#95

THE SPATIAL ORDERING OF KNOWLEDGE ECONOMIES:

The growth of furniture industry in nineteenth-century London

LAURA NARVAEZ ZERTUCHE
Urban Design Group, Foster + Partners Ltd. London, UK
lnzertuche@fosterandpartners.com

HOWARD DAVIS
School of Architecture and Allied Arts, University of Oregon. Portland, U.S.
hdavis@uoregon.edu

SAM GRIFFITHS
Space Syntax Laboratory, Bartlett School of Architecture, UCL. London, UK
sam.griffiths@ucl.ac.uk

BLERTA DINO
Space Syntax Laboratory, Bartlett School of Architecture, UCL. London, UK
blerta.dino.14@ucl.ac.uk

LAURA VAUGHAN
Space Syntax Laboratory, Bartlett School of Architecture, UCL. London, UK
l.vaughan@ucl.ac.uk

ABSTRACT

Small businesses in the same sector tend to be geographically concentrated. Understanding why businesses in some industries cluster is a key issue in urban economic theory, particularly in the Marshallian and Jacobsian traditions. These emphasize the logistical and informational synergies (advantages) that accrue to firms in agglomeration economies, allowing firms located near one another to accelerate their rate of innovation. However, little is known about how spatial forms foster the clustering of firms or the mechanisms through which this process might facilitate knowledge spillover over between different businesses.

In this paper we present an historical case study in which space syntax methods, archival research and urban economic theory were used to enhance understanding of the spatial ordering of London's nineteenth- and early twentieth-century furniture industry, a sector characterised by a proliferation of small, local firms. The spatial morphologies of the furniture industry in the Shoreditch and Fitzrovia areas of London are profiled by linking business directories, historical Ordnance Survey maps and Goad fire insurance plans to space syntax measures describing the spatial configuration of London's street network, on a GIS platform. Historically, the two case-study areas have hosted a wide range of furniture-manufacturing businesses. We hypothesise that the contrast between the spatial structures of the two districts contributed to the divergent paths development of the furniture industry in these places.

Our results suggest the two areas developed as different knowledge economies, in part as a consequence of their contrasting spatial configurations and their influence on industrial organization. Shoreditch became a 'specialization' economy (i.e. Marshallian). Here the

organic pattern of streets allowed specialized businesses to be located in close proximity to key streets, benefiting from more local footfall, and in close localization of firms belonging to the same industry. Fitzrovia, however, showed a more 'diversified' economy (i.e. Jacobsian), accommodating most of its retailers on streets highly integrated across scales and more commercially-driven. In the context of constraints of land use and rising land values, manufacturing operations moved to other places whilst retaining large-size firms that created a retail destination in a high footfall location good for attracting passing trade. We anticipate that this research will contribute to understanding the distinctive spatial cultures of urban manufacturing and to the development of a methodological approach that opens up new prospects for inter-disciplinary research.

KEYWORDS

London, urban morphology, furniture, agglomeration economies, knowledge spillover

1. INTRODUCTION

The research presented in this paper stems from the idea that the spatial structure of nineteenth-century London's furniture industry was able to accommodate the industry over time in ways that are resilient and sustainable. To the extent that the furniture industry as a whole is a complex system itself, we focus on the two following questions: What was the relationship between London's street network and the spatial distribution of firms? And what was the nature of business connections between firms, if such connections existed? This study investigates these two questions in the districts of Shoreditch in the East End and Fitzrovia in the West End of London. By using Goad's plans with historic business directories, in combination with space syntax methodology and GIS-based locational analysis, the paper presents descriptive and analytical maps examining the distribution of the furniture industry as it emerged in these two different areas in London (Griffiths and Vaughan 2016). This work aims to uncover the spatial relationships that may exist between firms' location decisions and the innovator's need to create or sustain a knowledge-based economy. In this particular case, we stress the role of dynamic externalities, or more specifically knowledge spillovers, for London's furniture-industry growth. This paper addresses this issue by developing on the idea of knowledge-based economies and how they are spatially manifested in the two districts of London.

The study begins by expanding on the concept of knowledge per se in the context of economics and its relation to Hillier's 'generic form' of the city (2016). The research expands on the concept of knowledge-based economies and its possible different spatial manifestations as those proposed by Marshall ([1890] 1920) and Jacobs (1969) and their respective hypotheses of knowledge spillovers as key for agglomeration of industries. Marshall's view asserts that cities with production 'specialized' towards a particular industry tend to be more innovative in that specific industry, whereas the Jacobsian proposition argues that a 'diversified' production favours regional innovativeness. We hypothesize that both of these types of knowledge-based economies (specialized and diversified) were possible to establish in our two case studies due to their morphological and configurational differences in the city.

2. KNOWLEDGE, ECONOMIES AND URBAN FORMS AS SPATIAL KNOWLEDGE NETWORKS

Knowledge, by itself, is an understanding of structured and organized information that is acquired by learning, experience or through skills; or perhaps by sharing information and discovering new ones. In this sense, knowledge is not easy to measure, to interpret or to codify mostly due to its indivisibility – it requires a direct, face-to-face exchange of information between two players. Loosely speaking, knowledge can be understood as a form of interaction or transfer of information from one person to another in which both parties need to calibrate their explanation and interpretation of what is being communicated with each other. Therefore, a face-to-face interaction may well be a facilitating condition for knowledge transfer. Von

Hippel (1995) for example, has argued that knowledge is generally non-competitive, and the knowledge developed and shared can easily spill over and find other means to apply that knowledge in different ways.

This notion of shared knowledge between individuals has a resonance in the term known as *knowledge economies* (or *knowledge-based economies*), which refers to the full recognition that the production, distribution and use of knowledge and technology are central to a city's economic development and growth. Since early economic theories, the idea that knowledge plays an important role in the economy is not new. Adam Smith suggested that in every economy there are new layers of what he called 'specialists who are men of speculation' (see Buckley 2014) and who make important contributions to the production of economically useful knowledge. Friedrich List argued that the infrastructure and the institutions which contribute to the development of production is achieved largely through the creation and distribution of knowledge (see Freeman 1995).

Since we are talking about knowledge, it is useful to distinguish what types of knowledge are produced in the advancement of societies and economies. Essentially this requires thinking about *what, why, how* and who creates, delivers and diffuses knowledge. In economic theory, these four aspects are described as the 'know-what', 'know-why', 'know-how' and 'know-who', respectively (see Figure 1; Lundvall and Johnson 1994). The know-what is the kind of knowledge that talks about facts, in what we commonly refer as information itself. The know-why is the kind of knowledge that underlies technological development and process advances in most industries; it is a production of knowledge that becomes more specialized.

The know-how refers to the skills or the capability to do something; it is typically the kind of knowledge developed within a business and that shares or combines other know-hows with other industries. And lastly, the know-who is what is perhaps the most important of all kinds of knowledge. It involves the information of who knows what and who knows how to do what. In this way, it involves the formation of social relationships which make possible access to other people's expertise and use their knowledge efficiently. Whilst the first two kinds of knowledge, know-what and know-why, are usually obtained by learning from different sources of information and descriptions (i.e. books), the second two kinds of knowledge, know-how and know-who -also known as 'tacit knowledge' (Lundvall and Johnson 1994)-, are primarily rooted in practical experience.

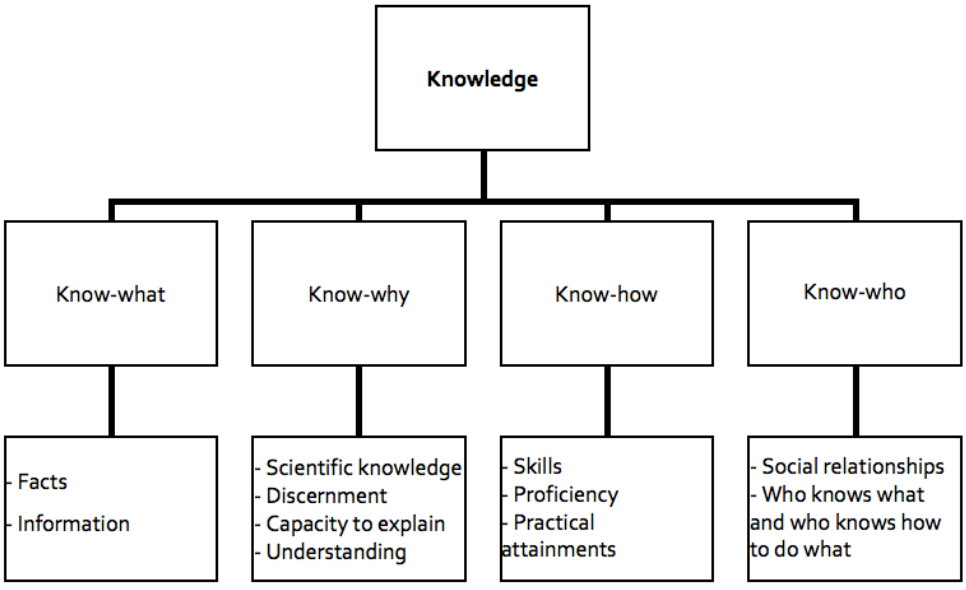


Figure 1 - Diagram re-drawn based on Lundvall and Johnson's descriptions of knowledge (1994).

With knowledge and its diffusion comes innovation (or the process of discovery). The concept of innovation is largely associated with Schumpeter's work on understanding innovation as a historical process for economic development. According to Schumpeter (1939, pp. 5-8), "carrying out innovations is the only function which is fundamental in history". Development, then, is a historical process of structural changes that is substantially driven by innovation, and with innovation comes entrepreneurship (ibid). The ideas for innovation can stem from many sources, such as new manufacturing capabilities in light of market needs (Abramowitz 1989); and can assume many forms, such as improving existing products or using new tools and technology in new markets (Mansfield 1991). However, innovation is not a linear process. It requires communication amongst different actors and firms, as well as feedback between a process of manufacturing, the development of a product, its engineering and marketing (Fujita and Thisse 2001). Whilst in a knowledge-based economy innovation is driven by the interaction of producers and users, it also enables a distribution of knowledge through formal or informal networks –networks of relationships that connect them. We argue that within these networks of relationships that enable the *diffusion of knowledge* amongst agents and firms, proximity matters in connection to knowledge, and that the way linked spaces in the city are historically formed may play a role in how knowledge networks emerge and therefore contributed to the creation of knowledge economies.

The creation and *diffusion of knowledge*, which precedes the process of innovation, has been studied through the concept of 'agglomeration' – a term used by economists to refer to the phenomenon of firms being located close to one another[1]. Economies of agglomeration theory (Glaeser 2010; Fujita and Thisse 2002; Marshall [1890] 1920) studies how economic life is concentrated in urban settlements where a variety of combinations of firms are clustered together. The theory argues that agglomeration results from the benefits of co-location, or being in close spatial proximity, of businesses in a similar field which can lower costs of transactions and production which in turn results in having more specialized businesses and division of labour (Dumais et al. 2002).

But what does knowledge have to do with urban morphology, or the generation of urban forms, in terms of agglomeration economies? In space syntax research, there is an increasing body of work addressing the need to re-think agglomeration economies as 'spatial cultures' of innovation (Griffiths 2017 forthcoming). From the perspective of industrial agglomeration and manufacturing innovation, a spatial and temporal description of agglomeration economies involves linking formal descriptions of urban structure (ibid: 4) within its social and historical context (Griffiths and von Lünen 2016). The link between *diffusion of knowledge* (information exchange) and *spatial morphological agglomerations* (urban activity) as spatial cultures is closely related to Lefebvre's concept of "spatial practices" (1991:117) in which the history of space can help explain the development of networks and their inscription in space by means of human actions, especially work related actions.

Hillier (2016) has brought to the fore the relationship between the generic form of cities and how this may generate different kinds of knowledge acting as social networks. He suggested that the basis of understanding a city's evolution and discerning what makes a city what a city is, lies in understanding the very nature of a city's street network and its 'dual process' -a spatial and functional process-, which is suggested to be akin to a 'genetic' code of cities, namely the "generic form of cities" (Hillier 2009, 2014). According to Hillier (2016), through the spatial geometry and scaling of the street network, a city acquires a dual function, made up essentially by a dominant 'foreground network' that links centres at all scales due to its route continuity and where a high concentration of microeconomic activities may be expected (ibid, p. 200); and a 'background network' of more localized concentrations of socio-cultural activities by less linear continuity of routes, often associated with the production of residential space (ibid).

In line with the idea of the dual process of spatial urban structures, Hillier (2016, p.206) proposes to reflect on cities "as knowledge systems" in which social networks are produced by the generic city. As the "informational morphogenesis" of the built environment evolves

1 See Weber, A. [1909] (1929) *Theory of the Location of Industries.* Translated by Carl J. Friedrich. Chicago: University of Chicago Press.

-that is, the function of cities to adapt as economies, information flows, human contact and technologies advance- two kinds of knowledge in societies arise: "practical knowledge" and "social knowledge" (ibid). The first relates to the microeconomic life of cities. Knowledge is constructed through non-local social networks as a collective information of individuals where the "interaction of knowledge groups [is expressed] in the foreground network". Whilst the latter relates to the local networks of social relations that seek to create the 'socio-cultural stability' of cities where knowledge is built through the "interaction of spatially located groups [manifested] in the background network". (ibid, pp. 208-211).

In the two propositions of knowledge by Hillier, we find similarities to those described by Lundvall and Johnson (1994) in terms of innovation. Practical knowledge reflects how a city works economically to develop and innovate, and therefore, the 'know-what' (facts) and the 'know-why' (understanding and development) can take place as a sparser social network. Social knowledge seeks to create 'stability' through the 'know-how' (skills that are shared or combined with other similar skills) and 'know-who' (social relationships) that make the denser and local social networks (Figure 2). Our proposition is to look at knowledge economies within these theoretical views as spatial knowledge networks -a network that is morphologically expressed as cities historically change over time (as practical and social knowledge develops), defining a spatial ordering of activities; and it is a network that reflects human capital (what, why, how and who creates the information necessary to construct the economic and social qualities for innovation). The core idea of knowledge-based economies is that all of our knowledge builds on things that we learn from others. But the central premise is that the presence of different types of knowledge enables spillover effects that produces agglomerations to take place (Paci and Usai 1999) and follows, we suggest, a certain logic of spatial ordering of activities in the urban fabric.

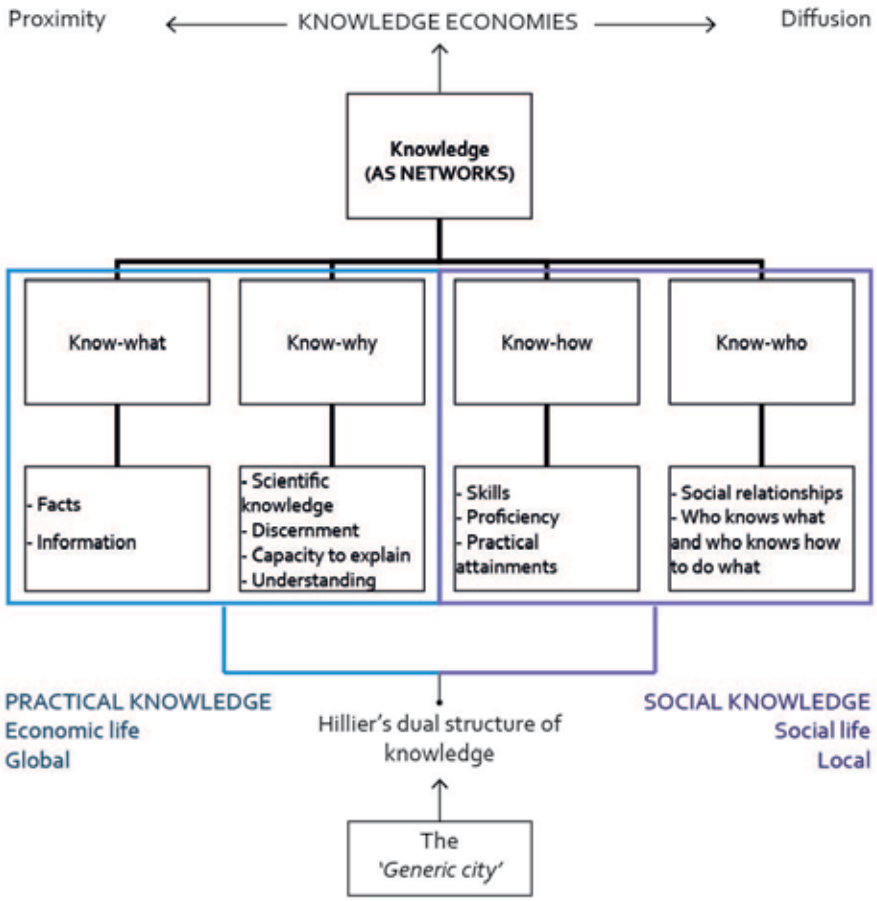


Figure 2 - Associating Lundvall and Johnson (1994) and Hillier (2016) on descriptions of knowledge.

3. KNOWLEDGE SPILLOVER: SPECIALISATION OR DIVERSIFICATION?

"…one learns that a cleaner of suede clothing is now starting to bottle and sell her cleaning fluid for people who want to clean their own suede; a chest and wardrobe manufacturer is starting, for a fee, to analyse what is wrong with one's household or office storage arrangements; a playground designer is starting to make and sell equipment for playgrounds and nursery schools; a sculptor is starting a line of costume jewelry; a designer of theatre costumes is launching himself as a couturier; a couturier is starting a boutique; an importer of Italian marble is starting to manufacture marble-topped tables; a clothing store is starting classes in teenage grooming and dieting"
(Jane Jacobs 1969, pp. 53-54).

Agglomeration economies theories, such as Marshall ([1890] 1920) and Jane Jacobs (1969), have emphasized the role that cities can play in speeding the flow of ideas. Knowledge spillovers relate to the dissemination of tacit knowledge (know-how and know-who) as it can only be acquired through the process of social interaction (Henderson 1997). As such, knowledge spillovers can be limited to its spatial geography (Feldman 1994). There are several hypotheses on the nature of spillovers (or externalities) from an economic perspective, mainly by the contributions of Marshall (1920), Arrow (1962), Romer (1986) and Feldman and Audretsch (1999). Our interest here is to concentrate on two particular theories that seemingly appear opposing, yet we argue that both are equally valid depending on the spatial ordering in which externalities take place. Marshall (1920) emphasizes that knowledge spillovers occur as a form of 'specialization' (In: Glaeser et al., 1992), arguing that knowledge tends to be industry-specific, that is, industries specialize geographically because proximity favours knowledge exchange between firms within the same industry field and can only be supported by other similar (or complementary) firms. This is what economists term as Marshall's 'localization externalities' (Kelly and Hageman 1999), namely producing a specialization economy.

The alternative hypothesis is that externalities benefits the creation of new ideas across industry sectors as originally proposed by Jane Jacobs in her work The Economy of Cities (1969). Jacobs' hypothesis is that the variety of local activities plays a fundamental role in innovation given that it enhances the economy's capacity of adding more work, and as such, more goods and services. She argued that new skills and knowledge can create new businesses, or finding new uses for one's skills contributes to a local diversity. The knowledge of individuals develops a chain reaction of how one kind of work can lead to another: "The new work is added to older work first, and then sometimes its new divisions of labor are added to other appropriate varieties of older work" (ibid: 52). In this sense, 'Jacobs' spillovers' (Mehaffy 2001) asserts that the exchange of complementary knowledge across firms facilitates new forms of innovation. Having a diversified production of knowledge available for an individual firm would give rise to 'urbanisation externalities' (In: Glaeser et al., 1992), namely creating a diversified economy.

From an urban morphological point of view, we suggest that knowledge spillovers are also linked to a building's form and use as well as the influence of its urban location. According to Sternberg (2007), while a designer may be concerned with identifiable spillover effects of a building, the individual's greater concern is on the broader relationships of the building with other factors. This suggests that knowledge spillovers may also imply a *spatial spillover* effect, such as the relationship of a building to the connectivity of the street and its urban surroundings, views, the character of the neighbourhood, or other indirect factors like land values.

4. LONDON'S NINETEENTH-CENTURY KNOWLEDGE ECONOMY IN THE FURNITURE INDUSTRY: SHOREDITCH AND FITZROVIA

During the nineteenth and twentieth centuries, the London districts of Shoreditch and Fitzrovia contained hundreds of furniture workshops and factories. Cabinet makers, chair makers, table makers, polishers, upholsterers, sawmills, carvers and related businesses together produced a large portion of furniture sold in England and Wales. Located on a variety of kinds of streets, in commercially-transformed variations of terraced houses and small factory buildings, as well as purpose-built factories, showrooms and warehouses, they formed a coordinated system of production that initially operated "from the bottom up" rather than out of large, multi-functional factories.

Until the middle of the twentieth century, making a piece of furniture involved numerous craftspeople and suppliers of materials and tools that were distributed in separate business firms. These included production of the wooden frame, the crafting of parts such as turned legs for chairs and tables, the carving of ornament, upholstery—which itself entailed making and fitting a web for the fabric pile or stuffing, the possible insertion of metal springs, the stretching of fabric, and the securing of the fabric with pins or tacks; polishing; gilding; the installation of hardware such as hinges, drawer pulls, latches and locks. Suppliers provided timber and veneers, fabric and pile for upholstery, feathers for mattresses, polish, lacquer and varnish, upholstery trimmings, brass hardware, springs for chairs and beds, glue; upholstery tacks; and other products. Tools included hand tools and, increasingly, machines.

The various crafts were separate from each other, and suppliers might have specialized in only one product and a small range of related products. Because consumers wanted unique products, and crafts such as carving did not lend themselves to automation and remained the province of craftsmen and hand workers the furniture industry resisted standardization and mass production. Up until the absorption of individual processes into large factories in the beginning decades of the twentieth century, the furniture industry was made up of hundreds of small shops, each employing just a few workers at most. The shops worked in coordination with each other, in what may be regarded as a giant factory that was the city itself, in which products moved from shop to shop for different phases of production. The shops were all over London, but there were concentrations in two areas—Fitzrovia, near Tottenham Court Road in the West End, and Shoreditch in the East End (Figure 3).

The industry in Fitzrovia, particularly around Tottenham Court Road emerged first, as craftsmen such as Thomas Chippendale moved north out of the city and from streets like St Martins Lane. This part of the industry made furniture at the upper end and served wealthier clients in Westminster, Mayfair and similar neighbourhoods (Edwards 2011). In Fitzrovia there were many independent shops carrying out different operations of manufacture, but instead of the wholesalers, large retailers began to emerge as central firms. Retailers such as Heals and Maples brought the smaller firms into their own operations, in addition to dealing with subcontractors in the East End, and were thereby the centre of a 'tree-like' hierarchical industrial organization (ibid, pp. 3-5).

The industry in Shoreditch and the East End grew as demand for furniture from the middle and lower classes grew (Smith and Rogers 2006, p.8). However, the industry developed differently in the two places. In Shoreditch, the cabinet makers and wholesalers remained independent and subcontracted with a variety of other firms, including firms lower down the value chain like suppliers and firms such as wood turners, and firms higher up, like upholsterers and polishers. The wholesalers were central to the coordination of the trades, and sold to retailers all over London who came to their showrooms to buy goods (ibid, pp.16-17). While some of the wholesalers incorporated finishing trades within their own operations, a lot of their work was with other independent firms, and this organization persisted well into the twentieth century.

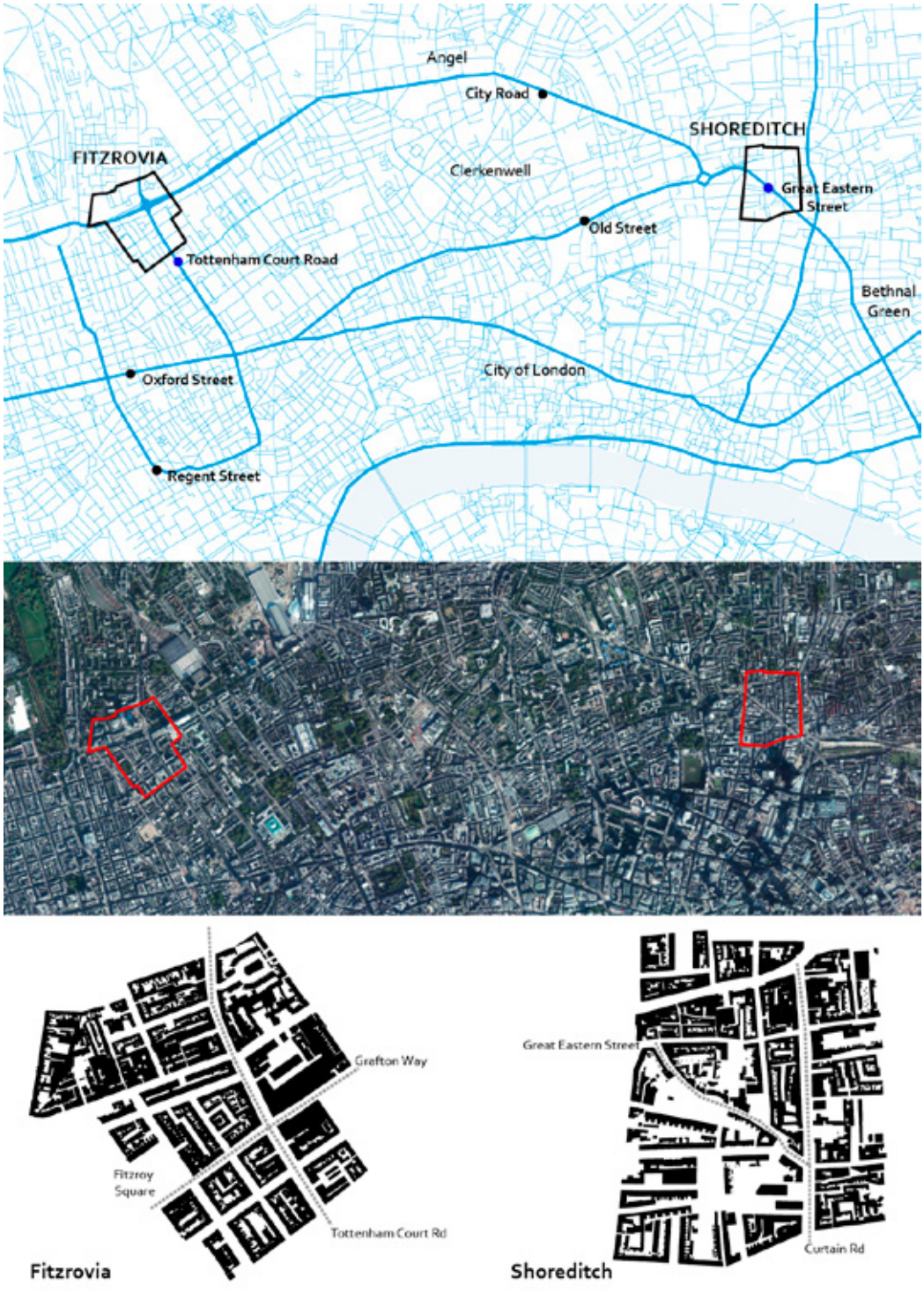


Figure 3 - Fitzrovia and Shoreditch at present: (top) wider urban context where both areas are located in London connected in the street network; (middle) aerial view of the urban fabric; (below) figure ground morphologies.

In Fitzrovia, then, when the industry grew it became fixed within the orbit of a few large retailers who had their stores on Tottenham Court Road, whereas in Shoreditch there was more fluidity as the wholesalers dealt with a variety of smaller craftsmen and suppliers. In his book The Industries of London (1961), Peter Hall claimed that the furniture industry in the East End was more resilient than that around Tottenham Court Road (ibid, pp.91-93). Indeed, the industry in the East End lasted until well into the twentieth century, while furniture manufacturing around Tottenham Court Road rapidly declined as the century progressed. By the middle of the century Tottenham Court Road had major furniture retail stores like Heals, and Shoreditch continued to house stores, warehouses, factories and the premises of various suppliers.

Although both places eventually gave up furniture manufacturing to large factories outside the centre of London that required more land than either central location could provide, Peter Hall's statement remains a tantalizing one. If we assume it is true, based on the greater longevity of the industry in the East End, the question is why? Various reasons are ordinarily offered. The proximity of Fitzrovia to the retail centres of Oxford Street, Regent Street and surrounding areas, is one reason. The rise in commercial rents of these areas rippled outward, and forced out manufacturing operations in favour of retail. In addition, the East End industry was near where many of its immigrant workers were living, and nearer to the sources of supply—including the Surrey Docks at which imported timber was unloaded from ships. But is this the whole story?

In addition to the differences between locations of the two districts within the city, did differences in the spatial form of the districts themselves help or hinder the persistence of the industry in the districts? We want to suggest that this was the case: that the difference between the local spatial structures of the two areas contributed to the economic difference between them, and that this may also be attributed to the knowledge spillovers of the furniture industry in the two areas. We are not suggesting a deterministic relationship, but instead that the local spatial structure provided affordances that supported or hindered the changes that were otherwise already taking place.

4.1 HISTORICAL DIFFERENCES

4.1.1 FITZROVIA

The modern development of Fitzrovia began in the eighteenth century with the construction of streets of terraced houses originally sold to upper class buyers. Although the area was in between the 'great estates' like the Bloomsbury and Grosvenor estates, and was developed in smaller chunks, the pattern of development was based on the typical London terraced house, on an orthogonal plot repeated in identical units along the street. The streets tended to be at right angles to each other, so the pattern of streets is a broken orthogonal grid.

After only a few decades, however, the character of the area began to change as buildings became subdivided and used for multiple tenants including the workshops of small craftsmen, such as those in the furniture trades. In some cases, industrial buildings were built in the back streets and mews but by and large the principal streets to the west of Tottenham Court Road maintained their terraces of Georgian houses. Tottenham Court Road itself changed during the nineteenth century with the construction of larger buildings some of which housed retail stores housing various furniture businesses (Figure 4).

4.1.2 SHOREDITCH

On the other hand, Shoreditch had a pre-Georgian origin with non-orthogonal streets. House plots could be readily transformed to those that were irregular in size and shape. The pattern of streets changed in the 1870s with the construction of Great Eastern Street, a thoroughfare intended to improve connections between the areas where furniture was made, Shoreditch and Bethnal Green, and some of the retail shops where it was sold, in the West End. Along Great Eastern Street were built four- and five-storey warehouse-showroom-workshop buildings that were the headquarters of the wholesaling firms at the centre of the production network.

The resulting streets range from the major thoroughfare of Great Eastern Street down to small lanes and alleys. Shoreditch maintained its status as a centre of the furniture trade well into the twentieth century. Although the centre of the district, the area on which we focused our study, was hardly bombed during the war, by that time many large firms of the industry had already moved away from the centre of London to places where larger sites were available, up the Lea Valley and other places further afield (Figure 4).

Figure 4 - Ordnance Survey maps of Fitzrovia and Shoreditch (1863-1895). Source maps: National Library of Scotland online maps. Photographs by Howard Davis.

5. COMBINING ARCHIVAL RESEARCH WITH GIS-BASED LOCATIONAL ANALYSIS

Our work included the following:

1. The use of advertisements in furniture journals to investigate firms and their premises, an extensive report prepared by English Heritage on the industrial buildings of Shoreditch and Goad's insurance maps (Figure 5.1).
2. A detailed GIS mapping of land uses related to furniture manufacturing, with data from historic street directories. In order to keep consistency of historical data and maps, we selected the following time periods for each area to investigate the relationship between businesses across a series of time (Figure 5.2):
   - Fitzrovia: 1867, 1889, 1902 and 1920
   - Shoreditch[2]: 1920, 1934 and 1951
3. Space syntax analyses of the two areas, focusing on the properties of the street networks and the distribution of land uses.
4. Combining the historical data and syntax analyses, we use a GIS-based network analyst analysis of location-allocation assessment. The purpose is to examine the possible combinations of knowledge exchange (or spillovers) that different types of businesses have in terms of their proximity. The goal of location-allocation is to locate the businesses in a way that supplies demand points (i.e. other businesses) most efficiently (Figure 5.3).

The method of location-allocation considers each type of business as a 'facility' (e.g. a type of business) that links to all related 'customers' (i.e. other businesses) in a given area. We statistically compare how quantitatively strong (synaptic weight) is the relationship between one type of business to the rest of the businesses across time. The lines marked in black in figure 5.3 shows an example of how furniture finishers have the strongest link to other businesses, and thus, assessing how much of the furniture finishers were more spatially allocated in relation to other businesses.

This same method was produced by selecting 5 types of businesses: Furniture makers, furniture manufacturers, suppliers, retailers, and finisher. As a result, we can estimate what kinds of businesses were spatially related and more strongly connected to other businesses, hypothesising that certain businesses may be related with within specialised fields (e.g. tool parts with furniture manufacturing) or others more diversified.

2 The data for Shoreditch includes also from 1852, 1867 and 188. Due to limitations of historical information on the location of businesses in these three time periods, we have excluded these years from our locational analysis (see Figure 5.2).

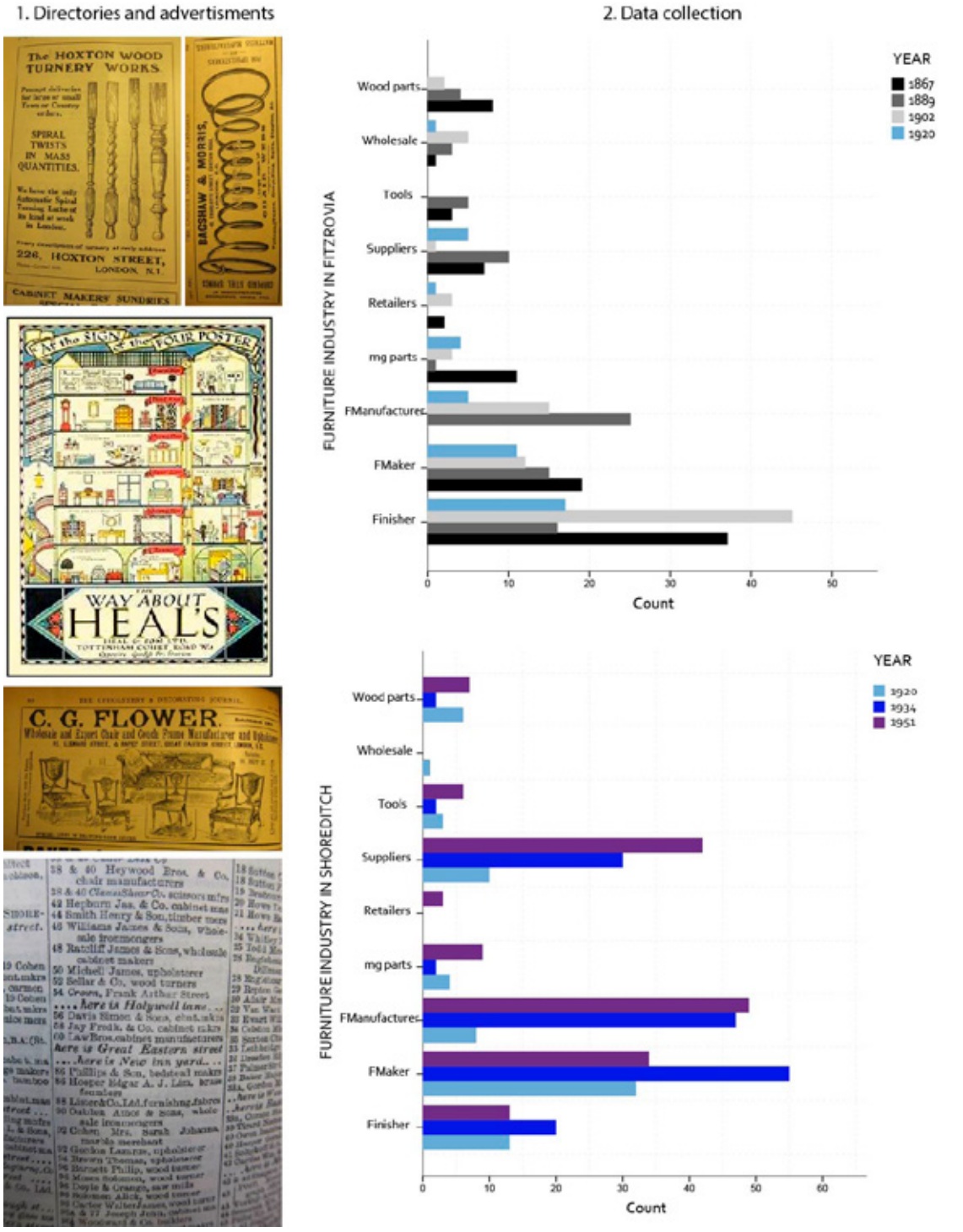
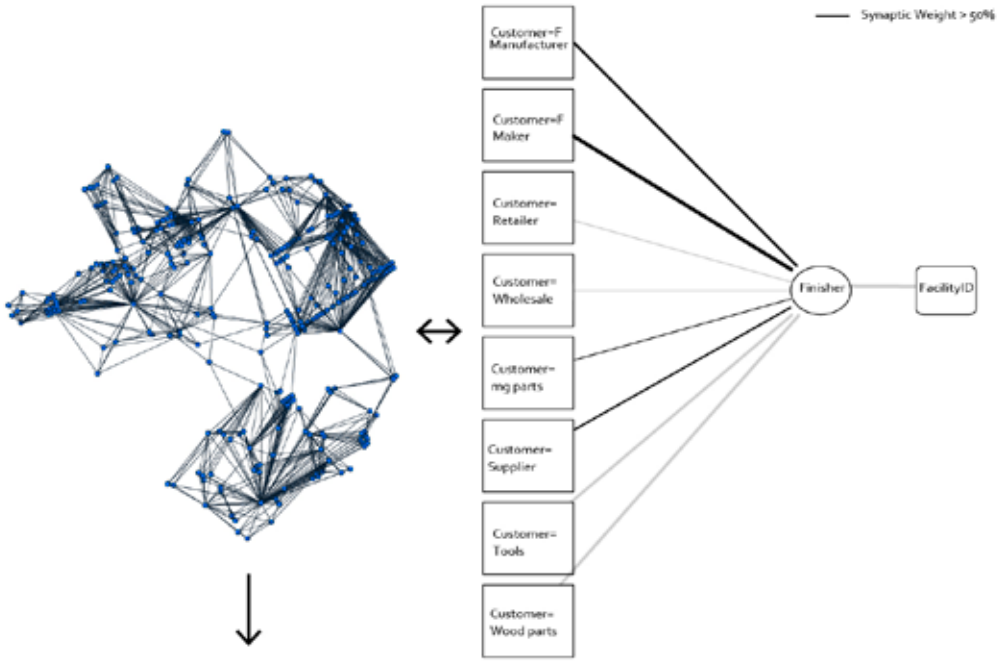


Figure 5 - Use of data and methodology: (1) Advertisements by English Heritage; Kelly's post office directory (1902) by Tower Hamlets Local History and Archive; Heal's advertisement by Susanna Gooden, A History of Heals (1984). (2) Data collection of businesses colour coded by year. (3, next page) constructing spatial networks with historical data by assessing how different businesses relate to each other in the two areas of London.

3. GIS locational analysis assesing relationships between businesses



Types of businesses selected for each London area to assess networks and spatial allocations:

1. Finisher
2. Furniture Makers (FMaker)
3. Furniture Manufacturers (FManufacturer)
4. Furniture Retailers (Retailer)
5. Suppliers

Description of types of businesses:

- **Finisher** = Furniture finish
- **FMaker** = Furniture makers
- **FManufacturer** = Furniture manufacturers
- **Retailers** = Furniture retailers
- **Suppliers** = Furniture suppliers
- **Tools** = tools or tool parts for furniture making
- **Wood parts** = wood parts for furniture making
- **Wholesale** = wholesale furniture
- **mg parts** = metal and glass furniture parts

6. OBSERVATIONS AND FINDINGS

6.1 MORPHOLOGICAL CHANGES AND FURNITURE INDUSTRY GROWTH

The first observation has to do with plot sizes and plot shapes. There is a greater variety of plot sizes and shapes in Shoreditch than in Fitzrovia. Until the war, this allowed for a greater variety of building sizes, for small old buildings to remain while newer, larger buildings were built. Indeed, buildings in Shoreditch underwent a considerable amount of rebuilding and consolidation of lots. But the Goad's plans and Ordnance Survey maps suggest that off the main street of Tottenham Court Road itself, the historic building stock of Georgian houses remained until at least the Second World War (Figure 6). While this building stock accommodated craftsmen working in small shops, in buildings that could easily be divided and subdivided, it did not lend itself as well to the establishment of large warehousing firms that were subcontracting with smaller firms. The larger buildings that were built in the alleys and back streets were smaller than new buildings built in Shoreditch, apparently because it was harder to assemble the land. On Tottenham Court Road, large buildings were built to accommodate the large retail firms. These physical changes relate to how the furniture industry evolved in the two areas. For example, Shoreditch increased its suppliers by 9% of all furniture businesses over the 100-year period whilst businesses making wood, metal and glass parts decreased in the same time period (see Figure 6). By comparing the data of directories with the Goad's plans we found that Shoreditch had 2.5 times more of suppliers (e.g. wood, varnish, cabinet hardware) than Fitzrovia. Shoreditch had also 12% more furniture makers whereas Fitzrovia had more than twice the amount of finishers (e.g. upholsterers, polishers, gilders, carvers) and 5% more of businesses doing finished furniture sales only than Shoreditch.

FITZROVIA GOAD'S INSURANCE PLAN

FITZROVIA NEAR TOTTENHAM COURT ROAD, 2015

	1867		1889		1902		1920	
Tools	4	3%	3	2%	3	2%	1	1%
Suppliers	7	5%	15	12%	15	11%	14	11%
Wood parts	4	3%	18	15%	12	9%	9	7%
Metal and glass parts	6	4%	4	3%	5	4%	4	3%
Furniture makers	22	15%	33	27%	22	16%	31	25%
Finishing	50	34%	42	34%	69	51%	53	43%
Wholesale	50	34%	4	3%	3	2%	1	1%
Retail	3	0	5	4%	7	5%	9	7%
Furniture manufacturer	15	0	37	30%	73	54%	85	70%
TOTAL	146		124		136		122	

CHANGES IN THE FURNITURE INDUSTRY IN FITZROVIA

SHOREDITCH GOAD'S INSURANCE PLAN

PRESENT BUILDING AT 124 CURTAIN ROAD, SHOREDITCH

CHANGES IN THE FURNITURE INDUSTRY IN SHOREDITCH

	1852		1867		1889		1902		1920		1934		1951	
Tools	1	3%	2	1%	5	1%	7	2%	12	3%	9	2%	10	5%
Suppliers	6	17%	30	17%	56	14%	71	15%	95	22%	95	24%	71	37%
Wood parts	7	19%	10	6%	14	3%	24	5%	22	5%	10	2%	13	7%
Metal and glass parts	0	0	8	22%	27	7%	32	7%	29	7%	23	6%	12	6%
Furniture makers	14	39%	92	53%	219	53%	248	54%	199	47%	200	50%	49	26%
Finishing	7	19%	29	17%	75	18%	75	16%	57	13%	61	15%	32	17%
Wholesale	1	3%	2	1%	15	4%	1	0%	8	2%	3	1%	0	0%
Retail	0	0	0	0%	0	0%	2	0%	1	0%	2	0%	3	2%
Furniture manufacturer	5	0	14	8%	31	8%	66	14%	66	16%	0	0%	102	54%
TOTAL	36		173		421		460		423		403		190	

- COMPARISON OF FURNITURE INDUSTRY GROWTH -

	Fitzrovia		Shoreditch	
Tools	11	2%	46	2%
Suppliers	51	7%	424	17%
Wood parts	43	6%	100	4%
Metal and glass parts	19	3%	131	5%
Furniture makers	108	21%	1021	44%
Finishing	214	31%	336	14%
Wholesale	58	1%	30	3%
Retail	24	5%	8	1%
Furniture manufacturer	210	24%	284	10%
TOTAL	738		2380	

SHOREDITCH HAD 2.5 TIMES HIGHER SUPPLIERS THAN FITZROVIA

12% MORE OF FURNITURE MAKERS IN SHOREDITCH, BUT MORE THAN TWICE OF PERCENTAGE OF FINISHERS IN FITZROVIA

FITZROVIA HAD 5% MORE BUSINESSES DOING FURNITURE SALES ONLY

Figure 6 - Goad's insurance plans for Fitzrovia and Shoreditch compared to the historical growth of types of furniture businesses. Goad's plans by British Library. Photographs by Howard Davis.

6.2 EVIDENCE-BASED ASSESSMENT OF BUSINESS LOCATIONS

The second observation is that the block structure in the two areas is different. In Shoreditch, most streets are continuous, whereas in Fitzrovia many dead-ends are contained within blocks. In space syntax terms, in Fitzrovia just about every block contains street segments in the middle of the block that have very low through-movement (Choice) values, whereas in Shoreditch there are fewer segments of low Choice, along with a variety of Integration values (distances of how close a location is in relation to all other locations). In Fitzrovia, this may have constrained the location of businesses that would otherwise want easy access to most other businesses nearby. In Shoreditch, because choice values were higher, these constraints did not exist as much. In syntactical terms, Shoreditch has a greater variety of spatial integration values among different streets, with even the secondary street segments having medium to high integration values. In Fitzrovia, there was less of a continuous spread of integration values within a radius of 400 metres among street segments. Major streets were consistently more highly integrated and minor streets less so (Figure 7).

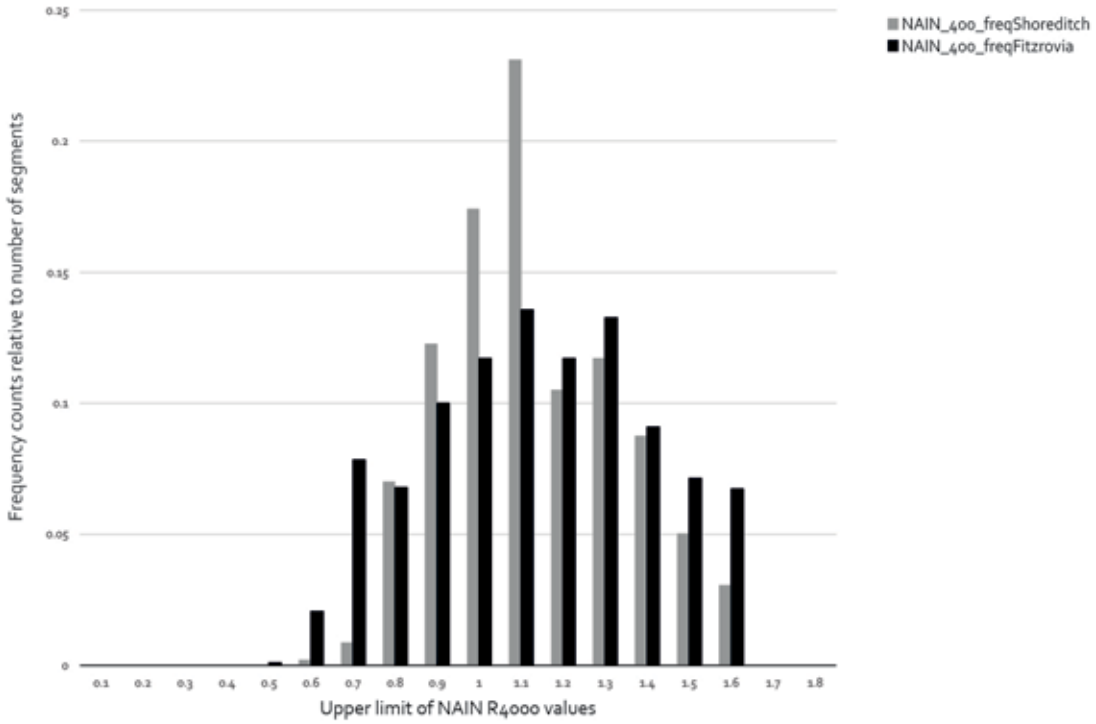


Figure 7 - Frequency counts in relation to number of segments at 400m radius in the street network comparing Shoreditch's and Fitzrovia's spatial integration.

Finally, comparing integration and choice values at a local scale of 400m radius, in Fitzrovia, except for businesses associated with large retailers, many secondary manufacturing businesses are on streets with low integration values. We suggest that this is connected to the fact that in Fitzrovia street like Tottenham Court Road that were highly integrated at a city scale let themselves to retail and commanded retail units. But because of the constricted sites in the back streets, it was hard for businesses in those streets to expand. In Shoreditch on the other hand, businesses are more evenly distributed amongst streets with different integration values but with relatively high local choice values (Figure 8).

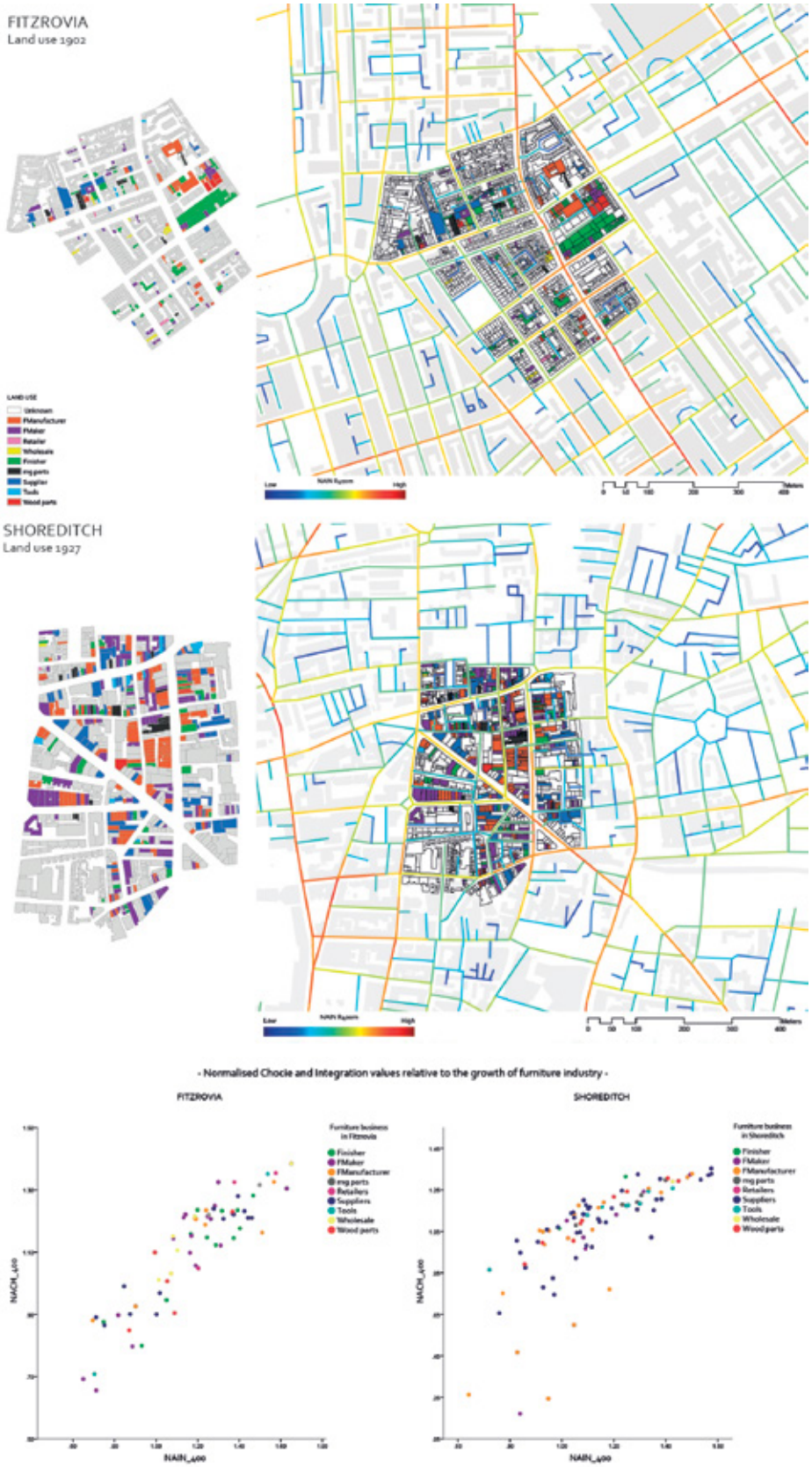


Figure 8 - (top) Syntactical analysis for Fitzrovia and Shoreditch comparing historical land uses and local integration of the street network (NAIN R400m); (below) Integration and Choice (R400m) comparison in relation to all historical time periods for both areas.

6.3 BUSINESS NETWORKS AS KNOWLEDGE NETWORKS: FORMING KNOWLEDGE-BASED ECONOMIES

Based on our previous findings relating syntactical and historical data, we further explore possible connections that may have existed between firms. Figure 9 shows all existing spatial connections that our selected types of businesses -finishers, furniture makers, furniture manufacturers, retailers and suppliers- have with all other firms for each of our study areas. By using the method of location-allocation analysis, the diagrams at the top in Figure 9 show all possible connections for the 5 businesses and within the historical time periods from our data collection. The graphs below of the same figure show how each type of business mapped as networks increased or decreased over time, confirming our previous results that, in Fitzrovia, finished furniture remained over time whereas in Shoreditch furniture manufacturing were still largely present.

The results of mapping spatial knowledge networks between businesses are shown for each case study. Figure 9 shows the urban grain of Fitzrovia showing that suppliers and retailers had more spatial connections to the rest. Finishers and furniture manufacturers have more spatial connections between them which may suggest that similar businesses of finishers like cabinet carvers, upholsters or polishers, may have resulted as spillover effect of the furniture making and manufacturing. In the case of Shoreditch (Figure 10), the outcome was an opposite effect to that of Fitzrovia.

The furniture making and manufacturing remained with more spatial connections with other businesses over time than retailers and suppliers. Furniture makers, such as cabinet, chair or bedstead makers, are firms that reflect more specialised businesses which require tools, wood parts or specialised manufacturing to produce the furniture. We hypothesise that these spatial relations between the businesses had also its implications on the spatial proximity in Shoreditch. The spatial networks in the urban grain of Shoreditch shows that each of the firms were connected within the same urban block, with the exception of retailers and suppliers. This suggests that knowledge spillovers may imply a more concentrated or 'specialised' forms of businesses to arise establishing in close proximity to each other. The contrary happens in the case of Fitzrovia. The spatial networks of the businesses appear sparser without too much concentration within blocks and would seem that knowledge spillovers are more 'diversified' as a larger amount of suppliers and retailers kept in the area.

Overall, the links between firms across time informs how the two areas evolved as different kinds of knowledge-based economies -Shoreditch as a specialised economy that kept resilient through time and in which innovation may reside in new forms of manufacturing, and Fitzrovia as a more diversified economy in which the furniture industry may have innovated as exchange of knowledge across firms and thereby establishing more retail-oriented businesses in the area.

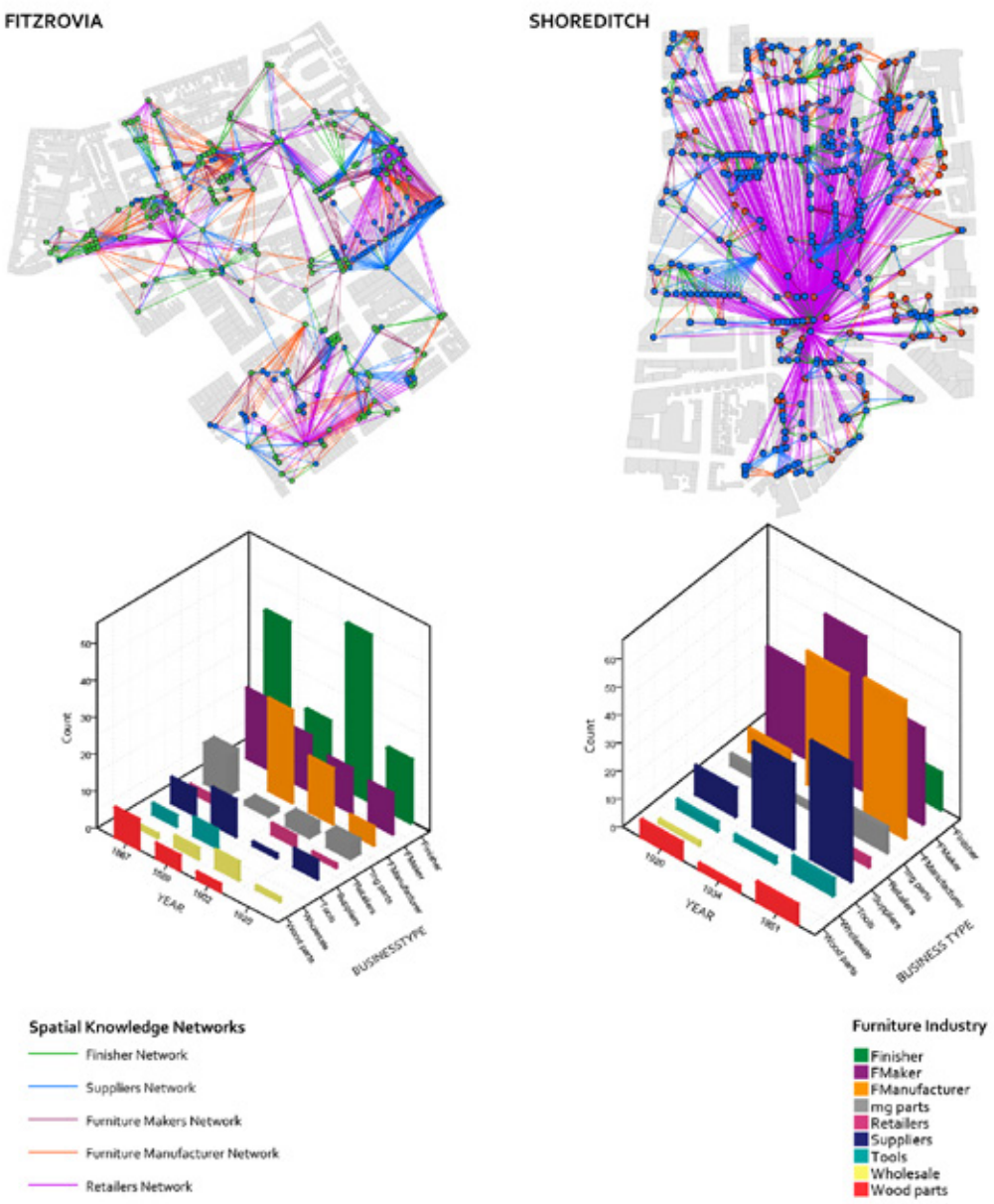


Figure 9 - (top) Fitzrovia and Shoreditch showing spatial networks between firms; (below) graphs showing types of businesses in relation to historic time periods.

Figure 10 - FITZROVIA SPATIAL NETWORKS: Maps show the links between finishers, furniture makers, furniture manufacturers, retailers and suppliers spatialized in the local morphology of the study area. Graphs below represent quantitatively the spatial connections between firms.

Figure 11 - FITZROVIA SPATIAL NETWORKS: Maps show the links between finishers, furniture makers, furniture manufacturers, retailers and suppliers spatialized in the local morphology of the study area. Graphs below represent quantitatively the spatial connections between firms.

7. CONCLUSIONS

This research takes place in the context of general increase in interest of the role of urban agglomeration in creating sustainable cities (Neffke et al; Scott and Storper) and its relation to the urban morphology and space syntax fields (Narvaez and Penn 2016; Froy 2016). The organism that is the city is a resilient and networked socio-ecological system—and understanding the historical circumstance that has similarities to emergent features of the contemporary city can help in the development of planning, design and policy for the form of cities in which small industrial shops are beginning to operate again in parallel with the massive firms of the global production system. Particularly in Shoreditch, the nineteenth century furniture industry was structured in a non-hierarchical way, in which relationships among firms were fluid, and in which a variety of small firms persisted over time. Peter Hall's observation of the greater resilience of the East End is connected to this fluidity, and with the ways in which the physical environment supported it.

In many cities, from London to New York to Detroit to Portland, Oregon, there is a resurgence of industry and much of it has a different form than the vertically organized large manufacturing firms of the nineteenth and twentieth century. It is composed of small firms, with limited

product lines, that deal with other small businesses that are their suppliers and subcontractors. Whilst previous research has argued that 'flexible accumulation' (Harvey 1990) presents a different way of organising production and of relations productive units, we argue that the industrial organisation of the furniture industry in the cases of London is not organised along vertical nineteenth and twentieth century developments. We suggest that this research into nineteenth century industrial organisation has parallels with much of the interest we see in urban agglomerations, more typically in the context of the creative economy but also in manufacturing and making. Before the ascendancy of modernist production, we could ask what role did the city play in industrial organisation but in the twenty-first century digital city, and if these agglomerative processes still apply, or are more vertical models being applied as companies go global?

REFERENCES

Abramowitz, M. (1989) *Thinking about Growth.* Cambridge University Press, Cambridge.

Arrow, K.J. (1962) The economic implications of learning by doing. *Review of Economic Studies,* 29, pp. 155-172.

Buckley, P. (2014) Adam Smith's Theory of Knowledge and International Business Theory and Practice. *Journal of International Business Studies,* 45, 1, pp.102-109. doi:10.1057/jibs.2013.44

Dumais, G., G. Ellison, and E. Glaeser (2002) Geographic concentration as a dynamic process. *Review of Economics and Statistics,* 84 (2), pp.193– 204.

Edwards, C. (2011) Tottenham Court Road: the changing fortunes of London's furniture street 1850-1950. *The London Journal,* 36 (2), pp. 140 - 160.

Feldman, M.P. and Audretsch, D.B. (1999) Innovation in cities: science-based diversity, specialization and localized competition. *European Economic Review,* 43, pp.409-429.

Feldman, M.P. (1994) *The geography of innovation.* Kluwer Academic Publishers: Dordrecht.

Freeman, C. (1995) The National System of Innovation in Historical Perspective, *Cambridge Journal of Economics,* 19, pp. 5–24.

Fujita, M. and Thisse, J. (2002) *Economics of Agglomeration: Cities, Industrial Location and Regional Growth.* London: Cambridge University Press.

Fujita, M., and Thisse, J. (2001) Agglomeration and growth with migration and knowledge externalities. Discussion Paper No. 531, Institute of Economic Research, Kyoto University, Kyoto, Japan.

Froy, F. (2016) Understanding the spatial organisation of economic activities in early 19th century Antwerp. *Journal of Space Syntax,* Vol. 6 (2), pp.225-246.

Glaeser, E. (2010) Introduction to agglomeration economies. In: *Agglomeration Economics,* pp.1-14. National Bureau of Economic Research: University of Chicago Press.

Glaeser E., Kallal H., Scheinkman J. and Sheifler A. (1992) Growth of Cities. *Journal of Political Economy,* 100, pp.1126-52.

Griffiths, S. (2017 forthcoming) Manufacturing innovation as urban spatial practice: Sheffield's cutlery and metals industries c.1750-1900. In: *Unscrewing the Creative city: The Historical Fabrication of Cities as Agents of Economic Innovation and Creativity,* Ilya Van Damme, Bruno Blonde and Andrew Miles (eds). London: Routledge.

Griffiths, S. and Vaughan, L. (2016) Mapping Spatial Cultures: The Contribution of Space Syntax to Research in Social and Economic Urban History. In: *Meeting of the European Association of Urban Historians.* Helsinki.

Griffiths, S. (2012) The use of space syntax in historical sesearch: Current practice and future possibilities. In: Margarita Greene, Jose Reyes and Andrea Castro (eds) *Proceedings of the 8th International Space Syntax Symposium.* Santiago, Chile: PUC, pp. 1-26.

Harvey, D. (1990). Flexible accumulation through urbanization reflections on "post-modernism" in the American city. *Perspecta,* 26: 251–272.

Henderson, J.V. (1997). Externalities and industrial development. *Journal of Urban Economics,* 42: 449–70.

Hillier, B. (2016) What are cities for? And how does this relate to their spatial form? In: *Journal of Space Syntax,* Vol. 6 (2), p.199-212.

Hillier, B. (2009) Spatial sustainability in cities: organic patterns and sustainable forms. In: Koch, D. and Marcus, L. and Steen, J. (eds.) *Proceedings of the 7th International Space Syntax Symposium.* Royal Institute of Technology, KTH: Stockholm, Sweden.

Hillier, B. (2014) The generic city. *AD: Empathic space,* Vol 5, pp. 100-105.

von Hippel, E. (1994) Sticky *Information and the Locus of Problem Solving: Implications for Innovation. Management Science,* 40, pp. 429-439.

Jacobs, J. (1969) *The Economy of Cities.* New York: Random House.

Kelly, M. and Hageman, A. (1999) Marshallian externalities on innovation. *Journal of Economic Growth,* 4, 39-54.

Lefebvre, H. (1991) *The Production of Space.* (eds) Donald Nicholson-Smith. Massachusetts: Blackwell Publishers Ltd.

Lundvall, B. and Johnson, B. (1994) The Learning Economy, *Journal of Industry Studies,* Vol. 1, No. 2.

Mansfield, E. (1991) Academic research and industrial innovation. *Research Policy,* Vol. 20.

Marshall, A. (1890) *Principles of Economics.* 8th edition published in 1920. London: Macmillan.

Mehaffy, M. (2001) The "Jacobs Spillover" as a model of urban dynamics: Can we describe a similar mechanism affecting urban resource use and greenhouse gas emissions? In: *On Resilient Settlement,* [online] Available from: https://onresilientsettlement.wordpress.com/2011/10/15/the-jacobs-spillover-as-a-model-of-urban-dyna/ [Accessed: 28 January 2017].

Narvaez, L. and Penn, A. (2016) The Architecture of Mixed Uses. *Journal of Space Syntax,* Vol. 7 (1), pp.107-136.

Neffke, F., Henning, M. and Boschma, R. (2011), How do regions diversify over time? Industry relatedness and the development of new growth paths in regions. *Economic Geography,* 87: 237–265. doi:10.1111/j.1944-8287.2011.01121.x

Paci, R. and Usai, S. (1999) Externalities, knowledge spillovers and the spatial distribution of innovation. *Geojournal,* 49, pp.381-390.

Romer, P.M. (1986) Increasing returns and long-run growth. *Journal of Political Economy,* 94, pp. 1002-1037.

Schumpeter, J.A. (1939) *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process.* Vol 2. New York: McGraw-Hill.

Scott, A. J. and Storper, M. (2015) The Nature of Cities: The Scope and Limits of Urban Theory. *International Journal of Urban Regional,* 39: 1–15. doi:10.1111/1468-2427.12134

Smith, J. and Rogers, R. (2006) *Behind The Veneer, The South Shoreditch Furniture Trade and its Buildings.* English Heritage: Swindon.

Sternberg, E. (2007) An Integrative Theory of Urban Design. Section one, In: *Urban Design Reader,* pp.35-36. Carmona, M and Tiesdell, S (eds). Architectural Press.

Weber, A. [1909] (1929) *Theory of the Location of Industries.* Translated by Carl J. Friedrich. Chicago: University of Chicago Press.