Volume 22, Issue 3 **Summer 2008**
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The Shot Peener

Dedicated to sharing information and expanding markets for shot peening and blast cleaning industries

The Green Issue

Embrace it. Green can be good for business.

PLUS:

- An Unlikely Partnership
- PRI Launches New Web Site
- Control of Peened Layer Development
- DISA's RDS-Mini Shot Peening Systems

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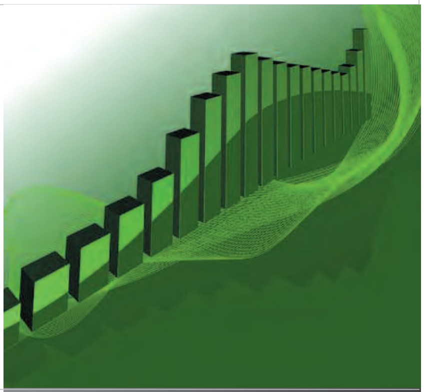

Articles

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Introduction to Green Manufacturing

by Kumar Balan
Wheelabrator Group

A significant shift in manufacturing techniques is being noticed in developed economies all over the world. Smarter and leaner production techniques have displaced inefficient means of production. On a more noticeable level, hybrid vehicles are beginning to populate our roads. The term 'Green Manufacturing' has established itself in the vocabulary of engineers and manufacturing professionals.

What does this mean?

Green Manufacturing is generically defined as 'elimination of waste by re-defining the existing production process or system'. Several other jargons such as 'end-of-line management' mean the same thing. We have all come across company examples that take their problem solving approach to the next level and develop innovative techniques towards effective solutions. Such solutions result in cost savings from reduced work handling, effluent control, process automation, etc. All these efforts are applications of green manufacturing.

This manufacturing concept is not just restricted to addressing the social and environmental impact of a pollution-centric process. Green manufacturing addresses process redundancy, ergonomics and cost implications due to faulty methods of producing goods. Faster and cheaper are no longer the only two criteria in manufacturing a product or evaluating an existing process line. Several other factors such as materials used in manufacture, generation of waste, effluents and their treatment (or possible elimination), life of the product and finally, treatment of the product after its useful life are all important considerations.

How does this relate to the blast cleaning and shot peening industries? Surprisingly, in many important ways! Right from the early days of blast cleaning components, this process has unfailingly generated dust. Every responsible blast equipment manufacturer and operator has, with a great deal of concern, adopted traditional and innovative means to contain, filter and dispose off this dust. This, at the grassroots level, has been our initiation into green manufacturing. History has shown the effectiveness of this process and its implementation in several industry sectors to clean, etch, de-burr and strengthen metal components.

Further development of the technique of blast cleaning resulted in the creation of standards of cleaning and parameters of peening, eventually increasing the application base. There are very few manufactured components that, at one time during their manufacturing process, have not been through a blast machine!

Green manufacturing as it relates to blast machines

Blast machine (cleaning and peening) users will gladly share their experience pertaining to their machines and maintenance aspects. It isn't uncommon to hear comments such as, 'we blast it because our customers insist that we do'. As disturbing as that sometimes sounds to a blast machine manufacturer, it's not far from the truth. However, on further exploration, the true purpose gets clearer.

Casting defects that could have led to scrap parts, potential rejected parts from the customer or even defective finished goods that fail prematurely get revealed at an early stage due to blasting. Premature tool wear is avoided by presenting a blast cleaned part to a machining center. With shot peening, the life of critical aerospace components is enhanced. Closer to home, in the automotive sector, components achieve greater strength when peened, permitting the use of lighter (stronger) components, reducing weight and improving mileage while maintaining reliability. Therefore, users of blast cleaning and shot peening processes play a very important role in everyday life instances.

So, how do all these relate to green manufacturing?
With the above background, consider the following in a macroeconomic environment:

Processing parts through a blast machine reduces incidences of waste in downstream production where these parts are required. Increased life of shot peened components has a direct bearing on eliminating short lived parts that are relegated to waste sites. (It is worth noting that several re-manufacturers of auto components process stators and alternators through a blast machine to clean them prior to re-building for supply to the aftermarket auto industry.)

A clean part offers better bonding, whether it is paint, adhesives or any such coating when compared to a part that hasn't been blasted. The savings in paint and other materials are significant, especially in high-volume environments. Preservation lines, commonly found in shipyards and large metal processing facilities, consist of a pre-heater and blast machine upstream to the paint booth. Plates and profiles are treated through the blast machine and cleaned to a near-white or white metal finish to ensure uniform paint adhesion and consistent dry film thickness (DFT).

Blast cleaning techniques, both manual and automated, are used globally by new and re-conditioned railcar manufacturers. End goals are the same – to minimize paint usage for economical operation. Also included as a goal is the reduction of volatile organic carbons (VOCs) and paint effluents. Hot rolled steel strips are cleaned in a series of blast machines for descaling purposes – a process that could have alternatively been carried out in a series of acid filled tanks, resulting in severe environmental impact when treating the effluent.

Blast cleaning and shot peening
Though the latter is sometimes used when carrying out the former, the differences between blast cleaning and shot peening, and their results are quite significant. Blast cleaning is just that, cleaning a component that has either rust, scale or some such impurity, with an effort to prepare the surface for a future coating stage. The effects are verified by purely visual means specified by SSPC (Society for Protective Coatings).

In comparison, shot peening is a clearly defined process with quantitative results. Components are peened to obtain specific results of intensity and coverage. The subjectivity of results obtained in a cleaning operation is absent in shot peening. Intensity results are checked using Almen strips and then used to plot a saturation curve. Additionally, the process is specification driven by the OEMs in aerospace and automotive. Parameters such as media size, hardness are also stipulated by the OEM.

Cleaning is an art, peening is a science!
Blast cleaning and shot peening can be carried out using either centrifugal blast wheels or compressed air nozzles, depending on the application. Centrifugal wheels are used when processing large surface areas and for higher productivity. Nozzles are used when targeting specific areas in the part and when using non-ferrous media.

So, how does this discussion relate to green manufacturing?
Whether with compressed air nozzles or blast wheels, shot peening requires monitoring and closed feedback loops for critical process parameters such as media velocity and media flow. Except for media velocity, which is controlled by varying the wheel speed in a wheelblast machine, and compressed air pressure in a nozzle machine, other parameters are monitored and controlled using common components in both types of media propulsion systems.

With these controls in place, the wheel or the nozzle receives only the right amount of shot required for peening. This means less waste by way of shot breakdown and reduced dust generation.

In a wheelblast machine, this means the right amperage is drawn and therefore effective utilization of power. Closed feedback loop to ensure optimum shot velocity eliminates waste of compressed air (and the power to generate it). Classification of shot size (using vibratory classifier) and separation of non-rounds in case of steel shot (using spiral separator) result in the correct media type in the machine. This eliminates incidences of re-work.

Peening results are required to be consistent and repeatable. Control of process parameters makes this goal possible and renders the process inherently 'green" in nature.

The discussions so far have revolved around how blast cleaning and shot peening are inherently green. In order to refine this discussion, it is important to consider the following points in the routine use of this process that will maintain its 'green' nature.

Some cleaning and peening processes dictate the use of non-ferrous media such as aluminum oxide, silicon carbide and glass beads. While the first two are more aggressive in their cleaning nature than glass beads, they also breakdown faster and wear cabinet and nozzle parts much quicker than other non-ferrous media. Unless dictated by the process, it is advisable to first try out metallic media such as steel shot or cut wire as alternatives. Ferrous media breaks down at a rate of 0.01% while aluminum oxide under the same process parameters experiences a 7% breakdown rate! Choice of media should be carefully evaluated. What appears as a short term gain may not continue to be so in the longer term.

Conditioned cut wire (CCW) displays greater consistency in size, density, hardness and acceptable shape than cast steel shot. Defect free internal structure results in greater durability. Dust generation with CCW is the lowest among comparable blast media. CCW is rapidly being employed as the peening media of choice

in critical peening applications because of these qualities.

Blast wheel setting (control cage settings determine the point where the media exits the blast wheel housing) is critical in ensuring that the blast media targets and hits the required area rather than blasting areas of the cabinet resulting in uneven wear and wasted energy.

Blast nozzles that are automatically manipulated increase their effectiveness by maximizing their blast pattern in required areas.

Hybrid machines eliminate the need for two separate machines in applications where large surfaces as well as specific areas need to be addressed. The cost savings and savings in utilities and operations need little elaboration.

Blast machines and ventilation

Blasting processes, whether with ferrous or non-ferrous media, generate a lot of dust. Sources of dust include (a) breakdown of blast media and (b) scale or other contaminants dislodged from the component being blasted. By design, blast machines have to be ventilated and the dust filtered in order to avoid contamination of ambient air.

Collectors are available in two types – dry and wet. Dry collectors with cartridge style filters and bag houses with bag (sock) style filters are more commonly used. Wet collectors are required when filtering ventilation air that contains certain hazardous material with a propensity for fire or explosion.

Filtration of dust in itself is a process related to green manufacturing. Further, the following points will help optimize this process:

- A pre-collector (such as drop-out box, cyclone and abrasive trap) to reduce dust loading and reduce the chances of explosion when filtering dust that is explosive in nature
- Design of ventilation system (ventilation volume and static pressure) as per universally accepted standards such as ACGIH (American Conference of Industrial Hygienists)
- Ensure that there are no leaks in the ventilation ducting
- Conduct routine air movement measurements (velocity and flow)

Other developments leading to green manufacturing goals in blast machines

Airblast rooms are the most commonly used manual blast machines. Such rooms employ both full floor and partial floor media reclaim systems. Reclaim systems are comprised of screws and belt and bucket elevators which are driven by gearmotors of different power ratings.

In a typical airblast room with a full floor reclaim system, all the screws and bucket elevator are always in operation. However, the media flow rate generated by even multiple operators blasting simultaneously doesn't warrant operation of the reclaim system continuously. The following could be considered and evaluated for suitability:

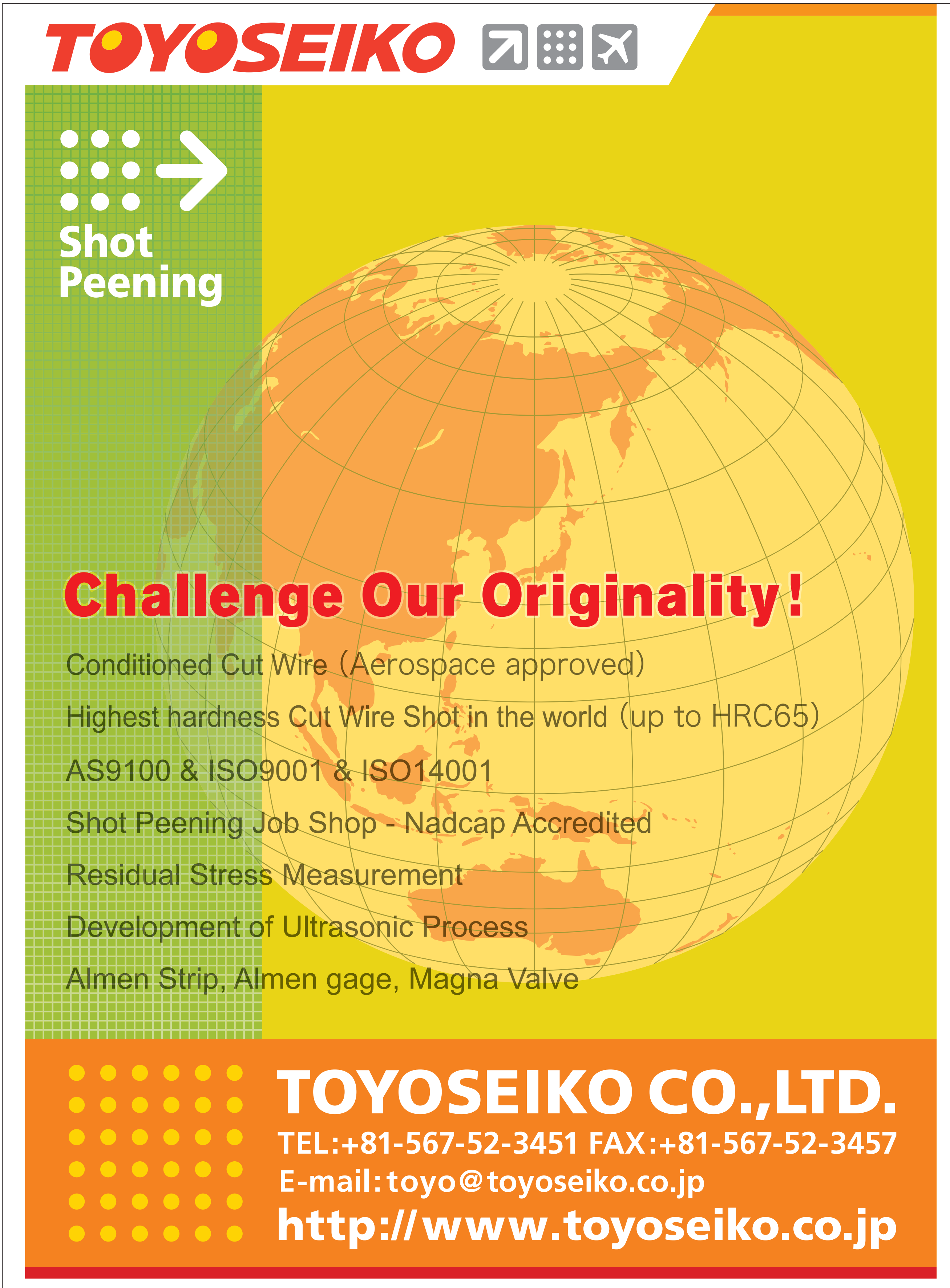
- Partial floor reclaim systems if the production rate isn't very high and a certain amount of manual labor is acceptable
- An 'abrasive on demand' system where the reclaim system operates as needed. A sensor in the media storage hopper senses the level of media and when low, actuates the motors in the reclaim system to turn the lower reclaim system to transfer abrasive to the upper storage hopper area and thereafter to the blast tank. This arrangement results in optimum power usage and reduces wear on reclaim system components.

The future of blast machines in a 'green' manufacturing environment

As green manufacturing gains greater levels of credence, blast machine manufacturers start exploring avenues to augment the production environment with better suited machines. Some of these initiatives include:

- Monitoring power and peak demand of motors with an effort to effectively manage energy (this is particularly important when operating a machine with multiple blast wheels and high HP motors).
- Human Machine Interfaces (HMI) that are highly intuitive and provide real-time information.
- Vibration monitoring to predict behavior and maintenance requirement for bearings and other wear items.
- Sound insulation techniques using sound curtains and other innovative materials (ergonomic operation).
- Reduction in abrasive leakage using aircraft-type profile seals around the door openings.

In summary, green manufacturing is more than a social cause. The benefits of adopting this technique and related costs are easily justified considering the benefits of adoption. In our own scale, in the blast cleaning and shot peening universe, let's innovate and set a precedent for downstream and upstream processes.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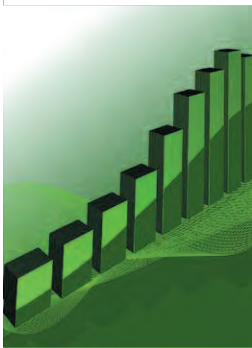

Greener Blasting Pays Dividends

by Jerry Conover
Empire Abrasive Equipment Company

A leading manufacturer of metal products wanted to improve the efficiency of its air-blasting operations in an effort to shrink its environmental footprint and save some green in the process.

Before Empire became involved, six pressure-powered blast cabinets were being operated manually for three shifts, seven days a week to produce a final finish on the company's products. Empire's evaluation quickly uncovered two major opportunities to save energy and money. For starters, none of the cabinets included media-reclamation equipment even though steel shot, a highly durable blast medium, was being used to finish the company's products. Instead, the shot, along with dust and debris, was falling into each cabinet's bottom cone where it would accumulate before being released — again, accompanied by dust and debris — into a pressure vessel positioned beneath each cabinet (Figure 1). As a consequence, the media mix continued to degrade during each blast cycle as more dust and fines built up, resulting in reduced finishing rates with no corresponding reduction in compressed-air consumption. As an alternative, the cabinet operators could recharge the systems with virgin shot during refills in an effort to conserve energy by maximizing throughput, but doing so would have driven up costs for buying and disposing of media. Neither tack was attractive: pushing the media mix past its prime not only wasted time and energy but also compromised finishing quality; discarding tons of perfectly good shot made no sense either.

Problems with Pressure

Adding media reclamation to the capabilities of the current blast system or its replacement presented one obvious step toward the goal of leaner and greener finishing (Figure 2).

A second problem, endemic to all six cabinets, proved to be thornier. As a preface to why, it's important to remember that pressure-blast systems outperform suction systems according to almost any yardstick with one notable exception: continuous operation. Manual pressure cabinets typically spend as much as ten percent of their operating time off line

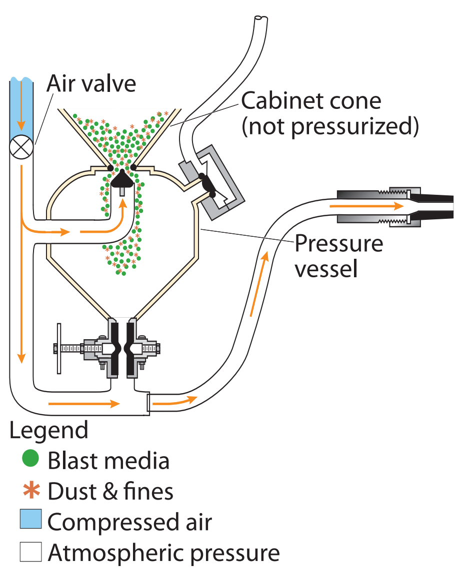

Figure 1 *If shot or abrasives are reused without being cleaned, broken media and work-surface debris degrade the mix progressively with each cycle, which wastes time and energy by slowing work and compromising quality. This drawing also shows why manual pressure-blast systems take time-outs. Because the media-supply vessel operates under pressure during blasting, it must be depressurized during refills. (Arrows show direction of air flow when system is active.)*

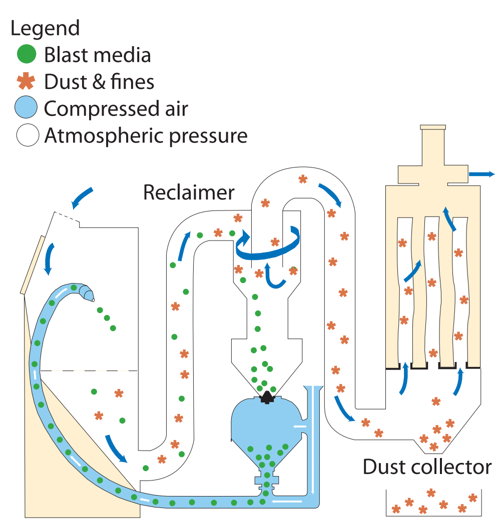

Figure 2 *Cyclonic reclaimers clean media by managing air flow. As air enters from the cabinet, it spirals in a downward vortex, throwing larger particles against the reclaimer's outer wall. Air pulled through the reclaimer's ports by the dust collector forms an upward counter vortex through a center tube that carries out dust and debris while good shot or abrasives drop into a storage hopper for reuse.*

while the pressure vessel within the system is being refilled with shot or abrasives (Figure 1). This drawback can be minimized to a degree by equipping the system with one of the larger, optional pressure vessels offered by most manufacturers of air-blast cabinets or completely eliminated by installing a continuous pressure system, which will be described shortly.

In most cases, the time lost to system refills is a small price to pay for the greater productivity possible with pressure systems. Typically, a pressure cabinet will work three, four or even five times faster than one powered by suction. In this case, however, a minor limitation was causing a bigger problem. Apparently, the control schemes in all six cabinets had been specified with little regard for the specifics of the application. Instead of going into the refill mode only when more media was required — a process normally taking over a minute — these cabinets would go into the refill mode whenever an operator released the on/off foot-treadle control. In certain types of applications this sort of arrangement makes sense but not in one where processing times per part are short and production is continuous. Saddled with inappropriate controls, the cabinet operators adopted the only reasonable procedure for maintaining acceptable production rates. They loaded the cabinet enclosure with as many workpieces as one pressure-vessel's worth of shot could handle and kept the air line open until the media supply ran out. Unfortunately, this pedal-to-the-metal approach wasted a lot of media and compressed air while the operators switched from one piece to the next.

It's worth noting that even the most operator-friendly manual blast systems suffer from inherent inefficiencies. Consider the problem of over-blasting, for example. It represents the norm rather than the exception for a couple of reasons. In a cleaning or finishing operation, an under-blasted part will be rejected while an overworked part will normally go unnoticed. Furthermore, seeing a workpiece clearly amid the airborne dust and media within a blast cabinet is not always easy, so operators tend to err on the side of too much rather than not enough. When blast durations are 15 percent longer than necessary, then 15 percent of the labor, energy and media invested goes to waste.

Answers in Automation

As mentioned earlier, this manufacturer relied heavily on air blasting — six manual cabinets operating for three shifts per day, seven days a week — to repeat the same task, making the application ideal for an automated approach. Consequently, the manufacturer's objectives, constraints and sample parts were turned over to our automation division for a proposal. With the help of our laboratory staff, which evaluates and demonstrates equipment approaches in our state-of-the-art test facility, we developed two machines capable of handling the entire workload.

The blast enclosures each house 36-inch indexing turntables supporting six workstations equipped with fixtures to hold the workpieces. Six nozzles stroking vertically deliver shot in bursts precisely timed to provide the required coverage with a minimum of air consumption. Moreover, the machines exploit the advantage of pressure blasting — but without taking breaks for media refills. By relying on two pressure vessels linked through a programmable controller (Figure 3), the systems finish workpieces continuously. In addition, they include media-replenishing devices that automatically meter new shot into the systems to make up for degraded media extracted during reclamation. As a result, the media mix remains consistent and so do the finishes.

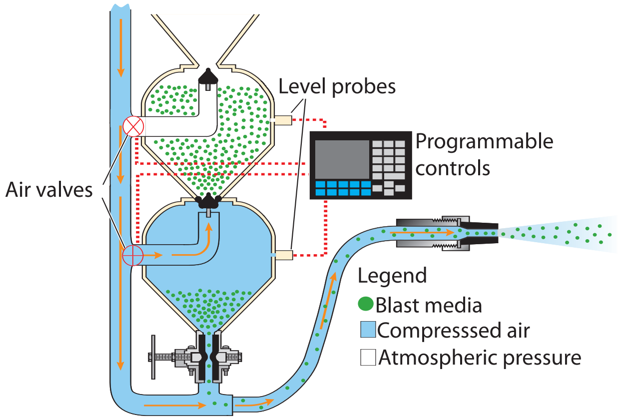

Figure 3 *Two-vessel system eliminates time outs for refills by coordinating pressurizations with media requirements. When the bottom vessel nears depletion, the top vessel pressurizes to supply more media via gravity feed.*

The Green News

By operating these two machines for 20 hours a day, five days a week, the company is able to perform an amount of work that previously required six machines and 144 man hours, seven days a week. At the same time, finishing results have improved, media costs have declined and compressed-air consumption has dropped by approximately 20 percent — green news all the way around!

10 Green Heresies

According to Wired magazine's web site, "Winning the war on global warming requires slaughtering some of environmentalism's sacred cows." The following are 10 "inconvenient truths" that will shake believers and non-believers alike. For the full story on each topic, go to http://www.wired.com/science/planetearth/magazine/16-06/ff_heresies_intro

Live in Cities: Urban Living Is Kinder to the Planet Than the Suburban Lifestyle

A/C Is OK: Air-Conditioning Actually Emits Less C02 Than Heating

Organics Are Not the Answer: Surprise! Conventional Agriculture Can Be Easier on the Planet

Farm the Forests: Old-Growth Forests Can Actually Contribute to Global Warming

China Is the Solution: The People's Republic Leads the Way in Alternative-Energy Hardware

Accept Genetic Engineering: Super efficient Frankencrops Could Put a Real Dent in Greenhouse Gas Emissions

Carbon Trading Doesn't Work: Carbon Credits Were a Great Idea, But the Benefits Are Illusory

Embrace Nuclear Power: Face It. Nukes Are the Most Climate-Friendly Industrial-Scale Form of Energy

Used Cars — Not Hybrids: Don't Buy That New Prius! Test-Drive a Used Car Instead

Prepare for the Worst: Climate Change Is Inevitable. Get Used to It


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Blasting Really Can Be Green!

Our customers have always been keenly interested in energy and media efficiency as media and compressed air are major cost factors in any blasting operation. That interest has been heightened even further in recent years, especially on the part of larger companies, as American industry becomes more focused on reducing its carbon footprint. Toward that end, more companies are being attracted to recycling programs offered by some media suppliers. And that is also why Clemco works with customers to achieve the most efficient use of compressed air in the blasting process as well as the most cost effective media reclaim options.
—Herb Tobben

The Problem:
From day one, in the interest of progress, man has been harming the planet. We are polluting the air, the water, and the land. Unfortunately, it has taken us a long while to realize and accept the wrongs we are committing. We debate about the causes and the fixes for global warming, air and water quality, pollution control, and waste management.

The Solution:
The first step toward the solution is acknowledging the problem; and since everyone is part of the problem, we all must be part of the solution. It was not until 1970 that we formed the EPA to be our watchdog. It's certainly not the be-all and end-all of the solution. We, in industry, have to take the ball and run with it and do our part. I think we are moving in the right direction. But it is a continuous process that takes great effort.

From the perspective of one whose life is devoted to an industrial process, air blasting, I know first-hand that it can be a dirty business. Without following the proper steps, blasting can definitely pollute the air, and the land, and also the water, depending upon waste disposal methods. However, with appropriate engineering controls in place, blasting need not offend in any category.

As a manufacturer, we respond to market needs, which are driven by people who respond to others, the EPA, the various air quality boards, and a host of others. Aside from our marketing responsibilities, we want to be good planet citizens as well. So, we engineer our products to help our customers be good planet citizens.

You wonder how this is so. Well, the blasting industry has many environmentally-friendly facets. Some examples follow.

- Blasting with plastic media came about in response to a need of the United States Air Force to eliminate or at least substantially reduce the use of caustic chemicals as stripping agents to remove paint from aircraft. Using plastic or other lightweight media indirectly reduces pollution by reducing the amount of waste that is stored in landfills or ends up in a waterway. Other lightweight media can be organic, such as starch, corncob, walnut shells, rice hulls, fruit pits or ground corn. These media decompose, further reducing landfill waste. Over the past 25 years, many thousands of aircraft have been stripped with plastic media.
- Dust collection protects air quality and helps prevent air pollution. Common to our industry is reverse-pulse dust collection, which when combined with HEPA (High Efficiency Particulate Air) filtration does an admirable job of reducing air pollution. HEPA filters can remove at least 99.97% airborne particles 0.3 micrometers (µm) in diameter.
- Blast rooms protect the environment by providing an enclosure for the blasting activity. Such enclosures are generally equipped with recovery systems that capture the media and contaminants removed from the object being blasted. Sophisticated recovery and cleaning equipment separates the dust and contamination from reusable media, allowing the media to be recycled sometimes hundreds of times. Recycling media conserves energy by reducing the media consumed. Less media means less fuel used to transport it.
- In blast cabinets or rooms, aluminum oxide media is used for industry or artistry for etching glass as an alternative to chemical etching methods. Glass bead media is used to blast medical parts, eliminating the need for toxic chemicals required for the passivation process.
- Shot peening improves fuel efficiency by reducing friction and increasing oil retention. It is used to improve permissible stress levels of components and therefore prolongs service life of automotive parts. Peening to strengthen parts can reduce vehicle weight, thereby reducing fuel consumption.

I'm sure I could go on and on with all the applications I have seen. I can only hope, however, that we can inspire one another to think twice about how we do work and the methods we use to stay on track toward being environmentally-responsible and saving the planet.

Got a question about shot peening, abrasive blasting, or sample processing? Clemco can help.

Call Herb Tobben at 636 239-8172 or submit your request online at www.clemcoindustries.com Herb Tobben is Sample Processing Manager for Clemco Industries Corp. He is a regular speaker at the EI Shot Peening Workshop.

Maxol Studios
Bringing Art & Science to Industry

An Unlikely Partnership Uncovers Superior Masking Products

When Goodrich Engine Components was looking for a shot peening masking resource, they found an unlikely partner with Maxol Studios. Maxol Studios is known for its industry-leading silicone tooling and resin casting technologies but these processes had been focused on the Rapid Prototyping / Rapid Manufacturing industry. Working closely with Goodrich engineers, Maxol Studios applied their unique and effective tooling and molding talents to create durable shot peen masking from high performance polyurethane casting resins.

Maxol Studios applied a proprietary tooling process developed by owner Mark Schanze in the early nineties. "In 1991, I developed a process for copying surfaces precisely when I was designing respiratory research equipment for the medical industry" says Schanze, "The process starts with a complete understanding of what the engineers' need to be masked by developing a close working relationship with the customer." From there Maxol Studios designs and produces a rigid master with such intimate shut offs that only one metal part can be used for surface duplication. "Because we come from the Rapid Prototyping industry, we can apply all these proven time compression technologies. This means we can turn around some designs with first article delivery within a week." says Schanze. Once the rigid master is finished, Maxol Studios' talent for silicone molding duplicates the precise master tool.

Duplicating the high precision surfaces required to manufacture labor saving masking is one of Maxol Studios stronger points. "Very specific steps have to be followed to maintain close tolerances when dealing with the flexibility of silicone molding," says Schanze, "Fortunately we have been chasing close tolerances with resin cast parts from silicone molds for a long time." By applying proven and effective molding technology to a new market, Maxol Studios is making a name for itself in the masking industry. But the advantage of of precision silicone tooling doesn't stop there. "Our tooling is fast and ingenious, with it we can put masking anywhere and on anything and repeat it over and over" adds Schanze, "And of course the price of silicone molding makes the expense of new tooling almost a non issue especially when spread over hundreds of cast urethane parts." Along with the precision and economics of Maxol Studios' tooling comes the unique ability to over mold and imbed various substrates and actions." With the ability to imbed rigid substrates and sensitive parts, we can design masking to withstand the forces of shot peen blasting," comments Schanze. Maxol Studios uses its high performance silicone tooling to supply industry with the same high performance durable resin cast parts.

Resin casting technology delivers custom molding like qualities based on inexpensive and flexible tooling. Together with a wide range of resin types, Maxol Studios offers high performance masking with urethane and silicone elastomers, rigid urethanes and epoxies, and other ablative materials. Maxol Studios has tuned the urethane resin used for elastomer shot peening and grit blasting to be long lasting and highly accurate. "Maxol Studios masking technology looked very promising from the start" states Robert Horton, Goodrich Engine Componants, "Since then they have continuously provided the most durable products we use."

Maxol Studios is currently expanding their masking technologies by providing masking for grit blasting and thermal spray part processing. "Due to the successful application of our tooling technology to the masking industry, we are focusing 100% on the market" says Schanze "By providing real solutions to difficult and economically sensitive masking requirements we will continue doing what Maxol Studios does best and that's helping industry to become more profitable…so we can too." ●

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Industry News

Process-safe shot peening of valve and small pressure springs with the new DISA RDS MINI

Switzerland. Coil springs, such as suspension springs, valve springs or small pressure springs, are typical work pieces whose endurance and service life are significantly increased by shot peening. Small metal work pieces (valve and pressure springs) can in fact be shot peened in bulk on trough-shaped barrel belts. However, this method does not provide process safety as is often required.

A specific feature of the RDS Shot Peening System is its ability to handle coil springs in a wide range of dimensions including small parts and to treat them individually under uniform and defined conditions in a continuous process. With suitably adapted loading and unloading devices, the shot peening process can be integrated into continuous production lines.

Operating principle

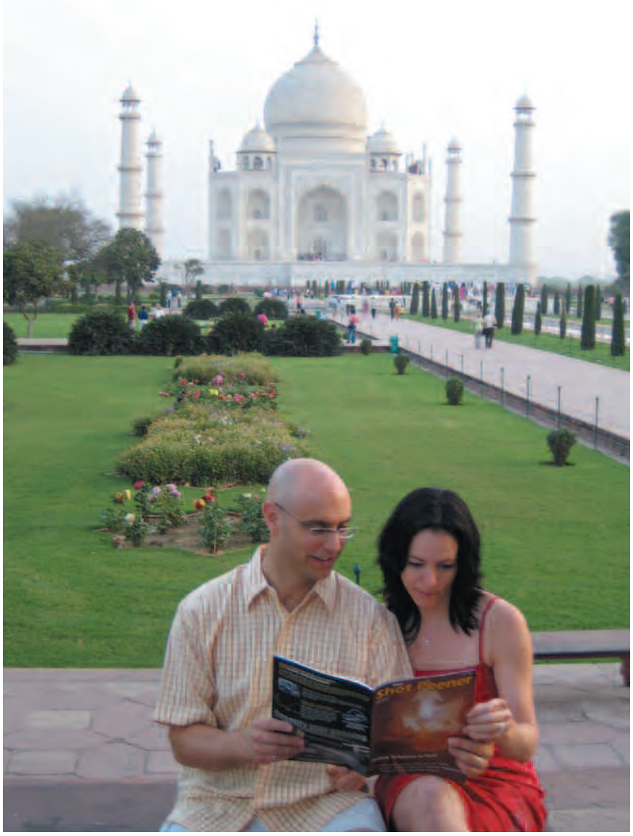
In RDS-Mini Shot Peening Systems, continuously rotating, single work pieces travel on horizontal rollers through the machine. The machines are designed to strengthen valve springs and suspension springs by shot peening at a throughput rate of more than 5,000 springs an hour, depending on relevant requirements. The springs are fed to the machine individually on a straight-line conveyor or other loading systems and then move through the blasting zone on continuously rotating horizontal rollers. Axial movements are effected by cams attached to chains.

Inside the blasting zone the springs are properly guided by adjustable baffle plates which also serve to focus the shot stream on the work pieces for optimal exposure within the "hot spot" of the blast pattern. The parameters of the shot peening process, such as shot quantity, blast wheel speed/throwing velocity, the speed at which the work pieces rotate and the dwell time, can all be regulated to suit the requirements of a specific type of work piece. It is this definition of all treatment parameters that ensures process-safety at all times. Process parameters can be recorded in the control system and retrieved when necessary.

Conclusion

- Shot peening based on the throughput principle is simple and process-safe, suitable for automatic production lines with a continuous work piece flow without intermediate storage.
- Individually adjustable parameters ensure work piece-specific shot peening of the desired quality.
- Automatic systems of high performance and manufacturing consistency reduce production costs.
- A solid machine structure and high-quality machine components ensure long service life and low maintenance costs.

For more information, contact Mr. Hans Jörg Stoll at hansjoerg.stoll@disagroup.com.



*Sylvain Forgues and Brigitte Labelle, Shockform, Inc., take a break from sightseeing to read **The Shot Peener**.*

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Sylvain Forgues and Brigitte Labelle, owners of Shockform, combined a business trip and vacation in India this April. Shockform, located in Quebec, Canada, offers new and emerging technologies in the field of Structural Fatigue Management. While in India, they visited MEC Shot, a shot peening machine manufacturer and distributor.

Jim Chambers, with Surface Improvements, started this fun pursuit when he sent us his photo taken on a Cuban beach. If you want to share your travels with **The Shot Peener**, send a high-resolution jpeg and a brief description of your trip to jack.champaigne@electronics-inc.com. We look forward to hearing from you!

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Control of Peened Layer Development

Dr. David Kirk is a regular contributor to The Shot Peener. Since his retirement, Dr. Kirk has been an Honorary Research Fellow at Coventry University, U.K. and is now Visiting Professor in Materials, Faculty of Engineering and Computing at Coventry University.

INTRODUCTION

The prime objective with shot peening is to induce a well-developed protective surface layer of plastically-deformed material. This layer has two important properties: compressive residual stress and work-hardening. Both of these properties act to improve service performance of components. Development of the layer proceeds with increase in amount of peening until it has stabilized in the required thickness range. Fig.1 represents, schematically, the development of a peened surface layer.

Control is needed in order to ensure that the layer is fully-developed, has the required thickness and is not over-peened.

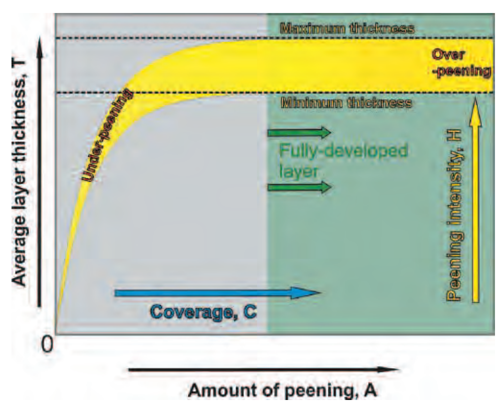

Fig.1. Development of shot-peened surface layer.

There are two primary control parameters:

1 **Peening intensity**, **H.** Peening intensity (also called "Saturation Intensity") controls the thickness of a fully-developed peened layer. The average layer thickness, **T**, is proportional to the average diameter, **d**, of the indentations produced by impacting shot particles. **d**, in turn, depends on the peening intensity that has been specified. Hence:

T α H

Peening intensity has to lie between specified minimum and maximum values – with corresponding minimum and maximum layer thicknesses.

2 **Coverage**, **C**. The development of the layer is gauged by the coverage of the surface by indentations. Coverage depends on the **amount of peening**, **A**, which has been applied. The amount of peening, **A**, is the number of indentations per unit area of peened surface, **n**, multiplied by the average area of the individual indentations, **a**. Hence:

A = n*a

Coverage, **C**, is proportional to the amount of peening, **A** so that:

C α A

Peening intensity is readily quantifiable and measurable – using sets of Almen strips. Coverage is easily quantifiable (being simply the percentage of surface area that has been covered by indentations) but measurement is relatively difficult – particularly on the shop floor.

This article is an over-view of the control of layer development – using peening intensity and coverage. Peening intensity control has been very adequately covered by other authors and by published specification documents. Coverage control, on the other hand, still presents problems. Coverage control requires knowledge of the required component coverage. There are several 'ad hoc' definitions used in the shot peening industry. These are generally based on the imprecise concept of '100% coverage' as being a level at which unpeened areas are not detected using low-power visual inspection. Following that concept we have terms such as '200% coverage' - requiring that peening is continued for twice as long (or for twice as many passes) as that required to achieve so-called '100% coverage'.

LAYER THICKNESS CONTROL

Peening Intensity and Peened Layer Thickness

Peening intensity is the arc height, **H**, of an Almen strip peened to the 'saturation point'. **There is a direct, almost linear, relationship between peening intensity and fully-developed peened layer thickness of a component.** This relationship and the allowance for component material hardness are illustrated schematically in fig.2 (page 26). At any specified peening intensity, **h**, the layer thickness will be greater for a component that is softer than Almen strip material. For component material that is harder than Almen strips the layer thickness will be

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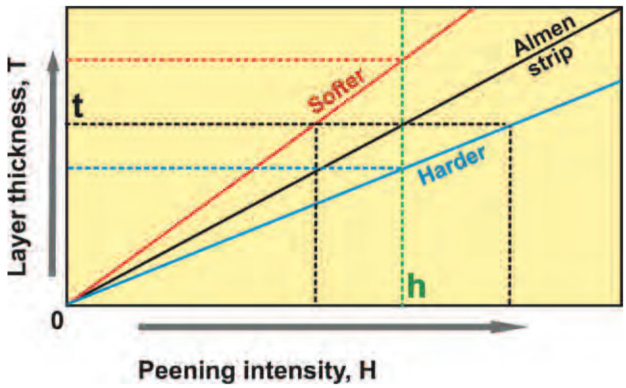

Fig.2. Effects of peening intensity and relative component hardness on fully-developed layer thickness.

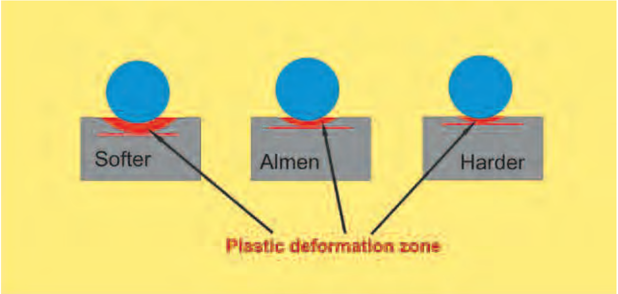

Fig.3. Effect of component hardness on depth of plastically-deformed surface layer.

less than that developed in the Almen strip. It follows that in order to achieve a specified layer thickness, say **t**, that a greater peening intensity is needed for harder materials than it is for softer materials.

Peening intensity is a direct measure of the indentation capability of the flying shot particles. The size of the indentations that will be made on the surface of the component increases with increasing peening intensity. The harder the component the shallower will be the deformation zone created by a given impacting shot particle. This is illustrated in fig.3.

A fully-developed peened surface layer consists of merged individual deformation zones. Hence, softer materials will develop a thicker deformed layer than will harder materials - for a specified Almen intensity. That explains the difference in slope of the lines shown in fig.2.

Control of Peening Intensity, H

We need to control peening intensity – if only to satisfy inspectors! Peening intensity depends upon a number of factors but only two are under the direct control of the shot peener – the others being pre-specified. These are shot velocity, **v**, and shot diameter, **D**. Users may have specified a particular type and size of shot e.g. S230 but that does not mean that the shot diameter is constant. Shot wears down progressively to smaller diameters and it is standard practice to add a proportion of new shot at intervals. This new shot has a larger average diameter than the worn shot of the same grade. Control therefore depends upon appropriate admixture regimes.

To a first approximation peening intensity, **H**, for a given set-up, is given by:

$$H = K*D*v^{0.5} \qquad (1)$$

where **K** is a constant.

D, as mentioned earlier, depends on our shot maintenance regime (based on shot additions and re-cycling). **v** depends mainly upon air velocity/wheel speed but is also affected by such factors as nozzle wear and shot flow rate. Nozzle wear must therefore be monitored and shot flow rate carefully controlled.

It follows from equation (1) that changes in shot diameter are more significant then changes in shot velocity. For example a 10% increase in shot diameter will give a predicted 10% increase in peening intensity. A 10% increase in shot velocity, on the other hand, will give only a 3% predicted increase in peening intensity ($\sqrt{10} = 3{\cdot}14$).

A wide range of shot sizes is available. For each shot size there is an appropriate range of peening intensity - which determines the corresponding layer thickness range. This is illustrated schematically in fig.4. **A very important feature is that peening intensity, layer thickness and shot diameter all vary by an order of magnitude (10 to 1)**. It is no coincidence that there are three thicknesses of Almen strip (N, A and C) that also cover a sensitivity range of 10 to 1 (approximately). Specifications indicate that a given Almen arc height obtained on an N strip is 3 times that which would be given by an A strip and that a given Almen arc height obtained on an A strip is 3·4 times that which would be given by a C strip. Hence **N:A:C = 10·2:3·4:1**. Fig.4 indicates that N strips are suitable for the smallest intensities/layer thicknesses/shot sizes whereas C strips are suitable for the largest. For each available shot size there will be a range between allowed 'minimum' and 'maximum' values of the specified peening intensity. This range recognizes the impossibility of guaranteeing a precise peening intensity value using commercial facilities (shot size and velocity must vary to some extent - even with the best control equipment).

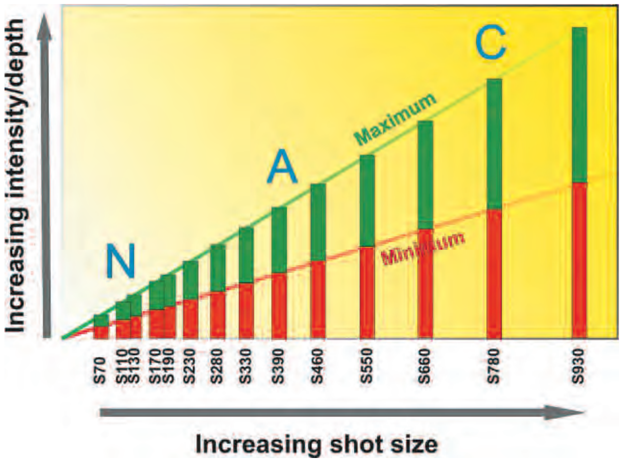

Fig.4. Influence of shot size on normal minimum and maximum specified peening intensities.

Shot velocity is the major factor used by shot peeners to control peening intensity/layer depth. The depth of a fully-developed peened layer is indicated by equation (1) as being proportional to the square root of the shot velocity. This variation is illustrated in fig.5 (page 28).

It is worth noting that, within the normal commercial range of shot velocities, A to B, the variation is almost linear. Departure from linearity is only acute at very low shot velocities.

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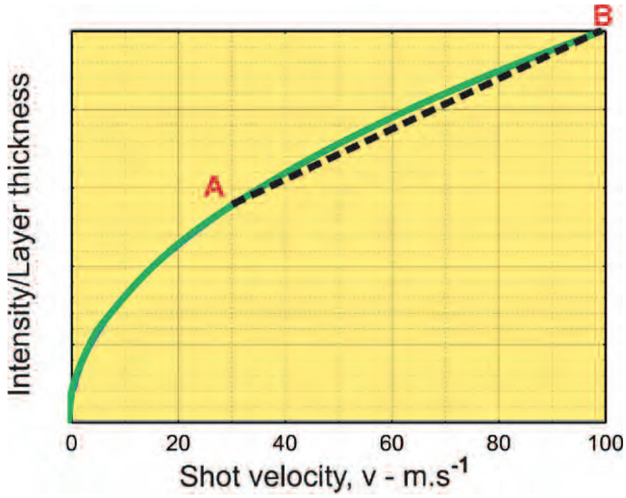


Fig.5. Variation of peening intensity and layer thickness with velocity of shot.

CONTROL OF THE AMOUNT OF PEENING

Coverage, C, versus Amount of Peening, A.

Coverage is a measure of the amount of peening that has been applied to a component. 'Amount of Peening', **A**, is the total area of the indentations imposed per unit area of the component. Hence:

$$\mathbf{A = n*a} \quad (2)$$

where **n = number of indentations per unit area** and **a = average area of the n indentations.**

For example, if we impose **240** indentations having an average area of **1**mm^2 on an area of 100mm^2 then the amount of peening, **A**, is **2·4** (240*1mm^2/100mm^2). Control of **A** is normally effected by varying **n**, the number of indentations per unit area. The average area, **a**, is normally pre-determined by the peening intensity and the hardness of the component.

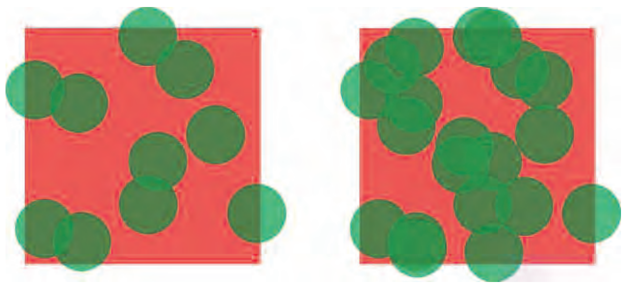
Coverage, **C**, is the proportion of area that has been indented. Its value is determined by the amount of peening that has been applied. However, **C** does not have the same value as a corresponding value of **A**. If, for example, **A% = 100** then **C% = 63** (reason given later). The basic problem is that indentations have an annoying habit of overlapping one another – the more so as coverage increases. Hence we do not have a linear relationship between amount of peening, **A**, and coverage, **C**. The cause of the difference between amount of peening and coverage is illustrated by fig.6. The amount of peening is exactly doubled in (b) as compared with (a) but the coverage is less than doubled.

Numerous experiments have shown that the actual variation of coverage with amount of peening closely approximates to what is known as an "Avrami curve". This is illustrated in fig.7.

The curve shows that **coverage increases at a decreasing rate** – eventually approaching 100% very slowly. An Avrami curve has a corresponding equation that describes it. A useful form of the equation for shot peeners is:

$$\mathbf{C\% = 100[1 - exp(- p*A)]} \quad (3)$$

where: **C** = coverage, **p** = number of 'passes' and **A** = total area of indents per pass per unit area of component (amount of peening per pass).



(a) 10 indentations (b) 20 indentations

Fig.6 Representation of (a) ten and (b) twenty indentations randomly distributed in a unit area.

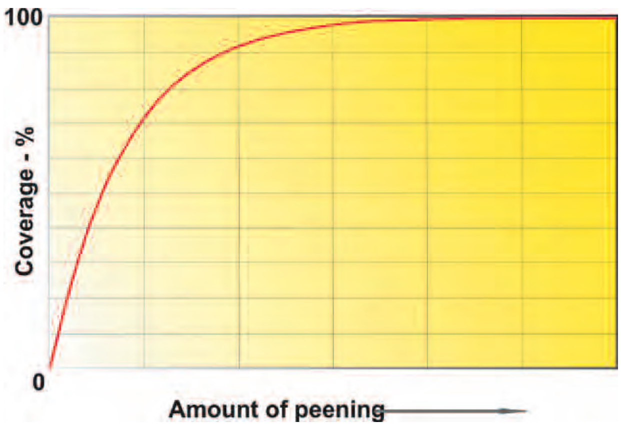


Fig.7 Avrami curve representation of coverage variation with amount of peening.

Equation (3) can be re-written as:

$$\mathbf{p*A = - ln[(100 - C\%)/100]} \quad (4)$$

where: **ln** stands for 'natural logarithm'.

Equations (3) and (4) represent vital relationships between coverage and amount of peening.

Direct Coverage Control

Direct coverage control is based on measuring the actual coverage and modifying the amount of peening in order to achieve a target coverage value.

The simplest technique is that of 'trial and error'. The amount of peening is increased in stages until the component is adjudged to have reached a nominal '100%' coverage. Coverage measurement is then based on a subjective visual judgment that '100%' has been attained.

A much more efficient approach can be applied if objective quantitative coverage measurement is available. Equations (3) and (4) can then be used to predict the changes in coverage that result from more and more passes being made of a shot stream over a component. **All we need is one, reasonably-accurate, measurement of the actual coverage achieved**. Let us assume that our standard practice is to make several passes of a defined shot stream over a particular component. We measure the coverage after the first pass (**n = 1**) and find that it is, say, **58%**. Substituting **p = 1** and **C = 58** into equation (4) gives that **A=0·87**. We can now substitute **0·87 for A** in equation (1) to give: **C% = 100[1-exp(-0·87*p)]**. Substituting different values for **p** then gives us the predicted coverage percentage for each of a number of passes. Fig.8 is pasted from an

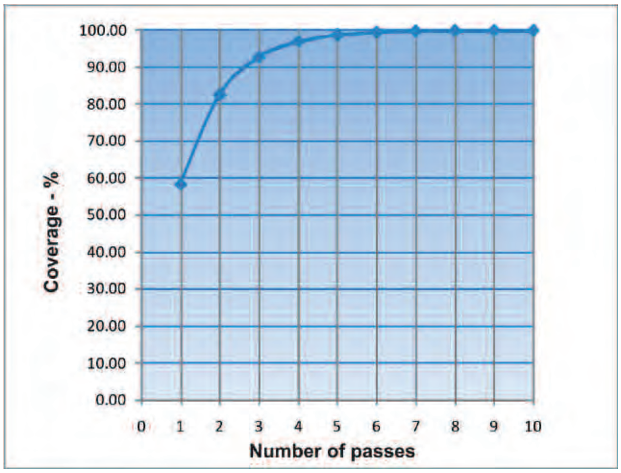


Fig.8. Automatic prediction of Coverage versus Number of passes.

Excel spreadsheet that does all of the arithmetic and graph plotting. Only the measured value (58%) has to be entered into the spreadsheet. The spreadsheet values are also given in Table 1.

Consider, for example, that a user has specified 99·8% actual coverage. This can be achieved, to the nearest decimal point, by applying seven passes to the component used for the data derived in Table 1. Eight passes would definitely satisfy the specification and would allow for a certain amount of process variability. This depends, however, on a reasonable maintenance of the defined shot stream parameters: velocity, size, material, feed rate, etc. that regulate average indentation area, **a**.

If the predicted/actual number of passes required is considered to be excessive then we must vary the amount of peening per pass.

Table 1. Predicted coverage values at different pass numbers.

No. of Passes	Coverage - %
1	58
2	83
3	93
4	97
5	98.7
6	99.5
7	99.8
8	99.91
9	99.96
10	99.98
A-value 0.87	

Varying the Amount of Peening

The amount of peening per pass, **A**, can be varied by changing either **n** (number of indentations per unit area) or **a** (average area per indentation) or both. **n** can be changed by varying either the nozzle movement rate or the shot flow rate. **a** is, however, prescribed by the peening intensity and hardness of component.

Example: Referring to the values given in Table 1 we can expect that doubling n would have the same effect as using two passes. Hence we expect that we would then get a coverage of **83%** in one pass - with a corresponding **A** value of **1·74**. That is only true, however, if we have adjusted air-pressure/wheel-speed to maintain the same shot velocity and hence indentation area, **a**. Assuming that we have done that, then we should get near to 83% coverage in one pass. **83** then substituted for **58** in equation (4). Four passes will then be predicted as applying 99·91% coverage. **A** is now **1·743** for 83% coverage in one pass. We should, however, actually measure the coverage achieved in one pass with the doubled flow rate – just to be sure.

a can be changed by varying the average indentation diameter, **d**. Since $\mathbf{a = \pi * d^2/4}$ then, using the value of **d** predicted by equation (1), we have that:

$$\mathbf{a = P*D^2*v} \quad (5)$$

where: **P** is a constant, **D** is shot diameter and **v** is shot velocity.

Equation (5) predicts, for example, that doubling the shot velocity (other parameters remaining constant) will double the average area of the indentations. That, in turn, means that the amount of peening per pass, **A**, will be doubled.

LAYER EVOLUTION CONTROL USING SATURATION 'TIME'

The primary function of a saturation curve is to indicate the 'saturation intensity'. This gives us our direct measure of layer depth potential. Saturation intensity occurs at a 'saturation time', **T**.

T corresponds to the amount of peening that was needed to reach the saturation point for flat Almen strips. Experience may lead users to be confident that the amount of peening that corresponds to some multiple of **T** will give a satisfactory layer evolution if applied to a particular component. This approach is crude but pragmatic. Its great attraction is that we have a readily-available, objective, quantitative, measure of an amount of peening. Three factors must, however, be borne in mind:

1 Components normally have a different hardness from that of Almen strips,
2 Components are not flat Almen strips - they will certainly have a different geometry and
3 At the saturation point the deformed surface layer of an Almen strip is not 'fully-developed'.

Taking the three factors in isolation:

1 Hardness. The average area of an indentation, $\pi d^2/4$, is inversely proportional to the square root of the hardness of the component (other things being equal). In order to achieve the same amount of peening of a component, $\mathbf{A_c}$, as has been applied to the Almen strips, $\mathbf{A_s}$, we can use the equation:

$$\mathbf{A_c = A_s * \sqrt{(H_s/H_c)}} \quad (6)$$

where $\mathbf{H_s}$ is strip hardness and $\mathbf{H_c}$ is the component's hardness.

As examples: if the ratio of hardnesses is 4:1 then A_c would be doubled and if it is 1:4 then AC would be halved.

2 Geometry. Life would be much easier for shot peeners if all components were simple rectangular blocks. In reality, a great deal of expertise has to be applied in order to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ensure that complex-shaped components receive full peening coverage. Specifications require, however, that the Almen strips used for saturation curve determination are in relevant positions. It is, of course, impossible to generalize about the effect of component geometry on degree of coverage. Doubling the amount of peening to **2T**, would be sufficient to allow for most geometrical shapes. One exception would be the well-known situation of deep-hole peening.

3 **Layer development at T for Almen strips.** A full discussion of this factor would require (at least) a complete article. As a guide it is simply suggested that at **2T** we have fully-developed layers on Almen strips.

Example of considering all three factors together (rather than in isolation):

A typical component having a hardness only a quarter of that of Almen strips would approach full development of the peened surface layer at **2T**. That estimate is based on allowing the amount of peening to be halved because of hardness, then doubled to allow for geometry and then doubled again to allow for the fact that Almen strips do not have a fully-developed layer at **T**.

It must be emphasized that predictions of required amounts of peening must be confirmed by actual inspection.

Confirmation of Coverage Attainment using Saturation 'Time'.

Let us assume that we have a particular set-up for which we have established the minimum amount of peening, **B**, that will give the required level of coverage. That minimum amount of peening has been found, for example, to correspond to a peening 'time' of **1·8T** (which might be the equivalent of, for example, **4·6 passes**). We now know that we can reach the required coverage level by applying **5 passes** – provided that the conditions that gave the measured T value are maintained.

DISCUSSION

This article has attempted to show that we can exercise effective control of peened layer development provided that we separate layer thickness control from layer evolution control. The 'Golden Rules' are:

1 **Layer thickness is controlled by applying a specified range of saturation intensity and**

2 **Layer evolution is controlled by applying a specified amount of peening.**

Layer thickness control is exercised effectively by deriving a saturation curve for each production set-up. Saturation curve testing is well-established, reliable and objective. Layer evolution is generally monitored by determining the amount of coverage that has been applied. The only specified procedure (to the best of the author's knowledge) is that of so-called "100% coverage". This is highly subjective and is based on an individual's opinion that there are no detectable unpeened areas. It follows that there must be a significant difference between "100% coverage" and true 100% coverage.

The procedures proposed in this article for objective layer evolution control are based on making coverage measurements well below '100%' – ideally in the region of 50% which gives optimum accuracy. Coverage changes close to a true 100% value are virtually impossible to detect. It is no coincidence that several patented methods of coverage inspection have been developed. Perhaps the best known of these is "Peenscan" which involves a fluorescent lacquer being peened off and any residue being detected using UV light.

The great problem with conventional visual coverage inspection is that human eyes (and camera lenses) accept reflected light from a variety of angles. This makes it extremely difficult to differentiate between an indentation and surrounding 'rumple zones'. Visual inspection is, however, very useful for detecting substantial under-peening and macro variation of coverage.

Effective control of layer evolution leads to higher productivity. If we can apply the optimum amount of peening we can avoid both under-peening and over-peening. Over-peening is all too prevalent with its consequential effects on increased shot breakdown, wasted peening time and surface property deterioration.

Characterization of peened surfaces will be the subject of the author's next article. This will include a novel, low-cost, objective, layer evolution detection procedure.


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With input and approval from quality industry leaders such as Alcoa, SAE International, Goodrich, Honeywell Aerospace and Rolls-Royce plc, eQuaLearn offers professional development courses in subjects such as Internal Auditing, Root Cause & Corrective Action and Introduction to Pyrometry.

PRI Launches eQuaLearn.com for Quality Industry Professional Development

On April 15, 2008, as part of their Customer Solutions and Support Initiatives, the Performance Review Institute (PRI) launched www.eQuaLearn.com, a new website dedicated to sharing information on Professional Development courses for quality industry professionals.

This new, dynamic and interactive site supports eQuaLearn courses including:

- **Internal Auditing** - Course is a two-day program designed to meet the needs of the Internal Audit Manager and Internal Auditor.
- **Introduction to Pyrometry** - Course is a two-day program designed to provide an in-depth review of the AMS2750D specification.
- **Root Cause Corrective Action** - Course is an one-day program designed to teach participants how to analyze problems and determine long-term solutions.
- **On-Site Learning Solutions** - Bring any of PRI's professional development programs to your company. You can train your employees at the location of your choice and customize the learning to meet your objectives.

Watch for new courses in Problem Solving and Mistake Proofing, Contract Review, Introduction to Quality and more. Currently, course fees are $250 to $600 and include all materials, breakfast, lunch and a course completion certificate.

Classes are held throughout the world with multi-lingual instructors to better serve the customers' needs. Administration is handled by the PRI sector offices in the Americas, Europe and Asia, allowing the instructors time to focus on the students. This also facilitates 24-hour customer service availability.

"To launch eQuaLearn, PRI has worked to develop an exceptional learning and performance management solution. This enables PRI to focus efforts on developing excellent quality industry professional development courses for international clients and consolidate PRI's position as a leader in quality training. This user-friendly online system gives customers greater control at their convenience," said Arshad Hafeez, Director of Global Business Operations at the Performance Review Institute.

Customers and Training Managers interested in improving Quality while guaranteeing business results can book and pay for courses online, participate in online training sessions from the comfort of their own desks, check their own training records – and those of their direct reports – and partner with PRI to develop customized courses and individually branded training websites based on www.eQuaLearn.com.

The web site also has a library with tips, articles and resources to help you and your business succeed. Some of the topics covered in the library include:

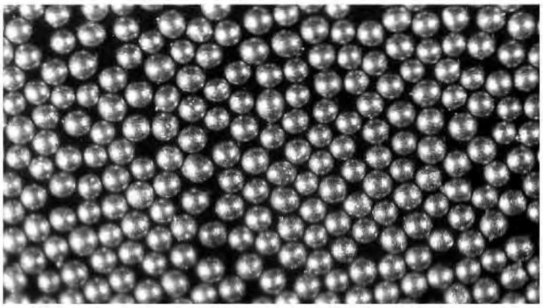
- **Internal Audit Preparation Tips**
- **Components of Quality**
- **Learning Keeps your Brain Young**
- **How to Get the Most from Training**
- **Study on Talent Management**

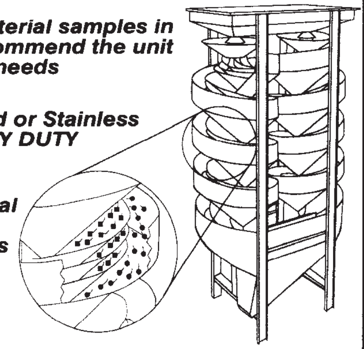
If you are attending AeroEngine Expo 2008 this fall in Paris, make sure to stop by the eQuaLearn exhibit. The exhibit will be free to attendees that register before the deadline. Visit www.aeroengineexpo.com.

To provide service across the world, eQuaLearn is recruiting instructors and subject matter experts to teach and develop programs. eQuaLearn Instructors:

- Travel the world as subject matter experts and work from their home
- Receive a competitive daily rate and are guaranteed timely payment
- Manage their own schedules and choose when they want to work

An pre-screening application is available at the web site.





The following is the paper's introduction—the paper is available in its entirety at The Shot Peener online library at www.shotpeener.com/library/index.html.

Relating Shot Peening Process Parameters to Residual Stresses – A Computational/Stochastic Marriage

Shot peening is a surface engineering treatment used to push the fatigue resistance of metals beyond their natural ability. This is achieved through the induction of near surface compressive residual stresses and (or) cold work. The first creates a virtual environment of lower macro-strains compared to those from the farfield source, while the second will either locally increase the dislocation density creating a difficult obstacle for further dislocation movement or, if severe, will deformed the grains minimising the distance between the grain boundaries. Of course there are additional benefits due to interactions between residual stress and cold work, i.e. when the crack propagates inside the cold work area; the plane favouring dislocation motion can change. Another interaction product comes from the increase in the plasticity induce closure for long cracks. Of course it is important to mention that there are also detrimental effects, in terms of fatigue performance; namely, surface roughness creating an amplified stress field and excessive cold work leading to loss of ductility and incorrect distribution of residual stresses leading to premature relaxation. The enhanced stress field, due to surface roughness, can overshadow part of the residual stress field and deliver reduced fatigue performance, especially when the application targets the region of high cycle fatigue. In addition, it can increase the natural scatter of the material in terms of fatigue life. The latter depends on the triangle grain size distribution, surface condition and type of loading. As a result, shot peening can cause an irregular performance which is beyond the design principles for which the material was first chosen. The reader here should keep in mind that there is limited knowledge relating material selection to shot peening and hence unless critically assessed, shot peening might not deliver the maxima. A second problem relating to surface roughness is the average grain size of the material. Herein, fine grains are more sensitive to roughness and usually deliver a less favourable result. Similarly, cold work, both in terms of profile as well as in terms of value, should be specifically designed in order to meet specific requirements. It is of outmost importance to understand that: a) material with natural tendency to cyclic hardening can react badly to increases in the dislocation density; b) the irregularity caused in the development of local plastic strain can significantly affect residual stresses relaxation, etc. The third and equally important factor is related to the geometry of the component and the expected type of fatigue crack. Herein, improvement from shot peening can be found simply by changing the geometry of the generated crack. In other words, we can select the shot peening parameters in order to enforce specific crack geometry with slower a propagation rate. Of course the above is decisively related to the specific industry and engineering component. For example, in the automotive industry where most components operate under conditions of fail safe, increases in the fatigue limit are mostly required. In this case, the engineer should be in a position to select the shot peening parameters so as to provide a crack shape which is most likely to be arrested (fatigue limit). On the other hand, the aerospace industry, with well established inspections, will benefit from crack geometries allowing them to minimise the cost of maintenance.

For many years, all the above have been examined through Almen strips, saturation curves, and coverage. Yet, the above parameters are not necessarily related to either the residual stresses or cold work. There are numerous examples where the selected parameters have not performed as expected. It is therefore important to realize that in order to move away from the time and money consuming process of trial and error, a more scientific procedure should be developed. Computational mechanics is a rather straightforward tool to replicate the mechanical phenomena involved. However, its simplicity can lead to unprecedented and erroneous results if all the phenomena characterising the process are not considered. Herein, the reader can find numerous cases and written scientific reports with unsuccessful results. Perhaps the problem is related to the large number of shot pellets constituting the shot stream. A typical Almen A strip can theoretically receive up to 200,000 shot impacts in one pass. Yet, its true coverage will never achieve 100% since shot interaction, deflections, and turbulence will minimise their impact energy, initial impact angle, contact time, etc. The number of shot pellets is so big as to prevent any deterministic approach and hence the use of stochastic theories is necessary.

In this work the authors try to examine a stochastic methodology able to provide the necessary information to feed a computational model for the prediction of residual stresses. The work represents an on going collaboration for the development of an in-house code for Superior Shot Peening, Inc. to be able to predict the optimum SP parameters as a function of material and operational stress/environment envelop.

**The cost of energy is a big part of the operating budget for metalcasting facilities, and any reduction in energy consumption results in direct bottom-line savings.
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It Takes Energy to Go Green

If foundries are thinking about the environment, then you know green is the new reality. In the past, blast cleaning operations in foundries have been able to consume vast quantities of energy and media with little regard for the costs.

Electronics Inc. had an exhibit at the recent CastExpo '08 (CastExpo is the joint exposition of the American Foundry Society and the North American Die Casting Association). The MetalCasting Congress, held in conjunction with CastExpo, held workshops and lectures on the U.S. dependence on oil, rising fuel costs, and climate change legislation. I took away these impressions from CastExpo:

1. It's energy costs, more than anything else, that are forcing U.S. manufacturers to change the way they operate their facilities and processes.
2. Going green will take hard work with potential high costs for manufacturers, especially U.S. manufacturers.

To be honest, we didn't see many U.S. companies marketing green attributes either in their manufacturing processes or products at CastExpo. However, we were impressed with Sintokogio's booth and media presenation on their "factory of the future". Like many large Japanese companies, Sinto is making a considerable investment to create facilities and products that are environmentally-responsible. Consequently, they will be the first to reap the benefits.

We exhibited the MagnaValve at CastExpo and received a terrific response, mostly because it eliminates downtime and the subsequent high labor costs. Reducing labor costs are key to making foundries competitive and meeting production schedules. The MagnaValve reduces energy and media usage but, interestingly, that wasn't as enticing as the maintenance reduction.

We picked up a nice flyer from Pangborn that promoted blast equipment rebuilds and retrofits and it struck me that "The Affordabale Alternative to Buying New Equipment" is also environmentally-responsible because it keeps older equipment in the work cycle and the updates make the machine's operations cleaner. The subsequent improvements in production time reduces energy costs, too.

It seems to me that if your products and processes are environmentally-sound, you should start marketing them as such. A recent survey of manufacturers commissioned by Dow Corning revealed that eight out of 10 companies globally say that environmental and sustainability factors are taken into account when they select suppliers.[1]

And here's an interesting concept from an online article—the high cost of fuel could affect globalization. In fact, the cost of transporting steel from China has been a boon to U.S. steelmakers. How would your busines be affected if your marketplace becomes smaller?

Yes, it does take energy to go green. Just trying to stay informed can be overwhelming. *The Shot Peener* staff will continue to share success stories and insights. As supporting industries to aerospace and automotive companies, we will have to work to be viable, but I'm confident that blast cleaning and shot peening have a place in a lean, green economy.

[1]Industry Week, December 2007

Don't forget, ICSP10 is going up soon: September 15 - 18 in Tokyo, Japan. Go to www.icsp10.jp for more information. Now is the time to make travel arrangements.