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Creative clusters and the evolution of knowledge and skills: from industrial to creative glassmaking

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Abstract

Glassmaking is considered part of the craft sector and represents an interesting cross-over between design and artistic research and industrial (material and technical) innovation and understanding. However, in the history of glassmaking - which has for centuries concentrated in regions that could provide energy and primary materials - we can recognise the struggle for preserving and developing glass making skills through processes of skill development and deskilling. The paper reflects on the emergence of new craft-based glassmaking in post-industrial contexts where glass was traditionally produced industrially, giving us the opportunity to question processes of deskilling, re-skilling and upskilling in relation to industrial, post-industrial and creative making. Using in-depth qualitative interviews across two case studies of glassmaking clusters in the UK cities of Sunderland (North East) and Stourbridge (West Midlands) we consider the role of tradition and local knowledge as well as the importance of networks and infrastructure. We propose to investigate how the old industrial past of these two locations, specifically how knowledge and skills are traditionally lost, is reinvented and re-used in the new glass making work taking place today. Finally, the paper reflects on how skills and knowledge from traditional industrial clusters might connect to new models of flexible and specialised production in the creative and cultural industries through phases of deskilling, reskilling and upskilling.

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1.1 Introduction

The development of creative clusters and their potential to revitalise the economies of often lagging regions has been a key argument in economic geography and urban studies literature in the last two decades in the UK. However, most of this literature presents the creative industries and their patterns of co-location and clustering (Chapain et al. 2013) as a policy strategy or intervention that can easily be implemented and adopted across a range of regions and cities, often with very little connection to their present economic structure or industrial past.

The results of these interventions have been very limited and case studies of failure in top-down interventions have also been highlighted (Mould and Comunian, 2015). One of the main criticisms made was the disconnection between these interventions and the specificity and traditions of their local context, highlighting policy blindness to issues of long-term development and evolutionary dynamics within local development. The other – maybe more recent – policy resolution is that intervention is not necessary, and that a laissez-fair approach will ensure the spontaneous development and growth of new silicon roundabout and creative clusters.

Berg and Hassink (2014) highlight that these extreme policy outcomes are mirrored in the academic literature, with a very limited amount of research trying to give a long-term perspective on creative clusters development and their link with historic evolutionary perspectives regarding crisis, re-organisation and adaption in the development of new economic systems in old post-industrial contexts.

Large parts of the literature on clusters and industrial districts address the role of trust, social networks, learning environments and institutional infrastructure (Amin, and Thrift, 1995; Banks, 2010), while literature on the evolution of industrial and post-industrial clusters further highlights the embedded nature of knowledge and skills held in specific places and institutions (Asheim & Isaksen, 2002) and often subject to specific lifecycles (Fornahl et al., 2010). It is indicated that such 'stickiness' is a key dynamic of cluster development (Bathelt, et al. 2004) with regional or context-specific tacit knowledge playing an important role in the development and transfer of skills (Gertler, 2003).

Against this backdrop, this paper focuses on a specific sector of the creative economy – craft, a contested field that has been investigated only partially and often considered at the boundary of the creative economy in itself (for a review see Luckman, 2015). There are a variety of reasons for this. Firstly, the limited size (and economic value) of the sector (Bakhshi et al. 2013) presents challenges in developing useful policy frameworks to support innovation and economic growth (Harvey et al. 2012). This links to the lack of attention given to craft in the literature as it is considered less important and more dispersed than media sector, film, design and music clusters (ibid). Subsequently, the craft sector is often undervalued in reference to its ability to generate economic growth, with social and cultural externalities tending to form the main focus.

A third issue relates to how the sector sits somewhat uncomfortably between creative arts and design; informed by original ideas, which are central to the Department for Culture, Media and Sport (DCMS) definition of the creative economy, and making/manufacturing which appears to be looked down on within policy discourses on knowledge and post-industrial economies.

The status of craft skill, both in industry and creative practice, is a further issue that has plagued the sector since the Renaissance period in that it is often seen as lower value than creativity (Adamson, 2007). Banks (2010) has also noted that despite the integration of craft skills within a broad range of creative industries sectors including economic high-performers such as media and film, their contribution is seen as supplemental and rarely acknowledged by industry or academic studies.

This paper reflects on the emergence of new craft-based glassmaking in post-industrial contexts where glass was traditionally produced industrially. Historically, the first craft deskilling happened due to emerging mass production and industrialisation in the UK, however, further deskilling and potential loss of knowledge and production practice has occurred more recently through de-industrialisation and international outsourcing of production in many craft sectors, including

glassmaking, ceramics and textiles. Our consideration of new contemporary practices gives us the opportunity to question processes of deskilling, re-skilling and upskilling (Gallie, 1991) in relation to industrial, post-industrial and creative making.

In order to consider the impact of this history and the relevance of clustering, knowledge, skills and geography in contemporary studio-based glass making, we take into consideration two key locations in the UK: Stourbridge and Sunderland, which share the presence of an historical and contemporary concentration of glassmaking activities. Via qualitative interviews and ethnographic work we explore how, in these two different contexts, individual research practice (particularly design and materials development) and place-based knowledge enable the success of glass artists and makers and facilitate the potential for the sector to be a key player in local economic development. The comparative nature of the research project will enable us to assess how these different factors come together and develop historically in different contexts. Attention is given both to the personal / individual understanding of these local dimensions (McAuley & Fillis 2005) and also to its policy and public support implications and interactions. The relevance of researching this specific field lies in the way glassmaking incorporates both industrial-technical knowledge and artistic and designed-based added value, making it an ideal context to research the way local industrial knowledge is nowadays being reinvented in new post-industrial, creative frameworks (Yair et al., 1999).

Bringing together the literature on clusters and their evolutionary nature in this context, the paper also engages with the literature on path dependency and adaptation in evolutionary economic geography and the literature on deskilling, reskilling and upskilling (Christopherson et al 2010; Comunian & Jacobi, 2015; Gibson, 2016) to understand how the industrial heritage of these two locations is reinvented and re-used in new glass making work taking place. We are interested specifically in how the creative industries and creative economy remain mostly underexplored in this literature.

In the first section, we review the key ideas from the literature focusing on how 'sticky' knowledge has been overlooked in the study of creative clusters. Here we also consider the connection between knowledge and skills pattern development and how, in contrast to digital clusters or contemporary creative clusters associated with a specific music or art scene, the craft sector demonstrates a connection between industrial and post-industrial economies and the translation of industrial knowledge into new creative outcomes and markets (Pollard, 2004). We then introduce two case studies in the UK (Stourbridge and Sunderland) to discuss changes and economic development specifically in relation to glass-making in the creative economy. Using qualitative interviews and data from extensive field work in these locations, we consider how glass makers in these areas relate their work to the local traditions of industrial glass making and also how knowledge, networks and cultures of making are passed on and demonstrate evolution and adaptation from the industrial economy to the new post-industrial creative economy. The conclusions highlight the need for more research to consider the longitudinal dimension of knowledge, but also to re-draft the genealogy of the creative economy within old industrial traditions and networks in order to account for connections with specific geographies and places. Finally, we reflect on how skills and knowledge from traditional industrial clusters might connect to new models of flexible and specialised production in the creative and cultural industries through phases of deskilling, reskilling and upskilling (Heisig, 2009).

1.2 Place, knowledge, skills and 'stickiness': an evolutionary perspective

Literature on the role of regions and locales in the preservation and development of industrial and post-industrial clusters has highlighted that the 'stickiness' of knowledge and skills and their embeddedness in places and institutions are key dynamics of clusters development (Bathelt, et al. 2004). Gertler (2003) provides a useful overview of the importance of tacit knowledge and its connection with skills development and transfer: the "tacit component of the knowledge required for successful performance of a skill is that which defies codification or articulation – either because

the performer herself is not fully conscious of all the 'secrets' of successful performance or because the codes of language are not well enough developed to permit explication" (p. 78). The craft sector is certainly under-researched by economic geographers (Gibson, 2016) and a preference towards manufacturing and innovation-led industries can be observed in the choice of sector and case studies analysed. Historically, the craft sector has been considered backwards looking and potentially rejecting innovation in favour of tradition (Warburton, 2016). However, the emergence of flexible specialisation (Phillimore, 1989) and the expansion of cultural product markets (Scott, 1996) has given the sector a new revival and new centrality in both making (Capdevila, 2013) and soft innovation (Eltham, 2013).

Nonetheless, moving from different modes of productions or industrial phases, in this article we are particularly interested in understanding how knowledge and skills are retained, preserved and updated within the same locale, and what mechanisms facilitate or hinder the re-invention of knowledge from industrial to post-industrial and creative. The 'stickiness' of skills and knowledge is recognised in the literature as being embedded in "regional resources" (Asheim, and Isaksen, 2002, p.77) including "place-specific, contextual knowledge of both tacit and codified nature, that, in combination, is rather geographically immobile". Subsequently, there is a risk of embedded knowledge and networks becoming "strongly self-referential and subject to lock-ins" (England and Comunian, 2016: 159; Visser and Boschma, 2004) which could hinder processes of industrial restructuring, reskilling and upskilling. However, linked to the growing interest in high-tech clusters and economic development, the greatest concern for the literature is innovation, while very little is explored in terms of knowledge preservation and tradition.

We aim to link the current understanding of knowledge embeddedness and 'stickiness' with its necessary evolution and change through time to reflect on its adaptation and re-organisation (Holling, 1986). Here we support the argument for a 'grounded and critical evolutionary approach' (Gibson, 2016) which contextualises this embedded knowledge and skills within changing labour environments. In this respect the efforts of some scholars to consider the importance of knowledge evolution and the drawbacks deriving from a lack of such evolution in old industrial clusters (Hassink 2010) can pave the way to repositioning the importance of skills as "deeper, place-specific inheritances" that "intersect with uneven geographies of growth and decline from the mass-manufacturing era" (Gibson, 2016 p. 82).

In the paper we argue that the evidence for embeddedness and 'stickiness' can usually be articulated around three main categories, firstly, the role of labour and knowledge pools created around an expertise or sector and their connected networks. While the industrial fabric of a place can often change quickly due to industrial-restructuring or other global economic dynamics, the labour force takes much longer to be re-located or re-purposed. In particular, as Tomlinson (1999) highlights, the evolution of new learning economies means that we rely much more on skill, however, workers with obsolete skills require much longer to acquire new skills to contribute to the economy. Therefore, skills and tacit knowledge seem to have the ability to 'stick' around for longer than they are required. While we could see this as a limitation and challenge in shifting from an industrial to a post-industrial economy, we should also consider what advantage this might have for specific places.

Another important element of embeddedness is linked the idea of brand and place branding (Pike, 2009). Where production might be outsourced or internationalised, places which have had long-term associations with the production of a specific product (and knowledge / leadership in its making) can sometimes retain their reputation longer than the production itself. Finally, and possibly most recognisably, is the role that institutions can play in connecting knowledge and skills to place. There is a lot of literature on the role of knowledge and educational institutions in industrial clusters (Goddard and Vallance, 2013; Chatterton and Goddard 2000), with Universities or R&D platforms cited as creating knowledge and learning and specialised human capital which feed into the cluster. The presence of specialised university courses or business advice services is often key to the resilience of these clusters and the influx of new producers that perpetuate innovation and value

creation. However, there is much less understanding of the role of heritage institutions and museums in preserving and connecting existing knowledge (both knowledge of style and repertoires as well as technical knowledge of historical processes of production) with new forms of creative production (Jonsen-Verbeke 1999). All of this research highlights the 'stickiness' of knowledge and skills and suggests that they remain embedded in place. However, given the long-term connection between place, knowledge and skills, we believe it is important to frame this in an evolutionary perspective and consider in particular the changes that such knowledge and skills might be subject to over time as they adapt.

Recent works by Berg (2014) and Berg and Hassink (2014) have also highlighted the limited use of evolutionary perspectives in the case of research on creative industries and creative clusters. This has been partly linked to their 'newness' as they emerged in the late 90s as a policy tool (DCMS, 1998), but also to their re-branding in connection with digital innovation and as a new sector disrupting the industrial past and providing an economic development alternative to the disappearing manufacturing sector (O'Connor, 2009). However, the changes brought about by the recent recession have highlighted to researchers and policy makers the challenges faced by creative and cultural producers, but also the effect that these challenges can have on the urban landscape, with a halting of regeneration plans and an increasing number of empty shops and abandoned public spaces (De Propriis, 2013; Felton et al., 2010; Pratt, 2009). In this context, words such as 'resilience' and 'adaptability' have become common jargon used to refer to the creative sector and justify cuts and vulnerable working conditions (Leadbeater et al., 2008; Robinson, 2010). These economic changes, in strong contrast with the positive innovation-led rhetoric of the early 2000s, have however highlighted the importance of looking at creative industries within an evolutionary perspective and re-considering its previous roots and longer term trajectories (Comunian and Jacobi, 2015). In particular, we think a better understanding of the complex interconnection between industrial and post-industrial knowledge is needed. The argument for the stickiness of knowledge in specific regional contexts highlights how knowledge persists but also how it needs to change, adapt and evolve. Holling's (2001) 'cycle of adaptive change' was developed as a tool to understand dynamics and changes in ecosystems, focusing on the changing processes of destruction and re-organisation alongside growth and conservation. Traditionally, these latter stages have attracted more attention from researchers as the growth and preservation of status quo has been the focus of much of ecology research. However, the phases of release and re-organisation play a key role in the evolution of the system, which instead of collapsing can re-build and reconsolidate. Such systems can move through these phases and re-emerge and re-organise over time. This paper is specifically interested in exploring the re-organisation phase, particularly how knowledge and skills which were part of the local industrial production systems might be re-organised in new forms of creative, studio based production within craft. While the process of deskilling is usually looked at negatively, following an adaptive cycle we can recognise that deskilling can also be an opportunity for initiating a process of re-skilling, and generally upgrade the existing stock of knowledge and skills available. This is valid at an individual level but also at the collective level as institutional learning also requires a degree of forgetting and un-learning to respond to ever-changing future scenarios (Hassink and Legendijk 2001).

If we apply Holling's (2001) cycle to local knowledge development and evolution, we could identify that at the beginning the system experiences a period of rapid growth or exploitation. This is a phase where there is a lot of investment in skills development and training. In the following phase of conservation, energy is stored, social capital is built and knowledge slowly accumulates. Here the focus is on preserving knowledge and skills and retaining them in the local context. However, it is also highlighted in the literature on the lifecycle of clusters (Fornahl et al., 2010) that consequently, fewer new connections are established as the system aims to exploit and preserve existing connections and capital developed in the growth phase. This is often linked in the literature with

problems of lock-in (Boschma, 2005) and periods of conservation are subsequently characterised by resistance and rejection of change. Skills at this time tend to become standardised and institutionalised, which does not favour innovation or creativity. If we think about the final phases of the industrial period in the UK, we see that resistance and the will to preserve the status quo were useless in response to international political changes and global economic pressure. The following phase of collapse or release is the result of multiple shocks or changes that affect the connectedness and stability of the system. As a result, the system comes undone or collapses, connections are broken or become weaker and the knowledge capital built often leaks out of the system resulting in deskilling. In economic geography this frequently is linked to phenomena of migrations or unemployment, which often cause knowledge and skills to be lost or dispersed. However, the consequent phase identified by Holling (2001) suggests that not all is lost. Instead of talking about a re-start, Holling uses the word reorganisation. He highlights a high degree of uncertainty as the system explores new options, which brings a phase of reorganisation and renewal where new opportunities and ideas can re-shape the system. In relation to skills this could correspond to re-skilling or up-skilling.

1.4 Researching craft and glassmaking: methodology and case studies

The choice to focus on craft was motivated by the acknowledgement that, while it is often overlooked and contested (Luckman, 2015) as part of the UK creative industries sectors, it also notionally maintains strong connections with the country's industrial past, often with regional specificity (Brown, 2014). Although craft, within the new creative industries policy framework, has received attention and investments in the recent years, the nature of the sector (comprising small and micro enterprises – often sole traders) has presented many challenges to policy makers, particularly in mapping and estimating the contribution of craft to the UK creative economy. Furthermore, very little research is available on the role of clustering in the sector in the UK, apart from an acknowledgement of its link with rural and regional economies (Thomas et al., 2012). While Comunian and England (forthcoming/2017) consider the case study of creative clusters in the West Midlands to highlight their interconnection with previous industrial knowledge in the case of pottery, jewellery and glass, this article focuses on a specific sector (glass making) to consider evolutionary dynamics from industrial to post-industrial creative production in two different clusters in the UK.

The research project started from an in-depth historical desk research which highlighted the common and yet distinct trajectories of glass-making in Sunderland and Stourbridge (as outlined in Table 1 and in greater detail below). Multiple visits to the location of Sunderland and Stourbridge took place between 2007 and 2015 to collect ethnographic accounts during specific events as well as visit to institutions and local studios in the two clusters. The length of the research project and repeat visits by two researchers highlights the centrality of evolutionary thinking within the project and the importance of gaining an in-depth understanding of the context overtime to reflect on changing patterns and adaption processes. The paper is mainly based on a collection of 23 semi-structured interviews undertaken during this period. The interviews were mainly conducted with local artists and makers but also include the contribution of one policy maker in each locale (one working for a local authority in Sunderland, one for a now-dissolved regional authority in Stourbridge) as well as experts based in the educational institutions and museums involved in the clusters (two in Sunderland and three in Stourbridge) to provide a broader overview of the context and development of the sector. A thematic analysis was applied to specifically consider the way interviews could articulate the local knowledge dynamics and their connection with the industrial past and the future of the cluster.

Themes were drawn from across the two cases to highlight commonalities in key facilitators and hinderers of evolution, adaptation, path dependency and creative reskilling and upskilling, although contrasts between the two locations are also noted within the analysis.

It is clear from a review of the literature that research on cultural quarters and creative clusters in the UK has tended to shy away from concentrating on makers, in favor of analyzing new digital clusters or artistic urban villages. The major studies of clusters engaging with both industrial production dynamics alongside new development in a creative industries framework and post-industrial economies are studies of the Jewelry Quarter in Birmingham (Pollard, 2004; De Propris and Wei, 2007) and the Staffordshire ceramic/pottery cluster (Sacchetti and Tomlinson, 2006; Jackson and Tomlinson, 2009; Tomlinson and Branston, 2014).

Glassmaking both as an industry sector and as a creative and artistic practice of production is under-researched but it is definitely acknowledged that historically it has always been a highly clustered activity across Europe (Starbuck, 1983; D'Amico et al. 2007; Segre and Russo, 2005; Godfrey, 1975). The specific development of glass making in Sunderland and Stourbridge exemplifies perfectly a mix of raw materials, access to transport and labour possibility to distribute the products internationally. As in many manufactory processes, the opening up of new international markets offering cheaper labour and manufacturing conditions (especially in Eastern Europe and later in East Asia) meant a slow but constant collapse (and reorganization) of UK production from the 1970s until the end of the 20th century. The development of a studio glass movement in Stourbridge (from the 1960s) and a more recent cluster of artistic production in Sunderland highlights a shift towards post-industrial, symbolic and artistic production of glass, as part of specialized flexible production development (Storper, & Scott, 1990). While the case studies could be read as examples of a contemporary creative cluster, our focus argues for a better understanding of the long-term, historic and knowledge conditions that lay behind the development of this contemporary concentration of creative production.

Glassmaking Industry Characteristics		
Location	Sunderland	Stourbridge
Specialism	<ul style="list-style-type: none"> • Antique glass • Pressed glass • Pyrex 	<ul style="list-style-type: none"> • Lead glass tableware • Cut crystal
Establishment	<ul style="list-style-type: none"> • Started in 7th Century • Facilitated by access to raw materials 	<ul style="list-style-type: none"> • Industry began in 17th Century
Growth and employment	<ul style="list-style-type: none"> • Steady growth 17th-18th Century • Revolutionised by development of new technologies and mass production methods • Around 3,000 people employed at Jobling & Co. in 1960s 	<ul style="list-style-type: none"> • Industry began in 17th Century • Growth throughout the Victorian Period • Employed over 2,000 people until late 20th Century

Decline	<ul style="list-style-type: none"> Declining manufacturing in the mid-19th century – cost of resources, import and internationalisation Factory closures throughout 20th Century, last factory closed in 2007 	<ul style="list-style-type: none"> Decline in late 20th century – environmental, health and safety, import, internationalisation, competition and social shifts
Contemporary reorganisation and education	<ul style="list-style-type: none"> Establishment of specialist University degree in 1982 Establishment of national glass network Cohesion in 2001 University acquisition of NGC in 2010 	<ul style="list-style-type: none"> Development of studio glass at Stourbridge College in 1960s Establishment of an International Glass Festival in 2004 Courses at Stourbridge moved to Wolverhampton University
Conservation	<ul style="list-style-type: none"> National Glass Centre opened in 1998 to preserve skills and showcase heritage 	<ul style="list-style-type: none"> Visitor attractions opened in 1984 and 2002 Generation of craft tourism through international events and capitalising on local heritage

Table 1. Glassmaking industry characteristics

Glassmaking in Sunderland

Glassmaking in Sunderland dates back to the 7th Century (NGC, 2015), growing throughout the medieval period and forming the “basis of the explosion of high quality glass produced in the Region from the start of the Industrial Revolution to the latter part of the 21st century” (Swan, 2002, p.3). Attributed to access to coal and sand, providing cheap fuel and raw ingredients, and easy exports (predominately to Europe) via the local shipping industry (NGC, 2015), the successful industry grew steadily throughout the 17th and 18th centuries before being revolutionized through the development of mass-produced pressed glass in the mid-19th century.

However, the factors that enabled the growth and success of the Region's glass industry also led to its demise at the end of the 19th century by which time many factories had closed. The last remaining manufacturer in Sunderland, James A. Jobling & Company, which in 1968 had employed around 3,000 people, moved production to France and closed in 2007 (Victoria County History, 2017) marking the end of glass manufacturing in the region. However, the development of support networks for craft makers in the Region eventually resulted in the creation of the first single Honours undergraduate degree in glass in 1982 (Davies, 2007) at Sunderland Polytechnic, now University of Sunderland. The closing of Hartley Wood and Co in 1997 also generated fear that the specialist glassmaking skills of craftsmen who had been working in the factories would be lost and the prevention of de-skilling subsequently formed “the driving force behind a new National Glass Centre” (Victoria County History, 2017: 2). The National Glass Centre (NGC) opened to the public in 1998 as a means of skills preservation but also to “showcase the city’s link to the creation and production of glass over the centuries” (Short and Tetlow, 2012, p. 283).

The NGC became part of the University in 2010 and the role of glass education in the region is significant; Sunderland University is now one of the few remaining providers of higher education programmes in glass in the UK following a spate of closures in 2010 due to high running costs (Petrova, 2010). Today, the North East is home to the largest number of glass makers in the UK, the majority of whom “have been educated in, or have some association with the Glass department of the University of Sunderland” (Davies, 2007, p.16). It has also been suggested that these

organisations “are the driving force within the region” (*ibid*). Most recently, the resilience of making, and the evolution of city’s industrial past into new forms of creative production, including glassmaking, have been dominant within Sunderland’s bid for City of Culture 2021 (Sunderland 2021, 2017).

Artist's formal groupings have also been influential in maintaining the glassmaking community in Sunderland. Cohesion, which was founded in 2001 with support from the City of Sunderland, was unique to the region as a specialist glass group, although today studio spaces are not specifically reserved for glassmakers (Creative Cohesion, 2017). This suggests that in the current economic climate, the University is critical in ensuring the future of contemporary glassmaking in Sunderland and the North East as the largest provider of educational and professional opportunities in the region. However, educational reforms and the closure of glass workshops across the UK pose significant challenges to glassmaking (Davies, 2007). Following a trend of de-specialisation and amalgamation in craft education (Crafts Council, 2016), the course at Sunderland also rebranded in 2017 as Artist Designer Maker: Glass and Ceramics (University of Sunderland, 2017).

Glassmaking in Stourbridge

The Stourbridge glass industry began in the 17th century and towards its end glasshouses had begun to make the region’s famous lead glass tableware (Dudley Metropolitan Borough Council, 2016). The industry flourished throughout the Victorian period and continued until the early 20th century (Farmer, 2008) due predominantly to the success of regional cut crystal (DMBC, 2016). Until the late 20th Century four major companies were based in Stourbridge; Thomas Webb and Sons, Webb Corbett/Royal Doulton, Royal Brierly Crystal and Stuart Crystal. During this time over 2,000 people worked in the glass industry, with over 1,500 of those employed by the four major companies. Others were working for small companies and as sole traders (Dudley Borough, 2015) as is common today (Crafts Council, 2014).

Once a booming industry and driver of the regional economy, the glass industry began to decline towards the end of the 20th century, attributed to a number of factors; ‘Environmental issues, Health and Safety, rising energy costs, European competition, life style tastes and changes’ (Dudley Borough, 2015). Factories closed or went bankrupt (Dudley Borough, 2015) and Stourbridge’s iconic Red House Glass Cone became a Working Museum in 1984 and visitor attraction in 2002 (DMBC, 2016).

However, Stourbridge continued as an important location for glass artists, collectors and exhibitors (Brocklehurst, 2010). As with Sunderland, this was partly due to the Glass programme at Stourbridge College of Art and Design. Whilst industry remained, many skilled glassmakers from the major production companies were employed by the college to teach (Dudley Borough, 2015). Teaching at the College was also heavily influenced by Sam Herman (Cummings, 2005), a pioneer of the British Studio Glass movement in the 60s, encouraging the development of Contemporary Glass in Stourbridge. At this stage, the training of glass designers was the priority of the College and links between industry and education were maintained until the mid-20th century when the industry was no longer viable (*ibid*). Today the programme is run by Wolverhampton University which takes a more flexible, interdisciplinary approach (Cummings, 2005) and ‘the Stourbridge glass industry now consists of some small traditional cut glass manufacturers and a handful of studio glassmakers’ (Dudley Borough, 2015).

One of the ongoing drivers of contemporary glass practice in Stourbridge is the biannual International Festival of Glass (IFG) and the British Glass Biennale (BGB) (Brocklehurst, 2010), held at The Ruskin Glass Centre since 2004. These events have “grown to be recognised internationally, nationally and regionally” (*ibid*), and their location has been described as key to the success of the event (Farmer, 2008) which has also been attributed to the strong glassmaking heritage of the town and local pride.

The success of the IFG and Biennale indicates the resilience of the artists, institutions that take part and produce the events. The 2010 exhibition was described as “particularly important as it [was] achieved within a very challenging economic climate at all levels” (Brocklehurst, 2010, p.4).

In addition to an industrial glassmaking heritage, a commonality between Sunderland and Stourbridge is that both are increasingly associated with craft tourism (Dudley Borough, 2015). This is an international trend that has led to a rise in open studio events and glassmaking ‘experiences’ as commercially viable manifestations of contemporary glass making, capitalising on the experience economy (Gilmore and Pine, 1999). While it is clear that both Sunderland and Stourbridge are two main areas of historical glass production, and that they remain key locations in British Contemporary Glass, it appears their greatest commonality is the resilience of their glassmaking communities and the way they have changed and adapted overtime in response to major shift in labour and production dynamics. Growing from industrial roots to form contemporary artistic and academic groups that have clear links to their heritage, they are able to capitalise on this through tourism, small scale glass production and glass education.

1.5 Knowledge resilience and skills in UK glass making in Stourbridge and Sunderland: an evolutionary perspective

Historical evolution and change in the context of production

Before looking more closely into the dynamics of place and knowledge evolution and re-organisation, it seems important to reflect on the accounts of interviewees regarding historical changes in glass making in the contexts of Stourbridge and Sunderland. Especially as for many there was a strong acknowledgement of links with the collapsed industrial glass industry. A few interviewees highlighted the great history of growth, the production and conservation of international status over the years but also the tragic collapse of the industry in a very short space of time. This can be understood using Holling’s (1986) framework and is common to other case studies (Gibson, 2016). Interviewees also strongly associated the increase of import and the reduction in number of companies in the area with the loss of knowledge and skills in production. This local ‘deskilling’ corresponds to a redundancy of knowledge and expertise as import became much more valuable than local production (Hudson, 2011). In this instance, deskilling emerged as a consequence of delocalization in glass production and a loss of sector specific knowledge. However, in these historical accounts there was also a lot of emphasis on continuity and re-organisation of people and knowledge, which is the focus of the analysis here. Re-organisation was articulated through the value of place, people and institutions and was something that some of the interviewees experienced first-hand. We next discuss factors that contributed to the case study locations’ ability to both draw in and retain artists and makers and to foster new knowledge and skills development despite the loss of industry.

you’ve come at quite a strange and difficult time for glass. The glass industry, glass makers and anybody associated with the uncertainty of the sector, all the factories closed [...] and yet there have been people like me, my brother and numerous people that we have studied with and met, before and after, have come to the area specifically, uprooted and whatever, change of direction, to pursue the knowledge and art of glass making (Glass Artist, Sunderland)

Legacy, brand and tradition: from industrial to post-industrial clusters

Firstly, the local heritage enabled the attraction and retention of new and existing makers in both locations, creating a path-dependency in the evolution of contemporary craft production (Gibson, 2016). Glassmaking was recognized as a specific kind of localized production in places and regions

which, as presented by respondents, often did not have much else to offer. However, while for Sunderland a requalification of its history of industrial glass making was connected to the development of the National Glass Centre, a millennium lottery funded regeneration project, for Stourbridge it was linked to the heritage of 17th century glass making in the area. Many respondents were also able to identify a brand and legacy that the place offered.

Sunderland's strong brand is the National Glass Centre, and if you step outside the National Glass Centre yes there are glass makers but the brand is the National Glass Centre. If you step into Stourbridge the brand is the history, it's 17th century glass began here [...] so this is trading on heritage. (Glass artist, Stourbridge)

Contemporary glass artists also recognized the tradition and glass making heritage in the area they were working and the value that this brought to their work. In this, artists are drawn to and able to draw from the reputation, specialist skills and knowledge of industry-trained makers still residing in the region and connected with local institutions. Artists also used words like 'evolution' and 'renaissance' to describe how they see themselves embedded in the tradition and legacy that stems from the historical industrial production.

Institutions certainly play an important role in keeping the tradition, legacy and its memento alive, particularly in establishing and strengthening the brand with events, activities and generally safeguarding the history (Amin and Thrift, 1995). Another important element which facilitates and connects the historical legacy and tradition with modern glass making is tourism (Jonsen-Verbeke, 1999) and markets for artists facilitated by specialized events like the British Glass Biennale.

I think in view of how the traditional industry has declined I think what is going on now, I think a few of us have perceived it as being more of a renaissance really. And so yeah, it's a re-birth. (Glass Artist, Stourbridge)

However, place brands are not just about glass but the research and innovation that influenced the evolution of glassmaking and is intertwined with the locale. The evolution of skills is here highlighted in terms of the way they have moved from factories to studios and are being adapted by contemporary artists. This adaptation was seen as both a means of developing new contemporary practices and preserving traditions. In some cases, de-skilling and un-learning factory techniques in favour of creatively upskilling becomes an opportunity for new skills to emerge. In others, it is the previous knowledge which gets re-contextualised outside the factory. The co-location and combination of factory and artistic skills was also found in local institutions where factory-trained glassmakers worked alongside studio-artists, enabling skills transfer, retention and adaptation.

What's always been respected about this area, is the innovations that have come out [...], the artists in this region predominantly are doing studio skills and techniques, so what they're showing is some of the skills that you would have seen in the factories, the hand-making skills that is, they have kept that tradition alive. (Glass Artist and educator, Stourbridge)

Knowledge, infrastructures, institutions and networks

As in the general industrial cluster and creative cluster literature, a lot of emphasis was placed on the importance of networks and infrastructure in the contexts of both Sunderland and Stourbridge. In particular, we articulate the role of cultural institutions – which is strongly linked to the argument for a legacy and heritage of the industrial glass making – but also the importance of the educational institutions that once served industry. Finally, we highlight the importance of peer-networks and knowledge networks.

Educational institutions are key both to Sunderland and Stourbridge glass making with many of the local artists coming to the location to study or specialize and staying on afterwards. The role of academic institutions is widely recognized in clusters (Lorenzen and Foss 2003) and in both contexts they play a role in enabling the use of central facilities which might not be available to all glass makers. Here, educational institutions play an important role in developing new skills, but also in retaining and attracting researchers and newly-skilled workers to the area.

Those businesses have been supported by what's going on regionally [...] the tourist potential of glass is recognised, and also through what the college have done and what IGC have done in facilitating, not breaking a thread, enabling graduates to continue to use the facilities on a study basis but being flexible in that mode of study. (Glass Artists & Educator, Stourbridge)

Another important element of the institutional infrastructure of both Sunderland and Stourbridge is the cultural institutions that have emerged in the locale and support, exhibit and promote glassmaking. In Sunderland this is specifically the case of the National Glass Centre, which was the recipient of the first major arts lottery award in the North East and the first Arts Lottery Funded building there. In respect to Stourbridge, the range of institutions involved in the promotion and celebration of glass is even wider, including museums, specialised libraries, a production quarter and the establishment of a Biennale from 2004. In this Stourbridge could be seen as having a broader network and support base for glass than Sunderland where the network is centred around the NGC and the University. Such embedded networks could lead to lock in (Boschma, 2005) and issues in institutional mediation of knowledge transfer and skill development (England and Comunian, 2016). Such organisations were nevertheless credited with preserving the regional heritage, generating wider public interest in glassmaking and facilitating the clustering of businesses that in turn created valuable networks for glassmakers.

I mean I say without the National Glass Centre being built in Sunderland you know there probably wouldn't be any glassmaking at all. So, it just carries on the tradition that's been here for hundreds of years (Glass Artist, Sunderland)

In relation to both Sunderland and Stourbridge, the cultural institutions also provide an important context for production and career advancement, especially in relation to hiring equipment or facilities to create work. In addition to the knowledge network and support provided by the institutions in each context, many also highlighted an overall supportive environment and ability of glass artists to share knowledge, network and support each other.

advantages are that you have this network of makers, and we've done some group things together and it's offered us access to places that as an individual you would maybe not have got - definitely wouldn't have got. So as a group of Stourbridge makers that's opened doors for us I'm sure. And yeah the equipment, the people, the knowledge that's here is all beneficial. (Glass Artist, Stourbridge)

All of these elements highlight an 'institutional thickness', the presence of a high degree of overlapping institutions and organisations all acting within the glass making field, which of course also creates a thickness in knowledge networks and a passing of knowledge from one generation to the next.

Specialised embedded knowledge: glassmaking from industrial to post-industrial

More consideration needs to be placed on the specialised knowledge and skills which were developed during the industrial period and used in factory glass making and their resilience beyond

the industrial context in post-industrial, artistic and studio glass making. There is a degree of knowledge which transfers from industry directly through people who lost their job in the glass industry during the major economic shift and continued in glass art and education. However, this is becoming rarer as time passes by. Nevertheless, there was an indication that ex-factory glassmakers were 'reskilling' in artistic techniques in order to access new markets for glass.

I mean when we started we were in an industrial background at Pyrex and we were scientific glass blowers making laboratory ware. But from there we've developed our skills in the art side, um, and contemporary glass, you know, we've gone that way. (Glass Artist, Sunderland)

Many interviewees highlighted the presence of highly experienced individuals in the area with a great degree of specialised knowledge and how this knowledge is shared within the network. However, the traditional and industrial skill-resources in these locations can be viewed as finite unless skills are passed on to the next generation of makers. It was also highlighted that material culture and know-how needs to be preserved in embedded and embodied forms in order to be valuable in craft, emphasising the role of museums and cultural organisations as sites for preservation and the facilitation of knowledge transfer.

"you can get glass makers who [...] want to look at the collection, they might want to look at something specific and actually be able to handle it in order to figure out how it was made. [...] We've had bits of old equipment we've had up there and they've had a go at using to work out how it works" (Museum worker, Stourbridge)

As glassmakers trained in industry reach retirement age or reduce their practice there is a risk that these skills will be lost altogether, although educational and sector institutions could mitigate this by ensuring that this knowledge is passed on to new generations of glassmakers in addition to developing new technology-driven skills in contemporary glass. The introduction of new technologies to glassmaking, particularly digital technologies, does however indicate 'reskilling' in these locations as glassmakers apply their material knowledge to new forms of creative production. Subsequent new specialised knowledge creation may perpetuate the attraction of researchers and newly-skilled workers to the area. This may be a particular strength for Sunderland given the continued presence of the University which opened a digital fabrication lab (FabLab) in 2015. Furthermore, there is a great degree of knowledge transfer which takes place from institutions (educational and specialised cultural institutions) to the sector that expands beyond the specifics of glass making to include the whole supply chain and the tools and equipment that make the sector viable (Amin and Thrift, 1995). This has further ripple effects such as developing the potential to contribute to work in other sectors (e.g. links with metalwork) or the 'heritage' sector via restoration and repair works, indicating a further adaptation and potential advancement of glassmaking skills through interdisciplinary collaboration. We now discuss the role of policy in supporting glassmaking resilience.

there are other people in the area, they might be metal workers or whatever, you can get your glass photographed, you can get some metalwork done or you can get your metalwork done somewhere else. You can get your glass repaired there. [...] So that's another support system. (Glass Artists, Stourbridge)

Policy investment and skills support

Local policy and support certainly plays a role in the ability to preserve and convert old industrial knowledge in new post-industrial frameworks offered by the creative industries and creative clusters. However, there is a strong acknowledgement that the different organisation of work

between industrial and post-industrial frameworks means that obtaining capital investments and facilities is a struggle for individual makers, and this is where policy has often intervened. Funding opportunities have however been developed to support specific aspects of production or export and exhibitions abroad, both from institutions and policy agencies in the regions.

the first thing that we'd do is to involve them on a one year project which we run, which is our core project which is called Passport to Export. And that is a one year project whereby the company, the individual, works with a qualified international trade adviser and they jointly develop an international strategy (Stourbridge policy makers)

Another policy intervention often highlighted is support for networking and marketing or visibility. For example, many artists highlighted the role of Cohesion, a network and online platform originally developed with the support of Sunderland City Council and sequentially open to glass artists across the UK. It is however important to note that dedicated Council support for Cohesion is no longer available due to shifting local priorities and resources.

I find Cohesion really useful but again in terms of knowledge sharing, of group exhibitions, of access to things that you wouldn't have, I think a network like that is really, really useful. And Cohesion's remit is to sell work, is to get out there and get exposure for artists and I think they do a really good job. (Glass Artist, Sunderland)

Policy of course also links with higher education policy, as courses that are developed (or sometimes closed down, as in the case of Dudley College) play a key role in the development of the local cluster and the kind of work that emerges. It also plays an important role in the business approach taken and opportunities sought by students. For example, this policy maker highlights the important responsibility of *"the University to employ people with some real commercial integrity to them, people who have been out there running their own architectural glass businesses or who have been running glass studios"* (Glass Institution, Sunderland)

Both in Sunderland and Stourbridge, the interviewees highlighted that the weakness in the system and cluster seems to be around the lack of local coordination and the need to integrate across different institutions and agents, which often become unproductive and exacerbated financial challenges. This highlights a need for a more joined-up approach in order to sustain glassmaking activity.

I can't see these things joining together. At the moment we're witnessing far too much competition between the university and the college for example, the college is closing. The Ruskin is a privately owned organisation [...] these places are run more like museums than necessarily to the benefit of the artists. (Policy Maker, Stourbridge)

Theme	Sunderland	Common Characteristics	Stourbridge
Heritage & Tourism	<ul style="list-style-type: none"> NGC as a re-qualifier of industrial heritage 	<ul style="list-style-type: none"> Value of heritage in reorganization Heritage-linked tourism 	<ul style="list-style-type: none"> Re-qualification of heritage with association with 17thC glassmaking history Use of cultural events such as British Glass Biennale as a tourism driver.
Skills	<ul style="list-style-type: none"> Potential for creative upskilling 	<ul style="list-style-type: none"> Loss of skills through delocalization and 	<ul style="list-style-type: none"> Embedded and embodied

	within University	industrial collapse <ul style="list-style-type: none"> • Reputation and sticky/embedded skills drawing in new makers • Partial retention of industrial skills • Reorganisation of local knowledge and creative upskilling 	preservation of material culture and know-how within cultural institutions <ul style="list-style-type: none"> • Skills transfer facilitated by international events (IFG)
Networks & policy support	<ul style="list-style-type: none"> • Limited local support base (NGC and Uni) following discontinuation of Cohesion network • Potential lack of non-institutionally based network • Prominence of education and University 	<ul style="list-style-type: none"> • Importance of networks and infrastructure • Disjointed policies and institutional agendas 	<ul style="list-style-type: none"> • Broad support base of different organisations

Table 2. Thematic characteristics

1.6 Conclusions

The paper contributes both to the general economic geography literature on adaption of knowledge in clusters, as well as to the literature on skills, reflecting on how the creative and cultural industries need to be studied in relation to long-term evolution and phases of deskilling, reskilling and upskilling (Heisig, 2009) in connection with the broader economy. Against the recent hype towards the development of creative clusters globally with new policies and incentives, we argue that creative and cultural production remains not only place specific but has a history, evolution and ‘stickiness’ which deserves to be studied further.

In Table 2 we summarize the thematic characteristics of our case study locations, highlighting both common and distinctive features in recognition of the importance of local traditions and specificities in their evolutionary trajectory. The case studies and data collected in the contexts of Stourbridge and Sunderland seem to suggest that beyond the embeddedness and ‘stickiness’ of knowledge and skills in local clusters, we need a better understanding of how this knowledge is preserved and transformed over-time. The findings presented here indicate the significance of industrial legacies as a brand, and how this both preserves locally embedded knowledge and attracts creatives to the case study regions. While in Sunderland education and the NCG have played a specific role in retaining and re-training skills, in Stourbridge local museums and heritage institution have preserved material knowledge and invested in new events, to pass on skills and attract – even if only for special events – highly specialised knowledge. In both, local educational and cultural institutions and policy support are positioned as key influencers. However, we also identify the knowledge-sharing culture of glassmaking clusters and broader networks as facilitating the preservation, dissemination and evolution of knowledge and skills. Adaption however remains a process of change, where new opportunities are sought but other place-specific institutions might disappear or be lost without due investment. In this context it is important to consider the role of local networks and institutions as repositories of skills and knowledge, but also reflect on the way policy can facilitate the re-organisation of local knowledge into new frameworks of production.

While glass making is a specific creative craft sector, it provides a framework which can be expanded to other craft related clusters and local economies. Moreover, we argue that the new emergence of craft and the makers' movement in post-industrial regions might offer an opportunity for locations that have retained some of their industrial knowledge and skills – via institutions and local networks – to be re-organised around new forms of production and creative product markets. However, further investigation is required into the support systems – institutional and political - required by creatives and creative economies in such locations in order to sustain new market development, preserve glassmaking knowledge, and enable reskilling. We present that the reskilling in glassmaking within these two locations is facilitated through the adaptation of traditional industrial skills by ex-factory workers, studio glassmakers and artists, the development of new technology-driven approaches to glassmaking and interdisciplinary collaboration fostered by support networks between co-located industries, organisations and creative practices.

In our case studies we can recognize that some of the de-skilling and un-learning of factory techniques in favour of creative upskilling has proven an opportunity for new skills to emerge. However, previous knowledge which gets re-contextualised outside the factory needs to be matched with new business skills to allow makers to emerge in highly competitive markets.

In order to avoid negative path dependency in the development of new production frameworks, we suggest a broad network and support base that brings together practitioners, institutions and community members would be advantageous to avoid lock in (Visser and Boschma, 2004) and facilitate the sharing of knowledge and expertise (England and Comunian, 2016). We further call for a more joined-up approach to policy that emphasises local coordination and integration across different institutions and agents to support the preservation of skills and the development of new creative modes of production.

In particular, following Holling's (2001) cycle of adaption, we highlight the strategic importance of institutions in relation to creative industries, specifically museums, universities and other heritage organisations, at the moment of collapse as they can become the place to retain and preserve specific knowledge, skills and techniques towards the re-organisation phase.

Finally, following Gibson (2016) this paper argues for the importance of an evolutionary perspective which engages with new forms of craft production, enabled by the re-organisation of skills, knowledge, networks and institutions. The current re-emergence of glass making skills, both through re-skilling and upskilling can only be understood fully if we engage in understanding the history of labour and making practices in the contexts we study, including painful processes of deskilling caused by de-industrialisation.

However, challenges remain in both contexts as the re-organisation of glass making skills needs to be developed alongside an understanding of new frameworks and business models for production, which require new skills (business, digital, marketing) and engagement with local and global markets.

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