In *Scottish Geographical Journal* 121(2) pp. 121-140

DUNDEE'S JUTE MILLS AND FACTORIES: SPACES OF PRODUCTION, SURVEILLANCE AND DISCIPLINE

Emma M Wainwright

Department of Geography and Earth Sciences

Brunel University

Uxbridge

UB8 3PH

Tel: 01895 266088

Fax: 01895 269736

Email: Emma.Wainwright@brunel.ac.uk

Abstract

Taking Dundee's jute industry as its focus, this paper provides a geographical reading of the architectural form, design and layout of the mills and factories of the late nineteenth century. By tracking the change from the multi-storey to the shed system, it emphasises the importance of the internal geographies of the production process. And drawing upon Foucault's notion of disciplinary power, notably his rule of functional sites and techniques of enclosure and partitioning, together with his tentative references to the factory system, I show how the external architecture and internal space of the mills and factories were used to create an ordered geography of both people and machinery and help maintain a gendered labour hierarchy. With the industry's largely female workforce channelled through points of visibility, a preliminary investigation is made into the matrix of knowledge, spanning the entire works, that ensured all space and all those within it, could be accounted for.

Dundee's jute industry: an introduction

The city of Dundee has had a long history of textile manufacturing. Prior to Scotland's Union with England in 1707, the woollen industry had been the city's main textile concern. But, after Union, Dundee became increasingly unable to compete with the larger English woollen industries and gradually moved to the courser fibre of flax. Flax became the industrial staple – not only for Dundee but also for Scotland as a whole (Turner, 1982). The west coast, with its locational advantages for trade and marketing, concentrated upon the production of finer flax materials whilst Dundee specialised in the manufacture of coarse, medium and heavy linens (Chapman, 1938). With the introduction of steam-powered flax spinning in the 1820s, Dundee's pre-eminence as a textile town grew and by 1851 the city's textile industry employed 11,382 hands, and imported 40,000 tons of flax (*Dundee Advertiser*, 18 June 1851). This industrial expansion was complemented by the growth of the city's railway network and harbour, enhancing its position as an important trading city (Beckles, 1966).

Raw jute first arrived in Dundee in 1822 but, due to the coarseness of the fibre and a lack of appropriate technology and incentive, early efforts at spinning it failed. It was therefore not until the 1850s that jute began to rival traditional fibres. However, not everyone welcomed its introduction. In 1839, one of the city's main newspapers, the *Dundee Advertiser*, reported that the reputation of Dundee textiles was lowered by "jute and other rubbish in Dundee materials" (cited in Lenman et al, 1969: 13). Change soon came with the rapid expansion of the carrying trade and jute became "the world's carrier" and its manufacture in Dundee one of the most spectacular boom industries in nineteenth-century Britain

(Turner, 1966: 34). This expansion is reflected in the imports of jute into Dundee that grew rapidly to a peak of 344,720 tons in 1891 (Lenman et al. 1969: 105). In the same year, a 2,800 ton sailing ship named 'Juteopolis' was launched – a name that became an epithet for the city's industrial outlook and heritage.

Powered by water and later by steam, mills and factories clustered around Dundee's three streams (Turner, 1953) and, as the concentration of mills grew, lack of space and an alternative power source enabled only limited and haphazard expansion (Turner, 1966), as one worker recalled:

> Our mill was planted in a part of the town where now, after its repeated amplifications, the ground was becoming scarce, so that much ingenuity had to be exercised when new machinery had to be fitted up. The millpond had been partly built over, and the ground dug away and quarried as far as was safe to give room for extension and improvement, and year by year it had become more and more crowded. (*People's Journal*, 14 May 1881)

As this suggests, the source of power determined initial geographical location and built form.

At its simplest, jute production was split into two processes; spinning and weaving, and two buildings; the mill and factory, with a range of connecting procedures and ancillary buildings. The mill was where the jute fibre was prepared for weaving and was itself split between two buildings and stages. The Low Mill housed the preparing stages (where the jute was softened, carded and drawn out),[1] and the High Mill was where the yarn was spun, twisted, reeled and

[1] This process began in the batching department where jute bales were opened, soaked in an emulsion of water and oil and put through a softener. The jute was then put through carding machines to continue the softening. Drawing frames then removed irregularities in the jute and turned it into a 'soft ribbon' like material that filled the bobbins. See Watson, 1990: 5-7.

wound.[2] The jute yarn then left the mills and was taken to the factory where it was woven into cloth.[3]

This paper focuses specifically on the design and architectural form of the jute works. Drawing on a range of primary and archival sources including contemporary journals and newspapers, mill and factory commentaries, and company records and plans, I explore how the mills and factories used space to both optimise production and workforce supervision. To do this, I draw upon the conceptual tools of Michel Foucault and his writings on disciplinary institutions and the first part of this paper roughly outlines his theoretical position before exploring connections/disconnections with Dundee's jute production process.

Importantly, though, the workforce in Dundee was made up overwhelmingly of women and the space of the mill and factory was aimed, in part, at their supervision. At the turn of the twentieth-century, women dominated Dundee's jute labour market and in 1905 the epitaph 'woman's town' was ascribed to Dundee, reflecting the high proportion of women workers (Lennox, 1905). Between 1871 and 1911, the city's jute works employed between two-thirds and three-quarters of Dundee's working women (Gordon, 1991: 141). The 1901 census, for example, showed that 31 per cent of the female population of Dundee was employed in the city's mills and factories and 27,635 of the 39,752 textile industry operatives – weavers and spinners – were women. In the latter part of

[2] Spinning frames twisted the jute into yarn by means of a revolving flyer on a spindle. This yarn could either be warp or weft. Warp threads required a heavier twist than weft. The process of shifting then removed filled bobbins from the frame and replaced them with empty ones. See Watson, 1990: 28.

this paper and in relation to a range of ideas on women's workplace position, this paper begins to tease out the specifically gendered form of supervision that persisted in the jute industry.

Foucault and the factory

According to Foucault (1991: 241), from the eighteenth century onwards, "[a]rchitecture is no longer built simply to be seen, or to observe the external space, but to permit an internal, articulated and detailed control – to render visible those who are inside it" . Foucault was "an exceedingly *visual* historian" and one who saw how "architecture helps 'visualize' power in other ways than simply manifesting it. It is not simply a matter of what a building shows "symbolically" or "semiotically", but also of what it makes visible about us and within us" (Rajchman, 1991). A significant portion of Foucault's discussion of 'space' is devoted to the problem of visibility – of how spaces are designed to make things seen and seeable – and Rajchman coins the term "spaces of constructed visibility" to describe how Foucault became interested in how things were 'given to be seen'.

Foucault treated Jeremy Bentham's panopticon as an ideal disciplinary mechanism that was "polyvalent in its application", that served "to reform prisoners, but also to treat patients, to instruct school children, to confine the insane, to supervise workers, to put beggars and idlers to work." Therefore, whenever "one is dealing with a multiplicity of individuals on whom a task or a particular form of behaviour must be imposed, the panoptic schema may be used"

[3] Jute yarn left the mill and entered the factory as either warp or weft. The weft was wound into cops and inserted in shuttles. On the loom the shuttle carried the weft backwards and forwards,

(Foucualt, 1977: 205). The rigid design of the panopticon, with its annular plan and central tower, must not be seen as a pre-requisite for its translation and transposition into other architectural types. Foucault's use of the panopticon as an ideal measure of various disciplinary projects, and how successful they were at creating a system of power, does not end with Bentham's annular plan. Rather, Foucault sensitises us to the use of architecture and space in the exercise of power and, particularly, practices of objectification that are based on confinement (Philo, 1989). To do this, Foucault uses the term 'panopticism' (Foucault, 1977: 195) to capture and, in a way, showcase, the idea that disciplinary power operates beyond the annular architecture of Bentham's prison.

Geographers have drawn upon the ideas generated by panopticism to explore the geographical histories of a number of institutions, including poorhouses, asylums, reformatory schools and women's colleges (Driver, 1993, Philo, 1989, Ploszajska, 1994 and Tamboukou, 2000). However, workplace organisation and, in a specifically historical context, the factory system, have been somewhat neglected (see Stein, 1995). There are good reasons for this, the main one being that Foucault himself did not devote much attention to factories and factory work, even if industrial dynamics are a "persistent sub-text" in his work (Jackson and Carter, 2000: 53).

Attempts to find the origins of 'discipline' in either various corrective institutions or factories have been considered by a number of theorists. Robert Sack suggests that it was through the move from feudalism to capitalism that new types of

---

interlacing it in the warps (parallel threads that unrolled from a beam). See Watson, 1990: 87.

social organisation and control came about. Work was used to both define deviance and correct it:

> Even when it was clear that classes of deviants were simply unable to work, the institutions in which they were placed were often organized like factories… From simple sheds and buildings to contain people, these institutions of confinement, just as factory floors, became architecturally sophisticated purpose-built structures to classify, contain, order and integrate. (Sack, 1986: 180)

Hence, "[t]he transformation of work, the rise of the factory, and the development of prisons, asylums, and schools were all interrelated" (Sack, 1986: 181). Melossi and Pavarini (1981) have also sought to establish the link between the rise of a capitalist mode of production and the origins of the modern prison, suggesting that they appeared at the same time. For Foucault, however, control via discipline developed first through various social institutions and, from these, were adopted by capitalists (see Bauman, 1982):

> [T]he two processes – the accumulation of men and the accumulation of capital – cannot be separated; it would not have been possible to solve the accumulation of men without the growth of an apparatus of production capable of both sustaining them and using them; conversely, the techniques that made the cumulative multiplicity of men useful accelerated the accumulation of capital. At a less general level, the technological mutations of the apparatus of production, the division of layout and the elaboration of the disciplinary techniques sustained an ensemble of very close relations. (Foucault, 1977: 221)

This has been reinforced by the idea that capitalist industrialisation modelled itself on institutions that already existed. Clegg (1989: 173), for example, suggests that "[t]he dark satanic mills of Yorkshire and Lancashire simply latched on to the disciplinary apparatus already let loose from the monastery into the poorhouse, the work house, the orphanage, the barracks, and so on". Indeed, Foucault's own focus on the prison led him to ask whether it was "surprising that prisons resemble factories, schools, barracks, hospitals, which all resemble prisons?" (1977: 228). Rather than discuss the origins and trajectory of

disciplinary power, my interest here is in how the closeness of the production process and corrective institutions centres on internal geographies and how we might see the relations between the 'accumulation of capital' and the 'accumulation of men' (Foucault, 2002: 78).[4]

Jonathan Crush has suggested that we need "to integrate an analysis of the domain of production with a Foucauldian reading premised on more diffuse definitions of domination and dispersed notions of power" (Crush, 1994: 307) than has otherwise been used in the study of the factory system. And, in a text devoted to Foucault and organisation theory, McKinlay and Starkey (2000: 3) suggest that "Foucault's project – and its limits – demand much more extensive research into the history of the factory and the office". In Foucault's own fleeting references to the production process, he remarked:

> In the factories that appeared at the end of the eighteenth century, the principle of individualizing partitioning became more complicated. It was a question of distributing individuals in a space in which one might isolate them and map them; but also of articulating this distribution on a production machinery that had its own requirements. The distribution of bodies, the spatial arrangement of production machinery and the different forms of activity in the distribution of 'posts' had to be linked together. (1977: 144)

This passage is taken from the section in *Discipline and Punish* where Foucault discusses the techniques of enclosure, partitioning and functional positioning that facilitated the development of discipline. One of my aims here is to expand on these fragmentary remarks about the factory and think more carefully about the disciplinary matrices – notably the use of enclosure, partitioning and function – that shaped Dundee's jute works.

[4] Foucault suggested that, in contrast to the confinement of the eighteenth century which excluded individuals from the social circle, the confinement of the nineteenth century 'attached individuals' – be it to an apparatus of production, training, reform or correction.

Women's workplace position

However, in thinking through these workplace geographies, reference to the specificities of the workforce must be made and, in Dundee, a powerful gendered division of labour characterised the jute industry with women positioned at the bottom of the working hierarchy. One of feminisms' early concerns was to highlight and understand women's low and restricted workplace participation. At first a critique of orthodox economic explanations of participation was made that, very simplistically, tended either to ignore gender entirely or work through essentialised understandings of 'woman' through the process of occupational segregation. For example, Hakim (1979: 1) highlighted how occupational segregation by gender persisted in positioning men and women in "two separate labour forces, one male and one female, which are not in competition with each other for the same jobs". Two types of occupational segregation have subsequently been identified: horizontal segregation (the concentration of women and men in different types of work) and vertical segregation (the concentration of men in higher grades and women in lower grades both within and between occupations and industries).

These theorisings, especially those which attempted to locate when and where segregation took hold, merely 'added women into' or fitted them around traditional theorisings and failed to explain the causes of segregation or the gender identities they constituted. The historian Joan Scott (1988: 47) articulates this failure by claiming that it means we "start the story … too late, by uncritically accepting a gendered category (the 'woman worker') that itself needs

investigation because its meaning is relative to its history". Through this and other critiques of the essentialist underpinning of early feminist ideas, the processes of occupational sex-typing through which segregation is produced and persists began to be analysed. As Game and Pringle (1983) have recognised, occupational segregation is produced by, and productive of, a range of ideal, 'innate' and oppositionary attributes of masculinity and femininity, which, they contend, 'sex-type' or stereotype jobs. Therefore, and as Bradley (1989) argues, there is a need to explore both occupational segregation (the way in which men and women are located in different job types), and occupational sex-typing (the process by which jobs are gendered).

More recently, McDowell (1997: 12) has suggested that rather than seeing the workplace as a site which men and women enter as "fixed and finished products" to become labour, "the ways in which the workplace or the organization play a key role in the constitution of subjects is becoming clear". So rather than simply mapping occupational segregation and recognizing its diverse spatial manifestations, she emphasises the workspace itself – the processes and micro-geographies within the workplace. Resonating with Foucauldian ideas, she refers to the shift from a gender-in-organization model where organizations are seen as settings in which gendered actors behave differently because of their own different attributes, to the conceptualisation of organizations as producers of gendered meanings. As such, the workplace itself is socially constructed and gendered as either masculine or feminine. Both location and the physical construction of the workplace – its site and layout, external appearance and internal layout and the surrounding environment – affect and reflect the social

construction of work and workers, and the relations of power, control and dominance that structure relations between them.

The latter part of this paper explores the process of gendering working activities and begins to explore how the internal geographies of the mill and factory were used to position women, and worked to produce and sustain the gendered division of labour. Drawing on these ideas and using Foucauldian terminology of visibility and partitioning, a preliminary investigation is made into the means by which women became the objects of disciplinary procedures.

Designing the spaces of production

William Strutt designed the first multi-storey fireproof industrial building in Derby in 1792. By 1807, at least seven fireproof mills had been completed with interior iron framing and, by 1818, this mode of construction was being used to eight-storey heights (Skempton and Johnson, 1962 and Markus, 1993: 270-4). The first iron-framed mill in Dundee was Bell Mill, built around 1806-7, although the main period of construction for this type of mill in the city did not come until the 1830s. In comparison to the spinning of wool and cotton, jute and flax spinning frames required less floor space but exerted greater pressure due to the heavier nature of machinery used. The sturdy construction of iron-framed mills with ten-foot spaces between columns was therefore favoured. Iron frames were also fireproof; an important consideration given that jute was prone to self-combustion. With heavier, fixed machinery, a high proportion of total floor space was restricted to ground level and Dundee's mills therefore tended to be lower than the textiles mills found elsewhere. The construction of Edward Street Mill,

Tayworks and Upper Dens Mills in the period 1850-1 marked a new departure in scale, architecture and building technique in Dundee, with the mills becoming grander and more ornate in design. However, in spite of this, Dundee's mills generally remained smaller than their cotton counterparts with only a handful over four-storey high (Watson, 1990).

As jute is a coarse material, great attention was needed to its preparation and this necessitated a lower proportion of spinning to preparing machinery than found in other textile industries. As Watson (1990: 28) explains, "[t]he system must … be balanced economically so that one machine does not outstrip or fall behind the others". Importantly, this greater focus on the preparation of the jute fibre had to be reflected in the design of the buildings and the use and layout of space. To be economically efficient, each stage of production had to be coordinated with those before and after, ensuring a balance of material passing through.

By the 1860s, this multi-storey design had been replaced by a single storey shed system. One observer described this as follows:

> Almost all the modern jute mills and rope works are built upon the shed principle, with very often no partition between departments, the objects being to minimise labour and to permit raw material coming in at one end, passing through and going out as a finished product at the other end. (Carter, 1907: 195)

Instead of partitioned departments, the shed system worked through an open plan design, bringing together a number of connecting processes under one roof. The first single-storey mill in Dundee was at Stobswell Works, completed in 1895. However, it was more usual for a company to make additions to existing works and end up with a more eclectic mix of buildings. According to Watson, it was

the Caldrum Works which was “perhaps the first large British textile complex to integrate spinning, weaving and finishing on a single storey.” Designed in 1872 by Robertson and Orchar for Harry Walker & Sons, Watson (1990: 75) describes how, with material moved effectively through the works, “[n]o textile works could have a more efficient layout”. The shed system enabled a movement and efficiency that was not possible within the multi-storey complex. Housing all departments under one roof brought new levels of coherence and efficiency to the production process.

The design of the sheds was determined by the shapes of the machines to be used, as the Engineer at Caird’s Ashton and Craigie Works recorded:

> Assuming that the building is rectangular, all column spaces should be such as suit the machinery. It is not good practice to make all roofs the same span if by so doing the arrangement of the machinery is to be in any way made inconvenient for working the material. (Caird, c.1917)

An example of this is the Caldrum Works. According to Watson (1990: 75-6), the widest roof spans of 35ft were found over the roving frames, finisher cards, and first and second drawings. The roofs over the spinning frames were 33ft, the same length as the frames themselves, and roof spans of 28ft were reserved for the breaker cards and powerlooms. In the batching shed, however, the 33ft roof was dictated less by the softener machines than by the space needed to store the batched jute. In the same way, the layout of the Manhattan Works, deduced from William Leggatt’s *Theory and Practice of Spinning* (1893) (Figures 1 and 2) demonstrates that the spans of the sheds depended upon the size of the machinery and the amount of shafting required.

Figures 1 and 2

At first, the shed system was only implemented on the weaving side of the process due to the particularities of the machinery. The powerloom, initially invented and patented by Edmund Cartwright in 1785, was not widely adopted until the second decade of the nineteenth century (Markus, 1993: 274-5). It was at this later point that their use gained momentum in Dundee (Watson 1990: 92). In contrast to other machinery, the vibrations created by powerlooms meant that they were only safe on the ground floor, hence the development of the shed system. In 1877, Leggatt stressed the importance of the design of weaving sheds and the organisation of space to ensure maximum output:

> I consider a ground floor the best adapted for a work of this sort. The light can be best arranged from the roof; the shafting should be below, as it is steadier on this plan, and the looms can be more firmly fastened down with the shafting on this principle; and besides with the steadier drive thus obtained, the looms can with advantage be driven 20 picks per minute quicker than with the shafting above. Eight looms driven on the side shafts are as many as will be found suitable to give a steady motion to the loom. There should be a main pass six feet wide, and the main shaft should go down this pass. There should also be a space of at least three feet allowed for weavers passes, so that they may have space to go about their work. As a rule, in all factory plans the machinery is placed too close. Very often there is no main pass, and the weavers have so little space that this along with other drawbacks in arrangement, prevents the looms from going more than thirty-five out of sixty hours, and sometimes even less. (Leggatt, 1877: n.p)

As this suggests, the perfect layout for maximum efficiency of the production process was constantly sought with exact placing of machinery and workers critical in ensuring maximum output. The drawing up of plans was essential for this. In his handbook *The Construction of the Powerloom and the Art of Weaving*, Alex Brown (1896: 81) noted the importance of the planning stages:

> When a new factory or loom shed is about to be built, or an old one rearranged, a plan of the arrangement of the machinery is drawn out with a view to work it with the best possible expenditure of labour and power, and that the space at disposal may be economized to the utmost. We must

> look to the drawing for the exact position of each particular machine, and put it down as indicated there, so that when all the machinery has been put in position it will form a completed whole.

Planning was vital for the positioning of each piece of machinery in relation to the production system as a whole:

> To economize the space for passes around the looms, and to have something like order in the factory, the looms should be grouped in fours, with all their belts running beside each other. (Brown, 1896: 81)

An ordered geography of machinery was therefore critical; the spacing of machinery was paramount and could only be achieved through precise organisation at both the micro and macro-scale of the works. Plans, such as those shown in figures 1 and 2, became the vantage point from which company directors could view mill or factory buildings and, in Foucauldian terms, an apparatus through which all space could be arranged, accounted for and made productive.

In Dundee, the shed system was adopted far more quickly than elsewhere, facilitating, it was hoped, both time and space efficiency. In 1877, one theorist of jute production wrote "[o]ne of the most important points in erecting a works is the saving of time. This object ought never to be lost sight of … From the first process of the manufacture until the cloth leaves the work as a finished piece, the various departments ought to be so arranged that the material leaving one process the next should be close at hand" (Leggatt, 1877: 91). Internal spatial arrangements were critical to ensure an efficient geography of movement as soon as raw jute entered the mill. The *People's Journal* (18 Feb 1888) explained the reasons for the shed system to its readers, in the following terms:

> The modern jute factory is as unlike that of twenty years ago as could well be imagined. There is now no high building of several storeys in which

> the different departments were connected by elevators or lifts of a more or less dangerous description, and which required, besides motive power to drive them, men and lads to guide their movements and to manage the loading and unloading of the hoists. All this is now done away with. The modern factory, as a rule is spread over a much wider area than the old. It expands to the width, and not the height, and the advantages gained are that spinning, weaving, finishing and, dispatching are all done on the one level. The raw material goes in at one end of the factory, and the bales of beautiful carpets or the bulk of finished hessian comes out at the other.

As stairs, cloisters, corridors and the movement of workers had been replaced by lifts and hoists – "where a piece of moving space contained static people or objects," (Markus, 1993: 280) – the shed system replaced vertical movements with a horizontal route of passage.

Such accounts emphasise the efficiency of the production process and how the geography of placement and movement within the works made this possible. Although we need to treat such accounts with caution – recognizing their origins and interests – they nonetheless tell us about how the city's jute industry was written about, made known and envisioned.

Jeremy Stein (1995: 279) suggests that the geographical dimensions of factory life normally receive short shrift in traditional accounts of the factory system as "a capitalist sense of time ignores the equally powerful and transformative role of space played in the industrialising process". However, the spatiality of mills and factories and the spacing of machinery were crucial to the time-efficiency of the production process. Workspaces had to be flexible and it was common to 'lay aside' or convert looms when demand for particular widths of material were short. Minute books and directors' reports frequently remarked how jute works were being kept in a "state of efficiency" presenting not only the company's

formal face but also the idea of the 'rational economic man' who would always maximise efficiency and profit.

As pointed out by one engineer, it was a matter of perfecting both the building and the organisation of machinery:

> The general plan of the buildings, their design and construction show that the originators of the firm knew their business and could take a long view of things… The buildings were built to stand the test of time and even today no better example of a substantially built mill and well-constructed sheds could be found. And there can be no doubt that had this policy been continued throughout the years of the successive generations this firm would still rank foremost in jute spinning. Unfortunately while the walls have stood the test of time the organisation and machinery have failed. (Caird (Dundee) Ltd, Works Engineer's Book, c.1917)

Both components – buildings and internal organization – were necessary for the efficient running of the production process and it was vital that owners could take the "long view" in maintaining and updating machinery to keep up with changing patterns of demand. Foucault's rule of 'functional sites' suggests that particular spaces were defined not only by the need to supervise those within, but also by the desire to create a useful space (1977: 145). He recognised the specificity of capitalist discipline and started to consider how the architectural space of the mills and factories was not simply about locating bodies, but also about ensuring the efficient operation of the production process.

Beyond machinery – internal geographies of surveillance

> The factory and the mill are the most revealing industrial forms in their organisation and space. In older economic histories it was common to trace their development through technological changes of machinery and power sources. The social dimensions of production were missing. (Markus, 1993: 261-2)

Mills and factories represent a functional geography and it is this functionalism that has been prioritised by industrial archaeologists. However, an understanding of the production process that rests solely on the constant re-organisation and re-adjustment of machinery is too technologically and economically determinist. In a Marxist vein, it would appear that "the labourer becomes a mere appendage to an already existing material condition of production" (Marx, 1995: 238). I want to move beyond these determinist understandings to think more thoroughly about the place of the workers. The contemporary commentator of the factory system, Andrew Ure, noted:

> It is … excessively the interest of every mill-owner to organize his moral machinery on equally sound principles with his mechanical, for otherwise he will never command the steady hands, watchful eyes, and prompt co-operation essential to excellence of product. (1835: 417)

It is the attempt to produce "steady hands, watchful eyes, and prompt-co-operation" that the rest of this paper focuses on and it is here that I draw specifically upon Foucault's writings to offer a different reading of the geography of the workplace.

The shed system not only enabled the smooth progression of jute through its various stages of manufacture but, as manufacturers and social commentators pointed out, there were a set of ties to surveillance. One factory proprietor remarked that the initial cost of the shed system "would be fully compensated by the facility of superintendence alone, as in many factories this was of the utmost importance" (cited in Watson, 1990: 76). Similarly, the contemporary commentator and Benthamite disciple, Edwin Chadwick (1842: 306), wrote that, in spite of the initial expense of a change in the building and layout, there were significant advantages:

> [I]t [the shed system] appeared to possess countervailing economical advantages to the capitalist, the chief of which are, – this same facility of constant supervision, the increase of the certainty of superintendence, and the reduction of the numbers of subordinate managers, the increase of efficiency of management, and the diminution of its expense.[5]

The successful surveillance of workers was part of an economic trajectory of cost reduction. Tying this more explicitly to the figure of the panopticon, Sack (1986) suggests that modern industrial architecture (of which the shed system was a part), has in fact taken the principles of the panopticon one step further. Partitions within the factory became far more flexible than Bentham anticipated, to the point that many were literally invisible. However, while partitions within the factory were not always physically demarcated, they were clearly etched in the minds of both worker and supervisor.

Markus (1993: 275) alerts us to concerns that these "huge open spaces generated":

> Diverse processes had to be accommodated, differentiated and controlled by elaborate management techniques rather than physical barriers. Surveillance became easier; this both increased control and discipline but also gave new opportunities for worker solidarity.

Whether a works conformed to the perfect shed system or had a mix of building types, the concern for the surveillance of workers as well as the efficient placing of machinery was ever present. The following is an extract from the Buist Spinning Company Directors' report for 1903:

[5] In his Report on the *Sanitary Condition of the Labouring Population and on the Means of its Improvement*, 1842, Sir Edwin Chadwick was particularly concerned for the moral and social repercussions. He wrote: "The bad manners and immoralities complained of as attendant on assemblages of workpeople of both sexes in manufactories generally occur, as may be expected, in small rooms and places where few are employed, and that are secluded from superior inspection and from common observation. But whilst employed in this large on room, the young are under the inspection of the old; the children are in many instances under the inspection of parents, and all under the inspection of the employer. It was observed that the moral condition of the females in this room stood comparatively high."

> Mill Buildings These are being well kept up and the Directors are now taking in tenders for extending the Mill to the North, so that a Mechanic shop, Joiners' shop & Smithy can be put down all in one. In this way there will be more complete supervision by foreman than at present with each shop in a different place.

Similarly, Thomas Cox of Camperdown Works wrote of how the Dundee mills, "are owned by the parties who carry them on" and therefore "everything [is] closely watched" (Cox Brothers, 1881). Surveillance of both machinery *and* workers was central to the efficient working of the production process and it is to the latter that I now turn more directly.

Work – an enclosed disciplinary space

> What was the factory if not a self-contained, highly centralized and controlled work environment? Sealed off from the outside world, split up into departments and workrooms, assigned specific tasks and works stations, workers experienced a discipline that was acutely spatial. (Stein, 1995: 289)

According to Foucault, discipline proceeds from the distribution of individuals in space and, to achieve this end, it employs several techniques. The first technique is that of 'enclosure'. In relation to the textile industry in Dundee, jute complexes were well-defined, homogenous spaces, segregated from the rest of city life. The *Dundee Year Book (DYB)* (1884: 62) described the scene when entering Grimond's jute works:

> Entering the large gates, you find yourself in a miniature town. To the left is the dining-hall which the firm is erecting for the convenience of workpeople who are far from their homes, commodious warehouses where the raw jute is stored, paved streets, handsome lamps, and a general air of spick and span orderliness which is very impressive after the bustle and confusion of the street we have just left on the other side of the gates.

This 'imagined' ordered 'minitiature town' is constructed in contrast to the chaotic world of the outside, with emphasis placed on the boundary between the two. But, despite the secure and contained nature of the workplace, workers did

not experience ‘confinement’ in a literal Foucauldian sense as would, for example, a prisoner or asylum inmate. Workers could leave during breakfast and lunch hours and, of course, at the end of the day. Confinement worked differently and, crucially, had a different geography.

Work gates, pivotal point in a works’ geography, became important symbolic sites for both employers and employees, as the only point of entry and exit. Designed to exclude uninvited outsiders, they could, when necessary, be easily sealed off from the outside world, which was particularly important in times of labour unrest.[6] Next to the gates was the porters’ lodge and, although the mills and factories were not fortified or under guard as such, jute companies stressed the need to have porters who were “tall powerful well-built, energetic and decided” men (Cox Brothers, 1893).

The working day was rigid; twelve-hours was the norm with two breaks of forty-five minutes for breakfast and one hour for lunch. Work began in the mornings at 6am and, to ensure prompt arrival, jute works had their own ‘bummers’ and whistles that, sounding at various intervals, gave notice that work was due to commence, imposing a sense of ‘time-thrift’ amongst workers (Thompson, 1967 and Pollard, 1975). It was also common for workers to call on the services of a ‘knocking-up’ boy, who would tap on doors and windows to waken workers (Dundee Oral History Project (DOHP), tape 020). Gates would be closed exactly

[6] In a paper on the prison system, Chris Philo (2001: 479) highlights the gate as a weak point in the prisons enclosing geography: “This [the gatehouse] was the vulnerable point in the prison’s spatial layout, the point of access or egress, and guards in the different parts of the ‘gate’ had to be especially vigilant in their counts, checks and searches to prevent both the escapes and the admission of unsanctioned people and items”.

at starting time and late workers would have a portion of their wages deducted (Royal Commission on Labour, 1893: 304).

During working hours, workers had to receive official permission before exiting the premises. At Grimond's, workers requiring to leave during working hours had to "get out a pass-check which will be signed by the responsible foreman of the department. This pass is to be handed to the lodge keeper before leaving" (Grimond, 1911). In this way, foremen were to account for every worker at all times. This form of spatial confinement or enclosure caused discontent amongst the workers as a letter from the Dundee and District Jute and Flax Workers Union to Grimond's articulated:

> I am requested by pieceworkers to draw your attention to a hardship that is being placed on them by the rule that no person will be allowed to leave the works without a pass. They are being kept hours in the works when there is no work for them. In cases where a pass has been asked it has been refused. (26 February 1912)

If any worker left without gaining their foreman's permission, they were reported to the porter who would then strike them off the company's books and ensure they did not return (Grimond, 1911). Through the use of foremen and porters in this way, the invisible but knowing gaze of the employers could be cast over the entire geography of the works, ensuring all workers were accounted for. This is how confinement or enclosure worked in the mills and factories, not through incarceration, but through the ever-present threat of an immediate loss of livelihood.

Discipline through visibility

Matthew Hannah notes that, "[w]hatever its concrete practical variation, disciplinary power involves *regulation through (either literal or metaphorical) visibility*" (Hannah, 1997: 171). In addition to being enclosed spaces, jute works were also internally partitioned as "[e]ach individual has his own place; and each place its individual" (Foucault, 1977: 143). According to Foucault, "the principle of 'enclosure' is neither constant, nor indispensable, nor sufficient in disciplinary machinery" but, requires "the principle of elementary location or partitioning" (1977: 143). In the workplace, as in other disciplinary spaces, this process of partitioning was made possible through a distinct hierarchy. Here I want to say something about how partitioning worked, with a preliminary look at women's workplace participation and location in Dundee's mills and factories.

In Dundee, occupational sex-typing and segregation were well-defined and a fairly rigid sexual division of labour existed in the mills and factories. Women were employed in the preparing processes, the spinning flats, and in the powerloom weaving. Although in preparing and spinning departments a few men could share the same job as women, weaving was an almost exclusively female occupation. In contrast men's employment in the mills and factories was largely confined to a small number of 'skilled' tasks, such as beaming and dressing, and supervisory and maintenance tasks. For women there were no opportunities for either horizontal or vertical mobility. The lack of horizontal mobility is widely recognized with discrete and separate groups of weavers and spinners developing. The only supervisory role taken on by women was that of 'Shifting Mistress' who

had responsibility for shifters who were mainly young children (see Gordon, 1991: 29).

However, while the early spinning of flax in the home had been the preserve of women because "it required no ponderous machinery; the young mother could spin and watch her child, and the housewife could look to the affairs of her house", original flax weaving had been carried out by men (*DYB*, 1884: 52). Weaving only became a 'female' profession when male handloom weavers refused to adopt the powerloom. It has also been suggested that the craft pride of the handloom weavers made them reluctant to work on a fibre seen as inferior to flax and that manufacturers, fearing the organisation of male workers, ensured that the new weavers would be female (Gordon, 1991). With a cheap fibre such as jute, the need to keep labour costs at a minimum was also put at a premium and led to the employment of lower paid women as both spinners and weavers.

All of Dundee's jute works operated a system of rules that codified vertical and horizontal segregation and this gendered labour hierarchy. For example, the first rule from the management book of Ward Mill reads:

> All workers shall be under the management and control of their respective foremen and chargehands, and shall be bound to obey their orders in everything relating to the carrying out of the work (Don Brothers, Buist & Co. Ltd., n.d.).

Further, each jute department had its own internal hierarchy. In the preparing department at Camperdown Works, for example, one overseer was in charge of ten workers employed in various preparing stages (Cox Brothers, 1860).

In the weaving sheds, overseers and assistant overseers were at the apex of the hierarchy of authority, although it was the male ‘tenters’ who most frequently came into contact with the female weavers. One tenter would commonly oversee about 20 looms. Although his task was to set up the looms, tune and tend to them, he effectively worked as a sub-foreman who exercised authority over the weavers and controlled the pace at which they worked. Work groupings were central to the production process and workers were known according to their place in a group. In addition, all workers were under the watchful eye of a series of managers which, at Camperdown Works in 1900, consisted of five General Managers, five Spinning Managers, one General Weaving Manager, three General and Carpet Managers, two Carpet Weaving Managers, two Calender Managers, and one Building and Engineering Manager (Cox Brothers, 1900). Against the backdrop of a moralizing Victorian middle-class, this supervision also had moralistic and patriarchal overtones; a means of breaking up potentially dangerous encounters between individuals; a functional extension of the space of the mill and factory (see Joyce, 1980).

Mills and factories were arranged so that a foreman could look down the pass between the machines, review his section and be immediately aware of empty places. In this way, workers were made visible as soon as they entered the works and their specific department. Furthermore, foreman could punish those involved in strike action, apparent in the ad hoc hiring and firing process. As rule 11 at Don Brother’s Buist noted, “[w]orkers who are absent for other causes and without previously obtaining permission from their foremen, are liable to find their places have been filled when presenting themselves for re-employment”

(Don Brothers, Buist & Co. Ltd., n.d.). Through the implementation of rules and regulations, each worker had their own place in the system of machinery and, through the hierarchy of the workplace, under the watch of their foreman. However, this is not to suggest that visibility within the workplace was completely pervasive as spaces of resistance could open up above and beyond the knowledge of the foreman through, for example, the use of sign-language and celebratory songs and practices (see Wainwright, forthcoming). These enabled the enclosed, partitioned and functional space of the mill and factory to be recoded on the terms of the working women.

Importantly, the production process hinged upon the nexus of working bodies and working machinery, with each having their own requirements. Foucault's observation that "[d]iscipline defines each of the relations that the body must have with the object that it manipulates" (1977: 153) is particularly relevant for research into the production process. Workers were individually attached to specific pieces of machinery and had to learn a certain set of skills and bodily manoeuvres in order to work effectively. Every movement and position of the body was stipulated and scrutinized to create workers inclined to the movements and operational needs of their machinery. To be productive, the positioning and partitioning of body to machinery had to be precise.

Conclusion

This paper has worked through and extended a set of concerns associated with traditional industrial geographers, providing details on the specificities of the location, built form and production process of Dundee's jute industry. By

drawing upon a range of archival sources and the words of contemporary commentators that scrutinised the production process, I have shown how the mills and factories were written about and conceptualized, and how they were created in pursuit of efficient working machinery, planning and organization.

However, the positioning of machinery was closely linked to the positioning of workers. Through the use of and connections between a particular set of ideas taken from Foucault's writings on disciplinary power and writings on women's workplace position, my key argument is that the mills and factories of Dundee were sites not only of production that required a specific spatial arrangement of machinery, but were also sites of surveillance that required a set of disciplinary procedures, aimed specifically at working women. These workplace geographies have been primarily tracked by working through the enclosure, partitioning and functional site of the workplace and drawing together a range of sources from directors' reports, company minutes, letter books and workplace manuals and. It has been in the details (and often what appear to be the mundane details) of these sources, that the very workings and very specific geographies of the production process are found.

By drawing upon Foucault's notion of disciplinary power and his tentative references to the production process, I have shown how the external architecture and internal layout of the mills and factories were used to channel workers through points of visibility – points that together formed a matrix of knowledge that ensured that all space, and all those within it, could be accounted for. A productive workforce depended upon a disciplined workforce – keeping a tight

reign on workers and ensuring what Foucault described as, “regulation through visibility”. By examining the gendered hierarchy that was created and maintained through the deployment of supervisory tools, albeit it in a preliminary fashion, this paper has begun to tease out the importance of spatial arrangements in the functioning of the mill and factory system.

Acknowledgements

I began this research in the School of Geography and Earth Sciences, University of St Andrews, and I would like to thank my PhD supervisor, Dr Dan Clayton, for his support and enthusiasm. Thanks also to the referees for their useful comments.

REFERENCES:

Bauman, Z. (1982) *Memories of class: the pre-history and after-life of class.* London: Routledge and Kegan Paul.

Beckles, N. (1966) Textile and port growth in Dundee, *Scottish Geographical Magazine* 82: 90-98.

Bradley, H. (1989) *Men's work, women's work.* London: Polity Press.

Brown, A. (1896) *The construction of the power loom and the art of weaving.* Dundee: James P. Matthew & Co.

Buist Spinning Company Ltd. (16 March 1903) Minute Book No. 1. Dundee University Archives, MS71/I/1

Caird (Dundee) Ltd, (c.1917) Works Engineer's Book, Dundee University Archives

Carter, H. R. (1907) *Modern flax hemp and jute spinning and twisting*. Dundee.

Chadwick, E. (1842) *Report on the sanitary condition of the labouring population of Great Britain.* Edinburgh: Edinburgh University Press, (1965 edition).

Chapman, D. (1938) The establishment of the jute industry: a problem of location theory?, *The Review of Economic Studies* 6: 33-55

Clegg, S. (1989) *Frameworks of power*. London: Sage Publications.

Cox Brothers, (1900) *Wages book.* Dundee University Archives (MS66/II/5/2).

Cox Brothers, (1893), *Private letter book.* Dundee University Archives (MS66/II/2/2).

Cox Brothers, (1881) *Private Letter Book.* Dundee University Archives (MS66/II/2/1).

Cox Brothers, (1860) *Wages book.* Dundee University Archives (MS66/II/5/5).

Crush, J. (1994) Scripting the compound: power and space in the South African mining industry, *Environment and Planning D* 12: 301-324.

Don Brothers, Buist & Co. Ltd., (n.d.) *Rules*. Dundee University Archives. (MS100/I/9/6).

Driver, F. (1993) *Power and pauperism, the workhouse system 1834-1884.* Cambridge: Cambridge University Press.

Dundee Advertiser, 18 June, 1851.

Dundee and District Jute and Flax Workers Union, (1912) *Letter book*. Dundee City Archives (GD/JF5/1).

Dundee Oral History Project, Local Studies Library, Dundee.

Dundee Photographic Survey (1916) Local Studies Library, Dundee.

Dundee Year Book, 1884.

Foucault, M. (2002) *Power: essential works of Foucault 1954-1984.* J. Faubion (ed.), London: Penguin.

Foucault, M. (1991) 'Space, knowledge and power' in P. Rabinow (ed.), *The Foucault reader*. London: Penguin, pp239-256.

Foucault, M. (1977) *Discipline and punish: the birth of the prison.* London, Penguin.

Game, A. and Pringle, R. (1983) *Gender at work*. Sydney: George Allen and Unwin.

Gordon, E. (1991) *Women and the labour movement in Scotland, 1850-1914.* Oxford: Clarendon.

Grimond's (1911) *Rules.* Dundee University Archives (MS66/IV/7/2).

Hakim, A. (1979) *Occupational segregation by sex.* Department of Employment Research Paper No.9.

Hannah, M. (1997) 'Space and the structuring of disciplinary power: an interpretive review', *Geografiska Annaler* 79 B: 1-17.

Jackson, N. and Carter, P., (2000) 'Labour as dressage', in A. McKinlay, and K. Starkey (eds.), *Foucault, management and organization theory: from panopticon to technologies of self*. London: Sage, pp49-64.

Joyce, P. (1980) *Work, society and politics.* London: Methven.

Leggatt, W. (1893) *The theory and practice of jute spinning.* Dundee: William Kidd.

Leggatt, W. (1877) *The theory and practice of the art of weaving.* Dundee: William Kidd.

Lenman, B., Lythe, C. and Gauldie, E. (1969) *Dundee and its textile industry 1850-1914*. Dundee: Abertay Historical Society.

Lennox, D. (1905) *Working class life in Dundee for twenty-five years, 1878-1903.* Dundee University, unpublished thesis.

Markus, T. A. (1993) *Buildings and power: freedom and control in the origin of modern building types.* Routledge: London.

Marx, K. (1995) *Capital, a new abridgement*. Oxford: Oxford University Press.

McDowell, L. (1997) *Capital culture: gender at work in the city*. Oxford: Blackwell.

McKinlay, A., and Starkey, K. (2000) 'Managing Foucault: Foucault, management and organizational theory', in A. McKinlay and K. Starkey (eds.) *Foucault, management and organization theory: from panopticon to technologies of self*. London: Sage, pp1-13.

Melossi, D. and Pavarini, M. (1981) *The prison and the factory: origins of the penetentiary system*. London: Macmillan Press (original published in 1977).

Murray, J. (1995) *Dundee at work*. Wiltshire: Sutton Publishing.

People's Journal, 18 Feb 1888.

People's Journal, 14 May 1881.

Philo, C. (2001) Accumulating populations: bodies, institutions and spaces, *International Journal of Population Geography* 7: 473-490

Philo, C. (1989) "Enough to drive one mad': the organization of space in the 19th century lunatic asylums' in J. Wolch, and M. Dear (eds.) *The power of geography: how territory shapes social life*. London: Unwin Hyman Ltd, pp50-66.

Ploszajska, T. (1994) 'Moral landscapes and manipulated spaces: gender, class and space in Victorian reformatory schools', *Journal of Historical Geography* 20: 413-429.

Pollard, S. (1975) 'Factory discipline in the industrial revolution', *Economic History Review* 12: 254-271.

Rajchman, J. (1991) 'Foucault's Art of Seeing' in *Philosophical Events of the 80s*. Columbia University Press: New York, pp68-102.

Royal Commission on Labour (1893) *The employment of women, conditions of work in various industries in England, Wales and Scotland*. London .

Sack, R. (1986) *Human territoriality: its theory and history*. Cambridge: Cambridge University Press.

Scott, J. (1988) *Gender and the politics of history*. New York: Columbia University Press.

Skempton, A. W. and Johnson, H. R. (1962) ‘The first iron frames’, *Architectural Review* 131: 175-186.

Stein, J. (1995) ‘Time, space and social discipline: factory life in Cornwall, Ontario, 1867-1893, *Journal of Historical Geography* 21: 278-299.

Tamboukou, M. (2000) ‘Of other spaces: women’s colleges at the turn of the nineteenth century in the UK’, *Gender, Place and Culture* 7: 247-263.

Thompson, E. P. (1967) ‘Time, work-discipline and industrial capitalism’, *Past and Present* 38: 56-97.

Turner, W. H. K. (1982) ‘The development of flax-spinning mills in Scotland 1787-1840’, *Scottish Geographical Magazine* 98: 4-15.

Turner, W. H. K. (1966) ‘The concentration of jute and heavy linen manufacturers in east central Scotland’, *Scottish Geographical Magazine* 82: 29-45.

Turner, W. H. K. (1953) ‘Some eighteenth-century developments in the textile region of east central Scotland’, *Scottish Geographical Magazine* 69: 10-21.

Ure, A. (1835) *The philosophy of manufacture: or, an exposition of the scientific, moral, and commercial economy of the factory system of Great Britain,* London.

Wainwright, E. M. (forthcoming) “Gendering and spacing resistance in Dundee’s jute industry”, in E Gordon and A McKinlay (eds.) *Women and the politics of protest*. Ashgate

Watson, M. (1990) *Jute and flax mills in Dundee,* Tayport: Hutton Press.

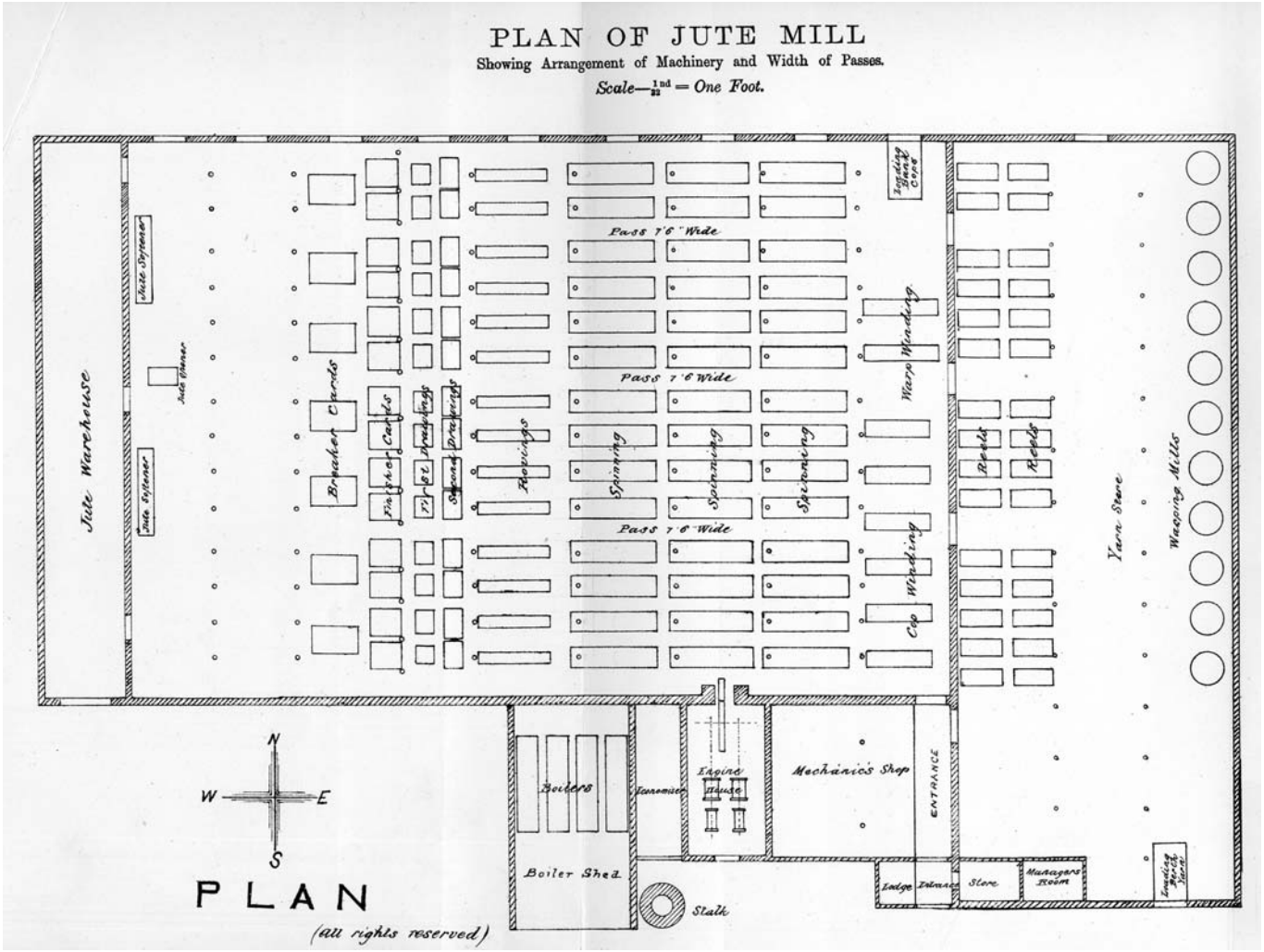

Figure 1: Plan of jute mill showing arrangement of machinery and width of passes.
Source: W. Leggatt, (1893) *The theory and practice of jute spinning.* William Kidd: Dundee.

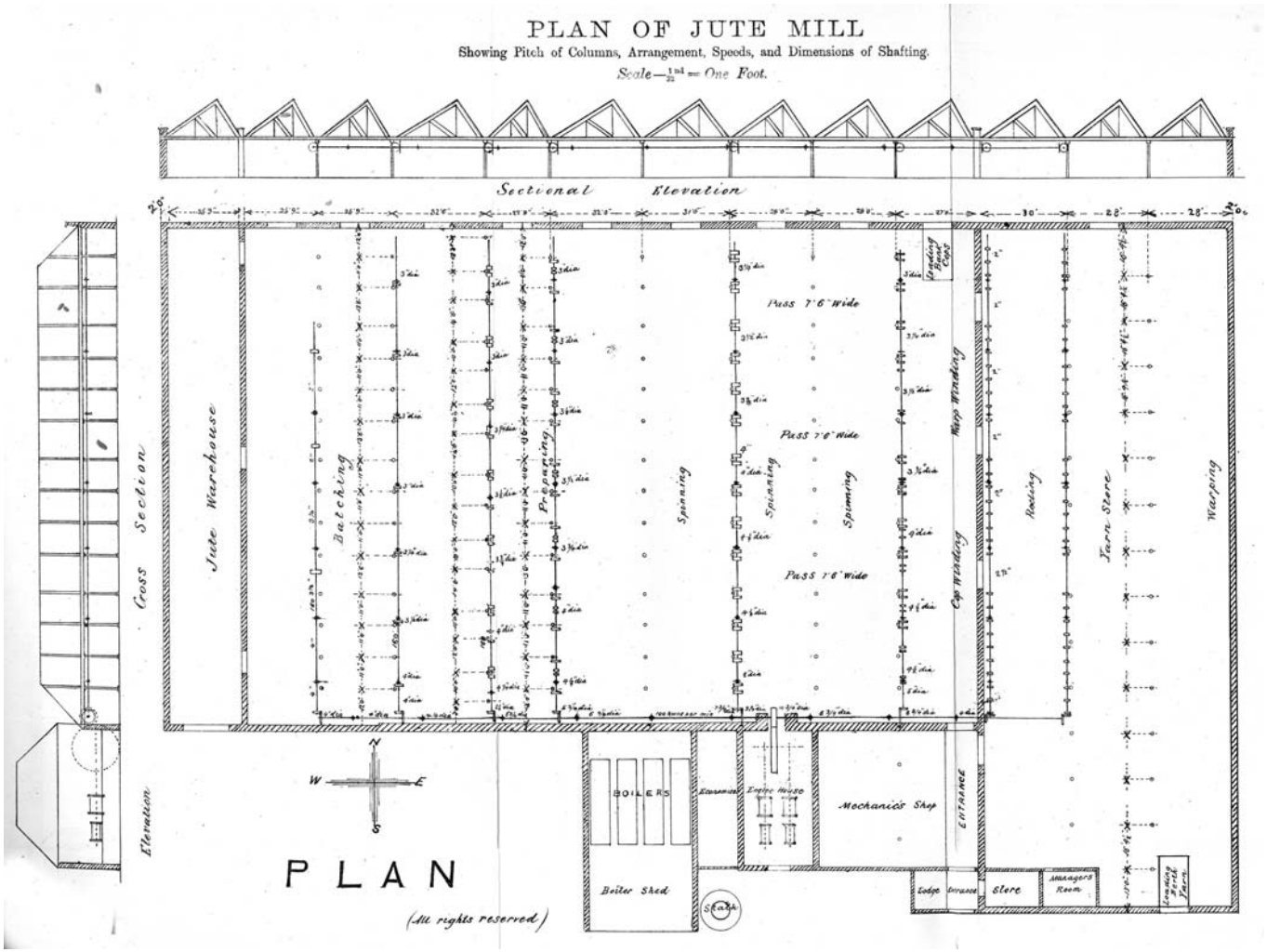

Figure 2: Plan of jute mill showing pitch of columns, arrangement, speeds and dimensions of shafting.
Source: W. Leggatt, (1893) *The theory and practice of jute spinning.* William Kidd: Dundee.

Figure 3: Work gates.
Source: *Dundee Photographic Survey* (1916) Dundee.

Figure 4: Spinning and reeling floor, Ward Mills.
Source: J. Murray (1995) *Dundee at work.* Wiltshire: Sutton Publishing.