Knowledge Management Capabilities for Steel Makers: A British–Japanese Corporate Alliance for Organizational Learning

SIMON COLLINSON

ABSTRACT This paper draws on a detailed case-study of a technical alliance between British Steel Strip Products (BSSP) and a leading Japanese steel company which was established to help the UK producer improve its product quality, its production control management and its customer links with Japanese car company transplants in the UK. The study is one of a series of comparisons of leading UK and Japanese manufacturing companies, from the steel, aerospace, telecoms and chemical industries. The overall project has been funded under the ESRC Innovation Programme.

Evidence of the success of the alliance is illustrated in a series of graphs depicting the reduction in scrap and steel losses from particular BSSP mill sites and clear improvements in quality and productivity levels at these sites. The case-study traces these improvements back to specific management practices transferred from the Japanese producer as part of the alliance. Detailed evidence comes from the activities of ‘Task Teams’ which were assembled, with engineers from the Japanese companies as team members, to identify key quality problems at the mill sites and initiate procedural changes to overcome them.

Using this empirical foundation the paper explores and develops a number of key concepts believed to be increasingly important within the broader analysis of organisational change and innovation at the firm level. The corporate ‘capabilities’ approach and ‘knowledge-based’ theories of the firm are brought together to help identify differences between the two firms and explain the resulting effects on company performance.

The main focus is on ‘knowledge management practices’, including practices and procedures governing project management, inter-divisional coordination, management roles, budgeting and resource allocation, networking and information exchange, human resource development, employee motivation and so on, in each of the firms. The study highlights important differences between the two firms in terms of how specialist knowledge is developed, deployed, integrated and exploited or ‘leveraged’ for manufacturing innovation (quality control improvements at the mill sites). This also encourages intra-firm knowledge flows between technical support departments, R&D and production sites.

The case study of the alliance represents an unusually clear illustration of how some knowledge management practices are more difficult to transfer between firms because they are more deeply ‘embedded’, that is, highly dependent on broader contextual factors (knowledge resources, organisational structure, Simon Collinson is at the University of Edinburgh Management School, WRB, 50 George Square, Edinburgh EH8 9JY, UK. E-mail: <s.colinson@ed.ac.uk>. He was Assistant Director at the Institute for Japanese–European Technology Studies (JETS) when this research was conducted. Funding for the project came from the Economic and Social Research Council (ESRC) Innovation Programme and is gratefully acknowledged. Revisions of earlier drafts benefited significantly from feedback given by Alex Perkins and Bernard Hewitt at British Steel and from Yoshio Matsuda at Nippon Steel Corporation. The usual disclaimers apply. Many thanks are due to the numerous managers and engineers from both companies who made themselves available for interviews and discussions for the project.

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culture etc.,) to operate effectively. Broader changes are more difficult to implement and usually take much longer. Moreover, as shown by other studies looking at the transferability of Japanese management practices, some changes, though leading to performance improvements, are probably not possible and/or desirable. The study therefore provides some insights into the capacity for and limits of various kinds of organisational innovation in the British firm.

Introduction

This paper describes a study comparing the management of innovation in two steel firms, Nippon Steel and British Steel. Because these firms are producing almost identical outputs, using almost identical production processes they are well-matched for such a comparison. Moreover our ‘window’ into these firms, for the purpose of comparing and contrasting management practices, is a technical alliance between Nippon Steel and British Steel Strip Products (BSSP) that has been established since the early-1990s to support the development of new practices in the British firm that incorporate lessons drawn from the experience of the Japanese firm, the world-leader in the steel industry.

The research involved a series of interviews and meetings with managers, engineers and researchers in both companies at their respective headquarters, central R&D facilities and steel mill-sites, in the UK (primarily South Wales) and Japan (in Tokyo, Futsu and Kimitsu). These were used to document details of the organization and performance of one of the UK strip steel mill-sites before and after particular stages of the alliance. Meetings with members of the various joint British–Japanese plant teams focused on the operational problems they were trying to change and aspects of the Japanese input into the change process. The author also had the opportunity to spend time with the joint-teams in Wales and interview Japanese participants both in the UK and Japan. This helped in the broader comparison of the two organizations and their respective procedures for managing innovation at the production level.

In addition to a rich, detailed description of the differences between the firms in terms of their organizational structures, management procedures, technical knowledge and innovative capabilities the study fulfils two important objectives:

(1) It clearly shows the link between a change in management practices and improved performance in a particular innovation context. Because we are examining the incremental improvement of processing reliability and product quality, which were the focus of the alliance and the self-improvement efforts at BSSP, these can be precisely quantified and measured over a period of time. A marked increase in useable ‘yield’, i.e. a decrease in product defects amounting to an increase in productivity, and in product quality at BSSP over the period of alliance can be traced accurately to changing practices which benefited from the participation of managers and engineers from the Japanese firm.

(2) It provides a good illustration of how difficult it can be to transfer lessons in best practice from one firm to another and provides an opportunity to explore barriers to restructuring that stem from the ‘embeddedness’ of such practices. By embeddedness we mean the degree to which certain aspects of these practices are dependent on other characteristics of the firm and as such are deeply rooted in the organizational context in which they have evolved. As such ‘embeddedness’ is central to competitive advantage (underlying the ‘uniqueness’ that sets firms apart) but it can also be a disadvantage when technological or market change demands a corresponding re-structuring of a firm and a reorientation of its knowledge and its knowledge-management capabilities.
Specific procedures and practices at Nippon Steel were identified by both firms to be sources of competitive advantage in the management of mill-site innovation, specifically improvements in processing reliability and product quality. Many of these were transferred or adopted in a modified form at BSSP as part of the technical alliance. During the learning process at BSSP it became obvious that most of these practices were dependent on other characteristics of Nippon Steel, including the knowledge and expertise of managers, engineers and line operators; the attitudes of personnel, their motivation and the broader culture of the company; and organizational structures that linked R&D, mill-sites and various head-office functions. BSSP was able to change many aspects of its operations and effectively implement some of the new mill-site practices. But it was recognized that other characteristics would take much longer to change and that some of the ‘better practices’ it identified in the Japanese firm would prove impossible to emulate outside the corporate (and industrial and national) context in which they had evolved. These limits to ‘best practice’ transferability, learning and restructuring, related to the embeddedness of certain aspects of such practices, are explored through this comparative case study.

The first part of this paper will describe this concept in the context of evolutionary theories of the firm and the notion of ‘path-dependency’. After a brief overview of the steel sector as the industrial context for innovation the paper will describe the alliance between Nippon Steel and BSSP and compare the management practices of each firm.

**Path-Dependency and ‘Embeddedness’ in Knowledge Management Practices: Theoretical and Practical Significance**

In analysing the relationship between the firm and its competitive environment evolutionary approaches have focused their investigations on how and why firms differ, ‘what are the sources of variety and what are the constraints on variety generation’.

This clearly lies at the heart of explorations into the dynamics of competitive advantage. In particular, both management theorists and practitioners are interested in the organizational differences between firms that underlie differences in their performance.

This study looks at an important sub-set of these issues, examining the differences between two firms in terms of their management of innovation. The approach draws from recent work that brings together elements of the capabilities perspective, the ‘core competencies’ framework, knowledge-based theories of the firm and evolutionary approaches in order to understand how organizations differ in their ability to identify innovative opportunities and mobilize human resources to exploit those opportunities.

One central theme in this combined approach is that the corporate capabilities, routines and procedures by which a firm manages knowledge and expertise for innovation are a significant factor underlying the differences in competitive advantage and competitiveness between firms.

This study aims to contribute to this approach by highlighting how particular knowledge management practices, which underlie competitive advantage, can be difficult to transfer between firms. These ‘limits to transferability’ are related to the embeddedness of such practices in the broader fabric of the organization. Differences between firms are partly sustained, giving better-performing firms more enduring competitive advantage, because of this embeddedness. However, practices that are deeply-rooted in this way also give rise to path-dependency and may, in a changing competitive environment, be a source of competitive disadvantage.

Competitive advantage arises because other firms find it difficult (and/or ‘costly’) to copy these elements. In this sense these are ‘core competencies’. The following provides
some indication, in theory and, later in this paper, in practice, precisely what it is that is difficult to transfer between firms, and why. One reason is the contextual embeddedness of knowledge itself, related to the embeddedness of knowledge management practices.

**Knowledge and Knowledge Management**

It is largely accepted that much of the knowledge and expertise within firms is highly context-specific and tacit in nature. The transfer of knowledge is limited because much of it is embedded within the specific social fabric of the organizations in which it is developed.

Lam, in a study which has some parallels with the one reported here, suggests that the nature and organization of knowledge can vary along three different dimensions:

1. the dominant form of knowledge in use and its tacitness
2. how knowledge and expertise are distributed and utilized within the firm (its structure)
3. methods of co-ordination and knowledge transmission

Differences between firms across all these dimensions, including the relative specialization of knowledge across different business functions, accepted ways of codifying knowledge and of valuing knowledge (related to the power given to particular specialists), the interactions of specialists (e.g., through job rotation) and dominant ‘knowledge integration’ mechanisms stem from differences in the cultural, social, industrial and economic contexts in which they have evolved.

**Competitive Advantage, Specialization and Path-Dependency**

The evolution of an organization is path-dependent in that it is constrained by decisions and choices made in the past. It has an inherited set of resources and capabilities and an ‘architecture’ which limit its future development options. In the context of this study the incremental, cumulative nature of technological learning in firms is particularly significant. It gives firms (and individuals within firms) a certain set of capabilities that are suited to a particular operating environment, sometimes providing, at least temporarily, advantages over other firms (or individuals).

Firms and the people that work in them are uniquely specialized and a change of specialization is costly. Moreover, costs are not just incurred because firms need to develop new areas of knowledge and expertise relating to new technologies and markets. Developing new organizational capabilities, routines and practices to manage knowledge and expertise in more efficient and effective ways also incurs (often hidden) costs.

Coombs and Hull see path-dependency as ‘located’ in three distinct ‘domains’ of the firm: in ‘technology-as-hardware’ (products, production machinery etc.); in the ‘knowledge base’ of the firm, which relates directly to the products, production systems, suppliers, customers and the market environment in which the firm operates (and its ‘cultural norms’); and in the ‘routines’ which are used to ‘develop and apply the knowledge base of the firm’.

Coombs and Hull’s approach is based around ‘knowledge management practices’ (KMPs), which are routines for managing knowledge. They see a number of benefits in focusing on routines, rather than the other two domains, for analysing competitive advantage:

1. they can be empirically observed;
they have common features which transfer from one firm to another but can be implemented differently or given different degrees of importance in different organizations, with an (often directly measurable) influence over performance;

(3) they are a major focus of restructuring and change as the firm works to improve its performance or responds to new conditions, as such they are actively debated by managers, making them and the reasons for change visible to the researcher.

All provide a good rationale for focusing on routines, and specifically knowledge management practices and their transferability, in the comparative case study described below.

These concepts, which highlight the difficulties of transferring (1) knowledge and expertise and (2) knowledge management practices between firms, provide us with a framework for understanding and explaining aspects of the comparison between British Steel and Nippon Steel Corporation. As mentioned above both use very similar ‘technology-as-hardware’ and production processes making it easier to match differences in performance with differences in the knowledge base and the knowledge management routines of each firm. This allows us to fulfil a more practical objective, to assess the degree to which transfer of best practice is possible between these two competing firms.

The learning process that took place as part of the technical alliance between Nippon Steel and BSSP has evidently already narrowed the differences that give rise to competitive advantage and hence narrowed the performance gap between the two firms. However, some of the limits to the transferring of best practice became evident during the process and many of these limits are directly related to the embeddedness issues described above.

Innovation in the Steel Industry

Developing organizational capabilities to manage technology, improve productivity, product quality and new product development is obviously important for competitive advantage across all industry sectors. Given the maturity of the steel industry and the continued pressure on firms to restructure current operations and diversify into new markets it also true for steel firms.

Key ‘milestone’ innovations in production technology, including the introduction of the basic oxygen furnace (in the 1960s to 1970s), continuous casting (in the 1970s to 1980s), and computer-controlled processing (also 1970s and 1980s) have each preceded periods of incremental improvement along more predictable technological trajectories. The industry has been marked by steady increases in productivity alongside relatively rapid declines in employee numbers. As this pattern becomes increasingly mature the scope for further performance improvements driven by reductions in employee numbers and/or radical changes in production technology becomes more limited.11

Competitive advantage lies increasingly in improving existing human resources and human resource management. That is: (1) improving the knowledge and expertise of employees; (2) better motivating and empowering employees at different levels to use their knowledge to pursue the main strategic objectives of the firm, and; (3) reorganizing and restructuring human resources, rearranging specialist divisions of knowledge and expertise and improving the interfaces (communication, knowledge-integration, etc.) between these.

Across the steel industry globally Japanese firms have led many of the above developments, consistently achieving better performance through the adoption of new technologies and the development of new working practices ahead of their rivals
elsewhere. Massive investment in new technology and production equipment was only part of the picture, although large-scale investment took place much earlier in Japan, in the 1960s, and not until the latter-half of the 1970s in the UK.\textsuperscript{12} Japanese steel companies have maintained this lead by ‘utilising the intellectual capabilities of shop-floor workers through the quality control movement’ and by ‘mobilising shop floor workers and engineering workers to make innovations in the manufacturing process’\textsuperscript{13}

Two ‘core competencies’ underlie Japanese success in the industry, here we focus mainly on the first:

(1) continuous improvement at the manufacturing level: ability to continually improve the quality of steel outputs by increasing the controllability and predictability of various production processes, thereby reducing defects and maintaining a high level of useable ‘yield’.

(2) close links with main customers, particularly in the construction, automotive, industrial plant and packaging industries, to better understand current product specifications and quality requirements and predict future new product development requirements.

Foreign competitors, including British Steel, have successfully focused on developing these competencies as a means of closing the gap with leading Japanese firms. The following section describes how this has been achieved in one case, but achieved only up to a point.

\textbf{The British Steel–Nippon Steel Alliance}

\textit{Background}

Nippon Steel Corporation (NSC) is the world’s leading steel producer and has maintained its competitive lead in the industry over a long period of time by focusing on the two core competencies mentioned above. It is a leading exponent amongst Japanese firms of quality-assurance and continuous improvement practices at the production-level (within the rolling mills) and is particularly well-known for its ‘\textit{Jishu Kanri}’ management practices.\textsuperscript{14} Like other Japanese firms in other industries it has also developed long-term relationship with its customers, including Toyota, Japan’s leading car manufacturer, to whom it supplies between 40 and 50\% of its steel inputs in Japan. This has provided Nippon Steel with an in-depth understanding of the quality standards and technical requirements for steel inputs for its car company customers, including Toyota, and strong interpersonal links with R&D staff, engineers and technicians at all levels.

British Steel is a major supplier of steel to Toyota’s UK manufacturing operations in Burnaston, Derbyshire and approached Nippon Steel initially in the beginning of the 1990s to improve its quality control mechanisms and develop its relationship with Japanese transplants (Toyota, Nissan and Honda) and other customers.

Nippon Steel and British Steel Strip Products (BSSP) established a technical alliance which formed part of a broader programme of change at the British firm focusing on improving the quality of its products, its Japanese customer relationships, and its management of process technology and new product development.\textsuperscript{15} Associated with this there has been a broader push to change the ‘corporate culture’ at British Steel works and it should be emphasized that the NSC alliance is just one aspect of this initiative.\textsuperscript{16}

The pursuit of ‘Total Quality’ has progressed through three stages (see the timeline in Figure 1):

(2) The ‘Viability Plan’ (September 1992); ‘focused problem solving’, with the introduction of the ‘task team’ approach and the involvement of Nippon Steel.

(3) The ‘Extended Viability Plan’ (January 1994); with the continuation of the task team approach and further co-operation with Nippon Steel, including the introduction of ‘Plant Teams’, ‘Small Teams’ and ‘Process Enhancement Groups’ (PEGs).

The Viability Plan and Task Teams

The initial process involved benchmarking the rolling and finishing processes against standards set by customers and competitors to establish whether, why and by how much (using numerical targets) British Steel’s individual processes fell short of expectations. At Port Talbot 40 total quality teams, the forerunners of the Task Teams, covered every aspect of Cold Mill operations between January 1990 and April 1994.

The 1992 Viability Plan contained target yields setting achievable improvements over 12–15-month periods, covering all aspects from Hot Mill, Cold Mill, Coatings and General Management. Works Managers (later ‘Team Leaders’) identified the most critical problems, which resulted in defects that reduced plant productivity, and teams were established to deal with these, including:

- Sticker wrench mark (SWM)—slight tearing of steel surface during uncoiling process
- Rust—rusting between process stages
- Chatter—differences in steel strip thickness caused by vibrations in rolling processes
- Edge condition—various problems with uneven strip edging
- Coil walling—‘telescoping’ of the coiled strip
- Roll management—general management of rolling processes
- Integrated quality management—overall organization of quality control procedures

Because one objective of the exercise was to achieve best practice across all three Cold Mills each team included an experienced engineer from each site. The ‘Premier League’ programme later promoted the spread of these best practices to Hot Mill sites. Three permanent R&D staff also joined each team to involve them first-hand in the production operations. Each team appointed one experienced R&D person to act as co-ordinator, to link the team with specialist expertise in other parts of the company and externally.

Three experienced Nippon Steel engineers worked with these teams, visiting BSSP every three months for 2 weeks, particularly to assist the ‘flagship’ teams, working on major problem areas such as Rust and SWM. Task Teams also spent a week at a Nippon Steel plant to observe the Japanese firm’s system for managing technology. In fact, over the period of the alliance, over 300 BSSP personnel have visited plants in Japan. Team progress was monitored by a steering group and every three months team leaders, together with the Nippon Steel participants, met with senior managers at BSSP for a formal report. Because the Task Team concept originated out of what were called ‘Working Groups’ at Nippon Steel, established to focus on particular plant-level problems and transfer best practice solutions to other plants, visiting teams from BSSP gained from observing experienced teams in operation at the Nippon Steel works in Japan.

The benefits from the Task Team initiatives between 1991 and 1994 are seen by BSSP managers as:

- information exchange between plants
- standardization of practices
- speed of implementation
- technical support from R&D
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Figure 1. Timeline: Key Elements of the British Steel Strip Products Technical Alliance With Nippon Steel Corporation
team working experience
Japanese experience
development of best practice
enforcement of PDCA (‘plan, do, check, action’) practices
powerful management tool
focuses attention to specific task
exposed operational weaknesses
development of team work
success through involvement and co-operation

In concrete operational terms the decline in the number of rust rejections and SWM rejections as a percentage of CTM (cold mill) throughput, for example, illustrates the improvements resulting from the team-based problem-solving. Rust rejections declined from 2 to 3% of throughput in 1991 to less than 0.5% in 1994. SWM rejections peaked in 1992 to early 1993 at over 3% of CTM throughput to less than 0.5% in 1993–1994 (see Figure 2).

A key productivity and quality measure for steel strip products in all steel firms is the

Overall mill ‘yield’. This is the proportion of raw iron and steel input that is transformed into final hot and/or cold-rolled steel strips for dispatch to customers. It reflects the amount of raw material that is being lost through quality rejections like those described above. Between 1991 and 1994, during the implementation of the Task Teams, BSSP’s Port Talbot mill-site experienced an increase in yield from an average of 82% (1991–1992) to 90% (1993–1994). At the end of 1991 a low of 76% was reached and in 1994 a high of 92.5% (see Figure 3).

The Extended Viability Plan and Process Enhancement Groups (PEGs)

Following this success an ‘Extended Viability Plan’ was established in 1994 through to March 1996, with a renewed agreement with Nippon Steel. The three key original benchmark targets remained the focus. These were to achieve:

- HR/CR (hot rolled/cold rolled) yield of 92.5%  
- customer complaints less-than or equal to 0.5%  
- on-time delivery 95% of the time

New Task Teams covered:

- Surface cleanliness and staining  
- Roll marking—(some kinds of marking defects are mentioned above)  
- Annealing practices—softening steel strip through heating and gradual cooling  
- Coil handling and damage—during in-plant transportation between processes  
- CR shape—controlling the variability of the shape of the cold rolled strip  
- Coater house practices—management of coating processes

Process Enhancement Groups (PEGs) were established by moving R&D personnel to works areas (Port Talbot Hot Mill, Llanwern Cold Mill and No.3 Coatings Complex at Shotton, in the first phase) to promote continuous process improvement. The Nippon Steel agreement was extended to cover operator teams and TQP teams to introduce the approach and the underlying culture to other areas of operations.
PEGs brought together groups of engineers associated with particular process areas to improve production and increase the ‘predictability’ of quality level and process problems, that is, to decrease the ‘variability’ in operations that created uncertainty and necessitated crisis management. There were five PEG teams initially, one each in iron-making, steel-making, hot mills, cold mills and coatings, each with around 15 personnel.

Prior to the PEG restructuring many R&D specialist technical personnel were located at a distance from the mill-sites, ‘on-call’ to solve particular processing problems and continually making recommendations for improvements in operation. The PEG system involves locating process-based R&D personnel at the mill-site, working closely with supervisors and operators to improve operations. This change in knowledge management practices underlies many of the above improvements.

Plant Teams

The success of the Task Team approach resulted in the second phase of the technical alliance being established for a time in parallel with phase 1 activities. Included in the second phase were plant-based TQP teams of operators, following Nippon Steel’s ‘Jishu Kanri’ model. This phase also involved visits by BSSP operators and supervisors to Nippon Steel mill-sites in Japan. A total of 40 such teams have been sent from BSSP to Nippon Steel to observe plant-level problem solving and procedures.

A central aim of this part of the alliance for BSSP was to make better use of front-line personnel, mainly the mill line operators, by devolving responsibility to them for maintaining the procedures recommended by the Task Teams and continuously looking to improve quality at the mill-sites. The traditional divisions between blue and white collar personnel, the lack of skills and training, plus the ‘cultural’ differences between British operators and their Japanese counterparts, in terms of accepting ‘ownership’ and responsibility, all posed (and still pose) fundamental challenges for those pursuing this aim. We will return to this point later in discussing ‘embeddedness’.

Increasingly in phase 2 the focus was on the transference of broader management capabilities and the particular aspects of corporate culture that supported them, to enable Nippon Steel’s technology management procedures to operate effectively in the BSSP context. However, rather than simply ‘blindly adopting’ Nippon Steel’s example, BSSP personnel worked with the seconded Japanese engineers and managers to develop a unique style of organization appropriate for the British firm, incorporating the technical and managerial experiences of both groups.

Small Teams

These were teams of younger engineers and junior managers, who visited mill-sites in Japan in groups of two or three, to learn about how to organize focused, plant-level technical and engineering improvements, bringing specialist technical expertise and R&D skills to bear on process improvement.

The ‘Boundary Sample Library’ Example

Before looking at a range of managerial and organizational differences between the two firms highlighted by the alliance it is useful to focus on one specific procedural change in a BSSP mill that contributed to the visible improvements in process control and product quality described above.

The study gathered evidence from individual Task Teams involved in the following
problem areas: Skin Pass Control; Roll Shop and Roll Management; Ridge; Annealing Practices; Mills Lamination; Camber; Coil Walling; Coil Handling; Operators Role; Shape and Profile; and Width Control.

As an example, ‘Shape and Profile’ refers to the cross-sectional shape of the steel strip. Variations in the thickness across the strip profile, influenced by temperature changes during cooling and uneven coiling speeds, are one measure of final quality. Similarly ‘Chatter’, which refers to rippling effects created by certain vibrations during the rolling process, is another quality indicator, analysed by stoned inspections (rubbing samples of strip with smooth granite stones to highlight surface defects). ‘Coil Walling’ (uneven coil edges) and SWM, when the uncoiling of steel strips creates marks near the edges, are other defects which Task Teams focused on. Optimizing the uniformity and therefore the quality of the final output—and reducing major defects that result in scrap strip—requires optimizing control over the various production processes. This requires an in-depth knowledge of the various conditions along different process stages that give rise to specific defects.

To help with solving many of these problems, mill-site personnel established a ‘boundary sample library’. This was a collection of photographs of rejected sections of steel strip, stored along with a description of the defect and the process conditions under which the defect occurred. The library was established before the Nippon Steel alliance to maintain a record of such defects. However, the review of mill-site operations that took place in the initial stages of the alliance along with the direct comparisons with Nippon Steel mill practices showed that the BSSP version of the boundary sample library was not being managed, developed or exploited particularly effectively. The improvements made to this particular practice significantly contributed to the measurable performance improvements described above.

One key difference introduced by the interaction with Nippon Steel managers and engineers was to store actual strip samples, cut from rejected coils and stored inside oiled plastic bags (to prevent rusting). This enabled easier identification and differentiation (cataloguing) of various defects and more accurate matching of defects with specific stages of processing.

In addition to this, by observing the way in which Nippon Steel personnel had developed and continually used a boundary sample library in their Hirohata mill (during field-trip visits to Japan by BSSP personnel) a number of other changes were made to improve (1) the ‘capturing’ of defects and (2) the use of the library to support quality improvement efforts.

The Nippon Steel mill had a full-time employee involved in logging defect samples and maintaining the library, it had a much more extensive range of examples and more detailed information about the conditions which led to the various faults and in some cases solutions that had effectively overcome the problem. Following the Japanese example, BSSP personnel established procedures to collect a greater variety of defect samples and organize the library more efficiently as a database for continual updating and expansion. An essential part of this was to (1) motivate operators, inspectors and engineers to log defects and describe the causes in some detail, (2) give them the power to do so (particularly in terms of a degree of flexibility from routine operations responsibilities), and (3) give them some knowledge (as well as a way of improving their knowledge) to identify defects, select useful samples and store them.

This was achieved in a number of ways, including raising the profile of the library as a reference tool and store of knowledge and experience on process defects that contributed significantly to (lack of) final product quality. It also required devolving the responsibility for building and maintaining the library to mill-level personnel and
giving them an understanding of what it represented, how it should be developed and the benefits it could bring within the overall drive to improve quality. This is one example of how attitudes had to be changed to involve all personnel, not just managers, in the process of monitoring and improving quality. Managers had to relinquish some degree of control over the operations and operators had to shift from being ‘reactive’ and ‘routinised’ to being pro-active and ‘discretionary’ in the organization of their activities. This, in turn, is one element of the restructuring of job profiles—expertise and responsibilities, knowledge and power—to break down the strict distinctions between managers, inspectors and operators.

As part of this change the boundary sample library has begun to be used a training tool to illustrate the visible effects of processing problems and convey an understanding of the relationship between different processing conditions and final output quality. Following the Nippon Steel ‘model’ it could also be used, alongside other methods, to transfer this knowledge and experience on to other managers, inspectors and operators, and to disseminate best practice between mill-sites.

We will return to this example of a specific knowledge management practice in our discussion of embeddedness in the concluding section of this paper.

**A British Steel–Nippon Steel Comparison**

Returning to the framework introduced at the start of this paper we now examine some of the major differences between British Steel and Nippon Steel that have been highlighted by the technical alliance. We begin with some specific mill-site procedures and practices and go on to describe some aspects of organizational structure, culture and knowledge which they rely on to function effectively.

**Procedures and Practices**

**PEGs.** The PEG mechanism was described as a major difference between the companies underlying the better process performance at Nippon Steel. Successfully transferring this mechanism was a critical part of the initiative, after the monitoring and performance benchmarking steps had been completed. It was seen by participants as the integrated quality control system (QC) that the British mills lacked. Successful transfer would provide BSSP with two key organizational capabilities, reflecting the core competencies highlighted earlier:

1. a mechanism to achieve daily, continuous improvement at the operations level, identifying defects and poor yields, tracing cause and effect, and problem-solving.
2. capabilities for forecasting future problems and incorporating likely future customer needs into on-going process development plans—an ability to prepare for the future technological requirements of the customer.

As described earlier, PEGs brought together groups of engineers, with different areas of expertise, to focus on particular process areas to improve production and increase the ‘predictability’ (reduce defects and ‘downtime’) of production subsystems. At the broader, organizational level this required bringing specialist technical personnel closer to mill operations and more in-tune with operational priorities. This required changing, for example, the link between the Technical Centres (in Wales and Teeside) and the central R&D and technical facility at Swindon House in Sheffield. About 20% of approximately 250 personnel at the Welsh Technology Centre (WTC) joined PEG teams during the first 5 years of the alliance.
Associated with these changes was a move towards: greater team-working for groups of specialists to jointly tackle process problems; better cross-functional communication, and; a customer-focus to emphasize the highest-priority improvements. This had significant implications for on-site personnel, particularly in terms of the required combinations of specialist vs generalist knowledge and expertise. The generalist role of plant operatives is beginning to merge with the specialist role of inspectors. Operators were taught to ‘inspect’ and develop an understanding of the different measures of quality that were important to different customers and how defects were created by different process conditions. The inspector–operator divide in terms of status and responsibility was (is being) substantially reduced.

Detailed In-process Inspection. One of the main changes made at the BSSP mill-site was to introduce more detailed in-process surface inspection procedures and to precisely record defects for comparisons using a ‘boundary sample’ library (see above). This allows for a close, continuous monitoring of outputs at each production stage and comparisons with standards set in-house and by competitors. Although some of these practices, like ‘stoned inspection’ stations, already existed it was the additional precision (e.g. introducing double-sided inspections), and the setting up of clear routines within the production process to achieve this precision, that made much of the difference. This allowed a more systematic monitoring of in-process cause-and-effect of defects. To some extent BSSP personnel gained insights into the importance of accuracy, detail and precision as ‘general principles’ for improvement from visits to Nippon Steel mills and gave these a higher priority in restructuring their organization practices.

Rigorous and Accurate Information-gathering, Documentation and Knowledge-transfer. Participants on both the British and Japanese side of the alliance noted significant differences in the amount of information-gathering and documentation of production processes in other areas of production. Personnel at all levels in Nippon Steel plants seem to engage in more detailed information-gathering, documentation and information-sharing activities in support of continuous improvement. The example of the ‘boundary sample library’ described above was the subject of comparisons by both Japanese and British engineers and the practice of compiling more rigorous, accurate and comprehensive records of various production line defects was adopted by BSSP.

Some of these practices were seen as a way to overcome problems that arose because much of the in-depth knowledge and experience at the BSSP mill-sites was ‘concentrated’ in relatively few senior engineers and managers. This problem had been compounded in the past by the retirement and loss of older, more experienced operators, leaving too-few experts holding the technical ‘memory’ of the organization.

Preventative Maintenance. Much these information-gathering and dissemination activities support what have been termed ‘preventative maintenance’ practices of Japanese firms. To avoid expensive downtime, when sections of plant are idle because of equipment failure, and avoid ‘crisis management’ in maintaining and upgrading process equipment Nippon Steel (and many other manufacturers) invest time and resources in establishing and documenting the operating parameters of equipment. Alongside this, often through close technical links with suppliers, they estimate the life-expectancy of various parts of the plant, so as to anticipate and prepare for problems rather than react to them when they happen. This is often done by establishing ‘what if’ scenarios to understand how processing equipment would operate under certain conditions and prepare mill-site personnel in advance.
Culture

Although corporate culture as it is broadly defined underpins a wide range of practices described here and represents an overarching difference between the two companies, there are some specific cultural attributes that were directly associated with the effective operation of mill-site practices at Nippon Steel. While BSSP managers at no time sought to precisely emulate these, since it was neither feasible nor desired, cultural change at BSSP was recognized as something that would take a long time to achieve and in many cases this would act as a barrier to the improvement of some areas of performance.

‘Volunteer Attitude’ Amongst Mill Operators. One Nippon Steel respondent in the study referred to the lack of a ‘volunteer attitude’ at the British firm. This limited the transferability of aspects of the PEG structure that required operators (who are often best-qualified to propose and implement minor line improvements) to be deeply motivated to strive for improvement. This comment and others from the UK-side highlighted characteristic differences between the British ‘job as a financial contract’ attitude and the Japanese loyalty and commitment (strongly ingrained and obligated through societal norms) to fulfil their responsibilities beyond any ‘formal contract’.20

Managers involved from both the Japanese side and the UK side noted positive changes in the ‘motivation’ and ‘attitude’ of operators at BSSP over the duration of the alliance, citing this as a component of the improved mill performance. However, managers also noted the strong possibility of a ‘retrenchment’ back to ‘older attitudes’ if the high profile initiatives ended and management attention moved on.

Blue-collar, White-collar Differences. Traditional differences between blue-collar and white-collar employees, their status, role in the organization and workplace attitude also vary between Japanese and British systems and this affects the implementation of initiatives to improve production.21 British Steel’s management practices that were highlighted by the comparison include: a ‘reporting culture’, or reliance on written technical reports to senior management (rather than Japanese-style consensus-based management or ne-mawashi) to promote technical initiatives; and a greater use of financial bonuses which accentuate individualism rather than teamwork amongst technical personnel. In general, the ‘territorialism’ and individualism of British managers contrasts the group-oriented Japanese for whom ‘lifetime’ employment and an age-related hierarchy has traditionally promoted a ‘mentoring’ towards other personnel (although changes are clearly taking place in the current recessionary environment in Japan).22

These differences had a number of effects at the mill-site. In particular, related to the ‘volunteer attitude’ referred to above, managers traditionally took the initiative to make production changes and often volunteered time to see these through. Operators tended to follow instructions and worked to a routine, with little or no ‘personal investment in improvement’ activities. This division of responsibilities clearly has an impact on the degree to which operators have a stake in supporting and assisting the improvement process, despite excellent knowledge and experience about the relevant processes. As has been well-documented elsewhere such divided interests as part of the overall ‘social relations of production’ very often act as barriers to change.

Knowledge and Expertise and Organization

Differences in the knowledge-base of the firm, from the technical capabilities of mill-site operators and engineers to the management experience of supervisors or head-office staff
clearly influence the innovative capabilities of different firms. However, in this comparison it is more the emphasis on: (1) different types of knowledge and expertise; (2) different combinations of specialist and generalist skills to perform different functions, and; (3) different ways of distributing, organizing and applying knowledge (knowledge management practices), that sets the two companies apart and adds to the complexity of learning from best practice. These mirror Lam’s three dimensions described earlier.

Technical Personnel at BSSP/NSC. Although British Steel compares very favourably with other global counterparts in the steel industry, as the third largest producer in the world, it has fewer technical specialists compared to Nippon Steel and this creates a clear disadvantage in terms of the sheer manpower and range of capabilities available for technical improvements. However there are also ‘knock-on’ effects from difference that extend beyond the simple cost–benefit evaluation performed by most managers. A source of competitive advantage described by the Nippon Steel engineers stemmed from the continuous opportunity for ‘polishing’ (migaku) or refining technologies and process improvements stemming from the larger number of specialist technical personnel with the relevant experience and expertise. Personnel were able and encouraged to pool knowledge and discuss and ‘negotiate’ technical changes from the most minor tweaking of control instrumentation to wholesale selection and installation of new rolling lines.

At BSSP production system changes are often based on the expertise of one or a few individuals, not the combined knowledge of many. This is because it does not have the range of technical specialists as Nippon Steel, or the same degree of pre-decision consensus-building that is characteristic of Japanese firms, or the routines in place to effectively integrate relevant expertise from around the firm. Individual experts have more independent power to take decisions regarding system changes or new equipment purchases and are more often left ‘unchallenged’.

However, it should be said in contrast, that in many situations where a rapid, ‘empowered’ response is urgently required the lack of a need to arrive at a broad consensus does speed-up decision-making and in such situations the ‘Western style’ of management provides a competitive strength.

Process-focused Expertise: Production-led rather than ‘Science-pushed’. As well as differences between the two firms in terms of the numbers of available specialists there were marked differences in terms of (1) the ‘division’ and organization of knowledge and (2) the status and relative decision-making power of different kinds of specialists.

Regarding technical support and R&D staff, process engineering specialists, such as iron-making, steel-making, hot and cold-rolling specialists are much more common at Nippon Steel, while discipline-based expertise, such as mechanical engineering, computer sciences or materials, is more the norm at BSSP. Nippon Steel tends to be organized around the works and around particular process teams. BSSP appears to be more informally structured around key individuals who head important ‘territorial groups’ and sometimes compete for recognition, budgets and decision-making power.

Overall, engineers and particularly mill-site specialists have less status in British Steel than their counterparts in Nippon Steel. Ability, status and decision-making power enables technical personnel at the mill-site in the Japanese firm to play a much stronger role in directing technical change and continuous improvement drawing on outside specialists when required. This contrasts the top-down structure at British Steel. Acknowledging this, however, the alliance resulted in a move to give greater recognition to the process-level specialists at BSSP who had built up significant experience about the performance tolerances and potential improvements of processes at the mill-sites.
Conclusions

After more than 7 years of working together to improve the mill-site operations of the British firm, BSSP and Nippon Steel continue to have a highly successful partnership. The three graphs showing improvements in defect rates and yield from 1991 to 1994 clearly demonstrate that better performance has resulted from a general initiative to improve quality, process-control, productivity and customer-orientation at BSSP and a central element of this initiative was the alliance with Nippon Steel.

It is clear from the descriptions of changes to working practices that Japanese managers and engineers, working on-site in the UK, introduced a range of improvements that contributed directly to BSSPs evolution. Procedures and practices relating to process control, quality monitoring and solving the causes of product defects were changed drastically through the Task Team approach and the creation of Process Enhancement Groups (PEGs). These emphasized the development of team working for groups of specialists, better cross-functional interaction and communication and better customer-focus to help prioritize improvement options.

‘In-process inspection’, ‘rigorous information-gathering and documentation’, with the example of the boundary sample library, and ‘preventative maintenance’ were also described in this paper. In some cases these procedures, or similar practices, were already in place before the alliance, like the sample library. Moreover, some of them cannot be described as particularly novel or ‘innovative’ in their own right. However, the lessons gained by comparing existing procedures with the Japanese firm often stemmed from the ways these procedures were carried out, rather than the procedures themselves.

The fact that many of the more impressive improvements in performance took place in the first-half of the alliance suggests that the ‘learning curve’ has got steeper as BSSP has narrowed the gap with its Japanese counterpart. Participants on both sides of the alliance confirmed that the challenge has increasingly been to maintain the higher levels of performance by making changes in management practices and attitudes towards continuous improvement ‘stick’. At the same time the remaining opportunities for further improvement lie in changing the more difficult ‘embedded’ aspects of the organization over the longer term.

Some practices were transferred or changed relatively simply and quickly, sometimes with a significant impact on performance. In other cases new practices were introduced but did not have the same impact. This was because their effectiveness was dependent on other elements that remained unchanged because: (1) they were not known to be significant; (2) they were beyond the scope of the particular restructuring initiative, or; (3) changing them turned out to be a long-term, costly or impossible process.

Drawing from the theoretical framework introduced in the first part of the paper the comparison highlights a number of these barriers to the adoption of new practices, particularly knowledge, motivation and power. Each is linked to broader aspects of culture, structure and organization within (and beyond) the firm. The detailed example of the boundary sample library provides an illustration.

Establishing the boundary sample library as an effective procedure supporting quality-control at the mill-site, following the Nippon Steel example, required a number of key changes. Some aspects of this particular practice were relatively easily transferred. For example the ‘innovation’ of cutting sections of strip, rather than taking photographs, and storing them in oil-filled bags immediately helped improve the library at the BSSP site. But to develop the resource and use it to support quality improvements and the dissemination of best practice internally, in the way Nippon Steel used it, entailed more fundamental changes.
Mill-level personnel had to be able to: identify defects and trace these to particular processing problems and equipment faults, or know which specialists could advise them on this; know which defects were already stored in the library and which were worth storing; cut defect samples from steel strips and log them (changing work routines and sometimes the process lines); either know how to solve the processing problems causing the defect and have the power to make necessary changes, or know who could provide specialist technical support and/or authorize these procedures.

Changing the responsibility and developing the capabilities to initiate such changes from the bottom-up required new technical knowledge, new levels of motivation (encouraging a ‘volunteer attitude’) and a redistribution of managerial power.

**Knowledge**

The three dimensions of knowledge, following the categories described by Lam and discussed earlier, can be observed. The technical knowledge and expertise of mill-site personnel had to be improved. Some of this knowledge appeared to be tacit, in the sense that it related to the long-term experience with each sub-process to understand cause-and-effect underlying particular defects. However, changing the distribution of specialist knowledge proved to be equally, if not more challenging in that prior to the restructuring key individuals (inspectors, engineers and managers) and not all line personnel had developed this expertise. Changing how knowledge was organized and distributed had direct implications for the existing hierarchy and distribution of power and as such was subject to more barriers than the tacitness of the knowledge itself.

At the broader level a different restructuring took place in terms of the distribution and utilization of knowledge, mainly through changes in the ‘transmission’ and co-ordination mechanisms. The PEGs proved to be particularly effective for bringing R&D personnel closer to the mill-site, improving the interface with production-line personnel, reducing the cultural barriers between scientists, engineers, inspectors and production-line personnel to improve knowledge integration.

**Motivation**

Motivating personnel to acquire new technical knowledge and expertise, to take responsibility for developing the sample library and engage in other continuous improvement practices, to learn about where sources of specialist knowledge and expertise are available around the firm entailed a significant and on-going change in ‘corporate culture’.

The sociology and psychology of personal incentives is not something this paper has been concerned with. However, it proved to be one aspect that was essential to the effective implementation of the boundary sample library procedure and to the other changes at the British Steel mills. It was also emphasized by participants from both firms as one of the more difficult and long-term of the changes that needed to take place if improvements in performance were to be sustained. The factors influencing different levels of motivation and involvement in innovation are clearly deeply embedded, not just in the broader organizational culture of the firm but also in the socio-cultural environment at the regional and national levels. This not only confirms the well-known fact that UK–Japan differences at this level contribute to the difficulty of transferring some practices from one country to the other (in either direction). But it also provides a better understanding of the specific barriers that appear to be important.

Again, at the broader cross-function level at BSSP, there was a re-orientation of R&D personnel and specialist engineers to focus their knowledge (and develop new knowledge)
to better-support the continuous improvement of mill-site processes. Restructuring the incentives for R&D personnel to engage in more applied activities did not appear to be too difficult in this case. Developing their first-hand knowledge about production processes, however, was seen to be a longer-term objective.

**Power**

The distribution of power is strongly linked to both motivation and knowledge and again appears to be strongly embedded in the particular ‘architecture’, culture and ‘norms’ of the individual organization. Devolving responsibility for initiating process changes away from key managers, ‘empowering’ personnel further down the management hierarchy, has proved to be difficult and change will take longer than anticipated. Again, the embeddedness of this barrier to change is clear when we look at the wide range of factors that underlie differences in the sources and distribution of power and authority in the two firms.

All three of these more embedded elements of the organization, knowledge, motivation and power needed to be changed to make new knowledge management practices work effectively, following the best practice example of Nippon Steel but in a new organizational context. Further improvements in performance require further changes in these elements over the long term.

At one level the study adds to our understanding about the differences between these two steel firms, reflecting more general differences between British and Japanese management styles, strengths and weaknesses. At another level it provides some insights into the barriers to restructuring, transferring best practice and the evolution of a ‘learning organization’.

**‘Embeddedness’, Path-Dependency and Competitive Advantage**

Returning to the theoretical approaches outlined earlier in this paper, beginning with Coombs and Hull’s domains of path-dependency: (1) technology-as-hardware; (2) the knowledge base of the firm, and; (3) routines, which develop and apply the knowledge base of the firm. At one level this study examines the transfer of technical knowledge which in this case, given the similarity of the firms and the technologies they employed, did not appear to be too difficult. Nippon Steel’s advantage appears to lie much more in the organizational practices which it has evolved to help it continually (as a ‘dynamic capability’) develop, deploy and utilize knowledge amongst the right people, in the right places, at the right times, for innovation that results in better performance. Because these practices are more deeply embedded, dependent on other aspects of their organizational environment, they are more difficult to transfer. Or, more precisely, it is difficult to transfer the procedures and routines into a new organizational setting and achieve the same levels of effectiveness. This, therefore, acts a source of ‘uniqueness’ and provides a competitive advantage.

For example, seeing the benefits that the boundary sample library procedure brought to Nippon Steel, BSSP engineers observed the detailed practices in the Japanese firm and were able to develop the same procedure. Getting the procedure to work as effectively as it appeared to in the context of the Japanese organization was much more of a challenge because the embedded factors underlying its effectiveness, particularly those related to motivation and power.

Many studies highlight the ‘sticky’, tacit and context-specific nature of knowledge itself, because of its ‘embeddedness’. Here we can see that the routines by which
companies internally develop (and appropriate from outside), deploy and utilize knowledge can often be seen as equally, if not more context-specific.

The case study shows how Nippon Steel gains a particular competitive advantage from these knowledge management practices, in terms of the superior productivity and quality levels of its strip steel mills. It also shows how BSSP managers and engineers, learning with Nippon Steel counterparts, were able to improve their own performance by taking on board some elements of these practices (but not all).

The alliance highlights some of the elements in both organizations that contribute to their inertia and path-dependency. In this particular case these represented constraints for the UK firm attempting to permanently restructure aspects of its organization, incorporating the practices and procedures observed in the better-performing competitor. An interesting twist is that the same embedded elements underlying the success of the Japanese firm also give rise to inertia and path-dependency and currently represent constraints in its attempts to change in response to the new economic, social and political environment in which it now finds itself.

Notes and References


2. At times, two elements of innovation can become confused in this analysis: (1) how well a firm innovates, i.e. the efficiency and effectiveness by which it carries out product and process development in the pursuit of better competitiveness and performance, and (2) analysis of organizational innovation, or innovativeness, the capacity for a firm to restructure to innovate better. Both are obviously closely related but often need to be clearly differentiated.


6. Lam’s study compares the Japanese ‘organisational’ and the British ‘professional’ models and their influence over the organization of knowledge through a case study of a high-tech collaboration between two firms. Problems with the collaboration are traced in part to differences in the way knowledge is ‘structured, utilised and transmitted’ in each of the firms, partly because of their distinct social settings. A. Lam, ‘Embedded Firms, Embedded Knowledge: Problems of Collaboration and Knowledge Transfer in Global Cooperative Ventures’, Organization Studies, 18, 6, 1997, pp. 973–996.


10. Routines are regular procedures that provide consistency, efficiency and predictability to management. Routines allow individuals in organizations to use tried, tested and accepted guidelines and norms to minimize ‘novelty’, uncertainty and risk in decision-making. The importance of routines and the link with path-dependency comes from R. Nelson & S. Winter, An Evolutionary Theory of Economic Change (Boston, Harvard University Press, 1982).

11. Although there is not a great deal of scope for radical innovation in the steel industry minimills and direct reduction may well create changes in the future. Moreover corporate restructuring stemming from pressures to both diversify and globalize, indicated by the growing number of international alliances, is taking place (my thanks to Seiichiro Yonekura at Hitotsubashi University for highlighting these issues).


14. According to interviewees at Nippon Steel Corporation kanri means, ‘management’, ‘control’ or ‘supervision’; jishu means ‘self’ or ‘autonomy’ (lit. ‘by themselves’) but also denotes ‘self confidence’. The two combined mean ‘self-management’ and represent the devolvement of responsibility not just for maintaining operations but for improving processes, to the operators. Jikokanri is the common term for this in Japan. Jishukanri is a particular term coined by Nippon Steel, which has a reputation for best-practice in this area amongst Japanese firms, and used by other steel makers and firms following the Nippon Steel quality control model. See also: I. Nonaka & S. Yonekura, ‘Innovation Through Group Dynamics: Organisational Learning in JK Activity at Nippon Steel’s Kimitsu Works’, Discussion Paper No.124, Institute of Business Research, Hitotsubashi University, Tokyo, 1982.

15. BSSP represents about 25% of British Steel as a whole and includes the Port Talbot, Llanwern and Shotton sites and the Welsh Technology Centre (WTC). British Steel has had technical associations with Nippon Steel for a long time and the BSSP Focused Problem Solving (FPS) agreement took place alongside other technical agreements.

16. On first coming across this example of ‘co-operative competition’ most observers want to know what Nippon Steel, as the ‘world leader’ in the field, stood to gain from this alliance. Why was it willing to provide lessons that apparently under-pinned its own competitive advantage to the UK firm? Four reasons were presented during the research: (1) they do not directly compete in these particular steel markets, because of transportation costs and possibly local-content rules for foreign-owned car firms that are major strip-steel buyers; (2) Nippon Steel’s relationship with Japanese car manufacturers in the UK, particularly Toyota, made them the obvious partner; (3) Nippon Steel earns a great deal of revenue by supplying technology and technical support to firms around the world; (4) if they had not entered into the alliance another, possibly Japanese, competitor probably would have done so and gained the above benefits plus an advantageous working relationship with British Steel.

17. The structure of the alliance up to 1994 and details regarding quantitative improvements achieved by BSSP as a result are in G.R. Jones, A. Perkins & T. Hinooka, ‘Quality and Yield Improvement Through the Task Team Approach at British Steel Strip Products’, Presented at the ATS Steelmaking Days Conference, Paris, 7–8 December 1994 (co-authored by two of the interview respondents).
18. Car companies, for example, are continuously aiming to reduce the weight of car bodies that are made primarily of strip steel (hence the competitive threat from aluminium, which is lighter). At the same time they want to maintain tensile strength and rigidity and improve body surfaces for retaining protective coatings and paint finishes. Their final product quality and continuous product development is closely tied to improvements in steel strip inputs.


22. Rather than listing the many studies that describe traditional differences a good reference for current changes in Japan is: M. Sako & H. Sato (Eds), Japanese Labour and Management in Transition (London, Routledge, 1997).

23. There are numerous studies comparing general management practices in ‘Western’ and Japanese firms that make similar points. Two very good comparative studies in the steel industry are: Yonekura, op. cit., Ref. 13; Hasegawa, op. cit., Ref. 12. Both confirm the conclusions made here.

24. BSSP managers have made it a high-priority to change certain aspects of the company’s culture following the Japanese example and have since recognized that this is a long-term goal. Most recently, in particular, there has been an initiative to establish a new management style, again stressing teams of expertise and experience as the basis for decision-making.

