# TOWARDS A THEORY OF BRITISH ECONOMIC DECLINE: THE CASE OF SHIPBUILDING, 1890-1970

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**Working Paper #148 - November 1990**

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A French translation of a modified version of this article is forthcoming in *Revue Travail et Emploi* N° 46, December 1990. The author is grateful to Gerald Berk, Amitava Dutt, Victor Goldberg, David Hachen, Ernesto Livacich, Donald McCloskey, Daniel Nelson, Patrick O'Brien, and Steven Tolliday for their comments on earlier versions of the text. Special thanks are due to Frank Wilkinson for allowing the author to refer to his unpublished work on shipbuilding industrial relations, and to Diego Gambetta whose suggestions have been invaluable in raising the level of the argument. The research on which this paper is based was funded in part by the Economic and Social Research Council (UK) under its Postdoctoral Research Fellowship Scheme. The contents are the responsibility of the author and do not necessarily reflect the views of the Economic and Social Research Council.

## ABSTRACT

A basic aim of this essay is to provide a persuasive explanation for the competitive decline of the British shipbuilding industry. Starting from a position of undisputed international preeminence at the turn of the century, Britain was reduced to a comparatively insignificant producer of ships by 1970. What accounts for the remarkable competitive reversal of this once great industry? In addition to providing an answer to this question, the author aims to indicate the directions of a theory of British economic decline. (The words "towards a theory" in the title are used advisedly: while the theoretical argument is presented in general terms, its relevance is only demonstrated with reference to the case of the shipbuilding industry.) The first section of the paper presents the basic facts concerning the decline of the British shipbuilding industry. The second section contrasts the assumptions and conditions of the argument developed here with those of the principal explanations in the literature for Britain's economic decline. The third section offers some reasons for the competitive success of British shipbuilding prior to the Second World War, and the penultimate section develops an explanation for the subsequent decline of the industry. The concluding section presents the more general argument about British economic decline.



## RESUMEN

Uno de los principales objetivos de este artículo es el de proporcionar una explicación persuasiva sobre la decreciente competitividad de la industria constructora de buques británica. Partiendo desde indisputable predominancia a nivel internacional hacia principios de este siglo, Gran Bretaña llegó a ser un productor de barcos relativamente insignificante en 1970. ¿A qué se debió este impresionante revés de esta otrora gran industria? Además de contestar esta pregunta, el autor intenta presentar una teoría sobre la declinación de la industria británica (las palabras del título, “hacia una teoría,” son usadas con la intensión de presentar el argumento teórico en términos generales, mientras que su importancia sólo se demuestra en el contexto de la industria constructora de buques). La primera sección de este trabajo presenta los hechos básicos referentes a la declinación de la industria constructora de buques británica. La segunda parte discute los presupuestos y las condiciones sobre el argumento desarrollado aquí con las principales explicaciones de la literatura actual. La tercera sección plantea algunas de las causas del éxito competitivo de la industria constructora de buques británica anterior a la Segunda Guerra Mundial, mientras que la penúltima sección estudia su posterior declinación. La última sección presenta argumentos más generales sobre la declinación de la economía británica.

## I. Shipbuilding Decline: The Facts

At the turn of the century, the British shipbuilding industry held a position of undisputed dominance in the world market. Between 1892 and 1899 Britain produced on average 75 per cent of world output.[1] Britain's share of the market fell to about 60 per cent around the turn of the century and fluctuated around this level until 1914. This decline resulted from the expansion of capacity in the United States and on the Continent, generally behind protective barriers.[2] Britain's control of the unprotected parts of the export market remained uncontested, her share being 80 per cent as late as 1913.[3]

At the turn of the century, Britain enjoyed a considerable advantage in labor productivity, as shown in the figures in Table 1 below.[4]

**TABLE 1**

**Comparisons of Labor Productivity in Shipbuilding, 1900**

| | Number Employed | Tons Constructed | Output per head (tons) |
|---|---|---|---|
| UK (a) | 85,000 | 1,290,369 | 15.2 (av. for 64 firms) |
| US | 33,340 | 385,511 (b) | 11.6 (av. for 11 firms) |
| Germany | 31,310 | 198,097 | 6.3 (av. for 14 firms) |
| France | 28,650 | 134,037 | 4.7 (av. for 11 firms) |

Sources: Numbers employed for the four countries and tons constructed for the UK, US, and Germany are derived from employment and output figures per firm in T. Schwartz and E. von Halle, *Die Schiffbauindustrie in Deutschland und im Auslande* (Berlin, 1902), Tables 36-39, pp. 174-79. Annual tons constructed in France taken from J. Latty, *Traité d'Economie Maritime*, Tome 1 "La Construction Navale" (Paris, 1951), p. 236.

a) For the UK, those firms engaged in naval construction have been excluded, as the output figures provided do not include the displacement tonnage of naval vessels produced.

b) Includes naval construction of 215,861 displacement tons.[5]

Britain's share of world production dropped dramatically during World War I while much of the world market was shut off to British producers. Exports, as a percentage of total British output, dropped from an average of 23.7 per cent during 1900-13 to an average of 7.8 per cent during 1914-18. After the war, during the reconstruction boom, Britain quickly reestablished its dominant position, though at a lower level. Britain produced on average 45 per cent of world output between 1920 and 1929, and 35 per cent between 1930 and 1939.[6]

The loss of market share during the interwar years can be attributed in part to protectionist policies abroad. These took a variety of forms, though direct subsidization of shipbuilders was not common. Subsidization was primarily indirect through support to shipping companies. The most common forms of support to owners were postal subventions and direct operating subsidies tied to construction in the home country.[7] Table 2 below provides an indication of their impact on the competitive position of British operators.[8]

**TABLE 2**

**Entrances at British Ports by Percentage**

| | 1913 | 1929 | 1937 |
|---|---|---|---|
| **Identity of Vessels** | | | |
| British | 65.8 | 65.0 | 55.8 |
| Subsidized Foreign (a) | 7.5 | 14.2 | 17.2 |
| Unsubsidized Foreign | 26.7 | 20.8 | 27.0 |

Source: S.G. Sturmey, *British Shipping and World Competition*, (London, 1962), p. 127.
a) Subsidized foreign refers principally to France, Germany, Japan, and the US.

Supply side factors also contributed to Britain's declining market share during the interwar period, particularly during the post 1935 boom, as shortages of manpower and materials in Britain led to the placement of orders abroad and a loss of export markets. Imports, which averaged 2.4 per cent for 1920-35, increased to 15.3 per cent in 1936 and 16 per cent in 1938. Holland and Germany were the major exporters to British account. Both Germany and Sweden made significant inroads into foreign markets during this period, both emerging as major exporters to Norwegian account. Britain's share of world export markets declined from over 40 per cent during 1927-30 to 21 per cent for 1936-38.[9]

In comparison to the rate of decline of the depressed interwar period, Britain's market share fell sharply during the post-World War II expansion. The more than twofold increase in world output of the 1950s saw the proportion of ships built in Britain cut from 40 per cent to 15 per cent. During the 1960s, while world demand expanded at an unprecedented rate, the British industry sustained an absolute decline with the closure of a number of the major yards. By the end of the 1960s Britain accounted for about 5 per cent of world output and, in terms of output, ranked fourth behind Japan, Sweden, and West Germany.

As shown in Table 3, the decline in Britain's share of the world export market was equally precipitous, plummeting from 35 per cent in 1948-50 to 4.5 per cent in 1961-65.

**TABLE 3**

**Per Cent Shares of the World Export Market (in terms of tons launched)**

| Year | Britain | Japan | Germany | Sweden | France |
|---|---|---|---|---|---|
| 1948-50 | 35.0 | 2.2 | 0.3 | 18.3 | 0.1 |
| 1951-55 | 22.0 | 10.6 | 14.9 | 12.9 | 2.1 |
| 1956-60 | 6.9 | 31.6 | 20.7 | 12.0 | 5.8 |
| 1961-65 | 4.5 | 38.8 | 13.0 | 15.7 | 5.5 |

Source: *Lloyd's Register of Shipping*, Annual Shipbuilding Returns.

Import penetration followed closely on the heels of loss of the export mazrket, as British owners responded to the lower prices and quicker delivery dates being offered abroad. As shown in Table 4, foreign producers increased their share of the tonnage delivered to the UK fleet from a paltry 3.2 per cent in 1951-55 to 38.3 per cent in 1961-65, and to an overwhelming 74.0 per cent in 1966-70.

**TABLE 4**

**Ships Delivered to the UK Registered Fleet (in terms of tons launched)**

| Year | Per cent from UK yards | Per cent from Foreign yards |
|---|---|---|
| 1948-50 | 100.0 | 0.0 |
| 1951-55 | 96.8 | 3.2 |
| 1956-60 | 81.1 | 19.9 |
| 1961-65 | 61.7 | 38.3 |
| 1966-70 | 26.0 | 74.0 |

Source: *Lloyd's Register of Shipping*, Annual Shipbuilding Returns.

4 By the 1960s, as shown in Table 5, there was a considerable shortfall in labor productivity in Britain as compared with her principal competitors.[10]

**TABLE 5**

**Comparisons of Labor Productivity in Shipbuilding (man-hours per weighted steel ton*)**

| Country | Average for 1960-65 |
|---|---|
| Japan | 70 |
| Sweden | 82 |
| West Germany | 155 |
| UK | 187 |

Source: K.J.W. Alexander and C.L. Jenkins, *Fairfields: A Study of Industrial Change*, (London, 1970), p. 38. [*Tonnage figures are weighted to reflect the approximate work content of a vessel. The weights vary from 0.3 for a large tanker to 3.0 for a small service vessel. See M. Stopford, *Maritime Economics* (London, 1988), pp. 310-11.]

What accounts for the dramatic competitive reversal of this once great industry? Before providing an answer to this question, I shall make a brief excursion onto the terrain of general explanations for Britain's relative decline in order to distinguish the assumptions of the argument developed here.

## II. Explanations for Relative Decline

In the literature on Britain's relative economic decline it is possible to identify two basic types of explanation. The first relies on the mechanism of cultural causation. It argues that the culturally specific norms or beliefs of British businessmen propelled them into behavior resulting in various deficiencies in the performance of the economy. This is usually referred to as the entrepreneurial failure thesis. The second explanatory approach denies that business performance was deficient and explains relative decline entirely in terms of the constraints, both economic and social, under which rational decision makers acted.[11]

It is possible to identify two sub-types of the entrepreneurial failure thesis, which relies on the mechanism of cultural causation to explain relative decline: one where norms shape the preferences of the actors; and one where the culturally specific beliefs of the actors affect the way they perceive their opportunities. The first sub-type, associated notably with the work of David Landes and Martin Wiener, argues that the culturally specific experience of British businessmen shaped their norms in such a way as to lead them to disparage business activity. The argument

goes that resources and talent were progressively diverted to nonbusiness activities to the detriment of competitive performance.[12]

The second sub-type of this explanation argues that the culturally specific beliefs of the business community led them to make biased estimates of the costs and benefits associated with various options with the result that profitable opportunities were missed. The early work of Derek Aldcroft is illustrative of this approach. He argues that Britain's legacy of nineteenth-century industrial dominance led entrepreneurs during the twentieth century to be contemptuous of new techniques or departures from established forms of enterprise organization. The most striking example, perhaps, is provided by their alleged failure to undertake profitable investments in research and in scientific and technical training.[13]

Criticism of the entrepreneurial thesis has come in a weak and in a strong form. The weak form of the criticism does not fault the cultural thesis on explanatory grounds, but simply notes that for each alleged instance of entrepreneurial failure it is possible to juxtapose examples of vigorous entrepreneurship.[14] This observation, combined with the point that the cultural argument provides no explanation for why only certain firms or sectors should be afflicted by the "British disease," undermines the force of any generalized indictment of British entrepreneurship.

The stronger form of criticism denies that entrepreneurial failure contributed to the relative decline of British industry. Rather, the choices of British businessmen may be understood in terms of rational actors optimizing subject to given constraints. This argument affirms that relative decline took place, but asserts that the culprit was a particular set of economic constraints rather than any deficiency in the decision making of British entrepreneurs. For example, Donald McCloskey and Lars Sandberg, who are wedded to this approach, exonerate British businessmen for their comparatively low rate of investment in research.[15]

The "redeeming" efforts of the neoclassical historians recently have been criticized by Bernard Elbaum and William Lazonick who develop an institutional explanation for relative decline.[16] Their criticism focuses on the question of whether constraints should be taken as given or be considered alterable:[17]

> As neoclassical economic historians have emphasized..., British businessmen may in general have performed well by the test of cost minimization subject to prevailing constraints. Britain's problem, however, was that economic decision-makers, lacking individual or collective means to alter existing constraints, in effect took them as 'given.'

Having identified what they believe to be the problem, both with the neoclassical approach and with the British economy, Elbaum and Lazonick then set out to provide an explanation for the apparent failure of British businessmen to transform their constraints. They attribute this failure to various rigidities in the institutions that developed during Britain's period of international economic hegemony in the nineteenth century.[18]

> Britain's distinctiveness derived less from the conservatism of its cultural values *per se* than from a matrix of rigid institutional structures that reinforced these values and obstructed individualistic as well as collective efforts at economic renovation. In such countries as the United States, Germany and Japan, successful economic development in the twentieth century has been based on mass production methods and corporate forms of managerial co-ordination. Britain, however, was impeded from adopting these modern technological and organization innovations by the institutional legacy associated with atomistic, nineteenth-century economic organization.

The idea that nationally specific configurations of institutions can influence business behavior in distinct ways provides a potentially useful framework for addressing the problem of British economic decline. It leads to insights into the basis for differences in behavior and performance that are precluded from the neoclassical approach which automatically discounts institutional effects by assuming that competitive market forces lead to organizational uniformity.[19] The argument is less than persuasive, however, for two related reasons: firstly, the failure to define institutions, specifying their relationship to human behavior; and secondly, the failure to address in general terms how institutions are maintained and why they should be unchanging or rigid in particular instances.

A standard definition of an institution is a rule of behavior that specifies action in particular recurrent situations.[20] More loosely, an institution may be defined as, "the way we do things." If we accept this definition, it is apparent that the argument that British businessmen acted in ways that resulted in relative economic decline because of the nature of British institutions is rather circular. It merely asserts that they behaved conservatively, or stupidly as the case might be, because the rules specified conservative, or stupid, behavior. It leaves entirely unaddressed the question of why the behavioral rules were maintained, whether through an unintentional process, such as cultural causation, operating on the actors, or through an intentional process.

When the argument of Elbaum and Lazonick is scrutinized in this manner it becomes obvious that its mode of explanation is the same as the neoclassical model they criticize. Rational agents are assumed to optimize given their preferences and beliefs and subject to pregiven constraints. The principal difference between the two approaches is that the pregiven constraints are identified as a host of institutional arrangements as opposed to a set of market conditions. The criticism these authors make of the neoclassical historians is equally applicable to their own work. They do not provide an explanation for why the actors failed to transform the constraints that were contributing to competitive decline.[21]

In what follows I develop an explanation for the competitive decline of the British shipbuilding industry that takes up this challenge. In common with the work of Elbaum and Lazonick, I identify the nature of Britain's institutions as key to the explanation for competitive decline. I do not examine all the institutions that have been earmarked as contributing to Britain's

relative economic decline. I focus on one key institution, enterprise organization and the system of labor management in particular.

Unlike the work of the institutional historians discussed above, I do not take the maintenance of the institutions as given in accounting for the behavior of British businessmen during a period of declining competitiveness. Rather, I develop an intentional explanation for the failure of British businessmen to transform their constraints. The key elements of the explanation are: firstly, the behavioral assumption of "*bounded rationality*" or limits to the ability of humans to collect and process the information required for optimizing; secondly, *uncertainty* about market conditions; and thirdly, *lack of trust* between labor and management.

It is worthwhile to elaborate somewhat on these assumptions and conditions. The condition of market uncertainty is based on Kenneth Arrow's definition.[22] The type of uncertainty I am referring to here derives not from our lack of descriptions of states of the world which are complete for all relevant purposes, but from our inability to assign objective probabilities to those states. The problem is imperfect foresight about an environment that is taken as given.[23]

In the context of strategic decision making, uncertainty also is relevant but it derives from a different type of ignorance than that referred to above.[24] It is well known that in certain game theoretic situations (notably the iterated Prisoner's Dilemma) there are multiequilibria. Our uncertainty concerning the best choice of action in this context derives from bounded rationality considerations. We lack complete information about the preferences and the beliefs of others, and are uncertain as to whether the knowledge we have about each other is "common knowledge."[25] Under these conditions, there is scope for the actors to behave opportunistically and consequently our choice of action will depend on whether we believe others to be *trustworthy*.[26]

There is one remark of a general order I would like to make before presenting my explanation for the decline of British shipbuilding. In identifying trust, or the beliefs of the actors concerning each other, as key to the explanation, I have introduced a "cultural" element into the argument. I do not take these beliefs as given. I show how they were formed by the history of relations between labor and management in the industry, and I show how, after the Second World War, management successfully built up trust around proposals for reforming enterprise organization. Further, as will be apparent, the argument in no way depends on there being significantly different levels of trust between Britain and her competitors.

## III. The Sources of Competitive Success, 1880-1939

Between 1860 and 1880 British shipbuilders captured their expanding domestic market and much of the foreign market. This was a period when competing maritime nations lacked developed iron, steel, and engineering industries and sufficient skilled labor to supply shipyards. Having captured these markets, British producers drew a critical advantage from the greater extent of the market they commanded, resulting in a greater continuity of demand for different classes of vessels. This allowed British builders to achieve a degree of specialization among yards that proved impossible in other maritime nations.[27]

When considering the higher productivity of British labor at this time, a paradox arises.[28] It might plausibly be assumed that the greater continuity of demand faced by British producers encouraged them to invest in more up to date machinery and that the higher level of productivity resulted from greater mechanization. In fact, the situation was much the reverse. In so far as there were intercountry differentials in the degree of mechanization, In fact, the situation was much the reverse. In so far as there were intercountry differentials in the degree of mechanization, British yards on average showed a preference for more labor intensive methods.

Sidney Pollard has argued that the severity of cyclical fluctuations in shipbuilding output encouraged British producers to minimize capital expenditure in order to avoid the potentially crippling overhead costs that would be incurred during recessionary periods. The fact that most vessels were expensive custom-made commodities, built with the close consultation of the owner who would usually pay in installments as the vessel was constructed, meant that a strategy of speculative construction and stockpiling of a standard commodity was not feasible. These conditions encouraged British builders to preserve labor intensive methods and to lay off labor during the cyclical downswings.[29]

American producers, in contrast, lacking adequate supplies of labor and in response to the higher price of labor, fitted out their yards around the turn of the century with expensive cranes and mechanical haulage equipment that only proved profitable during periods of peak demand and led to bankruptcy in certain cases. While wages were lower in Germany during the nineteenth century, firms similarly opted for more capital-intensive methods than in Britain, apparently in response to inadequate pools of labor to draw from. However, Pollard argues, the greater mechanization of foreign yards could not compensate for the superiority of British labor.[30]

While Pollard's analysis is illuminating in many respects, I would argue that it needs to be qualified. Detailed international comparisons of technical choice show that the differences between British and German or American yards did not result from a general strategy of substituting capital for labor in these latter countries. In shipbuilding, owing to the customization

and complexity of the product, it generally was impossible to eliminate skilled labor from the production process. Rather, American and German builders substituted machinery for less skilled labor, particularly in mechanizing their cranes and haulage equipment.[31]

These stringent limitations on the use of labor displacing machinery in shipbuilding in turn meant that competitive success depended on having a skilled and versatile work force. British shipbuilders enjoyed a comparative advantage in this regard owing to the industry's structure and its distinctive system of labor market and enterprise organization.

The British industry during the late nineteenth and early twentieth centuries was highly fragmented, being divided between two main districts each composed of 40 to 45 firms, the large majority of which were single yard establishments.[32] As each producer's relative demand for particular types of skills varied over time, they would hire and lay off workers with specialized skills who continually moved among the numerous yards in the industrial districts.[33] In this manner regional pools of skilled labor were built up and maintained.

The skilled trades were highly unionized by the turn of the nineteenth century. Seventeen craft unions organized the majority of the skilled workers and the closed shop prevailed in most yards.[34] Union imposed restrictions clearly constrained employers' ability to reorganize the division of labor and introduce new machinery at this time. In particular, the craft unions had considerable success in preventing the employers from exploiting the possibilities offered by technical change for substituting less skilled and lower paid workers for skilled workers. A prime example of this is provided by the outcome of a series of conflicts between the employers and the Boilermakers Society over the introduction of pneumatic machinery shortly after 1900.[35] In the case of pneumatic riveting machines, the Boilermakers Society enforced the use of a full squad of four on the new equipment despite the need for only three, and also resisted any reduction in piece rates below hand work rates. While the Boilermakers conceded reductions in hand rates for pneumatic caulking and drilling equipment, they were able to limit the employers' use of lower paid apprentice labor.[36]

It would be misleading to conclude, however, that the effects of unionization were solely negative as far as employers were concerned. The system of craft unionism conferred important benefits in cyclical flexibility in hiring and firing, the organization of work, and the acquisition of skills.

The unions provided a variety of forms of insurance including unemployment, sick, and superannuation pay.[37] The provision of these social welfare services contributed to maintaining the attachment of skilled workers to the shipbuilding districts.[38] Further, the geographically based union branches both acted as local labor exchanges and facilitated the movement of labor among the districts by providing tramping benefit.[39]

The skilled metal workers were organized on the squad system whereby a group of skilled workers contracted for tasks such as a row of plates. The squads took responsibility for coordinating the production process on the shop floor and for supervising their semiskilled assistants. This reduced the need for bureaucratic planning of production and for specialized managerial personnel to supervise the manual work force.[40]

The work force acquired its skills through a system of apprenticeship that was administered by the unions. Apprentices were paid well below the fully skilled rate during five year indentureships which, in general, were adhered to.[41] The low pay of apprentices relative to their productivity during the final years of indenture allowed individual employers to recoup their initial investments in training in an industry where skills were for the most part industry-specific.[42]

The important role of the system of craft unionism in sustaining the competitiveness of the British shipbuilding industry can be illustrated by contrasting conditions in the less successful French industry. Lacking the craft institutions that in Britain helped to ensure the coordination of the production process and the training the work force, French employers introduced more bureaucratic methods of work administration that were suitable for a less trained work force.[43] While there is evidence of increased bureaucratization of enterprise organization from the turn of the century, the full flowering of this development occurred after 1914 with the application of Taylor's system of scientific management in the yards of the Loire-Inférieure.[44] Scientific management was poorly adapted to the shipbuilding industry, however, due to the customization and complexity of the product. For example, time and motion studies at the Penhoet yard in Saint Nazaire had to be substantially redone for each contract and in many cases jobs went untimed. Clearly increased bureaucratization of work administration provided French builders with no improvements in productivity that allowed them to compete effectively with British producers, who continued to rely on the more informal craft system of enterprise organization.[45]

## IV. Competitive Declines, 1948-1970

### Enterprise Organization as Information Channel

The British shipbuilding industry after the Second World War is striking for its retention of traditional methods of enterprise organization. The 1962 Patton Report on shipbuilding technology noted the undeveloped nature of managerial hierarchies in the industry:[46]

> The British shipbuilding industry has a long tradition of working with a minimum managerial and technical staff and requires to learn how to effectively integrate and use specialist functions in its management structure, so that real advantage commensurate with the increase in overhead costs is obtained.

A 1973 Department of Trade and Industry commissioned report confirmed the continuing rudimentary nature of planning techniques in British shipbuilding, noting the key role of skilled workers and their supervisors:[47]

> Except in yards building warships, control of quality and dimensional accuracy is provided by the workforce... Informal scheduling and planning, depending on the skill and experience at foreman level, is often the only detailed planning available once original plans have been bypassed and due dates have been missed.

The retention of methods of work organization relying critically on the judgement and experience of skilled workers reflected in part a managerial perception that the industry's particular technical characteristics precluded the use of more systematic methods of production planning.[48]

> My mind goes back a year or two ago when I was directly connected with a similar planning scheme which was tried out, but it was found that what could be applied in an engineering shop was not suitable in a shipyard. The scheme did not work very successfully at that time... I think shipbuilding is an industry which is distinct from any other, and to get improved production in ships the detailed production planning system as applied to engineering is, in my humble opinion, rather out of the question.

Such managerial attitudes as those expressed in the quote above should not necessarily be interpreted as reflecting an irrational contempt for radical departures from established practice. A reasonable explanation for the conservativeness of British shipbuilders would start from the observation of Arthur Stinchcombe that different types of organizational structures are suitable for different market environments.[49] In general, bureaucratization of work administration depends on long-term stability of work flows. Only under this condition will the overheads associated with the firm-specific information processing channels required to operate bureaucratic systems be sufficiently productive to make them economical.[50]

The flexible British system of craft production proved to be highly successful during the late nineteenth and early twentieth centuries because of the nature of the market. The product was nonstandard and firm output levels were variable. The generally trained British workers were easily able to adapt to an ever changing product mix without the need for upper level supervision. They were also able to move among the yards in a district as firm output levels varied.

Starting from the late 1930s, there were a number of significant changes in product market conditions and technology that progressively shifted the competitive advantage towards yards using more systematic management methods. As world energy use shifted from coal to oil, demand for tankers grew. Tankers were relatively simple craft with long flat surfaces that could easily be built up from a number of standard components. The development and perfection of

welding during the 1930s and the war years increased the possibilities of preassembly and of adopting a straight line organization of work.

These nascent tendencies proved overwhelming after the Second World War. The expansion in world demand for ships during this period was rapid and stable by historical standards. By lessening the problem of high overhead costs during cyclical downswings, stable growth in demand favored the adoption of larger-scale and more capital intensive methods of shipbuilding. The average size of vessels also increased, and there was a growing acceptance in the market of standard designs for tankers, bulk carriers, and general purpose cargo ships.[51] Product standardization potentially allowed firms to benefit from economies of the learning process, generally estimated to confer a 20 to 30 per cent improvement in labor productivity over the first four to five standard vessels built.[52]

The rise of large-scale and capital intensive shipbuilding diminished the importance of flexible access to a highly skilled, mobile workforce. The larger volume of production of individual yards and the greater standardization of output provided a firmer basis for stabilizing work flows, while greater mechanization increased the amount of semiskilled machine tending work. The extent of work routinization and mechanization, however, varied considerably among stages of ship production.

Generally, it proved easier to mechanize production in shipbuilding at the initial stage of metal fabrication in the sheds than at the subsequent stage of block assembly at the berth or at the final stage of outfitting the vessel. This follows from the fact that with prefabrication of the hull, the aim is to start with relatively simple and standard shaped components which are built up into more complex and larger block assemblies. In constructing a large tanker or bulk carrier, for example, most of the hull can be built up from standard panels, which consist of a series of three or four steel plates, cut rectangular, welded together in a row, and to which steel beams are welded to stiffen the structure.[53]

Mechanization of this stage of production presented few technical difficulties since the surfaces to be burnt or welded are flat and they can be placed on a flat surface over which a mechanized burning or welding unit can be set to move in a straight lateral or longitudinal direction.[54] This stage of assembly and welding lent itself readily to an adaptation of mass production techniques with the development of the "panel-line" during the 1960s, the shipbuilding industry's version of Ford's assembly-line.[55]

This initial stage of assembling and welding plates and beams to form flat panels, however, is only part of the total work involved in constructing the vessel's hull. Panels have to be built up into larger three-dimensional units of varying shape and these have to be transported to the berth and assembled and welded together. The scope for mechanization at these latter

stages of hull assembly is limited because of the variety and often awkward locations in which the work has to be carried out.[56]

While technical change arguably decreased the inherent skill requirements for producing many ship's fittings, the work nevertheless tended to lack the routinized quality of the early stages of hull assembly. This is because even when successive hulls built by a yard for various owners are standard, outfitting specifications are apt to vary, which lessens the scope for repeat work.[57]

For the earlier stages of hull construction, the introduction of welding and prefabrication opened up the possibility for changes more qualitative in nature. At the earlier stages the worker can potentially be tied to one location in the flow of production while the materials flow past. Further, if component production is standardized, there is the possibility of establishing a division of labor not too dissimilar from that envisaged by Adam Smith in his example of pin manufacture. The worker can repeatedly perform one type of operation at one point in the flow of production.

The emergence of this simplified division of labor during the 1950s and 1960s in yards producing standard ships in series or specializing in supertanker production facilitated the effective use of more systematic planning techniques.[58] Yards in the highly specialized Swedish industry were amongst the most adept at this. The considerable success experienced in using these methods at the Eriksberg yard in Gothenburg is described in a 1961 report of a French investigatory mission.[59]

> The study they made allowed the yard (Eriksberg) to determine that 60% of their expenditure (value added) in building a ship corresponded to transporting personnel and materials and only 40% to work on constructing the vessel per se. Consequently they decided to rationalize the transportation system and to minimize the movements of the personnel by keeping a worker at the same work station and by assuring that the same team always would do the same work at the same point. But, a highly developed planning system is needed to achieve this and the work plan has to be established very carefully in advance.

Given British shipbuilders' long history of competitive success based on the craft system of production, their reluctance to jettison it and embrace systematic management methods during the 1950s is perhaps understandable. British shipbuilders had experienced periodic and severe depressions in demand and output in the past which made it reasonable for them to form cautious expectations concerning future growth in demand.[60] Management no doubt was uncertain whether the rapid expansion of the 1950s would continue into the 1960s, or be followed by a collapse that would shift the competitive advantage back towards the informal production system they were accustomed to.[61]

For this to be a plausible explanation we must explain why producers abroad acted differently. Why, for example, did Swedish and French builders react to market uncertainty differently and decide to adopt more systematic planning techniques after the Second World

War? The answer is, they didn't. Producers abroad, much as the British, continued to do what they always had done. Conservativeness was pervasive.

From the first years of the twentieth century there is evidence of significant differences in the methods of planning and production control used by British and foreign shipbuilders.[62] The reasons for this have been addressed above in Section III above. Product market conditions at this time bestowed the competitive advantage on the flexible craft system of production which relies on the expertise of manual workers. Britain consequently benefited from its ample supplies of skilled labor concentrated in shipbuilding districts. Producers abroad, facing shortages of skilled labor, were constrained to establish systems of top-down production control suitable for less generally trained workers. This connection between conditions of labor supply and methods of construction was observed by industrial economist J.R. Parkinson as early as 1956:[63]

> Yet the impression remains that Continental shipbuilders were anticipating (during the 1930s) the changes which would take place in shipyard organization in the next ten or twenty years rather more readily than shipbuilders in the United Kingdom.
>
> Paradoxically the Continental shipbuilders were drawing ahead because they did not dispose of adequate supplies of skilled labour. The legacy of skill in the British shipyards made it possible to build ships with the minimum of planning and labour supervision... The shortage of skilled labour on the Continent made such methods impracticable, and they were abandoned in favour of preparing detailed plans in the drawing office and templates in the loft, which could be used by semi-skilled labour in the marking and processing of material.

Both British and foreign builders continued to do what they always had done after the Second World War. Foreign producers experienced unanticipated benefits from a system that labor market constraints had compelled them to adopt in the past. British builders, in an unanticipated manner, witnessed their fortunes decline.

The above analysis suggests an evolutionary type explanation of outcomes in the shipbuilding industry along the lines of Richard Nelson and Sidney Winter's work, in which *ex ante* blindness and luck combined with *ex post* market selection forces determine which firms are successful.[64] While on the face of it there is much to commend this interpretation, I shall argue below that, while luck played a role, constraints were also important in determining outcomes. To develop this argument I now turn to the idea of enterprise organization as truce or compromise.

### Enterprise Organization as Truce

The competitive success of British shipbuilders based on the craft system of organization suggests an understanding of the system as a set of institutions that were retained because of their efficiency properties and the mutual benefits they generated for skilled workers and their employers. While the craft system undoubtedly had advantages over more formal and

bureaucratic systems and produced joint benefits, this did not preclude conflict between the principal actors. Not only were there serious differences between the employers and skilled workers over questions of machine manning, but also disputes among competing groups of skilled workers over the allocation of work. This suggests that the craft system in British shipbuilding, rather than an equilibrium solution to the problem of finding the most efficient way to organize production, should be seen as a *compromise*, where each actor recognized that the others had an interest in sustaining the system, but also an interest in shifting the terms of the agreement to their own advantage.

This conception of interests, as neither entirely the same nor entirely conflicting, was reflected in and reinforced by the history of sectional disputes in the industry. The metal-working trades in the Boilermakers Society, for example, worked in close proximity with members of the Shipwrights Society engaged in pattern making and hull assembly. There was an obvious mutual dependence. Yet the Boilermakers had only achieved their dominant position in the industry by displacing woodworking shipwrights during the transition from wooden to iron construction between 1860 and 1890[65]. Similarly, cooperative relations between the employers and the Boilermakers were punctuated by conflicts over the employers' efforts to exploit the opportunities that technical change offered for substituting less skilled and lower paid workers for skilled workers.[66]

The effect of such disputes was to promote a high degree of distrust over any proposed change in institutional arrangements that threatened to alter the established division of labor among groups of skilled workers or between the skilled and unskilled. This point can be illustrated by considering the manner in which welding technology was substituted for the traditional method of hull construction based on riveting. Although welding technology was only generally applied in Britain after the Second World War, its organization was determined by the outcome of series of conflicts during the 1930s and early 1940s when it was first introduced.[67]

During the 1930s welding initially was used as a supplement to riveting on main structural work in ship hull construction. The technology at this stage in Britain was almost entirely confined to the principal warship contractors such as Vickers-Armstrong, Cammell Laird, Swan Hunter, and John Brown. Despite this limited extent of practical applications, by the 1930s the view was widespread amongst British shipbuilders that the all welded hull would eventually make traditional riveted construction obsolete.[68]

It was in this context of limited practical experience, but with an eye to the future, that the Shipbuilding Employers Federation during the early 1930s set up a committee to establish a national policy for manning and rates on welding.[69] This reflected their concern that, in the absence of a national policy, the division of labor and rates on welding would be introduced in an *ad hoc* manner at the yard level, the result of innumerable conflicts between employers and

groups of skilled workers. Past experience suggested that the outcome of such fragmented conflicts could well be to the advantage of strategically placed groups of skilled workers who, backed by national union organizations, would be able to impose their terms.

There were already a number of disconcerting bits of evidence. Those naval contractors who had applied the technique to any great extent were paying exceedingly high time rates. Cammell Laird at Birkenhead, for example, was paying members of the Boilermakers Society a rate of 80/- to 90/- per week, substantially above the national uniform rate for skilled trades of 60/- negotiated in 1929. J. Samuel White, while engaged on an Admiralty contract for a cruiser, had unsuccessfully tried to apply the caulker's plain time rate of 57/6d. per week and instead was paying 74/6d. to caulker members of the Boilermakers Society.[70]

Significantly, with attempts by the Boilermakers Society to establish proprietary rights to welding, competing claims for the right to use welding plant had been filed with the Shipbuilding Employers Federation early in 1932 by the Blacksmiths, Shipwrights, and Plumbers Societies.[71] Employers faced both the prospect of costly demarcation disputes and the real possibility that, in the absence of a nationally coordinated employer policy, the well organized Boilermakers Society would establish exclusive rights to welding at a rate some 20 to 30 per cent above the national uniform rate.

Based on the welding committee's deliberations, the employers' federation presented its "Welding Scheme" to the unions in general conference in July of 1932.[72] The scheme called for the creation of a new class of skilled worker, shipwelders, to be organized and trained outside the existing union structure and to be recruited initially from the supply of shipyard workers and apprentices but not necessarily from those displaced by the process. The allocation of welding among shipwelders and other trades was to be at the discretion of the employer. Remuneration was to be at the national uniform rate for skilled labor, 60 shillings per week. Trainees with prior shipyard experience, whether skilled, semiskilled or unskilled, were to undergo a two year training period and to start at the rate of 41/- per week and advance to 60/- by equal half yearly installments. In the case of semi- and unskilled workers, progression to the 60/- was to be dependent on the employer's assessment of progress.[73]

While the Welding Scheme was hardly radical, it did challenge the established truce between management and labor in an important respect. It called for the training of a new class of skilled shipwelders outside the existing union structure and stipulated that those workers and their unions displaced by the introduction of welding should not necessarily be the ones to control the new technology.

The unions rejected these proposed changes in general conference in July and November of 1933 and the employers attempted to unilaterally introduce them in 1934. The control that the employers sought to exercise over apprenticeship was simply viewed as an

opportunistic ploy designed to indirectly dilute with cheaper apprentice labor. The lack of trust is apparent in the following remarks made at the November 1933 conference by the Vice-President of the Shipbuilding Employers Federation and the representative of the National Union of General and Municipal Workers respectively:

> I submit that the proposals in connection with the payment of trainees are in no sense unfair, and the term "dilution" has no proper use in connection with what is actually happening... The suggestion apparently is that although these men are not experts, although they cannot pretend to be experts, it is wrong to pay them less than the 60/- rate while they are being trained (Vice-President of the SEF, Proceedings in General Conference. Nov. 1933, TUC Library, Shipbuilding File).

> I am a practical man with 30 years experience in handling these problems, and my colleagues may have more experience but it is the general experience in industry that the lower rate becomes the maximum rate. You may have these men deemed to be failures for the first 12 months or the first 18 months, and out you go and in comes a cheaper man. You may have a few—3 men at the top and a greater proportion of 41/- or 45/- or 50/- men making up the bulk of the men engaged in welding (NUGMW Representative, Proceedings in General Conference, Nov. 1933, TUC Library, Shipbuilding File).

In April 1934 members of the Boilermakers Society went on strike in opposition to the scheme in the Tyne, Clyde, and South Coast districts.[74] These strikes were resolved when the firms involved, which were mainly naval contractors, agreed to pay the men on a piecework basis in violation of the provisions of the Welding Scheme.[75]

With employer unity broken and the Welding Scheme in disarray, the allocation of welding work in the yard was determined through a process of competitive struggles between groups of skilled workers and their unions for control of the new process. On a number of occasions the Shipwrights Society complained that members of its drilling section, who had been retrained for welding work, were being "poached" by the Boilermakers Society.[76] For a short period, it appears that the General Workers Union successfully recruited welders in the Belfast region.[77] By the early 1940s, though, the Boilermakers Society in large measure had been successful in establishing exclusive rights to arc welding in hull construction. In 1944 the Shipwrights Society conceded the claim, noting that given the Boilermakers established piece rates on welding and their uncompromising position, it would be unwise to press the issue and alternative sources of employment for displaced drillers were being considered.[78] Shipwelders were effectively a new section of the Boilermakers Society.

### Institutional Reform: Post-1965

Subsequent efforts by the Shipbuilding Employers Federation to bring about organizational change through national negotiations with the unions were similarly unsuccessful. In 1959 initial discussions took place within the federation concerning a comprehensive reform of existing working practices in order to improve productivity.[79] These discussions resulted in the

1962 plan which the employers presented to the unions in general conference at the national level. The plan included proposals for the relaxation of demarcation lines among the skilled trades and training provisions for upgrading nonapprenticed semiskilled workers to skilled status. Union opposition led to the breakdown of negotiations and the abandonment of the plan.[80]

It was only during the second half of the 1960s that significant changes were made to methods of work organization in the industry.[81] At this time, management at the local level negotiated a series of productivity agreements offering greater job security in exchange for increased flexibility and interchangeability between the skilled trades.[82] While a number of factors account for the emergence of local productivity bargaining at this time, foremost was the severity of the crisis, as increasingly effective foreign competition forced a number of the major yards to close. The employers identified restrictive union practices as a principal cause of the industry's poor competitive performance.[83] This was an argument that found a degree of acceptance amongst national union officials, who agreed for the first time to allow local productivity bargaining.[84]

Contributing to the change in the attitudes of the union officials at this time were changes in trade union structure, which altered the occupational boundaries the unions were committed to defending. The most significant structural change was the amalgamation of the Boilermakers, Shipwrights, and Blacksmiths Societies, bringing together the large majority of the hull construction trades in one union, the Amalgamated Society of Boilermakers, Shipwrights, Blacksmiths and Structural Workers (ASB). From the perspective of the defense of the ASB's occupational base, rigid demarcation lines between platers and shipwrights or between welders and blacksmiths, for example, were no longer necessary. This helps to account for the National Executive's generally positive support for productivity agreements, in so far as relaxation was restricted to ASB member trades.[85]

From the perspective of the shop floor and the individual craftsman, however, the logic of job control as a strategy to protect future job opportunities remained intact. The successful negotiation of relaxation was at once both a question of internal union politics and dependent on individual employers being able to offer a *quid pro quo* in the form of greater security of employment.[86]

The formation of regional multiyard consortia through the merger of established firms during the second half of the 1960s increased the ability of the employers to offer greater security of employment. By operating interyard mobility agreements in conjunction with interchangeability between the trades, the recently formed multiyard firms were in a position to offer a greater degree of security of employment than in the past.[87] These guarantees also allowed the firms to stem the loss of skilled labor to other industrial sectors offering greater security of employment.[88]

How successful was productivity bargaining in the British shipbuilding industry? This depends on the perspective one is interested in. Firstly, it is clear that relaxation of demarcation marked a significant break with the traditional character of industrial relations and trade union action in the industry.[89] While results varied from firm to firm, in most cases there was reasonable success in introducing and operating flexibility amongst the hull construction trades organized by the ASB. Similarly, interyard mobility agreements for these trades were operated with some success.[90] While interchangeability agreements were used less, it is not clear to what extent this reflected a limited need for them, purely technical difficulties in operating them, or principled resistance from workers.[91]

In the case of the outfitting trades, often organized in competing unions, flexibility and interchangeability were notably less successful. Further, it is clear that the limits of flexibility for the hull construction trades were precisely the limits of the ASB's occupational boundaries. The ASB was not willing to countenance a breakdown of demarcation lines among competing unions.[92] Thus, while craft regulations were relaxed, trade union structure set the parameters within which it took place.

While one could conclude on this basis that productivity bargaining was a partial success in the shipbuilding industry, if one considers the issue from the perspective of improvements in labor productivity, the balance sheet is much more ambiguous. Certainly relaxation resulted in no improvements in productivity that allowed builders to effectively meet the challenge from foreign competition during the early 1970s.[93]

In this context, it is significant that relaxation of demarcation only constituted a local modification of the traditional craft system of production. Organizational reform did not entail a radical departure in the direction of increased bureaucratization of work administration. The principal actors remained wedded to a craft conception of the production process. This is apparent from the content of the 1972 training recommendations formulated by the Shipbuilding Industry Training Board composed of employer and union representatives.[94]

> The recommendations reflect the need for the craftsmen of the future to be versatile and adaptable and for training to facilitate the effective deployment of labour. This is obtained partly by broadly-based initial training, with appropriate specialization subsequently, and partly by "supplementary" training on-the-job to assist flexibility and interchangeability.
>
> The revised aim of common basic training is to give craft trainees a sufficient appreciation of the work of other crafts to enable them to co-ordinate their production work with that of other craftsmen in the interests of the job as a whole.

The limited impact of demarcation relaxation on industry competitive performance raises the question of why organizational reform in the shipbuilding industry from the mid-1960s only amounted to a local modification of existing routines. In particular, it is striking that employers

never acted to solve the increasingly severe problem of skilled labor shortage by upgrading less skilled workers. The basic defining feature of the craft system remained intact. Employers continued to rely on skilled apprenticed workers for the coordination of the day-to-day process of production at the yard level. In the concluding section I shall provide a reason for this and consider its implications for general explanations for Britain's competitive decline.

## V. Towards a Theory of British Economic Decline

The aim of this concluding section is to present a general explanation for economic decline and demonstrate its relevance to the case of British shipbuilding. The argument rests on the behavioral assumptions and conditions laid out in Section II above: "bounded rationality," uncertainty, and the scope for opportunism in the context of strategic decision making.

The explanation for the decline of British shipbuilding presented in Section IV rested in part on the idea of management's uncertainty over the need for organizational change; in part on the obstacles they faced to instituting change when confronting a level of economic adversity that persuaded them of its necessity; and in part on the fact that when management achieved the necessary consensus amongst the actors making up the firm to bring about change, it proved to be too late. Reform arrived too late because, given the legacy of distrust, the precondition for the changes to be perceived as legitimate by all the actors was the very process of ongoing bankruptcy and closure.

It should be clear that providing persuasive reasons why established firms might find it difficult or impossible to effect change is insufficient to explain the decline of a national industry faced by increasingly effective foreign competition. We need a reason for the uniformity of the unchanging administrative practices amongst the firms making up the industry. In the case of British shipbuilding, this is provided by the strength of the collective organization of workers and employers at the national level and the interest of both groups in sustaining national level collective bargaining institutions.[95] In particular, the national scope of trade union organization prevented new firms employing substantially different methods of work organization from entering the industry.

It should also be clear, since we are not assuming greater ease of organizational change amongst competitors abroad, that different national industries must start in different places and be more or less well adapted to the changes in the economic environment that are occurring. Ample documentation has been presented to support this proposition in the case of the shipbuilding industry. British shipbuilders after the Second World War were distinct amongst major producing nations for their use of the craft system of work administration. This was a period when market and

technical conditions favored the comparatively bureaucratic systems of work administration being used by competitors abroad.

The idea of starting in different positions and being more or less well adapted to the economic environment is pursued more systematically below by drawing on evolutionary economic theory. But firstly, I propose to put the concept of organizational rigidity on a more sure theoretical footing by expanding on the notion of enterprise organization as truce introduced in Section IV above.

The starting point for understanding the organization of the firm as truce or compromise is appreciation of the fact that most decisions of complex organizations require the cooperation of many individuals to be effective. Were interests identical and information about interests complete, the problematic aspect of carrying out decisions would be trust in the competency of the actors, rather than trust in their commitment to refrain from opportunistic behavior.

One strand of literature assumes a fundamental opposition of interests between labor and management and resolves the problem of cooperation by assuming that all power resides with management.[96] Management, it is argued, devises internal control systems to monitor the behavior of workers and ensure that it conforms with the comprehensive instructions they issue. Accepting for the moment this assumption concerning the way labor and management perceive their interests, the argument nonetheless falls down for a number of reasons. Even in the case of routinized work, bounded rationality considerations preclude anticipating all contingencies in a plan and correspondingly workers will have to adapt in ways that cannot be precisely specified in detailed instructions. Further, even on highly mechanized jobs the efficiency of production rests in part on workers' tacit knowledge concerning the idiosyncrasies of particular machine processes. The effectiveness of work-to-rule strikes illustrates the importance of these potential sources of bargaining power.[97] A third point is that there is no guarantee that supervisors will perceive their interests as identical to those of their employers, and this poses the problem of who will monitor the monitors?

For these reasons, regardless of whether the workforce is organized in trade unions, it can be argued that workers inevitably retain discretion over how they perform their jobs. Given this, and the assumption that the interests of management and labor are radically opposed, the resulting vision of the firm is one of mutual defection in an iterated Prisoner's Dilemma.

While it is plausible to argue that workers and managers will see their interests as partly conflicting because of the zero-sum properties of the distribution of income at a point in time, it is also plausible to argue that they will perceive a reason for cooperating so as to increase the total income available for distribution. This conception of interests, combined with the idea that the conformity of workers' behavior with the requirements of the organization depends on the employer's having gained their consent, leads to a conception of the firm as compromise or truce.

The basis for the compromise is that, though each side has an interest in altering the terms to its advantage, both prefer maintaining the relation to breaking it off. In short, we are in a variable-sum game world.

The idea of organization as truce helps explain why adaptations to changing conditions may not be made and organizations often retain the structures they acquired at their formation. How are the individuals making up the organization to understand proposals for adaptations? As efforts by one side to shift the terms of the agreement to their advantage? Or as proposals for legitimate and mutually advantageous change? Given the less than complete information that characterizes such bargaining situations, and given the possibility of opportunistic behavior, it is not surprising that proposed adaptations, even apparently quite easy ones, often meet resistance and arouse suspicion. The result is that, in the absence of *trust*, existing routines and rules often become rigid, simply because of the consequences of breaking the truce.

In general, when trust is lacking, the nature and amount of resistance that can be anticipated to proposed administrative changes will depend on the type of change under consideration and whether trade unions exist. Changes that upset informally established relations of power among workers or between workers and supervisors are likely to provoke at most passive resistance since, as a rule, the informality of the power structure confers on it only a doubtful legitimacy.[98] Changes that subordinate workers to new authorities, as with introducing systematic management techniques, or that alter property rights to jobs, as with the relaxation of demarcation lines, are likely to provoke the opposition of trade unions if these organizations have been established. In the event that the work force is not organized in unions, such changes are likely to engender informal equivalents to formal union opposition, such as spontaneous walk outs or work-to-rule strikes.[99]

The above analysis makes plausible the notion that when there is a lack of trust among the actors, the firms composing an industry may find it difficult or impossible to change their routine behavior when faced with economic adversity. I now propose to integrate this idea of rigidity based on political constraints into an evolutionary model of firm and industry response, so as to provide an explanation for economic decline.

The standard formulation of the natural selection-evolutionary approach applied to the capitalist firm is attributed to Alchian.[100] A key feature of this formulation in relation to neoclassical modeling of firm behavior is the substitution of *ex-post* selection and local optimization for *ex-ante* maximizing rationality and global optimization. Firms are assumed to be operating in perfectly competitive markets and to be governed by rigid routines that are subject to random modifications rather than by rational decision making. Assuming that the modifications are not too large and that selection operates at a sufficiently fast pace relative to the rate at which the environment is

changing, it can be shown that the industry will move to a state in which all the surviving members of the group of firms use locally optimum techniques.[101]

This account of the evolutionary model does not require the notion of rationality. There is no need to assume that decision making is intentional, which is integral to the idea of bounded rationality that I am using here. The notion of bounded rationality implies that the actors aim to do as well as they can, taking into account their recognized limitations. The idea that decision making is intentional, but mistake prone, is in keeping with the spirit of the evolutionary approach. It is only essential to the evolutionary approach that the equilibrium results from the *ex-post* selection of the consequences of behavior rather than *ex-ante* rational decision making.[102]

This conception of bounded rationality in decision making can be captured by introducing Herbert Simon's theory of "*satisficing"*[103] and the assumption that firms *search*, developed in the work of Richard Nelson and Sidney Winter.[104] The assumption that firms "satisfice" as opposed to optimize is justified by Simon on the grounds of imperfect foresight and "bounded rationality" considerations which preclude optimizing over the set of all conceivable alternatives.[105] Given these limits to rationality, all the firm can aim for is to do "well enough" as opposed to optimally.

Search can be brought into a simple evolutionary model by assuming that the firm aims for a specified rate of return and as long as this rate is achieved there is no change in routine behavior. When gross returns fall below the satisficing level, however, the firm initiates a process of search which is assumed to be local and is treated as stochastic.[106] Search may involve the innovation of new routines or the attempt to imitate the routines of more successful competitors. Through the contraction of less successful firms and the expansion of more successful firms, successful routines are progressively spread throughout the industry.

While it is possible to develop an equilibrium story in this manner, one of the advantages of the evolutionary approach, as Nelson and Winter point out, is the scope it offers for investigating firm behavior under conditions of disequilibrium.[107]

> This kind of model can have an equilibrium with neoclassical properties, but it also is possible to explore the disequilibrium properties of the model, and indeed to set context such that equilibrium does not obtain over the entire relevant time span. While firms find better techniques, there always may be still better ones to be found. Profitable firms expand, unprofitable ones contract. But the system need not drive out all but the most efficient techniques and decision rules. Changes in the "best" techniques known by firms and in the external environment of product demand and factor supply conditions may be sufficiently rapid relative to the speed of adjustment of the overall system that a wide range of behavior can survive at any time.

Possible explanations for the coexistence of more and less efficient firms subsequent to a change in industry environment center on the idea of a "specificity" in the established buyer-seller relationship. Information, uncertainty and trust play key roles in these explanations. For example, in the case of complex products with a long life, buyers may be reluctant to switch sellers

in the short run despite a price differential because of asymmetric information considerations. They may question the quality claims of the unknown competitor and prefer to stick with the established and trusted supplier. Alternatively, in the case of less complex products, the buyer may question the veracity of the cost estimates of the unknown competitor, seeing the lower price offered as an opportunistic ploy to force the established seller out of the market with the aim of capturing future monopoly rents.[108]

These arguments are persuasive at best for a buyer maintaining a relation with an unchanging less efficient supplier over a short period of time. For example, those buyers willing to take the risk of purchasing from the lower cost suppliers will benefit from lower production costs and, with the passing of time, will outcompete their more cautious competitors in final product markets. Ultimately the less efficient supplier firms will be forced to search for more successful routines and, barring a further change in the environment, the industry will move to a new equilibrium. To account for the failure of a supplier faced with progressive loss of established customers to change, we need to introduce the idea of institutional rigidity based on the fragility of the prevailing truce between labor and management. This will account for a failure to initiate search even when gross returns fall *below* the satisficing level.

The power of this "constrained evolutionary" conception of economic development and stagnation can be appreciated by considering its relevance to the case of shipbuilding. While imperfect foresight meant that British builders after the Second World War were uncertain that changing market conditions would undermine the profitability of their established routines, they were certain that if they attempted to alter the rules defining the truce they would run into trouble with a well organized workforce that would view any proposed reform as a trap. Under these conditions, it was reasonable for British producers not to change. They only acted to change their established routines when economic difficulties were sufficiently close, not to push retarded men into action, but to persuade all the actors that the failure to undertake organizational reform would result in the collapse of the industry. At this time British builders succeeded in building up trust around proposed institutional reforms.

This interpretation of the failure to change, which places considerable emphasis on political constraints, is supported by the fact that there was a significant fall in industry profit margins from the late 1950s, but change only came about during the second half of the 1960s following the closure in 1963 of such major producers as Wm. Denny and Bros., Harland and Wolff's Govan yard, and Wm. Hamilton, and the financial collapse in 1965 of the Fairfields yard.[109] It was only after 1965 that the unions at the national level accepted the need for organizational reform and actively promoted productivity bargaining at the local level.

There is also strong evidence to show that political constraints played a role in determining the content of the organizational reforms. First of all, there is evidence that by the

early 1960s British builders were well aware that their increasingly successful competitors were using fundamentally different management techniques. The 1962 industry commissioned Patton Report pinpointed the underdeveloped nature of managerial hierarchies in the industry as a serious weakness and recommended a more systematic approach to production control.[110] Despite this, the 1973 Booz-Allen and Hamilton Report commissioned by the Department of Trade and Industry, showed that no significant changes in the degree of managerial control over shop floor production had taken place during the subsequent decade.

The lack of experience of British producers with systematic management techniques no doubt would have meant that any attempt to imitate the routines of more successful Scandinavian or French builders would have resulted in an organizational variation with distinct national characteristics. The fact that the post-1965 organizational reforms only amounted to a local modification of the craft system, however, can best be accounted for by the need to find a set of changes that both labor and management perceived as mutually beneficial. In this regard, it is not surprising that management never acted to resolve the increasingly severe problem of skilled labor shortages during the 1960s by up-grading less skilled workers. These measures would have been unacceptable to the craft unions since they would have displaced their members from the production process. The local nature of the modifications should not be understood primarily as resulting from a lack of information about alternatives, but mainly from the politics of negotiating mutually acceptable change.

The emphasis I have placed on political constraints and compromise among the actors is a significant departure from the main thrust of most evolutionary modelling. The resulting vision of the shipbuilding industry's development and the competitive decline of the British, however, is not out of keeping with the spirit of the evolutionary approach. Happenstance did play a role in the shifting fortunes of shipbuilders after the Second World War. But the failure of the British to change should not be understood in terms of the blind or irrational behavior of an incompetent management. British businessmen may have been lucky when they succeeded, but they were not stupid when they failed, just constrained by the lack of trust.

## Endnotes

1 Output figures are derived from *Lloyd's Register of Shipping*, Annual Shipbuilding Returns, unless otherwise stated.

2 German producers, who offered the British the stiffest competition, built various classes of vessels from the 1890s with little subsidization They were never successful, however, in making in-roads into Britain's control of the cargo section of the market. American builders relied for their commercial orders on legislation requiring lake steamers and coastal vessels to be of domestic make. French builders similarly relied on protective legislation, including the 1881 and 1893 laws which provided subsidies to builders to compensate for customs duties on imported materials. See H. Charpentier, *La Construction de Navires Marchands* (Paris, 1945), p. 183; S. Pollard, "British and World Shipbuilding, 1890-1914: A Study in Comparative Costs," *Journal of Economic History*, 17 (Sept. 1957), pp. 429-30; *Royal Commission on Depression of Trade*, 3rd Report, c. 4621 (1886), pp. 143-53 and 186-95.

3 This estimate is based on figures in a February 5, 1926 study in *The Glasgow Herald*. See J.R. Parkinson, "Trends in the Output and Export of Ships," *Scottish Journal of Political Economy*, 3 (1956), p. 242. Also see S. Pollard and P. Robertson, *The British Shipbuilding Industry, 1870-1914* (Cambridge, Mass., 1979), p. 43 where they note that between 1892 and 1913 the tonnage launched in Britain for registration abroad exceed the total tonnage launched in either of Britain's two principal competitors, Germany and the United States.

4 British productivity figures are likely to be upward biased for a number of reasons. The yard employment figures do not take into account variations in the amount of repair work undertaken by shipyards and the proportion of component work subcontracted to firms outside the yards. The highly specialized British shipyards are likely to have undertaken less repair and component work than yards in the US or on the Continent. Further, the work content per ton produced for a simple cargo vessel is considerably lower than for a sophisticated service vessel or passenger liner. Higher labor productivity in Britain reflected in part the comparatively large proportion of output accounted for by cargo tramps prior to 1914. Calculations of labor productivity in shipbuilding at the turn of the century presented by Sidney Pollard similarly show a large advantage for the United Kingdom: UK, 12.5 tons/head; US, 6.8 tons/heads; Germany, 3.3 tons/head; France, 1.8 tons/head. S. Pollard, "British and World Shipbuilding, 1890-1914: A Study in Comparative Costs," *Journal of Economic History*, 17 (Sept. 1957), p. 438.

5 A bias is introduced into the productivity estimate for the US by the inclusion of naval construction, which is measured in displacement tonnage as opposed to gross tonnage, which is the measure used for merchant construction. Gross tonnage refers to the total volume of a vessel, one ton being equivalent to 100 cubic feet, while displacement tonnage is the weight of the water displaced when a ship is fueled up but empty of cargo and passengers. There is no good way to convert from one measure to the other. See S. Pollard and P. Robertson, *The British Shipbuilding Industry*, p. 237.

6 W.S. Cormack, "An Economic History of Shipbuilding and Marine Engineering, with Special Reference to the West of Scotland," unpublished University of Glasgow Ph.D. dissertation (1930), pp. 308.

7 L. Jones, *Shipbuilding in Britain: Mainly Between the Two World Wars* (Cardiff, 1957), pp. 62-75; C. von Schirach-Szmigiel, *Liner Shipping and General Cargo Transport* (Stockholm, 1979), pp. 37-43; S.G. Sturmey, *British Shipping and World Competition* (London, 1962), Ch. 5.

8 The British government belatedly introduced supporting legislation with the British Shipping Act in 1935 which was aimed at the ailing tramp sector of the shipping industry. The legislation

provided for a scrap and build scheme and a subsidy to tramp owners which varied with the level of freight rates. The subsidy was discontinued in 1937 with the rise in freights. Under the terms of the scrap and build scheme owners were to scrap two tons of shipping for each ton built, and ton for ton in the case of assistance received for modernizing vessels. The scheme was little used, at least in part because the subsidy provisions of the act encouraged owners to retain their tonnage while rates were low, and as rates improved there was less incentive to scrap. Only 186,000 gross tons were authorized for construction under the scheme. L. Jones, *Shipbuilding in Britain*, pp. 149-55; J.R. Parkinson, *The Economics of Shipbuilding* (Cambridge, 1979), pp. 93-94.

[9] J.R. Parkinson, "Trends in the Output," p. 242.

[10] See the Patton Report, *Productivity and Research in Shipbuilding* (London, 1962), p. 15 for the comparatively low productivity of capital in British shipbuilding as compared with Continental producers.

[11] For general discussions of different modes of explanation in the social sciences and competing views of the individual agent, see J. Elster, *Ulysses and the Sirens: Studies in Rationality and Irrationality* (Cambridge, 1979), Chapters 1 and 3; and D. Gambetta, *Were They Pushed or Did They Jump? Individual Decision Mechanisms in Education* (Cambridge, 1987), Chapter 1.

[12] These explanations typically take the form of a third generation argument as in the following account of David Landes, *The Unbound Prometheus* (Cambridge, 1969), p. 336:

> Thus the Britain of the late nineteenth century basked complacently in the sunset of economic hegemony. In many firms, the grandfather who started the business and built it by unremitting application and by thrift bordering on miserliness had long died; the father who took over a solid enterprise and, starting with larger ambitions, raised it to undreamed-of heights, had passed on the reins; now it was the turn of the third generation, the children of affluence, tired of the tedium of trade and flushed with the bucolic aspirations of the country gentleman... Many of them retired and forced conversion of their firms into joint-stock companies. Others stayed on and went through the motions of entrepreneurship between long weekends; they worked at play and played at work.

Also see M. Wiener, *English Culture and the Decline of the Industrial Spirit, 1850-1980* Cambridge, 1981).

[13] See D. Aldcroft, "The Entrepreneur and the British Economy, 1870-1914," *Economic History Review*, 2nd series, 17 (1964), p. 118:

> One of the reasons for the slow progress made in both the old and new industries was the lack of appreciation by industrialists of the importance of science and technology and its application to industry... But the fact was that British economic supremacy had been built up by a nation of "practical tinkers" and British industrialists were strikingly reluctant to depart from "rule of thumb" methods and seemed even proud of the fact that they carried out little original research or employed few technicians.

[14] M.W. Kirby, *The Decline of British Economic Power Since 1870* (London, 1981), p. 9; S. Pollard, *Britain's Prime and Britain's Decline: The British Economy, 1870-1914* (London, 1989), pp. 49-57; S.B. Saul, "The Market and the Development of the Mechanical Engineering Industries in Britain, 1860-1914," *Economic History Review*, 2nd series, 20 (1967).

[15] See D. McCloskey and L. Sandberg, "From Damnation to Redemption: Judgments on the Late Victorian Entrepreneur" in D. McCloskey, *Enterprise and Trade in Victorian Britain* (London, 1981), p. 69:

> British investment in research may in any case have been constrained compared to the American or German by the relative shortage in Britain of scientifically educated personnel, and, for the most of the period, by Britain's peculiar patent system. A calculation of the rationality of more research would have to allow for these constraints.

More generally, see D. McCloskey, *Enterprise and Trade*, p. 106, who argues that the British economy during the late Victorian period was, "not stagnating but growing as rapidly as permitted by the growth of the resources and the effective exploitation of the available technology."

[16] B. Elbaum and W. Lazonick (eds.), *The Decline of the British Economy* (Oxford, 1986), Ch. 1. Also see W. Lazonick, "Competition, Specialization and Industrial Decline," *Journal of Economic History*, 41 (March, 1981).

[17] B. Elbaum and W. Lazonick, *The Decline*, p. 2.

[18] B. Elbaum and W. Lazonick, *The Decline*, p. 2.

[19] Correspondingly, most neoclassical economists evoke monopoly to explain nonstandard or unfamiliar business practices. For a general discussion, see O.E. Williamson, *The Economic Institutions*, pp. 17-19.

[20] P. Hall, *Governing the Economy* (Oxford, 1986), p. 19; R.N. Langlois, "Rationality, Institutions, and Explanation" in R.N. Langlois (ed.), *Economics as a Process* (Cambridge, 1986), p. 247; A. Schotter, *The Economic Theory of Social Institutions* (New York, 1981), p. 11.

[21] In making this criticism I am not denying that the work of Elbaum and Lazonick contains some of the empirical elements from which such an explanation could be constructed. My claim is that the they do not address the issue in general terms. Their general discussion is limited to the proposition that British businessmen failed individually or collectively to transform Britain's economic system because of the institutional constraints they operated under. See B. Elbaum and W. Lazonick, *The Decline*, p. 2. This general criticism is implicit in the comments of G. Saxonhouse and G. Wright, "Stubborn Mules and Vertical Integration: The Disappearing Constraint?" *Economic History Review*, 2nd series, XL (1987), pp. 87-9, on Lazonick's analysis of the cotton industry and the choice of British entrepreneurs between mule and ring spinning. Saxonhouse and Wright point out that while Lazonick argues that vertical specialization of production between spinning and weaving in Britain constrained the diffusion of ring spinning, there is no explanation offered for what "blocked the path to vertical integration."

[22] K. Arrow, Individual *Choice Under Uncertainty* (Cambridge, Mass., 1984), p. 173.

[23] I justify this limited notion of uncertainty below on page 28-29. I argue that with respect to transforming institutional constraints, the descriptive features of the market that were relevant for decision making were simply whether one could anticipate volatile demand for a nonstandard product or a comparatively stable demand for a standard product.

[24] J. Elster, *Sour Grapes: Studies in the Subversion of Rationality* (Cambridge, 1983), pp. 12-15; O.E. Williamson, *The Economic Institutions,* p. 58

[25] K. Binmore and P. Dasgupta, *Economic Organisations as Games* (Oxford, 1986), pp. 11 and 21.

[26] For the purposes of this paper, *trusting behavior* consists in action that (1) increases one's vulnerability to another whose behavior is not under one's control, and (2) takes place in a situation where the penalty suffered if the trust is abused would lead one to regret the action. In short, there is no best strategy independent of trust. See E. Lorenz, "Neither Friends nor

Strangers: Informal Networks of Subcontracting in French Industry" in D. Gambetta (ed.) *Trust: Making and Breaking Cooperative Relations* (Oxford, 1988). For a general discussion of how trust can be brought about, see D. Gambetta, "Can We Trust Trust?" in D. Gambetta (ed.) op. cit.

[27] S. Pollard, "British and World Shipbuilding," pp. 433-36 and 443-44; S. Pollard and P. Robertson, *The British Shipbuilding Industry*, pp. 84-87. Also see L. Basso, "Les entreprises françaises de construction navale," thèse, Université de Paris (1910), pp. 88-93). For the interwar period, see J. Hardy, "L'industrie de constructions navales en France," thèse, Faculté de Rennes (1951), p. 39; M. Pinczon, "Mission en Angleterre et en Ecosse avec la Délégation du Conseil National Economique, 1929-30," *Situation de l'Industrie de la Construction Navale*, Chambre Syndical des Constructeurs de Navires, Circulaire 11B (Paris, 1930), p. 96; and M. Roux-Freissineng, "L'industrie des constructions navales en France," thèse, Faculté de Aix-en-Provence (1929), p. 31.

[28] See Table 1, p. 1 for comparative productivity figures at the turn of the century. Also see L. Basso, "Les entreprises françaises," p. 89; and R. Chasseriau, "De la protection de l'industrie des constructions navales," thèse, Université de Paris (1901), p. 246.

[29] S. Pollard and P. Robertson, *The British Shipbuilding Industry*, pp. 28-29, 42, and 231; A. Reid, "The Division of Labour," pp. 46-7.

[30] S. Pollard and P. Robertson, *The British Shipbuilding Industry*, p. 40; S. Pollard, "British and World Shipbuilding," p. 437; *Royal Commission on Depression in Trade*, third report, XXI-XXIII (1886), evidence of J. Scott.

[31] W.A. Fairburn, "Methods of Handling Material over Shipbuilding Berths in American Shipyards," *Transactions of the Institution of Naval Architects*, XLIV (1902); J.R. Hume, "Shipbuilding Machine Tools" in J. Butt and J.T. Ward (eds.) *Scottish Themes: Essays in Honour of Professor S.G.E. Lythe* (Edinburgh, 1976), pp. 167-68. Manually operated equipment was typical of British yards during the interwar years as well. See R. Dugas, "L'industrie de la construction navale," Enquête du Conseil National Economique, 1929-30, *Situation de la Construction Navale*, Chambre Syndical des Constructeurs de Navires, Circulaire 11B (Paris, 1930), pp. 58-9.

[32] In 1910 there were 85 firms and 91 yards in the industry excluding boat, barge, and yacht builders. The number of firms increased to 109 and number of yards to 126 by 1920 and subsequently decreased to 60 firms and 80 yards by 1930. See *Shipbuilder and Marine Engine Builder*, January number of each year for output per yard in British shipbuilding.

[33] S. Price, "Labour Mobility in Clyde Shipbuilding," paper presented at the Gothenburg Conference on Shipbuilding History (Gothenburg, 1981), pp. 6-8 and 12.

[34] See A. Reid, "The Division of Labour in the Shipbuilding Industry 1880-1920, with special reference to Clydeside," unpublished University of Cambridge Ph.D. dissertation (1980), Ch. 7 for the pre-1900 development of trade unionism in British shipbuilding.

[35] The Boilermakers Society organized the majority of the hull construction trades including platers, riveters, angle-iron smiths, caulkers, and holders-up. The union accounted for about 30 per cent of the manual work force. Alistair Reid persuasively argues that the Boilermakers, and other unions in the industry affected by mechanization, tended to adopt centralized and nationally coordinated policies in an effort to limit dilution and secure their position in the shipyard division of labor. A. Reid, "The Division of Labour," pp. 223-24.

[36] For a detailed account of these conflicts, see E. Lorenz, "Two Patterns of Development: The Labour Process in the British and French Shipbuilding Industries 1880 to 1930," *The Journal of European Economic History*, 13 (1984), pp. 618-21.

[37] D. Dougan, *The Shipwrights* (Newcastle-upon-Tyne, 1975), pp. 130, 196 and 205; J.E. Mortimer, *History of the Boilermakers Society*, Vol. 1, 1834-1906 (London, 1971), pp. 22-23, 42 and 93; Mortimer, 1982, pp. 17 and 128.

[38] E. Lorenz, "L'offre de travail et les stratégies d'emploi dans la construction navale en France et en Grande Bretagne (1890-1970)," *Le Movement Social*, 138 (1987, pp 25-31).

[39] J.E. Mortimer, *Boilermakers Society*, Vol. 1, p. 42.

[40] C.A. Holms, *Practical Shipbuilding*, pp. 473 and 527; E. Lorenz, 1984, "Two Patterns of Development," pp. 611-12.

[41] S. Pollard and P. Robertson, *The British Shipbuilding Industry*, pp. 154-56.

[42] Bernard Elbaum argues that the more than doubling of earnings that typically followed the completion of apprenticeship lines in engineering at the turn of the century cannot be accounted for by the difference between this value and the value of apprentice marginal product net of training costs during the final years of indenture. He argues that the strength of apprenticeship in British engineering allowed employers and workers to make credible commitments for stability of employment. This permitted employers to make initial investments in skills that were for the most part industry-specific. B. Elbaum, "Why Apprenticeship Persisted in Britain But Not in the United States," *Journal of Economic History*, 49 (1989), pp. 337-49.

[43] Following Arthur Stinchcombe, I define bureaucratic administration of work by the criterion that the work process is planned in advance by persons not on the work crew. A. Stinchcombe, "Bureaucratic and Craft Administration of Production: A Comparative Study," *Administrative Science Quarterly* (1959-60), p. 170.

[44] M. Barbance, "Saint Nazaire: le port, la ville, le travail," thèse, Université de Rennes (1948), p. 447; L. Lavalée, "Résultats obtenus par l'application des nouvelles méthodes de travail dans un chantier de 3000 ouvriers," *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, 118 (1919); E. Lorenz, "Two Patterns of Development," pp. 610-611.

[45] M. Barbance, "Saint Nazaire," pp. 539-41 and 549-50; E. Lorenz, "Two Patterns of Development," pp. 610-11 and 625-31.

[46] Patton Report, p. 75.

[47] Booz-Allen and Hamilton Report, *British Shipbuilding 1972*, Department of Trade and Industry (1973), pp. 143-4.

[48] H. Orenstein, "Method and Motion Study Applied to the Shipbuilding Industry," *Transactions of the North-East Coast Institution of Engineers and Shipbuilders*, LXI (1944-5), p. D62.

[49] A. Stinchcombe, "Social Structure and Organizations" in J.G. March (ed.) *Handbook of Organizations* (Chicago, 1960).

[50] A. Stinchcombe, "Bureaucratic and Craft Administration of Production: A Comparative Study," *Administrative Science Quarterly* (19590-60), pp. 168-87.

[51] E. Lorenz and F. Wilkinson, "The Shipbuilding Industry 1880-1965" in B. Elbaum and W. Lazonick (eds.), *The Decline of the British Economy* (Oxford, 1986), pp. 119-24.

[52] K. Ollson, "Markets and Production in Swedish Shipbuilding," paper presented at the Gothenburg Conference on Shipbuilding History (Gothenburg, 1981), p. 13; L. Rapping, "Learning and World War II Production Functions," *Review of Economics and Statistics*, 47 (1965), pp. 81-86; M. Stopford, "U.K. Cost Competitiveness," mimeo, British Shipbuilders (Newcastle-upon-Tyne, 1979).

[53] R. Boekholt, "Welding—A Key Factor in Shipbuilding," *Shipbuilding International* (Sept. 1971), pp. 2-10; D. Cuthbert, "Welding in Modern Ship Construction," *Welding and Metal Fabrication* (April, 1969) pp. 122-32.

[54] See *The Procedure Handbook of Arc Welding (*1973) for a description of the Union Melt automatic welding system.

[55] The basic panel-line consists of a conveyor belt on which plates (three or four), after being cut rectangular, are clamped magnetically, tacked and welded, either on one side or with a turnover facility, to be followed by a gantry which automatically positions, clamps and welds stiffeners (steel beams) to the row of plates. See D. Cuthbert, "Welding in Modern Ship Construction," pp. 123-24 and 127-29.

[56] Even in the highly mechanized Japanese industry at the end of the 1960s, yards carried out 60 to 70 per cent of their welding with manual processes. See R. Boekholt, "Welding," p. 2; and D. Cuthbert, "Welding in Modern," p. 124.

[57] For the craft character of outfitting work at the Chantiers de France, Dunkerque during the 1970s, see BETURE, *Les ouvriers de la sidérurgie et de la métallurgie à Dunkerque*, Secrétariat d'Etat aux Transports (Trappes, 1978), p. 88.

[58] For the use of systematic planning methods in French shipbuilding after the Second World War, see CEGOS, *Organisation technique du chantier de Port-de-Bouc*, Centre Culturel, Port-de-Bouc (1949); and A. Ravaille, "Le planning en construction navale," *Nouveautés Techniques Maritimes* (1964). For comparisons of planning methods among British, German, and Scandinavian yards, see *The Patton Report*.

[59] *Navires, Ports et Chantiers* (January, 1962), p. 13.

[60] J.R. Parkinson, "Trends in the Output," pp. 244-45; Sir Wilfred Ayre, "Challenge to British Shipbuilding," *Shipbuilder and Marine Engine Builder* (August, 1954), p. 473.

[61] British builders' uncertainty as to whether changing economic conditions would undermine the profitability of their established routines was no doubt increased by the comparative lack of interyard specialization and product standardization in Britain during the 1950s. The degree of product standardization in British shipbuilding only achieved levels characteristic of Continental producers after 1965. See M. Stopford, "U.K. Cost." For an explanation of the comparatively tardy movement towards interyard specialization and product standardization in Britain, see E. Lorenz and F. Wilkinson, "The Shipbuilding Industry," pp. 119-23.

[62] See above, p. 21 and nt. 43 for the case of French shipbuilding. For the case of Dutch shipbuilding during the interwar period, see A. Van Donkelaar, "Modern Dutch Shipyard Arrangement and Practice," *Shipbuilding and Shipping Record* (March 3, 1932), p. 269-70. For developments in Continental shipbuilding more generally during the interwar years, see J. Montgomerie, "Shipbuilding Practice Abroad," *Transactions of the North East Coast Institute of Engineers and Shipbuilders*, 54 (1937-38), pp. 153-76 and the discussion to the paper, passim.

[63] J.R. Parkinson, “Trends in the Output,” p. 237.

[64] R. Nelson and S. Winter, *An Evolutionary Theory of Economic Change*, Cambridge, Mass. (1982).

[65] S. Pollard and P. Robertson, *The British Shipbuilding Industry*, p. 153.

[66] See above, p. 21 and nt. 43.

[67] The following discussion of the events surrounding the introduction of welding is based on E. Lorenz, “The Labour Process and Industrial Relations in the British and French Shipbuilding Industries: The Interwar Years” in J. Kusse and A. Slaven (eds.), *Proceedings of the SSRC Conference on Scottish and Scandinavian Shipbuilding*, University of Gothenburg (Gothenburg, 1980). For a related discussion of these events drawing on the same archive sources, see J. McGoldrick, “Crisis and the Division of Labour: Clydeside Shipbuilding in the Inter-War Period” in A. Dickson (ed.), *Capital and Class in Scotland* (Edinburgh, 1982), pp. 168-80.

[68] Shipbuilders and Repairers National Association (SRNA) Archives, National Maritime Museum, Greenwich, England, “Federation Circulars,” (9 Jan. 1932 and 28 Sept. 1932).

[69] SRNA Archives, “London Minute Books,” (24 Feb. 1931).

[70] SRNA Archives, “London Minute Books,” (24 Feb. 1931 and 28 May 1931).

[71] SRNA Archives, “London Minute Books,” (28-9 Jan. 1932, and 21-5 Feb. 1932).

[72] J. McGoldrick, “Crisis and the Division of Labour,” pp. 168-80.

[73] SRNA Archives, “Federation Circulars,” (7 March 1933).

[74] The Boilermakers Society went on strike against the scheme without the support of the other unions in the industry despite a February 1934 agreement amongst the unions pledging mutual support. See Associated Shipwrights Association Executive Committee Report (21 April, 1934). The unions signing the February 1934 agreement included the Boilermakers, Blacksmiths, Shipwrights, Sheet Metal Workers, Engineering Union, Patternmakers, Plumbers, Electrical Trades Union, Woodworkers, Painters, and Transport and General Workers.

[75] SRNA Archives, “Federation Circulars,” (28 May 1934).

[76] Associated Shipwrights Society (ASS) Executive Committee Reports (31 Jan. and 14 June 1933, and 6 June and 25 July 1934).

[77] ASS Executive Committee Reports (25 July 1934).

[78] ASS Executive Committee Reports (23 March 1944).

[79] J. McGoldrick, “Industrial Relations and the Division of Labour in the Shipbuilding Industry since the War,” *British Journal of Industrial Relations*, 21 (1983), pp. 210-11.

[80] J. McGoldrick, “Industrial Relations,” p. 211.

[81] The following discussion of institutional reform draws on the unpublished work of F. Wilkinson, "Demarcation in Shipbuilding," Department of Applied Economics Working Paper, University of Cambridge (1973).

[82] *Flexibility* refers to a worker performing tasks outside his established demarcation lines in order to progress what is his normal job. *Interchangeability* refers to transferring specialized workers from one occupational group to another on a temporary basis in order to relieve bottlenecks to production.

[83] Patton Report, p. 36 and 72-3; SRNA Archives, "Federation Circulars," (Oct. 1962).

[84] F. Wilkinson, "Demarcation," Pt. 6, pp. 10-13.

[85] F. Wilkinson, "Demarcation," Pt. 6, pp. 22-7.

[86] Commission on Industrial Relations, Report No. 22, *Shipbuilding and Shiprepairing*, XXV, cmnd. 4756 (1971), pp. 219-37; F. Wilkinson, "Demarcation," Pt. 6, pp. 20-1.

[87] Booz-Allen and Hamilton Report, 1973, p. 86; Geddes Report, *Shipbuilding Inquiry Committee Report*, VII, cmnd. 2937 (1966), pp. 88-90.

[88] During the 1960s, the casual nature of employment in the shipbuilding became a focal point of discontent amongst the work force. The industry sustained a net loss of skilled labor of 10 per cent between May 1967 and May 1968, while for apprentices the figure was closer to 20 per cent. See Shipbuilding Industry Training Board, "Report and Statement of Accounts," (31 March, 1968), pp. 6 and 13.

[89] The path-breaking nature of these agreements can be appreciated by considering that the Boilermakers Society was not a signatory to the 1912 General Demarcation Agreement which contained procedures for resolving demarcation disputes between the unions. The Boilermakers had refused to sign the agreement because it provided for employer representation on the courts charged with arbitrating demarcation conflicts.

[90] F. Wilkinson, "Demarcation," pp. 22-23.

[91] K. Alexander and C. Jenkins, *Fairfields: A Study of Industrial Change* (London, 1970), pp. 146.

[92] F. Wilkinson, "Demarcation," Pt. 6, pp. 23-26.

[93] Booz Allen and Hamilton Report, pp. 44-45, 154-55 and 220-21.

[94] Shipbuilding Industry Training Board (SITB), Training Policy Statement No. 3 (Aug. 1972, pp. 7, 12).

[95] The logic in this, from labor's perspective, is that organizing the entire relevant product market precludes firms outside the union's jurisdiction from offering competition that undermines their collectively negotiated standards. In the case of a fragmented industry such as British shipbuilding, the national level of trade union organization will encourage similar national coordination amongst employers so as to preclude labor a "whipsawing" advantage in bargaining. There is a vast literature on the relation between bargaining power and bargaining structure. See, for example, C. Craypo, *The Economics of Collective Bargaining* (Washington D.C., 1986); L. Ulman, "Connective and Competitive Bargaining," *Scottish Journal of Political Economy*, 21 (1974); and A. Weber, "Introduction" to A. Weber (ed.), *The Structure of Collective Bargaining* (Glencoe, N.Y., 1961).

[96] H. Braverman, *Labor and Monopoly Capital* (New York, 1974); D. Gordon, R. Edwards and M. Reich, *Segmented Work, Divided Workers* (Cambridge, 1982); K. Stone, "The Origins of Job Structures in the Steel Industry," *The Review of Radical Political Economics*, 6 (1975), pp. 61-97.

[97] M. Crozier, *The Bureaucratic Phenomenon* (Chicago, 1964), pp. 187-98; R. Cyert and J. March, *A Behavioral Theory of the Firm* (Englewood Cliffs, N.J., 1963), pp. 117-18; S. Mathewson, *Restriction of Output Among Unorganized Workers* (Carbondale, Illinois, 1969); R. Nelson and S. Winter, *An Evolutionary Theory*, p. 109-10.

[98] See, however, M. Terry, "The Inevitable Growth of Informality," *British Journal of Industrial Relations*, 15 (1977).

[99] These observations are based on A. Stinchcombe, "On Social Factors in Administrative Organization," Ch. 11 in A. Stinchcombe, *Stratification and Organization* (Cambridge, 1986).

[100] A. Alchian, "Uncertainty, Evolution and Economic Theory," *Journal of Political Economy*, 58 (1950).

[101] While in Alchian's formulation the equilibrium is an optimum, this is by no means necessary to the spirit of the approach. This might be the case for the simple, though rather uninteresting, reason that there are a number of equally and maximally good alternatives. J. Elster, *Sour Grapes: Studies in the Subversion of Rationality* (Cambridge, 1983), p. 12; P. Van Parijs, *Evolutionary Explanation in the Social Sciences* (Totawa, N.J., 1981), pp. 49-51.

[102] There must be some "blindness" resulting in "errors" in relation to the environment and criterion of selection, or else there will be nothing for selection to operate on. If errors are not possible, then it will be as if the equilibrium resulted from an omniscient actor weighing the expected consequences of a set of alternatives and choosing from amongst them according to a preference ordering.

[103] H. Simon, *Administrative Behavior* (New York, 1957).

[104] R. Nelson and S. Winter, *An Evolutionary Theory*.

[105] Sidney Winter has developed a general argument demonstrating the impossibility of profit maximization. He argues that although there is an optimal amount of costly information that the firm should acquire in order to maximize profits, it is impossible for the firm to determine the amount. The choice of an information framework to make this decision itself requires information and "it is not apparent how the aspiring profit maximizer acquires this information or what guarantees that he does not pay an excessive price for it." The infinite regress is cut short by assuming that the firm's goal is a "satisfactory," as opposed to maximum, level of gross returns. S. Winter, "Economic 'Natural Selection' and the Theory of the Firm," *Yale Economic Essay*s, 4 (1964), p. 262.

[106] In the simpler models of Nelson and Winter it is assumed that the firm tests a random distribution of techniques in the neighborhood of its current technique. See R. Nelson and S. Winter, *An Evolutionary Theory*, Ch. 7; and R. Nelson, S. Winter and H. Schuette, "Technical Change in an Evolutionary Model," *Quarterly Journal of Economics*, 90 (1976).

[107] R. Nelson and S. Winter, "Factor Price Changes and Factor Substitution in an Evolutionary Model," *Bell Journal of Economics*, 6 (1975), p. 469.

[108] Another possible explanation for the coexistence of more and less efficient firms in the short run is the idea of "organizational slack" developed by Richard Cyert and James March. In the short

run, when faced with economic adversity, firms will cut excess costs or engage in more aggressive sales behavior. R. Cyert and J. March, *A Behavioral Theory*.

[109] According to a private survey conduced by Hoare and Co., the industry profit/sales ratio fell from 6.4 per cent in 1958 to 2.4 per cent in 1964. A. Slaven, "Growth and Stagnation in British/Scottish Shipbuilding, 1913-1977" in J. Kusse and A. Slaven (eds.), *Proceedings of the SSRC Conference on Scottish and Scandinavian Shipbuilding*, University of Gothenburg (Gothenburg, 1980), p. 21.

[110] Also see *The Shipbuilder and Marine Engine Builder* (April, 1962), p. 210 and (Jan. 1964), p. 10.