ISSUE 2—WINTER 2018

PARTBUYERS AUTHORITY

TRANSPORTATION PARTS INNOVATION

(and why it matters)

This issue discusses Additive Manufacturing (AM) technologies, processes, part handling and consulting services that are specific to the transportation industry. It also showcases solutions for part buyers to understand the technologies behind the scenes to enhance working relationships with their vendors to reduce part defects & increase results.

MARKETING OPTIONS

2018 – A BIG YEAR FOR THE AUTOMOTIVE/TRANSPORTATION INDUSTRY

Welcome to our issue featuring solutions and technologies specific to the manufacturing or handling of parts for the automotive/transportation industry.

While there are several short-term headwinds facing the automotive industry, long-term opportunities abound as the industry continues to evolve. From aggressive miles-per-gallon goals to self-driving vehicles, it seems every day there is a pretty exciting announcement in this industry from an operational, safety, or regulatory standpoint. Although, having Elon Musk's Tesla Roadster strapped on top of SpaceX's Falcon Heavy rocket was one for the books.

This issue is chock-full of new technologies and services that are specific to the transportation industry and includes newer Additive Manufacturing technologies, complex aluminum parts processes, and part handling solutions. It also showcases solutions for part buyers to understand the technologies behind the scenes to enhance their working relationship with their vendors to importantly reduce part defects.

All of the author's selected for this issue are currently deploying these technologies and welcome part buyers to their production floors to learn more.

Our foreward for the issue is by John Kuhn, Foundry Automation Specialist for Rimrock Corporation. Rimrock is known throughout North America as a progressive robotic systems integrator and a specialist when it comes to part production within the automotive/transportation community. As an automation company, they explain how a part buyer can better understand how automation is properly deployed and the significant advantages to the production of your part.

As a reminder, this is a collaborative environment – which means you have a voice too. Do you have a technology or type of part that you would like us to discuss? **Complete Our Form**. We would appreciate hearing from you and understanding the material and technology questions you may have regarding your parts.

Barb Castilano
Owner, Marketing Options
Founder/Publisher, Parts Buyers Authority

MARKETING OPTIONS

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FOREWARD

JOHN KUHN Foundry Automation Specialist
RIMROCK CORPORATION

Automated Manufacturing Operations Deliver Better Parts at Reduced Costs

Aluminum foundries are of special interest to automotive manufactures to lighten their vehicles. These foundries are now producing suspension and structural casting for most car & light truck platforms including electric vehicles. Automation has helped these foundries to be more efficient and thus more competitive. It enables foundries to deliver higher quality parts at an economical cost.

What questions would an engineer or casting buyer ask to determine how automation has benefitted the foundry? You would be smart to visit the foundry and ask how many of the benefits listed below have been realized and to what extent. Today's foundries can readily show you their continuous improvement plans, value stream maps, and other metrics to quantify and qualify the results from their increased automation.

- **Increased productivity:**
  Metal casters report productivity increases of 10–300% because robots do not require coffee breaks, lunch periods, sick days and so on.
- **Reduced costs:**
  Direct labor costs and labor overhead costs such as pensions, health care, safety equipment, etc., are saved. Also consumables costs such as saw blades are reduced as equipment is more productively run at the proper speeds & feed rates.
- **Reduced injuries and illnesses:**
  Robots can replace a foundry employee working in dangerous and/or hazardous conditions. Many foundry tasks are very undesirable & people just won't do them.
- **Improved casting quality:**
  Properly installed and correctly programmed, a robot can perform the same production function repeatedly, rapidly, and consistently without the variations inherent in human handcraft.
- **High-speed precision:**
  Robots can move and position grippers and attach tools at higher speeds and accuracies than any human operator. Repeatability accuracies for some robot applications approach 0.013 mm (0.0005 in.) and movement speeds of 1270 mm/s (50 in./s) are also possible.
- **Performance flexibility:**
  Unlike hard automation, programmable robots can be retaught to handle varied and dissimilar tasks.
- **High uptime:**
  Maximizing the use of capital equipment, robots can achieve uptime performance levels as high as 98% in long-run high-production situations.
- **Inflation resistance:**
  The hourly rate for a robot installed today will be the same in 5 years, with no slowdowns or strikes.
- **Round-the-clock output:**
  Robots can work two or three shifts a day, seven days a week given sufficient parts, materials, and maintenance support.
- **Improved worker morale:**
  Robots have been shown to improve morale, especially when they are installed to perform unpopular foundry tasks. This allows employees the ability to focus on higher value tasks.

Automation is possible in all areas of the foundry. Core room automation is becoming more prevalent in foundries of all sizes. In the core making area, robots can tend core machines and remove fins on the parting lines. Robots can coat the cores with liquids or dip them in coatings. Robots can assemble the cores using glue, staples or screws. Robots can also place the completed cores on racks or hard plastic trays for storage and transport to the casting machine. These plastic trays can also be used as fixtures to position the cores for automated core setting in the mold.

In the aluminum casting area robots can set the sand cores in the mold. Robots can receive hot metal from one or more furnaces and pour sand or metal molds. Aluminum pouring is one of the most popular automation projects especially for small aluminum foundries starting with their first robot. Robots can extract molds, remove cores and quench them to cool.

The casting finishing area has unlimited possibilities for decreasing finishing rejects, increasing productivity, and reducing costs. Finishing cells can be made to saw, deburr, grind, laser mark, and inspect aluminum alloy castings. Depending on the casting type, size, and volume, a finishing cell can be designed for any application. The following is an example of a foundry that started with a robotic casting cell, and received most of the benefits I listed.

A foundry we work with that casts aluminum intake manifolds, cylinder heads and water pumps (over 2000 parts per day) for the automotive industry installed a new robotic cell with startling results.

Prior to adding a new robotic cell, it took on average, 29 minutes to deburr a small block manifold with parting line flash 141 inches long.

Additionally, quality suffered, which resulted in a high scrap rate.

After installing the new robotic work cell:

- **Labor:**
  Decreased, saving the foundry over $50,000 per year
- **Cycle Time:**
  Reduced to 70 seconds (from 29 minutes)
- **Consumables:**
  Reduced drastically as carbide burrs and sanding belts were eliminated.
- **Injuries:**
  Reduced by 90%
- **Unfinished WIP:**
  Eliminated, as castings were deburred and shipped next day after casting.

Understanding how your parts are being made, and the types of automation deployed will tell you if the manufacturing methods are the ones that will take your part production into the future and yield higher quality at less cost.

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Complex High-Performance Aluminum Castings for the Automotive Industry

DAVID SEILKOP President
EPCOR FOUNDRY, Division of Seilkop Industries, Inc.

As the number of automobiles increases, manufacturers of aluminum parts will be called upon to make more complex high-tech lightweight parts to increase safety and last longer. For this industry, aluminum builds better vehicles. The importance of aluminum in commercial vehicles and cars is increasing due to the many industry advantages. While most people emphasize the lightweight benefits for increasing fuel economy and reducing emissions, we like to also point out that castings made from aluminum can be amazingly complex while also being cost-effective, strong and very durable. Look for more aluminum in each vehicle in the future, including the structure.

Cast aluminum alloys are suited for a variety of parts with complex shapes and high performance expectations. Product applications include powertrain automotive applications such as turbo components, oil filter adapters, intake manifolds, exhaust gas Recirculators (EGR Housing), and cylinder heads. Aluminum castings are also used in a wide array of industrial applications such as pump, bulk transfer valves, fueling components, blower housings and impellers.

Given the complex nature of any given vehicle, there are more than a number of very complex castings that go into any car. Complex castings often perform more than one function and have evolved with newer designs to reduce the number of components and weight.

There are many foundries in the USA producing aluminum castings for the transportation market. And, there are many different kinds of aluminum castings in any given vehicle, truck or piece of industrial equipment. If all parts were created equally – this would not be a problem. But they are hardly the same. Parts in vehicles and trucks range from complex cylinder heads with air and coolant passages in the same part, oil filter adapters (gasoline and diesel), turbo housings, intake manifolds with integrated coolant passages, brackets, and more. Consider complex leak tight parts to be in a class by themselves.

Every engineer or part buyer faces the decision of qualifying a foundry for both prototypes and production of complex high-tech castings. Therefore, how do you qualify a foundry for your part with the understanding that people's lives rely on the safety of the parts put into any vehicle?

We think the first step is to understand that casting complexity is always evolving. It is fairly common for multiple parts to be redesigned into one complex casting. Therefore, having the proper resources to design and build larger, more complex high quality parts is one thing. Having the specific automotive engineering skills to be able to assist with your part's evolution, is quite another thing.

Some parts will change dramatically over time, whereas others will go through mild design changes. But one thing is for sure, parts will be changing – from several components to one part, from thick walled to thin, from handling multiple internal passages, etc.

Evaluating an Aluminum Foundry for your part requires an understanding of the casting process to fully understand

quality certifications, design and engineering expertise for production and prototypes, defect rates, capabilities, continuous improvement initiatives, and quality measurements.

While many aluminum casters will say they make parts for the automotive industry, when you look deeper you will find much of their expertise is lacking or in other industries, and that aluminum may be just a side market. In the automotive industry, quality is of the utmost importance. There is no room for aluminum castings that don't meet the very highest quality standards – therefore you don't want a foundry that isn't qualified, certified, and capable. You need a dedicated facility and tenured staff to ensure part quality for the automotive industry.

An aluminum foundry serving the automotive industry will be entrenched in the following certifications, technologies, Additive Manufacturing, and services.

ITAF Certification

IATF 16949:2016 certification is important as it is the automotive industry's most widely used international standard for quality management. This technical specification by the International Automotive Task Force (IATF) for automotive sector quality management systems has become the most widely used international standard in the automotive industry, harmonizing the different assessment and certification systems in the global automotive supply chain.

Achieving this level of certification ensures that the parts produced are of the highest quality parts from a manufacturer dedicated to defect prevention, and reduction of variation and waste in the automotive industry supply chain.

Technology

Complex parts require a different level of accountability. They require automated systems to ensure repeatability that guarantee a high quality part. Foundries entrenched in today's technologies have their processes verified from design to production.

Types of PLC-based automated process controls to look for:

- **Sand System**
  Accurate repeatability requires a system for screening, aeration, & additions testing.
- **Sand Production**
  Mold Conformity requires continuous sand testing.
- **Knockout**
  Exact Consistency requires specific pressure & timing controls.
- **Cutting**
  Precision cutting with 5-axis CNC saws & trim cells.
- **Blast**
  Great finishes come from better shot blast equipment.

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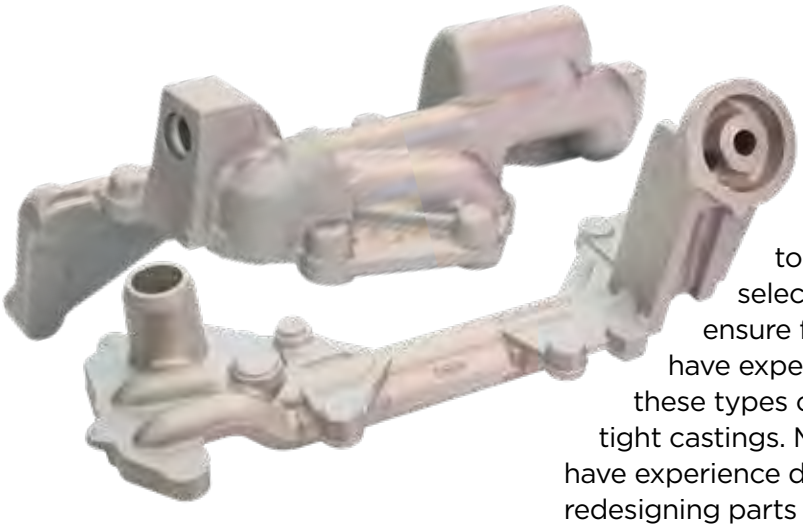

Additive Manufacturing & Rapid Prototyping

The metal casting world has literally been rocked by the advances in Additive Manufacturing (AM). A foundry actively using AM for design of your prototypes will be able to deliver your prototypes faster and cheaper. It is also easier to make changes to an AM prototype design as you are simply changing the CAD (and not hard tooling). Whether your prototype is made with CAD or hard tooling, a caster that keeps this in-house is always your best option, especially for changes and final production.

Prototypes of any kind require design and engineering expertise specific to automotive parts. Ask to see engineering automotive examples from prototype through to production. You need to be convinced that your design concepts are in the hands of engineers that understand how to design for manufacturability.

Engineering & Design

Only a handful of foundries excel at the most difficult of all automotive parts. Parts such as intake manifolds, turbo components, oil filter adapters and others require complex core packages and internal geometry that many would prefer not to touch. When selecting a partner, ensure first that they have experience with these types of complex leak-tight castings. Make sure they have experience designing and redesigning parts of this nature to make them better. Always think about your future part – as it most likely will be required to perform more functions and evolve into something larger and more complex.

Ask to see parts where they have assisted in the engineering design and subsequent changes. See if their thinking is along the lines of 'how to make it better.' If they see a concern with a design, do they speak up? Do they offer their engineering expertise as a matter of regular business? If so, this is the type of foundry that will partner with you through design changes to make a better part.

Don't be afraid to ask where they have reengineered a part to make it better, or, taken several components and redesigned it into one part. Ask to see these parts and other engineering challenges they have faced. Show them parts where others have failed –take them your toughest part challenges to understand their engineering approach.

In-House Tooling & Machining

Outsourcing of manufacturing processes from tool making to testing is common place in the metal casting industry, to reduce overhead. Sometimes it is difficult to determine if a foundry's processes are in-house or not, because they generally hide the fact that some processes are performed by others at different locations.

The benefits to working with a partner that keeps all of this in-house are substantial and paramount to the high quality needed for parts in the automotive and transportation markets. For critical parts, the flexibility that you get with an in-house tooling facility will always be better than working with a company that outsources this key element of your parts production. Also, a foundry that is completing the machining in-house can react faster to any changes. When design changes are needed – it is always better to communicate those changes with the same people in charge of your project.

Lastly, check them out on current manufacturing trends. Don't be afraid to ask about their financial stability, latest continuous improvement or sustainability initiative, Lean Manufacturing, or Six Sigma training. Ask about their deployment of AM technologies and where they see this going next.

In 2018, nearly 17 million cars are expected to be sold which means there is too much at stake to be using an Aluminum Foundry that doesn't understand the specific challenges of the automobile, large truck, and transportation market.

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Importance of Automotive & Truck Service Parts Packaging

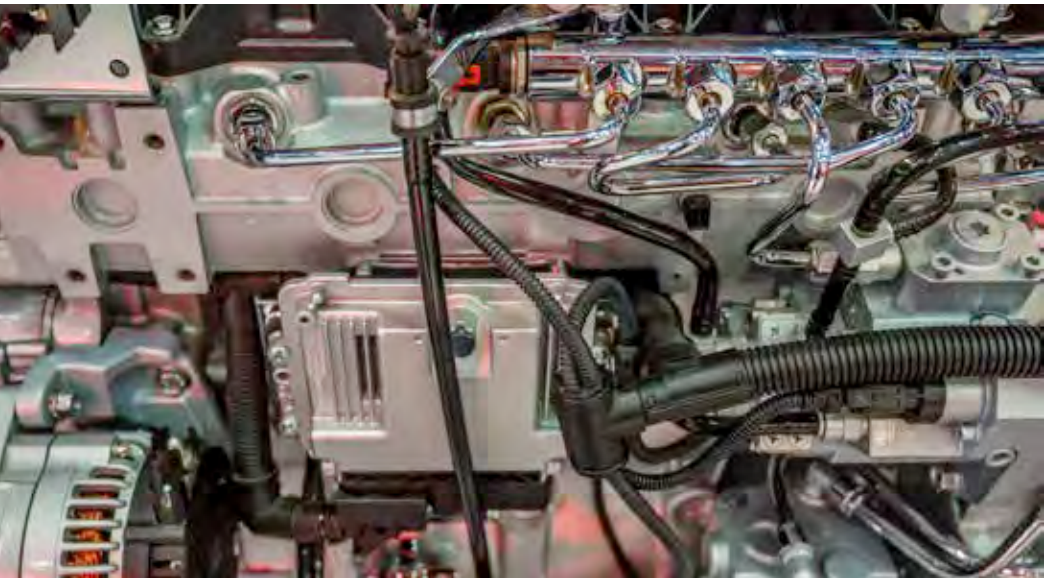
CROWN packaging

TONY XIDAS Director of Sales
CROWN PACKAGING, INC.

You are probably wondering why contract packaging would be a part of the puzzle for someone making parts for a major OEM automobile or truck manufacturer. In the world of manufacturing and supplying parts directly to an OEM manufacturer, there is one aspect of the program that many times gets overlooked. That aspect is the "Service Parts" portion of the business.

In supplying the OEM manufacturer, the part supplier is required to supply service parts as well. In the case of an automotive manufacturer, the current assembly part must be available a minimum of 10 years after that model year. Some OEM manufacturers are even requiring that a part is available 15 years after that model was produced. In the case of a truck or construction equipment, the OEM truck manufacturer requires that they have part availability of 30 years after the model is produced.

When I say, "Service Parts" I am referring to the replacement part that is needed when the part fails, wears out, is damaged and needs replaced with a genuine OEM part. Most part manufacturers are set-up for high volume production and putting parts in returnable dunnage, and shipping back and forth to the OEM assembly plant. When they are required to make and ship service parts, they are asked to ship multiple part numbers, and typically a small volume of parts. All of these parts have to be packaged in their own individual (unitized) expendable packaging, with specific label requirements, that may have to ship to multiple destinations. Part manufacturers often struggle with these requirements.



To take it a step further, you may be providing parts to multiple OEM manufacturers – which all have different rules. If you do something wrong, you stand a chance of receiving a problem resolution report (PRR), which will affect your performance scores, and if that non-conformance continues, it will put you on "business-hold."

This article is to educate you about what a contract packager can do to help manage the "Service Parts" side of your business, and to give you options to help make your supply chain run smoother.

EFFICIENCY

Typically, when the OEM manufacturer orders service parts, there are multiple part numbers involved and the part volumes are low. For many part manufacturers, when they package their own service parts in-house, they have a difficult time being very efficient because they lack the volume to run

continually. And because of this, they experience downtime which negatively effects productivity.

A contract packager however, packs hundreds of work orders per day, which allows a constant flow of work and naturally increases efficiency.

PACKAGING MATERIALS

The packaging materials used for packaging service parts is much different from the materials used for the assembly packaging process. The parts shipping to an assembly plant tend to be packed in returnable metal racks or plastic dunnage, or returnable corrugated trays, which are used over and over again. Service parts are typically packed in corrugated boxes or if heavy enough, may require wood crating. These parts will eventually be shipping from the OEM manufacturer's warehouse directly to the car or truck dealership.

The packaging materials for service parts include corrugated, wood, foam, bags, bubble wrap, pad pack cushioning, tape, labels, inserts, rust inhibitors, pallets, and stretch wrap. These materials are needed to pack and protect the part in shipment and in long-term storage. Packaging materials also need to be purchased, managed, and stored.

Every part we pack is built in our computer system and has a Bill of Material of the parts needed in the pack, and all material used in the pack. When we get an ASN (Advance Shipping Notice) from a customer that parts are on the way, our MRP system orders the material needed to package the parts. We have suppliers that come 2 and 3 times a day to deliver packaging material JIT for your parts.

ECONOMIES OF SCALE

Contract packagers order millions of dollars of corrugated and packaging supplies each year. The caliper for one OEM manufacturer is about the same size as the caliper we pack for other OEM manufacturers. This allows us to use the same box for both customers. Contract packagers naturally receive better pricing due to large volume buys and pass those savings on to customers.

COMPUTER SYSTEMS

How it works

As soon as your parts ship and the Advanced Shipping Notice (ASN)

Continued on page 12

is sent, the production work order is automatically produced in our computer systems, material is getting ordered, and routing to where the part is going to be packed is established. Material is tracked as soon as it is delivered and tracked through the process as it moves through the building. Parts are scanned into the warehouse, and scanned at job set up, with labels generated and ready to pack.

AUTOMATION

The volume of parts you package in many cases cannot justify getting automated packaging systems. Contract packagers have already invested in auto baggers, sprint machines, foam in place machines, heat bundlers, shrink machines, and skin machines that cost thousands of dollars.

PLAN B

(What is your back-up plan?) In today's world, changes in business are happening at lightning speed. Do you have a Plan B set up? What happens if there is an accident or natural disaster (e.g., fire, flood, or tornado)? Or you cannot keep up with production and you're out of warehouse space. Or the temporary or special projects (such as recall programs) you manage have disrupted your normal daily business. Or you find yourselves getting involved in things that are not your core business, like kitting, dunnage management, import/export, and light assembly work. You can benefit from having a contract packager as your Plan B. The better you protect yourself, the better you protect your customer.

FLEXIBILITY

Contract packagers can come to you. They can work in your facility, open a facility near your production plant, or often have a facility of their own to package your parts.

CASE STUDY: 'Near Site' Solution – meeting seasonal automotive part demand

A major automotive parts manufacturer provides service parts to a variety of OEM car manufacturers. The parts they manufacture get replaced as the season changes (summer to fall, winter to spring). This means they have to build parts ahead of time to be able to handle the seasonal demand of product. This particular customer benefited from a "near site" packaging solution that was close to their manufacturing site.

A "near site" solution allowed the manufacturer to open up floor space in their plant so they could focus on manufacturing. The contract packager packed the service parts as they came to the warehouse and parts were warehoused until they were needed to ship to their OEM customers.

CASE STUDY:
Large Truck – emergency

A major OEM truck manufacturer had a supplier give them notice that they were going to stop supplying parts to them. To maintain production, they needed to store a year's supply of these parts. We leased the space they required, inventoried and made daily deliveries to them while they focused on getting a new supplier. Their Plan B kept their production up-and-running.

CASE STUDY:
Manufacturer needs more production space

A major manufacturer was experiencing high growth and as a result was running out of space to warehouse their parts. Using a contract packager to inventory, warehouse, and daily sequence their parts allowed them to bring in additional machinery to expand production and grow their business. Depending on your production requirements this could be a temporary or permanent solution.

SUMMARY

Having a contact packager lined up can offer your company a part time or full time option to help with packaging, warehousing, and distribution of automotive, large truck, and construction equipment parts quicker and more cost effective.

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Casting Buyers Need to Understand Porosity Technologies to Prevent Defects

FOUNDRY SOLUTIONS & Metallurgical Services Inc.
FRANÇOIS AUDET
Director, SF FOUNDRY SOLUTIONS

Executive summary:
The growth of the transportation industry has increased casting production throughout North American foundries. This rise in production and the need for faster deliveries has led to an increase in casting defects – especially porosity defects after machining.

Read how a recent foundry defect was discovered by the casting buyer and how this problem was resolved.

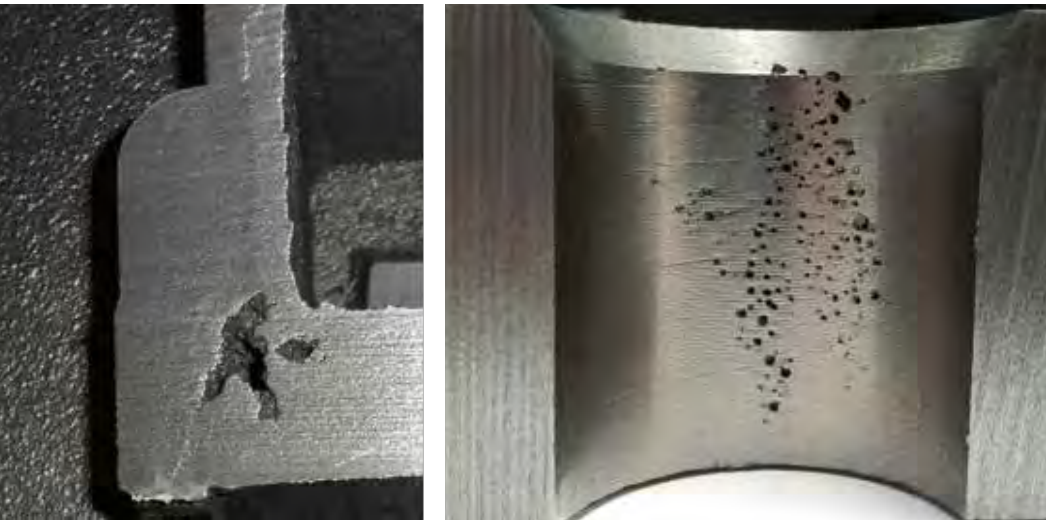


Figure 1: Shows two different ductile iron castings molded in sand with defects discovered after machining by an transportation sector OEM. The automotive OEM wondered, "What if I am buying more defective castings, that I'm not even aware of..."?

- A red flag was raised after casting defects were discovered after machining
- The OEM suffered delays due to an unexpected high reject rate at the foundry
- Casting defects and delays are expensive for both the foundry and casting buyer
- The OEM wanted to keep the job with that foundry
- The OEM did not have foundry expertise in-house to understand and challenge the foundry process specifically for the castings ordered
- The foundry was pressed by growth in orders and difficulties with labor retention
- The foundry needed to establish new process controls to keep quality high and attract young labor with technologies
- An audit on the foundry process was conducted by impartial foundry expert

  The measures on melt and mold design properties required for the specific castings were conducted by thermal analysis and casting process simulation, respectively. Sometimes the problem is in the mold design, sometimes it's in the melt or mold properties, especially for sand molding.
- It is important for both the casting buyer and the foundry to use metallurgical services to ensure quality.

How casting buyers can work with foundries to prevent porosity defects

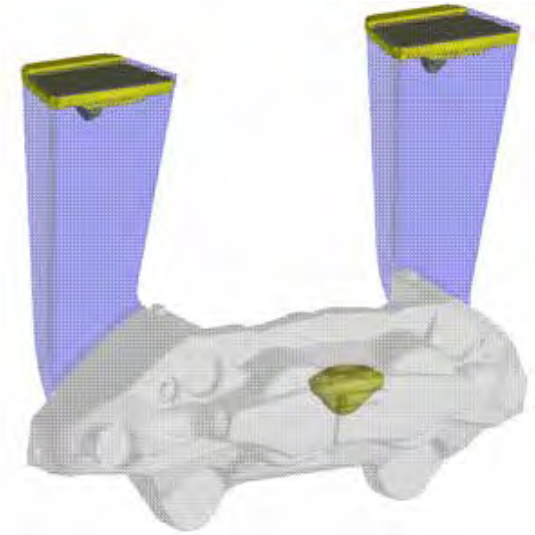
Casting buyers and OEMs typically work with several foundries to source aluminum, steel and ductile iron castings not only for transportation industry but also for several sectors. Moreover, OEMs often use foundries to convert their welded assemblies to castings. Casting buyers often seek a one-stop, cost-effective, problem-free, and long-term relationship with foundries, as keeping everything with one foundry under one roof usually yields higher quality. Right?

Defects from Porosities

Quality variations with castings are frustrating, especially when you don't understand the root cause. It's a loss of time and money when you discover porosities during machining or worse, in service. The time to setup and run the CNC machine can be worth more than the casting itself, which still needs to be rejected. The foundry usually replaces the casting, however, this still is a time consuming problem and the question remains, how to correct porosity problems?

Understanding the root cause and how the foundry is addressing it is important for everyone to understand in order to properly meet your objectives and future needs.

In this particular case study, it was critical for everyone to understand the importance of thermal analysis and casting process simulation. In other cases, sand properties are often the culprit, which is another area for OEMs to understand.



(image courtesy of Finite Solutions Inc., www.finitesolutions.com)

Figure 2: It took less than 5 minutes to simulate the porosity defect tendency (yellow region) in a tilt pour permanent mold A356 brake caliper casting design. The foundry knew it needed to work on an improved filling and solidification design to avoid defects. Then, what about the melt properties?

Casting buyers usually don't have the expertise in-house to understand porosity tendencies and need to trust their foundry, or decide based on the lowest cost. OEMs often don't have the measuring instruments to measure the process quality on the spot during the audit or introduction visit in order to compare two or more foundries. Plus, you don't know what to look for when you visit the foundry; everything will look fine but is it really?

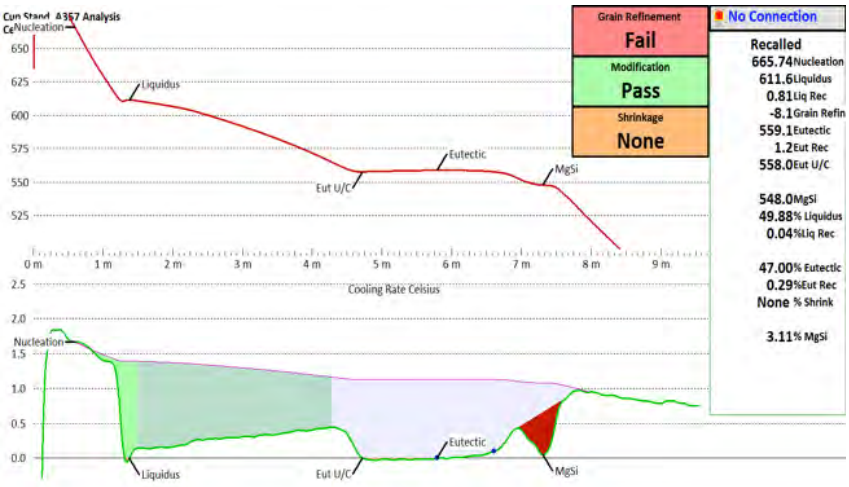
Our suggestion is for all OEMs to maintain a team of experts to guide them in these quality processes – to be proactive versus reactive. Your team can include internal engineers as well as outside consultants that can be pulled in on especially difficult projects.

Often problems arise because of lack of proactive engineering and process control, or it's too late and expensive corrective actions needs to be rushed. Cost-effective proactive actions are a must for win-win, long-term relationship between the foundry and OEM. Casting cost is only one variable in selecting the right foundry. Invest in this effort before ordering your next casting.

Controlling Melt Variation

Figure 3: Shows a foundry is serious about controlling their melt quality variation by using thermal analysis. Is this always a necessity for all foundries–No. Should the OEM care to understand why such technologies are not needed at that particular foundry–Yes.

Also shows thermal analysis of a given aluminum A357 melt sample which failed the grain refinement test. The melt needs to be grain refined before molds can be filled with molten A357.



(image courtesy MeltLab™ Systems, www.meltlab.com) **Continued** on page 16

How to challenge your foundry?
Here are three effective ways to challenge the foundry you're working with or seeking to work with:

1. Request to see the casting simulation results on the mold design to see how the liquid metal you buy fills the mold and solidifies to avoid porosity defects.
2. Request to see the thermal analysis measurements on the melt quality that will fill your molds, to review how consistent the melt quality is to avoid defects.
3. Ask an impartial foundry process engineer to work with you, the machining shop and the foundry as a team for long-term follow-up and success. Audits once a year don't work; invest in a closer relationship.
4. For sand molding, require data regarding sand properties and the controls that are in place.

Predictive Simulation

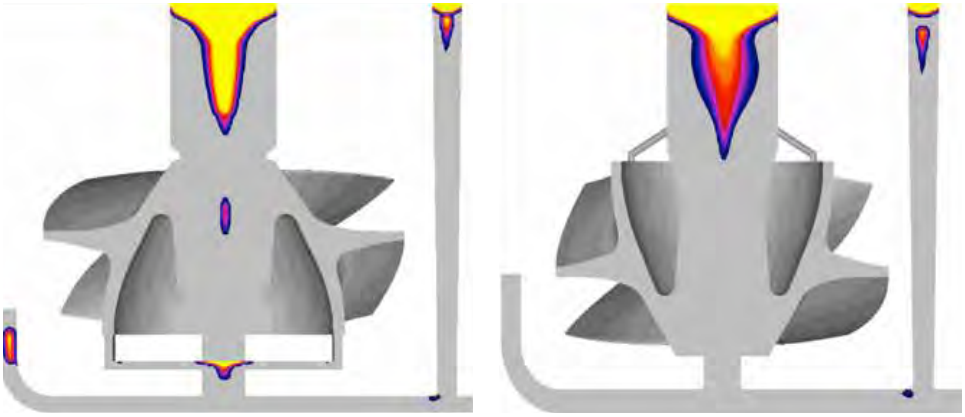


Figure 4: Cut plane showing porosity defects as predicted by simulation in the cast steel impeller for mold design #1; no porosity predicted on the improved mold design #2 to produce the same impeller with success.
(image courtesy of Finite Solutions Inc. www.finitesolutions.com)

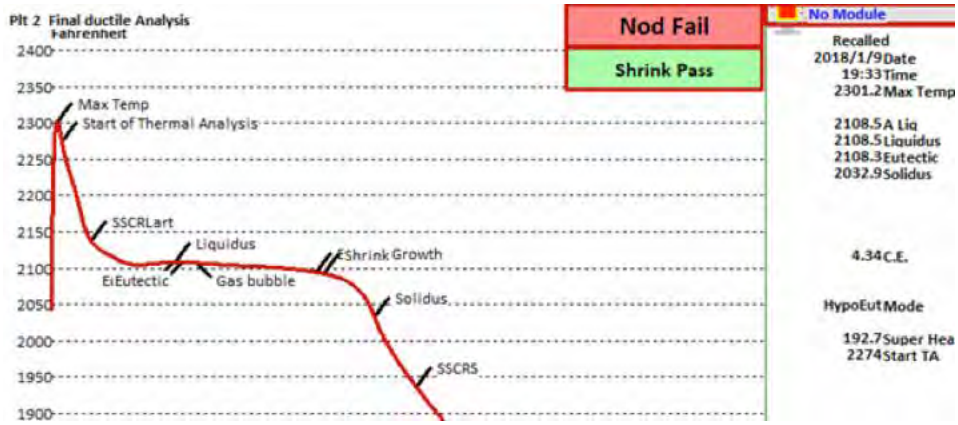


Figure 5: Ductile iron 80k thermal analysis sample with bad nodularity and gas bubble as the sample solidifies, while shrinkage porosity test passed.
(image courtesy of MeltLab™ Systems, www.meltlab.com)

How to collaborate successfully
Casting buyers and machine shops need to talk the same language that the foundry uses, or frustration awaits. While you can rely on the foundry to be your experts – challenging their team with your expert team will bring you the most value.

Sometimes the foundry needs a little push from the OEM to adopt a new technology. For example, OEMs need to see newer technologies that can prevent these defects such as casting simulation and thermal analysis to support their in-house experts. You as an OEM will end up with more consistent castings delivered more quickly by participating in the process and being up to date on current technologies.

Foundries do their best to be current in the latest technologies, however as castings become more complex, the dynamics change. Your particular project may be that situation where a collaborative environment yields the highest results for all of you.

Figure 5: shows a thermal analysis sample taken from a final ductile iron melt. That's what the foundry was pouring into the molds. As predicted, castings from that melt exhibited casting defects especially due to low nodularity and gas. The mold design was improved to reduce turbulence, however, the thermal analysis results indicated the metallurgical properties of the molten metal were not right.

In this particular case study, the analysis was conducted and problem solved because the OEM took the lead and hired an expert to bring this resources at a critical time.

The OEM has this consultant as part of their internal team, exactly for this purpose.

In conclusion, stop working in silos; start working as a team with the machine shop, foundry, and your own team of experts. You'll save time, prevent defects, and overall save money. Therefore, before you order any castings, challenge the foundry first by asking to review the predictive simulation and thermal analysis processes they have in place to prevent these porosity defects.

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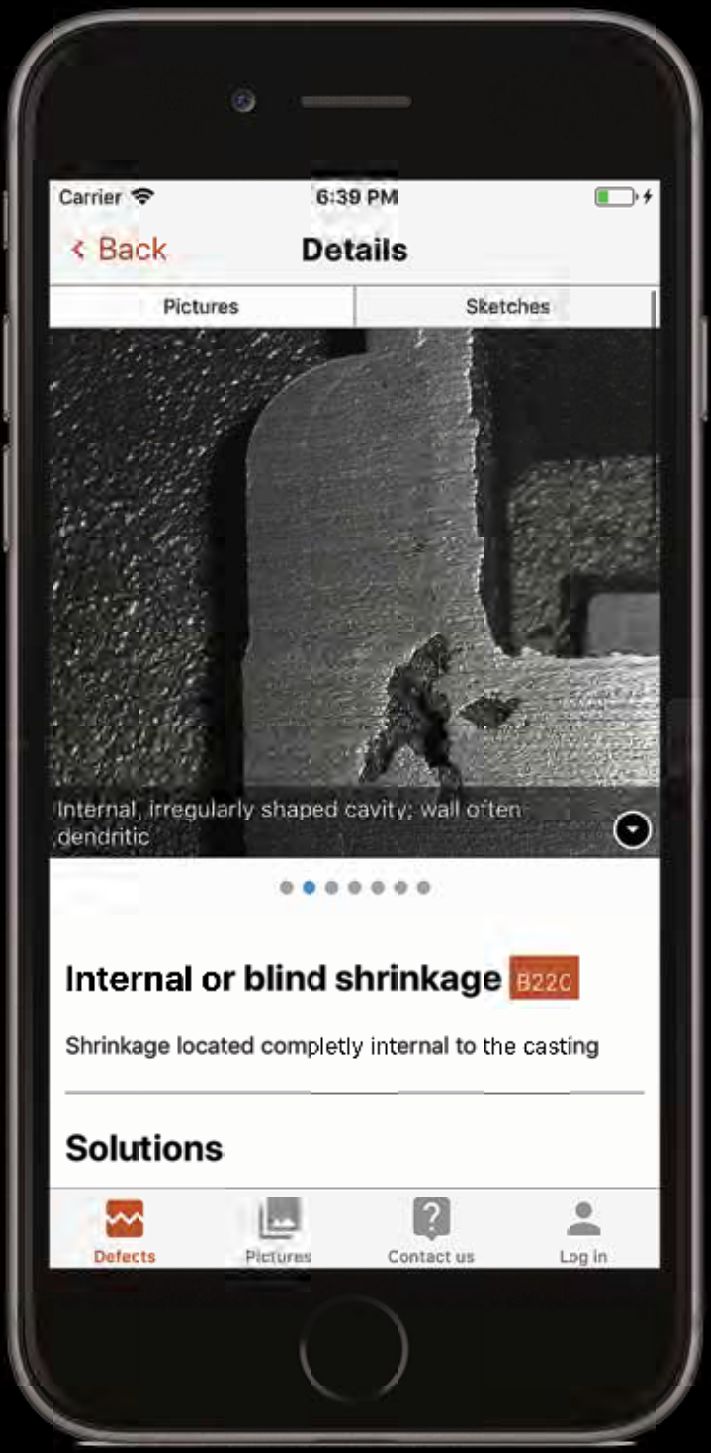
Casting Defect

A casting defect diagnosis tool by
Foundry Solutions & Metallurgical Services Inc.



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3D METAL PRINTING & THE AUTOMOTIVE INDUSTRY

INNOVATIVE 3D MANUFACTURING

CHRIS BECK
Manager of Operations, Co-Owner
INNOVATIVE 3D MANUFACTURING

Two of today's big buzzwords in manufacturing are Additive Manufacturing (AM) and 3D Printing. The technology is not new to the world but over the last few years it has grown exponentially. This is due to the number of inexpensive desktop printers that have been brought to the market and a new younger generation of engineers that are embracing this technology.

For under $500 you can have a 3D printer in your house which can allow you and your kids to make all kinds of cool things. I know my kids were so excited to see the first 3D printer work at home. The only problem was they lost interest quickly as that cool little boat they wanted printed didn't take 5 minutes – it took 12 hours to make. Pretty much all schools and universities now have 3D printers and talk about the technology to their students. This is a great thing for the future of this growing industry which leads into our discussion.

Additive Manufacturing in the Automotive Industry

My background is CNC Machining (which today they call "Subtractive Manufacturing" which still sounds funny to me) and Automation. I live in the Midwest which is the automotive belt. The goal has always been to produce automotive parts faster, lighter, cheaper, more efficient with less labor, as seconds save hundreds of thousands of dollars per year. So where does a slow process like AM/3D printing fit into the automotive space.

The answer is, it may never be the solution for making high volume automotive parts. But it is the answer to compliment the manufacturing process in the Automotive Industry. AM can help make the process of making parts run faster which in the long run saves time and money.

For our discussion lets focus on 5 ways Additive Manufacturing (AM) using Direct Metal Laser Sintering (DMLS) can benefit the Automotive Industry.

1. Prototypes of gears

2. Prototypes of complex sheet metal parts and brackets

3. Making fixture details, replacement parts and end effectors for automation

4. Conformal cooling for plastics injection molding

5. Conformal cooling for aluminum die casting

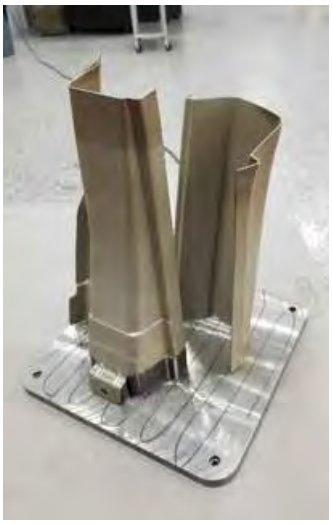
Prototypes
Gears

With all the changes in the transmission industry and the ramp up to 8, 9, and 10 speed transmissions DMLS machines can print near net shapes of gears out of variety of materials, fully dense and heat treatable. With the quick turnaround times and the near net shapes the R&D teams have minimal machining and grinding to get a whole working set of gears for a new project.

Prototypes
Complex Sheet Metal Design

Some amazing parts that our company has printed on our DMLS machines are complex steel sheet metal parts and brackets. Sheet metal parts were something that I would have never thought about printing until we started doing it for the aerospace industry. After proving successful in that industry, we adapted to printing a number of sheet metal parts for automotive industry. This process is great because we can print a tall thin walled part without warping. The downside is it has to be printed in 10" segments and welded or fastened back together. But for fit and trial it works great before the final investment of large progressive dies and breaks. Brackets are another component

that can be printed quickly for mockups. The brackets can also be Topology Optimized (TO) for weight reduction and fit for tighter spaces in engine and drivetrain areas. When it comes to high performance automobiles, supercars and race cars the use of lattice structures and materials such as Titanium are also a huge game changer.



Producing
Fixtures, Replacement Parts, End Effectors

Another problem that we face is the skills gap shortage in manufacturing. As time goes on most predict that this is only going to become increasingly worse. With the use of AM it's possible to take a person without the skill set of a Journeyman Machinist or Tool & Die Maker to make a fixture detail or replacement part very quickly. This can be a huge advantage in the automotive world when something breaks and the replacement part has a long lead time. With today's technology we are able to reverse engineer a part and make it quickly. We can also generate backup details, tooling and end effectors at a very competitive price, in many cases at less cost versus traditional manufacturing.

Conformal Cooling
Injection Molding

Conformal cooling is one of the places where AM can deliver HUGE time and cost savings. The use of contoured cooling channels (called conformal cooling), gives the mold maker the ability to add water cooling lines in very tight spots and follow complex contours.

Traditionally lines are added by drilling holes and either making side intersecting holes and plugging them or not being able to cool some of these areas at all. With conformal cooling technology companies can now decrease cycle times of the parts, increase tooling life of the mold and reduce scrap. This is a new process – we have many studies that show the substantial cost saving benefits and better part production with the use of conformal cooling technology.

Conformal Cooling
Aluminum Die Casting

We have saved the best for last and the most exciting one for us. The challenge with conformal cooling and aluminum die casting is the extreme heat and pressures of the die casting process. Our company Innovative 3D Manufacturing has started a joint R&D project with a large die casting company, a large powder supplier and Purdue University. Our goal is to develop conformal cooled die cast mold inserts that will revolutionize the aluminum die casting market and will have a direct impact on the automotive parts industry.

Stay tuned! 3D Metal printing has proven itself to be important especially in complex part prototypes and production. It is proven in rubber mold applications as well. Watch for conformal cooling technologies as they are in the works now.

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INNOVATIVE CASTING TECHNOLOGIES

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Additive Manufacturing for complex parts you can't get with traditional manufacturing and no tooling costs!

ICT Patterns & Machining
100% In-House Pattern Making & Machining for accurate and quick complex machining.

ICT Dualtech Foundry
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REAL CHROME
is the Only True Chrome

KENTUCKY CHROME WORKS
BOB BILTZ
Vice President, KENTUCKY CHROME WORKS

Cars and chrome have been linked together for decades. Reaching its peak in the flamboyant styling of the 1950s, chrome wheels, trim, and accents have historically been used by car designers to help impart a distinctive look to their cars.

In the 1980s exterior chrome virtually vanished, in part due to fashion and styling changes and weight reduction efforts for fuel efficiency, but also because of concerns over quality. There were significant problems seen with premature corrosion, a problem frequently encountered as a result of the inadequate plating practices and limited technology available in the 1970s.

In the 1990s exterior chrome made a comeback, first on trucks and SUVs, and shortly thereafter on upscale cars. Since the majority of automobile manufacturers did not offer all the chrome accessories consumers wanted, a thriving after-market business developed to service the high demand. It did not take long for automobile manufacturers to recognize the demand and begin offering chrome plated wheels, trim, and accessories to distinguish their vehicles. The quality of the decorative trim put on their vehicles needed to meet the demanding performance criteria established by the car companies. They recognized that substandard chrome plating could compromise the quality of their products.

Fast forward to current day...
Advances in plating technology have made it possible to dramatically improve the performance of chrome plated parts compared to what was commonly seen in the 1970s and 1980s. Dramatic improvements in corrosion resistance evolved throughout the 1990s. Today the performance of real chrome is light years better than it was in the heyday of chrome.

Today's OEMs offer a wide array of lesser bright trim accents. None of them match the luster and performance of today's real chrome. On aluminum alloy wheels alone, there are several distinctive lesser options.

But there is only one real chrome. The most distinctive and popular option of the discerning consumer is the real chrome plated aluminum alloy wheel.

Lesser Bright Accent	Issues
Bright Machined	Normally clear coated or bare aluminum
Polished	No protection, prone to oxidation, high maintenance
Chrome Clad	POP (plating on plastic) Glued on hubcap, issues with attachment, looks cheap.
PVD	Not yet approved by all OEMs; vacuum metalizing on steroids, poor impingement performance, looks wet or sprayed on, looks cheap

Meeting the OEM performance criteria for these wheels is a task that requires a great deal of effort. Kentucky Chrome Works is the only US based plater certified to OEM specifications.

We polish and chrome plate alloy wheels manufactured by any Tier 1. We have a "dealer direct" program wherein we take in new painted alloy wheels (with no or very low mileage and no road damage); have the paint non-chemically stripped, polish and plate the wheel to OEM specifications.

Producing an OEM wheel from raw aluminum ingots to finished product involves many different stages. In simplified form, the stages are below:

PRE-PLATE
1) Casting
2) Heat treatment
3) Machining

PLATE
4) Polish
5) Pretreatment
6) Copper Buff
7) Plate

Pre-plate operations such as casting, heat treatment, and machining can have a tremendous impact on the metal finisher. For example, poor casings can result in porosity in the plating, leading to CASS failures, poor machining may cause adhesion and cosmetic failures. Many problems that are evident after plating may have a root cause, which is outside of the plater's control.

The actual plating process for OEM wheels is divided into two fundamental operations, pretreatment and plating. Pretreatment is normally defined as all of the process steps up to the copper buff, while plating is defined as all the processes performed after the buff. So, while a nickel strike over zincated aluminum and acid copper plating are actually plating processes, they are part of the pretreatment line. Conversely, cleaning and activating the buffed copper wheels are technically pretreatment operations, but in wheel plating nomenclature they are incorporated into the plating line.

The pretreatment processing chemistry and sequence utilized must be capable of processing the specific aluminum alloy used. Typically, the aluminum used for cast OEM wheels is A356.

356 aluminum comes in many varieties, with the specific type represented by the alloy designation. For example, some alloy names include a letter before the alloy number. This letter is used to identify alloys that are slightly different in alloying composition or impurity levels. Examples include A356 or A380, which are just a bit different from 356 or 380. In addition, there may be a decimal notation following the alloy. Thus, an aluminum alloy XXX may be designated as XXX.0, XXX.1 or XXX.2. The decimal indicates the following:

- XXX.0 - Indicates the composition limits applied to an alloy casting.
- XXX.1 - Indicates the composition limits for ingots used to make the alloy casting.
- XXX.2 - Indicates the composition limits for ingots used to make the alloy casting, but which are normally tighter limits than no designation (XXX) or a designation of 1.

In practical terms the XXX.1 designation generally denotes aluminum ingots from a secondary source, such as ingots recycled from scrap aluminum, while the XXX.2 ingots are primary aluminum produced from reduction cells.

Pretreatment is often considered the most important step in any finishing operation, and while it is a complex science, there are several basic objectives for pretreatment operations in OEM wheel plating:

- Create a clean, active, uniform surface on the aluminum substrate.
- Remove foreign material from the surface of the aluminum substrate.
- Modify the aluminum substrate surface to create a specific surface topography that generates mechanical bonding sites.
- Prevent the highly active aluminum from forming a passive oxide layer prior to plating operations.

Continued on page 24

Proper pretreatment is critical to ensure maximum adhesion, to optimize the appearance, and to control the performance characteristics. One critical aspect of any industrial finishing process is its ability to maximize productivity regardless of the condition of the base substrate. KCW partner and supplier, MacDermid, has a unique process cycle that maximizes the adhesion to the base aluminum, while simultaneously offering a high degree of resistance to substrate porosity, two of the major causes of rejects in OEM wheel plating.

There are several successful methods for processing A356 alloy, but the pretreatment process KCW uses is unique. It is called the "Dual Etch" cycle. There are several advantages to this cycle:

- There is a significant increase in adhesion compared to conventional aluminum pretreatment processes.
- It does not utilize nitric acid.
- The cycle is fluoride free.
- The process is cyanide free.

In general, the purpose for plating a wheel is to create a hard, corrosion resistant cosmetic coating that provides an attractive finish, provides an abrasion resistant coating, and protects the wheel from corrosion damage.

Plated wheels are commonly referred to as "chromed wheels". This term misrepresents what is actually an exceptionally complex plating system, where a series of coatings, each applied for a different purpose, are applied to meet the necessary quality requirements.

Typically, plated OE wheels have six or seven layers of plating. The basic plated layers are below:

1. Nickel strike
2. Acid copper
3. Semi-bright nickel
4. High sulfur nickel
5. Bright nickel
6. Microporous nickel
7. Chrome

Each layer serves a specific purpose, and to maximize the overall appearance and performance of the wheel all layers need to be applied correctly.

The strike layer is to provide adhesion of subsequent plating processes. Acid copper will level out minor surface imperfections in the aluminum casting, provide a soft deposit which can be polished, and increase the corrosion performance of the wheel by providing a copper barrier coating on the wheel. The nickel layers will be described in detail below. The chrome is applied for appearance, to prevent oxidation of the nickel and provide abrasion resistance.

The nickel layers have different properties. Specifically, each layer has a different electrochemical potential. These differences in electrochemical potentials are the main factor in the corrosion resistance of the wheels. The potential differences between the layers can be measured and specified. The most common method is the STEP test, a test which measures both the thickness of the nickel layers and the electrochemical potential of each layer. STEP stands for Simultaneous Thickness and Electrochemical Potential.

The multiple layers of nickel are the primary reason for the tremendous corrosion resistance seen on today's high-quality wheels. These anti-corrosion mechanisms are:

Barrier Layer (Bright Nickel)
Plating a single layer of nickel, such as bright nickel, over an aluminum or steel item will provide corrosion resistance to the part only so long as the barrier is intact.

Duplex Nickel (Bright Nickel over Semi-Bright Nickel)
By plating two layers of nickel, with the top layer being more active (i.e. less noble) a new level of corrosion performance is reached. This is generally accomplished by plating bright nickel over semi-bright nickel. Once the initial bright nickel barrier is penetrated, the corrosion spreads laterally into the more active bright nickel layer instead of penetrating the less active semi-bright nickel layer.

Microporous Nickel
The addition of a microporous nickel layer over a duplex nickel deposit further increases the corrosion resistance of a plated wheel. Instead of penetrating a single corrosion site corrosion potential is distributed into many smaller sites. The result is that instead of a single large corrosion site, there are hundreds or thousands of smaller sites, all of which corrode much more slowly.

High Sulfur Nickel
The addition of a high activity nickel layer between the bright and the semi-bright nickels result in even better corrosion protection. Once the nickel barrier is penetrated, corrosion occurs laterally in the active high sulfur layer, thus slowing penetration of the corrosion to the substrate.

Today's real chrome is the true choice for the best appearance, the best performance and the best value for the discerning consumer.

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Below is a resource listing that would be of benefit for those involved in purchasing, specifying, and designing parts. Have a resource you would like to see added to this list, or a topic, material, or process discussed?

Complete Our Form

Metal Part Manufacturers

Epcor Foundry ..... www.epcorfdy.com
Innovative Casting Technologies ..... www.innovative-castings.com
..... www.innovative3dm.com
Kentucky Chrome Works ..... www.kentuckychromeworks.com
Southern Cast Products ..... www.southerncast.com
Tech Cast ..... www.techcastllc.com
Trident Alloys ..... www.tridentalloysinc.com

Suppliers of Technology for Part Buyers

Foundry Solutions ..... www.solutionsfonderie.com

Contract Packaging

Crown Packaging ..... www.crownpkg.com

Additive Mfg Consulting/Part Design Consulting/Engineering

Carl Berube, Celero Partners ..... www.celero-partners.com
Will Shambley, Metal Fish ..... www.themetalfish.com
John Kuhn, Rimrock Corporation ..... www.rimrockcorp.com

Industry Associations

3D Printing Industry News www.3dprintingindustry.com
Additive Manufacturing ..... www.additivemanufacturing.media
Additive Manufacturing Users Group (AMUG) ..... www.am-ug.com
America Makes ..... www.americamakes.us
American Foundry Society ..... www.afsinc.org
ASM International ..... www.asminternational.org
Ductile Iron Society ..... www.ductile.org
Investment Casting Institute ..... www.investmentcasting.org
National Tooling & Machining Association ..... www.ntma.org
North American Die Casting Association ..... www.diecasting.org
Precision Machined Products Association ..... www.pma.org
Precision Metal Forming Association ..... www.ntma.org
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PART BUYERS AUTHORITY

Are you a manufacturer of metal, plastic, or composite parts?

If so, we encourage you to contribute as an author in our next issue of ***The Part Buyers Authority***, an industry online publication. Featured authors are positioned as the topic expert in your 2-page article. Your company will also receive a full page advertisement (for a total of 3 pages). As an additional benefit, competitors to you cannot contribute in the same publication to provide you with dedicated space to your expertise.

Our sole focus of ***The Part Buyers Authority*** is to provide technical information to assist anyone that designs, specifies or purchases metal, plastic or composite parts. Specifically we will address the changing technologies that affect the many ways that parts can be manufactured.

The Part Buyers Authority will be issued several times a year on topics of interest to buyers of parts. Our planned editorial line-up includes:

Winter 2018	Automotive/Truck/Transportation Part Manufacturing
Spring 2018	Aerospace Part Manufacturing
Summer 2018	Oil/Gas Mining Part Manufacturing
Fall 2018	Additive Manufacturing Technologies

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