

Challenges Facing the Rebirth of Japanese Manufacturing: Part 1

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The importance of manufacturing has again come to be recognized not only in Japan, but also in the United States and Germany in their pursuit of economic globalization and because of growing expectations for greater innovation, growth in domestic employment, higher incomes and other economic multiplier effects that manufacturing could have on other industries.

German companies have created a business model enabling the design and development of products that are tailored to meet local needs in emerging economies even with limited development resources available there, and have continued to gain momentum in these markets. In the United States, both the public and private sectors work toward developing the next generation of manufacturing such as creating services through the integration of IT and manufacturing. The moves of these two countries provide a valuable source of inspiration for Japan's manufacturing industry.

Among emerging economies, the presence of China has overwhelmed all others. While Japanese companies that are already operating in the Chinese market have been struggling in the face of fierce competition from local businesses, the fact remains that the Chinese market still presents immense potential. In inland China, which has huge growth potential, there is a wide range of growth areas where first-mover advantage can be attained. Companies should actively explore the possibilities without pessimism. While India also presents a very large potential market, the pace of growth is not as fast as that in China. For the time being, given the rich engineering talent that the country possesses, focus should be given to the country not just as a market but also as a design and development center aimed at emerging economies.

In order to successfully respond to the diversification of the global market that includes developed and emerging markets, a need exists for the establishment of a system whereby all business processes ranging from marketing to product planning, design, development and production are carried out in local markets. This full localization cannot be achieved by Japanese executives alone. Rather, human resources should be recruited on a global scale, and a personnel management mechanism whereby employees can be trained up to management level is required.

I Abenomics and the Revival of Japan's Manufacturing Industry

The Outlook for FY 13 – 14 Corporate Earnings, which was published by Nomura Securities on August 30, 2013, forecast sales growth of 10.3 percent and recurring profit growth of 36.1 percent on a year-on-year basis for companies in the Russell/Nomura Large Cap Index (excluding financial firms) for FY 2013. These growth projections were the highest since FY 1989 in the midst of the asset bubble. For FY 2014, sales growth was projected to stand at 3.0 percent and recurring profit growth at 12.0 percent year-on-year. While these growth rates are smaller than those for the preceding fiscal year, nevertheless, an upward trend is projected to continue, and recurring profits are forecast to reach the level of FY 2007 when the previous peak was reached. This significant increase in projected profitability for FY 2013 could be attributed to the emergency economic stimulus measures adopted as part of Prime Minister Abe's economic policy mix (dubbed "Abenomics"), which are beginning to take effect, in particular, in the form of significant benefits provided by the weaker yen.

Nevertheless, there are still some concerns that keep us from celebrating. Looking at exports, which constitute a major source of revenue for manufacturers, although there is year-on-year double-digit growth in terms of yen value, the figures are down or at least staying level in terms of volume. In and after March 2013, the yen value of exports entered positive territory relative to the same months of the previous year, up 12.2 percent in July and 14.7 percent in August (Figure 1). However, according to Trade Statistics of Japan published by the Ministry of Finance, in terms of volume by product, exports of "automobiles" showed a 23.4-percent increase in August in terms of yen value, although growth was only 0.8 percent in terms of the

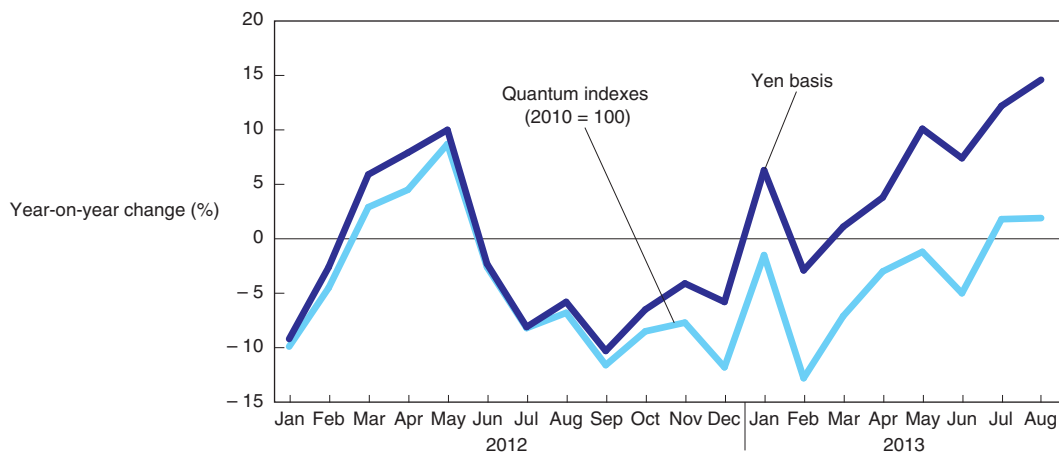
number of units shipped. Similarly, exports of "ICs" (integrated circuits) recorded a 15.8-percent increase in August in yen value, even though the volume was actually down by 3.9 percent, while exports of "computers" were up by 15.9 percent in yen value, but down by 17.5 percent in volume.

Although Japan's exports appear to have made a rapid recovery in terms of yen value, we find that some sectors have not actually done so when we consider the volumes shipped. For this reason, it is not possible to positively say that Japan's export competitiveness has recovered. Although some people believe that "a weaker yen will boost export competitiveness, which will then lead to larger shipments in the future," the author does not believe that the situation is that straightforward. Many exporters have already pursued a policy of moving their production capacities overseas, such that a considerable portion of the value chain on which business is based now resides abroad.

Exports would continue to grow if new technologies were developed in Japan, giving rise to new products that could be exported overseas. However, if this were not the case, the growth of exports from Japan would peak out simultaneously with an end to the fall in the value of the yen.

With the sales and production of existing products and services having been increasingly localized as time passes, the current trend is toward moving overseas even for planning, development and design functions. For markets, in particular, those of emerging economies, where the target costs, required levels of quality and specifications are completely different from those for the Japanese market, a company must commit to a policy of localization if it is to not lose out to local competition. In view of this need, moving the value chain for business overseas is inevitable. Therefore, to compensate for such outflow, it is essential that breakthrough innovations occur within Japan, leading to the creation of new products and services. As such, Japanese companies must be successful both in pursuing a

Figure 1. Japanese exports (in terms of yen value and volume)



Source: "Japan's International Trade in Goods (Monthly)" published by the Japan External Trade Organization (JETRO).

global strategy of full localization and in developing new technologies and business models originated in Japan. However, considering long-term market trends, the development of any technologies and business models within Japan must also be based on the assumption that these technologies and business models will eventually be offered in overseas markets. Similarly, the development of new products and services that originate in Japan would be meaningful only when a robust globalization scenario underlies such development.

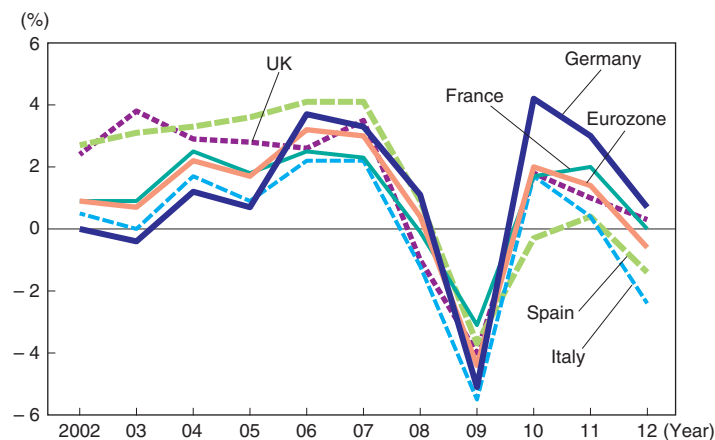
The depreciation of the yen as a result of Abenomics has given Japanese companies an opportunity to regain their profitability. For companies to be competitive in global markets in the future, this recovered profitability must be directed towards investments at home and abroad so as to take full advantage of this golden opportunity. In this paper, the author takes a general view of the business environment surrounding the manufacturing industry in Germany, the U.S., China and India. Specifically, focus is placed on the industrial policy, market environment and industrial trends of these countries. While so doing, the author discusses the rebirth of Japanese manufacturing viewed from the perspective of a global strategy.

II Learning from Germany's Structural Reforms

1 The dramatic revival of the “sick man of Europe”

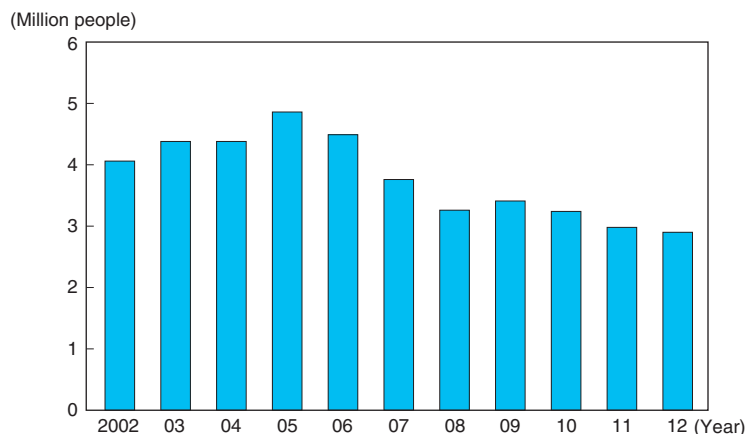
In the 1990s, starting with the reunification of Germany in 1990 and ending with the 1999 introduction of the euro, Germany was plagued by a recession with low economic growth and high unemployment rates, which earned it the moniker, the “sick man of Europe.” However, in the 2000s, bold structural reforms were implemented in both the public and private sectors, leading to the achievement of a stunning transformation and restoration of its status as the most productive and most competitive economy in Europe. Until 2005, Germany's gross domestic product (GDP) growth rate was the lowest of all major European countries. However, the country took the top spot in 2008, and exhibited a remarkable recovery since 2009 after the collapse of Lehman Brothers (Figure 2). In addition, the annual average number of unemployed persons fell by 2 million between 2005, when the figure was highest, and 2012 (Figure 3). As of

Figure 2. Real GDP (gross domestic product) growth rates of major European countries



Source: Organization for Economic Cooperation and Development (OECD).

Figure 3. Annual average number of unemployed people in Germany



Source: Federal Statistical Office of Germany.

July 2013, the unemployment rate in Germany stood at 5.4 percent, less than half that of the Eurozone average of 12.1 percent. Compared to 11.0-percent unemployment in France, Germany's unemployment is very low, to the point that there is even a shortage of human resources in some engineering fields. This shortage has led to drives to recruit talent from other European countries such as Spain and Portugal.

2 “Agenda 2010”—a package of economic and structural reforms

(1) Bold but painful implementation of structural reforms

One of the driving forces behind Germany's recovery was a series of economic reforms known as “Agenda 2010” proposed by former Federal Chancellor Gerhard Schröder in 2003. This initiative was said to be the biggest reform package undertaken by Germany since World War II, with changes to many areas such as social security, employment, wages and taxes. Despite being the leader of the Social Democratic Party (SPD), whose support base was trade unions, Schröder launched a business-friendly policy. Of course, the conservative opposition parties at the time, such as the Christian Democratic Union (CDU), welcomed this policy, allowing the bill to be passed without any resistance. The following paragraphs discuss the features of Agenda 2010.

When a comparison of unit labor costs was made across each European country by assuming the level in 2000 to be 100, in the subsequent eleven years, only Germany managed to keep its percentage increase in labor costs within a single digit, while every other country experienced increases in excess of 20 percent (Figure 4). Moreover, between 2000 and 2007, German unit labor costs actually fell slightly. While the remuneration of workers in other European countries has increased year on year, German workers have had to patiently endure a loss in their incomes. This was the primary goal of the Schröder reform. By putting the brakes on Germany's

Achilles' heel of rising labor costs, increasing unemployment was stemmed and employment levels were protected. The reduction in the number of unemployed people, which was discussed in Section 1 above, is said to be brought about by the effect of suppressing labor costs.

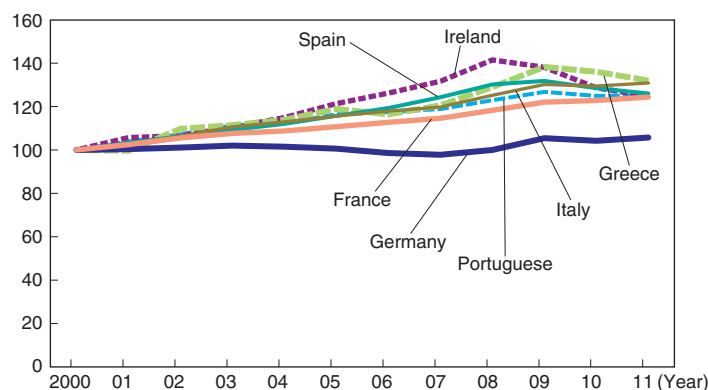
Since Schröder took office as federal chancellor in 1998, he had many discussions on labor cost reduction with trade unions and employers' associations. However, a breakdown in talks between labor and management in 2003 led to a negotiated settlement being abandoned, instead setting the government on a path toward labor reforms through legislation. These reforms, which included loosening dismissal restrictions and liberalizing rules for part-time and temporary work, considerably reducing unemployment benefits and shortening the entitlement period of such benefits, and de facto eliminating statutory minimum wages for certain occupations (low-wage jobs known as “mini-jobs”), have been painful for workers. Even so, in hindsight, this approach actually led to job growth.

Agenda 2010 also addressed the public pension system and health insurance system, implementing reforms that reduced the levels of service provided by the country's social security system, reduced the burden on businesses and moved more of the burden over to individuals.

Schröder believed that “companies will not increase employment unless their tax and social security burden is reduced.” In an interview after the government change, he stated “Germany's social security system has already reached its limits. By consuming more than the country produces, Germany will be left behind the rest of the world's economy if this situation continues.”

In fact, there is deep-rooted criticism that as a result of the Agenda 2010 reforms, the number of people in low-wage jobs has increased and the income gap has grown. On the other hand, within Germany's business community, the dominant view is that “currently, only Germany's economy is successful within Europe, and this is due entirely to the country being proactive and

Figure 4. Comparison of unit labor costs of European countries



Note: Indexes based on “2005 = 100” were recalculated to obtain indexes based on “2000 = 100.” Figures for 2011 are estimates.
Source: Eurostat (the Statistical Office of the European Union).

ahead of other countries in decisively implementing structural reforms in the shape of Agenda 2010.” At the summer 2013 Bundestag elections, Chancellor Angela Merkel of the current conservative government stated “we Germans took on high unemployment existing when the Euro was introduced and were the first to push through Agenda 2010 reforms and other fundamental structural reforms. As a result, Germany is now the driving force behind the growth of the European economy and is a source of stability within the Union.” As such, even Angela Merkel, the leader of the former opposition party, has a high opinion of Schröder’s reforms.

(2) Structural reforms and governance in German companies

Corporate governance in Germany is very different from that in the U.S. and Japan. In Germany, trade unions have a much greater influence than they do in either of the other two countries. While German trade unions are organized by industry, at the same time, each company has a work council (Betriebsrat), which is an employee representation organization. These work councils are established in all companies having at least five employees. For example, if an employee receives notification of dismissal that he/she believes to be unfair, by applying to this council, a member of the council can negotiate with management. If the performance of a company has degraded to a point where major restructuring is essential, management must negotiate with the council. In addition, the council is also responsible for acting as a watchdog over management, a function that would be unthinkable in Japan. Within each German company is a board of auditors (Aufsichtsrat) consisting of representative employees and shareholders, as well as a representative of the work council, who together oversee the board of directors. A system whereby trade union representatives oversee the board of directors can be found only in Germany and Austria.

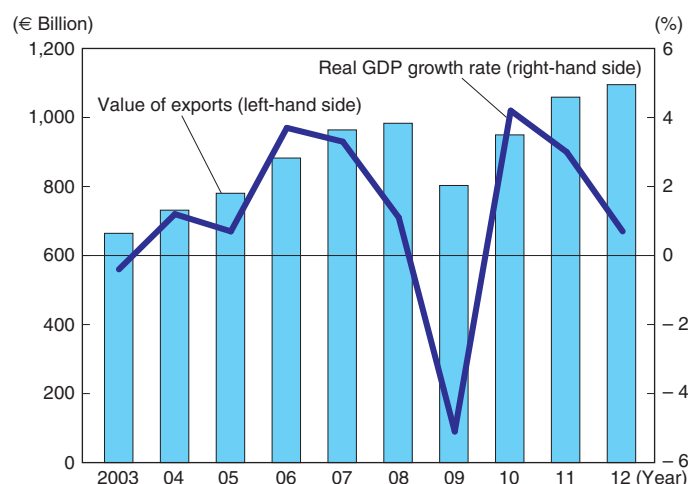
For example, when making major decisions such as those related to transferring a production facility overseas or restructuring the company, management is obliged to disclose information to employee representatives through the board of auditors. In this way, a consensus involving employees can be attained. Therefore, because of the type of corporate governance that is unique to Germany, which has allowed employees to participate, albeit indirectly, in management, it has been said to be possible for companies to undertake major restructuring since the 1990s with a minimum amount of friction with the workforce. The decisive action taken by the Federal Government to implement structural reforms led to many German companies undertaking business structure reforms in the 2000s, which led to those companies subsequently achieving global growth.

3 Strong, export-led economic growth

In addition to government policy, another factor contributing to Germany’s economic recovery was that many companies have undertaken management reforms, in particular, have pursued globalization strategy and, as a result, exports exhibited significant growth. As shown in Figure 5, Germany’s exports have continued to increase steadily, with the exception of the period around the collapse of Lehman Brothers. In 2012, exports to other EU (European Union) countries accounted for 57 percent of Germany’s output. However, this ratio has been declining, with exports to the U.S. and emerging economies such as China, India and Latin America increasing rapidly.

It is not possible to say whether Germany’s exports would have shown such a strong performance if the country had continued to use the strong mark. Obviously, the introduction of the euro, which eliminated the exchange rate risk associated with exports within the EU, had a positive effect on exports. In particular, small- and medium-sized companies that have kept their

Figure 5. Trends in Germany’s exports and GDP growth rates



Source: Basic data for countries and regions published by Japan External Trade Organization (JETRO).

production facilities within Germany because of their limited business resources saw great improvements in their exports with the introduction of the euro.

It is said that small- and medium-sized companies (those with up to 500 employees and sales of up to 50 million euros) form the backbone of Germany's economy. According to a survey undertaken by the Institute for SME (small- and medium-sized enterprises) Research (IfM), as of 2012, small- and medium-sized companies accounted for 99.5 percent of all German businesses (a total of 3.7 million companies) and employed 80 percent of the total workforce. In Japan, small- and medium-sized companies (for example, in the manufacturing sector, those with 300 employees or less, or a capital of 300 million yen or less) constituted 99.3 percent of all companies and employed more than 70 percent of the total workforce. While these figures are very similar to those of Germany, the contribution that these companies make to exports is very different.

According to the 2012 White Paper on International Economy and Trade published by Japan's Ministry of Economy, Trade and Industry, in Japan, the top 10 percent of exporters accounted for 92 percent of all exports. This figure is 96 percent in the U.S., but only 69 percent in Germany. That is to say, in Germany, the degree of oligopoly formed by leading exporters is much lower than that in either the U.S. or Japan. In other words, in addition to the country's largest companies, Germany's small- and medium-sized companies also play an active part in promoting exports. In fact, the management of these small- and medium-sized companies stands out in that they strive to deal directly with overseas customers. Their employees repeatedly undergo training to improve their ability to respond to different cultures. As such, these companies are highly attuned to overseas business development. Although it is possible to see the booths of many relatively unknown German companies at any international trade fair, the same cannot be said of small- and medium-sized Japanese companies. While in both Japan and Germany, there are many small- and medium-sized companies that can boast superior technology, there is a large gap between the two countries in terms of international marketing ability.

The euro has not been the only factor positively affecting Germany's exports. German companies' own efforts to improve their performance have also played a role. The opportunities that made German companies keenly aware of the need for globalization were the reunification of Germany in 1990 and the dramatic political changes in Eastern and Central Europe that occurred thereafter. Companies in the former West Germany suddenly found themselves having access to new consumer markets and production sites in the former socialist countries of Eastern and Central Europe. The former East Germany failed to become an attractive production site after reunification because wage levels were increased to the same level as the rest of Germany.

Nevertheless, even in the early 2000s, labor costs in countries such as Poland, the Czech Republic, Slovakia and Hungary were only around one-seventh to one-sixth that in Germany at the time. Because the cost competitiveness of German companies suffered as a result of their having to pay high wages, they were quick to transfer not only their production bases to the former Eastern and Central European countries, but also their labor-intensive administrative tasks. Therefore, as early as the 1990s, the executives of leading German companies keenly recognized the importance of spreading their business locations outside Germany.

4 VW Group works towards a global strategy

The Volkswagen Group (VW) is notable among German companies for the degree of globalization that it has attained. In 2012, VW produced 2.62 million vehicles in China, or about one-third of the company's global production. This volume of production is more than VW's production in its native Germany. VW has announced that it will invest 9.8 billion euros to increase its production capacity in China to 4 million units by 2018. In addition, according to VW headquarters, the per-car profit in China is about 3,000 euros, compared to only about 1,800 euros elsewhere. Therefore, in terms of revenue as well, China occupies a very important position for VW.

The main factor behind the company's strength in China is the 2008 launch of the Lavida, a compact car developed in China and aimed specifically at the Chinese market. In 2012, sales of the Lavida constituted about 10 percent of all of VW's sales in China. The car's platform was based on that of the existing Golf model. However, the interior and exterior of the upper body were all designed and developed in China, with the front grille and other exterior parts projecting a luxurious image, which have been very well received by Chinese consumers. Since VW launched its China-only model, GM (Buick), Fiat, Renault, Nissan and Honda have all launched China-only models in cooperation with their local partners. However, in terms of local design and development, VW, together with GM, is well ahead of its competitors.

To enable local development in China, VW has introduced a development technique known as "standard architecture." As mentioned above, the basic design of the difficult-to-develop platform is completed in Germany. However, the design and development team in China takes on the design of the body that rides on the platform, flexibly adjusting quality standards as necessary. For the platform, a minimum set of dimensions is defined while the same components are used in different models of the vehicle. By pursuing this "up-down separation" of the platform and body, as well as by reforming the design concept towards a high degree of

standardization, local development in China, where related resources are still at the developmental phase, has become possible. This approach facilitates local development in countries other than in Germany and, at the same time, brings about the advantages of enabling the use of low-cost local components and shortening the time required for development.

From the viewpoint of a local partner, it is preferable for local engineers who have a better understanding of local needs to undertake the design of the exterior and interior of the vehicle, which is a major determinant when making purchase decisions according to consumer preferences. From the viewpoint of VW headquarters, VW wants to maintain the quality of the platform that is important enough to determine the dynamic performance of the car and wishes to take a “black box” approach to prevent the loss of proprietary technology by means of standardization. As such, VW’s development scheme consisting of the up-down separation and the adoption of a high degree of standardization strikes a good balance between the intentions of both parties.

In fact, as shown in Figure 6, different development methods are applied to vehicles that are marketed globally, compared to those that are adopted only in China. In the former case, the German headquarters takes full responsibility for the development of the vehicle including the upper body. However, in the latter case, it plays only a supporting role, with the development of the body, including decision making and design work, being done in China. Nevertheless, the German headquarters continues to make all development decisions related to platform and powertrain even for China-only models. Furthermore, when development is split between Germany and China, VW’s China headquarters in Beijing is responsible for coordinating between the two sides, ensuring that there are no misunderstandings or discrepancies.

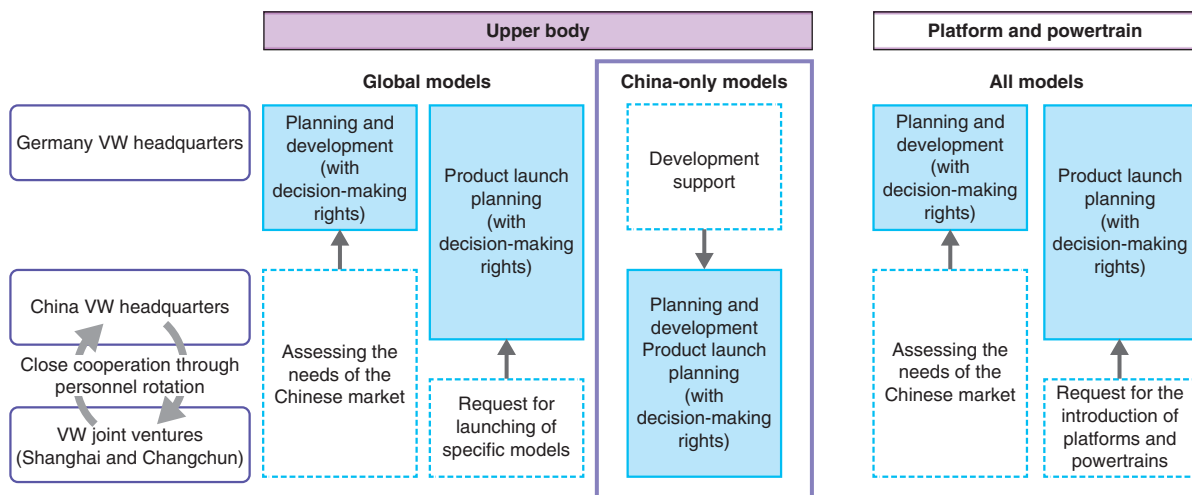
At the beginning of 2013, VW announced a new design concept known as MQB (Modularen Querbaukasten), which has superseded its standard architecture. This

modularization strategy goes beyond the common use of only a platform to the shared use and standardization of components that are mounted on the platform. The first MQB line in China began production in September 2013, followed by another line in Brazil before the end of the year, producing VW and Audi products based on the common MQB platform. VW has announced its intention to expand the scope of standardization from platforms to modules (MQB), and further to assembly kits. By increasing the number of common parts in this way, VW plans to build an efficient business model, whereby even if a wide variety of models are offered in the global market, not only can development costs be suppressed, but also by expanding the scale of parts procurement, costs can be further reduced.

With the expansion of the G8 to the G20, the global market has rapidly become much more diverse because of the participation of emerging countries in addition to developed countries. Pursuing a conventional course of designing and developing products tailored for individual markets would lead to a huge increase in the number of different models, such that the company would never be able to have sufficient development resources. In addition, in order to satisfy local needs precisely, it is necessary for local engineers to undertake design and development at local bases rather than doing development work in far-off Germany. However, in emerging countries, the development quality cannot be as good as that in Germany because of the lack of technical capabilities. Furthermore, although VW intends to promote the localization of development, it also wants to restrain the flow of technology out of Germany. Therefore, pursuing a strategy of a standard architecture would provide an optimal solution to meet these challenges.

The revival of the German economy can be attributed to the structural reforms implemented by the government, together with the globalization efforts of German companies. Because of the impact of Abenomics, Japan has seen a correction in the overly high yen. However,

Figure 6. Volkswagen Group (VW) local development scheme



the revival of Japan’s economy still faces many remaining challenges such as the implementation of structural reforms and the pursuit of a globalization strategy by Japanese companies. In addressing these issues through cooperation between the public and private sectors, Japan could look to Germany as a model for structural reforms that should be pursued.

III U.S. Reindustrialization Strategy

1 U.S. reshoring phenomenon

In the United States, the second-term Obama administration has made “re-industrialization” (re-strengthening manufacturing) a priority policy. This policy is aimed not only at advanced manufacturing industries such as those involving the environment, energy, biotechnology, medical equipment and aerospace, but also at other export manufacturing industries. The weakening of the dollar through quantitative easing has recovered the country’s cost competitiveness relative to offshore manufacturers. In addition, by signing new trade agreements such as the Trans-Pacific Strategic Economic Partnership Agreement (TPP), the United States has begun in earnest to strengthen its export manufacturing sector. Given that manufacturing is thought to make a major contribution to the income of a very large middle-income segment, this “re-industrialization” has close ties with the country’s employment policy. In fact, the average weekly wage of workers in U.S. manufacturing is about 600 dollars, about 50 dollars more than the average wage of those in non-manufacturing (about 550 dollars).

According to an analysis undertaken by the Manufacturing Institute, an American think tank, the multiplier effect (numerical indicator of total demand for all

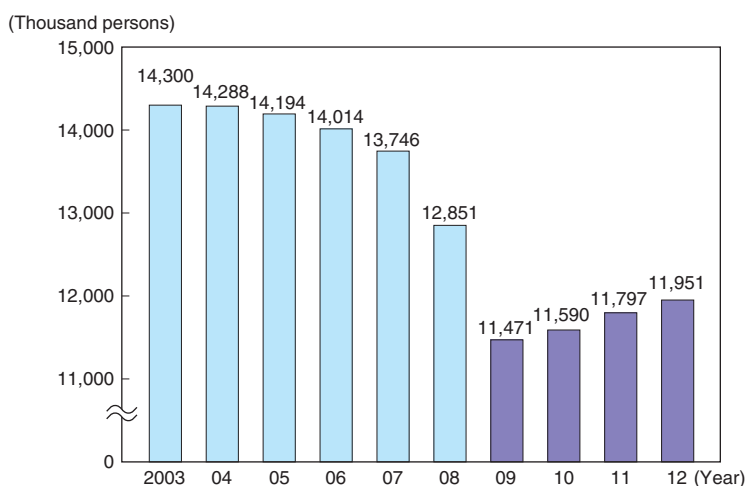
industries when a manufacturing demand of 1 occurs) of U.S. manufacturing is 2.34. While manufacturing only contributes about 10 percent to U.S. GDP, given its far-reaching multiplier effect, it has a valuable presence among all industries.

A symbol of this revival in U.S. manufacturing is the shale gas revolution. The exploitation of shale gas has reduced the cost paid by American manufacturers for natural gas to nearly one-seventh to one-eighth of the price paid in Japan. According to some estimates, the effect of cost savings in U.S. manufacturing will reach 1 trillion yen every year. Shale gas has had a significant impact on the competitiveness of the U.S. petrochemical industry. When related industries are included, the creation of more than 1 million jobs by 2020 has been predicted.

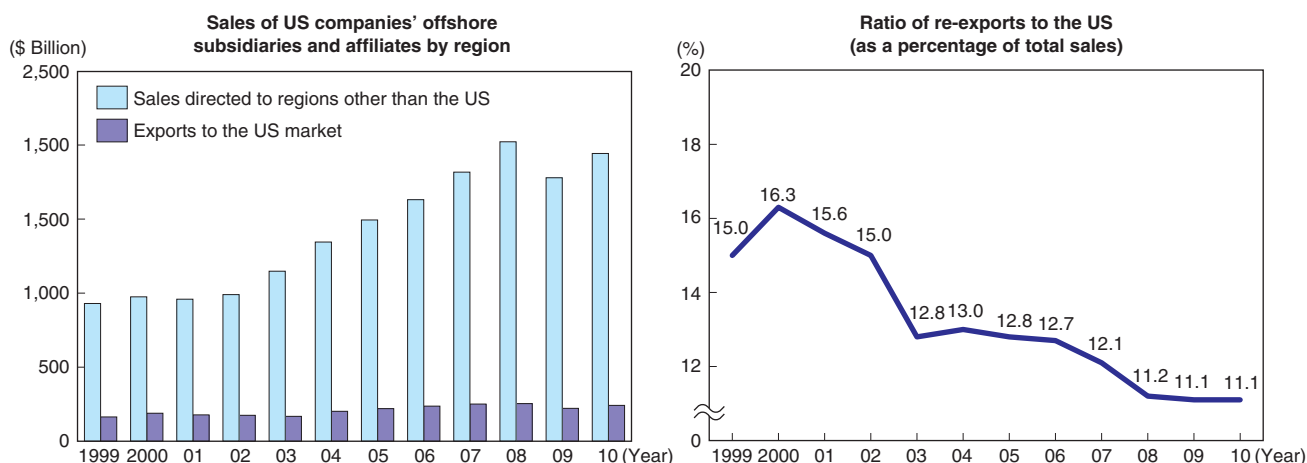
In addition, a noticeable trend among reindustrialization moves is “reshoring,” where offshored manufacturing is brought back to the U.S. Although production was once moved overseas to emerging economies such as China to take advantage of low labor costs available there, recent increases in labor costs in such countries have led to their losing cost competitiveness, such that manufacturers have been repatriating their production to the U.S. As is clearly shown in Figure 7, after bottoming out in 2009, the number of manufacturing jobs in the U.S. has been increasing steadily ever since.

However, there are some opinions that to begin with, the purpose of the movement of U.S. companies overseas was not to export products back to the U.S., but rather to tap local markets (Figure 8), such that the number of types of products being returned to the U.S. is actually small. Moreover, any efforts to bring production that was outsourced to emerging economies such as China back to the U.S. will face the need for the rebirth of manufacturing as well as supporting industries because the basis of peripheral industries such as parts and materials has already been lost (hollowed out) in the

Figure 7. Employees in U.S. manufacturing



Source: Bureau of Labor Statistics, U.S. Department of Labor.

Figure 8. Sales directed to the US by US companies' offshore subsidiaries and affiliates

Source: Economics and Statistics Administration, U.S. Department of Commerce.

U.S. Therefore, even though a company wants to return production to the U.S. because of cost advantages lost in emerging economies, such repatriation is not easy.

It should be noted that close relationships between China and the U.S. have made a considerable contribution to China's remarkable economic development since 2000. China exported low-priced products, which led to employment growth, and then, purchased U.S. Treasury securities using U.S. dollars acquired from the resulting trade surplus. The U.S., for its part, imported low-priced products from China as a means of expanding consumption while suppressing inflation. With the return of dollars from China, balance of payments equilibrium was achieved. As such, the U.S. and China have built a "win-win" relationship, which has come to be known as "Chimerica." However, after the collapse of Lehman Brothers, the U.S. trade deficit with China grew to more than \$300 billion. Monetary easing in the U.S. weakened the value of the dollar, which affected the value of the U.S. debt held by China. In this way, the interests of the two nations began to be slightly discordant. In addition, increased awareness of security issues relating to China has led to the concept of "Chimerica" coming under review. Some people consider that the rebalancing strategy (shifting the focus of U.S. foreign policy to Asia) announced by the Obama Administration at the end of 2011 includes implications of restraining China, and that the reshoring initiative also connotes a political intention of correcting America's excessive reliance on China.

2 Obama administration's strategy to revitalize American manufacturing

In his February 2013 State of the Union address, President Barack Obama stated that "our first priority is making America a magnet for new jobs and manufacturing" and asked Congress to guarantee that "the next revolution in manufacturing is made right here

in America." The intention behind this statement is to create new American manufacturing that would be capable of leading the world, with a focus on emerging technologies and innovation, rather than setting out to rescue those legacy industries that have already lost their competitive edge.

In July 2012, the Advanced Manufacturing Partnership (AMP) Steering Committee, which works within the framework of the President's Council of Advisors on Science and Technology, released its report, "Capturing Domestic Competitive Advantage in Advanced Manufacturing." This report contained a set of 16 recommendations covering three pillars of enabling innovation, securing the talent pipeline and improving the business climate (taxation, etc.). Among these recommendations, the author pays particular attention to the establishment of Institutes for Manufacturing Innovation (IMIs).

IMIs have already been established in 15 locations, and focus on technologies that are expected to become practical within the next 10 years or so, such as 3D printer technology, "digital manufacturing," which combines machines and information technology (IT), lightweight metal materials for aircraft and turbines, next-generation electronics technology for integrating vehicles and a smart grid. The Department of Commerce has defined the areas in which the IMIs specialize; namely (1) those fields involving the integration of information, automation, computing, software, sensing and networking, and (2) leading-edge materials using biotechnology and nanotechnology.

These institutes are located in each region of the U.S., and are connected through the National Network for Manufacturing Innovation. Their activities are coordinated by the Advanced Manufacturing National Program Office (AMNPO) under the umbrella of the Department of Commerce. A total of 1 billion dollars is planned to be invested as an annual budget for the AMNPO to operate the institutes for the ten years from 2012 to 2022

(Figure 9). Furthermore, in addition to the initial 15 institutes connected through the NNMI, the establishment of three more institutes was announced in 2013. With the Department of Defense, the Department of Energy and the National Aeronautics and Space Administration (NASA) all contributing additional funding in the future, the NNMI is well placed to make important contributions to the innovations needed for the next generation of American manufacturing.

3 “Convergence and services” are the keywords of next-generation manufacturing

In President Obama’s 2013 State of the Union address, using the example of 3D printing technology, it is said that future manufacturing innovations will be achieved through collaboration between traditional manufacturing industries and other industries such as IT, in what is known as “collaborative manufacturing.” In fact, IMIs, which were mentioned in Section 2 above, have many projects in hand that combine manufacturing and information and communications technology (ICT). In the U.S., the percentage of electrical components in a car (as a percentage of total cost) was around 20 percent in 2000, but is around 35 percent now, and is said to rise to 50 percent by 2030 (80 percent for hybrid vehicles). Regardless of whether technology relates to drivability, safety or comfort, the areas of technology such as sensors, IT and control, in which the U.S. has competitive advantages, are predicted to constitute the major sources of competitiveness.

For home appliances and mobile phones, the value to be added is shifting from the performance of the product itself to the provision of services such as networking and content. In the same way as in these product areas, services are expected to account for a greater proportion of all added value created by manufacturing. The U.S. companies that have traditionally been strong in the areas of IT and services are moving

towards making the best use of their strengths in global competition.

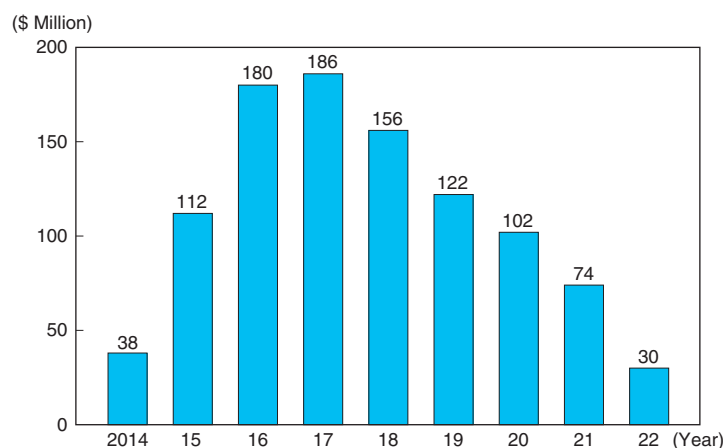
The following paragraphs consider the case of General Electric (GE), one of the largest manufacturers in the U.S.

Prior to the collapse of Lehman Brothers, GE’s financial services unit constituted the largest source of GE’s revenue. However, the company has since implemented major transformations in its business structure towards the areas of energy, aviation and medical equipment. The company expects these areas to generate 70 percent of its profit target by 2015. The company is placing great faith in its “Industrial Internet” initiative, a strategy of connecting all GE products offered globally via a network so as to create new services based on collected data (Figure 10). According to GE, the users of its hardware products, such as airlines, railways, electric power companies, oil and gas companies, and medical institutions, are faced with unplanned expenses of a total of 150 billion dollars a year in all these industries in order to overcome unexpected machine problems. By collecting relevant information from a group of sensors on its machines over the Internet and analyzing these data, as well as in conjunction with the personnel responsible for maintenance, preventive maintenance can be provided based on diagnoses made using collected data. Such preventive maintenance can significantly reduce downtime caused by machine failures, and thus greatly enhance the productivity of user companies. In order to launch a new customer service business based on these data, GE has earmarked a total development budget of 1 billion dollars by 2015. Using its high-quality hardware products, GE has set out to create a business model whereby most of the company’s profits are generated by its service business.

Jeffrey Immelt, chairman of GE, stated that the following three elements are key to realizing the Industrial Internet vision.

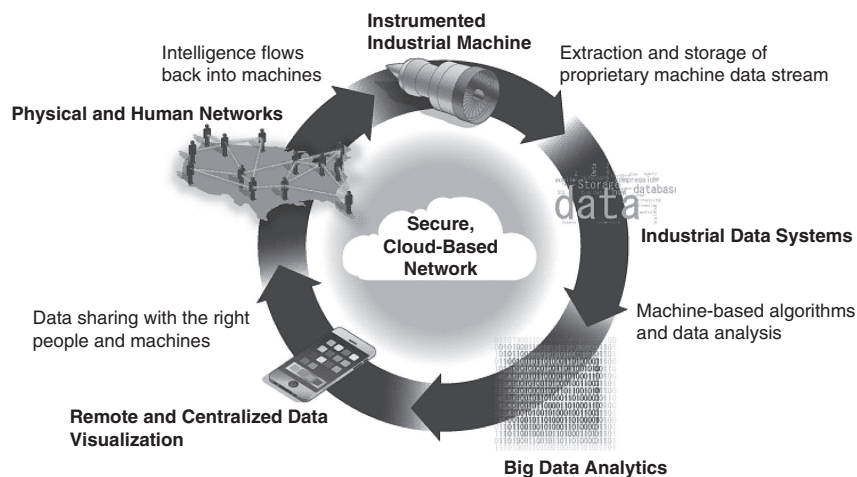
- ① Network-connected “intelligent machines” that are equipped with sensors so that the operating

Figure 9. Budget for U.S. National Network for Manufacturing Innovation (NNMI)



Source: Executive Office of the President of the United States (April 2013).

Figure 10. GE's Industrial Internet



Source: GE Japan's website (http://www.ge.com/jp/images/1355387813862_1.gif).

status of machines can be monitored, enabling machine control

- ② “Advanced analytics” capable of analyzing the vast amounts of data collected from more than one billion sensors mounted on networked machines
- ③ “People (field engineers) at work or on the move” who actually implement maintenance based on collected data

However, regarding the “analytics” aspect in particular, no one company, even one as large as GE, can provide the necessary resources, so GE decided to enter into partnerships with many related companies. These companies include Kaggle, a leading analytics company, and Pivotal, which builds an operating system needed for analytics. Amazon.com provides cloud-based Internet infrastructure and Salesforce.com is responsible for ensuring that error messages from hardware are shared with field engineers in real time.

In addition, jointly with launch customers, such as Electric Cities of Georgia in the electrical power field, AirAsia in the airline field and Shell in the energy field, GE started field trials of new services using the Industrial Internet. In October 2013, at a conference held for GE's customers, Chairman Immelt reported that “Brazilian airline GOL, the largest carrier in Latin America, could achieve a 2 billion dollar reduction in its annual jet fuel consumption thanks to the increased efficiency of its aircraft engines.” He went on to say that “Up until now, there had been a conflict of interest with our customers in that our service revenue had depended on customers experiencing product failures. Now, however, the situation is quite different. By using analytics to minimize downtime, which is aimed at improving the level of customers' performance, our interest coincides completely with that of our customers.”

Additionally, GE has been running a campaign called “Industrial Internet Quests,” whereby it invites business ideas from all over the world in every area of business where cost can be reduced and productivity can be improved through the use of the Industrial Internet. These activities represent GE's intention to achieve a bold shift in the value of business from the “value of things” to the “value of using things to optimize operations.”

The United States is pursuing a strategy of reindustrialization at the national level. This strategy goes beyond the mere issue of cost, but is exhibiting the country's strong will to lead the world in innovation towards the next generation of manufacturing. The next-generation manufacturing aimed at by the U.S. involves the integration of manufacturing, information and communications, and cutting-edge materials, as well as the creation of services by leveraging manufacturing.

GE's Industrial Internet, which represents a business model that consists of greatly differentiating the company from its competitors by incorporating sensing devices into its hardware products and generating profits from service-driven business aimed at the users of such hardware products, can be said to be a first glimpse of next-generation manufacturing, which could very well be expected to occur in the U.S.

Editorial note: Because of its length, this paper has been divided into two parts: Part 1, *NRI Papers No. 195*, consisting of Chapters I to III, and Part 2, *NRI Papers No. 196*, consisting of Chapters IV to VI.

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