Circumstances of the Automotive Industry Impact on Aluminum Foundries

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ABSTRACT

At the beginning of the 4th quarter of 2009, aluminum foundry executives still are showing signs of prudence. They are less positive and more realistic than they were on the early 2000. It will take several years for the aluminum foundry industry to fully recover to the high production levels of the mid 2000s. The collapse of the U.S. auto industry in 2008, the continued downsizing of U.S. foundries, and the development and start up of foundries abroad would not necessarily translate in positive impact for the U.S. foundries.

While the global foundry industry has undergone significant changes in recent years, the U.S. foundry industry has been dramatically shaped and changed for the last 62 years. There have been thousands of foundries closing down, and recently, consolidating.

Despite the fact that the U.S. foundry industry as a whole has been shrinking, aluminum foundries on the other hand have experienced continuous growth since the 1950s up to the mid 2000s. The total shipment of castings in 2005 was 14.2 tons.[1] Shipments of aluminum castings in the U.S. have quintupled in the last five decades, with an average of 2.1 million tons per year in the first five years of the 2000s.

Forecasting of the aluminum casting tonnage was reasonably predicted until 2007. For the last two years, market conditions and global competition have proven to be a challenge to predict with higher levels of confidence the future of aluminum casting tonnage shipments. Still the total casting tonnage shipments of 10.0 million tons reforecast for 2009 are expected to be 20% lower than 2008.[2]

Looking at the recent aluminum casting shipments trend, and the projected future of casting sales, it is evident, more than ever, that if the foundry industry wants to succeed, not only factors of competition such as labor, raw material, energy cost, and foundry technology are essential to be controlled. Like it or not, foundries must rapidly adapt to the demands of customers and strong global competition.

The aluminum casting industry went through a solid growth period from 2002 to 2005. Incidentally, 2005 was the year in which U.S. aluminum foundries produced the highest tonnage recorded in history. In 2006, the industry started to show an indication of a slowdown. Along these lines, and for the purpose of writing this article, 2005 will be taken as a reference year to compare and to relate the present casting conditions and challenges ahead.

This article will cover the impact of the auto industry on aluminum foundries in the U.S., and present the five forces model of competition to show how the interaction of them collectively determines the aluminum foundry competitive environment. Thus, the purpose of this article is to present some thoughts that might be appropriate for each of us to consider in this extremely challenging marketplace.

INTRODUCTION

Although the global production of automotive vehicles (passenger cars, light trucks, heavy trucks, and buses) has expanded about 72% since 1979, from about 41 million to about 70.5 million in 2008. [3], the major regional automotive markets of the traditional “triad” (Japan, North America, and Western Europe) continue dominating the global manufacturing and sales segments of the industry. Although the U.S. automotive industry stopped being the largest automotive vehicle producer in the world in 2005 with11.9 million units produced, the U.S. is still the largest consumer of vehicles in the world, and one of the largest industries in the United States. Whereas in 2006, Japan had produced 300,000 more vehicles than the U.S., in 2007 it had produced 800,000 more. In 2008, both Japan and China produced more vehicles than the U.S.; 2.9 million and 0.6 million respectively.[3]

The year 2005 could be considered a significant year because the U.S. was still the largest automotive vehicle producer in the world, and the U.S. aluminum foundries had established the highest casting tonnage produced. A closer look at the 2005 global production of vehicles in 2005 reveals that the U.S. produced 18% of the global market. The other major producers, in decreasing order, as shown in Figure 1, were Japan, Germany, China, South Korea, France, Spain, Canada, Brazil, England, Mexico, India, Russia, and Italy (vehicle production statistics [3]).

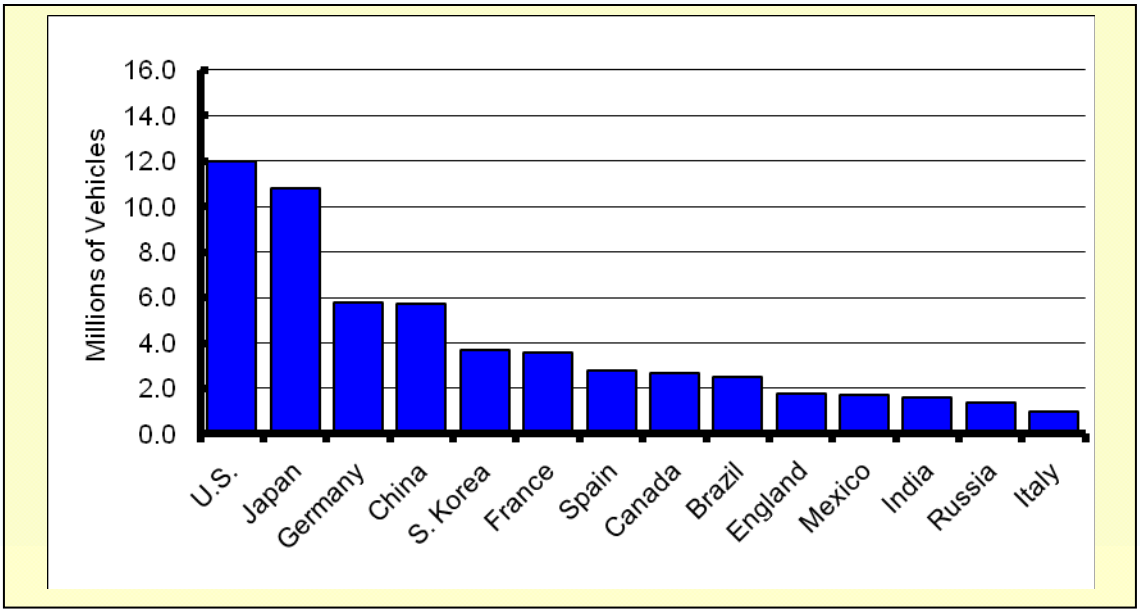

Fig. 1. 2005 vehicle production in major countries.

The U.S. as one of the largest automotive vehicle producers in the world, and the largest consumer of vehicles in the world, creates a very competitive market for foundries to serve its needs. In 2005, the total U.S. vehicles sales, including foreign models, produced both inside and outside the United States, as well as domestic models produced in Canada, and Mexico were 17.4 million vehicles. This total number of vehicles sold in the U.S. was almost three times larger than the next two largest markets of about 6.0 million vehicles sold in Japan and China.[4] In addition, the U.S. manufactured 12.0 million vehicles representing 10% more than the next largest industry, which was Japan. Another important fact to be noticed is that China almost equaled Germany's production. Figure 2 ranks the largest national markets in 2005 in terms of total vehicle sales.

Three important facts about the global automotive industry can be highlighted by comparing the data from Figures 1 and 2. First, vehicle imports in the U.S. accounted for almost 31% of the total vehicles sold in 2005. Second, Japan exported 56% of its domestic production. Third, China's automotive industry served the needs of its domestic market. Thus, the U.S. aluminum foundry industry's potential business opportunities are also directly affected by the number of imported vehicles being sold in the U.S., and therefore aluminum foundries must look outside the U.S. for increasing market share.

In spite of the overall downturn in the U.S. economical activity for the last 3 years, the contribution of automotive output to the U.S. Gross Domestic Product (GDP) has remained substantial. Economic contributions of motor vehicle manufacturing to the foundry business is well known, since the majority of the foundries rely on automotive industry purchases for a substantial share of their production.

It is more evident than ever that the U.S. automotive industry meltdown in 2008, and the continued downsizing of it, had a significant impact on the foundry business. As documented [5] , the U.S. automotive industry was considerably initially weakened by the higher gasoline prices linked to the oil crisis which caused customers to move away from the main market (sport utility vehicles, and pickup trucks), of the "Big Three" (General Motors, Ford, and Chrysler). In addition, the global financial crisis and the increased costs of raw materials made the situation more critical for the industry. Moreover, the wages, salaries, and benefits of the "Big Three" U.S. automakers negatively impacted their cost competitiveness.

In early 2009, all automakers, around the world, were hit hard by the global economic slowdown. Since then, many foundries have experienced negative double digit percentage sales or have been forced to close. Nevertheless, the present situation in the U.S. foundry industry is not a reflection of the last two years recession but a manifestation of significant loss in market share to global competition throughout the years. Nonetheless, the struggling economy has accentuated the problems in the foundry industry.

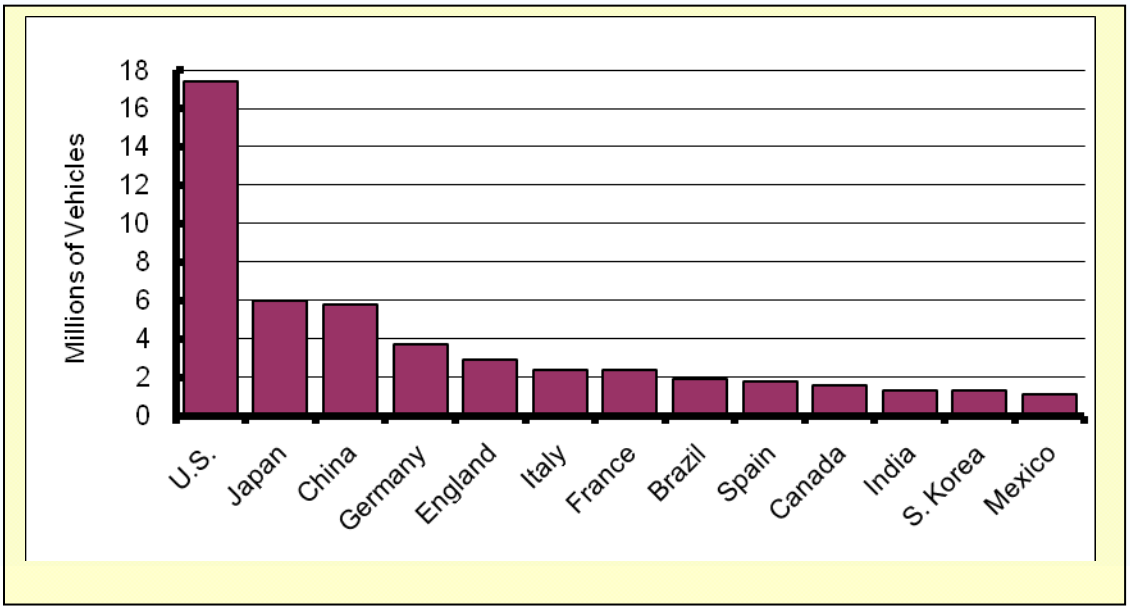

Fig. 2. 2005 vehicle sales in major countries

AUTO INDUSTRY AND IMPACT ON FOUNDRIES

The 1st Census of World Casting production published in Modern Casting [6] showed that in 1966 the total global tonnage produced was 63.3 million tons from which 96% of the tonnage was for ferrous castings and only 4% for nonferrous. In addition, it showed that the top five casting production nations (in terms of tonnage produced) were U.S.S.R. (21.5 million tons), U.S. (19.6 million tons), Great Britain (4.9 million tons), West Germany (4.7 million tons), and Japan (4.4 million tons).

Nevertheless, the U.S. casting industry experienced an unprecedented drop in casting production during the 1970s and 1980s. Casting tonnage production fell off from 19.6 million tons in 1966 to 11.3 million tons in 1990. During that period, over 1,000 foundries went out of business. Such dramatic decline was attributed mainly to four factors: 1) decreased number of vehicles being produced compounded with smaller, and lighter weight vehicles manufactured for increased fuel efficiency that in turn negatively affected the demand for automotive castings, 2) increased foreign competition; 3) substitute materials, such as plastics, ceramics, and composites, started to gain market share at the expense of castings, and 4) increased costs to comply with health, safety, and environmental regulations.

Although the foundry industry had a recovery period in the early 1990s, the casting tonnage produced was still less than in the early 1970s. The recovery was attributed to the increase in automobile production, which in turn increased domestic casting demand. At the same time, exports of castings increased and imports decreased. Between 1993 and 1994, U.S. metal casting facilities increased their global market share of production from 18% to 20%. In that time, the increases in production were predominantly due to existing metal casting facilities increasing capacity utilization rather than by an increase in the number of casting facilities.

In 2007, according to the 42nd Census of World Casting production by Modern Casting [7], the top five casting production nations were China (31.3 million tons), U.S. (11.9 million tons), Russia (7.8 million tons), India (7.7 million tons), and Japan (7.0 million tons). The total tonnage produced was 95.0 million tons from which 83.3% of the tonnage was for ferrous castings and 16.7% for nonferrous castings, which includes a 13.4% for aluminum castings. An interesting fact to be noted with respect to the U.S. casting tonnage market is that while 2007 was considered a record year for total global casting tonnage produced, China's tonnage represented an 11.3% increase over its 2006 output, while the U.S. output represented a

loss of 5.1% from 2006, and a loss of 8.3% from 2005 levels. Data also showed that 2005 was a record year in which U.S. aluminum foundries produced the highest aluminum tonnage output in the U.S.

Prior to 1970, the majority of the castings used in American automobiles were made from cast iron. Application of aluminum castings in U.S. vehicles was almost entirely limited to cylinder heads for specialty or low volume engines.[8]

In 1974, when it became apparent that U.S. automakers would have to conform to the Corporate Average Fuel Economy (CAFE) governmental regulations, aluminum castings components such as cylinder heads, transmissions cases, oil pans, intake manifolds, road wheels, and pistons were immediately considered and adopted for engine, and powertrain applications. Since then, aluminum castings have been replacing cast iron to reduce vehicle weight, and therefore, the expected future growth of aluminum castings in the automotive sector will still be linked to the positive competitive impact that CAFE regulation will exert to the automotive industry.

The overall picture of the U.S. automotive industry and its influence on the aluminum casting industry was fairly documented in 2005.[9] Figure 3 shows an updated chart that includes available public information from references made in this article. As shown, aluminum castings' shipments have exhibited similar peaks and valleys as the automotive industry during the recessionary period 1980-1982, the recovery period of the late 1980s, the onset of a recession in at the end of 1999, the growth after 2000, and the collapse of 2008. Aluminum casting shipments grew from 688,000 tons in 1975 to 2.29 million tons ($10.1 billion) in 2005, and then abruptly and rapidly decreased until reaching the lowest level of 978,000 million tons in 2008.

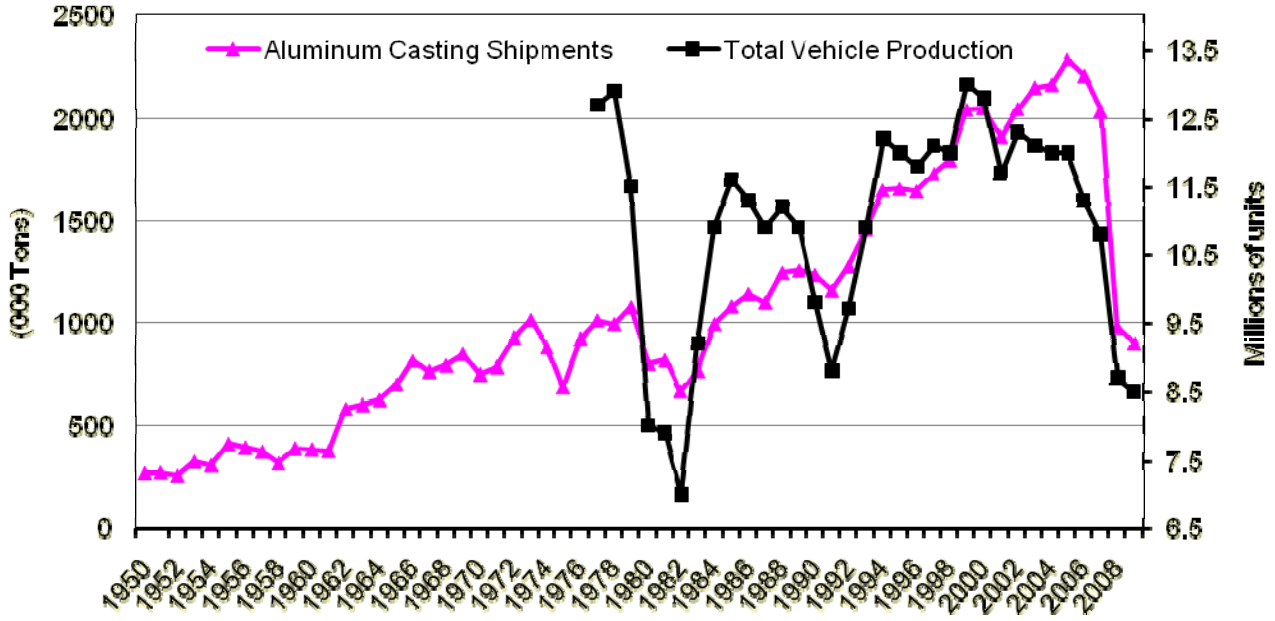

Fig. 3. Automotive influence in aluminum casting shipments.

PERSPECTIVE OF THE FOUNDRY INDUSTRY IN THE U.S.

It is recognized that the U.S. foundry industry of the 1990s that emerged from the years of decline in the 1970s and 1980s was stronger and more competitive, however it still produced less than in the late 1960s. Whereas the U.S. foundry industry once was the largest producer of castings, the foundries now operate on a global basis. While in 2001, China became the world's leader in casting production with 14.2 million tons produced, the U.S produced 13.9 million tons. [10] Ever since, global competition to supply castings has been more brutal and has had other influences in addition to China. In consequence, foundries must now find niches in the global supply chain of U.S. auto companies or their foreign competitors to succeed in

today's market. The possibility of relying on increased auto sales that automatically translate into increased orders and components for U.S. suppliers simply no longer exists.

In 2005, the metal casting industry in the U.S. rose 4.2% over 2004. The industry shipped 14.2 million tons of castings in 2005 (sales of $32.9 billion) from which 10.8 million tons (sales of $ 15.5 billion) were from iron and steel castings, 3.1 million tons (sales of $ 13.9 billion) were from nonferrous castings, and 0.30 million tons were from investment ferrous and nonferrous castings. Aluminum casting shipments in 2005 were 2.29 million tons. [11] As illustrated in Figure 4, iron accounted for approximately 68% of all the cast tonnage, while aluminum accounted for 16% of all the cast tonnage.[1] The aluminum casting industry went throughout a solid growth period from the beginning of 2000 to the middle of 2006. Thus, it was in 2005 that the record year was recorded. By the end of 2006, the industry started to show indications of a slowdown. As mentioned previously, 2005 would be taken as the reference year to compare and to relate the present casting conditions. In view of that, it is interesting to note that in 2008 the casting industry produced 12% less tonnage than in 2005 (12.5 million tons versus 14.2 million tons) from which 11.1 million tons were produced from ferrous castings and 1.1 million tons from aluminum castings. As it can be observed, casting tonnage in aluminum was reduced by 52%!

According to data published data, [12, 13], the number of operating foundries in the U.S. has declined close to 66% over the last 54 years, largely as a result of foreign competition, and environmental compliance. In 1955, there were about 6,150 foundries in operation. By 1987, foundries dropped to 3,700, averaging a closure rate of 77 foundries per year (2,450 foundries out of business in 32 years).

From 1987 to July 2005 another 1,364 foundries closed (a mortality rate of 76 foundries per year) leaving only 2,336 foundries in operation. From 2005 to the end of 2007 another 206 foundries went out of business (103 foundries per year). Thus, by the end of December of 2007, there were only 2,130 foundries left in the U.S (42nd census of world casting production of Modern Casting [7]). A moderate growth in the casting industry does not necessary imply that the number of foundries in the states will increase in number. On the contrary, still the number of foundries might be lower in the future as more capacity increase at the expense of less competitive foundries.

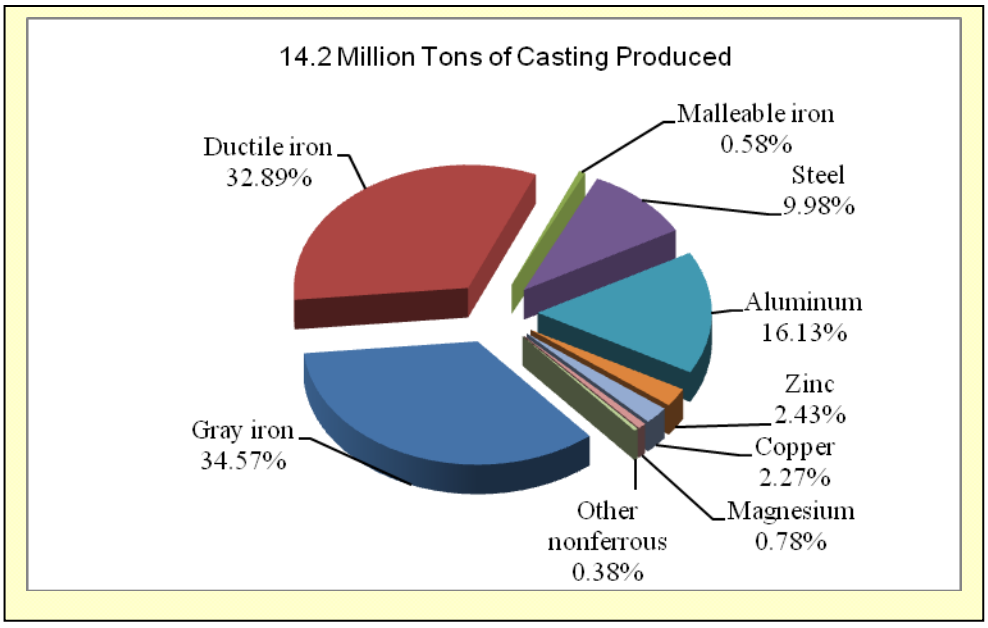

Fig. 4. Castings tonnage produced by metal type in 2005.

The global casting market is typically segmented into commodity and specialized/aircraft castings. In general, commodity castings are simple uncomplicated castings that could be produced by most foundries having limited but adequate technical skill and technology levels. Specialized/aircraft castings, on the other hand, are complex castings in design that require higher levels of technology, process knowledge, tighter material specifications, and may even be of proprietary technology. Consequently, it is very common that specialized castings be not only much more expensive than commodity castings but also that they be sourced from a small number of more sophisticated foundry operations.

THE U.S ALUMINUM CASTING INDUSTRY

Despite the fact that the U.S. foundry industry as a whole has been shrinking, aluminum castings on the other hand experienced continuous growth since the 1950s up to the mid 2000s as shown in Figure 5. Shipments of aluminum castings in the U.S. have increased by a factor of eight and a half from 0.27 million tons in 1950 to 2.29 million tons in 2005. The aluminum foundry industry was able to average 2.1million tons per year for the first 7 years of the 21st century. Aluminum alloy castings accounted for 2.29 million tons or 73.3% of the total nonferrous castings shipped in 2005. [1]

In 1972, only five percent of all castings were aluminum. In 2005, aluminum castings accounted for over 16% of the total tonnage produced. Aluminum castings represented only 50 pounds per vehicle in 1960.[14] By the late 1970s, aluminum castings weight surpassed 100 pounds. Since that time, the use of aluminum castings for automotive applications has been rising. In 1995, the average weight of aluminum castings per vehicle was 150 pounds, while in 2005 it was 250 pounds, as can be seen in Figure 6. Aluminum castings took over a larger share of the castings market as their use in motor vehicle and engine applications grew. Aluminum wheels were the biggest contributor to aluminum growth in the 1990s. To produce lighter weight, more fuel-efficient vehicles, the automobile industry has continuously been in the process of redesigning engine blocks, heads, and other parts of passenger cars and light trucks in aluminum. Aluminum castings were expected to increase from 260 pounds per vehicle in 2007 to 330 pounds per vehicle in 2009.[15] However; it is understandable that such increase would take a longer time to be accomplished. The growth would come by further penetration of existing components, primarily at the expense of gray iron cylinder blocks, knuckles, and suspension brackets.

Nevertheless, based on what the automotive industry has experienced since 2007, and the accumulation of significant changes that have occurred in the last decade on the global aluminum foundry market, the prospects for the aluminum foundry industry in the U.S. are gloomy. Expectations about profitability are mixed. On average, foundry profits from the first five years of the 2000s have been considered to be marginal by the majority of casting facilities. In addition, profits since the 2007 fiscal year up to now have been considered insignificant (if any) or not existent at all. Many foundries are just in the survival mode (sales equal to operating expenses). The impact of the 2000s economic downturn has been reflected by the numerous foundries that have gone out of business, and/or by the type of consolidations that have taken place in recent years. By now, foundries that remain in business have realized that the profits of the early 2000s may not even be attainable for many years to come. To make reality tougher, many areas of the aluminum foundry industry could be considered a mature market. While visiting foundries during the last two years, it was common to see major aluminum automotive foundries working with 50 to 70% less employees.

The U.S. aluminum foundries are diverse in size, ranging from large operations producing thousands of tons of castings per year to small operations that specialize in low-volume products. The aluminum casting industry as a whole includes two markets: aluminum foundries and aluminum die-casters (high-pressure diecasting). Both markets not only have their own segmentation but also differentiation based on their respective casting principles. Aluminum foundries are segmented into permanent mold, low pressure, sand and lost foam.

The 2.29 million tons of aluminum castings shipped in 2005 are the combined totals of the aluminum foundries (0.95 million tons or 41%) and aluminum die casters (1.34 million tons or 59%). Historically, higher aluminum casting tonnage has been shipped by high-pressure die casting operations. In the first seven years of the 21st century, this difference in tonnage shipped has represented as an average 1.28 million tons per year for die casters, and only 0.91 million tons per year for aluminum foundries, resulting in a near 40% more tonnage shipped by die casters as compared to aluminum foundries.[16]

As illustrated in Figure 7, high-pressure diecastings accounted for the majority (59%) of the total aluminum tonnage produced in 2005. The remaining casting tonnage was divided between permanent mold and low pressure (26%), and sand and lost foam (15%).

The aluminum castings shipped by the aluminum foundries in 2005 were consumed by a highly fragmented market, which consisted of 22 major end-users, as shown in Figure 8. However, as shown in Figure 9, four sectors used up to 81.8% of the castings shipped by the aluminum foundries. The automotive sector dominated the market by far, consuming 63% of the total aluminum casting tonnage shipped. The next three end-users were aircraft industry, instruments, and the internal combustion engines sectors. The instruments market includes those firms that manufacture optical, analytical, and scientific instruments. The internal combustion engines include the small gasoline engine market.

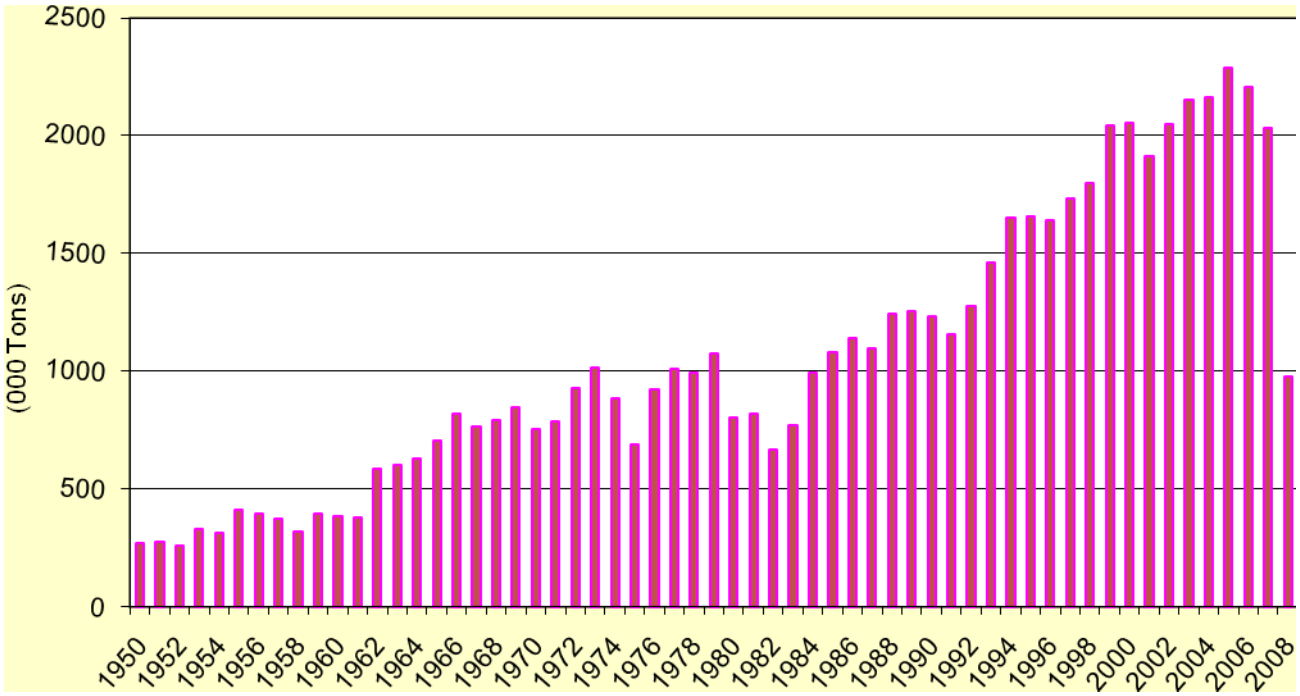

Fig. 5. Aluminum casting shipments.

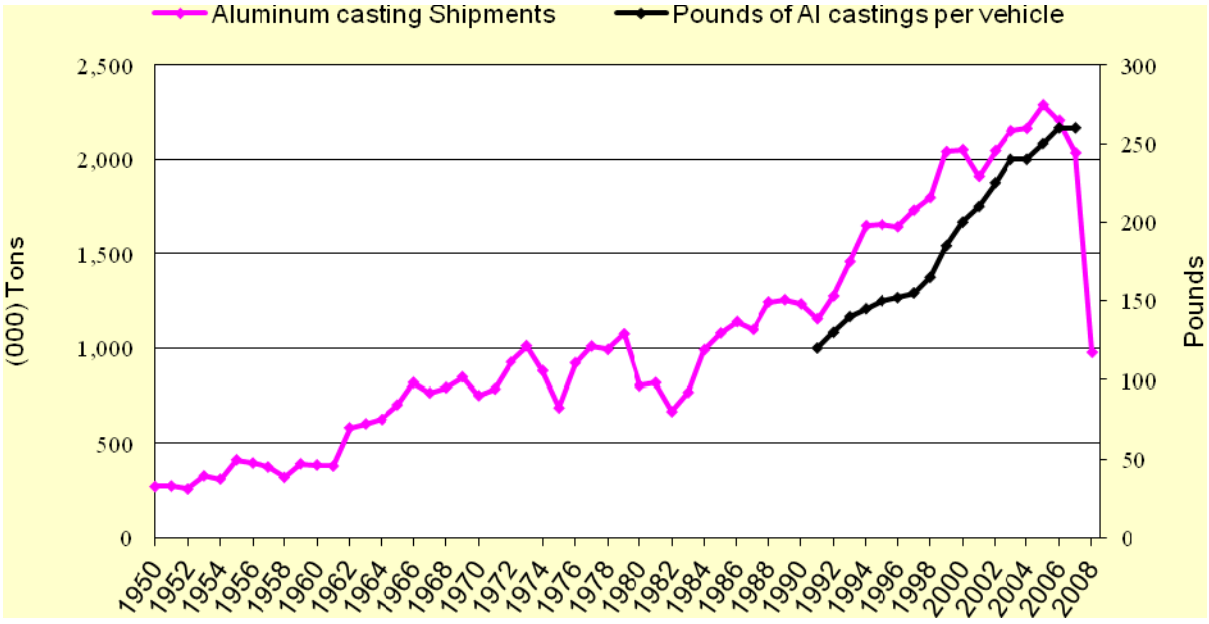

Fig. 6. Average weight of aluminum castings per vehicle.

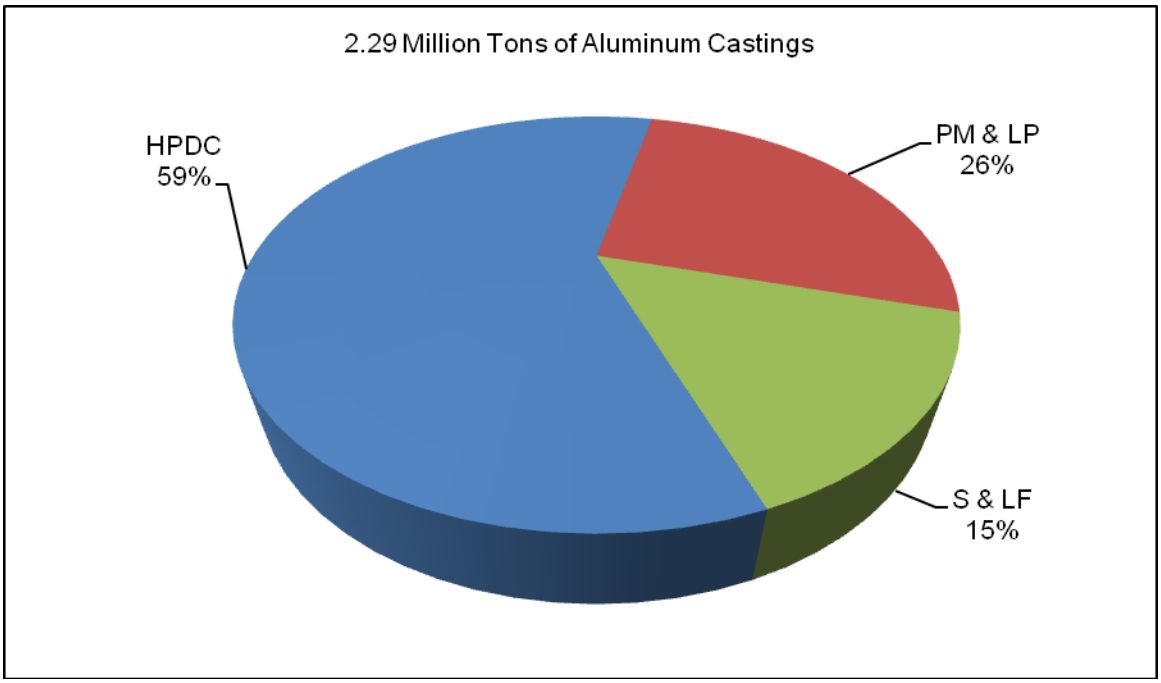

Fig. 7. Aluminum casting market share between aluminum foundries and aluminum die casters in 2005.

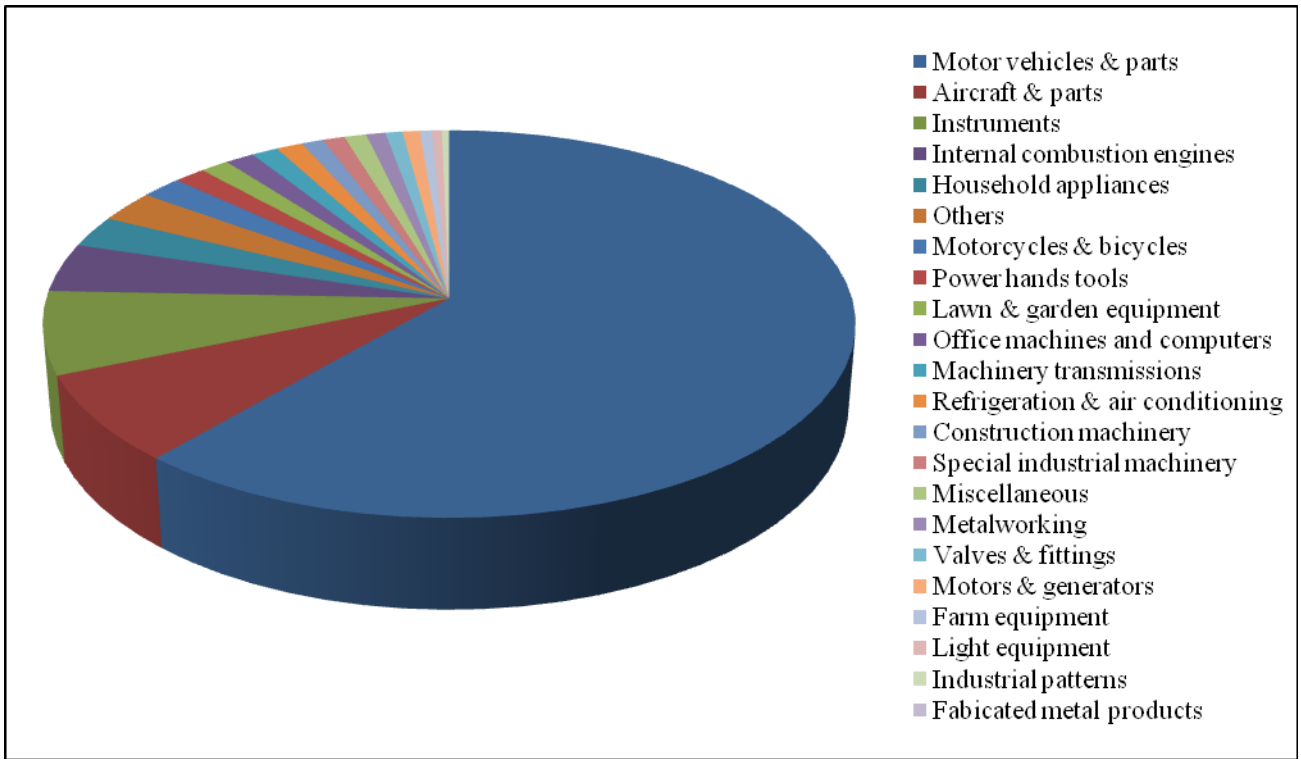

Fig. 8. Aluminum castings by end-user market in 2005, excluding die casters.

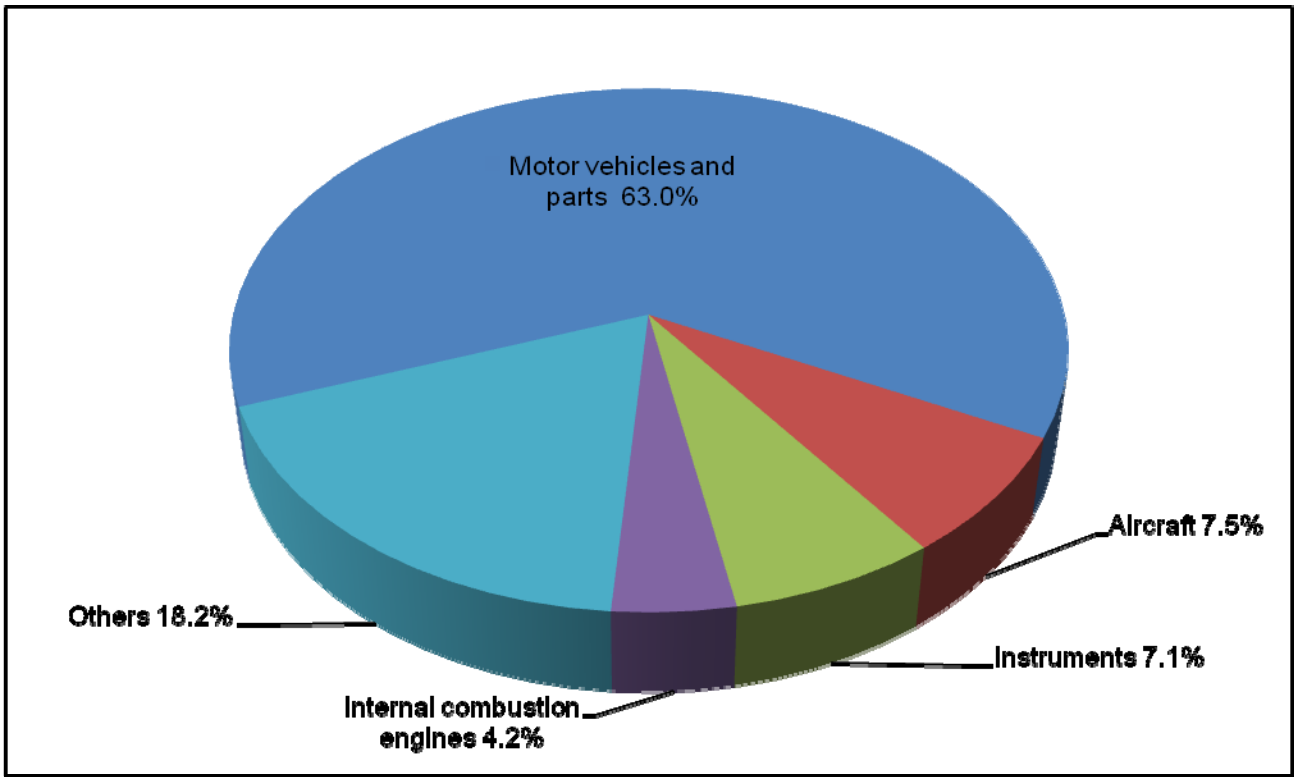

Fig. 9. Aluminum castings main end-user market in 2005, excluding die casters.

While the 42nd Census of World Casting Production by Modern Casting showed that by the end of December of 2007 only 2,130 foundries were left in the U.S, it also showed that 1,342 of them were nonferrous foundries. The latest public information available (by the U.S. Department of Commerce [17]) indicates that in 2002 there were only 542 aluminum foundries operating in the U.S. As shown in Figure 10, primarily small foundries populate more market segments, often with less than 19 employees. Three hundred ten (57.2%) of the aluminum foundries have less than 19 employees, 156 (28.8%) of the foundries have between 20 to 99 employees, 49 (9%) of the foundries have between 100 and 249, 26 (4.8%) of the foundries have between 250 and 999 employees, and only one (.20%) foundry has more than 1,000 employees.

Based on the fact that a total of 537 foundries closed from 2002 to 2007, as previously documented, and considering that the proportion of nonferrous foundries in 2007 was 68% of the total number, it may be valid to extrapolate the data and be able to estimate that perhaps at the present time there may be no more than 450 aluminum foundries in the U.S. It is certain that there is not any more a foundry with more than 1,000 employees, and perhaps neither many foundries left with more than 250 employees.

In a very broadly structured characterization, these aluminum foundries could be segmented into three categories: 1) high-volume automotive castings, 2) specialized aircraft/military/aerospace castings, and 3) commercial jobbing (less sophisticated and simpler castings). With the exception of a few of the largest aluminum foundries, most are privately owned by families or by private partnerships.

Aluminum foundries that supply the automotive market are typically characterized as highly automated, and more technically advanced when compared to commercial–jobbing foundries. The automotive market is considered a highly competitive, low margin segment, in which only high-volume production foundries can be competitive. Since the castings provided by these foundries are considered a commodity, the castings are subjected to a very intense price competition. To add value to the casting, it is very typical for these foundries to supply machined castings rather than in the as-cast condition.

Another difference between automotive aluminum (largest) foundries and jobbing (smallest) foundries is the R&D budgets and training structures, which are seldom possible in the small foundries. Therefore, larger foundries usually have a more skilled workforce.

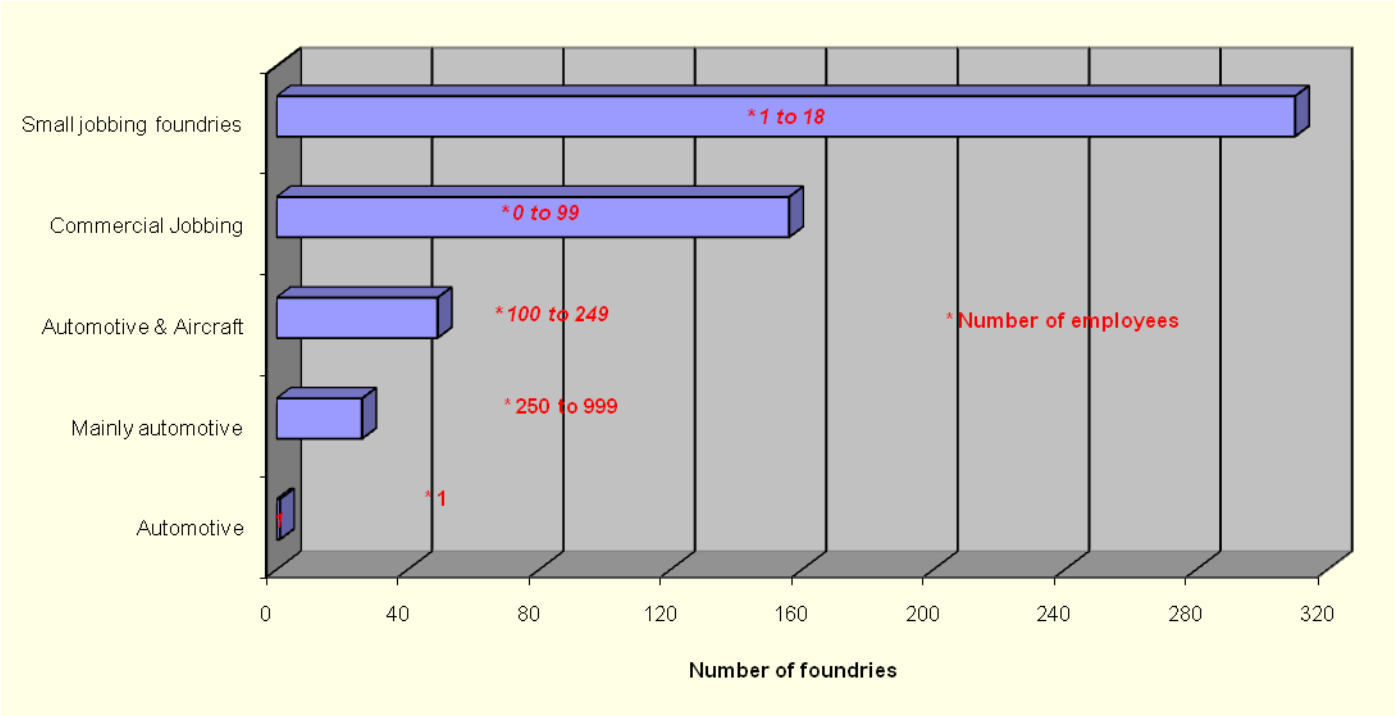

Fig. 10. Distribution of aluminum foundries by number of employees.

Aluminum Foundries Competitive Environment

Aluminum foundries operate in a competitive atmosphere shaped by the impact and the influence of external and internal environments. The external environment may include the economy at large, governmental legislation and regulation, population demographics, societal values and lifestyle, and technological factors. The internal environment includes five competitive forces such as rivalry among competing foundries, the bargaining power of buyers, the threat of entry of new rivals, the bargaining power of suppliers, and the threat of substitute products that any aluminum foundry faces.

For the most part, the influences coming from the external environment had always been considered as low impact on the foundry business situation. Nevertheless, such influences are always important in adapting the foundry direction and strategy as needed. Typically, the influences coming from the internal environments have the biggest strategy shaping impact.

Although the present situation of the foundries is due mainly to their external environment, sluggish economy, and lack of domestic automotive production, foundries that will survive will do so because they were financially sound and able to adapt quickly to the market economic demands. Going forward, any aluminum foundry that wants to gain market share, would have not only to think that they understand the internal competitive environment but most importantly that they certainly apply the competitive analysis in their advantage to systematically diagnose the competitive pressure of the industry and adapt and implement strategies for capturing customer needs.

Recent aluminum foundry surveys [13, 14, 18, and 19], have identified labor, raw materials, and energy costs as key production factors to be competitive in the aluminum foundry industry. In addition, casting price, foundry technology, casting quality, delivery, and overall customer service have also been identified as competitive factors. Thus, by using the five forces model of competition shown in Figure 11, the interaction between the competitive forces that collectively determine the aluminum foundry industry's long-term attractiveness can be assessed.

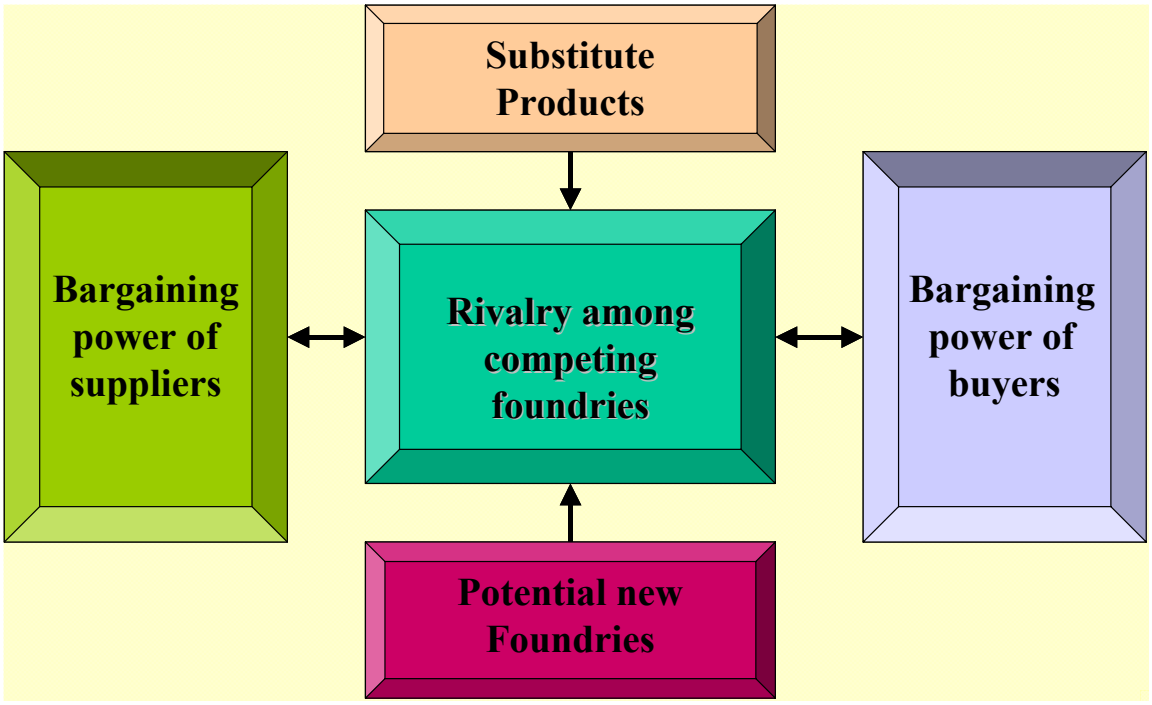

Fig. 11. The five forces of competition

PRESSURE FROM RIVALRY AMONG COMPETING FOUNDRIES

The competition among all aluminum foundries supplying to the auto industry is portrayed as fierce (cutthroat) low margin segment because of eight major factors:

1. aluminum castings are considered a commodity,
2. the demand of the majority of the aluminum castings for the U.S. auto industry is virtually saturated,
3. slow-growing market, 1.4% for the next 5 years,
4. buyers' demands can drop off unexpectedly,
5. competitors have similar manufacturing capabilities despite the fact that they are not the same in size,
6. castings of rival foundries have comparable attributes,
7. competing foundries pursue the same casting programs, and
8. attempts by foreign rivals to penetrate each other's domestic market.

Rivalry among these foundries is characterized by casting price, foundry technology, and overall customer service, which includes casting quality, delivery, and warranty. Buyers can shop for the best deal in each auto program. Although the selling prices of the castings are determined through negotiating each casting program, price sensitivity is greatly influenced by the market end user. While the automotive market is considered the most sensitive to pricing, the aerospace market is considered the least sensitive. Thus, price sensitivity for the commercial market is somewhere between these two markets.

Casting process technology is critical, primarily for development and improvement of manufacturing and engineering capabilities to meet customer requirements in the most efficient and cost effective manner, and secondly for maintaining casting quality and consistency. Although technology was a critical success factor in the past to gain competitive advantage, now is a necessity just to remain in the business.

Over more than a decade, aluminum foundries have been able to manufacture and satisfy stringent customer demands for consistent higher quality and lower cost castings through the implementation of total quality management systems, advance planning, and certification programs such as QS 9000, ISO 9000, and various other standards specific to the industry. While in the 1980s, casting quality could drive a higher casting price, in the 21st century, quality is not only demanded but also is

expected. Therefore, at the present time, casting quality alone does not appear to be a significant factor when negotiating the price of aluminum castings.

As with casting quality, delivery is expected, and consequently is not an important factor in the negotiating process. Nevertheless, aluminum foundries have to provide just-in-time (JIT) delivery service. In addition, they are required to shorten their lead times, and to be able to increase production demands within short notification notices. Although on time delivery is important, transportation costs become factors that are more significant when the foundry is further away from its customer. Aluminum foundries consider delivery not just as the activity to deliver castings, but also as an opportunity to enhance overall customer service and satisfaction.

Customer service is not just about providing a JIT inventory system to reduce the costs of storage. Perhaps it is more important these days for foundries to have proactive sales and marketing technical personnel that interface with the customer. It is also important for foundries to understand customers' needs and requirements, and most importantly, to provide guidance in casting choices, design, process options, and tracking their future casting needs.

Foundries are evaluated not only based on corporate stability, product design and product engineering capabilities, but also on long term cost reduction programs, as well as willingness to locate plants in close proximity to their end user.

PRESSURE FROM BUYERS BARGAINING POWER

Original equipment manufacturers have strong bargaining power when purchasing aluminum castings, since they buy in large quantities and the majority of the aluminum castings are considered to be in a mature and commoditized market. In addition, more bargaining leverage is gained because they are a small group of buyers that are well informed about suppliers' prices and costs. Since buyers can shop around for the best deal, they can use this knowledge to negotiate the best price from the supplier foundry. In some instances, the prospect of losing such casting program forces foundries to lower their casting price, and consequently reduce their profits.

Moreover, the present aluminum foundry industry excess capacity, and the continue interest by the U.S. OEM automakers of looking for sourcing castings offshore, have resulted in an opportunity for OEMs to leverage the situation into lower casting prices. As a result, the aluminum foundry industry faces additional pressure on pricing and margins.

Furthermore, aluminum foundries provide more bargaining power to the buyers by believing that they will gain a preferred status by supplying under priced casting programs. Aluminum casting producers have faith in that being on the buyer's list of preferred customers will help them gain future new casting programs. Foundries know that once a new casting program is awarded, the business becomes relatively guaranteed because the potential threat of the buyer switching to a competing foundry is practically nil due to the extreme high tooling costs that would be necessary to accommodate competitive designs in different foundries. Unless buyers are very dissatisfied with their current casting supplier, the high costs of switching make difficult to switch casting programs from one competitor to another. In addition, aluminum foundries know that the OEMs would not integrate backwards into the making of the aluminum casting. Consequently, the aluminum foundries do not feel any threat or pressure from the OEM buyer in this area.

PRESSURE FROM ENTRY OF NEW COMPETITORS

Competitive threat from potential new foundries entering the U.S. market could be considered to be low since with the exception of present players that might consider capacity expansion (unlikely at this time), a very small number of outsiders to the cast aluminum industry would venture to enter this highly competitive market in which competitors are struggling to earn profits.

High entry barriers such as capital investment ($2.00 in sales for each dollar spent on equipment), learning curve, slow growth (almost stagnant) market, and strict environmental regulations, are some of the factors that create unattractive conditions for starting a new aluminum foundry. However, such factors may not prevent established aluminum foundry rivals from entering competitors' domestic markets. Based on the last two years' economic conditions, future forecast, and overcapacity in the industry, perhaps no other aluminum foundry may be built in the near or distant future in the U.S. On the other hand, cheaper labor cost in other countries may influence U.S. foundries to continue and/or to consider manufacturing castings outside the U.S. Since the majority of the automotive castings are fairly simple to source from just about anywhere: labor, inventory requirements, shipping costs, and infrastructure are only meaningful geographic barriers especially for the smaller simple castings.

The domestic aluminum-casting suppliers still possess a number of advantages (shipping cost, process yield, quality, reputation, and service) except the most important advantage: cost.

Present day environmental regulations influence aluminum foundries to be established outside the United States. The U.S. aluminum foundries not only use large quantities of energy but also emit significant quantities of volatile organic compounds (VOCS), hazardous air pollutants (HAPs) and generate large amounts of waste metal. The aluminum foundry industry has an emission intensity higher than the average for the manufacturing sector overall. Therefore, it is typical that foundries will spend as close to three times more on environmental controls as compared to the other manufacturing industries.[19] Areas for such environmental improvements including increasing energy efficiency are highly pursued and supported not only by environmental agencies but also by the U.S. Department of Energy (DOE) and the Aluminum Association.

PRESSURE FROM SUPPLIERS BARGAINING POWER

Competitive forces deriving from raw material suppliers could be considered from two perspectives based on the type of raw material being supplied: commodity raw materials such as aluminum ingot, and/or standard products or components.
The common and most critical raw materials used by any aluminum foundry are the aluminum alloy ingot for the product and the natural gas for the casting process. Other important raw material for specific foundries would be the sand used for core making and/or the molding process. The aluminum alloy ingot is supplied by a primary producer and/or by a secondary smelter providing recycled material. Because the alloy ingot is an international priced and traded commodity sold in a global market, foundries pay comparable prices. Aluminum metalcasters, producing automotive castings, adjust their selling prices periodically to reflect current aluminum market conditions, based upon market price changes during specific periods.

Therefore, aluminum alloy ingot suppliers have normal bargaining power or leverage for trying to negotiate different terms and conditions as the ones offered by other suppliers. In addition, another factor that decreases the bargaining power of ingot suppliers is the low switching costs for the foundries to switch their purchases from one supplier to another. Since aluminum foundries are major customers of suppliers of ingot, ingot suppliers are closely tied to the well being of their major foundry customers.

The production of aluminum castings is an energy-intensive process (i.e., melting, casting, and heat treatment). As such, energy expenses are directly proportional to the market energy cost. In 2003, energy expenditures were reported to be about 5% to 7% of the foundry manufacturing cost.[20] While the natural gas price remained stable in 2004; it peaked to the highest prices in 2005 to more than double for half of the year. In 2006 and 2007, the prices had fallen but again another surge occurred in 2008. Thus, in response to the increasing and fluctuating energy costs, U.S. foundries have been forced to implement price increase initiatives. However, multi-year casting contracts between a foundry and its automotive customers make it difficult for a foundry to counterbalance the impact of increasing energy costs during the life of a contract. Therefore, the pattern of competition in the marketplace is greatly affected by the actions of energy suppliers since increasing energy prices have an adverse impact on the foundry earnings. Therefore, the suppliers of energy have strong bargaining power.

Suppliers of standard products or components could exert normal to moderate bargaining power since they are safe from the threat of backward integration by the foundries they are supplying.

PRESSURE FROM SUBSTITUTE PRODUCTS

Aluminum castings compete with ferrous castings for use in automotive components. Aluminum castings had gained quite a bit of the market share at the expense of ferrous castings, mainly because of the weight reductions obtained by using aluminum castings. Since the initial loss of market share to other materials such as ceramics and composites, as previously mentioned, aluminum castings have not lost significant market share.

While the aircraft and the commercial aluminum castings have not lost market to substitute products, some automotive castings such intake manifolds lost market to polymers. There have been a few attempts by ferrous suppliers to regain market share in suspension components and wheels. Other than that, it appears that aluminum metalcasters as a whole do not have pressure from other industries to offer substitute products for the present aluminum castings being used. Nevertheless, the pressure may come from die casting facilities to convert existing permanent mold castings to high-pressure die casting (HPDC). Moreover, the automotive industry remains active in converting to magnesium.[15]

IMPACT OF COMPETITIVE FORCES

The individual impact of the competitive forces is shown in Figure 12. However, the collective impact of the competitive forces is considered fierce because of two main competitive forces: 1) Rivalry among foundries due to the large number of

competitors competing in a mature industry with a commodity product, in an industry with excess capacity, and 2) Automotive casting buyers strong leverage in casting program pricing. Thus, these pressures fuel the competitive environment among foundries.

	Pressure Scale				
Competitive Force	**Fierce**	**Strong**	**Normal**	**Moderate**	**Low**
Competing rivalry among foundries	■				
Pressure from buyers bargaining power		■			
Pressure from suppliers bargaining power		■	■	■	
Pressure from entry of new competitors					■
Substitute products				■	

Fig. 12. Individual impact of competitive forces

Thus, it appears that there are four main driving forces shaping the foundry industry. The first driving force relates to the change in the long-term industry growth rate since commoditization and maturing demand characterize the automotive aluminum castings. The forecasted yearly average growth of only 1.4% for the next five years may cause the industry to become more competitive.

The second driving force relates to the increasing requirements for global capabilities from the U.S. automotive EOMs, which have focused on expanding their business operations globally to capitalize on markets that are experiencing high growth rates, or that have low production costs. As a result, aluminum-casting suppliers are being required to operate in the same global markets to obtain new business from their customers.

Not only have many industrialized economies developed large foundry industries to support their manufacturing sectors but also government officials in many developing markets are reducing trade barriers, as it has been occurring in Asia and Eastern Europe, that coupled with their lower labor costs provide a stronger incentive to attract aluminum foundries to supply global market demand.

As the automotive aluminum castings market has become more global, it is important not only to have the right product but also to produce it in the right place to meet the demand of the world market. Nevertheless, growing in the right geographic markets does not mean investing only outside of the United States.

The third driving force relates to regulatory policies and governmental legislation. The cost of compliance with government regulations is making U.S. aluminum foundries less competitive when compared to foundry operation in countries with less stringent regulations. A variety of federal, state, and local environmental regulations apply to the aluminum foundry industry in the United States. The most significant regulations [19 and 21] are the Resource Conservation and Recovery Act (RCRA), Clean Air Act (CAA), Clean Water Act (CWA), and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Additionally, the aluminum foundry industry is indirectly impacted by environmental regulations affecting OEM's and automotive manufactures.

It is well known that much aluminum foundry activity has been occurring for the last decade in some Asian and Eastern European countries. Despite the claims by government officials from these countries that their environmental laws are as stringent as those in the United States, it is known that the enforcement of those regulations has been lax. More troublesome is that economic development priorities often overshadow environmental considerations. Consequently, foundries in such

countries gain competitive cost advantage by not having to spend as much in environmental compliance as in the United States.

Finally, the fourth driving force relates to the continuous use of aluminum castings in vehicles because of the improvement in fuel efficiency weight realized by the OEMs.

Since aluminum castings for vehicle applications are dependent on the automotive industry, there are no unpredictable or expected changes in who buys the product or how it is used. Thus, by providing castings directly to OEMs, there are not marketing innovation opportunities to spark automakers buyers' interest.

From the mid 1980s to the mid 1990s technological innovations were considered a driving force in shaping aluminum casting applications such as wheels, suspension parts and cylinder heads among others. Such innovative emerging technologies provided a competitive advantage to the first foundries that introduced and implemented them. Thus, foundries were very secretive about the diffusion of their technical expertise, especially in the casting process area. Technological transfer among competitors was not easily obtained. However, as technology transfer across national boundaries occurred over time, it caused many aluminum castings to become more globally competitive. Thus, technology is necessary just to compete in the market.

In short, the low growth rate of automotive castings in the U.S. will cause the competition to be more intense. Increased globalization of the aluminum castings will cause the industry to be less profitable. Fuel efficiency regulation and new customer needs will sustain aluminum casting demands despite the low rate growth. Different regulations and compliance standards among countries will favor global competition, and opportunities to establish aluminum foundries in different countries.

CONCLUSIONS

It is more evident than ever that the U.S. automotive industry meltdown in 2008, and the continued downsizing of it, has had a significant impact on the foundry business.

The present situation of the U.S. foundry industry is not a reflection of the last two years recession but a manifestation of significant loss in market share to global competition throughout the years.

Aluminum foundries operate in a competitive atmosphere shaped by the impact and the influence of external and internal environments.

The number of operating foundries in the U.S. has declined to nearly 66% over the last 54 years, largely because of foreign competition, and environmental compliance. The global aluminum foundry industry is shrinking, coalescing through both merger and acquisition, and collaborative efforts.

Aluminum castings have experienced continuous growth since the 1950s up to the mid 2000s. Ever since, the use of aluminum castings for automotive applications has been rising.

Although small in numbers, the U.S aluminum foundry industry is highly productive, and efficient.

Historically, higher aluminum casting tonnage has been shipped by high-pressure die casting operations than by aluminum foundries. In the first seven years of the 21st century, the average difference in tonnage shipped by die casters over aluminum foundries was around 40%.

Aluminum castings shipped by the aluminum foundries is typically consumed by a highly fragmented market. However, the automotive sector dominates the market with about 63% of the total aluminum casting tonnage shipped.

The automotive aluminum casting market is considered a highly competitive, low margin segment.

The U.S. aluminum foundry industry's potential business opportunities are also directly affected by the number of imported vehicles being sold in the U.S. Thus, aluminum foundries must look to outside the U.S. for increasing market share.

It is evident, more than ever, that if a foundry wants to succeed, not only factors of competition such as labor, raw material, energy cost, and foundry technology are essential to be controlled but most importantly, the foundry must rapidly adapt to the customer demands and strong global competition while remaining competitive in pricing.

The interaction of the five competitive forces collectively determines the competitive environment.

- Pressure from rivalry among competing foundries
  The competition among all the aluminum foundries supplying to the auto industry is portrayed as cutthroat low margin segment because: 1) castings are considered a commodity, 2) the demand of the majority of the castings is virtually saturated, 3) it is a slow-growing market, 4) buyers' demands can drop off unexpectedly, 5) competitors have similar manufacturing capabilities, 6) castings of rival foundries have comparable attributes, 7) competing foundries pursue the same casting programs, and 8) attempts by foreign rivals to penetrate each other's domestic market.

- Pressure from buyers bargaining power
  Original equipment manufacturers have strong bargaining power in negotiating to buy aluminum castings because the majority of the aluminum castings are considered to be in a mature and commoditized market. In addition, more bargaining leverage is gained by the buyers because they are a small group of buyers, which are well informed about suppliers' prices and costs. Moreover, the present aluminum foundry industry excess capacity, and the continued interest by the U.S. OEM automakers of sourcing castings offshore, has resulted in an opportunity for OEMs to leverage lower casting prices.

  Furthermore, aluminum foundries provide more bargaining power to the buyers by believing that they will gain a preferred status by supplying under-priced casting programs.

- Pressure from entry of new competitors
  Competitive threat from potential new foundries entering the U.S. market could be considered to be low with the exception of present players that might consider capacity expansion (unlikely at this time), a very small number of outsiders to the cast aluminum industry would venture to enter this highly competitive market in which competitors are struggling to earn profits.

  High entry barriers such as capital investment, learning curve, slow growth (almost stagnant) market, and strict environmental regulations create unattractive conditions for starting a new aluminum foundry

- Pressure from suppliers bargaining power
  Competitive forces deriving from raw material suppliers are based on the type of raw material being supplied. On one hand, alloy ingot is an international priced and traded commodity sold in a global market and therefore foundries pay comparable prices. In this case, aluminum alloy ingot suppliers have normal bargaining power for negotiating.

  On the other hand, foundry energy expenses are directly proportional to the market energy prices, and therefore the competition in the marketplace is greatly affected by the actions of energy suppliers. In this case, suppliers of energy have strong bargaining power.

- Pressure from substitute products
  It appears that aluminum-casting facilities as a whole do not have pressure from other industries to offer substitute products for the present aluminum castings being used. Nevertheless, the pressure may come from die casting facilities to convert existing permanent mold castings to the HPDC process.

The collective impact of the competitive forces can be considered to range from fierce to strong because of two main competitive forces: rivalry among foundries, and automakers buyers' strong leverage in casting program pricing.

There four main driving forces shaping the foundry industry: 1) changes in the long-term industry growth rate, 2) increasing requirements for global capabilities from the U.S. automotive OEMs, 3) regulatory policies and governmental legislation, and 4) the continuous use of aluminum castings in vehicles because of the improvement in fuel efficiency.

In conclusion, the United States is and will continue to be a large automotive market with opportunities for aluminum foundries. Despite the fact that some market segments are mature or fully penetrated, other markets will continue to grow, offering growth potential in new structural components, suspension parts, and engine blocks. Similarly, the aerospace market can be considered a saturated market, but the replacement of castings has been continuous throughout the years. Being a niche market, the outlook is more attractive because casting complexity and quality requirements support higher pricing.

Despite the competitive pressures the aluminum foundry industry is expected to face in the future, it is also expected that the auto industry will provide an opportunity for revenue growth, hopefully in the high single digits. Nonetheless, foundry's profitability won't return to mid-1990s levels, in all likelihood.

The threat of much lower labor costs in other countries should be a driving force to become more productive and efficient. Otherwise, the tactic should be to outsource one's castings.

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