Columbia Project: Use of Software to Achieve Competitive Advantage

STEEL: NIPPON STEEL, K.K.

Gaining and Sustaining Long-term Advantage Through Information Technology

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SOFTWARE AS A TOOL OF COMPETITIVE ADVANTAGE:
INTEGRATED STEEL INDUSTRY

Introduction: Objectives of this Benchmarking Study

This integrated steel case study for Nippon Steel (NSC) was completed under a three-year research grant from the Sloan Foundation. The project examines, through a series of case studies, US and Japanese firms that are recognized leaders in using information technology[1]. The purpose is to analyze how these firms have organized and managed the use of informational technology to achieve long-term, sustainable advantage. While each case is complete in itself, each is part of this larger study[2]. While there is no comparable integrated US steel company case, the case research on mini-mills has been completed for Tokyo Steel and is underway for Nucor.

This case for a large integrated steel producer, along with other cases[3], supports an initial research hypothesis that leading software users in the US and Japan are very sophisticated in the ways they have integrated software into their management strategies. They use it to institutionalize organizational strengths and capture tacit knowledge on an interactive basis. In Japan this strategy has involved heavy reliance on customized and semi-customized software (Rapp 1995) but is changing towards a more selective use of

[1] In this paper and the study, software, information technology (IT) and systems are used interchangeably. In addition, when referring to the firm as a whole, the text will use "it," but when referring to management, "they" will be used. Integrated steel covers blast furnace producers of steel as opposed to those using electric arc furnaces.

[2] The industries and firms examined are food retailing (Ito-Yokado), semiconductors (NEC and AMD), pharmaceuticals (Takeda and Merck), retail banking (Sanwa and Citibank), investment banking (Nomura and Credit Suisse First Boston), life insurance (Meiji and Nationwide), autos (Toyota), steel (integrated mills and mini-mills, Nippon Steel, Tokyo Steel and Nucor), and apparel retailing (Isetan and Federated). Nationwide has replaced USAA, as the latter was unable to participate. These industries and cases were generally selected based on the advice and research of specific industry centers funded by the Sloan Foundation. These are the computer and software center at Stanford, the semi-conductor and software centers at Berkeley, the financial services center at Wharton (University of Pennsylvania), the pharmaceutical and auto centers at MIT, the steel project at Carnegie-Mellon, the food services project at the University of Minnesota and the apparel center at Harvard. The case writer and the research team for this case thus wish to express their appreciation to the Alfred P. Sloan Foundation for making this work possible and to the Sloan industry centers for their invaluable assistance. They especially appreciate the time and guidance given by the steel research center at Carnegie-Mellon as well as the staff at NSC and ENICOM who were so generous with their time. Still, the views expressed in this case are those of the author and not necessarily those of NSC or its management.

package software managed via customized systems. An example of this is Nippon Steel's development of an E-commerce system to automate its traditional faxed-based ordering system from the Japanese trading companies (TCs). In turn, US firms, such as Merck, who have often relied more on packaged software, are now customizing more. This is especially true for the systems needed to integrate software packages into something more closely linked with the firm's business strategies, markets, and organizational structure.

Thus, coming from different directions, there appears to be some convergence in approach by these leading software users. These cases confirm what some other analysts have hypothesized; a coherent business strategy is a necessary condition for a successful information technology (IT) strategy (Wold and Shriver 1993.[4] These strategic links for Nippon Steel and the Japanese steel industry are presented in the following case.[5]

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[3] This refers to cases for which interviews have been completed. See footnote 2.

[4] These and other summary results are presented in another Center on Japanese Economy and Business working paper: William V. Rapp, "Gaining and Sustaining Long-term Advantage Through Information Technology: The Emergence of Controlled Production," December 1998. Also see: William V. Rapp, "Gaining and Sustaining Long-term Advantage Using Information Technology: Emergence of Controlled Production, "Best Papers Proceedings, Association of Japanese Business Studies, Salt Lake City, UT, June 1999.

[5] All the cases are being written with a strategic focus. That is, each examines a firm's IT strategy rather than the specific software or IT systems used. In this sense, they illustrate how IT is used to improve competitiveness rather than what specific software a firm is using. The latter is generally only noted to illustrate and explain the former. This emphasis was not specified when the project began but has evolved as research has progressed. There are three major reasons the cases have become focused this way. First, at a detailed level, all these firms have unique software and IT systems due to the way each weaves organization with packaged and custom software. There is thus little others could learn if a case just explained each firm's detailed IT system or systems. Further, the cases would be long and would quickly drown the reader in data since IT pervades all aspects of these very large corporations. This was apparent at an early stage in the study when the project team tried to develop IT organization charts for Takeda, Merck, and NEC. The second reason is that at a general level, differences in firm IT systems can be almost trivial since there are only a limited number of operating system options, e.g. IBM mainframes, UNIX workstations, and Windows or MAC based PCs. Third, information technology changes very rapidly and thus each firm is constantly upgrading and evolving its systems. So detailed descriptions of each IT system would rapidly become obsolete. For these reasons, focusing the cases on strategic principles developed as the best way to explain to readers something they could use and apply in their own situations. This reasoning has been confirmed when we have presented the material in different forums as discussants have commented favorably on the approach. Equally importantly, in our interviews and conversations with management, this is where they have focused their responses. That is, as the various cases illustrate, the

The experience of Nippon Steel, along with the other cases, also illustrates that the implementation and design of each company's software and software strategy is unique to its competitive situation, industry, and strategic objectives. These factors influence how each chooses between packaged and customized software options for achieving specific goals and how each measures its success. Indeed, as part of each firm's strategic integration, Nippon Steel and the other leading software users interviewed have linked software strategies with overall management goals. This is achieved through clear mission statements that explicitly note the importance of information technology to the firm's success.

Each has coupled this view with active CIO (Chief Information Officer) and IT (information technology) support group participation in the firm's business and decision making structure. Thus for firms such as NSC the totally independent MIS department is a thing of the past. This may be one reason why outsourcing for NSC has not been a real option except to a captive subsidiary, ENICOM. The company's relatively successful business performance in steel is not based solely on software, however. Rather, as will be described below, software is an integral element of the firm's overall management strategy with respect to producing and selling steel to major customers, especially the Japanese auto companies. This approach also plays a key role in serving corporate goals, such as: enhancing mill productivity by improving production scheduling, reducing

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firms manage their IT decision-making by following a set of strategic principles integrated with their view of their competitive environments. This is similar to Nelson and Winter's (1982) rules and routines for other kinds of management decisions and innovations, and illustrates these firms' evolutionary approach to IT use and development. Their basic reasons for this incorporate the points noted above, i.e., each firm's unique system, the limited operating system options, and IT's rapid technical change. Based on what the case study teams have learned, therefore, it is these firms' strategic approaches, including the concept of controlled production explained later, that seem to have the widest applicability and offer other organizations the most potential insights without becoming dated in how to use IT to improve competitiveness. The detailed strategy describe here, though, only applies to steel in Japan.

inventories, and strengthening customer relations. The systems are coupled with an appropriate approach to marketing, production, customer service, new product development, and constant cost reduction. All this reflects NSC's clear understanding of its business, its industry, and the firm's competitive strengths within this context.

This clear business vision, especially of the E-commerce and customized casting strategies described below, enables NSC's management to select, develop, and use the appropriate software to assist its steel mills to operate at a higher and more consistent level of performance, and to augment customer support. In turn, NSC has also integrated this support to the mills into a total support system for the firm, including its overseas affiliates. That support is coupled with the company's overall operations, including accounting systems. Since this overall vision has also impacted other corporate decisions, NSC seems to have strong human and financial resources, as well. (See Appendices I & II on Strategy & Operations as well as Firm & Industry Data).

Nippon Steel also shares some common themes with other leading software users, such as the creation of large proprietary interactive databases. These databases promote automatic feedback between various stages of the order, production, and delivery process. NSC's ability to use IT to economize on traditional delivery systems and inventory practices, such as the amount of steel that must be held for various automobile models, is also a common theme for other leading software users. In addition, it has been able, organizationally and competitively, to build beneficial feedback cycles or loops that increase productivity in different areas. Those areas include customer service, accounting, and product availability. Cycle times have been reduced and the production and delivery of products to the customer has been improved.

Management recognizes that better cycle times between client orders and ultimate delivery reduce costs and also improve business forecasts, since projections are for shorter periods. Customer satisfaction is enhanced as well through more timely delivery of the product. One example of this is that NSC's new E-commerce system (Dazai 1997 and Dazai & Maruyama 1997) allows the customer to automatically track an order through the production process without phoning mill personnel. The customer does not have to wait to discover when the order will be shipped and delivered. The ultimate customer can also by-pass the trading company in this process, again saving time and phone calls. Further, this system has eliminated potential errors from erroneous copying of information from faxes that, under the old system, might have caused additional delays, expensive errors, and customer frustration. Telephone and fax charges have been reduced as well. So software inputs are critical factors in NSC's and other leading users' overall business strategies. The results for doing it well are strongly positive, while the implications for competitors are potentially negative.

An important consideration in this respect is the emergence of a new strategic. This paradigm differs from mass and lean production in that mass production dramatically improved on craft production through economies of scale in using standardized products, and lean production improved on mass production by making production more continuous and tying it more closely to actual demand. What we call "controlled" production seems to significantly improve productivity by using IT to monitor, control, and link every aspect of producing and delivering a product or service, including after sales support and product changes. Some of these effects for Nippon Steel are illustrated in the case that follows. It describes NSC's new E-commerce system,

production scheduling algorithm, proposed accounting system, joint auto industry inventory control project, and customized casting system.

Such controlled production is only possible by actively using IT and software systems to continuously monitor and control functions that previously had been parts of a business structure that only responded to changes in expected or actual consumer demand, rather than influencing or stimulating those changes. This may be why these firms' skillful use of IT is viewed by themselves and industry analysts as important to their business success. But this is only true when IT is integrated with the firm's operational and organizational standpoints, reflecting its overall business strategy and its clarity of competitive vision.

At NSC the software and systems development people are part of the decision-making structure within each steel mill, as illustrated below for the Kimitsu Works. The head office unit only manages the overall system or firm-wide projects, such as the new accounting system. In turn, IT systems are integral to the way NSC organizes, delivers, and supports the mills and the steel business from product development to ordering and production, and through to delivery and after-sales support. This sequence is particularly critical in steel where the demand and supply for particular products shift according to the customer's business and economic situation. That is, as economic conditions affect the demand for autos, ships, and construction differently, the mix of steel products demanded by the customer constantly shifts.

Therefore Seagate Technology is certainly correct for Nippon Steel when it states in its 1997 Annual Reports: "We are experiencing a new industrial revolution, one more powerful than any before it. In this emerging digital world of the Third Millennium, the

new currency will be information. How we harness it will mean the difference between success and failure, between having competitive advantage and being an also-ran."

In NSC's case, as with the other leading software users examined in this case study series, the key to using software successfully is to develop a mix of packaged and customized software that supports the firm's business strategies and differentiates it from competitors. NSC management has done this by using IT to enhance its existing organizational strengths, rather than trying to adapt its organization structure to the software used. They have also looked to functional and market gains to justify the additional expense incurred in customizing certain systems. This includes factoring in the related costs of integrating customized and packaged SW into a single information system while training employees to use it. This integration is done by first assessing the possible business uses of software within the organization and its operations. Particular focus is placed on IT's role in enhancing NSC's core competencies in developing, producing, and delivering many different qualities and types of steel. Management rejects the view that IT systems are generic products, best developed by outside vendors who keep costs low through economies of scale, and who can more easily afford to invest in the latest technologies.[6]

[6] Nippon Steel an the other cases have been developed using a common methodology that examines cross-national pairs of firms in key industries. In principle, each pair of cases focuses on a Japanese and American firm in an industry where software is a significant and successful input into competitive performance. Excepting Nationwide Insurance, the firms examined are ones recommended by the Sloan industry centers as ones using SW successfully. Nationwide was recommended by a leading securities analyst as a replacement for USAA. So all are recognized by their industry as being good at using IT to improve competitiveness. To develop these "best-practice" studies, the research team combined analysis of current research results with questionnaires and direct interviews. Further, to relate these materials to previous work as well as the expertise located in each industry center, the team talked with the industry centers' managers. In addition, the study coupled new questionnaires with the materials used in a previous study to either update or obtain a questionnaire similar to the one used in the 1993-1995 research (Rapp 1995). This method enabled the researchers to relate each candidate and industry to earlier results. The team also worked with the different industry centers to develop a set of questions that specifically relate to a firm's business strategy and software's role within that. Some questions address issues that appear

Approach: Methodology and Questions

In undertaking this and the other case studies to assess the importance for each firm of the issues noted above, the project team sought to answer key questions while recognizing firm, country, and industry differences. These have been explained in the summary paper referenced in footnote 4. They are set forth in Appendix I as well, where NSC's profile is presented based on company interviews and other research. Readers who wish to assess how NSC's strategies and approaches to using IT address these issues may wish to review the summary prior to reading the case. For others, it may represent a useful outline.[7]

Introduction to Case

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relatively general across industries such as inventory control. Others such as managing the IC manufacturing process are more specific to a particular industry. The focus has been to establish the firm's perception of its industry and its competitive position as well as its advantage in developing and using a software strategy. The team also contacted customers, competitors, and industry analysts to determine whether competitive benefits or impacts perceived by the firm were recognized outside the organization. These sources provided additional data on measures of competitiveness as well as industry strategies and structure. The case studies are thus based on extensive interviews by the project team on IT's use and integration into management strategies to improve competitiveness in specific industries, augmenting existing data on industry dynamics, firm organizational structure and management strategy collected from the industry centers. Further, data was gathered from outside sources and firms or organizations that had helped in the earlier project. Finally, the US and Japanese companies in each industry were selected based on being perceived as successfully using software in a key role in their competitive strategies. In turn, each firm saw its use of software in this manner while the competitive benefits were generally confirmed after further research. In the case of steel, the team was particularly aided by presentations given by the Carnegie-Mellon steel group at the annual Sloan Industry Center Meetings from 1997-99 as well as the book produced by that Center (Ahlbrandt, Fruehan, and Giarratani 1996).

[7] The questions are broken in to the following categories: General Management and Corporate Strategy, Industry Related Issues, Competition, Country Related Issues, IT Strategy, IT Operations, Human Resources, Organization, Various Measures such as Inventory Control, Cycle Times and Cost Reduction, and finally some Conclusions and Results. The questions cover a range of issues from direct use of software to achieve competitive advantage, to corporate strategy, to criteria for selecting software, to industry economics, to measures of success, to organizational integration, to beneficial loops, to training

The case begins by placing Japan's steel industry in a competitive context and then examines the governmental policies, economic factors, and competitive dynamics affecting Japan's steel markets and its producers. As Japan's leading steel producer, and the largest in the world (Appendix II), Nippon Steel's evolution, competitive situation, and current strategies are an integral part of this picture. Its situation illustrates well the competitive issues facing Japan's steel producers. As Japanese firms are being aggressively challenged in both export and domestic markets, it is critical that NSC successfully manages its planned transition to a new competitive model. This is because while it has diversified as a corporation into other areas, not all these efforts have been successful (Nagai 1998). Furthermore, steel still represents the overwhelming part of total revenues, operating earnings, and invested capital (Appendix II and Ostrom 1996).

Also, several of NSC's more successful diversification efforts, such as its entry into software and information systems (ENICOM) or engineering services are primarily based on its expertise in steel making and its continued progress in that business (Fortune 1998). NSC's organizational structure and software product choices help one understand the company's use and demand for IT. The case study describes how NSC uses IT as a tool to create competitive advantage in selling and delivering steel products. The last section summarizes the research and case study findings and identifies other potential strategic benefits from NSC's use of IT. But to appreciate IT's role within NSC's steel business, some industry, market, and economic characteristics need to be explained.[8]

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and institutional dynamics, and finally to inter-industry comparisons. These are summarized for Nippon Steel in Appendix I.

[8] O'Brien (1992) describes how "steel was one of Japan's earliest and possibly most dramatic industrial successes....The industry was rebuilt in the early 1950s, and...for the next two decades, Japan's steel output grew at an average annual rate of 15%. By 1976, the industry was capable of producing nearly 150 million tons of steel yearly and was responsible for 16% of the world's steel market share. Even in the mid-1980s, by which time Japan had lost its superiority in steel to Korean companies, Japan produced over 20 percent

The Industry Context: Japanese Steel Industry

In his 1996 review of Japanese Steel (Ostrom 1996), Douglas Ostrom describes an industry that "has been seen as an exemplar of Japanese industrial competitiveness." In deed, in the 1960s and 1970s, it was perceived globally as an industrial juggernaut that dominated the world steel industry and gave Japanese steel users, such as auto manufacturers and shipbuilders, a huge competitive advantage (Ahlbrandt, Fruehan, and Giarratani 1996 – A, F, & G). This industrial clout was highly concentrated in five domestic firms (O'Brien 1992). This competitive benefit persisted through the early 1980s due to the weak yen, and Japanese auto and heavy equipment producers, such as Toyota and Komatsu, were helped accordingly. Even during the Bubble Period, from 1985-1990, when the yen was strong, the major steel producers did fairly well due to buoyant domestic demand (NSC 1997a, Ostrom 1996, and Nagai 1998).

Competitive pressures began to shift significantly during the 1990s, however, due to two forces (A, F & G 1996). One was the emergence of several new and efficient competitors such as POSCO in Korea and Nucor in the U.S. (Fujitani 1995, Ostrom 1996 and Ahlbrandt, Fruehan &Giarratani 1996). The second was the serious decline in domestic steel demand as the Japanese economy felt the combined pressures of the Bubble collapse and a continuing strong yen (NSC 1997a and Appendix II). As seen in Appendix II, these effects were only somewhat ameliorated by growth in steel export demand due to a rapidly expanding Asian economy (Fujitani 1995, Nagai 1998, NSC

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of the world's steel exports." See A, F & G (1996) for discussion of impact declining steel demand in late 1970s and early 1980s on all producers globally.

1997a). While steel production hit an annual rate of 110 million tons toward the end of 1991, it subsequently fell 15 million tons due to the Bubble collapse of which only 5 million of this was covered by increased Asian demand (Fujitani 1995).

While some firms have tried to solve the problem of declining demand by just further rationalizing production, reducing their labor force, and diversifying into new products (Fujitani 1995, NSC 1997a, and Salomon 1997), the reality is such that solutions generally can and have been replicated by competitors.[9] For example, while the total employment of the five large Japanese integrated producers fell from 150,000 in 1985 to 90,000 in 1995, similar drops were posted by the top 5 US integrated producers, which fell from 150,000 in 1985 to 77,000 in 1995 (Fujitani 1995). Indeed, NSC continued to decrease its steel workforce from 32,344 in 1995 to 26,275 in 1997 (NSC 1997a) and then to 24,000 in 1998 (interview ENICOM). While employment reduction helped NSC maintain competitiveness, this tactic did not really raise production at its domestic mills. Because price and cost declines were generally emulated by competitors, there was no increased demand for NSC's products.

Therefore, several Japanese steel companies, including NSC, began to sell some of their remaining stock and other appreciated assets to cover operating losses (NSC 1997, Harada 1998 and Appendix II), just as the Japanese banks and some other large Japanese manufacturers, such as Nissan have had to do. However, there was no real business benefit from this action since it just diminishes the actual "hidden" reserves

[9] See Appendix II "Cost Reduction Efficiency Indices Major Japanese Producers 1994-98 (Average 1994=100)" where cost reductions of 6% by NSC are shown as being replicated by other large integrated Japanese produces. Similarly, weak Yen benefits that helped all steel producers from 1980 to '85 but came to an abrupt halt in October 85 with the rapid Yen appreciation due to the Plaza Accord, resulted in the same US FDI increase by all producers (Ostrom 1996). The logical strategy for each was affiliation through technical assistance and partial or complete acquisition.

while doing nothing to improve competitiveness in steel (NSC 1997 and Appendix II). It was only a temporary solution to cover losses, not a long-term strategy to address the basic problem of a global commodity industry with large swings in demand and price, often driven by foreign exchange rates, with little relation to the industry's efficiency.

For Japanese producers particularly, trade and international competition now play a much larger role than before in determining profitability and the demand for Japanese steel in domestic and export markets. While exports have been an important demand for Japanese integrated producers since the 1960s (O'Brien 1992) and continue as an area of intense (even acrimonious) negotiations with the US, gone are the days when Japanese firms were always the low cost producer (Harada 1998, Tilton 1000, O'Brien 1992), or could constantly move into higher grade steel.[10] Rather, a strong or weak Yen relative to the dollar or currencies tied to the dollar will drive prices for Japanese steel both overseas and domestically (Ostrom 1996).

This is because imports into Japan from Korea are particularly sensitive to this situation, having grown from 647,000 tons in 1980 to 2,596,000 in 1996 (NSC 1997a). Further, Japanese auto producers and shipbuilders, who indirectly compete with less expensive steel from Korea, Taiwan, and Brazil when the yen is strong, will pressure Japanese steel producers to reduce prices during these periods. For example, in early 1997, prior to the Asian Financial Crisis, K. Yoshida (Salomon 1997) describes this situation at some length in assessing the competitive and revenue outlook for Japanese producers. At the time he was optimistic for Japanese steel producers, given his

[10] JEI (Choy 1999) and articles in Japan Times (October 99) describe current trade (dumping) controversy between US and Japan over seamless stainless steel pipe, a very high technology product used mostly in nuclear facilities.

expectations of continued economic strength in Asia (and thus growing steel demand), coupled with strong Asian currencies other than the yen (Appendix II).[11]

That this expectation did not actually materialize due to Asia's economic collapse (which started in Thailand), does not change the validity of his observation concerning how external demand and exchange rates impact Japan's steel industry.[12] Indeed, Mr. Nagai, of Morgan Stanley Dean Witter, made a similar argument on how a weak Yen could potentially help the profitability of Japanese steel producers (Nagai 1998). This is because he expected, in mid-1998, that an Asian recovery would reverse the weakness seen during the first part of 1998, when a very weak Korean Won and the Asian Financial Crisis kept this potential impact in check (Harada 1998).

Given these conditions, it is very difficult for Japanese integrated steel producers to anticipate either prices or demand. Also, such international pressures have been exacerbated by Japan's continued economic weakness that limits demand generally. Therefore, other large Japanese corporations are not building or expanding capacity either. The net effect has been that NSC's steel assets and revenues have been essentially constant since 1993. Added to these considerations is the assessment of some observers that Japan still has too much steel capacity (A, F & G 1996, Harada 1998a, and Tilton 1999). For companies like NSC to rationalize operations further and shut down more blast furnaces, however, they must concentrate a wider product range in fewer mills (Fujitani 1995).

[11] For contrary views on constant downward price pressures on steel producers, see Tilton (1999) & Ostrom (1996).

[12] In 1998 Nikko's Mr. Harada (1998a) expected 1998 steel demand to be 95 million tons down from 102,8 million in 1997. Also, he expected exports to the US to fall due to a stronger Yen and US anti-dumping pressures.

Given this combination of factors, it is hardly surprising that steel producers have turned to other opportunities and activities to try to develop new, more profitable business. Included among these are non-steel products such as semiconductors, engineering, and even amusement parks. Indeed, this focus on new products and businesses has led steel producers into both acquisitions and affiliations (NSC 1997a, NSC 1997 and Fujitani 1995). Some of these examples are: NSC's Singapore-based semiconductor JV with Hitachi, Sumitomo Metal Electronic Device's JV with Read-Rite, and Kawasaki's investment in LSI Logic Japan. Indeed, all five producers have semiconductor divisions (Harada 1998a). Their performance, however, has been affected by fluctuations in both DRAM demand and exchange rates (Nagai 1998 and Yoshida 1997). Like steel, DRAM production is just another globally competitive cyclical business, where profitability is subject to exchange rates. Thus it is not clear that this or other diversifications have been so successful (Nomura 1998 and Ostrom 1996); nor have these new activities reduced exchange rate exposure. Moreover, after several years, steel remains overwhelmingly the large Japanese integrated steel producers' basic business, either directly or indirectly, via engineering, or in the case of NKK, ships as well (Appendix II).

Recognizing this situation, Japanese integrated steel producers have tried to raise the value-added in their products (Ostrom 1996). They have also participated in the global proliferation of new steel capacity and the emergence of new competitors, through a wide range of acquisitions and affiliations, and by selling engineering services (A, F & G 1996). Ventures in the US alone include 3.5 million tons of galvanizing and coating plants, such as Kawasaki and Armco's 50/50 operations, NSC's two plants with Inland,

Sumitomo's two 40/60 facilities with LTV, Kobe Steel's with USC, Nisshin's two 64/36 operations with Wheeling Pittsburgh, and NKK's JV plant with DOFASCO (Fujitani 1995). More specifically with respect to NSC, in addition to its relationship with Inland, it directly participates in steel making ventures in China, Thailand, and Malaysia (NSC 1997a). It also announced in March '99 that it would be purchasing a 33.8% stake in POSCO [Pohang Steel] (Goldman Sachs Japan Research 1999).

However, as just explained and illustrated in the above examples, almost all the large integrated steel producers have sought similar solutions. Given the same business and economic environment, they have responded similarly in terms of geographic or business diversification possibilities, and to trade pressures and cost reduction initiatives (Harada 1998a and Ostrom 1996). Thus the latest round of announced and prospective rationalizations will once again raise the issue of tit-for-tat cost benefits that will be quickly competed away as has happened before (Appendix II).[13] It is for this reason that

[13] In 1995 Mr. Fujitani (1995) of NKK noted that all "the five major Japanese steel companies have targeted cost reductions totaling 930 billion yen in 3 years from 1994. (NKK's target is 175 billion yen). Cost reduction measures include first, reduction of employees eliminating multi-layer management (about 25,000 employees) through a 25% cutback of white collar and 20% cutback of blue collar employees relying on substantial incentives for early retirement and relocation to subsidiaries: second, cutback of capital investment to 30-40 % of traditional investment; third, drastic reconsolidation of manufacturing plants; and fourth, reconstruction or readjustment of diversified businesses and more concentration on core businesses." Similarly NSC reported in its 1997 Annual Report (NSC 1997) that during its third Medium Term Business Plan for FY 1994-1996, it reduced annual steel division costs by 300 billion Yen. In addition, during 1996 it implemented "a new strategy designed to precisely respond to market trends under a single, unified system integrating by product, the whole of manufacturing, marketing and research and development resources."

These cost reduction strategies take account of the "multipart" process noted by Ostrom (1996). "In an integrated plant iron ore goes in one end of the mill, and finished steel products come out the other. Hence, steel makers need a variety of raw and intermediate materials, such as iron ore or steel scrap, as inputs. In Japan these account for three-quarters of the cost of producing a ton of steel. At least for an integrated plant, steel companies also need massive amounts of capital. A plant with an annual capacity of 3 million metric tons of crude steel requires around $5 billion in capital; this accounts for about half of the remaining cost of production. By contrast, labor costs are relatively modest and comprise about one-third the costs net of raw materials and intermediate inputs. The 10 percent share of total costs accounted for by labor in the steel industry contrasts with the 25 percent share paid to labor in the case of labor-intensive industries, such as precision instruments."

NSC recognized in 1996 that another strategic approach was required to address the cyclical nature of the industry, the increase in global cost-based competition, and periodic excess capacity. Otherwise, the firm's major business and the company would continue to be a toy of exchange rate fluctuations and global economic fluctuations (Harada 1998a and Fujitani 1995).

Therefore, the strategic problem in integrated steel, as in many other areas, remains how to differentiate one's product and services, including new ones, from those offered by competitors, while creating a lasting competitive edge in an increasingly competitive environment, both domestically and overseas. This strategic issue is especially critical in steel, given even more competition for the available markets from expanding competitors. These competitors (can) include mini mills in the US and Japan, such as Nucor and Tokyo Steel, or new integrated mills in the NICs, such as one recently announced for Malaysia. The competitive field is therefore increasingly crowded with Japanese and foreign firms of every description. Nevertheless, if one can succeed in the objective of efficiently selling existing and new customers a wider range of specialized or custom products, then cash flow should improve as sales and earnings increase. This is the key strategic issue NSC has been facing. Their solution has been to develop a customized production and marketing strategy that can efficiently offer customers such an expanded and customized range of product and service options.

Historically, and currently, under the guidance of MITI (Ministry of International Trade and Industry), the Japanese steel industry has done many things cooperatively (Ostrom 1996; A, F & G 1996), including sharing new technologies (e.g. continuous casting) or negotiating coal contracts (e.g. with Australia) [O'Brien 1992]. In addition,

all domestic orders for both product and raw materials are handled through the Japanese trading companies. This is because as O'Brien (1992) explains, "the over-riding principle guiding MITI's policies was that to succeed internationally, the industry had to minimize its manufacturing costs. To do this required large scale plants, high throughput and modern technology." But this kind of overlap and industry integration has complicated NSC's strategic problem as a single firm: differentiating its products and services from its Japanese competitors' in terms of kind, quality, or price in a way that cannot easily be replicated (footnote 9).

Nippon Steel's Multi-faceted Steel Strategy

NSC is very much a part of this competitive and economic environment. While its financial situation remains strong (Appendix II) with 1998 revenues of about 3 trillion Yen and operating earnings of 180 billion Yen, it has still suffered from stagnant sales for several years. Further, though its free cash flow is among the best for global producers, it has experienced wide fluctuation in pretax and after tax income. In addition, it has been forced to draw down its hidden stock reserves to cover periodic operating losses (Appendix II). As a result, NSC has not been able to translate its larger market share and operating efficiencies into a meaningful and long-term strategic benefit (in terms of man hours and expenses per ton relative to other Japanese producers as well as compared to several large foreign producers (Nomura 1998)).

NSC thus recognized about 5 years ago that it needed to develop a new strategic initiative. The needs were to reverse and improve the downward price and stagnant

demand trends in its steel business as well as to safeguard against the emerging competitive developments.[14] Further, given the evolving economic and competitive context for steel companies explained above, this strategy had to address certain fundamental conditions. It had to use NSC's existing steel making capacity; it had to accept the existing relationships with the trading companies and other Japanese or foreign steel producers; and it had to establish a competitive advantage relative to other producers. The strategy NSC has developed appears to meet these conditions and depends on three basic aspects of its business.

One is its diversified steel making capacity and trained labor force. The second is its new e-commerce and customized casting marketing and production strategy, and the third is its sophisticated use of IT to economically rationalize and manage production and inventories. Though it is very difficult, NSC makes a particular effort to manage and analyze the complex information related to all aspects of its business. It is able to differentiate its products and client support from competitors', and to retain its customers and product/market competitiveness on a long-term basis. It has coupled this approach with an effort to integrate sophisticated data management at the order and corporate level (order allocation and accounting) with an IT system that also links the head office (HO)

[14] Major Steel Products – Out of a 103 million tons of steel products produced in Japan in 1995 and 1996, about 93 million ended as finished steel, split between ordinary (78 MM tons) and specialty (15 MM tones) products. (The total included finished exports of about 22-24 MM tons.) About 53 million tons was hot and cold rolled products, including plates and sheets (coated, finished and uncoated). Both domestically and for export, automobiles are the largest user of high quality sheet followed by appliance makers. NSC's domestic share of the 11 major Japanese car manufacturers is 40% and of the 8 major appliance makers 44%. It also has about 38% of Japan's capacity to produce these products (NSC 1997a and Harada 1998). This is more than twice the next largest producer, NKK and 50% more than its share of total Japanese steel production. Out of NSC's total steel sales in 1996 of 1.7 trillion Yen, 1.1 trillion Yen were flat-rolled products (NSC 1997a). Therefore, NSC's strategy of concentrating on areas such as appliances and automobiles through customized casting and e-commerce appears to be one that enhances its position in a market where it has a strong existing competency. This is consistent with Ahlbrandt et al's view that all steel producers in "today's steel market" can only succeed by choosing "markets where they believed it

strategy with the production management system that enhances the productivity of each mill. The object is to improve customer service, NSC's pricing policies, and its production flexibility. In this manner, NSC is using IT to achieve a result that meets its strategic business goals for its all-important steel business.[15]

One outcome of the global proliferation of steel products' users and providers has been that the relatively simple structure of Japan's steel industry is changing rapidly from the consumers' and producers' viewpoints. Previously, if you wanted to buy steel from a Japanese producer you placed the order for a standard steel product through a Japanese TC. They placed the order with a steel producer, and the steel was shipped to either a domestic or export location. As explained by Tokyo Steel, for many standard products such as construction rebar, this system continues today. For each standard product option, there is in fact a clear set of suppliers (Harada 1998). However, for many other products, such as the wire used in a bridge (Fortune 1998) or the sheet used in many automobiles and appliances (NSC 1997a and NSC 1997), the quality or product produced is made to customer specifications, a more customized approach. While naturally there has always been some product customization for particular projects, this has generally been on a case-by-case basis due to higher cost compared to buying the off-the-shelf predetermined industry standard. This is the tailor-made suit versus ready-made suit

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was possible to create and sustain a competitive advantage" and by using "technology to help secure and maintain market position."

[15] NSC's new strategy initiated in 1993 is well articulated in a report from Nomura (1998). Here the analyst notes that Mr. Imai, NSC's president, "would not tolerate any more loss of market share for crude steel and that there would be no more temporary shutdowns of production facilities;...its primary goal in the steel business to be operational at full capacity, rather than an ability to withstand production cuts...Second, Mr. Imai instituted a system of product-specific cost management. Steel materials were divided in 59 separate types, with costs managed on the basis of a matrix system that also tracks total costs at each of the company's 10 mills. The system also enables management to keep abreast of the cost-earnings situation for individual orders. Third, division managers were given more responsibility. Previously, major decisions

paradigm that is firmly entrenched in the mass-production revolution that transformed the world economy during the 20th Century. What NSC's strategy aims to do is to bring the steel business within the lean-production paradigm and then extend it into the emerging controlled production paradigm. The difference between this "Custom Made" approach and that used by other steel producers is presented in ENICOM's Briefing (1998a). It specifies that NSC's "all customer support" leads to "more frequent status reports, on-time delivery and more categorized products" that improve customer satisfaction. Conversely, Tokyo Steel's "commercial usage" is for "ready made sales." But given the "Data Explosion" that is a direct function of the former strategy, NSC could only accomplish it through an "integrated, multi-layer customized system."

Under the original mass-production paradigm, Henry Ford said one could have any color car one wanted as long as it was black. Nothing would disturb his totally integrated production system. Sloan and GM then established how a firm could achieve economies of scale through common parts and platforms but still deliver greater variety. This is currently where most world steel producers are situated. They can provide a wide variety, indeed thousands, of standard steel products by making a common material and then processing it into a product that can be inventoried in response to expected demand. About 35 years ago a new production paradigm – lean production – was developed by Toyota. Originally conceived for automobiles, lean production was then extended to other assembly-based manufacturing, lean production (Womack, Jones, and Roos 1990).

Using lean production techniques Toyota and other manufacturers have shown that a firm can produce an infinite variety of products on the same assembly line with no

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had been left to senior management... The company has set its sights on gradually increasing its share of the steel market, strengthening its balance sheet, and spinning off businesses."

loss of efficiency. Indeed, one problem lean producers faced in the early 1990s was that the very power of the system to produce such variety costlessly led firms to offer the consumer too many options. This then became an inventory and timely replacement problem. Lean producers have thus voluntarily reduced the number of options or degree of customization offered. However, because lean production does tie production directly to consumer demand, it is inherently cheaper and better meets customer needs. It has therefore become the dominant manufacturing paradigm in autos and similar industries such as appliances.

NSC would no like to apply this strategy to steel in two ways. The first is to offer and respond to customer demand for more customized steel products (tailored to a particular end use or customer product design) without the cost premium that would have previously been required. Secondly, it would like to become part of lean producers' design, just-in-time, consumer-driven production paradigm (Womack, Jones, and Roos 1992). An obvious potential example of this would be having specific steel sheets tailored to a particular model car of appliance. This would mean Japan's steel users and NSC would work together at the customer's product design stage. NSC would then become an integral part of that customer's production system. If we use an example, such as Toyota's JIT production, we can see how the requirements needed to meet these objectives are, in turn, driving several aspects of NSC's evolving strategic initiative.

One. NSC must explain the benefits of its customized casting e-commerce approach to new products as compared to those being provided by the alternative standard product providers. Two. NSC must significantly reduce its product delivery and cycle times for such products, if JIT delivery needs are not to escalate in-process and

finished inventories. Three. Customers must be able to track their JIT orders so there is no disruption to the clients' own finely-tuned production schedules. Four. NSC needs a sophisticated accounting system that can accurately assess the cost of mass producing such customized products. Five. NSC must have a way to allocate production of the increased product variety between and within mills. Six. Inventories of replacement-part steel for such customized end products and uses must be controlled and competitively, but accurately, priced. Seven. Customization should add value or reduce customer costs as a trade-off for price stability and a single source supplier, as has been true for auto parts suppliers (Womack, Jones and Roos 1990).

It is with such factors in mind that NSC set out five years ago to develop its E-commerce, customized casting, and product accounting systems. It then combined these with a flexible IT managed production system that would permit it to deliver customized products as cost effectively as the traditional approach of producing to a predetermined set of industry standards. Thus, the primary strategic drivers have been the customers' demand for more tailored steel products at a low cost similar to their own ability to produce variety at no extra cost. Further, it is in terms of these goals that NSC has developed criteria for selecting software and measuring the success of its IT systems.

As NSC has developed its plans to offer greater variety and customized products at little or no premium, its goal has been to determined how it can best produce these products while rationalizing its existing mill capacity. This means efficiently producing a larger product variety in fewer mills. It would also like to do this in a way that retains and expands its customer base so competitors cannot just take the business away on the basis of price. So a critical aspect of management's strategic thinking is to build

sustainable competitive barriers between customers and the wider competition, based on NSC's core competencies. Only in this way can it maintain profitability and avoid the global "excessive" competition (Rapp 1999) typical of this cyclical industry. It will also help them in dealing with US dumping allegations since customized products will be less easy to categorize and will be less subject to price pressures, especially if those products are tied to large customers' JIT production systems.

NSC's strategic solution has been the e-commerce customized production model incorporated into a continuous order-to-product delivery system. The stated strategic aims in implementing the new system are to automate and rationalize the order and mill production allocation system. Simultaneously, the goal is to become more involved with its largest customers' evolving and growing set of steel requirements that change with clients' new product developments or model changes. The key for NSC is tracking and being involved in these changing needs by individual customers. This can be effected by becoming part of the design process and then producing and delivering the appropriate steel products while developing and changing the steel in ways that are responsive to advances in steel making technology (including using IT) and its customers' evolving requirements. Further, NSC needs to know how valuable customized production is for particular customers and, therefore, how easily it can retain them on a long-term basis. For example, if lighter corrosion resistant steel reduces warranty claims and helps auto firms meet fleet mileage requirements, then this steel will add value that will more than compensate for a higher price and customization. Further, if NSC can reduce delivery times, it can better meet JIT requirements. Knowing the most effective way to market

and deliver its customized product capabilities involves complex issues that vary by product and customer group, requiring thought and data.

Since NSC is very conscious of the expense of producing and delivering its products to different customers, it has developed, as part of its strategy, a new accounting system to identify fairly specifically different customer groups and the particular costs of delivering any product to them. These categories are not broad, such as all auto producers or even just Toyota, but are well-defined with respect to a given steel in a specific quantity delivered to a certain plant or subcontractor. However, because NSC still relies on the TCs for orders, its approach is somewhat different from a normal parts supplier that might be part of Toyota's keiretsu (Womack, Jones and Roos 1990). Nevertheless, NSC closely analyzes the production and delivery costs for an individual product to try identify the best production approach, first by plant and then by schedule within each plant. In this way it expects to couple the E-commerce software system with NSC's new internal accounting system and optimum production allocation system to lower steel production costs for the firm as a whole. This is a kind of iterative expert system based on an analysis of its own "best practice" operations.

At the same time, NSC recognizes that its leading customers are being targeted by other competitors. So competition for such customer business will continue to be fierce. Indeed, this is a primary driver for the new customized product approach. But for the strategy to be effective, NSC must gather and manage a wide range of information about its clients and potential customers so it can offer them customized products in a timely and cost-effective manner. Making the strategy work, therefore, requires NSC to

efficiently track its large customer base and huge order volume in terms of individual needs, and then to deliver products to that base efficiently and profitably.

As already explained, NSC has spent considerable effort in evaluating costs and also in increasing productivity. Indeed, it believes its new strategic approach is good at combining cost containment with revenue enhancement. Further, NSC's management recognizes that this approach has become even more important as old and new competitors add new steel making capacity. (See footnote 15 and Appendix II.) This is because increased competition will put pressure on prices globally, especially when economic activity is depressed. So it has become very important to target customers with specific product needs that are not easily matched with current standardized specifications.

A critical aspect of NSC's approach to this situation has been to increase the independence of its mills through IT by incorporating most of what the customer and head office (HO) need to know in the E-commerce and new accounting systems (Dazai 1997 and ENICOM 1998). This includes direct links to the central information system. The basic information infrastructure for allocating production is controlled by HO, which now considers the total cost of producing and delivering a product in deciding mill allocations. Previously, the allocation was based on a given mill being identified with a particular set of products. However, as more production is now concentrated in fewer mills that can produce a wider variety of products, this process is much more complex than before. In effect, each mill's cost of producing and delivering an order for a particular customer must be assessed in advance, using the new accounting system while

optimizing total mill usage. In this way NSC's sophisticated IT system works to allocate orders and control costs.

Further, as the new IT system is constantly being revised based on the observed "best practice" of its mills, the system is constantly improving the consistency, performance, and productivity of the mills and NSC's overall production efficiency. In practice, based on HO's allocation analysis, each mill receives orders from HO that have been sent by the TCs. Under the new E-commerce system, this will all be done in a common, preformatted manner compared to the old system using individualized faxes. These e-orders incorporate all aspects of the steel order, including the appropriate delivery schedule and location (Dazai 1997). The client, in turn, is able to immediately track the order elect4ronically, as it moves through NSC's production system, so that they do not need to call or contact any individuals at NSC (Dazai & Maruyama 1997).

The customer can therefore know where various products are in the supply pipeline and the expected delivery dates. Prior to launch, the system was extensively piloted with the major Japanese appliance producers and the trading companies to assure that both steel producers and customers could easily understand and respond to its nuances (Dazai 1997 and Dazai & Maruyama 1997). This is because the system's effectiveness depends on a symbiotic integration of steel producer, trading company, and user. Once an order is made, NSC's HO sends it electronically to the designated mill that they have selected based on their cost assessment using the new accounting system. Thus through direct marketing and electronic means, NSC has found it can build a structure that will support a long-term customized customer relationship. So far the system has improved not only product delivery but has also lowered costs. The system achieves

these results by: simplifying deskwork and order tracking; reducing and speeding paperwork; eliminating redundant inputs (faxes); confirming and allocating the order at its inception; and by adding value through supporting each mill's optimal functioning. This simplification and improved data processing also extends to after-sales services, such as invoicing, account management, and inventory control for replacement part steel (Dazai & Maruyama).

Because the newly trained sales-force and automated support system are cost intensive (Dazai & Maruyama 1997), the costs are subject to user-base economics (Rapp May 1997 and Gurley 1998). That is, each additional user reduces the cost of delivering products to others by spreading the fixed systems costs over more and more users. This favors e-commerce between large enterprises first, with smaller firms becoming associated later, though they must yield first-mover advantages to the bigger enterprises. Success in this area is thus subject to a beneficial loop of increasing returns and greater profits. A clear indication of the benefits to the NSC of this strategy has been its ability to close some of its mills and further reduce staff without any loss in efficiency or production capabilities. This should give it significant cost and operating profit advantages at a time when corporate earnings and revenues are under pressures (Appendix II). Importantly, the steel analyst at Nikko was aware of what NSC was doing in terms of E-commerce, IT, and the accounting-based mill allocation system, and felt that such efforts definitely improved NSC's competitive situation (Appendix II).

NSC's management's approach is dynamic in that they are constantly adding to the number of products and services the mills can deliver, as well as to the required IT support. This is part of the constant strategic upgrading and development of the

company'' IT and steel production system that has allowed it to increasingly shift towards higher grade steels and now more customized products (ENICOM 1998a). The driving basic decision criterion, in this respect, has been to: enhance the mills' capabilities with systems and machines, expanding the capacity of the system and reducing costs, all through extending the use of electronics and in turn mill capacity (NSC 1997a).

Management always keeps in mind NSC's customers' various and shifting needs, so those customers feel helped by the shift towards more tailored products and the new E-commerce ordering system. This was one reason for the extensive piloting of the system before its launch (Dazai 1997 and ENICOM 1998a). It is also one of the reasons why they have continued to modify it, since its introduction, according to trading company and customer feedback. The objective is to make the sales approach more congenial and user friendly, while getting the customer to accept the e-commerce approach to doing business, since this means clients (other than appliance makers) will use it for their orders. This is critical since NSC's strategic success depends on clients appreciating the system's benefits and expanding the user base. One clear advantage is that it is now easier for NSC to deliver products produced by joint-ventures or affiliates.

Information Technology Infrastructure and Project Selection

NSC's basis information system is a typical Japanese "three-tier" mainframe system similar to most other large Japanese companies (Rapp 1995 and ENICOM 1998).[16] The mainframes manage a series of servers that manage the PCs and

[16] The mainframe (IBM) controls servers that control the networking system and communicate with each mill and its equipment. The mainframe has the task of scheduling production and operations as well as

workstations.[17] In addition, because it is a real time on-line system, it has been totally integrated with NSC's own business operations, as is typical of most large Japanese firms. But NSC's customized mainframe system is large, even by Japanese stands, involving over three billion lines of code (Rapp 1995). It is completely managed and maintained by ENICOM. Internal communication depends on NSC's own fiber optic system and its own customized middleware that provides the interface or bridge between different users within NSC.

In addition to reducing paperwork, the improved systems and communications have facilitated order tracking and processing, improving customer satisfaction. The clear objectives of speeding communication, improving mill productivity, and increasing client satisfaction have enabled NSC to select, develop, and use the software required for each function, and to integrate it into the support system. This is because it is relatively easy to measure whether these objectives have been achieved. Except for the operating systems, NSC has generally developed all its own software and IT systems. About 150

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tracking orders. The next system project is how to use the accumulated information to improve the system and its competitive impact.

[17] NSC uses a client server system but the client servers are 70% mainframe, though physically the mainframes are getting smaller as is the disc-storage space. These can now store 100 gigabytes of storage in a fairly small box. NSC's system has 1.3 billion lines of execution code and the total lines in the system might be twice that. So this is a huge system. In turn, each plant has its own IT systems division since each plant has its own unique operation in terms of what it is producing and the capacity it has to produce it. In fact each plant decides it own actual production once it has been assigned orders by head office. So how much each plant produces is related to these assigned sales. On the map received from the HO each black dot is a steel mill and the triangles are offices. This means there are many many systems within the overall system and most of these are IBM. But NSC also has several UNIX based workstation systems, and many employees also have personal computers that are using Windows and Windows NT. Altogether the HO systems group has 8000 clients within the company.

The main issues for all these systems, particularly those related to production, is that steel plants must operate continuously: 24 hours a day, 7 days a week, 52 weeks a year with no real shutdown (O'Brien 1992 and A, F & G 1996). Thus at the Kimitsu works NSC has fault tolerant Tandem computer to insure continuous operation. The process begins with the flow of orders coming from the trading companies. These companies track their major customers' inventories, production requirements, etc., and place the orders with the steel companies for a certain kind of steel. Traditionally these orders have come into head

people are working in its internal Information Systems Division and another 2,400 in its captive software subsidiary ENICOM. Most of its EDP needs are purchased from ENICOM, and these purchases account for about 50% of ENICOM's revenues (footnote 20).

Outline of Systems Use at NSC[18]

Everything starts with demand (juchu) and the orders from the trading companies that are given requests by their related keiretsu firms' demand for steel. This is NSC's demand network. The PP or Production Program (SW system) is designed to support this demand. The Head Office (HO) Administration or (Honsha-kei) decides what systems are best to use within the HO and the company as a whole. The plants decide what is best within each plant to support that plant's particular production system and especially SW related to controlling specific equipment. So, in fact, there are a series of separate systems whose procurement and development are decided by different people but which are close to the software's actual use. NSC's head office financial system keeps track of the results determined by the data emerging from these basic systems. All the systems are interrelated, so that even though overall it is complex, it is still integrated. The order receiving system is probably the most complex within the overall system.

As the steel orders come from the network of Trading Companies (TCs) to HO, it is HO that is responsible for its design. Using this system, the computer decides which mill should produce the order. Since all equipment is automated, delivery and shipment

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office by fax. They are then assigned to each mill based primarily on geography but also on capacity and ability to produce. So as of 1998 the new automated order system was just coming on-line.

are included in this determination. The financial system relates the material and equipment used to produce the steel in order to calculate the cost of production, shipment, and delivery. So the whole order is assessed in advance, from order through shipment and delivery. While there is some human input as it relates to personnel and NSC's personnel system, the raw material purchasing and equipment usage/maintenance are all done by the computer. ENICOM, NSC's totally owned IT subsidiary, is the one that has developed this total system and the related software. Modifications and additions to the system are decided by HO and each mill according to their individual areas of responsibility, i.e., core competencies. At the plant level, the mill manager can make this decision unless the new system or change is very large or could impact the whole system. Then it must come to HO. Thus, control depends on size, amount, and impact.

HO has responsibility for all changes and systems relating to sales or financial issues. Even within the Head Office group, though, there are limits to budget authority. The General Manager of the group can decide up to a limited certain amount. Above that amount, the decision goes to the Managing Director in charge of systems and information technology, and, if it is a very big amount and has an impact on the entire corporation, then it may have to be decided by the President. These latter situations are very rare, but one example is the new corporate-wide accounting system that NSC is using to determine the cost of alternative production options. Another example is the already described on-line E-Commerce ordering system involving the trading companies. This latter system is very complex and involves all aspects of NSC's steel production, including sales, orders, receivables, HO finance, accounting, personnel assignments, and purchasing. Purchasing

[18] Based on briefings with Nippon Steel's Head Office (HO) Systems Group and ENICOM July 1998.

is divided into materials, equipment, and payables including third party expenses, like paper and office supplies.

The HO IT group's interaction with ENICOM is on several levels since they are administering the overall ENICOM relationship, including monitoring the interaction between ENICOM's regional offices and the mills. At the same time, this group works directly with ENICOM on certain projects like the new accounting system. In all cases, NSC assigns both a budget to the project and a project team. That is, ENICOM never works in isolation from NSC, ENICOM in turn assigns its teams as well in consultation with NSC. The group at head office then checks with the project team periodically to make sure it is on track. Then, when the projects gets to the point where it is ready to proceed, HO first checks and tests the new SW's implementation on a trial basis, before it is actually incorporated in to the overall system, since NSC does not want any crashes. If the budget is over-run, then this is the responsibility of the general project leader who comes from NSC, the user side. ENICOM is only providing technical systems expertise and is not responsible for the entire project. This remains with NSC. Such over-runs do not just happen in a vacuum since the HO group requires regular progress and budget reports at least once a month in order to monitor the project's progress. If a project is behind schedule or is over budget, the HO group looks for the reason and whether it is the responsibility of NSC (the user) or ENICOM. The HO IT group then talks to the user or ENICOM, as appropriate.

If the problem is with ENICOM, HO does not get involved except as to identify the problem. The HO IT group looks to ENICOM to solve its own issues on the computer side. This is ENICOM's area of expertise and responsibility. To this extent,

ENICOM operates separately and independently of NSC, even though it is a wholly owned subsidiary (Appendix II). Currently, the HO group has some small projects on which they are working and a very small number of large specific projects, such as the new cost accounting system. They have tried to do a few BPRs (Business Process Reengineering) within the financial division, but are not doing any now. (The case writer received the impression these efforts had not worked well.)

In reality, during 1998, the new accounting system absorbed most of the HO IT group's time and effort. This is a very complex and expensive effort (several billion Yen), since before, each mill had its own system, whereas now, NSC is trying to apply a common standard to all mills. The purpose of this is to enable HO to assess each mill's cost of producing and delivering various products on a comparative basis. As all 10 mills will change to the new system simultaneously, this is a big effort involving the entire steel making operation and HO. There are two main components to the system. One is a "parent-only" system, and the other is an internal accounting system. Both are operated by ENICOM for NSC. Each mill has its own computer managing this system with the main computer at ENICOM's office. NSC leases a high-speed line from NTT to connect ENICOM with each mill and the sales offices. (ENICOM actually is the one leasing and it, in turn, provides a lease to NSC.) NSC HO has its own line that is connected directly to ENICOM. The whole operation is viewed as a VAN (Value Added Network) by MPT and is thus classified as a second class telecommunications carrier.

NSC's e-mail or (Shanai) inside the company uses this VAN system, as does its internal website. However, company personnel use the Internet for news and external e-mail, and the external web-page is what provides information to people who want to

assess the company externally. This separation is due to security issues and not everyone inside the company has access to the internal website or home page. To try to upgrade the integrity of the system. NSC has just bought a new security handbook. However, from a total corporate perspective, the biggest issue facing the firm is actually steel production consolidation in fewer mills. This, in turn, is forcing the integration of production, accounting, and purchasing that has previously existed as separate systems. When each mill was associated with a particular set of products, each one had its own IT system. But, consolidation means fewer mills produce more products with more complex specifications. This is forcing NSC to replace the system that has been working well for ten years. This decision has technological and eventual cost merit, but is still very expensive.

Such complex, expensive systems are why the HO IT group together with other IT groups and ENICOM follow a specific procedure when introducing a new system, whether for the company, a mill, or a function. First they specify the proposed merit of introducing the system or change. This is on a case-by-case ad hoc basis and is promoted by the users within NSC to meet a specific current or expected need. The HO systems group or ENICOM do not introduce it. Once the real benefit has been determined, the HO group creates a special team to develop and manage the introduction of the new system. (This is not a special procedure but is the procedure as each case arises.) As noted above, this includes ENICOM and the user's group. These groups then determine a work program and a proposed budget. If it is a big project with a big budget, they create a special review committee that includes an NSC director who will judge, usually on a

quantitative but sometimes qualitative basis, whether the project's merits justify the budget expense.

It is this approach that has resulted in several major business improvements through the use of IT. NSC has gotten better at projecting demand through a bottom-up (micro) rather than top down (macro) approach. Before it estimated economic growth and how much steel was likely to be demanded. But given the need to produce a wide range of customized products, management recognized they had to do a better job of forecasting specific user demands to estimate the effect on certain equipment and mill capacity. So better networking with users was required, especially if NSC was going to have to adopt improved JIT interfaces without over-expanding inventories. Furthermore, since the collapse of Japan's bubble economy affected various industries differently and, even within industries, affected specific products differently, NSC needed to be more attuned to such demand differences. (An example of this is that the steel demand related to Lexuses and Landcruisers has been different from the demand for Corollas).

This is when NSC began to negotiate with the car and TCs to develop better steel demand forecasts and ordering systems. Sheet inventories for automobiles and replacement parts have been particularly critical in this regard. Yet, NSC could not just push this issue on to the TCs, even though they are the only channel to the steel companies for physical delivery and so handle the buffer stocks. This is because shifting inventories do nothing to reduce the overall delivered cost of the product. Further, TCs are just service companies that do not forecast but, rather, meet specified customer requirements as they exist. Therefore, to change the system, NSC had to work with the auto companies directly to estimate the actual new production and replacement parts

demand for cars. The objective was to reduce the steel inventories required for each car and part type. This it can now do using a sophisticated IT model and database.[19]

Implementation of E-Commerce and Customized Casting Strategy

In July 1998 the Sloan study team received a briefing at the Kimitsu works on the introduction of NSC's new e-commerce strategy and its implementation in terms of customized casting. At that time, NSC's management reported that they had developed 100% of the system themselves along with ENICOM NSC's captive subsidiary. They did note some client-related issues, however, concerning the new system and security. Furthermore, these issues will become more of a problem as the company uses the Internet more for e-commerce and other purposes, potentially exposing its database to unauthorized access. Already with 20,000 employees access to the corporate database is a difficult situation for both the firm and the employees since the latter need information (data) about NSC's customers and orders to do their work.[20] Security and authorized access will multiply when clients and suppliers need information on the database too.

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[19] In the case of the US, SW transactions are usually handled directly with the end buyer and the systems group is not involved. This is also true of the relation with Inland, though NSC, ENICOM and Inland do consult on systems usage.

[20] Mr. Kawanami, ENICOM's Managing Director, originally joined NSC and became part of its Systems Corporation that had 200 people. Now it has 70. People coming into ENICOM who are assigned to the Nippon Steel account (about 50% of ENICOM's business) have to learn about steel, including steel-making technology, the different products and NSC. When ENICOM sets up a project with NSC, it is at NSC's request. That is, someone at NSC asks for systems support. ENICOM and NSC then address this issue together as a joint effort. ENICOM does not just go in, get information about the project, and come back later with a program. This is because on every project there is a steel technology component, an IT component, and a NSC business component. These are never completely and clearly separated. Therefore, it is not possible for ENICOM to do its IT piece in isolation from NSC. The overall strategic vision directing ENICOM's relation to NSC became clarified as the team learned more about ENICOM, other IT projects and the driving forces behind customized casting. In terms of projects, ENICOM has two ways of organizing relative to NSC. One, it has groups at the job sites that work directly with those producing the steel. In this case, the ENICOM people join the steel mill conferences. Two, it can produce new systems to

E-Commerce System[21]

At the time NSC undertook the new E-commerce initiative, steel-making IT was still very customized at each plant because since they produced different product groups, the associated systems were different. Steel production is not like auto assembly where

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order such as the accounting system it is developing using Oracle. As noted above, the latter type projects are sometimes ordered separately from the business or operating unit by the IT unit at head office. NSC's Corporate EI (Electronic Information) Division is composed of the following: Planning & Coordination, Industrial System Solutions, Financial System Solutions, Public Sector System Solutions, Network System Solutions and System Research & Development Center.

NSC established ENICOM in 1988 as a separate company from the IT division, and it currently has 2185 employees, about half of whom work on NSC-related projects. In steel related areas, it only works for NSC, but it has clients in other areas such as pharmaceuticals and chemicals, e.g. Takeda is a client. It also has an electronics business unit in Shinjuku with 600 people and does work for Matsushita and Daiei. It also has small manufacturing companies as clients. This is one way to reduce the cost of maintaining this captive IT operation, and it seems to have worked. In 1988, virtually 99% of ENICOM's revenues were from NSC, whereas in 1997 out of total revenues of ¥83 billion, billings to NSC were only 37%. However, because it only charges NSC on a cost basis, this somewhat depresses NSC's percentage of ENICOM's total business in terms of people and resources. Because other steel companies' captive IT firms often charge their parents a profit, their sales are usually about 60-70% steel related. ENICOM's systems operation has 1000 people. ENICOM's main departments are: Planning & Administration, R&D, Project Auditing, Solution Business, Network Business, Steel-making Systems and its 14 regional offices (ENICOM 1998). In addition, it has 28 access points, 10 computer centers and a 4300 km high speed network in Japan.

[21] J. William Gurley (1998) has an excellent analysis of the criteria needed to establish a strategically effective e-commerce system. He notes such a system must address both industry and IT issues. More specifically he stresses that "the companies that will do well…are the ones that take the time to understand the context of the industry in which they operate. Rather than aggregate technology, they must aggregate context." For this reason, "the home-run opportunities belong to companies with people who deeply understand how a particular industry works: who understand how the Internet as a channel can serve that industry. These companies will build Websites that aggregate buyers and sellers to help facilitate both the decision-making process and the subsequent delivery of products or services. Kevin Jones of *Interactive Week* calls these butterfly businesses, because if you draw a picture of a service that aggregates buyers and sellers, it involves two triangles pointing inward at the single Web source.' Gurley "prefers to call these sites vortex businesses, since their success involves aggregating not just the two butterfly wings of buyers and sellers, but also technology, content, and commerce." Further, he emphasizes "the hard part isn't assembling technology; the hard part is aggregating context"; only in this way can one "create an industry transforming vortex." A key element in this regard is "understanding the features and specifications a customer would typically evaluate to make a purchase decision. The intricacies of such decisions vary enormously from industry to industry:…search routines need to be set up to follow the thinking of a typical industry decision-maker." In addition, the system must reflect "a complete understanding of the way products or services are moved in each industry. How are products ordered? How are they delivered?" Finally, the vortex must make "the information generated at the Website…available in various forms to the industry community." From these perspectives, the e-commerce system NSC has helped pioneer for Japanese steel would seem to meet Gurley's criteria as a vortex business. Furthermore, NSC would seem to be in his words a "New Age facilitator." In that it is helping to integrate a large fragmented commercial market with "many independent buyers and sellers…who will find value in a single, automated site that concentrates information" and where "acquiring the data needed to build the content on the site" is "not overly difficult."

the system associated with assembling a car is similar for each car. Autos also usually have only one design division, so the design system is more integrated into the production process. However, in steel, even within a product category, each order can have its own unique specifications and associated R & D. Further, the process and materials flow for each basic steel product is different and therefore varies with each plant. Material quality therefore depends on equipment, people, and process control. But managing this situation became much more complex once NSC began consolidating production at fewer plants due to demand and supply pressures. This is because it no longer had the simple luxury of focused-production plants with their self-contained and uniquely dedicated IT systems. In addition, HO could no longer just send an order to the plant producing a specific product.

Instead, NSC introduced more production flexibility into certain swing plants that could produce a variety of products to order. This way production throughput could still be optimized in terms of the different equipment, without losing the advantages of focus and scale. This was the beginning of the shift towards a more flexible, even lean, steel production system where "the inventory quantity of the distribution process will be adjusted to the production fluctuation." (Dazai & Maruyama 1997). This strategy is what has driven the Kimitsu Works and its sophisticated IT system.[22] In essence NSC

[22] Retailing steel is altogether different and takes place at various steel centers, some of which are run by the trading companies. While at the product level, each plant and product has its own control system that is different from the control system at other plants and for other products, certain functions are controlled centrally. These include raw material purchases, transportation, aggregate demand forecasts, personnel administration, and accounting. Management's experience has been that while it is difficult to forecast demand for individual products or clients, they have been pretty good at forecasting aggregate demand for steel. This has allowed them to order raw materials and transportation on a long-term basis. It also is important in estimating likely price trends for both raw material and products. This has led to a fairly sophisticated ordering and inventory control system that NSC does jointly with the other 6 steel companies. This helps even out the effects of fluctuations in demand among individual producers.

has tried to mover closer to what it envisions as the greater factory automation, integration, and business control of the auto producers, particularly Toyota.[23]

They call his the "Flexible Customer Order Control System" (ENICOM 1998a). Because of the complexity and individuality of each plant and NSC, itself, ENICOM and NSC find that EMS systems are not suitable for them, or, probably, for any large Japanese company. Instead, they believe software development economies will probably be generated through commonalities and the use of object-oriented software that can be used in multiple programs within the firm, e.g. in several mills. This is why they initiated E-commerce as they envisioned extending to others the initial efforts with appliance manufacturers. The objective was to develop the E-commerce system so orders come directly to the NSC HO computer and then are sent to the appropriate plant, saving much time and effort.

In effect, the TCs gather the steel demand information efficiently and transfer it to NSC. This works for the big companies, such as the TCs or the auto and appliance makers, but not for small companies, such as the coil manufacturers. The trading companies handle the distribution to the small clients. Since all users do not always have a precise idea of what their needs will be, there is sometimes a shortage. This can create problems for customers following a strict JIT system, especially as parts makers determine many of the orders. However, NSC can meet a JIT schedule if the customers specify a strict delivery time, say once a week. Otherwise, NSC and the customer may not know about delivery for three months.

[23] As stated in Dazai & Maruyama (1997), "the purposes are as follows: the order entry business speed between iron & steel industry and electrical industry by computer data transmission is improved. The production style which changes an output by the demand fluctuation is realized. The inventory quantity of the supply chain is reduced."

Under the E-commerce system, though, gathering all the required information that used to take two to three days, now takes two minutes and uses a standard EDI (Electronic Data Interchange). It was decided to combine this EDI into an "Open End Standard" that will be used by 2001. A local standard was converted into an open-ended database via the web. From this information NSC and ENICOM have data on each company and everyone is connected via the Internet. Direct results of introducing this E-commerce system are lower inventories and fewer deferred orders. NSC also hopes to reduce lead order time to delivery since the system is based on the real demand of electric appliance manufacturers. Another team is doing autos, but it will take time to extend it further. In the future all orders should be done this way developing a vortex business as outlined in footnote 21 (Gurley 1998).

While designed as an open format system, presently the E-commerce project is being confined to flat-rolled products for appliance makers in Japan. This is the first stage. It will then be extended for flat-rolled products to other users, especially autos, and then to other products. It may eventually be applied in the US market as well. Presently, it is only used for steels that are made to order and not to standard products. This is because it is in customized products that NSC has the biggest scheduling problem, as well as the greatest need to implement its new value-added strategy. In this sense e-commerce for NSC is not an open market the way it is done off the web in the US for consumer products.[24] In effect, this is supply chain management that extends beyond the boundaries of the firm, and is thus consistent with the CP model and the similar IT approaches seen for: Ito-Yokado, Merck, NEC, Toyota, and Nomura (Rapp 1998, 1999).

E-commerce, as implemented and used by NSC, represents an extension of ERP (Enterprise Resource Planing) that considers and tries to influence the external environment on the firm's behalf (Gurley 1998), though NSC noted it did not realize CALS [Communication at Light Speed]; Dazai 1997 and Dazai & Maruyama 1997.)[25] Still, by using the new E-commerce system, the Japanese steel industry plans to reduce inventories by 10% or six million tons. This is almost equivalent to the annual output of the Kimitsu works and in value terms is ¥400 billion (roughly $3.5 billion). So its impact will be big and will be especially beneficial to NSC, since it is both Japan's largest, most efficient steel producer and has a focused complementary business strategy. The system will also impact Japan's small steel distributors and the TCs, since it will become more difficult for both groups to compete in flat rolled products.

For small distributors, part of the reason for this is that these firms will be charged ¥5 million to be a part of the E-commerce system, i.e. to maintain and operate it as a VAN. For many of Japan's 2000 small steel distributors this is too expensive, given their tiny margins. Further, standardizing the order process will also impact on smaller, less efficient firms within the current distribution system, as E-commerce's open form will force a commonalty on steel sales and distribution. Data will be introduced through an Internet connection using PCs and Windows NT. For instance, NSC has a small NT server that coordinates the process, and customers can access it through any Internet provider. Even big trading companies may be threatened by this new system, since they

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[24] The parts makers determine their orders for steel from the production schedule given them by the assemblers. This complicates NSC's JIT strategy for larger buyers such as Toyota and requires significant additional IT support.

[25] "CALS (continuous acquisition life-cycle support for commerce at light speed)…is a new concept that uses information systems to integrate the many horizontally and vertically affiliated units within a large enterprise and to integrate even separate companies, in order to bring about more effective collaboration." (NSC 1997)

will need fewer people to run their steel businesses than they need with the current system, where the TCs fax data to NSC. Under ECN, there will be a continuous flow of market information, and large customers may even see it as easier and cheaper to order directly themselves. So far about 50 to 100 companies have joined ECN (Electronic commerce Network), including Honda and Toyota. The Internet providers include Unicom, NTT Data, and Niftyserve.

After input by the customer or TC, the E-commerce information is then connected to NSC's proprietary intranet system. This is linked and integrated with NSC's production system, including plant assignment and scheduling. Auto engines and engine parts are not involved in this process because they use cast aluminum. It is only products made from flat-rolled steel that are being ordered. This is NSC's most important market (footnote 14 on page 22), with presently about 60% of such products going to autos, cans, furniture, electrical appliances (refrigerators, washing machines & dryers), as well as vending machines. In Japan, the last is a very big market as any walking tour of Tokyo can testify. Ships take some flat rolled products, but mostly plate, which is not part of ECN. Exports are also a big items, but are not yet included.

Once the order is assigned to a plant such as the Kimitsu Works, that mill's system takes charge of the order in terms of production scheduling. This is a very complex task, since each piece of steel is prepared especially for each customer. The slab cast for each customer's order is different. In particular, the systems controlling the order for flat rolled products from the auto and appliance companies are especially large and complex. This is not only because the steel for every model car and appliance is different in terms of width, thickness, and coating, but also because the customers want just-in-

time (JIT) delivery. Usually, the contracts the trading companies are managing are for one year with specified daily deliveries. This is also true for some of the heavy equipment makers such as Komatsu. It is not true for shipbuilders, as they generally have more space and operate with a one to two year backlog. The TCs also manage the steel producers' raw material contracts for iron ore and coking coal. But these are usually set year s in advance. This is because although the steel companies do not know the expected demand for steel by customer or type, they do have a good idea of overall volume, which has not changed much during the 1990s (appendix II.) Hence there has been a rather steady demand for raw materials with more precise delivery fluctuations negotiated about six months ahead as explained in footnote 22.

In the E-commerce system the delivery date to the customer is also specified when the order is made, but the payment and billing stream goes through the trading company. Once the order has been specified, the mill's IT system controls how and over what period the steel is made. This mainframe system supports a WAN (Wide Area Network) that delivers and processes both voice and data. Inside the plants or at HO, the local area networks use network servers. Head Office also has a TCP/IP Internet system. The mills have many Unix based systems as well as a Windows NT server. However while the production operations are fairly efficient, NSC feels it needs more office automation or TOA (Total Office automation) to speed up the work flow. Thus, it is looking at doing some benchmarking and re-engineering, since it believes there are several other firms that are more efficient at TOA, which may or may not be true.

Generally, though, NSC has not changed its organization to use this or any other system. Rather, as in the E-commerce case, it develops almost all its own systems with

the user very much involved. When it does buy SW, as it recently did in the case of an accounting system from Oracle, NSC ends up having to heavily customize it. Payroll, billing, etc, as they relate to E-commerce are, therefore, all NSC's own self-developed programs. Furthermore, order and delivery are all in real time. So management knows where any customer's order is within the system at all times. This is called the open steel supply chain; it enables a one-to-one flow of data and the physical movement of the steel. Thus as part of this IT steel management process, NSC gathers data from the many companies and corporate elements that contribute, directly and indirectly, to the making of the steel and related costs, until it arrives at the appliance manufacturer, and is paid for by the appliance maker. The information flow must mirror the product flow (Exhibit 1), which is not easy in terms of production scheduling given that customers and products are divided.

Because the core part of NSC's business and its biggest investment is in the physical steel production facilities, it is extremely important that NSC use these mills most efficiently. This is why it uses computers and sophisticated IT systems to manage the production system that then feeds into accounting and the allocation of human resources. That is, the production management system tries to support the upstream HO activities through the flow of information concerning a mill's allocation of resources to produce steel for each customer's order, and thus the cost of producing that steel. This is where the mill production ties with corporate accounting, human resources, and billing.

NSC has invested, and continues to invest, heavily in this IT area including the scheduling system, because it already produces a large number of special and customized steel products, and the strategic plan is to produce more. That is, NSC is not producing

just the most popular steels, which appears to be Tokyo Steel's approach (ENICOM 1998a and interview Tokyo Steel.) Rather, it makes many customized steels, which are a source of value added for both the company and its clients. As explained above, this requires knowing how much it really costs to produce each order as well as the optimal way to produce it. This was the reason for initiating the new accounting system and TOA. Like many other firms in 1998 and 1999, NSC and ENICOM were also addressing the Y2K problem and had 30 people working on it, expecting to finish and be MITI certified by August 1999. However, it was not a simple task for them to complete because it is difficult to reprogram the small process control computers used to run the equipment. Therefore, they had to address the problem directly in each computer.

The most important impact from the new E-commerce system is that actual results from its introduction have been even better than expected. The speed of order processing is measurably better. Whereas, before there could be errors in coding the faxes and it took time, now the new order is shown and incorporated into the system instantly. In addition to the direct sales benefits and the faster order cycle, the customers can now easily connect to NSC's order tracking system. The TCs and their clients are better informed about orders, products, and NSC since they now have direct access to information that previously was generally only available via telephone calls to the company and the mill producing the order. The new system also means it is no longer necessary to have personnel whose primary function is tracking orders and communicating this information to customers. Databases and e-mail have eliminated a lot of fax paper and paper shuffling as well. Further, in organizing sales data and

forecasts by product, type of customer, and mill, it is now very easy to assemble and reassemble data for every type of steel and customer.

Kimitsu Works

At the mil level, Kimitsu is NSC's leader in implementing the new strategy that links E-commerce with customized production and the new JIT/inventory control paradigm for automobiles. It will also be tracking its cost of producing these products and carrying inventory using the new corporate accounting system. It thus represents a microcosm of NSC's emerging CP vortex strategy.[26] Located in Chiba, facing Tokyo Bay, NSC started designing this plant in 1961. The facility includes docking, unloading, and loading facilities, and covers a site 5 kilometers in length and 2 km wide, thus occupying 10 square kilometers, or about 1500 acres. It is well positioned near the large Tokyo market and produces 8-9 million tons of steel per year, using three of its four blast furnaces. (The number 4 furnace is the largest, and has been replicated by the Chinese in Shanghai under license from NSC. The number 1 furnace is shut down because it is too small to operate continuously.) The furnaces are designed to use iron ore shot directly into the furnace, rather than pellets. This saves on the cost of pelletizing. They keep about 42 days of raw materials on hand, including what is in the docked vessels.

Kimitsu is the most diversified of NSC's facilities in terms of what it can make. It has a huge hot strip mill making hot coils from the slabs of steel produced by the continuous caster. The iron making facilities are all enclosed, due to environmental regulations. This retains and conserves heat. A cold rolling mill is used to make very

thin coils, down to 1 mm thickness, other than those used by auto or appliance makers. It also has a pipe mill that can make pipe up to 2 meters in diameter. These are sold to the oil industry, building contractors, and water distribution systems. It also makes shaped products, which go into construction, and wire and rod, which go into everything from radial tires to reinforcing bars for construction. The wire is very high quality, though the Japanese steel makers, including NSC are currently having dumping problems in the U.S. In the making of rods, NSC is competing with various mini-mills. Finally, Kimitsu produces heavy plate that goes into shipbuilding.

It is a very complex task to schedule all these products and individual orders through the mill and the blast furnaces, and still optimize the efficiency and use of the mill, especially the basic steel making process. The production control center thus operates 24-hours, three shifts a day, seven days a week, using four pools of people. This is because, as explained previously, once a furnace is started it must be run continuously.[27]

The computer center is complemented by an on-line satellite command and control center. NSC has a long, almost 40-year history of using computers to control its plants and steel making process. Thus, when Kimitsu was designed in 1961 and began operating in 1965, it was AOL (all on-line), computerized from the beginning to permit

[26] Based briefings Kimitsu and ENICOM 8/98. Also see NSC (1996 & 1998): Rapp (1998 and 1999). Similar systems exist at other works, e.g. Yawata has the same order-production flow using 280 GB mainframe (ENICOM 1998a).

[27] As O'Brien (1997) explains: "To minimize fixed cost, ….a steel plant has to operate at or near full capacity; operating below capacity wreaks havoc on unit costs. Consequently, a steel plant's overall efficiency depends on it operating…around the clock, throughout the year." Also, A, F & G (1996).

continuous control of the process (i.e. PMS – Production Management System). At that time, it required four IBM 360-M40 machines to handle the work.[28]

To run the plant, NSC developed KOCS (a new on-line system called Kimitsu On-line Computing System). This was combined with office automation and organization of a computer systems group at the mill level. This was required to efficiently operate the furnaces non-stop, since, as the mill must operate continuously, so must the software, the computers, the people responsible for maintaining operational integrity, the control room, and the supporting systems. NSC had to have people there all the time who could manage the on-line processing software. This could not be done remotely from head office, but had to be integrated into the local operation. This was a very new idea at the time. NSC used a three-layer computer structure to accomplish this. The process computer system controlled the computers in the plant. Those, in turn, controlled the computers that managed each operation on a batch system basis.

Given this structure, the system currently uses two basic types of software (SW). One involves the massive data processing of orders, production scheduling, production flow, etc. The second is quick design SW system that can be used to modify the SW controlling a particular machine or activity. Because it took them ten years to fully construct and complete the Works, the mill's design and the control systems were modified along the way. This was due to the effects of the first Oil Crisis on the cost of raw materials and the demand for various steel products, combined with changes in IT and steel making technologies. Since then, construction on the Works has continued in response to the Second Oil Crisis and further changes in steel demand as well as to new

[28] While these were the largest machines available at the time, today's top-of-the-line laptops would have equivalent computing power.

steel making technologies. The new technologies include structural improvements, environmental investments, and new production techniques. The new techniques include such developments as continuous casting, rather than casting slab-by-slab, and, in turn, hot-charge rolling (HCR) instead of cold strip rolling, since continuous casting made HCR possible on a continuous basis. These developments have also permitted continuous descaling. Nevertheless, despite the mill's flexibility and constant improvements (Kaizen-Imai 1986), the "strong" Yen induced recession after 1985, and collapse of the bubble economy did impact the mill.

NSC as a whole had to restructure and closed four to five blast furnaces. It also began a new business plan, which it normally does every three years (Fortune 1998 and Japan Times November 1999). For Kimitsu this new strategy meant becoming the strongest mill in the world by the middle of NSC's 4th business plan (1998-99). The key to doing this would be its use of information systems. Management had spent the first 20 years (1968-1988) at Kimitsu on improving the plant and IT systems controlling it. This resulted in a 25% improvement in physical labor productivity. While crude steel production in 1989 was almost the same as in 1973-74, employees had fallen from 7700 to 6000 (NSC 1998a). But, during the following 10 years, NSC's management had to change to a dialogue-based on-line management system in its mills, using CRTs, or the equivalent, that relate the mill more directly to the external business environment. This has resulted in further productivity improvement, as employment dropped to 3800 in 1997, while output was about the same as in 1989 (NSC 1998a).

This has meant a major structural adjustment within NSC and at Kimitsu. In the past, HO merely passed orders on to those mills that seemed to have capacity, without

closely analyzing the cost and delivery schedule associated with that order. Under the new system, a receipt and delivery schedule associated with that order. Under the new system, a receipt and delivery system, with a built-in JIT (just-in-time) component, will handle incoming orders. NSC calls this system EDS (Electronic Data System), and it is a batch file transfer system, linking Head Office (HO), the trading companies (TCs), and the customers. It is thus NSC's interface with the Japanese steel industry's new E-commerce system explained above.

NSC has been working on this since 1992-93, and in conjunction with the E-commerce effort since 1996. The dialogue orientation starts with head office then goes to the production planner and then back to HO, until the optimum production allocation between and within plants is developed. This allocation process will incorporate cost information provided by the new accounting system. This has allowed NSC to downsize the number systems people at the core (HO) and focus systems integration at the plants, while still relating the mills to the total business environment for steel. In conjunction with ENICOM, NSC and the local employees, Kimitsu has developed its own groupware to manage this process, and this groupware is integrated with the people who are operating the system. The overall size of Kimitsu's system has therefore grown a lot over the last 15 years. Beginning in 1984 in the millions of instruction per second (MIPS), it has grown to billions of instructions (GB) in 1998. The size of disk drives in turn ahs gone from 100 GB to 600 GB, the number of CPUs has risen from 30 to 300, and the number of lines of code or logic steps in COBOL has grown from 10.8 million to 34 million. Further, this system is now fully amortized. Kimitsu also began addressing Y2K issues in 1997, expecting to be fully compliant and converted along with the rest of

NSC as of the summer of 1999. The budgeted cost for solving these Y2K issues was about 400 million Yen for Kimitsu and about 2 billion Yen for NSC as a whole.

The SW issues and systems for Kimitsu are first, as noted above, based on managing a huge data warehouse (one half a terabyte or 500 billion bytes of information). This data covers production, quality control, and the history of all the steel ever produced at the works. The production management system or PMS (see schematic attached as Exhibit 1) is the biggest part of this data management system, since as already explained, Kimitsu produces many types of steel, and there are several different processes involved in steel production, depending on the type of steel and end product. The basic flow, however, must still start with iron making, then steel making, and then proceed to specific end products, such as wire rod, pipe & tube, coiled sheets heavy plates, or rails.

Against these physical or technical requirements are placed the GSA (General System Administration) requirements: Accounting (which for Kimitsu is accounting only for its own costs as HO handles receivables, overhead, etc.), Machinery Usage, Equipment Management, Engineering Management, Energy Usage, and Equipment Controls. HO manages personnel on a corporate-wide basis. The computer hardware running this system is still all IBM mainframes, which Kimitsu upgrades roughly every five years by changing the lease. The mill currently has two such mainframes for management and operations control, with a third acting as a back-up, though in fact each one supports the other. These mainframes control several Unix-based servers (mostly IBM A/X). The Management and Planning Server is an RS 6000 – SP2 and the Intranet Server is an RS 6000. They also have six Tandem fault free computers that directly control six nodes, and an NCR-5100 that handles the Data Warehouse. These latter

computers control the 100 processing computers. Kimitsu also uses IBM's Lotus Notes for internal communication. The workflow reporting, mail, and scheduling system uses Fujitsu DS-90 groupware servers, for which NSC has developed special teamware.

In reality, the true Network Servers (NSC) are the mainframes that manage the Integrated Network System (INS) that is connected to HO and the other steel works. The trunkline making these connections is an optical fiber network, which, as already noted above, NSC operates as a Class 2 VAN. In addition, Kimitsu has automated and integrated its office operations using 1500 PCs and 20 PC servers, with each department having its own server. As of August 1998, these were Windows 95 machines connected using Windows NT. Management did not intend to upgrade to Windows '98, as Windows '95 works well enough for their purposes. Indeed, 100 PCs are still using Windows 3.1. The standard application program is Office '98, including Power Point. Kimitsu also has 2400 dumb host terminals and 40 Unix workstations.

PMS, however, is the "core" system controlling steel making. (See Exhibit 1). This is why Kimitsu and NSC are not able to adopt an outside ERP (Enterprise Resource Planning) or EMS (Enterprise Management System) type package. Under PMS, the system begins with orders form customers such as Toyota, the shipyards, etc., that first flow to the TCs, then to HO, and then are allocated to Kimitsu. (This allocation will be based on the new accounting system once it is fully installed and operating, while most of the orders will flow via E-commerce.) All the TCs participate in this process.

As explained previously, the trading companies have all the information on steel demand and do the forecasting for the steel producers. They also track orders for their customers, keep track of available stock, etc. They then supply the details associated

with each order to NSC's HO. Head Office in turn converts HSC's sales plan into a production plan and splits each order in to two components. The first is order-processing that has six months, three months, and one month schedules. This addresses the processing materials needed to complete the order that helps to generate the materials ordering plan (six months horizon). The next applies to the production-scheduling plan (three months horizon), and the third relates to production control at the mill level and to the actual shipment directly to the customer. This shipment generates a bill to HO that then flows to the TCs and finally to the customer while physical shipment travels separately, directly to the customer. Within the Tokyo area, shipments usually go by truck, while outside, they go by rail or ship (e.g. to Nagoya and Kyuushuu). Toyota's use is mostly in Shizuoka. Naturally, exports are by ship. The usual time from order to delivery is about two months, though with appliance and auto manufacturers, as described above, NSC is trying to move towards JIT.

The second component of the order is the actual production instructions that flow from HO to each mill, based on each mill's capacity, territory, and product specifications. Once Kimitsu has received an order, PMS controls the next levels in the process leading to the actual production of steel to complete the order. There are three levels to PMS: Planning Systems, Operational Control (24 hours), and Process Control (directs mill machinery such as cranes, torpedo cars, etc.). Planning Systems uses high-speed computers and large amounts of data to plan the best way to optimize the production of the large number of orders. It then schedules production based on the results of these calculations. These calculations are high level and very complex, relying both on Kimitsu's historical database and a sophisticated mathematical algorithm. Planning

Systems in turn sends scheduling results to the real time, 24-hour, non-stop data processing control system. This system uses fault-free Tandem machines to make sure there is never any down time in the mill's continuous operation.

This planning control system provides the work instructions for each steel product and its corresponding order, including the necessary input materials. Thus, the system knows where every order and related materials actually are, at any point in time. Consequently, there is a precise match between in-process or finished inventories in the yard and a given order. NSC sees these factors as mission-critical issues that its new proprietary ERP can perform. However, this ERP is not a package from an outside vendor, but was developed totally by ENICOM and NSC. Furthermore, it is completely customized to NSC's and Kimitsu's operations, since no outside vendor would have the knowledge about how the mill and the existing system actually works. The complex optimization model and its associated software are absolutely critical to making the mill efficient when each order is handled on a unique basis. It must also be tightly integrated with the mill's physical, technical, and personnel operations.

In this way it appears that Kimitsu's IT strategy is being driven, at least partially, by NSC's strategic decision to move to customized casting as a way to capture and hold important clients like Toyota. This means mill efficiency must be optimized in the face of each order being unique. Further, the new accounting system is then needed to track costs more precisely by mill and process to price such customized products. Finally, the new inventory control and E-commerce systems are necessary to keep the stock associated with each car model under control and to permit individual order tracking by customer, as required by the JIT mandate. Interestingly, a key consideration in NSC's

thinking about its success in implementing this complex and sophisticated system has been Japan's long term employment system. For the system to work well, there must be close integration of both steel making and IT systems knowledge so NSC can actually optimize the production model economically and efficiently. NSC's experience is that four to five years are required to train someone to use and help develop these systems. If NSC or Kimitsu were to lose such employees on a regular basis, it would be very expensive and the system would be difficult to implement. But, since they know these people will be working for NSC for 35 or 40 years, it makes sense and works. This is also consistent with the need identified by Ahlbrandt et al (A, F&G 1996) for successful strategies to closely integrate technology and personnel practices.

At the first level of order production detail, Kimitsu is working on roughly a monthly basis. At the next level of detail, PMS becomes even more precise. (See Exhibit 1.) For example, scheduling the Hot Strip Mill is very detailed and is the newest system Kimitsu has developed using this concept. This is consistent with the customized casting strategy, described above, since the Hot Strip Mill is a key part of NSC's auto and appliance related programs and offers a potentially high value added benefit.[29] For this mill, when Kimitsu receives an order, it is first screened for Quality Design. This is because the Hot Strip Mill can produce as many as 10,000 different qualities of steel, just for different cars and car parts. This screening then determines what process will be needed to achieve the specified quality and, in turn, the amount of steel required, as well as the time need to produce that steel, given all the other orders in the pipeline. Once volume and production time is determined, a delivery date can be scheduled. This

scheduling program was one reason why Kimitsu and NSC had a Y2K problem that had to be fixed. Given this decision-tree, we see why every product and order has a unique cost point that feeds back to each mill, based on overall product demand and the necessary production schedule to meet each customer's requirements.

Based on the orders Kimitsu has in hand, including ones remaining from the previous week, Kimitsu repeats this production scheduling process every week and selects the orders to be produced accordingly. This weekly schedule then translates into a daily plan and schedule. Steel that is not used is reallocated to inventory. For orders that are processed, each one has its own unique slab of steel that emerges from the continuous caster. This slab is then made into coil that is the final product. This is how NSC makes and develops new steels from the information/specifications it receives from customers. To ensure that each mill is using its iron making and blast furnace efficiently, each mill will produce surplus slabs that are allocated differently. These slabs go to inventory and are used later to produce other more standard products. This process control applies to the whole Kimitsu Works and all the products it produces.

Sequencing, rather than efficient assembly, a la Toyota, (Womack, Jones and Roos 1990), is the key to economic success in this manufacturing process and is the hallmark of this newly developed system and its complex high level OR (Operations Research) optimization method. The three shift 24-hour control system operates to closely integrate its personnel. Further, every level (i.e. each major piece of equipment or process) gets more detailed attention and is in turn optimized within the context of the whole operation. Major cost efficiency variables appear to be yield, inventory, and

[29] NSC's customers; diverse demands include: "thin but strong, highly corrosion-resistant, mirror-like finish, fine as hair, usable in frigid regions, highly fire-resistant, aluminized steel sheet for fuel tanks, and

delivery, since the last determines when NSC gets paid as well as its ability to efficiently meet its high priority customers' JIT requirements. In this manner, the system is constantly balancing costs and physical efficiency, and NSC noted that part of its efficiently model is managing the supply chain. But it also knows that this chain varies by industry and firm. NSC is not like Takeda or Ito-Yokado, and because of this, it could not copy a system from an outside ERP package. Rather, as explained above, it had to develop its own system, just as Takeda and IY had to develop theirs.[30] This results is also consistent with Gurley's view that successful E-commerce systems must be industry-specific with high industry content (footnote 21).

Kimitisu's Office Automation uses a separate database system and each back-office worker at the mill has their own PC attached to a network. There are 1000 of these white-collar workers. In addition, there are 900 four-man blue-collar crews who are also beginning to use PCs on a team bases. From their inputs, Kimitisu's management hopes to develop a database that can be mined to improve production and quality. They and ENICOM are currently looking at outside data-mining packages to see if there is one suitable for the task. This shows NSC's flexibility when the basic complex functioning of the mill and NSC's system are not involved. NSC also shares data with other firms in the overall demand/supply chain. This is done with the TCs through the E-commerce system, with subcontractors who need to supply materials, and other support services, such as transport firms, maintenance companies, or ENICOM.

In terms of NC's IT organization, the big shift occurred 10 years ago. NSC reduced staff and merged Nippon Steel Information Systems (NIS) with Communication

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pre color-coated coiled sheet (VIEWCOAT). (Nippon Steel 1998a)

System Inc. to form NICOM that became ENICOM (footnote 20 page 38). Now, within NSC itself, including HO, there are only a few systems people. At Kimitsu, there are only 13. However, ENICOM maintains a regional office that serves Kimitsu. There are 400 employees in this office: 250 systems engineers work only for Kimitsu and 150 work for other companies. This is out of ENICOM's total employment of 2,300 plus another 1,000 in various subsidiaries. Roughly 50% of ENICOM's business is steel-related and based on personnel numbers; about 10% of that would be Kimitsu-related.

Looking ahead, Kimitsu and ENICOM see their next big project as the auto inventory issues. This is because auto company steel in stock is currently over one month plus what Kimitsu has in production to meet projected JIT requirements (can add another 3 months of in-process inventories). Since each car model has a different type of steel in terms of size, thickness, coating, chemistry, and use, this is expensive. The electrical appliance makers also have diverse demands but the problem is less complex for them since they do not have the some degree of replacement part demand and the volume is much less (footnote 14). There are currently 10,000 different specifications for sheet products at Kimitsu. This is why the outside car project is the next big project the IT group and ENICOM are going to address, followed by the varieties of wire rod required for different projects and, finally, steel for ocean going vessels that now require special chemical compositions.

Benefits, System Linkages, and Strategic Impacts

[30] See Rapp 1998 and 1999. Based briefings with Nippon Steel's Head Office Systems Group and ENICOM in July 1998.

There is substantial information sharing between Japan's integrated steel producers and, as noted previously, they often cooperate in areas like negotiating a common coking coal contract with Australia (A, F&G 1996). The Japan Steel Association also has a technical committee through which, after two years, firms will generally share new steel making processes such as continuous casting.[31] In addition, the firms came together on the joint E-commerce project with the trading, appliance, and auto companies. However, this cooperation has usually not extended to computerization that is heavily customized and unique to each firm (Rapp 1995). That has been left to each individual company, including each firm's interface with the E-commerce system. Therefore, unlike continuous casting, NSC does not feel such benefits will just be competed away by the industry. Additionally, NSC can use the data it is gathering for management decision-making across the firm. So management will have better information to respond to the changes evolving due to expanding competition. These benefits could be very important when many of the changes that are occurring are not just technical, but regulatory and are not limited to steel firms, but also affect customers. This is because NSC now recognizes steel will remain its main business for the foreseeable future, even as it moves into other products and services, such as engineering, computer services, and semiconductors (Fortune 1998 and Japan Times 11/99).

Customers, Intermediaries, and Strategic Organization

NSC's approach to introducing its E-commerce customized product strategy seems more customer-oriented in terms of its basic strategy than US producers'. That is,

[31] The steel industry's adoption of E-commerce is only one in a long-string of such initiatives where Japanese firms have adopted new technologies more rapidly than competitors so as to lead to cost

NSC is no longer forcing its customers through price or availability to buy from a predetermined set of industry standard products if the customer would prefer something else or would like to design steel into its lean production system. Rather, NSC is developing and promoting a more flexible production and marketing approach that it believes can respond to what is actually demanded by each customer segment. Indeed, further planned refinements in the system are focusing on issues that will improve the ability to respond to customer requirements. These plans include the accounting project, the auto parts related inventory project, and the JIT strategy. Such projects will more closely tie NSC's organizational structure to the software, and not force its clients to use something convenient or low-cost to NSC, but not necessarily helpful to clients. The E-commerce system, for example, was developed with the customer very much in mind (Dazai 1997). Rather, the overall system is designed to help NSC better supply the steel the customer wants currently, and, in the case of autos, over a model's life cycle.

Management's perspective in this regard is that the functional and market gains analyzed above justify the additional SW customization expense needed to efficiently produce and deliver customized steel products. This includes the cost of integrating the required customized software applications into its total corporate and production IT systems. Further, the overall system from HO to each mill operating unit enhances the learning and productivity of the corporation and each mill. It builds consistency, reliability, and repetition into each mill's system and operation so that each one can more effectively deliver products and service. NSC has integrated both clients and the clients' products into its strategic sales and production system. It has also formalized its customers' acceptance of the E-commerce customized product model, including its

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advantages. These include BOF, continuous casting, and computerization (O'Brien 1992).

related service and support mechanisms, such as JIT supply and optimizing replacement part steel inventory.

Outsourcing of such systems would put NSC and its IT support systems one step removed form its mills and clients. The overall systems are so large and complex that only ENICOM has the legacy knowledge to modify the existing systems or to integrate the new systems. These are major reasons why NSC rejects outsourcing or EMS concepts and with ENICOM internally develops virtually 100% of its own application systems and software. Its human resource (HR) and client policies appear to be closely aligned with this process and its IT systems. As emphasized by Ahlbrandt, et al (A,F&G 1996), employees and customers use and get the benefits of automation and continued customer service. This approach should continue to improve sales, an important strategic goal in developing the new systems. Otherwise, both TCs and final customers would have difficulty understanding the benefit of the increased variety of possible products they are being offered by NSC.

Summary - Controlling the Future

In their study - "Information Technology, Work Practices, and Wages," Larry Hunter and John Lafkas (H & L 1998) note two approaches to using IT in the workplace. One automates existing practices to reduce the skills needed to perform a task, "deskilling." (A, F&G 1996 call this "dumbing.") The other enhances employees' existing skills, extending capabilities and making them more productive, "upskilling." H & L then evaluate the performance of customer service representatives in terms of their IT support at different retail banks to see how these two alternatives apply in practice.

The results are instructive for this case, despite differences in industry, economics, and culture.

H & L indicate IT systems that generate information, as opposed to just automating existing tasks, tend to be "skill-biased" and support high performance work practices. They are "upskilling." Such "upskilling" usually improves existing skills, creates new ones, and leads to greater worker autonomy. The IT system usually evolves and changes with the job so there is a co-evolution of technology and work practices. As such development is based on the firm's original choices, it supports an evolutionary understanding of IT's use and how certain firms achieve best practice (Nelson and Winter 1982). Further, since H & L correlate upskilling with higher wages and strategy solutions, this approach should be preferred when possible.

Indeed, the specific results and comments on cross-selling and cross-selling prompts by the IT system are worth repeating here. "More extensive use of this software is consistent with…the potential of technology to create new kinds of information and new ways of linking different sorts of data. Such software can suggest sales opportunities to its users, provide information that enables users to link together financial services that might have been previously unrelated, and can help the service representative to engage the customer more fully in the sales and servicing processes." From this perspective, one can see NSC has selected a combination of upskilling and deskilling in developing its E-commerce and customized product IT system. Its solution is deskilling to the extent NSC has substituted E-commerce for the previous faxed-based system and its associated customer support personnel. However, it has been upskilling in

terms of mill use, productivity and related personnel. Overall from a steel business perspective the latter seems more important.

The recent declines in steel demand combined with the pressures of periodic Yen strength and expanded competition has forced NSC to develop a steel production and marketing approach that differentiates it from other Japanese producers and foreign competitors. NSC's strategy focuses on improving the productivity and delivery of its existing mill structure and the trading company order system through a more automated order and production allocation system. In addition, it emphasizes expanding the range of products and services related to NSC's model of its customers' current and evolving steel requirements.

To differentiate its strategy, NSC's management is depending on three basic elements: (1) its mill and personnel infrastructure, including its proprietary IT system; (2) its E-commerce marketing product strategy; and (3) management's evaluation of their existing and potential customers' increasingly sophisticated and specialized steel requirements. Though difficult, NSC systematically collects, manages, and analyzes the data needed to link these elements together and to integrate that information directly with its mills' own sophisticated production scheduling algorithms. This is because NSC envisions its customers as having evolving steel requirements that will change and become more sophisticated over time, given the customers' own product innovation and the development of new steels and steel making technology. The new system will permit NSC to become part of these customers' design and JIT systems at an early date, building a competitive barrier between themselves and the competition.

A critical part of NSC's success in implementing this strategy is to track, market, and deliver these products on a timely and cost effective basis. It must also assure that product development evolves in ways responsive to changes in its customers' steel requirements. To address these and related strategic issues, NSC has worked to develop the E-commerce ordering system that is built into its IT system in terms of the way HO allocates each order to a mill and the way the mill schedules the production and delivery of that order. In turn, NSC is constantly modifying this system based on its understanding of how the system is working and how it could be improved, based on feedback from mills, customers, and the trading companies. In this way NSC is constantly offering new and old customers products tailored to their changing steel demands. The mechanism to deliver these steels can also be adapted to changes in IT technology, such as web-based ordering.

By getting the customer acquainted with NSC's automated and customized ordering system at an early date, and by constantly increasing the number and quality of its services and products, NSC hopes to improve customer contact, reduce customer migration, and keep costs low. They are thus using IT to influence customer behavior and expectations and tie them to NSC on an interactive basis, particularly since the competition looks less advanced and sophisticated. For this strategy to work, NSC must gather and manage a wide range of information about its client base and its demand for steel so it can offer products in a customized and direct manner while constantly improving the efficiency and client appeal of its products. NSC seems good at doing this, as well as at improving and managing the related organization and customer complexity needed to manage the technical complexities for steel and IT. As explained by ENICOM,

trained personnel who understand both steel and IT are critical to the success of NSC's strategy since both technical streams are needed to develop new steels, new steel making and processing technologies, and the supporting IT systems.

To efficiently meet customers' JIT demand, NSC has recently linked several processes that now enable steel to flow directly from the continuous caster through cold rolling and finishing. This required developing DHCR (direct hot charge rolling), which links the continuous casting process with hot rolling; FIPL (fully integrated processing line), which integrates hot coil descaling through cold rolling; an CAPL (continuous annealing and processing line), which integrates cold coil cleaning through finishing. This effort reduced processes taking over 21 days to 45 minutes (NSC 1997a), but required combining steel making expertise with IT system controls. Similarly, NSC is working on "near-net shape continuous casting technology to allow the small-lot production of steel of various grades, shorten production time, and eliminate the hot-rolling process." This work will be combined with complementary IT projects. These include an "intelligent computer software engineering (CASE) system to monitor and control all processes comprehensively, organically combining artificial intelligence with a neural network designed to assist the operator in his recognition and judgment and to assign to the computer all the jobs now performed by an operator on the strength of his intuition and experience." (NSC 1997a).

This close integration of organization, personnel, and technology is important as it is well known that when conflicts arise among managers and employees in goal setting, employees can sabotage the system and productivity improvements become limited (H&L 1998; A, F&G 1996). NSC's approach of making the mills and the users

stakeholders in the system's development and evolution therefore seems very sound. Simplicity and easily understood, measurable goals have been part of this successful IT strategic development and its implementation. For example, very large projects will be divided into three or more projects, often over several time periods, so that NSC can more easily track development, budget, progress, performance, and final results.

As with other leaders in using IT, establishing *beneficial* IT loops with articulated goals and outcomes appears to be part of this process. For example, using IT to monitor customer requirements in terms of products (customization) and delivery (JIT and replacement part inventories) keeps the information loop on order, product, and delivery focused on the customer and repeat business. Such repetition for customized products and JIT delivery stabilizes revenues and increases NSC's user base, both in terms of products and customers. This then reduces the fixed cost per ton steel while enhancing the demand for high-end products that are less subject to price pressures. This, in turn, justifies more IT investment to improve and expand the system to other customers and product segments, further building revenues while lowering fixed system costs. Gurley (1998) calls this use of IT a vortex business (see footnote 21). One clear case of this involves NSC's new color coating process (VIEWCOAT - NSC 1998) where a color coating is added to steel sheets prior to customer shipment. This enables appliance manufacturers to eliminate paint shops and associated environmental problems. In the past, this product would have created large multiple color inventory costs for NSC. But, with the new E-commerce ordering and JIT production process, NSC can efficiently serve the customer with this benefit. The customer gains by eliminating a production

process and being able to easily order a color when actually needed. NSC gains since producers who can offer only standard uncolored steel sheet cannot compete.[32]

Further, with such customized JIT supply capability, order success is likely to be greater. This will reinforce trading company and customer acceptance of the system and the E-commerce customized product concept. In turn, NSC will build the basis for its own business success including client and product diversification. This helps to reestablish its earnings and asset base. Given current economic and competitive conditions domestically and globally, such developments are critical for its competitive position with other Japanese producers. This is explained in NSC's new three-year plan to begin April 2000 (Japan Times 11/99). A stronger company will then find it easier to retain customer and market confidence in an uncertain environment.

The powerful strategic benefits of such a "vortex" business are well stated by William Gurley (1998). This is especially true for a capital intensive industry that is particularly vulnerable to diminishing returns due to product commoditization and foreign exchange fluctuations. "Vortex businesses are likely to have one very powerful edge over traditional distribution and manufacturing operations: they will get increasing returns rather than diminishing marginal returns. As a site becomes more successful, the chances of its becoming more successful increase. The more buyers are attracted, the more sellers will be drawn in, and the more products that are available, the more customers will be drawn in. That, in turn, makes content aggregation easier - vendors

[32] These results are consistent with those of the Sloan industry center as reported in April 1998 and in A, F&G (1996). The Center's research indicated the critical differentiating variables between steel producers seem to be R & D expenses and the decision-making process. The more efficient producers spend much more on R & D and push decision making farther down in the system. In addition, the successful firms have an articulated conscious strategic link between technology and market objectives based on technology, people, and organization. Indeed, research by Ichniowski shows organization matters and

must bring you content, rather than your having to gather it. Everything is drawn to the center of the vortex. The implication is clear: great vortex businesses will tend toward monopolies, and there will be no such things as second place." (Gurley 1998)

Similarly, NSC's integrated IT strategy corresponds to the various important criteria for success in steel or any business stressed by Ahlbrandt et al (A, F&G 1996). Each IT investment decision is "made in light of a focused market strategy" and fits with the totality of the firm's investments, including links to steel making technology and the employees' knowledge base. NSC's and ENICOM's managers, at both the corporate mill level, "understand and take advantage of the interlocking nature of investments" in the broadest sense (i.e., machines, IT, employee skills, HR practices, and organization), as well as their complementary relationships. This includes the recognition that "new technology and human capital must be developed in use at the same time." Further strategy and practice are aligned "in the same direction so they reinforce one another," and so that improvement is continuous. The basis for this is "a conviction about where they want to go that is rooted in a deep understanding of products and markets." At the same time they are "setting a very high goal: to pursue quality and efficiency simultaneously." This includes the conviction of NSC's president and chairman (Fortune 1998 and Nomura 1998), another key element of A,F&G's analysis. In addition, the emphasis at NSC along with the other leading IT users is on the "effective use of technology…to gain quality or cost advantage" as opposed to being "on the cutting edge of technology" for its own sake. In the case of its work with IBM on the new mill

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particularly the integration of human resources, technology and plant layout. Also, see Fujitani (1995) on high Japanese R&D expenditures in steel.

production algorithm, NSC illustrates that it can also be on the frontier, when it is necessary.

In this way one can see that NSC's integrated steel division is using IT to control every aspect of its business from sourcing to delivery and even after-sales support. Further, management, including top management, now can view its customer relations even more as an extended relationship. Previously, that relationship was based more on a price-sensitive, order-by-order set of transactions for a standard product with a well-known market price. The success of the new E-commerce system indicates NSC's customers are beginning to see the relationship in this new way, too. NSC has used IT to impact its competitive environment by changing the way its customers look at their steel requirements, supply base, and product service support, so as to favor NSC's business strategy. Again, this conforms to the view presented by Ahlbrandt et al that "truly important cost or quality differences can virtually always be traced to technology," and "technology shapes the workplace." At the same time, this approach would appear to take NSC beyond the technology strategic model posed by A, F&G (1996). This is because NSC's E-commerce customized product model has already absorbed and moved beyond the thin slab and strip casting frontier explained in that study. In this sense, A, F&G's view is correct on "the importance of competition in determining a company's or an industry's level of attention and commitment o ongoing improvements in productivity, quality, and customer responsiveness objectives."

As explained in the introducti9on to his case, the major driver for NSC's new IT-based E-commerce customized product strategy has been its need to move away from the foreign exchange impacts and cost-cutting only initiatives of the 1990s. But to do this, its

revised approach had to reduce the ease with which competitors can emulate its strategic and technical advances with "me-too" responses facilitated by global equipment vendors (A, F&G 1996). By coupling steel-making and organization skills with proprietary IT systems in creating and implementing its new initiative, NSC has moved a long way in this direction, especially since competitors do not have access to the latter key element.

This would seem to be a well-developed, though still evolving, "Controlled Production" paradigm (Rapp 1998a and 1999a). This is the approach several leading IT users examined in the Sloan case studies appear to be practicing. That is, they are using IT not only to control all aspects of their businesses but also to directly influence their external environments to their strategic advantage. Because NSC appears to be successful in this respect, this interactive process should reinforce the Nikko research analyst's rating of NSC as the top Japanese steel company both from a business and an IT strategy perspective. This is why he believes Nippon Steel is the most likely to emerge from the current competitive pressures as the leader in global steel.

EXHIBIT 1

Production Management System (3) – Kimitsu Works

APPENDIX I

Summary Answers to Questions for NSC – Steel Strategy & Operations

General Management and Corporate Strategy	Yes	No
Has the firm integrated IT into their management and production strategy, including using it to institutionalize organizational strengths and capture tacit knowledge on an iterative basis?	**x**	
Has the firm succeeded solely on the basis of its software strategy?		**x**
Does the firm believe some customized software and its close organizational integration enables it to capture and perpetuate on a more consistent basis certain tacit knowledge and unique corporate features, i.e. core competencies, that account for its continued success in the marketplace with reliability and repetition important elements in their thinking?	**x**	
Is firm's software strategy successful because it is well managed and introduces software innovation when it serves corporate goals for enhancing productivity or customer relations within its industry?	**x**	
Does the division generally meet established criteria as a quality organization such as: effective organizational self assessment, use of project and especially cross functional teams, improving quality outcomes through reducing uncertainty, rapidly diffusing learning throughout the organization including the use of software and information technology, effective implementation of organizational and technical change, facilitating change via evolution rather than revolution or reengineering[33], emphasizing participatory management, having process excellence, using value added analysis, actively doing benchmarking, constant organizational improvement, commitment to concrete realistic goals, effectively managing a dynamic iterative experimental process through goal setting, training and constant consultation?	**x**	
Does the firm plan in detail for operational excellence including the contribution of IT to the allocation of resources?	**x**	
Do planning systems enable management to make better business, operating and resource allocation decisions, including IT?	**x**	
Do projects focus on a small number of IT goals, usually three or	**x**	

[33] MIT Systems Dynamics Group in 9/97 presentation estimated 70% of reengineering efforts fail.

fewer, with a well-defined system reaching from the commitment of senior management to the department level with associated metrics?	
Is the firm a "high performance" workplace for services?	**?**
Is there a heavy emphasis on improving process through IT?	**x**
<u>Industry Related</u>	
Are industry economics and competitive dynamics important strategic drivers for the firm and for its use of IT in that IT has been adapted to the firm's particular industry and competitive situation?	**x**
Are there industry paradoxes such as: falling stock prices, production improvements that create product improvement difficulties, or employees' active product use that retards improvements?	Low Stock prices but good IT
<u>Competition</u>	
Is software a significant and successful input into the firm's competitive performance?	**x**
Does the firm explicitly and consciously perceive implications of IT strategies and use on their competitiveness and business success?	**x**
Are there direct links between IT strategies and overall management goals?	**x**
Do customers, affiliates, competitors, industry analysts, government officials, industry associations and suppliers perceive the competitive benefits or impact of the firm's use of information technology?	**x**
Has the firm gained first mover advantages through successfully introducing software-related innovations?	**x**
<u>IT Strategy</u>	
Is firm a sophisticated software user that consciously designs and implements an IT strategy to achieve competitive advantage?	**x**
Does firm combine several types of IT to achieve an advantage?	**x**
Does firm's system work to rapidly uncover implementation barriers,	**x,** e.g.

[34] Easton, G. S. and S. L. Jarrell, "Using Strategic Quality Planning More Effectively: Lessons Learned from NSF Project Research," Columbia Business School conference presentation, September 1997

including using new or better IT, while generating cross-functional and hierarchical consensus so measured goals are achieved?	accounting	
Is leadership at different levels actively involved in IT planning, assessment and deployment with regular progress reviews that link plans, goals, metrics, milestones, resources and responsibilities?	**x,** varies project size	
Does system allow for flexibility and innovation plus change and individual efforts if they meet goal, planning and metric criteria?	**x**	
Is there a clear vision making project and new software selection straightforward and closely related to strategic goals and processes?	**x**	
Does this IT strategy involve conscious and clearly defined reliance on customized and semi-customized software in addition to packaged software with specific criteria and goals for selecting each type, and do they have ways to measure this so the firm knows customized software achieves functional or market gains that justify the added expense, including related costs of integrating customized and non-customized software into a single information system?	**x**	
Does firm use option valuation methods to manage uncertain random outcomes since this approach seems at the software implementation frontiers even among very well managed companies?[34]		**No**
Does strategy include greater use, development and integration of industry and company specific vertical application software and embedded software in its production and delivery processes to improve competitiveness?	**x,** mill schedule algorithm	
If the firm has an embedded software strategy, is this integrated or interactive with their other IT and overall business strategy in ways affecting production, product design or service that improve quality and costs long term?	**x** with E-commerce	
Do they favor increased outsourcing of software design and development?		**No**, only use captive
Does firm believe large-scale outsourcing by many US firms assumes that IT systems development need not be integrated with business organization and that they view IT systems as generic best developed by outside vendors who achieve low cost by economies of scale? That is, do they feel these firms' approach focuses on SW costs and such firms do not see differences in systems used by competitors?	**x,** ENICOM's opinionmost large J firms customize	
Do they believe this is a mistake by competitors that gives them a	**x**	

long-term and sustainable competitive advantage over such companies because they believe outsourcing surrenders a firm's strategic software options since systems service companies have an incentive to develop increasingly standardized products and are one step removed from the company's customers and business?	
Has the firm established a software strategy that is open and interactive with its customers and/or suppliers?	**X,** E-commerce, auto project
Has this enabled it to capture information or cost competitive externalities?	**X**
<u>IT Operations</u>	
Do participants own goals and are then committed to implementation strategies?	**X**, user driven IT
Does the firm embed software into its production and delivery processes with competitive market implications?	**X**, E-commerce
Is software technology tied to high speed telecommunications technology, allowing the firm to track, receive and deliver shipments or services directly or on-line without further handling or processing?	**X,** have optic VAN
Does it manage potential risks in extensive IT use or open systems? Do they work to ensure consistency and reduce programming errors?	**X**
Is informal interaction a key aspect of planning and implementation?	**X**, user initiated
Is firm's system institutionalized and self-reinforcing with good communication and consensus building while IT plays a role, including preventing retrospective goals or target reduction?	**X**, review panels
<u>Human Resource and Organizational Issues</u>	
Does firm pay close attention to systems training and organizational integration for all employees, reducing errors through improved consistency and staffing efficiencies across the firm since software can confound even routine operations?	**X**, compare Inland
Does certain software require special HR competencies or education?	**X**
Does the firm try to change human behavior to use software?	**X**
<u>Parameter Metrics - Inventory, Cycle Times and Cost Reduction</u>	
	X, HO

	reviews regularly	
Are goals or targets tightly linked to regularly reviewed metrics with inputs coming from all levels that are often cross-functional affecting large parts of the organization, e.g. cycle times, timely delivery, and customer satisfaction?	**X**, jointly ENICOM	
Does the firm have standard agreed ways to explicitly organize or manage this software selection process?	**x**	
Does the firm have agreed ways to measure and evaluate success in using software to promote objectives such as lower costs, contract time, market share, product development times, or system support?	**x**	
Are IT costs balanced against overall long-term productivity or revenue gains?	**x**	
Does the firm have methods to ensure increased customization costs result in lower costs downstream so developing and using customized software makes sense?	**x,** E-commerce, mill control	
Has the firm created large interactive databases to allow automatic feedback between stages or players in the production and delivery process? And are these databases constantly being refined and updated on an interactive basis with actual performance results in a real time global environment?	**x**	
Are there competitive and metric impacts such as reducing inventory costs and wastage while improving the quality of customer service?	**x**	
Has the firm used software to create beneficial feedback cycles that increase productivity, reduce cycle times and errors, and integrate product and delivery?		**Not noted**
Do other firms or analysts have alternative measures of competitiveness or views on the appropriate industry strategy?	**x**	
Has the firm achieved better than industry growth, superior delivery, improved control, reduced down-time or changeover problems, reduced product or process errors, fewer complaints, an improved product development process, and/or any other definite and measurable progress relative to competitors?	**x**	
Do the firm's metrics go beyond financial to areas like customer satisfaction, operational performance, and human resources?	**x**	
Does their evaluation system apply to new product development and		

significant projects as well as to continuous operations?

Summary and Conclusions

Conclusions and Results

Can you summarize mission statement on the role and impact of IT as a tool of competitive advantage for this firm in this industry?	**x**	
Is it consistent with strategies identified as successful or appropriate in existing competitiveness research from Sloan's industry study center?	**x,** 1996 book	
Are there important business or IT situations requiring further research?	follow-up	
Are intellectual property issues important in explaining firm's successful and sustainable use of IT to achieve competitive advantage?		**x**
Are beneficial cost impacts generally an important consequence of this firm's successful software strategy?	**x**	
Does this company fit a profile where IT seems most likely to contribute to enhanced competitiveness?	**x**	
Based on this study is the market for vertical application and embedded software growing?	probably	
Since Japanese competitors normally do not outsource, do Japanese firms see themselves as benefiting from this US trend?	possibly	
Does this leading Japanese firm assign positive value to improved integration and enhanced control through selective customization?	**x**	
Do general measures such as decreased costs, as evidenced by reduced account servicing expenses, reflect benefits of a successful IT strategy?	**x**	
Are the benefits of a successful software strategy also reflected in specific industry standards such as an expanded customer base?	**intent**	
Does this leading IT user have explicit criteria for selecting package versus customized software and for semi-customizing IT packages?	**x**	
Does this firm closely integrate or couple their software and business strategies beyond mere alignment?	**ntegral**	
Do they closely integrate their organizational and HR policies with their software systems?	**x**	**x** but

Have they reorganized to use software and information technology?		created ENICOM
Has IT codified or built on existing organizational strengths or core competencies, including HR alignment with business and IT strategies?	**x**	
Have they embraced and integrated information technology as part of their business strategies and core competencies?	**x**	
Is MIS function integrated with the rest of steel division in terms of organization and decision making?	**x**	

APPENDIX II

SOME INDUSTRY AND FIRM DATA

Financial Positions Large Japanese Steel Companies 3/3/98 and Forecast (Harada 1998)

Consolidated (Billions of Yen and %)

Company		Sales	Growth Rate	Operating Profit	Ordinary Profit	After-Tax Profit
Nippon Steel	‘98	¥3077	0.9%	181.6	86.5	5.9
	’99	2950	-7.0	130.0	80.0	2.0
	’00	2930	-0.7	120.0	80.0	5.0
NKK	‘98	1934	3.0	73.6	37.2	14.3
	’99	1860	-3.8	54.0	18.0	5.0
	’00	1850	-0.5	52.0	17.0	4.0
Sumitomo	‘98	1469	0.8	98.7	40.7	4.0
	’99	1450	-1.3	94.0	31.0	11.0
	’00	1500	3.4	104.0	41.0	20.0
Kawasaki	‘98	1244	0.9	74.8	43.4	8.5
	’99	1200	-3.5	70.0	42.0	14.0
	’00	1200	0.0	73.0	46.0	18.0
Kobe	‘98	1535	0.1	84.4	12.9	-4.9
	’99	1450	-5.5	67.0	0.0	-6.0
	’00	1430	-1.4	63.0	-4.0	-8.0

Source: Nikko Research Center

Crude Steel Production Major World Areas 1970-95 (Ostrom 1996)

Country/Year	**1970**	**1975**	**1980**	**1985**	**1990**	**1995**	**(million M/T)**
Japan	93.4	102.3	111.4	105.3	110.3	101.7	
US	119.3	105.8	101.5	80.1	89.7	93.6	
Other G-7	106.0	123.3	128.0	120.3	118.6	110.9	
China	17.0	23.9	37.1	46.7	66.3	93.0	
Korea	0.5	2.5	8.6	13.5	23.1	36.8	
Other	256.7	290.4	329.7	353.0	362.0	313.6	
World Total	592.8	648.2	716.3	718.9	770.0	749.6	

Rankings of Major Integrated International Steel Companies

Nikko Research Center (Harada 1998) – Times per year, ¥ bil, MT, 1000¥

Company*	Gross Asset Turnover	Rank	Free Cash Flow	Rank	Tons per Worker	Rank	¥ Operating Expenses/ton	Rank
Nippon Steel	0.69	8	89	3	1048	2	79.9	7
NKK	0.63	10	68	5	664	4	104.9	11
Sumitomo	0.53	12	-13	10	649	5	93.8	10
Kawasaki	0.51	13	73	4	853	3	87.6	8
Kobe	0.64	9	33	6	440	9	179.8	12
Thyssen AG	1.52	1	-27	11	75	13	293.6	13
Usinor Sacilor	1.09	2	113	2	256	11	89.3	9
USX	0.99	3	25	7	508	7	64.8	6
Bethlehem	0.92	4	-33	12	468	8	57.7	5
Iscor	0.87	5	2	9	132	12	47.1	2
British Steel	0.87	6	114	1	322	10	57.3	4
LTV	0.76	7	14	8	569	6	54.7	3
Pohang	0.61	11	-64	13	1234	1	46.4	1

Source: Nikko Research Center (Harada 1998)

Cost Reduction Efficiency Indices Major Japanese Producers 1994-98 (Average 1994=100)

Company/Year	**1994**	**1995**	**1996**	**1997**	**1998**	**'94-'98 Reduction**
NSC	100.4	96.8	93.5	95.4	94.1	-6.3
NKK	99.9	98.0	94.9	95.3	96.2	-3.7
Sumitomo	100.4	98.1	94.9	95.1	95.5	-4.9
Kawasaki	100.5	98.8	96.3	95.1	94.0	-6.5
Kobe	97.6	95.0	92.7	95.6	96.6	-1.1

Source: Nikko Research Center (Harada 1998)

Expected 1997-98 Steel Related Earnings, Volume & Prices (Unconsolidated) – (¥ Billions)

Company/Year	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997E**	**1998E**
Nippon Steel Revenues	2231	1950	1723	1683	1722	1722	1725	**1720**
% Total Sales	84.8	82.3	79.8	80.5	82.0	79.0	78.6	**78.2**
Volume (million MT)	26.7	24.1	24.4	25.4	25.7	25.9	25.9	**25.8**
% Annual	-3.3	-9.7	1.4	3.8	1.2	0.7	1.0	**-0.4**
Price/ton (¥1000/MT)	83.6	80.9	70.5	66.3	67.1	66.6	66.6	**66.7**
% Annual	1.8	-3.2	-12.8	-5.9	1.1	-0.7	0.1	**0.2**
NKK Revenues	978	866	760	734	740	724	732	**726**
% Total Sales	74.4	68.6	63.2	62.6	63.8	61.1	64.2	**63.9**
Volume	11.7	10.7	10.6	10.3	10.2	10.0	10.2	**10.0**
% Annual	-3.7	-8.7	-1.2	-2.8	-0.9	-1.5	1.0	**-1.5**
Price per ton	80.5	77.2	68.9	66.9	67.8	67.7	67.9	**68.4**
% Annual	2.5	-4.1	-10.7	-3.0	1.4	-0.1	0.3	**0.7**
Sumitomo Revenues	991	908	857	843	844	855	863	**862**
% Total Sales	85.6	81.8	82.2	83.3	79.8	84.2	83.7	**82.9**
Volume	10.1	9.4	9.5	10.1	10.0	9.9	10.0	**9.9**
% Annual	2,8	-6.4	0.2	6.8	-1.3	-0.2	0.5	**-1.0**
Price per ton	98.2	96.1	90.6	83.4	84.6	86.0	86.0	**87.0**
% Annual	1.1	-2.1	-5.7	-7.9	1.4	1.6	0.0	**1.2**
Kawasaki Revenues	926	823	715	688	706	702	723	**719**
% Total Sales	76.7	75.3	71.1	70.2	76.1	74.4	74.6	**74.3**
Volume	10.4	9.8	9.8	10.2	10.2	10.1	10.5	**10.4**
% Annual	-0.5	-6.0	0.2	4.6	-0.6	-0.8	3.8	**-1.0**
Price per ton	88.8	84.0	72.9	67.0	69.2	69.5	68.9	**69.1**
% Annual	1.7	-5.5	-13.2	-8.0	3.3	0.3	-0.8	**0.3**
Kobe	630	516	514	477	500	506	516	**519**
% Total Sales	48.4	43.9	50.9	44.8	43.6	44.3	44.7	**44.4**
Volume	5.4	5.0	5.0	4.6	5.0	5.1	5.2	**5.1**
% Annual	-2.4	-8.9	0.1	-6.7	9.0	1.7	0.5	**-1.0**
Price per ton	78.3	75.0	67.7	64.1	63.0	62.5	64.0	65.5
% Annual	-	-4.1	-9.7	-5.3	-1.7	-0.8	2.4	2.3

Source: Salomon Brothers Japanese Equity Research (Yoshida 1997)

Key Firm Data - Nippon Steel (Billion Yen)	3/31/93	3/94	3/95	3/96	3/97 (NSC 1997)
Revenues	¥2951.4	2749.4	2881.1	2954.9	3061.3
Operating Income	115.9	(10.9)	92.3	193.4	142.1
Income Pretax	(59.7)	(0.0)	(17.9)	57.0	(25.1)
Steel Revenues	2170.3	1934.1	1998.4	1993.9	2015.7
Customers	2170.3	1934.1	1976.4	1971.2	1991.9
Intersegment			22.0	22.8	23.8
Steel Operating Income	79.3	(53.5)	63.0	115.1	109.6
Total Assets	4475.5	4346.3	4547.5	4527.3	4509.5
Steel Related Assets				2966.5	2968.8
Depreciation Steel Assets				181.0	177.3
Capital Expenditures Steel				160.6	146.8
Production & Shipments of Steel (million tons)					
Crude Steel Output	25.3	25.1	26.6	26.2	25.7
Steel Products	24.1	24.3	25.3	25.6	24.7
Steel Shipment	24.1	24.4	25.4	25.7	25.9
Employees	36316	34619	31072	27583	24527
Hidden Assets at Market Value (billion Yen)				1152.4	605.4
100% Investment ENICOM (billion Yen)					4.9
After Tax Return on Equity (%)	0.2	-5.6	-0.5	6.0	0.4

Firm Data (billions of ¥en) **ASSETS & LIABILITIES**	**1996 (3/96)**	**1997 (3/97)**
Cash, Short term Money Claims	508.2	457.9
Receivables	679.8	788.4
Inventories	727.8	668.8
Other Current Assets	95.2	89.7
Fixed Assets	1587.6	1557.1
Land	294.3	281.9
Construction in Progress	70.7	68.9
Other Assets	563.7	597.8
Total Assets	**4527.3**	**4509.5**
Liabilities	**3623.9**	**3618.4**
Equity	**903.4**	**891.1**

Source: (Nippon Steel 1997)

Nippon Steel Consolidated Earnings Model 1990 – 1997E (¥ Billions)

Salomon Brothers Japanese Equity Research (Yoshida 1997)

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997E**
Total Sales	3209	3230	2951	2794	2881	2955	3061	**3100**
Steel Revenues	2527	2487	2170	1934	1976	1971	1992	**1995**
Operating Profit (OP)	250	196	116	-11	92	193	142	**195**
Steel OP	200	159	79	-53	63	115	110	**145**
Steel Operating Margin (%)	7.9	6.4	3.7	-2.8	3.2	5.8	5.5	**7.3**

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