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The Shot Peener

Sharing Information and Expanding Global Markets for Shot Peening and Blast Cleaning Industries

The Products and Processes Issue

PLUS:
- IRON CONTAMINATION IN NON-FERROUS MEDIA
- BACK TO BASICS: SHOT PARTICLES
- ICSP14

The Products and Services Issue

A sampling of new and unique products and processes in surface finishing

Thermal spray booth with operator at a CWST facility.

The Coverage Checker Ultraviolet Light Version by TOYO SEIKO at a steel bridge repair work site.

Press Releases

THE SHOT PEENER

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OPENING SHOT

Jack Champaigne | Editor | The Shot Peener

Media Inspection

I REMEMBER trying to understand the requirements for media inspections and quality control in my early days in the blast cleaning and shot peening marketplace. One issue was the allowance of 10% of smallest screen size media (in the pan) for new media but the in-use media allowed 20%. My experience in the field revealed that the in-use media seldom had more than 5% in the pan.

After several years of involvement with SAE, I considered that the committee participation by large numbers of media manufactures helped to write the specs and they wanted their media to broadly qualify. In those early days of shot blasting, the on-board media screens were not required thus the 20% broken content was needed. As more rigorous specifications evolved and demanded the on-board screens, the in-use media became much better than the new media. During early impacts of new media, the "weaker" particles would break and were discarded. The process actually improved the media as it was used. Unfortunately, the specs were never tightened to take advantage of this phenomena.

The improvement of media applied not only to cast steel shot but also to cut wire media. The conditioning of cut wire starts from a cylindrical shape and after multiple impacts tends to become spherical. This transition continues during usage so the media continues to improve beyond the as-new state.

So, the media gets better for size and shape and that's good news. But what about iron contamination of glass bead or ceramic bead? The specs allow .01% by weight of iron contamination. During usage the iron contamination can actually increase since the media is impacting the steel surfaces of the blast cabinet and fixtures. There can also be left-over cast steel or cut wire media when a machine is emptied and new non-ferrous media is placed into use. Continuous monitoring of the iron contamination should be practiced. Don't just rely upon the original certification or incoming inspection.

My article on page 22 goes into more detail on iron contamination of non-ferrous media. EI's engineering staff plans to build the magnetic inspection tray mentioned in the article and they will use it on a frequent basis in our prototype laboratory. If it proves useful, we may add it to our web site as optional equipment and recommend that it be used in our non-ferrous valves.

Editor's Note: Don't miss the informative article on the 14th International Conference on Shot Peening (ICSP14) by Professor Mario Guagliano (page 38). This event is the foremost conference in the surface treatment industry. The International Scientific Committee for Shot Peening, the ICSP14 Committee, and the Local Organizing Committee have done an outstanding job of bringing together presentations in the state-of-the-art science, technology and applications of mechanical surface treatments. In addition, the beautiful city of Milan, Italy will be an exciting venue for ICSP14. If you haven't already, visit www.icsp14.org to reserve your place at the event.

THE SHOT PEENER

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Background image courtesy of Progressive Surface.

AN INSIDER'S PERSPECTIVE
Kumar Balan | Blast Cleaning and Shot Peening Specialist

Fine Particle Peening: Review and Challenges

Why Are We Discussing Fine Particles?
Automotive and Aerospace, the two common users of shot peening equipment, seldom refer to anything smaller than S110, or the equivalent in CW peening media. S110 is approximately 0.011" (0.28 mm) in nominal diameter. Smaller particle sizes are commonly used in thermal spray techniques. However, that is not always true. For instance, Japanese automakers have media that is smaller than the smallest SAE/AMS size of S70 for their peening operations. In "Fine Particle Shot Peening" (*The Shot Peener*, Winter 2010), Kathy Levy introduced us to this technique and also informed us of its history with our Japanese colleagues who continue to realize distinct advantages in terms of fatigue resistance among other attributes with its use. Kathy identifies the limited availability of this media in US and EU as one of its drawbacks but also contends that this is easily solvable.

I would like to stay on top of this potential trend and continue this discussion with (a) subtleties in manufacturing fine particles, and (b) equipment design challenges in reclaiming fine particles during process.

Classification of fine particles seems to be manufacturer-specific. The size range between 20 and 200 micron is being categorized as fine particle by some manufacturers of fine particles (175 micron is around nominal the size of S70). Given our familiarity with SAE J444 and AMS 2431, I suggest for our discussion that anything smaller than the smallest SAE size S70 (175 micron) be referred to as fine particles.

Fine Particles and Impact Energy
I often use the term "Impact Energy" and emphasize its importance in governing everything we aim to accomplish with blast cleaning and shot peening. Impact energy (or kinetic energy, transmitted energy, etc.) is the energy carried and transmitted by a particle of abrasive on to its target upon impact. This energy results in scale or rust being dislodged, or in the case of peening—creation of a dent that results in a desirable zone of compressive stress.

This impact energy is represented by $\frac{1}{2} \times m \times v^2$, where **m** is the mass of the individual shot or grit particle and **v** its velocity. Velocity is developed by multiple means, using a centrifugal wheel that accelerates the abrasive particles or air pressure that helps propel the media with the desired force.

Mass is directly proportional to the media type and size. Dense media like cast steel shot and cut wire carry greater mass than glass bead and ceramic. Therefore, in order to generate a desired value of compressive stress that requires peening your component to an intensity of 18A, your drawing and specifications will likely instruct the use of S280 or S330. Fine particles will not be capable of achieving this and will not be applicable here. You might be able to compensate for the small media size by ramping up the velocity (higher air pressure or wheel speed), but after a certain magnitude of pressure the abrasive particle will saturate in its ability to deliver energy. At this point, a larger size, or greater hardness of the same size of abrasive, will be required. If all the above are true, how and when do fine particles find suitability in our conventional applications?

Coverage Rate and Media Size
Phil Waser with Ervin Industries shares a chart in his class at the EI US Shot Peening Workshop. The chart shows the number of particles per pound of different media sizes. The lesson behind the chart is that smaller media will achieve faster coverage. To understand this, consider a pound of S170 with 745,000 pellets as compared to S230 with only 345,000! With comparable impact values, each of those S170 particles will pack the same punch, except that they are more than twice in number as S230 particles. The common nozzle size flows about 10 to 15 pounds per minute of this media! As a comparison, S70, though much smaller, dwarfs them all with its 8,200,000 particles per pound! Fine particles will only be exponentially higher in particle count, if someone attempts to count! This is where we derive the advantage of fine particles.

I recall a gear peening application from the past where the customer had specified dual peening with the second size of media in the "fine particle" range around 100 micron (close to S40, if there was such a size in SAE). The understanding with the use of fine particles was that it strengthened the compressive stress layer closer to the part surface and improved the surface finish of the gear. Another application in Aerospace used fine ceramic particles since it provided the desired compressive stress without causing the part distortion that took place with steel peening media.

Manufacturing Techniques and Challenges

Cast steel shot is manufactured by atomizing molten metal with high-pressure water as it is poured out of a furnace. Solidification of molten metal produces a range of different sizes of spherical (or almost spherical) particles, which are then screened and tempered to the required ranges of hardness.

Fine particles are not as easy to manufacture. I spoke with Mark Hash, the Research & Development Director at Ervin Technologies (E-Tech) in Tecumseh, Michigan. His company manufactures speciality powders for unique applications and also private labels fine particles for a customer that markets it for shot peening applications. Mark explained, "High-yield fine particle manufacturing requires high energy atomization such as centrifugal. (Gas atomization is an alternate technique that yields similar results.) Finer particles are more prone to oxidization simply due to larger surface area-volume ratios. Additionally, these fine particles require slower screening methods for size uniformity."

Mark disclosed that this technology and the first centrifugal atomization rig were acquired from a defence contractor. The technology, called Rapid Solidification Rate (RSR), consists of pouring molten metal on to a rotating disc that disperses it centrifugally and allows it to atomize in a controlled, gaseous atmosphere.

"The most common cover gas is nitrogen, though our process sometimes requires the use of helium (**He**) and argon (**Ar**). **He** provides high thermal conductivity and helps in quenching whereas **Ar** is inert and allows the system to stay hot," added Mark, thereby concluding a short refresher for me in metallurgy and particle chemistry! He also cautioned that fine powders have to be manufactured in a highly controlled atmosphere to prevent formation of dust clouds that can initiate hazardous process explosions.

To summarize some of the manufacturing challenges: (a) likelihood of non-roundness is very high unless the process is minutely controlled (alloy composition, temperature gradient, rotating disc speed and disc design are some controlling factors); (b) any process that relies on stringent controls will also carry a hefty price tag, and finally (c) yield that is not highly predictable due to the above. E-Tech takes special precautions in proper storage since fine particles could cause inhalation issues—which brings us to the next important segment in our discussion—the equipment.

Equipment Design for Fine Particle Peening

Unlike thermal spray applications, where recycling is not a key part of the process, the media in shot peening applications impacts the part and has to be returned to the blast system for re-use. As we established earlier, fine particle peening is most effective as a second stage process (dual peening). Assuming both stages are designed to be carried out in the same machine, the cabinet and reclaim system should be able to handle both sizes.

I remember a past conversation with an end-user of such a system. The primary peening media (that delivered the desired compressive stress) was S330 (or the equivalent CW shot), and the secondary media was in the range of 125 micron. The application was to peen automotive gears at a very high production rate. The system utilized eight pressure blast nozzles, each flowing at least 15 lb/min (my estimate) of S330. This system utilized a mechanical recovery system, as is required for the quantity of media being processed.

Conveying fine particles through a mechanical recovery system, with a screw conveyor and bucket elevator, causes a lot of concerns. The transit loss in such a system could lead to several dead pockets of fine media, in suspension, and in general results in a very inefficient recovery system. If the fine particles somehow did manage to be elevated by the buckets to the upper recovery, expecting the airwash separator to handle this fine particle and differentiate it from the dust that it normally extracts is another challenge.

Finally, we rely on the classifier to maintain consistent shot size through all peening cycles. Maintaining that with fine particles poses the same screening challenge that was referred to earlier when we discussed the manufacturing process of such particles. There is likely a solution to all of the above, either already established and kept proprietary, or yet to be made commercial by a creative manufacturer. Perhaps two different machines, one for each media type—in a cost-effective fashion—just a thought.

Is There a Future for Fine Particle Peening?

I have often commented in these columns that our industry doesn't change rapidly. However, I will only exhibit unintended pessimism by doubting that a process has potential for improvement by a new technique, material or automation. Our discussion here attempted to continue the work started by Kathy Levy in 2010, and to get all our minds thinking collectively to (a) understand and expand on those niche markets that have benefited from fine particle peening, (b) consider changes to machine and the reclaim system design that will allow use of fine particles efficiently, and (c) make the process commercially cost effective.

Let us also not forget the importance of non-conventional peening techniques such as laser peening, needle peening, ultrasonic peening, vibratory peening, flapper peening and cavitation peening. Fine particle peening may end up a mainstream process or be restricted to specific applications, and prove to be the optimum solution, whether it be by increasing the compressive stress layer near the surface or forming minute cavities to store lubricant and decrease contact friction. As someone once said, "If it doesn't challenge you, it won't change you!"

Harolton Alexander and Dave Breuer | Curtiss-Wright Surface Technologies

Shot Peening and Thermal Spray Coatings: Complementary Surface Treatments

Curtiss-Wright Surface Technologies (CWST) is a subsidiary of Curtiss-Wright (NYSE: CW). CWST performs surface treatments and technical services to high-performance OEM parts and their Tier 1 and Tier 2 suppliers. The footprint of CWST consists of 65 job shops located in 16 countries including 40 shot peening locations. CWST offerings to industry are as follows.

- Shot and Laser Peening
- Peen Forming and Distortion Correction
- Super Finishing and Non-Destructive Testing
- Solid Film Lubricant and Liquid Coatings
- Thermal Spray Coatings
- Parylene Conformal Coatings
- Material Testing Services

This breadth of surface treatments provides solutions for a number of component failures including metal fatigue (shot/laser peening), friction and lubrication (solid film lubricants) and corrosion and erosive wear (thermal spray coatings). A full listing of material testing services is available at www.cwst.com/analytical-services.

CWST's thermal coatings group grew as a series of acquisitions in the United States and Europe with seven locations currently providing thermal coatings. Shot peening and thermal spray coatings are the most complementary surface treatments CWST offers.

CWST's Thermal Spray group offers coatings solutions for the following industries:

- Aerospace / Industrial Gas Turbine
- Oil and gas / Petrochemical
- Refining / Mining
- Agricultural and On / Off Highway

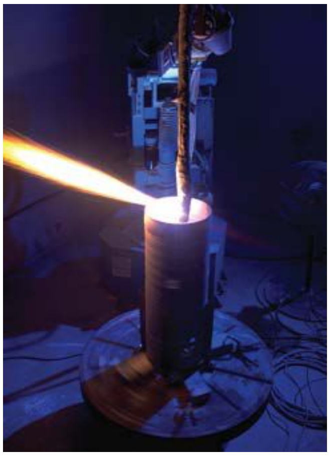
Thermal spray coatings provide solutions for applications in a multitude of stationary, rotating and linear movement applications. Thermal coatings provide corrosion, wear, erosion, oxidation protection and thermal sealing management.

Aerospace engine applications include hot and cold section components such as vanes, combustion liners, turbine shrouds, casings, knife edge seals, blades, and complex geometry blisks. Dimensional restoration of rotating journals and electrical run-out journals can also be accomplished by thermal spray coatings.

Arc Spraying on ID of Large Housing

Common Thermal Spray Processes

HVOF: The high velocity oxygen fuel (HVOF) technique combines a hydrocarbon fuel (in gas or liquid form) and oxygen which is fed into the combustion chamber of the gun. This combination is ignited and forms a high-pressure ultrasonic velocity flame which is accelerated in a similar way as a rocket engine. This propels the molten (or semi-molten) coating material onto the component creating a low-porosity and high-tensile strength coating.



Plasma Spraying on ID of Combustion Liner

Flame Spray: Flame spraying is a coating process that uses the heat of combustion. The flame produces heat which melts the thermal spray material. Molten particles are then propelled onto the surface to be sprayed. When using powder flame spray, metal or ceramic powder particles are softened and

melted by the flame. Then, they are sprayed onto the surface to be coated by the use of the combustion gases through a nozzle.

Plasma Spray: Plasma spray uses extremely high temperatures of a plasma plume which is generated by electrically ionizing a controlled gas stream. This allows high melting point materials such as refractory metals and ceramics to be applied. Lower melting point materials such as abradables containing polymers, metallic materials, and carbide cermets can also be used. Plasma spray coatings can be optimized for controlled levels of porosity making this process the ideal choice as a thermal barrier coating for critical applications operating in severe high-temperature environments.

Shot peening can be specified before or after thermal spray coatings depending on the application.

When is shot peening performed *before* thermal coating?
Many high-performance components require the benefits of both shot peening and thermal spray coatings. In these situations, shot peening is performed before thermal spray. Shot peening provides a layer of high magnitude (residual) compressive stress that opposes the initiation of surface cracking.

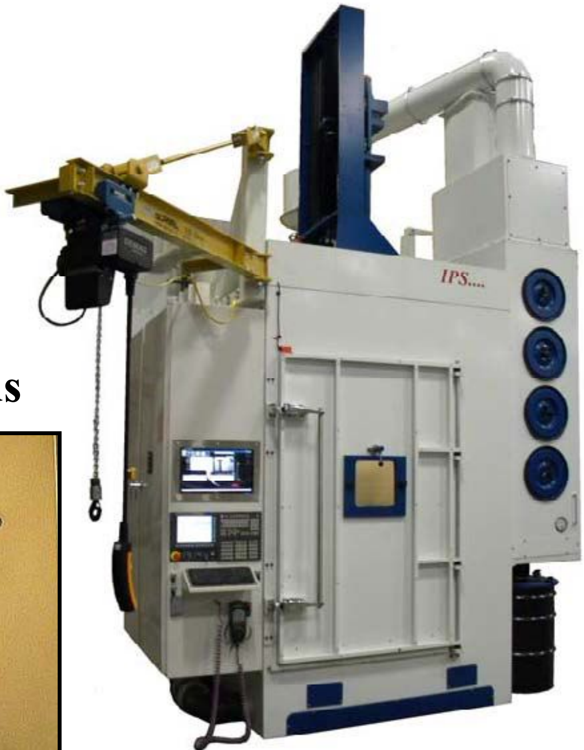
Most thermal processes are discouraged after peening as they may relieve the shot peening stress. When applying thermal coatings, either the component or gun is in motion such that the dwell time of the thermal coating application is short. This minimizes relaxation of shot peening compressive stress and corresponding benefits.

When is shot peening performed *after* thermal coating?
Shot peening compressive stress is beneficial in removing potential detrimental residual stress that occurs during the coating process. In addition, many real world applications involve contact with other surfaces where wear is an important consideration. Thermal-coated surfaces without subsequent treatment generally have rough surface finishes due to inherent porosity.

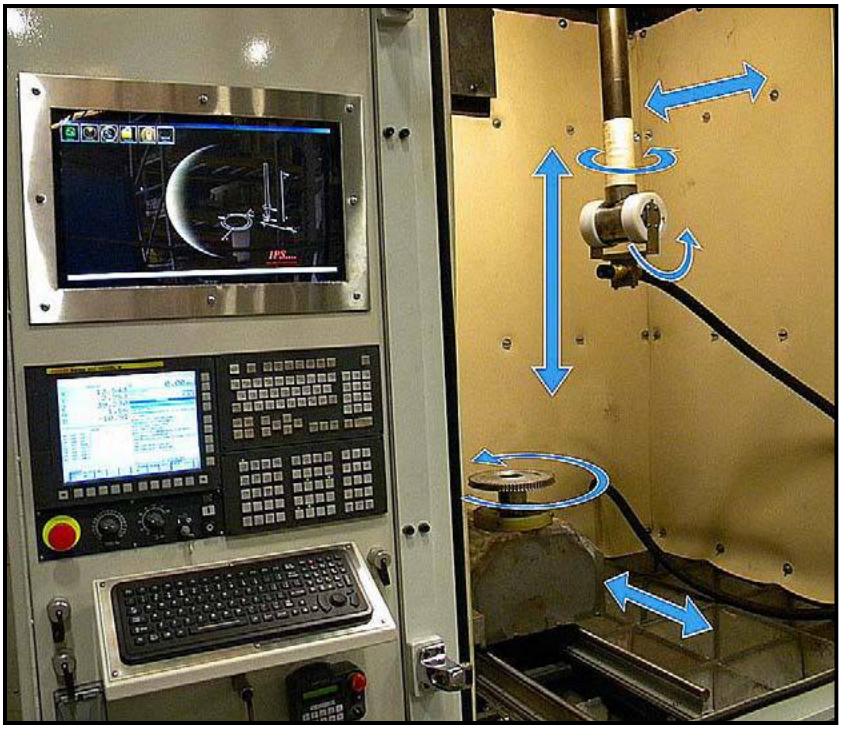
Shot peening after thermal spray offers benefits associated with reducing wear. Increases of surface hardness up to 25% offer more wear resistance. This is accomplished by densifying the surface via shot peening cold work and reducing surface porosity. In addition, an improvement in surface finish from peening is achieved thus lowering the coefficient of friction. Greater surface harness and improved surface finish usually offer better wear resistance for most applications.

Additional information on Curtiss-Wright Surface Technologies and our shot peening and thermal coatings can be found at www.cwst.com.

Innovative Peening Systems



High Performance for High Standards



CNC motion allows the nozzle to follow the contour of the part. This motion provides consistent intensities and coverages to occur with optimal speed and precision.

IPS....
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5425 Progress Court, Braselton GA 30517
Phone: 770-246-9883
www.ipeenglobal.com

Coverage Checker: UV Light Version

A More Applicable and Useful New Device

WE ARE PLEASED to introduce a new Coverage Checker using ultraviolet light.

1. Background of development
Coverage Checker has been designed for easy and precise coverage measurement in place of human eyes. It is mainly used for the quality check on automobile parts after shot peening or blasting.

However, some customers asked us to make the creation of a “recipe” easier. The recipe is a set of measurement condition and calibration line between the number of pixels in an image and coverage% on the parts surface determined by human eyes.

In order to simplify recipe creation, the surface condition before shot peening should be uniform under all measurement conditions.

So, we considered combining the fluorescent paint “Peen Scan Pen” handled by Electronics Inc. with Coverage Checker. As a result, we have developed Coverage Checker UV light version (Fig. 1) with a coverage measurement system that can respond to one fluorescent paint with only one recipe.

Fig. 1 Image of Coverage Checker UV light version.

2. Outline of Coverage Checker UV light version
Coverage Checker UV light version (hereinafter, UV-CC) uses UV LED with a wavelength of 375 nm as a light source and measures the degree to which the fluorescent paint applied in advance on the surface to be measured has been peeled off by shot peening or shot blasting. It has the following characteristics.

2.1 Fluorescent paint
The color components to be detected can be arbitrarily selected from all hues. There is no restriction on emission color of the fluorescent paint that emits at 375 nm UV light.

The surface irradiated with UV light emits a slightly purple glow due to the purple component near the UV. For precise coverage measurement, it is recommended to use a fluorescent paint that emits red to green light with wavelength of 500 nm or more.

2.2 Modified algorithm
The normal type TOYO SEIKO Coverage Checker calculates the coverage% on image data captured by pressing the shutter. In this case, only the area selected by the operator is measured, but there is a possibility that other areas with lower coverage% may be missed.

In UV-CC, the algorithm has been changed so that the coverage% is always displayed on screen for obtaining live image (Fig. 2 on next page). As a result, the operator can determine the coverage% of the required area after grasping the coverage% distribution of the entire measurement target area or the entire part.

2.3 Increased worthiness as evidence
The coverage% measurement value can be recorded on the captured image obtained by pressing the shutter. With the normal type TOYO SEIKO Coverage Checker, the entire measurement screen including coverage% could be recorded, but with UV-CC, the captured image and the measurement coverage% can be recorded in association (Fig. 3 on next page). This function can increase the reliability of recording

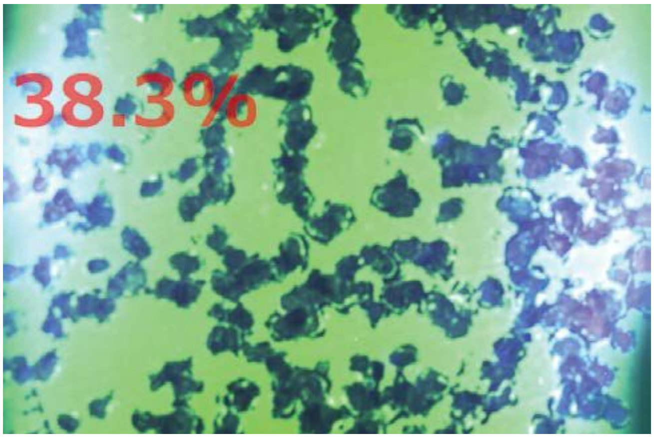

Fig. 2 Coverage% displayed in live images.

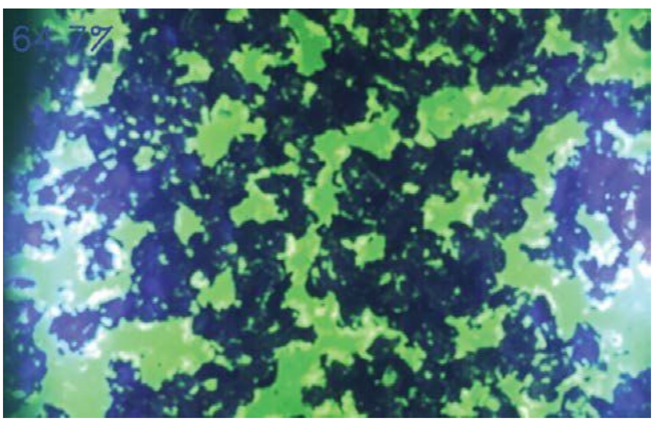

Fig. 3 Captured image including coverage% value.

as a coverage% measurement result. It is also possible to choose to hide coverage% measurement result.

2.4 Other specification
The specifications of UV-CC are shown in Table 1.

Table 1 Primary specification of UV-CC

Number of pixels of light receiving unit	360,000 pixels
Light source	Ultra-violet LED light (Wavelength 375 nm)
Lens	Macro lens system (0.5x magnification)
Area size of measurement	4.8 mm × 3.6 mm
Measurable radius of curvature	Minimum 5 mm

3. Specific advantage of UV-CC
UV-CC can handle the following cases that could not be applied before.

- It can measure on surfaces such as carburized parts which are difficult to dent by shot peening.

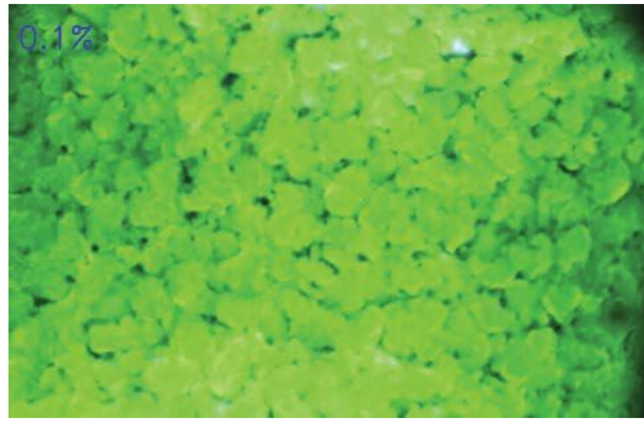

Fig. 4 It is confirmed that the coverage is almost 0% on the surface where the fluorescent paint was applied after shot peening with full coverage.

Fig. 5 UV-CC at a steel bridge repair work site.

- It can measure on surfaces that already have indentations such as two-step shot peening (Fig. 4).
- It can measure on surfaces with heat-treated scale regardless of the type of scale.

4. Application
In Japan, shot peening is performed to apply compressive residual stress to HAZ of welded area of steel structures. It can realize long service life against damaged area of aging steel structures with low cost. In public constructions, operation and inspection methods shall be specified and documented. UV-CC is registered as an inspection method after shot peening and is being used in applications such as steel bridge repairs (Fig. 5).

Contact Information
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A Unique Recipe: Wheelabrator's "A-Team" on Super High-Spec Peening

__WHEELABRATOR'S__ global airblast team develops blast processes for some of the highest-spec peening applications out there—from mainstream automotive and medical to aerospace and motorsport. Based in France, Germany and the United Kingdom, but operating globally, the team supplies airblast equipment, parts and services, as well as offering advanced subcontract shot peening. Here, Yves Dufour, who heads up Wheelabrator's Global Air team as Senior Vice President, and Tony Grammauro, Vice President in charge of Wheelabrator Impact Finishers, discuss the evolving demands on airblast processes, global market trends and the benefits of a tight symbiosis of equipment and process.

Yves Dufour (left) and Tony Grammauro (right) discuss the latest market trends and developments in high-spec peening.

The Growing Demand for High-Spec Airblast Equipment and Services

Tony: Both on the equipment and the subcontracting side, zero-defect manufacturing and traceability are key themes that drive our business. Demand for high-spec peening is growing and we are able to deliver the process—be it as a service or baked into equipment—with the performance and reliability industries like aerospace and automotive need.

Where we previously mainly dealt with aircraft manufacturers and their suppliers, we're now also seeing huge growth in maintenance, repair and overhaul (MRO) on the operator side of the aviation industry. And we continue to work with most of the major automotive companies globally where the shot peening of critical parts has become a mainstream process.

Wheelabrator's Customers

Yves: Customers come to us for our process know-how. I'm in the fortunate position that I have Tony and the Impact team, who will test things for us and provide feedback, and who get requests for the most advanced peening tasks from their customers. That's gold dust to us in terms of shaping our product offering. As we evolve our equipment, the Impact guys are our harshest critics, but they also have their fingers on the pulse of the industries we're serving.

Tony: That works both ways, of course. We're the only subcontract shot peening outfit that is also part of an equipment manufacturer. It means we can influence the machine development and feed back anything we don't like. So far, this has meant that we're very happy customers of Yves's team and wouldn't dream of buying our equipment from anybody else. Together, we can make it the best equipment there is.

Wheelabrator's Response to Customer Challenges

Yves: On a practical level, a lot of the challenges we're helping our customers with are quite immediate: around productivity, energy use, reducing maintenance requirements, etc.

As more parts require higher-spec treatment at bigger volumes, customers need technical support to reliably control sophisticated peening processes.

Outsourcing the process to Tony's team is one potential answer, but for high volumes—in automotive for example—this is not realistic. So we're building a lot of the expertise and skill into the machines, using automation to ensure that crucial repeatability. We're expecting this challenge to extend into areas like MRO, as volumes increase along with a growing global aircraft fleet. Customers want a reliable process out of the box, which is about more than just delivering a machine.

Tony: When Yves says it's not realistic for global industries to give everything to me and my team as subcontracted peening work, he is of course right.

That said, with the predicted growth in commercial aviation alone (Airbus and Boeing have both released figures last year projecting a doubling of the global fleet by 2038), capacity is going to be a major issue. Who is going to peen all those parts to aerospace standard?

That's why we're already drastically increasing our capacity in the UK—to give the industry that extra capacity. We've just commissioned two new fully automated shot peening machines and will be adding a robot shot peening machine in the next twelve months. We're also primed to scale things up at our facility in France if needed. Beyond this ramping up in volume, we're working with Yves's team to evolve the equipment to anticipate future process needs.

Yves: Part of that work is looking at elements of the process and improve those or develop add-ons that tackle specific issues. For example, we're just working with a supplier on a new type of innovative media, and we've developed a new hose that delivers hugely improved uptime as well as reducing contamination of the abrasive. These products will be available in the coming months, as soon as they come out of testing and pilot projects.

Another add-on we've developed and that I'm particularly excited about is a high-speed camera that allows us to measure the speed and size of individual particles of abrasive. That way we can establish the energy we're applying to the part more accurately. It allows us to see phenomena we've not previously been able to see—turbulences in the airflow, etc.

Currently, the camera is designed to be used primarily for process calibration and validation. It's temporarily attached to a nozzle or placed in a cell with a robot arm, so the arm can hold the nozzle in front of the camera for checking.

Ultimately, we could see this develop into real-time monitoring. Through the digital products that are being developed in the group, we can very easily connect the camera output to a central system where we could use advanced image processing and AI to get an even tighter grip on the process. Suddenly the black box that used to be the shot peening process opens up and we can see what's happening inside. That would deliver so much more than an Almen strip ever could. This is how we'll get to genuine zero-defect manufacturing.

About Wheelabrator

Wheelabrator, part of Norican Group, is one of the world's leading providers of surface preparation technology, offering a complete range of airblast and wheel blast equipment, and shot peening solutions, as well as comprehensive global aftermarket support.

For over 100 years, leading companies in the foundry, automotive, aerospace, energy, medical, rail and construction industries have trusted Wheelabrator's products and services to improve productivity and profitability. From cast iron pans to aircraft wings, there's hardly a surface we haven't improved.

Operating from strategically located service centers on four continents, Wheelabrator provides 15,000 active customers in over 100 countries with state-of-the-art parts preparation technology and services.

Jack Champaigne | President | Electronics Inc.

Iron Contamination in Non-Ferrous Media

Many blast cleaning and shot peening processes benefit from non-ferrous media (ceramic bead and glass bead) because the media eliminates contamination such as rust. It is often assumed that the media is free of all iron contamination, either new or in use. SAE specifications J1173, J1830, AMS2431/7 and AMS 2431/6 state that the magnetic particle shall not exceed 0.1% of the original sample, by weight. Descriptions of an inspection method are included in each of these documents as follows.

> Magnetic particle content shall be determined by slowly sprinkling approximately 1500 grams of the sample glass shot on an inclined aluminum tray, 0.062 inch (1.6 mm) deep by 6 inches (152 mm) wide by 12 inches (305 mm) long. The tray shall be supported by a nonmagnetic frame so that it is inclined with a 6 inch (152 mm) rise from end to end, (30 degrees from horizontal). Four 1 x 1 x 6 inches (25 x 25 x 152 mm) bar magnets shall be positioned against the under surface and crosswise of the inclined tray about the middle of its length. Thickness of tray at the magnet locations shall not exceed 0.062 inch (1.6 mm). Magnets shall be not less than 10,000 Gauss each and arranged so that the magnetic north and south poles alternate. The magnetic particles (iron) that accumulate on the tray as the beads roll down shall be brushed into a pre-weighed dish. The procedure shall be repeated with the same 1500 gram sample until all visible magnetic particles are collected. The dish shall be reweighed and the magnetic particle content calculated as a percentage of the total original sample.

This inspection method should be performed on all new media prior to introduction to the machine and on a frequent basis. An easily avoidable source of contamination is using ferrous and non-ferrous media in the same machine. It is impossible to get all the ferrous media out of the machine so contamination is all but guaranteed. Another source of contamination is erosion of the blasting machine and even dislodged machine parts.

Magnetic traps should be installed on machines to extract the iron contamination and these need frequent inspections and cleaning. Below are examples of bar-type magnetic traps.

Magnetic Separators

Author's note: The following information is from Eriez—"the world authority in separation technology."

Magnetically susceptible metal contamination (iron) is commonly removed using magnetic separators. There is magnetic separation equipment that traps metal using ceramic or neodymium iron boron (neodymium). Ceramic magnets produce low strength but deep reach magnetics fields, while neodymium magnets create the strongest permanent magnetic products presently commercially available.

High-strength magnetic fields, as produced by neodymium, are needed to capture fine iron metal contamination. These are the main magnet configurations suitable for handling powders:

a. Tubular magnetic cartridges, often in a multi-rod grate configuration
b. Flat-faced magnetic plates
c. Cone-shaped magnets
d. Magnetic drums with a curved magnetic arc

Although occasionally a magnetic cartridge may be used on its own, it is more commonly part of a larger multi-cartridge grate system. The magnetic grate is designed to fit inside a hopper, or can be supplied complete with a housing (as a drawer filter magnet).

In operation, powder falls freely onto the surface of the magnetic cartridge where fine iron strikes the surface and is held by the strong magnetic field. To ensure that the powder makes contact with the cartridge surface, deflectors are often deployed above the gaps between the cartridges.

Powder build-up on the surface of a magnetic cartridge will reduce the separation efficiency. Also, in severe cases, a slight build up on the surface of the cartridge may quickly cause a blockage of the whole housing.

Such blockages can be prevented by ensuring that there is optimum space between the magnetic cartridges. Also, in some cases, the mounting of an external vibrating motor on the side of the hopper or housing will provide enough disturbance to prevent any material coagulation. The frequency of the vibration needs careful consideration as it could affect the flow ability of the powder. Additionally, when vibrators are used, the magnetic cartridges need to be manufactured to withstand prolonged periods of vibration.

Flat-faced magnetic plates are ideal when it is possible for the material to flow over the surface. For fine iron removal, the magnetic plates would use high strength neodymium magnets. This magnetic field is further enhanced when a tapered step is added to the face of the magnet. Captured iron migrates behind the step and away from the material flow, reducing the risk of re-entering the cleansed product. As well as being fitted into chutes, magnetic plates are incorporated into housings. The plate housing magnets resist bridging and choking to remove tramp iron and ferrous fines from flow-resistant bulk materials. The stainless steel housings mount easily to enclosed spouting or directly on processing equipment.

There are optional square, rectangular, and round adapters for easy connection to existing chute work. A baffle at the top of the housing helps break up clumps and directs product flow over the unit's two powerful plate magnets. Plate magnets are used in in-line magnets with two designs:

1. Gravity in-line magnets: The plate magnets are positioned in round, sloping spouting where material is under gravity flow. For effective tramp metal capture, the sprouting should be angled no more than 60˚ from horizontal.
2. Pneumatic in-line magnets: These designs are for use in dilute phase pneumatic conveying systems (up to 15 psi). They can be installed easily with optional factory-supplied compression couplings and work best in horizontal runs with the plate magnet down to take advantage of material stratification.

Another design of in-line magnet is the center-flow although the magnetic field is generated in a cone configuration instead of a plate. The magnetic cone is positioned in the center of the housing, allowing the powder to flow in the space left between the housing. Center-flow in-line magnetic separators are commonly used in dilute-phase pneumatic conveying lines up to 15 psi.

To achieve optimum contact with the product flow, a conical magnet is suspended in the center-line of the housing. This tapered, exposed-pole cartridge has a stainless steel "nose cone" to direct the flow of materials around the magnet. The tapered poles of the cone magnet allow ferrous fines to collect out of the direct air stream. Additionally, the trailing end of the magnet is an active magnetic pole and holds any tramp metal that is swept down the cone.

Both types of in-line magnets are designed with clamps and doors to enable easy access for cleaning.

In specific applications, a high-strength neodymium drum magnet will enable the best level of separation. The drum magnet is gravity-fed, usually via a vibratory feeder. The drum magnet has a stationary high-strength magnetic arc positioned inside a rotating outer shell. When material flows onto the drum magnet, the magnetic field projected by the stationary magnetic assembly inside the shell captures fine iron and holds it securely to the drum's stainless steel surface. With contaminants removed, the good product falls freely to a discharge point. As the drum rotates, the captured fine iron travels along the drum surface and out of the magnetic field, where it is discharged.

There are various magnetic field configurations possible, but the most suitable for removing iron from powder is one that produces a radial magnetic field. This ensures that once captured, the fine iron does not leave the drum surface until it moves out of the magnetic field.

Processing powder on a drum magnet presents more difficulties that other designs of magnetic separators. First, it is recommended that the vibratory feeder has an air bed to produce a consistent feed of powder. Standard vibratory feeders may deliver powder in clumps, significantly affecting the separation performance.

Second, the shell of the drum magnet should be rotated at high speeds. This will result in some of the powder pluming, and this can be minimized by keeping the distance between the end of the vibratory feeder tray and the rotating surface of the drum magnet to a minimum.

The high rotation speed of the drum magnet significantly reduces the amount of product lost to the magnetics. This is because there is less material on the surface of the drum at any one time, reducing the chance of entrapment. Drum magnets operating at high rotational speeds are successful in removing fine iron from abrasives, refractories, and other applications where the material has a high specific gravity.

As the demand for finer and purer powders increases, so does the need to remove even the finest iron. Understanding the properties and behavior of the powder is vitally important when considering the optimum method of fine iron separation. Often the ultimate solution is a series of magnetic separators and metal detectors located at strategic points within the process.

Magnetic Separators at Electronics Inc.

Electronics Inc. (EI) uses a magnetic separator on an airblast machine in their testing laboratory. The photo below shows how much ferrous contamination was captured by EI's airblast machine's dust collector with a grate magnet. The debris is erosion of the cabinet walls and tooling as it gets abraded by the media. After seeing such positive results from using magnetic protection, the EI engineering staff has invested in additional magnetic separators.

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ACADEMIC STUDY
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Back to Basics: Shot Particles

INTRODUCTION

The aim of this mini-series is to cover the basic scientific principles of shot peening. Fundamental principles are presented together with relevant theoretical explanations. Shot particles themselves are an obvious starting point—without them we could not have shot peening.

Shot particles have a set of properties that govern their suitability for specific peening operations. These properties include: shape, size, mass, chemical composition, elasticity, hardness, toughness, wear resistance and structure. Ease of manufacture is also very important for commercial viability.

SHAPE

The ideal shape for a shot particle is a sphere, but real shot particles are not perfect spheres. Deviation from sphericity is important. The most commonly employed media are cast steel shot, cut steel wire shot, glass beads and ceramic beads. These media are manufactured either by spheroidising solid particles (cut steel wire and some glass beads) or by spheroidising liquid material (cast steel shot, some glasses and most ceramics). Because of the methods of manufacture, variations from sphericity are inevitable.

Shot shape is determined from two-dimensional images rather than from spheres. The most important parameters are therefore:

(1) Circularity and
(2) Angularity.

Circularity

Circularity is the measure of how closely the shot's outline resembles a circle.

Quantification of circularity involves calculation—either easy or complicated. The simplest method is the width/length ratio. Fig.1 shows the principle of the width/length parameter when derived from an elliptical shape. Width being the minimum diameter, D_{MIN}, and length being the maximum diameter, D_{MAX} . In fig.1 the ratio works out to be precisely 0.3 because D_{MIN} is 30% of D_{MAX}. The drawback with this method is that it gives the same value for some shapes that are very different in terms of circularity. For example: the width/length ratio for a perfect circle is 1.0 but the ratio is also equal to 1.0 for a square!

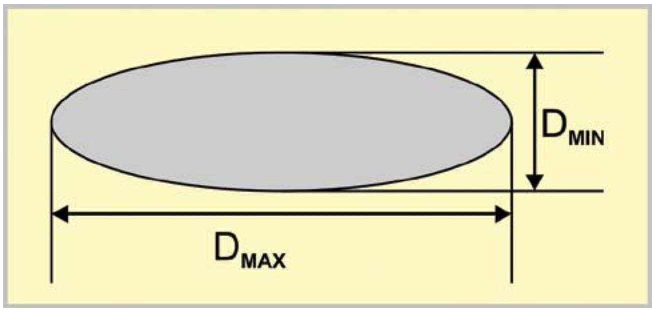

Fig.1. Width/Length ratio shape parameter.

A commonly employed method of quantifying the circularity of an ellipse is to use the parameter $4\pi^*A/p^2$ where **A** is the area and **p** is the perimeter of the object. These are indicated in fig.2 which uses the same ellipse as that in fig.1. Solving $4\pi^*A/p^2$ for an ellipse is, however, unusually complicated. That is because there is no simple way of determining the perimeter of an ellipse. Fortunately for researchers, relevant computer programs are readily available via the internet. These indicate that $4\pi^*A/p^2$ is 0.196 for the ellipse of fig.2, 1 for a circle and 0.785 for a square. This method is more powerful than width/length when applied to ellipses. It is rarely employed in shot peening, possibly because elliptically shaped shot particles are uncommon. Width/length has the great advantage of being universally applicable and simple to measure. Any shot image can be enlarged on a computer's screen allowing minimum width and maximum length to be measured needing only an office ruler.

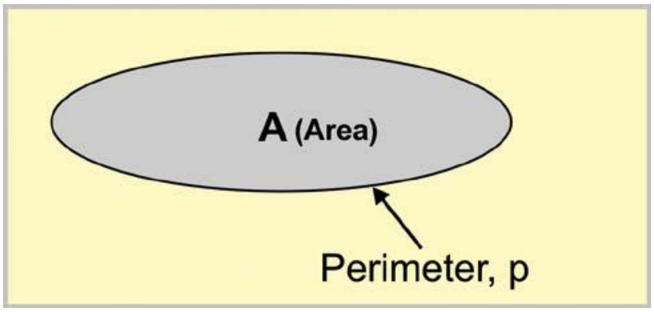

Fig.2. Circularity shape variables for $4\pi^*A/p^2$.

Angularity

Angularity is a measure of how much a particle deviates from perfect smoothness.

A square has no smoothness—only four straight sides at 90˚ angles to each other—hence it is regarded as having very high angularity. By way of contrast, an ellipse is a perfectly smooth curve and is regarded as having zero angularity. Cut wire shot particles have many flat surface regions, albeit tiny, even after multiple conditioning. Cast steel shot has very low angularity. Grit differs from shot in that it is, necessarily, very angular.

Angularity is very, very difficult to quantify. Some idea of angularity variation is provided by fig.3. This is a modified version of a chart popularized by Krumbein and Sloss. The chart values are those calculated for roundness. Angularity is the opposite of smoothness so that low smoothness corresponds to high angularity.

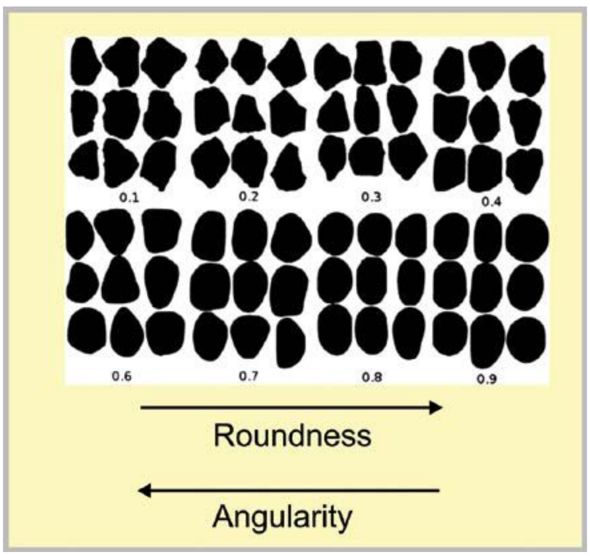

Fig.3. Angularity versus roundness of particles.

SIZE

Size is probably the most important shot property. Any variability of shot size is therefore important. Specifications, such as SAE J444 and AMS 2431, nominate shot size in terms of sieving results. The range of sieve sizes employed leads to a corresponding nominal shot size. Hence we have **nominal shot sizes** based on sieve mesh spacing.

Shot size can also be associated with the diameter of a sphere. That is convenient from a scientific point of view because the geometry of a sphere is well-known. For example: volume is $\pi D^3/6$ where D is the sphere's diameter. Association of a particle's size with sphere diameter is based on the concept of its "equivalent sphere." The equivalent sphere of an individual shot particle is one that has the same volume as that of the particle.

Fig.4 illustrates the difference between nominal size and corresponding equivalent sphere as methods for sizing shot particles. Although not to actual sizes, it allows us to get a mental picture of the huge range of available shot sizes. By way of analogy, the range is similar to that between a shotgun pellet and a cannonball.

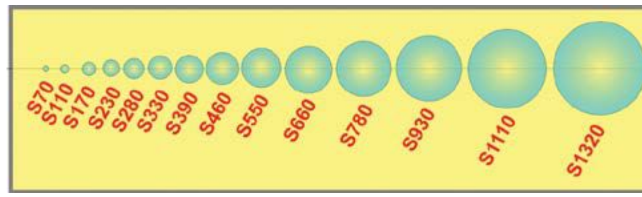

Fig.4. Nominal and equivalent sphere sizes for cast steel shot.

Another way of looking at the huge range of shot sizes is to compare how many particles there are per 100 grams. Table 1 shows the range for cast steel particles.

Table 1. Variation of Size, Mass and Particles per 100 g of Cast Steel Particles

SHOT	DIAMETER		MASS	PARTICLES
	-inch	- mm	- mg	Per 100 g
S70	0.0070	0.1778	0.02313	4322983
S110	0.0110	0.2794	0.08976	1114037
S170	0.0170	0.4318	0.33134	301808
S230	0.0230	0.5842	0.82055	121869
S280	0.0280	0.7112	1.48046	67547
S330	0.0330	0.8382	2.42362	41261
S390	0.0390	0.9906	4.00052	24997
S460	0.0460	1.1684	6.56441	15234
S550	0.0550	1.3970	11.22045	8912
S660	0.0660	1.6764	19.38894	5158
S780	0.0780	1.9812	32.00414	3125
S930	0.0930	2.3622	54.24643	1843
S1110	0.1110	2.8194	92.23404	1084
S1320	0.1320	3.3528	155.11154	645
Ratios				
highest/ lowest	19:1	19:1	6700:1	6700:1

MASS

Mass is volume multiplied by density. If the average mass per particle is small there will be a large number of particles per 100 g. The calculation given in Table 1 indicates that there will be more than four million S70 particles per hundred gram handful!

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The range of mass for cast steel particles at 6700:1 is the same as the range of particles per 100 grams. This contrasts with the range of only 19:1 for particle diameter due to the fact that the volume of a sphere is $\pi D^3/6$ where D is its diameter. Nineteen cubed is approximately 6700.

CHEMICAL COMPOSITION

The commonest groups of shot particles are steels, ceramics and glasses with each group having a range of chemical compositions.

Steel Shot

Steel shot is generally made from carbon steel as opposed to the much less common stainless steel. Carbon steel is used to make either cast shot or cut wire shot. Cast steel shot has a higher carbon content than does cut-wire shot. Table 2 shows the ranges involved. Cast shot is **hyper-eutectoid** (more than 0.8% C) whereas cut wire shot is **hypo-eutectoid** (less than 0.8% C). Fig.5 reveals the significance of this carbon content difference. Both types of steel have to be heat-treated. Austenitizing is followed by quenching. Quenched hyper-eutectoid steel may contain hard brittle phases. For cast shot this is not a problem as the particles are already in their finished shape. For cut wire shot this would be a big problem as cut particles have to be pounded severely during conditioning. That is why a hypo-eutectic composition is employed. Identical hardness ranges can be achieved for both cast and cut wire shot.

Table 2. Carbon content and hardness properties of carbon steel shot

Cast Shot		Cut-Wire Shot	
Carbon content	0.8 – 1.2 wt.%	Carbon content	0.45 – 0.85 wt.%
Regular hardness	45 – 52 HRC	Regular hardness	45 – 52 HRC
High hardness	55 – 62 HRC	High hardness	55 – 62 HRC

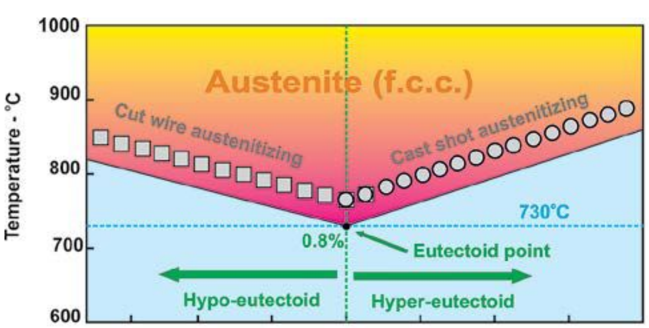

Fig.5. Cut wire versus cast steel shot austenitization.

Ceramic Shot

The composition of the common zirconia/silica/alumina shot is specified in AMS2431/7B and in J1830. Table 3 indicates the permitted composition ranges.

Table 3. Composition ranges for ceramic shot

Zirconia/silica/alumina shot	Content
Zirconium oxide, ZrO_2	60-70%
Silica, SiO_2	28-33%
Alumina, Al_2O_3	10% max
Free iron, Fe	0.1%max
Others	3% max

A disadvantage of zirconia/silica/alumina shot is its relatively low density when compared with that of steel shot —3 versus 8 g/cc. An interesting development is that of "high density ceramic shot." The corresponding AMS Specification is undergoing evolution. Essentially, high density ceramics contain a substantial proportion of a rare earth element, typically cerium. Consider a three-dimensional framework of cerium atoms that is infiltrated by zirconia molecules. As an analogy, imagine that the cerium atoms (ions) act as if they were hungry octopuses that mightily clutch zirconia molecules to themselves. This strong clutching/attraction reduces the volume being occupied hence increasing density to about 6 g/cc.

Glass Shot

AMS 2431/6B states that the composition "Shall be high quality glass of the soda-lime type. Silica content shall be not less than 67% by weight." Pure silica melts at the very high temperature of 1723˚C. Soda (sodium carbonate, Na_2O_3) is therefore added in order to lower the melting point dramatically but, on its own, makes the glass water soluble! Lime (CaO) is therefore added to remove this solubility. Magnesia (MgO), Potassium oxide (K_2O) and alumina (Al_2O_3) may also be added to improve glass shot durability. Table 4, published by a glass shot manufacturer, is an example of the final composition.

Table 4. Typical Glass Bead Composition

Silica, SiO_2	72%
Sodium oxide, Na_2O	13%
Lime, CaO	5%
Magnesia, MgO	4%
Potassium oxide, K_2O	3%
Alumina, Al_2O_3	1%

SURFACE STRUCTURE AND COMPOSITION

An important feature of chemical composition is its effect on the surface of the shot particles. Ceramic and glass shot are composed of stable oxides so that they do not react with air during shot peening. Surface and core structure and composition are the same. Metal shot particles, on the other hand, become coated with a brittle layer of metal oxide when in contact with air. Fig.6 (fig.1 of *The Shot Peener*, Spring, 2011) illustrates this phenomenon. The iron oxide coating has a variable chemical composition of Fe_xO_y. The value of y to x varies continuously from 1 at the shot interface to 1.5 at the air interface. A value of 1 gives FeO, 1.33 gives Fe_3O_4 and 1.5 gives Fe_2O_3. The ratio of oxygen to iron atoms is lowest at the skin/core interface and highest next to the surrounding air as would be expected.

Fig.6. Iron oxide skin on carbon steel core.

The skin on stainless steel shot particles is chromium oxide (Cr_2O_3) which is so thin as to be transparent but it is also fairly brittle. If damaged on impact, self-repair occurs very quickly—chromium atoms combining with oxygen atoms—hence the term "stainless."

ELASTICITY

Elasticity is probably the most significant of a shot particle's properties, but doesn't rate a mention in specifications! Rubber, which is very elastic, is obviously not useful for shot peening. Steel, being much less elastic, is useful. Quantifying the difference in elasticity is not helped (for beginners) by the fact that Young's modulus, E, is a measure of stiffness rather than of elasticity. Table 5 lists approximate Young's modulus values for shot materials and for rubber.

Imagine dropping a rubber ball onto a steel plate. Any effects would be purely elastic—and a waste of effort from a shot peener's point of view. A steel ball, on the other hand, will induce plastic deformation because of its relative stiffness.

HARDNESS

Hardness is a measure of a material's resistance to plastic deformation. It is therefore an important property of shot particles—we don't want flats to appear on impact. Hardness values appear regularly in specifications. Table 6 lists some of these values.

Table 5. Approximate Stiffness Values

Material	Young's Modulus, E, - GPa
Ceramic	200 - 400
Steel	200
Glass	60 - 80
Rubber	0.01 – 0.1

Table 6. Typical Specified Hardness Values for Shot Particles

Material	Condition	Hardness - HRC
Steel	Cast	45 - 52
Hard Steel	Cast	55 - 62
Steel	Cut wire	45 - 52
Steel	Carburized	57 - 62
Stainless Steel	Cut wire	45 min
Glass	-	48 - 52
Ceramic	-	58 - 63

The values shown in Table 6 indicate that there is a fairly narrow range of hardnesses for commonly used particles.

TOUGHNESS

Another very important property of shot is its ability to resist fractures, that is, its toughness. Toughness values do not, however, appear in specifications. This may be due to the fact that there is currently no appropriate test procedure for shot toughness. Izod and Charpy tests have a long history of use for assessing resistance to fracture propagation, but employ large, notched specimens.

In view of its significance, a simple fracture resistance test is outlined as follows.

Shot Fracture Resistance Test

A familiar test of glass sheet toughness is to strike it with a hammer. Velocity and mass of the hammer are then the controlling factors. These parameters can be simulated for a shot particle by artificially increasing its mass using a striker as indicated in fig.7. Velocity can be varied by dropping the striker from different heights down a tube. In essence, the effective kinetic energy, $\frac{1}{2}mv^2$, is being controlled. Relevant theory is contained in the author's TSP. Spring, 2004, article titled "Actual and Predicted Shot Peening Indentations."

Fig. 7(a) shows a schematic representation of the overall device and fig.7(b) shows an enlargement of the striker's head.

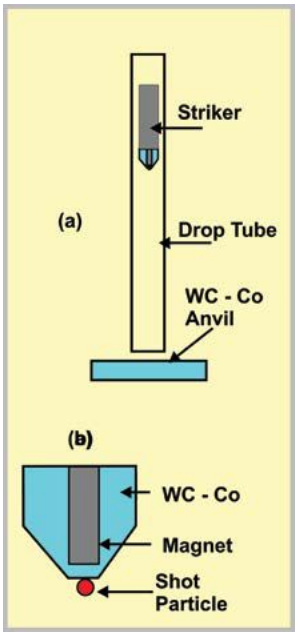

Fig.7. Schematic representation of shot fracture resistance tester.

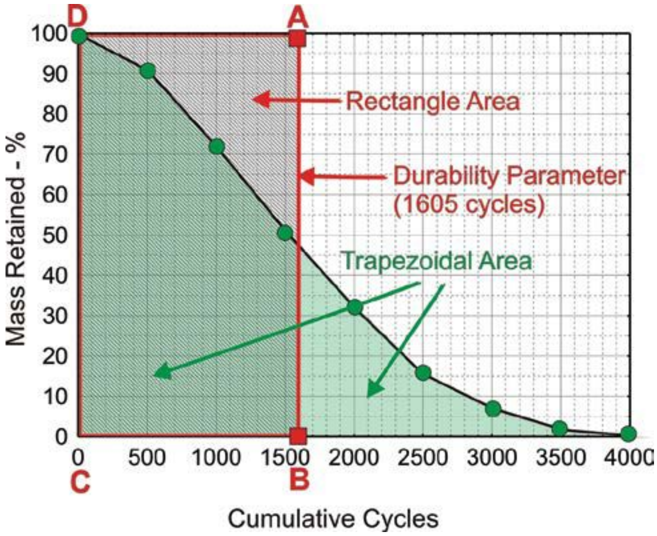

Fig.8. Modified version of J445's fig.1.

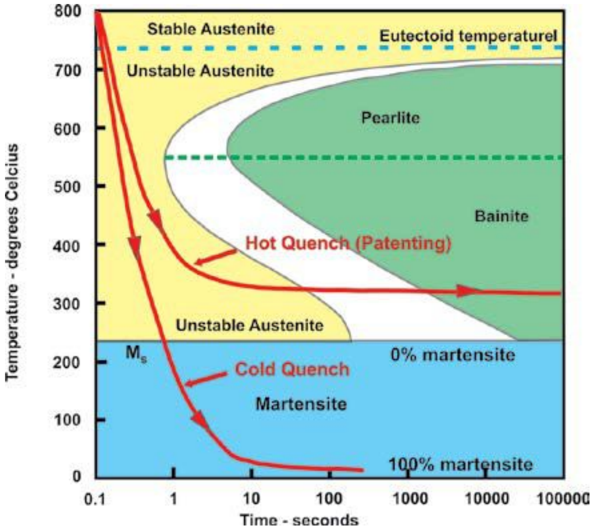

Fig.9. Basic structures obtained by quenching carbon steel shot.

SHOT WEAR RESISTANCE

All available types of shot wear away during use but at different rates. They can therefore be classed as an essential consumable. The most obvious effect of wear is a progressive reduction in the average diameter of the shot particles.

Shot wear mechanisms are based on either oxide layer breakdown and/or adhesive interaction with components. There are no standard tests or specifications that relate directly to shot wear. J445 Metallic Shot and Grit Mechanical Testing, is commonly used in conjunction with an Ervin Tester to estimate the durability of shot samples. It has the considerable advantage of only requiring about 100 g of shot. It does not, however, measure wear rate directly.

Wear resistance is dealt with in a previous article, "Wear and its Reduction", *The Shot Peener*, Winter, 2016. Relevant parts of the excellent J445 are described there in some detail. Fig.8 is fig.7 from that article. Durability is indicated by the loss of mass after different numbers of use cycles. Durability in terms of cycles is shown as **B** which is the point where the rectangle's area is the same as the trapezoidal area. The J445 durability test can, however, be modified to give a direct indication of shot wear rate.

STRUCTURE

Modification of structure is mainly confined to steel shot. This involves heat treating the shot to obtain the correct balance of hardness and toughness. Shot is first austenitized followed by quenching and tempering. The structural changes involved vary with carbon content—hypo-eutectoid cut wire shot behaving differently from hyper-eutectoid cast shot.

A previous article in this series ("Properties of Carbon Steel Shot," *The Shot Peener*, Spring, 2011) gives a general account of the ways in which steel shot structure evolves. Fig.9 from that article summarizes the structures obtained by quenching austenitized carbon steel shot. Cold quenching is normally preferred, with the martensitic structure subsequently being modified by tempering. Tempering substantially increases the toughness of a martensitic structure which is inherently brittle.

DISCUSSION

This article has presented the individual basic properties of shot particles. It is, however, the sum of the individual properties that prescribes the limited range of commonly used materials. Selection from this available range is normally determined by the user rather than by the shot peener. Often the choice depends on possible chemical interactions between the shot particles and the component. The available range of useful shot particles is being steadily widened due to competition between manufacturers.

ICSP14 is Here!

We are in the 4th Industrial Revolution, also called I4.0, characterized by the deep digitalization of the industrial production and by the progressive diffusion of the additive manufacturing using new materials. Shot peening is rapidly changing and moving toward new applications, new quality paradigms, new machines and media. The 14th International Conference on Shot Peening (ICSP14) is the best place to present the latest achievements and discuss the next steps for shot peening and allied processes.

The ICSP conference, due to the quality of the talks presented and the number of attendants, has become the most important conference on shot peening and allied processes such as cavitation peening, ultrasonic shot peening, laser shock peening and water jet peening. It is now the best-known forum on the science, technology, and applications of mechanical surface treatments. It offers a unique forum for scientists and engineers to deepen and update their knowledge on all aspects of mechanical surface treatments.

ICSP14 will be hosted for the first time in Italy. The organizer is Politecnico di Milano (POLIMI) in partnership with Peenservice. The venue is in Milan at the Campus Bovisa of POLIMI. The chairman is Professor Mario Guagliano—a well-known name in the field and the author and co-author of many papers on shot peening and its effect on the mechanical properties of materials and structural parts.

The expectation for ICSP14 is high not only for most recent development in terms of new materials and the attractive achievements in fatigue strength and life, but especially for the recent innovations in the production environment not yet completely implemented in the manufacturing technology, the so-called 4th Industrial Revolution or I4.0, which is opening new windows also to shot peening.

"I think that with the recent technological developments in line with the "Industry 4.0 revolution", strictly related to the digitalization of industrial production, there is a great need to know the way shot peening is changing and how this can affect the final results, especially in terms of process quality control as well as the final mechanical properties, fatigue first of all," said Professor Mario Guagliano.

Bearing this in mind, ICSP14 represents a unique opportunity for researchers and industry representatives to present and learn about scientific and technological developments on shot peening and surface treatments.

Another important subject, intended to become a major topic in the next few years, is the application of shot peening to additive manufactured parts obtained by LMD, SLM, EBM or other processes based on powder deposition and melting.

This new paradigm for industrial production has many limitations related to the poor quality of the surface that limits the mechanical strength (especially fatigue) and prevents a wider diffusion of these technologies. Shot peening and allied processes are very interesting as post-process treatments of these parts. However, the way to set up the treatment and the choice of the optimal process parameters is a still unsolved key point and it is attracting the interest of academics and industrial engineers.

Professor Mario Guagliano, Chairman of ICSP14

"Despite the present limitations induced by the low deposition rate of AM processes, additive manufacturing will grow and become a leading option in many industrial sectors. We are receiving many papers about the application of shot peening to additive manufactured parts, regarding both the practical aspects and the science behind controlling the surface features. Special sessions on this subject are attracting many participants," said Dr. Sara Bagherifard, member of the Scientific and Organizing Committee.

Traditionally ICSP is open to the other surface treatments characterized by a peening action on the target material, even if obtained by media different from usual shots. These processes are frequently called "allied processes": water jet peening, ultrasonic shot peening, cavitation peening, laser-based peening, burnishing, deep rolling, flap peening and so on. Dedicated sessions are planned for these treatments at ICSP14 as well.

Another hot spot of every conference is the quality of the plenary lecturers. These are chosen among the leaders in the field to give an overview of the latest achievements and the present topical subjects. In the case of ICSP14, five plenary lecturers were chosen balancing the academic and the industrial environments. Among the academics, Professor Martin Levésque (Ecole Polytechnique Montréal), president of the International Scientific Committee on Shot Peening, and Professor Emmanuelle Rouhaud will present and discuss their activity on simulation of shot peening and peen forming and SMAT to get grain refinement and superior properties, respectively. Yongxiang Hu, professor at Shanghai Jiao Tong University, will give a lecture on laser peening, while Dr. Dan Sanders (Boeing) and Pierangelo Duò (Rolls-Royce Deutschland) will discuss the implementation of cavitation peening and surface finishing properties in their companies, respectively.

"What I would like to highlight is that the conference is not only the place to present the latest scientific achievements or interesting case studies about peening, but it is also the perfect place where international exhibitors can present their products and services. We have many companies, both from Europe and overseas, that have confirmed their presence at ICSP14. We have received several requests for booths for demonstrations," said Professor Mario Guagliano.

Social events are an equally important part of a conference and the same applies to ICSP14. Indeed Milan is a wonderful city in the north of Italy. It is the second largest and the most important financial and economic city in the country. It is a well-known international capital of fashion and design with many opportunities for shopping. Maybe less known than Rome or Venice, Milan is also attractive for history and arts, rich in historical monuments and buildings, with many museums and art exhibitions. In Milan, it is possible to visit *The Last Suppe*r, the masterpiece by Leonardo da Vinci or the Cathedral, a masterpiece of Gothic architecture.

Walking in the center of the city, around the historical castle or the new districts with innovative buildings is quite pleasant, especially in the late-summer days like the second week in September when ICSP14 is planned. Milanese people like to meet up during the evening along the Channel "Naviglio" to enjoy their aperitif with Prosecco wine or Spritz, tasting the delicious Italian food.

ICSP14 covers these activities and wants to give to the attending people a "taste of Italy." Thus, a welcome reception is planned at the end of the opening day and the gala dinner is expected in the courtyard of the historical castle in Milan with a cultural visit of the castle itself. A social program for accompanying persons as well as cultural visits and post-conference tours are under development and will be communicated on the website (www.icsp14.org).

"To summarize, while ICSP14 is rapidly approaching, the organizing and the scientific committee are doing our best to host a successful conference, pleasant and fruitful for speakers, attendants and exhibitors. We know that someone could be late in submitting a paper. If you would like to make a contribution at ICSP14 and you have not submitted the abstract, please contact me or the organizing committee. We will do our best to get you on board. And do not forget to check the website for updates and latest information," said Professor Mario Guagliano (mario.guagliano@polimi.it).

FerroECOBlast:

Leaders of the Evolution of Aerospace Surface Treatment

Complete Turnkey Solutions for Engine Blades and Vanes
FerroECOBlast has been heavily investing in research and development in the aviation sector over the last few years and has established itself as one of the leading companies in the surface treatment machinery industry.

"We don't produce only machines for our customers—we provide them with complete solutions and real knowledge. Our main goal is customer satisfaction, which we attain once they begin using our high-quality products. We strive to have flawless products as there is no room for mistakes, especially when it comes to the aviation industry where there is a lot at stake," said Mr. Aljaž Molek, FerroECOBlast's in-house shot peening expert.

FerroECOBlast delivers complete turnkey solutions to MRO workshops where jet engine blades and other aircraft components come for repair. They provide complete surface treatment solutions including machine design and production, installation, operator and maintenance personnel training, and technical consulting.

"We provide tailor-made solutions and always deliver them together in conjunction with installation, training and consulting. Our employees are highly educated and most of us have been certified by the FAA for shot peening. We want to understand the process to really help our customers, not just sell equipment. One of our latest installations was for a MRO workshop dealing with engine parts—engine blades and vanes, to be precise. When the coating is removed, vanes are inspected for cracks and repaired. After inspection, shot peening is performed to reduce residual stresses and prevent the occurrence of corrosion. After shot peening, grit blasting with fine aluminium oxide (30 microns) is performed with a separate machine and the part is ready for new metal or ceramic coating. If both coatings are to be applied on a vane, grit blasting needs to be performed between coatings as well," Mr. Molek said.

Automatic Shot Peening Machine – ASP Series
The ASP Series is designed for high productivity and meets all requirements according to AMS2430 and AMS2432 specifications. The operator loads the part on the satellite turntable and presses a safety switch that initiates the rotation of the turntable which enters the working area, passing through a par-detection station. The machine is also ready for robotic loading that will be an option in the near future. Shot peening is performed with steel shots according to customer requirements and the shots are recycled in a "recycling

ASP Series shot peening machine for blades and vanes.

tower." All media is transported through a dust extraction unit to remove dust. Subsequently, the recycled media goes through a series of classification units that make sure only good and still usable media is fed back in the system. The recycling tower is designed in such way that media is always being recycled according to AMS2431 specifications. All our machines feature our own user-friendly interface system called the "FerroSmartPanel." The FerroSmartPanel controls all parameters and stores reports for each part, providing complete traceability and repeatability of the process to the customer. A large touch screen panel gives the operator good visual feedback of the process and parameter setup. The ASP Series features:

- User-friendly "FerroSmartPanel"
- Parameter setup
- Data report and visual monitoring
- Safety features
- Full media recycling system (AMS2431)
- MagnaValve media flow control
- Closed-loop airflow control
- Repeatability of the process
- Traceability of the process

Precise Pre-Coat Grit Blasting Robotic Machine – RoboBlast Series
Surface preparation ahead of coating is of utmost importance to ensure a high-quality final product. For this specific


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purpose, we designed a robotic grit blasting machine. Since this type of surface treatment requires working at low pressure and with very fine aluminium oxide (~30 microns), designing and manufacturing a custom media delivery and recovery system has been a real challenge. The working process is essentially very similar to shot peening—either an operator or a robot loads the part on the satellite turntable to start. Since this machine allows both pressure and injection blasting, a robot selects the correct system according to a present program formulated by a technician on the FerroSmartPanel. The process is performed in several steps with different pressure and media flow parameters, which ensures the workpiece meets the specific requirements and is ready for coating. The flexibility of the robot and synchronized working satellite allows the operator to implement this application on parts of differing geometries. Recycling of media is similar to shot peening and it also uses a continuous system. Years of experience and knowledge paid off as we were able to successfully design a special system for fine media. To comply with low-pressure working requirements of around 0.1 bar (~1.45 PSI), we engineered a completely new pneumatic system that delivered perfect results. Due to closed-loop airflow regulation, we managed to stay within tolerances despite the low working pressure. Our continued efforts in research and development paid off, and we managed to combine all these innovation into a truly state-of-the-art machine. The RoboBlast Series features:

- Robotic manipulator
- Synchronized satellite movement
- User-friendly FerroSmartPanel
- Pressure blasting system
- Injection / suction blasting system
- Low pressure blasting – 0.1 bar / 1.45 PSI
- Specially designed media recycling system
- Fine media blasting – 30 microns

All FerroECOBlast shot peening machines are compliant with AMS2430, AMS2432, AMS-S-13165, and Nadcap.

In the last few years, FerroECOBlast has made a big step forward in its technological, marketing and R&D departments. We also started hosting a yearly "Share & Succeed Business Conference" for partners from all over the world where we teach and share new technologies, projects and business opportunities to succeed in different markets and industries. "We are a family company, so we treat our business partners and customers like family members. We believe that trust and respect are of utmost importance for a successful long-term partnership," said Ms. Mojca Andolšek, FerroECOBlast's CEO.

A New Asset for FerroECOBlast

FerroECOBlast has acquired a Bombardier CRJ 200 ER passenger jet. Their engineers are testing some of the components in their laboratory. They will use the parts to develop new technologies and applications which could help improve parts' safety and extend the durability of aerospace materials. The aircraft was transported to the FerroECOBlast headquarters in what was one of the most challenging and extraordinary transports in the history of Slovenia. The jet has already become an attraction and will be used as a very unique meeting room. Ms. Andolšek said, "Too bad we didn't have the space for a bigger plane as we could have hosted our FerroECOBlast Academy aboard it. But having a meeting on a passenger jet is quite impressive on its own!"

RoboBlast Series blasting machine for surface preparation before coating.

The FerroECOBlast team and partners pose in front of the CRJ 200 jet FerroECOBlast acquired for research purposes.

PRESS RELEASE

Sinto Offers Industry 4.0 Solutions and IIoT Analytics

SINTO AMERICA continues on its path to integrate Industry 4.0 Analytics in manufacturing. Sinto America recently introduced their 4.0 Solutions to yet another customer's facility in the United States. (Learn more about Sinto analytics at sintoamerica.com/foundry-analytics-2.)

"We are excited to revolutionize manufacturing through Industry 4.0 solutions and IIoT Analytics. Having a smart plant accelerates performance through digitization which allows for easy interpretation of operational data and gives you the necessary insight to take immediate action to keep downtime minimal," said Jim Wenson, Project Manager for Sinto Analytics.

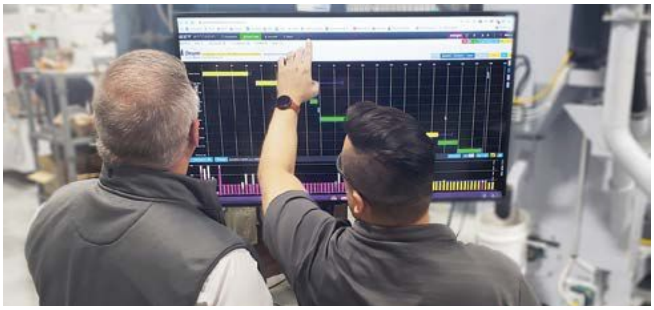
Sinto's analytics allows you to identify failures and downtimes in advance and improve your overall equipment effectiveness (OEE). Industry 4.0 Solution features include:

- Total Process Visibility at a level no one else can provide
- Digitize and visualize every device, motion, and event in real-time
- Simple, visual and immediate feedback
- No additional hardware required
- Single dashboard for all existing and new equipment

Sinto has long strived to be the technological leader in the design and manufacture for all metal casting applications. From standard to custom, simple or complex, or a single piece of equipment to a full system, that's the Sinto difference.

About Sinto America

Sinto America, Inc. is the North American group holding company of Sintokogio, Ltd., Japan. Sinto America focuses on six primary markets: Foundry Mold and Core Making, Sand Processing, Automation, Surface Technologies and Surface Treatment. Sinto also provides contract blasting and precision shot peening services through our National Peening and Technical Metal Finishing divisions and cut wire abrasives through our Frohn North America division. To learn more, visit www.sintoamerica.com, call (517) 371-2460 or send email to sales@sintoamerica.com.



Jim Wenson, Sinto Analytics Project Manager (on the right), teaches others how to run Foundry Analytics on the equipment. Industry 4.0 (IIoT) allows for real time analysis, predictive maintenance and increased productivity.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PRESS RELEASE

Norican Group Americas Expands LaGrange, Georgia Technology Hub

NORICAN GROUP is pleased to announce the expansion of operations at its LaGrange, Georgia Technology Hub. The facility, operated as the Wheelabrator Group Americas headquarters since 1987, offers manufacturing, inventory and logistics capabilities. The planned expansion will move all Norican North America business operations, including Wheelabrator, DISA, StrikoWestofen and Italpresse Gauss, into the LaGrange technology hub.

The company will ramp up current resources to meet commercial operations and administration requirements of all lines of business. Inside sales and customer support activities will join inventory and logistics centralized in LaGrange. The expansion will transfer the current operations of DISA in Oswego, Illinois and StrikoWestofen and Italpresse Gauss in Holland, Michigan to LaGrange.

"We see this move as an opportunity to improve our speed to serve customers and optimize order fulfilment with all capabilities in a single location," said Mike Lewis, Vice President DISA & Aluminum Products. Norican will complete these expansions in the 2nd quarter of 2020.

About Norican Group

Norican Group is home to four leading globally operating brands: Wheelabrator, DISA, StrikoWestofen and Italpresse Gauss. Together, they offer customers around the world a broad spectrum of solutions, spanning end-to-end grey iron foundry equipment, integrated light alloy castings solutions, high-end furnace technology, and surface preparation technology and services.

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The Norican Technology Hub in LaGrange, Georgia, USA.