New Trends in the Supplier-Customer Relationship between Steel Mills and Automakers

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1. Introduction

As key national industries, the automotive and steel industries are closely related from the perspectives of forward and backward linkage effects, and represent a relative importance in GNI (gross national income) and employment population. Governments politically support these industries and protect their domestic markets from foreign competitors by adopting various policies such as safeguards, import quota systems, and with free trade agreements such as the EU and NAFTA (North American Free Trade Agreement). The regional productions of automotive vehicles in the year of 2001 recorded about 36% in Europe, about 32% in Asia, and about 28% in North America (Korea Automobile Manufacturing Association 2003). Morcott(2000) says that 70% of the new growth in the automotive industry will come from markets outside of North America, Western Europe and Japan. China's automotive industry is now emerging with about a 12.8% production increase in 2001 compared with the previous year. However, it is still in the pursuit of localization and motorization through the intensive acquisition of advanced technologies from the world's leading automakers.

Steel is one of the most consumed materials in the automotive industry, and in particular flat products such as hot rolled, cold rolled and coated steel sheets account for about 80% of steel products consumed by automakers. Approximately 14~15% of domestic shipments by U.S. steel mills has been sent to automakers during the last 10 years (AISI 1991~2001). However, lightweight materials such as aluminum, magnesium and plastic are rapidly substituting for steel as automotive body sheets. For instance, steel as a percentage of automotive body weight decreased by about 10.3% points during the last 24 years; that is, from 81.1% in 1973 to 70.8% in 1997 while competitive lightweight materials increased by about 9.2% points from 7.9% to 17.1% (Takita and Maruta 2000).

The world's leading automakers in North America, Japan and Europe have steadily supplied high quality products from adjacent local mills over cooperative, interdependent and long-term contracts. Major steel suppliers in these regions can be considered to be US Steel, AK Steel and International Steel Group (ISG) in the United State, Arcelor and ThyssenKrupp Stahl in Europe, and Nippon Steel Corporation (NSC) and JFE Holdings in Japan. Once steel processing facilities, dies and tooling machines are established at an automobile manufacturer, it is not a simple matter to change to new steel suppliers or products due to a high switching cost.

Morcott(2000) defines five new trends in the automotive industry: globalization, speed to market, modular manufacturing, consolidation and increasing technologies. The mega-mergers and acquisitions between global automakers are being spread worldwide so that they are stronger in their bargaining power against suppliers. Furthermore, automakers tend to adopt global sourcing, concentrate purchasing with fewer suppliers and expand

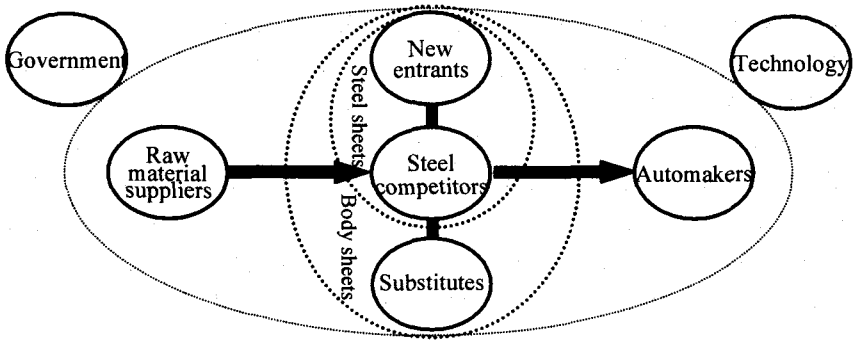
their outsourcing range. Then suppliers are more responsible for technological innovation as well as cost reduction, development time reduction and quality improvement.

Technology innovation can be classified into two patterns: radical and incremental innovations. In the case of automotive steel sheets, radical innovations such as hot-dip galvanizing steel (HDG) and electro-galvanizing steel (EG) have resulted in the substitutes of cold rolled steel (CR) for corrosion resistance. On the contrary, through incremental innovations such as continuous casting and continuous annealing, the improvements of productivity and quality as well as cost reduction have been obtained. Both types of technology innovation have to be continuously performed in order to maintain market leadership.

This study considers new trends in customer-supplier relationships in the automotive steel sheets market. The second section we describe competitive environments of automotive steel makers based on Porter's competition model. Then, as one of the major material suppliers, the essential role of steel mills in new product development is defined in the third section, including their technical responsibilities based on life cycle assessment. In the fourth section, automakers' role transfers to steel mills in stamping and painting processes are shown with new trends in buyer-supplier relations. Our conclusions are presented in the final section.

2. Competitive Environments for Automotive Steel Sheet Makers

In order to consider the industry environment based on the concept of competition, Porter(1998) defines five forces driving industry competition: industry competitors, buyers, suppliers, potential entrants and substitutes. In the automotive body sheets market, steel mills are competing with their own competitors including new entrants and the lightweight substitutes such as aluminum and magnesium. In addition, steel mills are squeezed between steel consuming automakers and raw material suppliers such as iron ore and coking coal. However, Huh and Kim (2002) add the two forces of technology and government to Porter's list, as shown in Figure 1.



<Figure 1> Seven Forces Driving Competition for Automotive Steel Sheets Makers

In order to protect their own industries, governments strictly control market entry and exit through business permission or approval. Until the 1980s, the Chinese and Indian governments prohibited the entry of foreign automakers, while their protection barriers are becoming alleviated according to the WTO entry and market opening policy. Recently, new emerging countries such as BRICs(Brazil, Russia, India and China (Wilson and Purushothaman 2003)) are proactively permitting the direct investment of foreign automakers possessing technical skills and capital power. Local manufacturers then supplement their technical and managerial capabilities in lower business risk. For global leading companies, this is the way to easily approach the target market and avoid trade barriers such as import tariffs, import quota systems and safeguards. Currently, free trade agreements between or among countries are widely spread in pursuit of mutual survival.

Technological innovations change the industrial structure and determine the level of competition among leading companies. In terms of the processes of industry evolution, the steel and automotive industries are in the mature stage and therefore, in fierce competition, market growth and technological innovation occur slowly. In order to maintain and/or expand the market with customer loyalty, competitive advantages such as cost leadership and product differentiation have to be accomplished through technological innovation in products and manufacturing processes.

The world's dominant mills in the automotive steel sheets market is divided into three continental regions with leading companies each, that is, NSC and JFE Holdings in Japan, Arcelor and ThyssenKrupp Stahl in Europe, and US Steel, ISG and AK Steel in the United States. As a follower, POSCO in Korea is expanding its market share since 1990s. To gain competitive advantages, steel mills have endeavored to expand their production capabilities in pursuit of the economy of scale. This can be achieved through the mergers and acquisitions of steel mills. Some mega-mergers in the global steel industry have recently performed, that is, Arcelor in Europe, JFE Holdings in Japan, and ISG in the United States. However, the steel industry is not much concentrated compared with the automotive industry because the steel industry is based on a domestic market as one of key industries in a country. Therefore, strategic alliances among global steel mills such as technology collaboration are rather preferred, which is not financially allied.

Furthermore, through strategic alliances between or among global steel mills possessing high value creating capability such as Arcelor and NSC, TKS and JFE Holdings, and POSCO and NSC, the acceleration of growth and technology acquisition can be expected. Global leading mills have made technological collaborations in automotive steel sheets. It is noticeable that Japanese mills with the technology leadership are allied with regional leading mills worldwide. Especially, their technical skills in coated and high-strength steel sheets (HSS) are top ranked in the world. In order to catch up with this technological gap or supplement their weakness, even global leading mills have engaged in technology collaboration or exchange programs with Japanese steel mills.

New entrants, Baosteel in China and Tata Iron and Steel Corporation (TISCO) in India, are threatening the traditional players through the remarkable growth of domestic automotive market and transfer of offshore technology. The technology renovation in steel business offers advantages to new players versus traditional ones because the technological barrier and capital investment for facility are getting lower.

In the mean time, competing materials such as aluminum, magnesium and plastics challenge conventional body steel sheets with an extraordinary impact of lightweight. However, steel products are still much less expensive than light metals. Aluminum is unsuitable as a replacement for steel due to the price, although it is competitive in performance where LME(London Metal Exchange) official price of aluminum in February 13, 2004 was US$1,695 per tonne while Western Europe export price of cold rolled coil was US$455 per tonne (www.metalbulletin.com). Besides, key technologies of light metals such as energy efficiency and CO_2 emissions during recycling are under being developed although they are much progressed.

The main raw materials for steel making are iron ore and coking coal. As shown in Table 1, the global iron ore industry is highly concentrated in which top ten iron core companies account for about 97% of global market share. Especially, three companies of BHP Billiton and Rio Tinto in Australia and CVRD in Brazil are dominating on the global iron ore market with about 70% market share. By the sharp demand growth of Chinese steel mills, the pricing power of these companies is extremely influential over the iron ore consuming industry.

<Table 1> Industry comparison with global market shares of top 10 companies

Industry	Platinum	Iron ore	Nickel	Cement	Aluminum	Steel
Market share(%)	98	97	95	50	49	27

Source: Exane 2003, CRU 2003

As shown in the above model of Figure 1, steel mills are under the severe pressure in the middle of two strong parties, original equipment manufacturers (OEMs) and raw material suppliers with the competitors and substitutes. The global steel industry is far less concentrated where top ten steel mills control only about 27% of global market share. Note that world's top ten automakers in 2002 account for about 73% productions in the world (Korea Automobile Manufacturing Association 2003). Consequently, steel mills have lower negotiation power against both customer and supplier industries. To make matters worse, the steel industry is threatened by the overcapacity problem worldwide.

It is not simple to accurately estimate the speed and impact of market change because a revolution in technology progresses so fast in a worldwide range, and therefore, various perspectives of marketing should be strategically integrated in order to survive in fierce competition. Among ten marketing perspectives defined by Bearden et al.(1999), the customer relationship of steel mills is mostly concerned in the globalization of the automotive industry. Strategic alliances between automakers and/or suppliers have been performed worldwide in pursuit of the economies of scale and scope as well as the share of risk burden for technology development. The world's leading automakers preferentially adopt global sourcing, concentrated purchasing, and platform unification for a reduction of production costs and time. Furthermore, the modularization or systemization of vehicle components accelerates the interdependent partnership of OEMs with tier-1 suppliers. Generally, the modularity is performed as an attempt to reduce the capital invested by automakers, to share the business risk with suppliers and to reshape the firm boundary with the relationship between automakers and suppliers (Salerno 2001, Doran 2003). Morcott(2000) says that modular manufacturing offers the opportunity to increase content, provide valued-added services, advance technology, and develop systems integration expertise for suppliers, and the reductions of cost, risk, development time and administrative expense, and improved capital efficiency for OEMs.

The concept of relationship is based on a close linkage of companies with stable and long-term contracts, with an eventual goal of developing an organic cooperative system in total marketing. In relationship marketing, the customer and its suppliers in mutual trust share related information/technology and pursue common business goals through win-win value chain systems. That is, steel mills can stabilize the volume of sales with more accurate demand forecasting in longer-term contracts while automakers can develop a stable supply chain from the aspects of both cost advantage and product differentiation.

3. Possible Roles of Automotive Steel Suppliers in New Vehicle Development

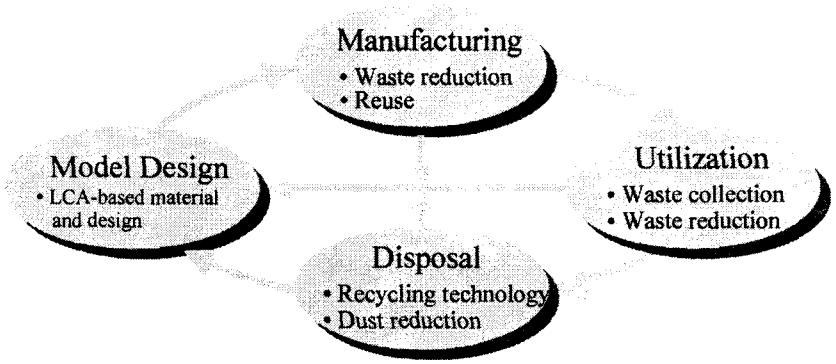
From technological aspects of materials, OEMs are concerned with innovative substitutes, new components by using conventional materials, improvement of physical and mechanical properties, and processing technologies. Then, they ask steel mills to devote to advanced technology development and to have capabilities in forming simulation and predictive modeling. Steel mills also suggest on tooling design, material applications and stamping process with appropriate simulation and CAD software.

Through the early selection of steel suppliers, automakers make them to join much earlier than the production in order to be provided sample materials. It is obvious that the activities of steel mills in the conceptual design and engineering phases make a great contribution towards the automotive industry technically and economically. That is, the earlier steel mills are involved in a new model development, the more development time and cost are saved with higher quality. If critical failures or corrections caused by materials occur during manufacturing processes, basic and detailed engineering designs might be reworked, even with fundamental changes such as the conceptual design. Generally, once the commercial production has been started, automakers do not change the materials and their suppliers. This is the merits to steel mills which involve earlier. In the engineering phase,

Four types of engineers can be considered in automotive steel: design, tooling, cost reduction and service

engineers. Design engineers focus on designing chemical ingredients of steel, simulating collision and vibration, and testing formability and crashworthiness with customers. Tooling engineers solve problems in stamping, and support steel selection by analyzing the formability of each body part. Cost engineers find methodologies of how to reduce automakers' production cost in whole phases of Table 5; for example, lightweight steel and optimal logistics. Automakers expect that roles of steel mills are extended to processing fields, beyond steel designing and technical service as their traditional roles.

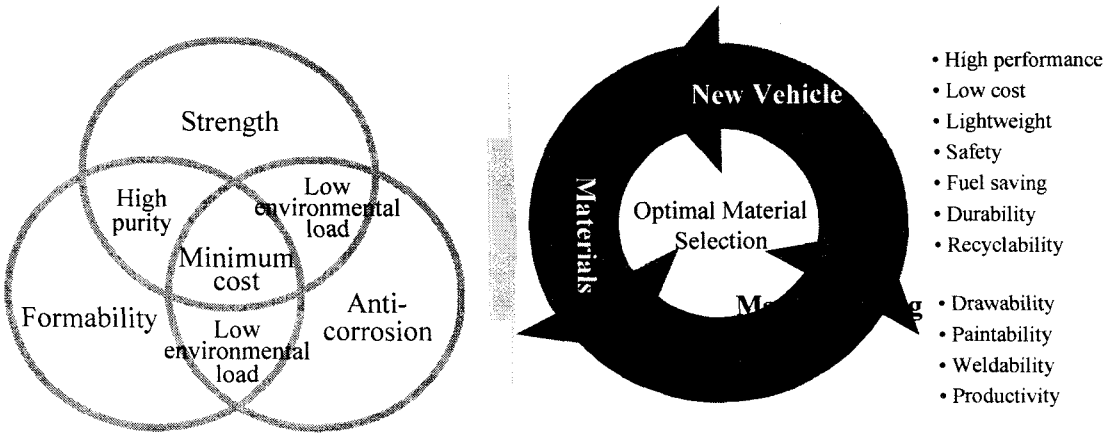
Up to now, steel mills' roles are considered on the aspects of new vehicle development and utilization. However, automotive materials should be selected based on the end-of-life vehicle (ELV) from model design to disposal, as shown in Figure 2. Recently, the phase of disposal is emphasized in order to reduce the environmental burden according to the laws of product liability and environmental protection. It seems that automakers will transfer the burden of vehicle disposal costs to suppliers sooner or later.



<Figure 2> Automotive Material Selection based on the End-of-Life Vehicle

In order to satisfy environmental regulations in domestic and global markets, automakers pursue 3R - recycle, re-use, and reduce - environmental technology strategies to suppress waste and hazardous materials. Life cycle assessment (LCA) based model design is performed, including easy decomposition, material unification as much as possible, and reduction of dust.

Through the feedback of results at each stage, material selection systems in a vehicle development can be developed under the consideration of constraints such as appearance, style, functional performance, comfort, durability, collision safety, fuel saving, reduction of emissions, hazardous materials and waste disposal, recycle and reuse. Then, automotive steel sheets are required some important physical properties such as high strength, excellent formability and corrosion resistance as shown in Figure 3. These are based on the customer needs and life cycle assessment of a vehicle.



<Figure 3> Physical Properties of Automotive Steel Sheets based on the LCA

The lighter the weight of a steel product, the more satisfied are customer needs and the more growth the market enjoys. And, the more value-added are their products, with high strength and advanced manufacturing skills, the more marginal are the earnings of a firm. global leading steel mills have developed advanced products such as high strength steel (HSS) or advanced high strength steel (AHSS) as well as new manufacturing technologies such as hydroforming and tailored blanks welding. Advanced products require more intensive technical support of suppliers for customers, and it makes the relationship of OEMs and steel mills stronger and more interdependent.

4. OEMs' Traditional Role Transfer to Automotive Steel Suppliers

Veloso(2002) classifies OEM suppliers into four categories such as system integrator, global standardizer, component specialist, and raw material supplier, based on the main roles of each category. System integrator provides a module or system for manufacturing plants and global standardizer sets forth the standard of each component on the global market base. Component specialist designs and manufactures a component precisely fabricated for a vehicle. Finally, raw material supplier provides either OEM themselves or OEM's suppliers with materials like steel, aluminum, etc.

Actually the position of steel mills is not clearly defined in the supply chain of automotive steel sheets. Steel mills could supply to automakers directly as tier-1 or to their subcontractors as tier-2 and so forth. As the most consumption material in the automotive industry, steel products are relatively of less importance on the supply chain. If steel mills just stay in the existing roles as raw material suppliers, they will be threatened by the substitute or processing business with value adding activities. The more tier-1 outsourcing of OEMs, the more modularization or total solution system progressed. Then, steel mills have to find value adding activities in the extended value chain, ultimately pursuing the component specialist of Veloso. According to the proactive outsourcing policy of OEMs to tier-1 suppliers, steel mills are taking over some assembly processes of OEMs in a maximum range, including component processing. We will consider two cases of OEMs' role transfer such as TWB in stamping process and pre-painted steel sheets in painting process.

In conventional manufacturing processes of the automotive industry, a body panel is pressed or stamped from a single blanked sheet. Generally, each panel requires 4~6 stamps with the same number of stamping dies. However, a panel may require different functional properties such as strength, formability, thickness, coated or uncoated format, etc. In such a case, the steel sheets are tailored on the basis of customer specifications and tailored blanks are welded together by using 3-D laser beams. This process is known as tailor welded blanking (TWB). Conventional and TWB stamping processes are compared. Steel mills take over part of stamping and welding processes in automaker's conventional roles and create value added products, not coils or blanks through simple slitting and shearing processes. TWB is also beneficiary to automakers because their investment cost and processing time can be reduced. Furthermore, the TWB technology can reduce body weights by selecting optimal steel sheets for each composite with the effects of fuel savings and low emissions. It is known that the value of TWB sheets is about 1.5 to 2 times as much as conventional steel sheets.

TWB processing business in steel mills pursues in order to enhance the customer-supplier relations with major automakers, rather than the profitability. Thyssen Fugetechnik in Germany initially started to produce TWB products in 1985 and there were 12 TWB makers worldwide in 2002.

Since 1998, TWB investments have actively been carried out in Asia and POSCO and Hyundai HYSCO in Korea have competitively participated in TWB facility investments in recent 2~3 years. Recently, Baosteel in China made an agreement with Arcelor in Europe for the establishment of a TWB joint venture aimed at

operation in 2004. Their TWB products will be supplied to global joint venture automakers in China such as Shanghai Volkswagen, First Auto Works Volkswagen, Shanghai GM, Changan Ford, and Guangzhou Honda.

The world's leading steel mills in Europe are currently focusing on the innovative technology of organic coating such as pre-sealed, pre-primed and pre-painted skills, in order to improve the formability and corrosion protection of life-long rust warranty and simplify the painting processes of OEMs. OEMs will adopt pre-painted steel sheets in the near future, which will eliminate further in-house painting processes of automakers.

These sheets are not so widely spread yet but Western Europe and Japan where are technically advanced. Western European steel mills such as ThyssenKrupp Stahl, Arcelor, Salzgitter and VoestAlpine are globally leading this research area with major customers such as DaimlerChrysler and Volkswagen in Germany. However, there is demand potential likewise TWB was rarely applied in the early adoption period.

According to the expansions of outsourcing range and modularization, some activities of OEMs in the value chain will be proactively shifted to their major suppliers, and they will only perform certain key managerial activities including conceptual design and marketing. It seems that most of OEMs' manufacturing processes will be continuously outsourced and they will maintain only few key roles such as R&D, design and marketing. Therefore, steel mills have to extend their existing roles with value added processes such as stamping and painting, not a raw material supplier on the conventional supply chain.

Staying as a raw material supplier, a steel mill will be controlled by OEMs or even threatened by its market competitors. If a steel mill extends to value added processes such as tailored blanks welding or pre-painting or co-operate with technically advanced regional mills, it could maintain the current market position. However, those activities are not be enough for the provision of future market and have to extend to a total solution provider or component specialist.

According to the role extension of steel mills up to stamping and/or painting processes, automakers become more dependent upon technical capabilities of suppliers with high levels of exchanges of information and knowledge about market trends and innovative materials including frequent offering of suggestions for quality improvements. However, automakers require stronger commitment to preferred steel suppliers while lowering the number of suppliers and lengthening contracts in order to keep technological innovation from rivals. Consequently, supplier relations between automakers and steel mills are becoming more cooperative, interdependent and longer-term contracts in loosely coupled networks (Brusoni and Prencipe 2001b) which are led by automakers as system integrators. Here, a system integrator firm outsources engineering design and manufacturing to suppliers while maintaining in house concept design and systems integration capabilities to coordinate the work of suppliers (Brusoni et al. 2001).

5. Conclusions

In facing fierce competition in the global market, key industrial manufacturers such as automakers and steel mills have endeavored to achieve a competitive advantage through cost leadership and product differentiation with technological innovation. The world's leading automakers have preferentially adopted global sourcing, concentrated purchasing, and platform unification for a reduction of production costs and development time and quality improvements. Furthermore, they are gradually expanding the range of outsourcing to tier-1 suppliers and adopting processes that include the modularization or systemization of vehicle components. Some experts argue that the traditional roles of OEMs will be shifted to their suppliers in the future, and they will only perform certain key managerial activities including conceptual design and marketing in the value chain. Eventually, automakers could adopt outsourcing systems in the style of Dell Computers, where automakers as a system integrator have architectural technological capabilities as well as modular knowledge in loosely coupled networks with suppliers.

As steel is one of the most consumed materials in the automotive industry, this study considered new trends in buyer-supplier relations between automakers and steel mills. The world's leading automakers in North America, Japan and Europe have steadily supplied a high quality of products from adjacent local mills over cooperative, interdependent and long-term contracts. Major steel suppliers in these regions are US Steel, AK Steel and ISG in the United State, Arcelor and ThyssenKrupp Stahl in Europe, and NSC and JFE Holdings in Japan. Since the cost of switching to new suppliers is high due to expensive processing facilities, dies and tooling machines and the uncertainty or risk of steel quality, automakers show a tendency of not easily changing steel suppliers.

Automakers urge annual cost reductions of their steel suppliers, typically 3~5% per annum, and encourage their advanced technology development and capability in forming simulation and predictive modeling. Advanced products require the more intensive technical support of suppliers and then, make the OEMs more dependent on steel mills. In addition, global leading automakers have adopted the early vendor involvement program in order to induce the participation of steel suppliers at an earlier stage in new model development. The activities of steel mills, even in the conceptual design and engineering phases, make a great contribution towards the automotive industry both technically and economically. Through more face-to-face contacts and discussion with customers, steel mills investigate customer needs in new steel products and also carry out problem-solving activities. These initiatives can be accelerated by co-locating guest engineers from steel mills at the sites of automakers.

It seems that OEMs' manufacturing processes will be continuously outsourced and they will maintain only few key roles such as R&D, design and marketing. At the same time, steel mills will have to extend their existing roles with value-added processes such as stamping and painting, and not merely act as a raw material supplier on the conventional supply chain. If it remains a mere raw material supplier, a steel mill will be controlled by OEMs or even threatened by its market competitors. The responsibility or risk of OEMs in technology development and cost reductions will be shared with steel mills according to the expansion of roles in the value chain. According to the role extension of steel mills up to stamping and/or painting processes, automakers have become more dependent upon the technical capabilities of suppliers with high level exchange of information and knowledge about market trends and innovative materials including the frequent offering of suggestions for quality improvements.

On the contrary, automakers require a stronger commitment to preferred steel suppliers while lowering the number of suppliers and lengthening contracts in order to keep their technological innovation from rivals. In addition, the strong commitment of both parties can be expected due to the relationship between automakers (as systems integrators) and their suppliers, which is governed by contractual partnership arrangements such as cost-sharing agreements, joint ventures and formal alliances. Although the phenomenon of collaboration between the steel and automotive industries is not widely spread, an evolving relationship between automakers and steel mills seems inevitable.

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