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by

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Between c.1750 – c.1850 the world wood shipbuilding industry was marked by a series of competitive shifts, from Dutch leadership prior to 1800 (Unger, 1978) to British, French and American struggles for dominance through to the 1850s (Slaven, 1980). The British industry was cushioned by rising trade, but beset by poor ship design and heavy duties on the necessary timber imports (Jones, 1957). However, pressure from shipowners led to improvements in British ship design and Britain survived as a leading player in the world wood shipbuilding industry, albeit as a relatively high cost producer given that British ships were about 25 per cent more expensive than their American counterparts (Jones, 1957; Slaven, 1980). From the 1850s onwards, there was a technological revolution in shipbuilding as iron began to replace wood in the construction of the hulls of ships (Clarke, 1986). The current paper examines the role of accounting information in shipbuilders' decisions to replace wood by iron as the primary material of hull construction and thus bring about technological and organisational transformations of the industry.

The context

Essentially, the demand for ships is the outcome of a complex set of relationships between the volume and pattern of trade, freight rates, the size, speed and age of existing fleets and technical advances in

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construction (Jones, 1957; Pollard and Robertson, 1979; Slaven, 1980). Shipbuilding is a capital goods industry *par excellence* (Slaven, 1980), subject to violent swings in the demand for its products, and, given this, the prospect of bankruptcy always loomed large for the shipbuilder during the nineteenth century (Todd, 1985). By the mid-1850s, British shipbuilders had developed a routine process for the building of iron ships (Harley, 1973) and by the 1860s had capitalised on their cheap natural resources and pool of skilled engineers to such an extent that Great Britain was not only the world's leading shipbuilder "but for some time practically monopolized" (Pollard and Robertson, 1979, p.12) iron shipbuilding. In 1862, Britain's iron shipbuilding equaled its wooden tonnage for the first time and then moved inexorably ahead (Clarke, 1986, p.1). Nevertheless, within Britain there were regional variations in the rate of adoption of the new material and its technology. Sunderland, on the River Wear on the North East Coast of England was a centre of shipbuilding activity (Clarke, 1981;

Table 1
Iron shipbuilding output (tons) in Sunderland 1853 – 1871, by firm

Year	Laing	Oswald*	Pile	Doxford	Illiff*	Thompson	Blumer	Watson	Short
1853	479								
1854	577								
1855	939								
1856	nil								
1857	610								
1858	3,083								
1859	2,003	497							
1860	2,573	3,798							
1861	6,153	3,903	2,580						
1862	5,429	4,115	4,752						
1863	6,307	6,081	5,093						
1864	6,525	7,974	5,430	2,191					
1865	7,681	7,171	4,708	2,212					
1866	5,084	6,477	1,533	3,198	965				
1867	2,569	3,126	4,853	1,823	1,677				
1868	8,097	9,622	7,296	4,071	5,240	1,112			
1869	7,058	18,983	8,146	2,122	4,478	1,073	1,790	912	
1870	14,502	12,399	10,177	3,724	5,181	2,296	nil	3,750	
1871	15,246	15,485	12,926	7,214	6,091	4,384	533	6,118	2610

* Oswald opened a purpose-built iron shipyard; he was a nephew of James Laing and had started his career in wood shipbuilding; Illiff's was a purpose-built iron shipyard; all other shipyards were converted from wood to iron shipbuilding.

Adapted from Clarke, 1986, p. 69

Pollard and Robertson, 1979) and by the 1850s claimed to be the greatest shipbuilding town in the world (Smith and Holden, 1953). However, this claim was based on the town's wood shipbuilding industry. In the 1850s Sunderland had between sixty to seventy shipyards; the shipyards were generally very small-scale, each employing about 30 men, industry entry and exit costs were minimal, land prices were low and labour forces flexible (McLean, 1995). At a competitive advantage in terms of wood shipbuilding, Sunderland lagged behind the national average in the rate of changeover to iron shipbuilding: in Sunderland, tonnage output of iron shipbuilding did not overtake that of wood until 1868, significantly later than the national changeover date of 1862 (Clarke, 1986). Moreover, within Sunderland itself there was considerable time variation between firms in the adoption of iron shipbuilding (Table 1).

The current research analyses the roles of personality, business environment and accounting information in order to explain this variation, focusing on two particular firms, Laing and Doxford, these firms being selected for research on

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the basis of the availability of archive material (Note 1). The remainder of this paper is organised into five sections: first, wood and iron shipbuilding are compared; second, an analysis is made of the development of the Laing and Doxford shipyards; third, there is a consideration of the role of accounting information for decision-making in shipbuilding; fourth, there is a discussion of the material presented in the paper; and, fifth, conclusions are drawn.

Wood and iron ships compared

Between c.1850 – c.1875, wood ships could generally match iron ships in terms of size, quality, speed and technical specification. However "in Britain by the end of the 1850s it is probable that iron ships could generally be built more cheaply than wooden vessels" (Clarke, 1986, p.47), mainly because British iron was a cheaper raw material than imported wood. In 1861, the *Sunderland Herald* noted that "iron vessels, with a full East India outfit, can be purchased at prices varying from £15 to £l5.15s.0d per ton; while a wooden vessel of the same class could not at present be laid down in any of the (Sunderland) yards . . . at the same figure" (ibid, p.49). Although relative raw material costs did vary from time to time, it is clear that the cost advantage lay with iron shipbuilding which also benefited from increasing mechanisation and improving labour productivity, given that metal-workers were paid on piece-work while wood-workers were paid on time-rates. These cost advantages made iron rather than wood ships increasingly attractive to shipowners and iron shipyards were developed to meet the changing demand (Clarke, 1966, 1981, 1986, 1988). The application of new materials and technology changed much in the shipbuilding industry; whereas shipwrights and other wood-workers had naturally dominated the wood shipbuilding industry, "overwhelmingly, in Britain, the men who built the first iron ships were from a mechanical engineering background" (Clarke, 1986, p.47). However, in Sunderland virtually all of the men who set up the new iron shipbuilding yards during the current research period were from a background in wood shipbuilding (Table 1). The development of the Laing and Doxford shipyards, the subjects of the current research, are examined in more detail in the next section.

The Laing and Doxford shipyards

In 1792, Philip Laing abandoned the profession of medicine to become a partner in his brother's business and took over sole control in 1818. Philip's son James was born in 1823, became head of the firm in 1843 and presided over it until his death in 1901, always employing specialists to run the day-to-day operations of the shipyard.

From its beginnings Laing was a multi-activity business, involved in trading, shipowning and shipbuilding. Laing's firm was innovative and took out several shipbuilding patents (Clarke, 1981; Jeremy, 1984-86; Smith and Holden, 1953). The Laing shipyard was to the fore in Sunderland's adoption of iron shipbuilding. Apart from the isolated exception of another yard that launched the town's first iron ship, of a mere 72 tons, Laing's shipyard was well ahead of Sunderland's other shipbuilders in the adoption of the new material and technology of shipbuilding (Table 1): by 1858 four of its five ships built were made of iron and, although iron tonnage fell to only half of total output in the following year, the firm was established as an iron shipbuilder (Clarke, 1986). Although the archives of the firm and of the Wear Shipbuilders' Association reveal no direct discussion of the changeover from wood to iron, the Association's minutes do reveal that in 1859 James Laing led a campaign against the "oppressive and unjust" duties imposed on timber (TWAS/EM/WS/1/1, pp.117-127), indicating the ongoing importance of that raw material.

The available sources present rather differing views regarding the background of the Doxford family. The introduction to the Doxford archive (TWAS 1811) states,

> William Doxford senior had a small wood shipyard . . which he began in 1840. He and his partner were declared bankrupt the following year, and he returned to working as a craftsman for another firm. The partnership was re-established in 1845 and continued until 1851, when once again William senior returned to working partly as a shipwright and partly as a timber merchant.

However, Clarke (1986, p.72) states that "the family yard had almost twenty years of continuous existence before… it began (building). . . iron vessels in 1864". Furthermore, the Doxford accounting archive (TWAS 1811/12/4) indicates that William and J. Doxford were in partnership as timber merchants as early as 1833 and later moved into shipbuilding. Despite the differing views presented by these sources, they do all confirm that the background of William Doxford was in wood rather than in metals engineering or general trading business. William's son, William Theodore, 1841 – 1916, was probably responsible in 1864 for starting the family shipyard's changeover from wood to iron shipbuilding (Clarke, 1986).

Accounting information for decision-making

An analysis (McLean, 1995) of the nineteenth century Laing and Doxford accounting records indicates that each firm operated a mer-

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cantile double-entry accounting system adapted to include a form of contract accounting for shipbuilding activities, thus enabling the calculation of cost and profit or loss on each ship constructed. However, there were differences between the accounting systems. Laing included data which Doxford did not: Laing's ship accounts routinely included a note of ship tonnage, which would have facilitated a calculation per ton of selling price, cost and profit or loss, although such calculations are not extant. Neverthless, tonnage data was, of course, available in Doxford outside of the accounting system and it would have been straightforward to make the relevant calculations, although none are extant. A further difference between the systems lay in approaches to periodicity. Whereas Doxford's system was based around the half-yearly calculation of profit for the firm, Laing's system was not. Unlike Doxford, Laing was also a trading and shipowning firm and when

> Laing built and operated a ship as owners, that ship's account reflected its building cost, voyage profits and, ultimately, the selling price obtained on the eventual sale of the ship and the final overall profit made over its entire life cycle with the firm . . . Profit measurement was not periodic, but was based on ventures and on the ship as a focus of economic activity (ibid, p.124).

It is conceivable that, by focusing on profit over the life-cycle of the ship rather than the calculation of half-yearly company profit, the Laing accounting system acted as a form of social technology enabling the development of a long-term view of the business in general and the changeover from wood to iron in particular. Nevertheless it is apparent from the 1861 *Sunderland Herald* quoted above that the respective costs and profits per ton of wood and iron were common knowledge and that the relatively small and tight-knit community of Sunderland shipbuilders would have been well aware of them.

Discussion

Laing began iron shipbuilding in 1853, significantly earlier than Doxford's entry into the industry in 1864. Although Laing's accounting system provided a longer term perspective than did Doxford's it is unlikely that this explains the difference in entry dates. Both accounting systems enabled the calculation of costs and profits per ton for each ship built and this information could be viewed in the context of comparative cost and profit data for wood and iron ships which were freely available in the market place. Thus it is improbable that differences in information availability can explain the difference in timing of entry into iron shipbuilding, and answers must be sought elsewhere.

A new iron shipyard needed to be financed of course, but the available evidence suggests that this in itself need not have prevented Doxford from making the changeover earlier than it did. By the 1850s, Doxford was a well-established business, making profits of £1,872 in the 6 months to 30 December 1854, for example, (McLean, 1995) and other Sunderland shipbuilders such as Oswald and Pile were able to finance iron yards earlier from no more favourable circumstances (Clarke, 1986). It is improbable, therefore, that lack of finance explains Doxford's later entry into iron shipbuilding.

Insights into the problem of delayed entry into iron shipbuilding are provided by Harley (1973) and Clarke (1986). In the context of the North American shipbuilding industry, Harley contends that delayed entry into iron shipbuilding was not due to prejudice, ignorance and inertia, but due to factors such as the immobility of labour. However such labour problems did not arise in Sunderland where shipbuilders were able to draw on North East England's pool of skilled metal-workers as Laing in fact did do. However Harley also notes shipbuilders' willingness to accept lower but adequate returns in order to persist with wood shipbuilding. Similarly Clarke (1986, p.72) has argued that Sunderland's wood shipbuilders "continued to find enough customers and accommodating credit from timber merchants to continue in their old ways", and, moreover, continued to benefit from the repair work needed by existing wood fleets.

Nevertheless, in considering delayed entry into iron shipbuilding it is not sufficient simply to examine the technical and structural factors affecting the decision-making process. As Parker (1981, p.131) has remarked "a history of accounting . . . without some knowledge of the actors – those for whom as well as those by whom the records were kept – must be rather anaemic and thin". The "actors" relevant to the current research are James Laing, William Doxford and William Theodore Doxford. In 1853 when James Laing took his business into iron shipbuilding he was 30 years old, a successful innovator, the head of a firm that had been in continuous existence for over 60 years and a businessman rather than a wood-working shipwright and shipbuilder. In comparison, in 1853, William Doxford was 41 years old, with 20 years of experience of basing his working life around wood, as a timber merchant, a working shipwright and a shipbuilder and, possibly, as a bankrupt. The Doxford shipbuilding moved into iron shipbuilding only in 1864, probably under the direction of William's son, the 23 years old William Theodore Doxford (Clarke, 1986).

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Conclusions

In the context of freely available market information, both the Laing and Doxford accounting systems provided clear data on the costs and profitability of shipbuilding. Although there were differences in the systems, particularly in terms of reporting time-frames, it is unlikely that these are significant in explaining the different entry dates into iron shipbuilding. Working experience and skills, age, personality and business outlook are probable causal factors in James Laing's early entry into iron shipbuilding, William Doxford's commitment to wood shipbuilding and William Theodore Doxford's success in making the changeover.

Note 1: All of the archives drawn upon for this research are held by the Tyne Wear Archive Service (TWAS), Blandford Street, Newcastle Upon Tyne, Great Britain.

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