *Creative Industries Radar: Mapping the UK's creative clusters and microclusters*. London: PEC.

Sucar, L. E. (2015). Probabilistic Graphical Models: Principles and Applications. London.

Swords, J. (2017). Crowd-patronage - intermediaries, geographies and relationships in patronage networks. *Poetics, 64*(null), 63-73.

Swords, J. (forthcoming). Social Network Analysis of the Creative Industries in Yorkshire and the Humber, UK. York: University of York.

Swords, J., & Liu, X. (2015). Visualizing urban and regional worlds: power, politics, and practices. In: SAGE Publications Sage UK: London, England.

Swords, J., & Wray, F. (2010). The Connectivity of the Creative Industries in North East England – The Problems of Physical and Relational Distance. *Local Economy, 25*(4), 305-318. doi:10.1080/02690942.2010.498954

Taylor, M. (2019). *Who Run the Arts? (Men): Social Network Analysis of Directors and Trustees in English Arts Organisations*. Paper presented at the CAMEo Conference - Re-Futuring Creative Economies, Leicester, UK.

Wreyford, N. (2015). Birds of a feather: informal recruitment practices and gendered outcomes for screenwriting work in the UK film industry. *The Sociological Review, 63*(S1), 84-96. doi:10.1111/1467-954X.12242

Wu, D. (2017). Rethinking creative industries research: Synthesizing the Creative Class thesis, clustering, and global production network approaches. *Geography Compass, 11*(12). doi:10.1111/gec3.12348

Zweig, K. A. (2016). Graph Theory, Social Network Analysis, and Network Science. In K. A. Zweig (Ed.), *Network Analysis Literacy: A Practical Approach to the Analysis of Networks* (pp. 23-55). Vienna: Springer Vienna.