The die casting industry in North America grew in 2016 and is expected to grow further in 2017. The growth is fueled by continued record levels of automobile production and the increased use of aluminum die castings in almost all areas of the newest cars. Mexico grew faster than the United States due to lower labor costs. However, the U.S. saw a good number of new die casting plant start-ups in 2016.

There is no doubt the election will change the landscape of manufacturing in the United States. The direction which it will be changed will unfold in 2017.

Policy Impact:
Due to the direct impact the stated policies of the incoming administration will have on manufacturing, I have started this article with the major policy topics and how they may or may not impact die casters.

In the 3rd quarter of 2016, the National Association of Manufacturers published a report that outlined the ‘challenges’ CEOs of manufacturing companies in the United States faced. Rising healthcare costs (74%), unfavorable business climate (specifically taxes and regulations, 73%), and weaker domestic economy (61%) headed the list.

The new administration has focused their first 100 days on addressing the challenges facing manufacturing CEOs in this country. Keeping jobs and growing the economy is the intended focus of the effort. The impact of these changes will be based on the details surrounding them.

Healthcare:
According to the World Health Organization (WHO), the United States spent more on healthcare per capita ($8,608), and more on healthcare as percentage of its GDP (17.2%), than any other nation. Germany spent 11.3% and Canada 10.4% of their GDP on healthcare.

Healthcare premiums for both the employer and employee have been rising steadily since 1999. There is a clear jump in the average premiums from 2015 to 2016 and even more drastic jumps will be seen for 2017. The effort to repeal and replace the existing system will only help manufacturers if the premiums decrease and the percentage of our GDP for healthcare decreases to be in line with the rest of the world.

The specific issues being suggested are:
• Create Across State Lines Competition
• Reducing Federal Assistance
• Maintain Coverage Age on Parents Insurance Until 26
• Maintain Nobody Can be Turned Away, But Allow Varying of Premium Based on Risk

Experts expect Health Savings Accounts (HSA) insurance to be the most prevalent type of insurance in the future.

Corporate Tax Structure:
There are pros and cons of lowering corporate taxes. This effort will take a few years to take hold and will most likely help small and medium sized companies more than the multi-nationals.

What really drives the U.S. economy is small businesses (firms with fewer than 500 employees). They drive the U.S. economy by providing jobs for over half of the nation’s private workforce. In 2015, there were 28 million small businesses in the United States, compared to 18,500 larger firms with 500 employees or more.

Lowering the corporate tax rate leads to economic growth and job creation because companies have more money to invest. A tax cut that increases corporate or personal income equivalent to one percent of GDP increases GDP by between 2-3%, according to a June 2010 peer-reviewed study by UC Berkeley Political Economy Professor David Romer, and former head of Obama’s Council of Economic Advisers Christina Romer. A tax increase of one percent of GDP lowers GDP by roughly three percent. Higher GDP leads to job growth because companies make more money and have more to invest.

Regulatory:
Government inaction is almost as harmful to businesses as government interference. There are too many regulations on all businesses to even try to put a cost on the impact. In December, 2016, the current administration’s inaction (eX-Im bank), interference (pipeline permitting), and misguided focus has wasted millions in taxpayer money and made it more difficult to do business in this country. Cutting unnecessary regulations will definitely save money for all businesses.
There is one government regulation that has helped the die casting industry. The fuel efficiency standards have caused automotive companies to place an emphasis on light weighting their fleet.

Light-weighting is still seen as the best way to try to meet the emission standards. But the auto industry can’t get Americans to buy what will help them achieve the lower emission standards. So, they must look at increasing, even more, its use of aluminum on many more model vehicles.

Automakers in 2012 signed onto a target of 54.5 miles a gallon by 2025 on the condition that the standards be reassessed in 2017. The issue now is that cars we are buying are getting heavier.

Cars have gotten heavier as U.S. consumers have tended to buy bigger vehicles. (Source: Wall Street Journal)

The government is taking a much wider view of emissions as we reduce the tailpipe emissions. Green House Gas (GHG) is produced throughout the life of the vehicle and the amount of GHG in materials production will have a greater impact in the future.

In 2010, tailpipe emissions accounted for 71% of GHG emissions and material product 20%. In 2020, the numbers are expected to change to 53% and 38% respectively.

In internal combustion engines, the split between the embedded emissions in materials and manufacture remains at about 20%, with 80% of emissions relating to the use from fuel combustion.

Hybrid vehicles, particularly in situations where plug-in recharging is from carbon-free electricity, the balance of the environmental burden switches to the embedded carbon in the materials of vehicle construction rather than the use.

Therefore, material production methods have a much higher impact on the overall emissions from the production and use.

When you look at materials emissions due to their manufacturing process, aluminum comes out on top. The graph shows both the range of carbon equivalent emissions from steel, aluminum, magnesium, and carbon fiber reinforced polymer (CFRP) in terms of their emissions per kg and emissions per functional equivalent of component weight.

As it clearly shows, recycled (secondary) aluminum in optimized vehicle structures dominates compared to other materials, even recycled steel.

The most environmentally friendly production of magnesium and perhaps even eventually CFRP components can begin to be as environmentally effective as the most high carbon forms of primary aluminum production. However, the production and use of secondary aluminum creates a smaller carbon footprint than even the best steel!

The average carbon footprint for a standard automotive cylinder housing, made using primary aluminum, is 9.5 kg of CO2 per kg of aluminum produced. It is 6 kg of CO2 using a secondary aluminum. Crash boxes create just 4.4 kg of CO2 per kg of aluminum, 58% below that of primary aluminum.

High pressure die casting is the ideal process for using secondary aluminum and therefore the process of choice for automotive component designers.

Figure 2 - The challenge to meet lightweighting regulations is greater due to the difference between real world and measured emissions. (Source: Constellium)

Even if they meet the goal, will they really improve emissions? The official fleet vehicle average test results are moving away from the real world improvements and this could cause even further regulations.

Figure 3 - Cars have gotten heavier as U.S. consumers have tended to buy bigger vehicles. (Source: Wall Street Journal)

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Figure 4 - Aluminum has the highest upside potential.

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Figure 5 - Shipment history for aluminum casting methods.
Thin wall aluminum die castings significantly reduce the weight of the component, when compared to other casting methods, and therefore it creates a smaller carbon footprint than any other aluminum casting process!

When we look at the change in product mix (figure 6) there is a decrease in the percentage of castings on the vehicle, but the weight of the castings increases. This is mostly due to the growth in the flat roll of aluminum body enclosures. We think there is opportunity not only in the growth of aluminum high-pressure die casting but also that aluminum die casting will impact, at a higher percentage, the flat rolled market and permanent mold market.

Infrastructure:
During the 50s and the 60s, the U.S. was spending between 3 and 4 percent of GDP on infrastructure. Today, that figure is down to about 2.4 percent.

After dropping to 11.4 million manufacturing jobs in 2010 from 19.5 million in 1979, total U.S. manufacturing jobs have rose to 12.3 million in 2016. However, the industry still needs 4 million more jobs to return to a manufacturing base that supports the middle class and a healthy economy. To increase manufacturing jobs, the best short-term solution is to repair the nation’s infrastructure.

The rebuilding of our infrastructure is likely the most direct way to create domestic jobs. You can’t import a road paver or a bridge riveter. However, you can dwarf the impact of infrastructure rebuild if you buy non-U.S. made road paving machines from another country or bridge structures from Japan. Much like the ‘content’ labeling for automobiles, perhaps we need to keep this in mind when drafting our infrastructure spending plan.

NAFTA and Its Effects:
During the elections, we heard quite a bit about NAFTA and China. NAFTA is between three countries. It seems to work for us when it comes to Canada, but falls short when looking at Mexico. There was an even trade ratio (import to export) between the U.S. and Canada in 2016, and a trade imbalance between the U.S. and Mexico.

Large OEMs want to keep their stock value high by producing products cheaply in Mexico and selling them in the United States. Small and Medium companies in the United States, which supply the large OEMs, get squeezed out and normally cannot compete with Mexican labor rates.

The companies with marginal gains projected from moving to Mexico may think twice about moving if there is a 35% tax on bringing the products back in to the United States. But the large OEMs probably don’t care because they know any tax added will most likely not be as high as 35% and their savings from moving will be greater, even with the tax.

Bloomberg News reported that in 2016, Mexico could overtake Canada as the No. 2 exporter of goods to the U.S. Shipments from Mexico “totaled $245 billion in the first 10 months of the year, according to Commerce Department figures released Tuesday, ahead of Canada’s $230 billion.” If the trend continues, it would be “the first time ever the U.S. bought more imports from its neighbor to the south.”

China is a similar story to Mexico in terms of the balance of trade being so one-sided. However, the order of magnitude is 50 times worse with China. The deficit for Mexico is $6B and the deficit for China is $320B.

Roughly, for every $1B in trade imbalance, the country on the short end loses 10,000 jobs. The imbalance of trade with China has cost 3.2 million American jobs.

A Value Added Tax (VAT) is used by over 160 countries. The U.S. is one of the only countries that does not impose a VAT. Perhaps this is key to staying competitive globally.

Increasing Minimum Wage:
The impact of raising the minimum wage would be felt by the die casting industry.

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It’s not only the new employees, but it’s the entire structure of direct labor. You can’t bring someone in at a minimum wage of $15/hr and pay the average guy that has been there $17/hr. Die casters pay a little worse than retail trade! Would you work in a hot die casting plant if you could make the same money driving a forklift at Costco or folding jeans at the GAP?

Simply put, we cannot compete with low cost wages, nor should we. We must automate, reduce basic ‘button pusher’ labor content to part-time work and we must bring in and train higher level talent which far exceeds the minimum wage.

This is the only way to compete globally. Ultimately, it is less jobs, higher productivity.

Figure 9 – Engineering salaries.

Immigration:
We have to be concerned about illegal immigration, from a business standpoint, only if we want to be the lowest wage provider. We should be concerned about laws regarding H1B visa issuance. This is because our industry does not pay enough to attract the best and brightest engineers.

We are at a disadvantage with other industries because we must automate to become more productive and we do not pay the engineers enough to attract the top talent to develop better automation. The solution may be to bring in the brightest from other countries.

Macro Economics

There has been a steady stream of good economic numbers since the election. Strong consumer spending helped push real GDP growth higher, to a revised 3.2 percent in the third quarter of 2016. Original estimates set the growth at 2.9 percent, with both figures marking the fastest quarterly growth rate in two years.

Figure 10 – Real gross domestic product.

With the U.S. economy expanding by only 1.1 percent at the annual rate in the first half of 2016, the third quarter numbers were very much welcome, especially for consumer spending and net exports. Business investment remains a concern, but will hopefully recover moving forward with improvement confidence. In the end, real GDP will grow by 1.6 percent in 2016, but expect stronger activity next year, with the current forecast being 2.5 percent growth.

In November 2016, the unemployment rate decreased by 0.3 percentage point to 4.6 percent and the number of unemployed persons declined by 387,000 to 7.4 million. Both measures have shown little movement, on net, from August 2015 through October 2016.

The civilian labor force participation rate, at 62.7 percent, changed little in November 2016, and the employment-population ratio held at 59.7 percent. These measures have shown little movement in recent months and have never been higher.

The number of persons employed part time for economic reasons (sometimes referred to as involuntary part-time workers), at 5.7 million, changed little in November 2016 but was down by 416,000 over the year. These individuals, who would have preferred full-time employment, were working part time because their hours had been cut back or because they were unable to find a full-time job.

Figure 11 – Improvement in personal consumption.

Consumer Sentiment:
Consumer confidence soared in November 2016 to its highest level since July 2007, according to the Conference Board, bouncing back from a pre-election lull in the October 2016 report. This mirrored a similar post-election rise in sentiment seen in the competing survey from the University of Michigan.

Manufacturing Capacity:
Manufacturing capacity use has been trending downward since early 2015 and even though it was up in November 2016, it seems the increase in the number of businesses in the United States and Mexico is impacting the capacity
use by production levels being maintained but spread over more facilities.

The recent NAM CEO outlook numbers began a downward trend in early 2015. They picked up for most CEO’s in 2016, but the small firms continued to have a downward outlook. As mentioned earlier in this article, small businesses drive the economy and it seems that the new administration’s policies may help these type of businesses more than the multi-nationals.

Benchmarking the industry has become one of the key focuses of NADCA in the past two years. The ability to segment the industry and compare “like” operations has shown promise and utility for the die casters.

The volume of aluminum being produced in the die casting industry is at one of its highest points in history. The larger automotive machines entering the market have produced a lot of very large die castings. The slowdown in the sales/employee rate is mostly attributed to the cost of aluminum decreasing.

Our 2016 benchmarking efforts subtract out the cost of materials and finds the value added in sales/employee. As we develop this data for multiple years, we will be able to determine the real change in productivity from one year to the next.

The capacity use for die casters in aluminum auto in the 3rd quarter of 2016 increased over the second quarter. It also slightly increased for non-auto aluminum die casters. The overall average for aluminum die casting had a 67% capacity use, while zinc was at 55.5%. It is expected that capacity use for the final quarter of 2016 will be up slightly from the 3rd Quarter level.

Figure 12 – Manufacturing capacity trending downward.

Figure 13 – Manufacturing CEO outlook index.

Benchmarking

Figure 14 – Productivity of HPDC slows.

Figure 15 – Capacity use in 3rd quarter of 2016.

By using benchmarking data, a comparison was made between the cost of energy at various die casters. Figure 15 shows further delineation between auto and non-auto, aluminum and zinc operations.

Aluminum Die Casters Revenue/Pound

Figure 16 – Aluminum die casters revenue per pound.

Every die caster wants to maximize their revenue/pound cast. This chart shows the variation among the aluminum die casters. It further shows the difference between auto and non-auto facilities. Interestingly, the two operations which cast structural components generate a high revenue/pound among aluminum auto die casters, but are below several of the non-auto companies.

Die Casting Industry Profitability

Figure 17 – Die casting industry profitability.
All the numbers translate to the profitability of the industry. For aluminum die casting, some of the key financial benchmarks are shown with 2015 being one of the better years. This data was obtained from a risk assessment firm which collects the information for lending companies to use.

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<th>Overall</th>
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<th>Non-Auto</th>
<th>Zn</th>
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**Figure 18** - 2016 vs 2015 Forecasts vs Actual.

The year started with high expectations from most sectors of the die casting community. However, as the year progressed, the non-automotive sector started to downgrade their forecast. The final quarter saw some rebounding of the non-auto sector in order to finish the year overall at 2.1% growth over the previous (record setting) year.

**End Market Analysis**

**Automotive:**
The automotive industry is the major end market served by the die casting industry, and its sales, trends and forecast ultimately determine the direction the overall die casting industry will take.

U.S. light-vehicle sales rallied at the end of 2016 and sales levels for the year ended on par with 2015’s record volume.

Industry analysts forecast motor vehicles and parts production falling by 3% in 2017, and drop 2% in 2018. Auto and light truck sales are forecast to be 17.8 million units in 2017, and 17.7 million units in 2018.

The effect Mexico is having on the auto supply chain is beginning to be felt. Motor vehicles and parts imports were up 1% while exports fell 2%. For every dollar of exports there are $2.40 of imports, so the sizable trade deficit was $1.7 billion more negative in 2016 compared with one year earlier.

Even though analysts forecast 2017 to be a slower year for the auto industry, it appears the auto companies did not get the memo because their production schedule for the first quarter shows increases for almost all the car companies and an overall 3% increase in production.

Also, the number of new launches for tooling is forecast to be the same as it was in 2016. Tool redesigns are expected to exceed 2016 numbers. 2017 through 2020 appear to be significantly higher and may even reach record highs. New entry programs are expected to be significant in 2018 and 2020, while redesigns will grow slightly.

**Figure 19** - Light-vehicle sales leave potential for record year.

**Figure 20** - 2017 through 2020 may reach record highs in new launches for tooling.

**Housing:**
The second largest end market that the die casting industry serves indirectly is housing.

New housing starts will grow at a rapid pace in the next three years because they are at a low level relative to the pace of expected household formations. The 2016-2018 growth rates will favor single-family starts; multi-family will grow at a slower pace after many years of leading the housing recovery. The housing supply chain (wood products, nonmetallic mineral products, HVAC, household appliances, furniture, etc.) will continue to grow.
The forecast is for housing start gains of 6% in 2016, up 16% in 2017, and up 9% in 2018.

One of the main reasons the housing forecast is so bullish for 2017 and 2018 is that residential property prices have almost fully recovered to their pre-recession level and similarly mortgage delinquency rates are almost where they were in 2007. Additionally, home inventories remain low, which is helping to boost median sales prices.

Production of small appliances was up 14% and large appliances rose 2% (the production value of major appliances is three times as large as that of small appliances).

Household appliances’ import to export ratio is 6.4—one of the highest adverse trade ratios in manufacturing. Household appliance imports declined 2% and exports fell 10%, but because imports are so much larger than exports, the decline in imports left the trade deficit of 2016 relatively unchanged compared with one year ago.

**Electric Lighting:**
Electric lighting equipment includes electric lamp bulbs and residential, commercial, and industrial lighting fixtures.

Electric lighting equipment production should be unchanged in 2016 before increasing 1% in 2017 and 2% in 2018.

At 7.3, electric lighting equipment’s import to export ratio is also adverse to our country in manufacturing. Imports were unchanged while exports fell 9% in 2016 compared with one year earlier. The trade deficit was $50 million more negative than one year earlier.

**Medical Equipment:**
This category encompasses surgical and medical instruments, surgical appliances and supplies, and dental laboratories.

The forecast for medical equipment production growth of 7% in 2016, 3% in 2017, and 2% in 2018.

Medical equipment and supplies imports increased 6% while exports fell 3%. With an import to export ratio of 1.3, the strong growth in imports pushed the trade deficit $697 million more negative in the second quarter of 2016 compared with one year earlier.

**Communications Equipment Production:**
Communications equipment encompasses telephone apparatus and broadcast and wireless communications equipment. The category also includes alarms, signaling equipment, and safety detectors.

Communications equipment production increased 12% in 2016 and will be up 3% in 2017, and 5% in 2018.

The communications equipment industry is very dependent on imports from contract manufacturing plants in Asia. With an import to export ratio of 5.8 (for every $1 of exports there are $5.80 in imports), domestic production accounts for only a small proportion of domestic consumption. Imports rose 1% while exports fell 7% in 2016 versus one year ago. The very large trade deficit was $538 million more negative in the 2016 compared with one year ago.

**Heavy Truck:**
Heavy truck production is a leading economic indicator and the last quarter of 2016 was a very good one for heavy trucks.

Don Ake, Vice President of Commercial Vehicles at FTR, commented, “The adjusted number of 21,300 was fueled by the big fleets placing their requirement orders for the first half of 2017. This indicates the freight markets are stabilizing and the fleets are confident enough to replace older trucks.”

Appliances:
Household appliance production grew 4% in 2016 and is forecast to grow 3% in 2017, and another 2% in 2018.
While overall Heavy-duty truck production declined 8% in 2016, the last quarter is the start of a turnaround. Production will be up 3% in 2017, and 5% in 2018.

The Overall Consumer Goods (non-Transportation) Value ended 2016 about the same as 2015. However, recent overall inventories are decreasing which should mean an increase in orders for 2017. There are some strong headwinds coming from imports into many of these markets which drives home the point that balancing the trade will help significantly.

End Market Conclusions:
End markets that are important to die casting move in a cyclic pattern, but not in the same cycle.

The slow pace of manufacturing growth, strong dollar, excess capacity in Mexico and China's manufacturing sector, and low commodity prices will impact the metals industries. Steel, aluminum, and fabricated metal products production will need to stave off threats of imports into their markets.

If you are looking for new markets in a changing environment, perhaps the best place to look is in the industries that are projected to have the largest rate of change between 2014 and 2024.

Industries with Largest Annual Rate of Change 2014-2024

As die casters review their customers and processes to meet their future demands, one of the end markets that still has an upside is in automotive applications. The many product groups and potential die casting components are quite significant.

New Applications

Although much focus is on aluminum sheet products for body and closure, the share of castings, between powertrain and wheels is nearly 50% of the total average aluminum content.

A European study dismantled a large number of European cars to determine the current aluminum content in each of them. The average aluminum content per vehicle was 150 kg and ranged from 62 kg for the Smart Fortwo, up to 610 kg for the Range Rover Sport.
Although still dominant, the share of aluminum castings in the total aluminum consumption has decreased by 8 percentage points in the last 4 years. The share of rolled products has grown significantly due to the increased penetration rate for body closures and body structures. As mentioned earlier, the growth of high strength die castings can penetrate some of the closures and structures market that is being allocated for rolled products.

Overall aluminum content per vehicle is poised to grow from 2016 thru 2025. The vast majority of growth is expected to be sheet driven, particularly for closure applications.

**Future Scenarios – Total Market**

Based on scenario forecasts, aluminum content per vehicle will continue to grow to nearly 170 kg in 2020, and around 190 kg by 2025. The use of aluminum auto body sheet is expected to increase by 110% over the next 10 years. Differences between low and high case scenarios are largely attributed to penetration rates and use of aluminum for body closures, structures, as well as chassis & suspension components. A great deal of growth is due to an anticipated increase of aluminum vacuum die casting replacing steel stamped components (sub-frames, shock towers) within the body and structure.

Additionally, growth of aluminum content will also fluctuate largely based on the OEMs’ ability to meet CO₂ requirements with powertrain improvements.

**Technology Disruptions**

In the material world when it comes to castings your metal and process need to stay viable or vanish. Iron castings have declined over the years between 1995 in 2013. Similarly zinc die castings were used in the late 50s and early 60s.

Right now, for many reasons, aluminum is the material of choice for the automotive industry. But only because they have not found anything to replace it, YET.

There is a lot more to come in vehicle light weighting than the battles between steel, aluminum and carbon fiber for the keys to the body-in-white castle. Ford used clever engineering and plastic composites to replace an expensive magnesium part on the new 2017 Ford F-250 pickup. The new carbon-fiber hatch on the Toyota Prius Prime plug-in hybrid replaces steel.

For expanding our applications, we have to make what the designers want. Crash and Strength relevant die castings are going to have to be made. New alloys with higher elongation will need to be used. Current die casters should be learning how to cast these materials now, before the European and Asian transplants and those in Mexico take the lead and basically force us out of the business.

If you believe that the rate of auto production will continue in the next few years and that Mexico will continue to grow, then newer higher tech, more challenging market applications need to be developed. The ability to produce as-cast HPDC with a 14% elongation will allow you to enter markets that were previously dominated by low pressure/gravity/permanent mold castings. Because of our ability to produce at high production rates, with less people, more repeatable, thinner wall products is what is needed by the end market customers.

We are going to have to grow the application market because the number of die castings will decrease as electric vehicles become more prevalent.

The charging capacity and duration of the battery will drive the acceptance of the EV market. One huge downside of the battery was its dependency on rare earth materials. The cost and domestic availability of these materials was...
costly and geopolitically an issue. Late in 2016, Honda and Daido Steel demonstrated an electric motor without rare earth materials.

To put the world on track to limit global warming to the most stringent goal set by world leaders in 2016, the last gasoline-powered car will have to be sold by about 2035.

A report, by a Climate Action Tracker (CAT) was backed by three European research groups, said a drastic shift was needed towards clean electric cars and fuel efficiency since transport emits about 14 percent of world greenhouse gas emissions.

It assumes the last fossil-fuel vehicles would be on the roads until 2050.

The phase-out is earlier than set by most car makers. Toyota, for instance, has a “zero carbon dioxide emissions challenge” for new vehicles under which it aims to cut emissions from its vehicles by 90 percent by 2050, from 2010 levels.

Conclusions

At this time, we are looking at 3 to 3.5% increase in 2017 versus 2016. But there could be a “Trump Effect” that will help to accelerate our economy. Die casters will benefit from a reduction in corporate taxes, a better NAFTA deal, rolled back regulations, defense and infrastructure rebuilding. If, and that is a big “if”, these move forward rapidly, we could see higher growth. The key market to watch will be ‘heavy truck’ production. This is a leading economic indicator.

Finally, if the market can withstand (not tank by much and rebound rapidly) a Federal Reserve interest rate increase, this would be a very positive sign for faster growth.

Mexico is already talking about adjusting NAFTA, companies are talking about keeping production here, and we have China’s attention. If this keeps going, an interest rate increase can be withstood and strengthen the economy further.