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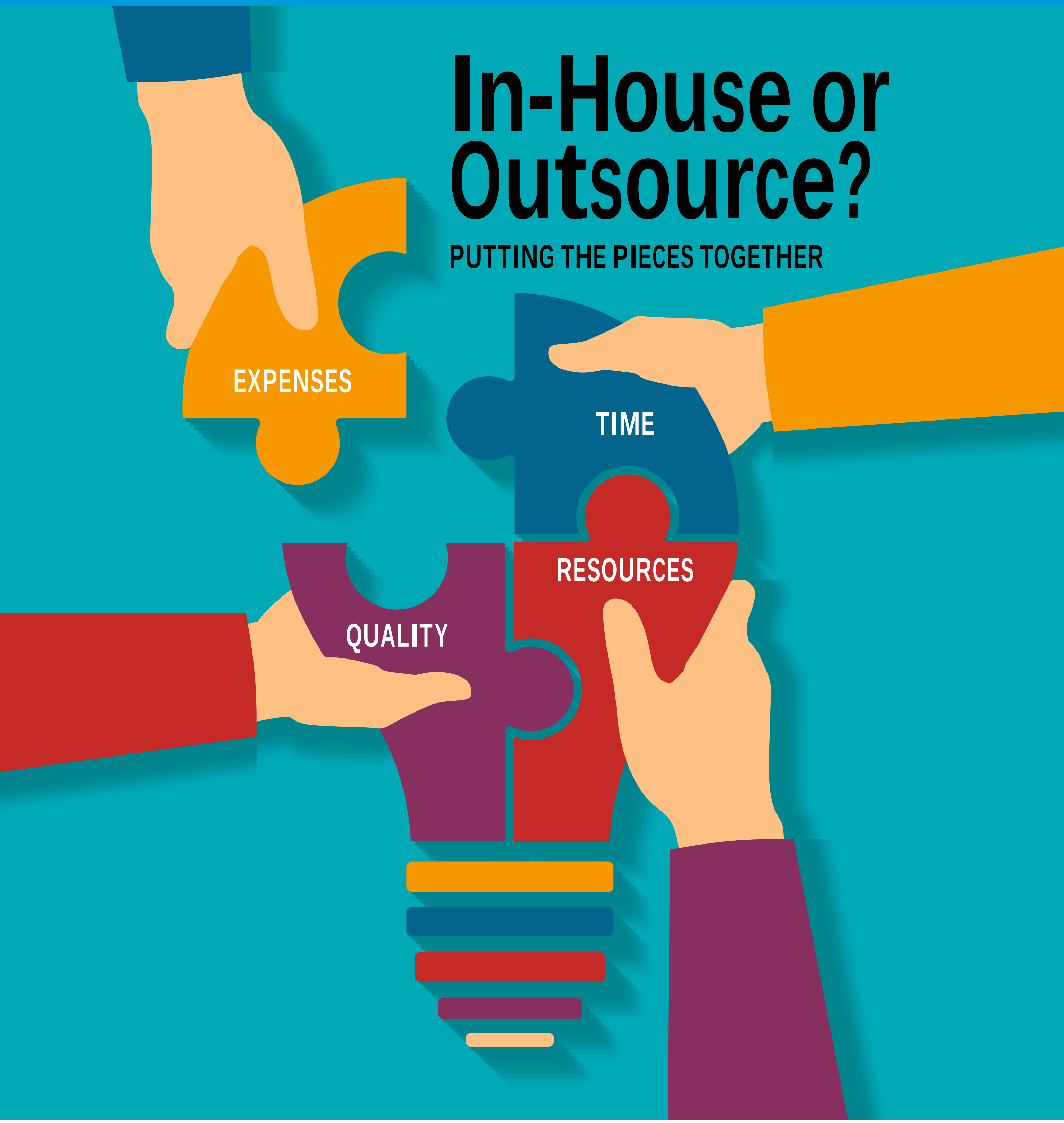
The Shot Peener

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

In-House or Outsource?

PUTTING THE PIECES TOGETHER



PLUS: WHAT REALLY MATTERS | THE MAGNAVALVE: JUST A BLACK BOX? | ALMEN STRIP CURVATURE STUDY

Peening Innovation

COVERAGE CHECKER

COVERAGE CHECKER

COVERAGE CHECKER the device for easy and precise coverage measurement

Coverge Measurement Device

Easy USB connection to your PC

※PC is not included ※Device image

- Automated coverage inspection eliminates human error
- Multiple operators will get consistent results
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- A nozzle is available to measure coverage in the interior walls of holes
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- USB connection to your PC (USB cable is included)
- Compatible with Windows XP,7,8 and 10

※Specifications of this device may be changed without notification.

Positron Surface Analyzer

Non-Destructive Inspection

by Anti-coincidence System

US Patent : US 8,785,875 B2

Application

- ■Shot peening inspection
  (Inspection Depth : Down to 100 micron)
- ■Evaluation of Fatigue behavior
- ■Evaluation of sub-nano size defect
- ■Free volume on Polymer and Glass

Specification

Device size : 430(H) X 400(W) X 400(D) mm
Positron source : Na-22 (under 1MBq)
Measurement time : 5 min minimum

Distributor

Country	Company	TEL	E-MAIL
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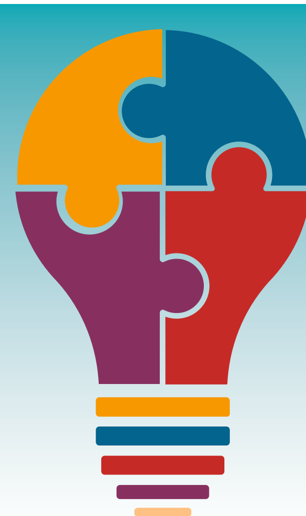

THE SHOT PEENER
Sharing Information and Expanding Global Markets for Shot Peening and Blast Cleaning Industries

OPENING SHOT
Jack Champaigne | Editor | The Shot Peener

Shot Peening and Ice Cream

DURING A RECENT summertime ritual, I found myself waiting for a response at a fast food restaurant's drive-thru order station. After several minutes of waiting, I pulled forward to the pay window and again there was no one to take my order for ice cream cones. I proceeded to the last delivery window and asked the only employee in sight what was going on. She informed me that they were short on help and after apologizing, she asked for my order. She again apologized and said that the ice cream machine was shut down for cleaning and no one knew how to clean it.

Now I know this is a stretch, but there were a couple of points in my story that relate to the shot peening industry. The first is the shortage of employable staff and the second is training.

With a strong economy and a low unemployment rate, especially in the United States, finding and keeping good staff has become difficult. It is all too common to see "help wanted" or "now hiring" signs in business windows and parking lots. Maintaining and cleaning an ice cream machine can hardly be compared to operating a million dollar shot peening system, but when maintenance is required on a routine basis, a customer cannot wait for a business to find and train new employees in either situation. The Performance Review Institute (PRI) is addressing this problem in the aerospace industry. In June 2018, PRI held a conference for suppliers, prime contractors, training providers and airlines. The goal was to develop programs for identifying and keeping qualified special process personnel and closing the skills gap in the workforce. Read more about the conference in "Shaping the Aerospace Workforce of the Future" on page 40.

The topic of training ties in with the article "Deciding Between In-House and Outsourced Peening? Seven Points to Consider" on page 10. While researching this article, our writer found that many top OEMs also offer shot peening services at their facilities. These OEMs send their machine operators to shot peening training. One OEM even pays for the training of their customers' machine operators after the purchase of one of their shot peening systems, thus ensuring that the machine will be used properly. (Another interesting point: Outsourcing is a viable option if you can't find qualified employees.)

So I guess my story has a sweet ending after all. As you read the variety of articles in this issue, you'll see that our industry is continually adapting and growing to meet the challenges and opportunities ahead.

THE SHOT PEENER

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Know Your Limits

A spring manufacturer finds a successful balance between in-house and outsourced shot peening.

WINAMAC COIL SPRING (WCS), located in Kewanna, Indiana, has been family owned and operated since its inception in 1948. The company manufactures wire forms and compression, single torsion, double torsion and extension springs for agricultural, off-road recreational vehicle, lawn and garden, railroad, construction, recreational vehicle, valving, industrial, furniture, and general industrial markets. Springs and wireforms are produced on state-of-the-art CNC spring formers and innovative secondary equipment. Their engineering department develops custom spring designs. Because of their commitment to innovation and customer service, WCS is the sole or primary source for many of their customers.

Over the years, the product engineers at WCS developed a successful shot peening program that encompasses in-house and outsourced shot peening. Compression, extension, single and double torsion springs are peened in Winamac's tumblast machines. Torsion springs that aren't suited for the tumblast machines, due to their size and shape, are sent to Metal Improvement Company (MIC).* "Our shot peening service provides an economic shot peen process for customers that aren't interested in specific performance targets but want the added benefit of fatigue resistance," said Chris Swope, Product Engineering Manager at Winamac.

This division of labor served the company well until a manufacturer of off-road recreational vehicle components wanted a longer fatigue life for a compression spring than Winamac typically produces.

Investing in a New Process

The company requesting the new spring was a valued customer. Winamac has developed numerous spring designs for them and approximately 100,000 springs are outsourced annually to MIC for peening. The Winamac team was therefore willing to make the investment to find the ideal solution. WCS put together a research team of Chris Swope, Joe Zielinski (Chicago area sales manager for MIC/Curtiss-Wright Surface Technologies) and Michael Brauss (President of PROTO Manufacturing). Each company contributed their specialty to the study. Winamac provided the spring design, coiling and fatigue testing. MIC provided a range of shot peening treatments. PROTO provided residual stress measurements which clarified how different levels of residual compressive stress correlate to spring performance. The team had the following objectives:

- Design a compression spring similar to those used in the off-road recreational vehicle industry
- Design and manufacture a fatigue test stand that could withstand high loads for months of testing
- Generate a matrix of shot peening treatments to produce different amounts of residual compressive stress
- Measure the shot peening residual compressive stress via X-Ray Diffraction (XRD)
- Correlate the residual stress to fatigue life performance
- Evaluate the effects of a post shot peening bake cycle on fatigue performance

The team measured the residual stress levels and fatigue tested the following shot peening variables:

- No peening (baseline)
- 230R @ 0.30-0.40 mm A (regular hardness shot)
- 230H @ 0.30-0.40 mm A (fully hardened shot)
- 460H @ 0.20-0.25 mm C (fully hardened shot, with and without post peen 204˚C bake)
- 460H-230H dual peen (0.20-0.25 mm C followed by 0.25-0.35 mm A)
- Reversing the order of shot peening and cold pressing

The testing and analysis showed that harder shot and dual peening had a more beneficial effect on residual stress and fatigue life than higher shot peening intensity. The customer is pleased with the newfound knowledge and WCS continues to

Springs for high fatigue applications.

**Metal Improvement Company is a business unit of Curtiss-Wright Surface Technologies.*

be their primary source for technical information and spring design. In addition, Winamac has incorporated this MIC shot peening process into spring designs for other customers.

Recognizing Your Limitations

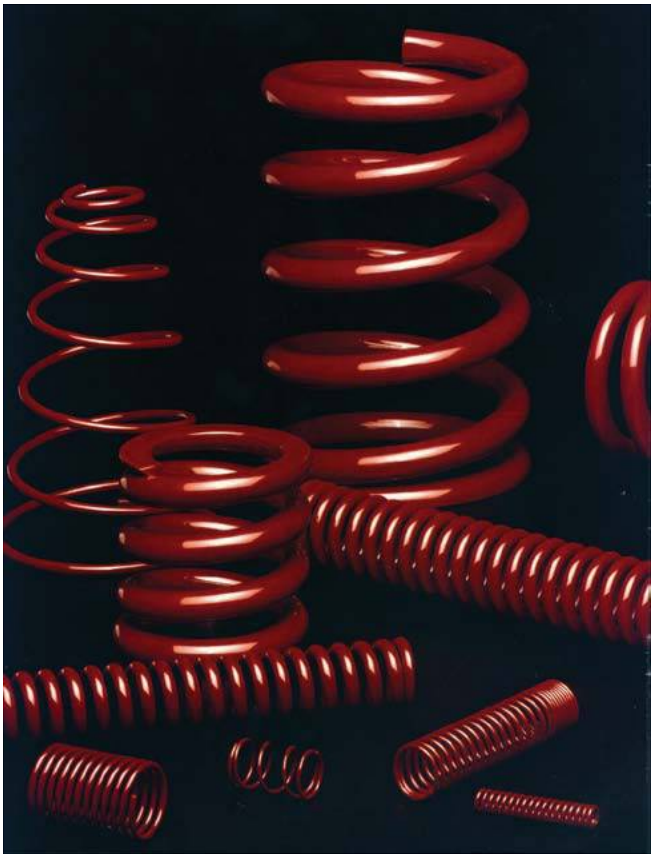
Winamac Coil Spring had already been working with MIC for many years so the decision to partner with them to develop a new peening process was an easy decision. For companies that have never used an outside resource, they must balance the ability to control costs by doing the work in-house versus employing the expertise of a specialist. "Failure to recognize your strengths and weaknesses can win or lose customers," said Joe Zielinski. "For a large spring company that shot peens a high percentage of their product, it may not be cost competitive to outsource 100% of their peening requirements. Managing tight delivery requirements also becomes a greater challenge when doing significant outsourcing, especially on a diverse product line," he added.

Your Product Line Matters

The shot peening requirements of an engineered spring company, such as Winamac, that makes a variety of spring designs are different than a spring company with a more focused product line such as those that specialize in engine valve springs. Companies with fewer product lines put great effort into streamlining the process and reducing cost. They are most likely to optimize an in-house shot peen process with the same shot size and the same or similar machines with similar process parameters. In comparison, a dedicated shot peening job shop specializes in managing a wide variety of peening media (usually more than 20) and rotating media through different machines depending on current workflow—that level of specialization isn't feasible for many manufacturers. The best solution for Winamac, with its multiple product lines, is to peen what they can in-house and outsource the rest to MIC.

"What MIC offers to spring manufacturers is a wide variety of shot peening media sizes and media materials including steel, stainless steel, glass and ceramic. Peening companies have the common tumble peen-blast machines and also air nozzle machines. A small percentage of springs require shot peening in local areas such as specific radii or inside coils that can't be reached with tumble peening. In addition, the quality department at a peening company is solely dedicated to shot peening quality," said Joe.

"It's important to understand the limits of your in-house shot peening capabilities and to know when to move on. We couldn't meet the new fatigue life requirements ourselves and MIC developed a process that no other company could have done for us. Our close relationship with Metal Improvement Company through the years has given us a better understanding of the shot peening process. Their expertise is a readily available resource that many spring manufacturers do not have," said Chris.



Winamac Coil Spring typically sends compression springs for high fatigue applications like these to Metal Improvement Company for shot peening.

The 10 Most Popular Languages

Given that shot peening is an international industry—would it benefit you to learn another language? Here's a list of the 10 most popular languages spoken worldwide, along with the number of countries where the language is established, and the approximate number of primary or first language speakers for that language.

- Chinese/Mandarin—37 countries, 13 dialects, 1,284 million speakers
- Spanish—31 countries, 437 million
- English—106 countries, 372 million
- Arabic—57 countries, 19 dialects, 295 million
- Hindi—5 countries, 260 million
- Bengali—4 countries, 242 million
- Portuguese—13 countries, 219 million
- Russian—19 countries, 154 million
- Japanese—2 countries, 128 million
- Lahnda—6 countries, 119 million

Source: Mark Rosenberg @ www.thoughtco.com

PREMIER

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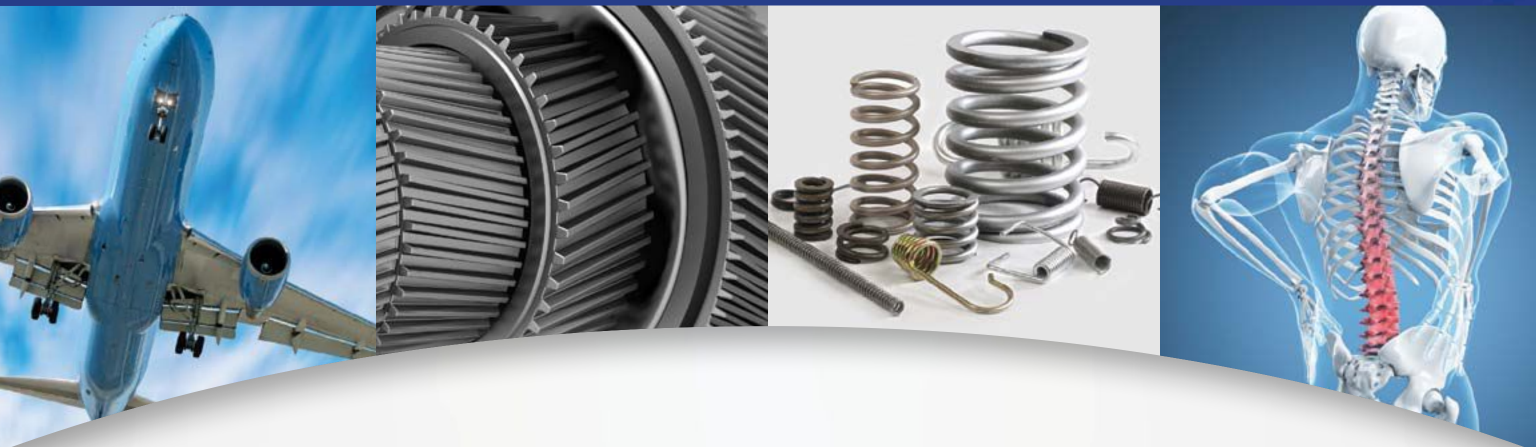
A Cut Above



The advantage of Premier Cut Wire Shot

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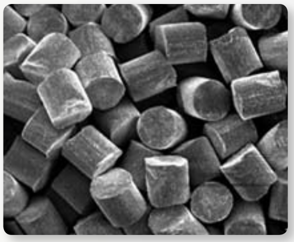
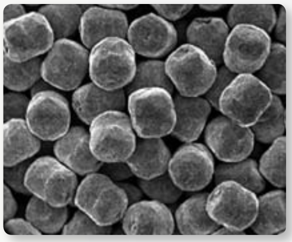
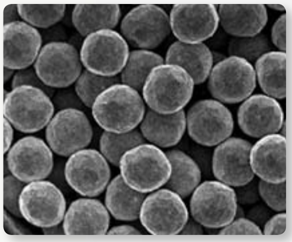
- **Improved Consistency** Highest consistency from particle to particle in size, shape, hardness and density compared to commonly used metallic media.
- **Highest Resistance to Fracture** Premier Cut Wire Shot media tends to wear down and become smaller in size rather than fracturing into sharp-edged broken particles, which may cause surface damage to the part.
- **Lower Dust Generation** Highest durability equals lowest dust levels.
- **Lower Surface Contamination** Cut Wire Shot doesn't have an Iron Oxide coating or leave Iron Oxide residue — parts are cleaner and brighter.
- **Improved Part Life** Parts exhibit higher and more consistent life than those peened with equivalent size and hardness cast steel shot.
- **Substantial Cost Savings** The increase in useful life of Premier Cut Wire Shot results in savings in media consumption and reclamation, dust removal and containment, surface contamination and equipment maintenance.



As Cut



Normal Conditioning



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Kathy Levy | Associate Editor | The Shot Peener

Deciding Between In-House and Outsourced Peening?
Seven Points to Consider

1. Many manufacturers give you the best of both worlds
Industry-leading OEMs sell shot peening machines *and* shot peening services. These OEMs are the ideal vendor for three types of customers:

1. **Purchased machine only.** Given that the OEM uses their own machines in their shot peening job shop, customers can have confidence in their machines.
2. **Uses job shop services.** The service provider is an experienced machine builder and therefore is knowledgeable on the shot peening process. Most job shops send their machine operators to shot peening training programs to ensure quality service.
3. **Purchased equipment and uses job shop services.** This hybrid of in-house and outsourced peening provides the ultimate safety net. The OEM's job shop can meet your deadlines when you have high volumes or downtime due to natural disasters or labor issues. They can also duplicate your production requirements with high-quality, consistent processes.

2. An outside vendor can provide several services
Many vendors can provide several services including shot peening, blast cleaning, coating services and non-destructive testing. Working with one vendor simplifies workflow and allows a manufacturer to concentrate on their core offerings. In addition, working with surface finishing specialists provides the benefits of their knowledge, skills and resources.

3. If you are bringing peening in-house, do your homework BEFORE purchasing equipment
This warning covers not only choosing the right equipment but making sure your shot peening team is educated on every aspect of a controlled peening process. Here's an example of why you should do your homework: An aerospace MRO realized that rotary flap peening was the ideal solution for their facility after they sent their team to a shot peening workshop. Unfortunately, they had already purchased a shot peening machine.

4. Outsourcing accommodates fluctuations in volume
How often has this happened to you: You buy a great tool, thinking it will save you time and money. And then it sits and gathers dust. It's reasonable to outsource your shot peening until it generates a steady and reliable income stream. If you can't justify the expense of an in-house process—equipment and materials, labor, overhead—and you need flexibility, outsourcing is the way to go.

5. Successful outsourcing requires a willingness to invest in a relationship
Employees from Winamac Coil Spring and Metal Improvement Company were willing to invest the time to build a mutually beneficial relationship. (Read "Know Your Limits" on page 6.) It takes trust and communication to build this kind of an association but the outcome is well worth the effort.

6. Industry 4.0 and in-house peening
"Advances in technology gathered into a package called Industry 4.0 will revamp and revitalize manufacturing, potentially bringing outsourcing to an end," wrote Rob Spiegel in an article for *Automation & Motion Control, Design Hardware & Software* on June 20, 2014. Despite the fact that Industry 4.0 won't deliver on its full promise for many years, we can see the potential now. Advanced technology allows real-time data sharing of shop floor equipment through internet connectivity. (Handheld devices are becoming the norm on the shop floor.) Data sharing from and among machines can eliminate downtime by detecting wear on parts and foreseeing bottlenecks. Manufacturers in aerospace, for instance, now have inline shot peening systems that are integral to their automated production lines.

7. Employee morale and in-house peening
Good employee morale is probably never a factor in the decision to develop an in-house shot peening program, but it is a nice bonus. Employees like to see growth and progress. The new shot peening program may require additional employees and training for new and existing staff. Training adds confidence and pride. Again, morale is not a make-or-break component in the decision, but a happy workforce and maybe even a small boost to a local economy are always good things.

SINTO SURFACE TECHNOLOGIES

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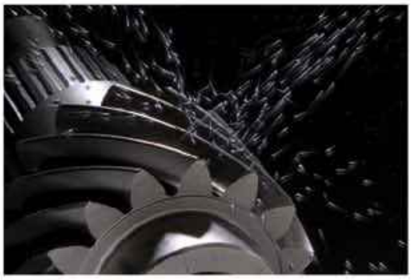

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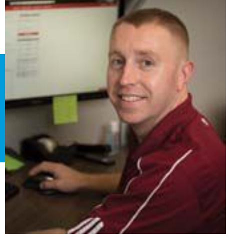

ENGINEERING NOTES
Bryan Chevrie | Product Engineer | Electronics Inc.

The MagnaValve: Just a Black Box?

AS I WRITE THIS, it is getting close to that time of year again. That's right, you guessed it, the EI Shot Peening US Workshop. For some of you that means buying plane tickets and booking a hotel. For others it means buying costumes and putting up Halloween decorations. However, this year, I'm super excited, because my wife and I will be running our first Spartan race. I know what some of you are saying right now, "But Bryan, aren't you an engineer? And I thought engineers didn't have any measurable upper body strength to run an obstacle race and didn't like the outdoors?" And you would be correct if I were a stereotypical engineer, but I'm not. I love physical actives such as lifting weights, HIIT (High Intensity Interval Training), swimming, and running. I also prefer to be outside, where there are fewer engineers—some of those people are crazy.

The rest of you readers are probability asking yourself, "Bryan, what does running a Spartan race have to do with MagnaValves? And, are you ever going to get to your point?" And, yes, there is a point to be made here. Before my wife and I signed up for a Spartan race, we first researched what a Spartan race was and what type of obstacles were involved. This allowed us to compare our current physical ability to what would be required to complete the race. Once we made this comparison, we were able to design a training regimen to concentrate on our weaknesses.

It would be foolish to just signup for a Spartan race without first knowing if you are physically and mentally up for such a demanding challenge. For the physically fit, this may work out fine in the end. For the less physically fit, this could turn into complete failure.

Likewise, it would be foolish to purchase a MagnaValve, mount it below a media hopper, connect it to whatever 24 Vdc power supply is inside the cabinet of the machine and hope it works. This situation may work okay on an OEM's shop floor but may turn out to be a disaster at the customer's facility. For some this sounds obvious; however, we see this happen all too often.

The MagnaValve appears to be such a simple device. Put a hopper full of shot above the MagnaValve and you get the requested flow rate below the MagnaValve. What can go wrong? Well, for starters, a lot. The MagnaValve's performance and life span can be affected by pressure differentials between the pressure pot and the blast hose, improper start-up and shut-down sequencing of the blast air and shot flow, and coupled noise from high-voltage devices such as motors, just to name a few life-threatening situations for the MagnaValve.

I'm hoping to uncover the deep secrets of MagnaValve installation and use over several articles, but today I'm going to concentrate on MagnaValve basics, specifically the 5xx-24 Vdc MagnaValve. The 5xx-24 Vdc MagnaValve is the family of valves that control the flow rate of ferrous media. I know this is the boring stuff, but some basic knowledge will go a long way when Murphy and his law (anything that can go wrong, will go wrong) stops by to visit or takes up permanent residency. I know some of you can relate. You pray every night that he moves into your buddy's house or better yet, your competitor's. However, until he moves out, we must be prepared to deal with his disruptions.

So here we go—the 24 Vdc MagnaValve is made up five parts (please see Figure 1 on page 14). The five parts are the Supply and IO Line Filter, System Electronics, Valve Driver, Media Flow Valve, and Sensor. I'll briefly go over each part.

Supply and IO Line Filter

The filter blocks any high voltage transients and high frequency noise that may be present on the wiring connected to the MagnaValve. You may have noticed that the GREEN wire and the BLACK wire are connected internally. Also notice that the GREEN wire is NOT connected to ground or the chassis. In earlier versions of the 24 Vdc MagnaValve, the BLACK wire was signal common for the System Electronics while the GREEN wire was the signal return for the Valve Driver. However after some customers invented new and unique ways of destroying the MagnaValve, we added additional filtering. Thank you for that by the way. To keep the 24 Vdc MagnaValve directly replaceable with older versions, we tied the GREEN and BLACK wires together internally.

The Chassis should be connected to earth ground through the machine. This is typically done through the plumbing of the machine; however, if the plumbing is not a reliable grounding connection, a ground clamp can be connected to the pipe of the MagnaValve.

The brass pipe of the MagnaValve is the best Chassis ground connection. The enclosure and the filter ground are connected to the brass pipe internally. So please DO NOT drill a hole in the side of the enclosure to attach a ground wire.

System Electronics

The System Electronics contains all the logic of the system. The System Electronics reads the 0 – 10 Vdc Input Signal, sets the 0 – 10 Vdc Output Signal, monitors the 24 Vdc Enable Signal, reads the Sensor Signal, and sends the control signal to the Valve Driver

The System Electronics reads the 0 – 10 Vdc Input Signal and converts it to a 0 – 100% PWM (pulse width modulation) signal that is sent to the Valve Driver. The frequency of the PWM is controlled by the Pulse Hz potentiometer on the front of the MagnaValve. The duty cycle of the PWM signal is based on the 0 – 10 Vdc Analog Input, where 0 Vdc input equals 0% duty cycle and 10 Vdc input equals 100% duty cycle.

The System Electronics reads the Sensor Signal and converts it to a 0 – 10 Vdc Output Signal that represents 0 – Maximum Flow Rate (the Maximum Flow Rate is programmed through a terminal program).

The System Electronics also monitors the 24 Vdc Enable input and commands the Media Flow Valve to flow media when an Enable Signal is applied.

For those that want to use the MagnaValve without a FC-24, one thing to note is that the PWM signal is derived from the 0 – 10 Vdc input and not the Sensor signal. The Sensor and the Valve Driver are two separate stand-along systems. This set-up with the 0 – 10 Vdc Input and 0 – 10 Vdc Output allows the MagnaValve to be connected to the FC-24 Controller or direct connection to a PLC with a programmed PID controller.

Valve Driver

The Valve Driver is an amplifier that will take the PWM signal from the System Electronics and control the Media Flow Valve. The Valve Driver contains all the high current components and generates most of the heat in the MagnaValve. Some of you may have noticed that the body of the MagnaValve gets warm to the touch after media flow. This is normal.

The Valve Driver not only takes the 0 – 100% PWM signal to control the flow rate through the Media Flow Valve, but also adjusts its amplitude. This ensures the MagnaValve will flow the maximum amount of media that it is physically capable of flowing.

Media Flow Valve

The Media Flow Valve contains the brass pipe the media flows through, the permanent magnet that stops the media flow, and the power coils that allow media to flow. Using a permanent magnet to stop the media flow makes the MagnaValve a normally closed media valve. This means that if there is a loss of power or the machine is shut down, the hopper will

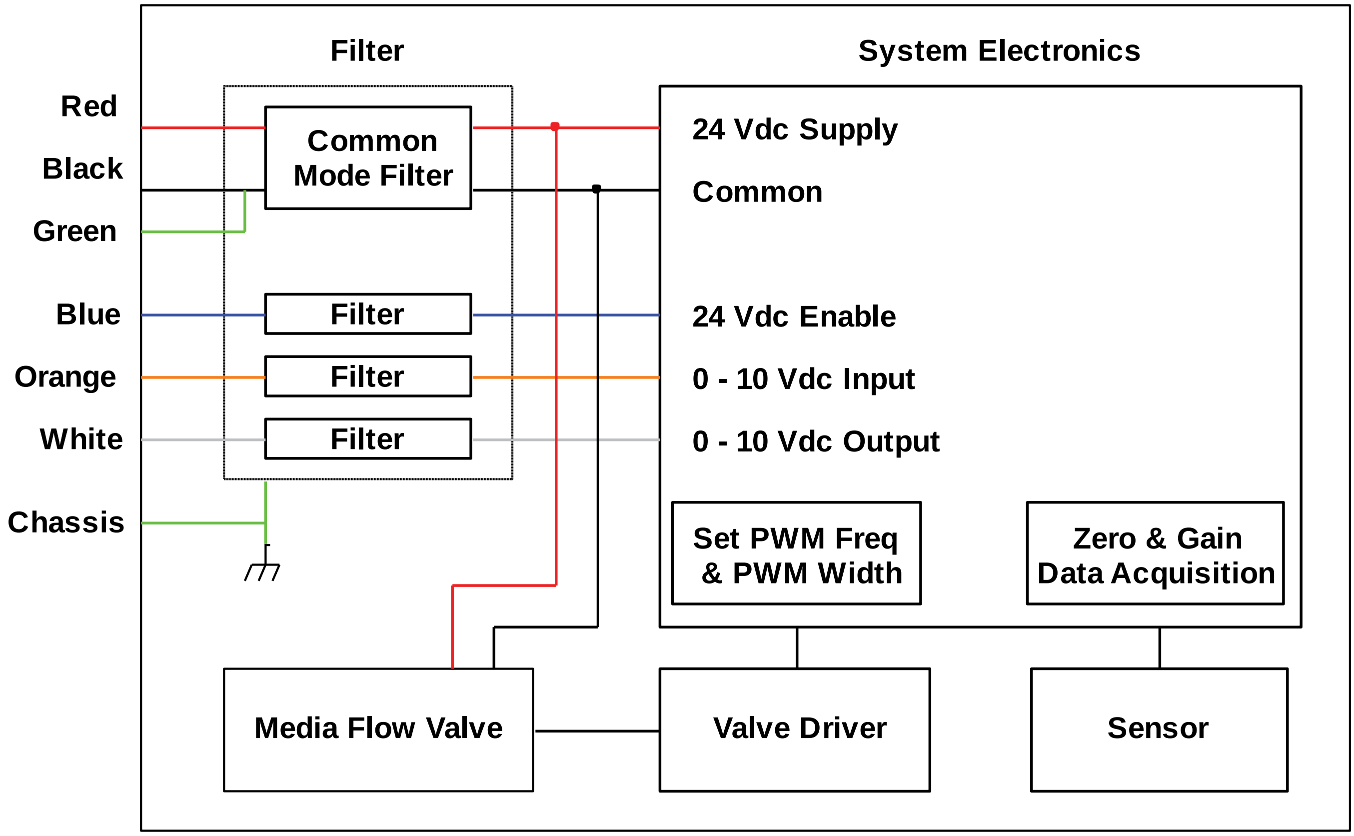

Figure 1. The five parts of a MagnaValve.

Background image courtesy of Progressive Surface

not empty into the blast hose. A very important note: While the MagnaValve is a normally closed media valve, it can NOT hold back air pressure. If the MagnaValve is used in a direct pressure application, it must have a pinch valve mounted directly BELOW the MagnaValve. (Mounting the pinch valve below the MagnaValve is the preferable installation method.)

To get a better sense of the flow rate in response to the 0 – 10 Vdc Input Signal, see Figure 2. Figure 2 shows an example of the flow rate through the MagnaValve as the Analog Input voltage changes. This is not a linear relationship. This graph is called the Open Loop Profile of the MagnaValve. This profile will be different for each media type and size. The media type that works in the 5xx-24V MagnaValve is ferrous media, such as cast steel and steel cut wire. Cast stainless media will not work in the 5xx-24 Vdc MagnaValve. The reason cast stainless media will not work is because it is not magnetic or it is weakly magnetic.

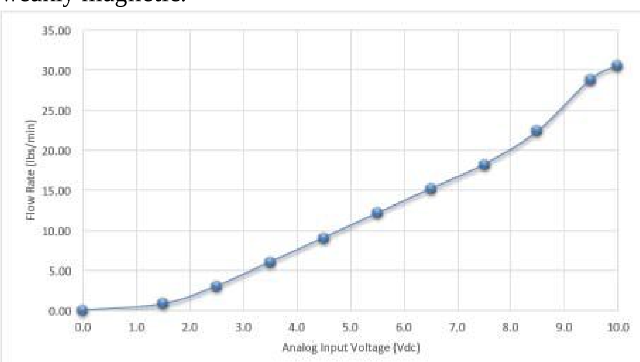

Figure 2. Example of open-loop performance of a 24 Vdc MagnaValve.

Sensor

The Sensor does just what it says. It senses and measures the flow rate of the media flowing through the MagnaValve. The sensor is an inductive type sensor and therefore it works very well with ferrous material. Many customers, however, do not understand the basic operation of the sensor, so I'll give an overview here.

When the MagnaValve is calibrated before shipment to the customer, a catch and weigh test is conducted. This is where the Open Loop Profile is created, see Figure 2. Each one of the points on the graph in Figure 2 represents a catch and weigh test. During the catch and weigh test a look-up table is created. The following is the procedure:

1. Set the analog input voltage to the value of interest.
2. Apply the Enable Signal for a set time (one minute makes the calculation easy). The Sensor Signal is recorded during this time.
3. After the set time, weigh the amount of media dispersed by the MagnaValve.
4. Calculate and enter the flow rate into the MagnaValve.
5. Repeat for all points.
6. Set the Maximum Flow Rate in the MagnaValve.

You maybe asking, "What does all this mean and how does the MagnaValve use this information?" And these are very good questions.

The MagnaValve uses this information to determine and set the 0 – 10 Vdc Output Signal. The Output Signal is 0 Vdc with 0 lb/min flow rate and 10 Vdc with Max Flow Rate. To see the sensor's output response to flow rate, see Figure 3. The Max Flow Rate value sets the scaling of the analog output. Notice that the maximum flow shown in the Open Loop Profile of the MagnaValve (see Figure 2) is approximately 30 lb/min, but shown in Figure 2, the analog output is 10 Vdc when the MagnaValve is flowing 20 lb/min. This is because the 0 – 10 Vdc Output Signal is scaled for 0 – 20 lb/min, where 20 lb/min is the Max Flow Rate.

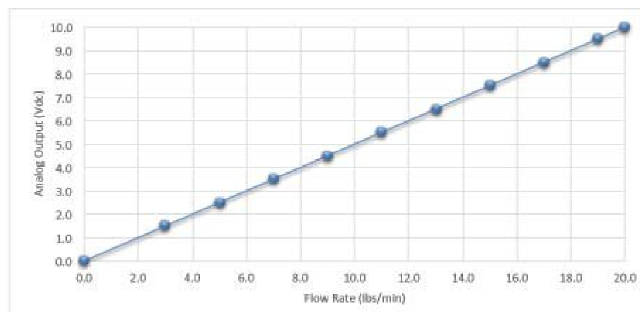

Figure 3. Example of the Analog Output voltage with respect to Flow Rate.

I hope this article helps provide a better understanding of the 5xx-24 Vdc MagnaValve. I know that for many the MagnaValve is just a black box both literally and figuratively. I'm going to keep bringing you articles that will provide in-depth information like this to ensure a successful integration of the MagnaValve into your equipment.

So please say tuned.

About Bryan Chevrie

Bryan Chevrie is a Product Engineer with Electronics Inc. In addition to the research and development of new products, Bryan provides product support and conducts classes in shot analysis and media masking at the EI Shot Peening Training seminars and workshops. Before his employment at EI, Bryan worked at K & R Electric as a Commercial/Industrial Electrician. He earned the rank of Sergeant in the United States Marine Corps Reserve during his six years of service.

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

What Really Matters to Your Shot Peening Process

INTRODUCTION

Going back in time to the first shot peening workshop I attended, Jack Champaigne asked the question, "How does shot peening work?" He responded to his own question with "works very well"! After almost three decades in this industry, I've learnt that Jack's lighthearted response has considerable depth. Critical components peened properly assure me that I won't be food for the sharks when flying over the Pacific or stuck by the roadside holding a broken connecting rod from my car that cracked due to fatigue! These are common application/industry examples and shot peening has propagated to many industries outside of Aerospace and Automotive and it continues to grow in importance. Over the years, we've had several discussions about specification conformance, process controls, equipment design, maintenance, retrofits and training. With that background, I believe it's now a good time to narrow down aspects that users of peening equipment consider key in maintaining an efficient shot peening process.

For this exercise, I used the combined expertise of colleagues that design and sell shot peening equipment worldwide with feedback from users of equipment from a well-established industry base. Additionally, the discussion incorporates education from the supplier of a key input to the process. In responding to the question in the title, the following aspects were weighed by the respondents based on their unique experience:

- Vendor's understanding of the process and ongoing support
- Design of equipment and quality of inputs
- Ease of work handling
- Maintainability
- Adaptability for modifications
- Controls (mechanical and electronic process control)
- Technology and innovation
- Price and delivery (of equipment, spares and service)

DOES EVERYTHING MATTER?

The simple answer is "yes", but then that won't satisfy the word count requirement for this article! During a recent car rental experience in North America, I couldn't help noticing features of the car that we take for granted, such as Bluetooth for the phone, powered windows, rear-view camera, etc. Similarly, we can (and should) expect to take for granted certain features of shot peening machines, especially those supplied within the last ten years. Such features include a classifier to maintain consistent media size, flow control valves for constant media flow rates, a system to maintain constant media velocity, and an HMI with recipe creation, storage and retrieval functions. Of course, it's basic to expect a properly functioning reclaim system, well-routed blast hoses in an airblast machine, blast wheel blades balanced to tight tolerances in a wheelblast machine, wear-protection in exposed areas of the cabinet and work handling systems, a safety circuit to immediately stop blasting during accidental opening of the cabinet door, adequate part masking to protect specific part surfaces, and finally a ventilation and dust collection system that takes into consideration all necessary ventilation guidelines including fire and explosion protection.

Let's consider some scenarios where one or multiple systems malfunctioned:

- A broken screen in a classifier will affect the quality of media in your shot peening machine. If left unchecked, it will alter your expected peening result. This issue will lead to an undesired "operating mix" in your hopper that is detrimental to peening. Shot peening and blast cleaning rely on transfer of energy from the media particles on to the part, with a requirement for the transfer to be at a constant rate in peening. The ensuing "operating mix," though desirable in blast cleaning, will not transfer constant impact energy in your peening machine due to a mix of sizes and varied energy content in the particles/media. The hope at this stage is that you'll detect it soon enough when peening Almen strips and plotting the saturation curve—you will likely see the emergence of a double knee signifying media size contamination. With a properly established process and training, this can be identified before bad results reach catastrophic proportions.
- A faulty flow control device and incorrect velocity transfer caused due to inconsistent blast wheel speed or air pressure will cause similar disturbances with impact energy transfer. Your shot peening machine should have closed-loop controls to identify and correct or warn you of both incidents. Unlike the classifier screen damage, which could go undetected until the end of the shift, your machine should correct itself


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unless there is a problem with the velocity source. In that case, the controls should shut down your process.

The above scenarios demonstrate the need for regular inspection, operator discipline, and a reliable controls system. In the next section let's discuss some of those factors that are semi-machine related, but with the potential to determine the efficiency of your shot peening operation.

QUALITY OF INPUTS

Your automobile's controls will trigger the "check engine light" when you continually fill it up with a lower octane rated fuel when it calls for one that's rated above 90 octane. The higher grade of fuel is intended to deliver superior performance, and the engine is designed to operate with it. A critical input to shot peening machines is the peening media, whether it be cast steel shot, conditioned cut wire, glass bead or ceramic. Machines will operate with sub-optimal levels of media quality, but there's always a catch!

Joe McGreal, Vice President at Ervin Industries, validated our discussion on impact energy by saying, "The molten metal chemistry of cast shot is critical to the "strength" formation of the grain structure when it is atomized. Using high quality steel scrap with low sulphur and phosphorus contents is imperative to help fortify the internal microstructure. At Ervin, we keep very close control on this attribute so that the final product conforms to SAEJ827 and AMS2431. The chemistry also determines the other characteristics of peening media such as hardness and controls physical imperfections such as voids, shrinkages, cracks and particle shape. In addition to controlling the primary scrap quality and chemical dosing, Ervin follows a proven water quenching process to manufacture cast steel shot which we have found to be most effective in maintaining consistent durability."

As we know, broken media with sharp edges is not desirable for shot peening due its potential to create nicks on the part, leading to local tensile stress risers. Quality of peening media is central to achieving repeatable results regardless of whether you use blast wheels or nozzles in your peening process. Now, if only machine controls were built with the smarts to recognize sub-optimal media quality in a machine before processing parts over and beyond the functionality of the classifier and spiralator!

Some of the aspects that didn't have a significant bearing in our respondents' assessment include:

- Blast nozzles and hoses – possibly because of their monetary value and the ease of switching to an alternate style and size to suit.
- Controls – except for preference of popular makes of components.
- Price – though all markets are price sensitive, respondents said that they placed greater emphasis on technical and service features before even evaluating the price proposition.

EXPERTISE AND ITS IMPORTANCE

The end-user is clearly the expert in manufacturing their product and none of us can claim dominance over that fact. With shot peening, however, the end-users were unanimous in passing on the "expert" badge to the supplier. To them, the supplier's understanding of the peening process and the way it applied to their product was very important. This included process set-up (media drop tests, saturation curves and coverage checks), and technique/recipe development. Robotics is relatively new to our industry, and an end-user I spoke with clarified their expectation that robot (path programming) training had to be in vendor's scope during machine start-up.

Though a significant point of discussion with vendors, Equipment Design was taken for granted by most end users. End users with years of experience and familiarity with a specific make of shot peening equipment expected proper design standards to be part of the machine and took for granted the machine performance. By contrast, new users took their time to learn about different design aspects of their machine and related them to their peening process.

The efficiency and effectiveness of pneumatic media recovery systems continues to be an issue with some users even though this feature should be well-engineered and standardized by now. Here's a real-life example: A vendor/supplier couldn't get a pneumatic media recovery system on a manual blast machine to work for his customer. The vendor finally bailed on the project, leaving the customer hanging. I was associated with the company that finally fixed the problem (which is why I know the story). The exasperated customer had almost given up on the pneumatic recovery system until we got it fixed.

I found this situation unfortunate and wished the vendor hadn't been the reason for the customer to misjudge some basic laws of physics! When designed properly, such systems are the most suited for airblast applications, particularly when working with multiple media types/sizes in your peening process. Mechanical reclaim systems, though commonly used for greater media flow rates and almost always with ferrous media, involve many moving parts with the need for regular inspection and maintenance.

End-users that work with a variety of part styles (job shops, for example) need their machine to be adaptable to their changing requirements. They place importance on large open cabinets with simple work handling systems and ergonomic access points and an efficient reclaim system that allow them to purge media without involving a lot of labor. Interestingly, this user-group prides itself on its extent of knowledge of the shot peening process and maintenance skills. Their reliance on vendors to help with their peening operation and/or equipment was minimal.

Most respondents worked with shot peening systems with controls and HMI with a minimum level of sophistication.

This level included a PLC, controlled nozzle (or wheel speed) and part movement. Some of them had upgraded their controls to conform to specifications. The response was unanimous—controls played a major role in helping them achieve repeatable peening results.

OPERATORS PLAY A KEY ROLE

A special mention needs to be made to the operators of peening equipment. The end-users I spoke to, particularly in the Aerospace, trusted their operators' expertise with the equipment and process. A validation to this fact can be seen at the US and other Shot Peening Workshops where companies regularly send their operators to get trained on the process and examined for different levels of expertise in shot peening. Maintaining a consistent team of operators is very critical since this process takes time to establish and is fraught with nuances that can be gathered only over a stretch.

Walter Beach, Vice President at Peening Technologies, manages a sub-contracted shot peening operation in Hartford, Connecticut. Mr. Beach, who serves on several SAE committees, understands the importance of training. "All our shot peening process engineers have qualified to the different levels of FAA approved certifications through the EI workshops in Canada and the US. This is a requirement with our customers that their parts be peened by qualified personnel only. We have found our trained engineers take total accountability for the process and come up with process improvements on a regular basis. They certainly play a key part and they matter in our shot peening process."

TECHNOLOGY AND INNOVATION

Nathan Bjornson is an industry colleague who manages the ZERO product line for Clemco Industries. Clemco has been an innovator in portable, manual, and automated airblast equipment since the 1940s. "Technology growth and innovation at Clemco is not restricted to shot peening. Over the years, our customers in sensitive sectors, such as the military, and conventional ones in automotive and aerospace, have pushed us to innovate in processes such as etching, paint stripping and de-burring. Some of these processes demand traceability that was until now only seen in shot peening projects." Nathan adds, "One of our product lines, Aerolyte Systems, pioneered paint stripping technology in the '80s using plastic media. This technology has now advanced and uses several other lightweight media, requiring media reclaim systems that work with extra-sensitivity to the particle's mass." The advent of newer media types for a conventional application is directly driven by input costs, reduced dust generation due to increased durability, local availability and other such factors. During a time when we focus on Industry 4.0 and cloud technology, Mr. Bjornson's experience tells us that there are still several opportunities available to optimize existing processes.

SO, WHAT DOES REALLY MATTER?

A consultative approach – a customer in the medical implant industry once remarked that their project was successful because by the end of it, the vendor almost functioned as their employee! Though not always possible to this extent, everyone I spoke to—industry colleagues and customers alike—benefited from each other's in-depth participation. Interestingly, such projects continued to thrive after the end-user took ownership of the process and equipment in the early stages.

Nimbleness and adaptability – Though the presence of structure and organization was important to all end-users, so was the vendor's ability to adapt and deliver to ever-changing circumstances. An industry colleague in Europe recounted his experience with a shot peening project where the intensity value was misinterpreted by their customer due to metric and imperial units being used interchangeably. The change required some major modifications to their wheelblast machine including replacement of blast wheels and re-tuning the process. The resulting "customer for life" was a feather in their cap and proving to be an inevitable requirement for success in the current landscape.

It is worth repeating that several items in my criteria list were taken for granted by the respondents. Most end-users work with sophisticated machines and processes and they expect nothing less from their shot peening machines and processes.

The equipment and process are catching up with the industry expectation, but there's an inherent weakness—skilled manpower. Most of us in my generation were fortunate enough to learn from more experienced peers. However, the rate of newcomers into this industry is alarmingly low. The retention rate, due to various reasons, is low and there are no easy solutions to change that. Our end-users have identified some interesting requirements from this process and its vendors. Maybe addressing these requirements will create an environment that's interesting enough to retain talent and help our industry grow.

About Kumar Balan

Kumar Balan is a shot peening and blast cleaning technical specialist. He assists industry leaders achieve business growth in North American and overseas markets. His expertise is in centrifugal wheel- and air-blast cleaning and shot peening equipment. Kumar has published many technical papers on blast cleaning and shot peening and is a regular contributor to *The Shot Peener* magazine. He is a speaker at industry conferences and training seminars worldwide. Kumar is also a Lead Instructor for EI Shot Peening Training at their international seminars and workshops. Please email him at kbalan13@gmail.com.

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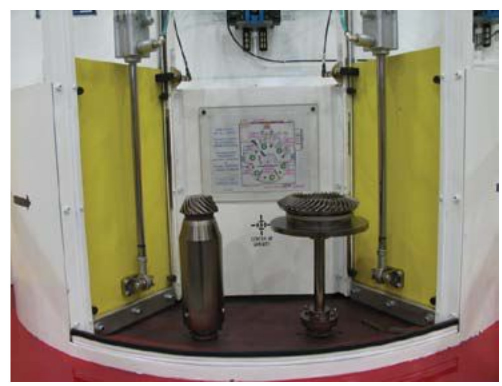

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ACADEMIC STUDY
Dr. David Kirk | Coventry University

The Curvature of Peened Almen Strips and Its Applications

INTRODUCTION

Peened Almen strips have a familiar shape—displaying both longitudinal and transverse curving—after release from hold-down. Fig.1 shows how the duplex curving contributes to the measured arc height, h.

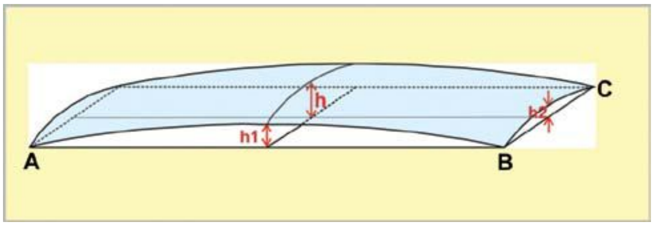

Fig.1. Duplex curving induced in a peened Almen strip.

At a first glance, both curves appear to be arcs of a circle. This is, however, incorrect. The two curves are, in fact, both parabolas. If a parabola is graphed, an optical illusion can be induced. This phenomenon is illustrated by fig.2.

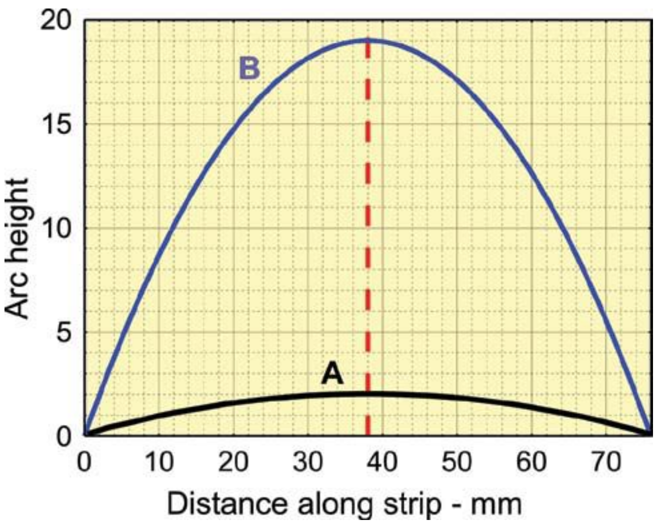

Fig.2. Longitudinal Parabolic shape of a uniformly peened Almen strip.

Curve B has the same equation as curve A but with the vertical scale magnified by a factor of ten. It is difficult to differentiate visually the shape of curve A from that of a circular arc hence the concept of an optical illusion.

This article embraces an analysis of why peened Almen strips have this parabolic shape together with experimental evidence and a consideration of its practical significance. Understanding the cause of strip deflection enables us to identify and control variations in peening procedure. One section is presented in the form of an article. The tutorial includes a demonstration of how calculus can be employed to solve a peening problem!

EXPERIMENTAL EVIDENCE

The results of an experimental program titled "Factors Affecting Almen Strip Curvature Readings" were presented at ICSP7, Warsaw, 1999 by D.Kirk and R. Hollyoak (pp291-300). Measurements were made using a Kemco 600 co-ordinate machine and QCT-3d measuring software operating with digitized points. Figs. 3 and 4 show the longitudinal and transverse deflection variations for a peened N strip.

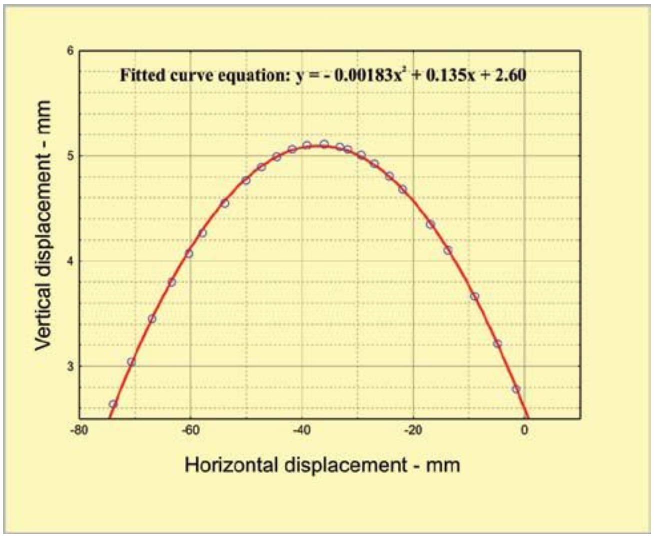

Fig.3. Longitudinal curve shape of a peened Almen N strip.

Figs.3 and 4 are a clear indication of the parabolic nature of the curves induced into a peened Almen strip. The fitted equations were $y = -0.00183x^2\ 0.135x + 2.60$ and $y = -0.00271x^2\ 0.0485x + 6.05$ respectively with goodness of fit, r^2, being 1.00. Both equations correspond to that of a vertical-axis parabola. Other parabolas were noted in the quoted ICSP7 paper.

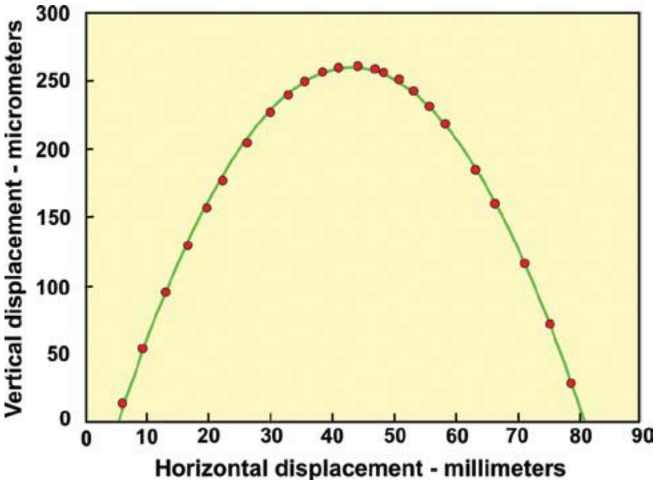

Fig.4. Transverse curve shape of peened Almen N strip.

TUTORIAL ON PARABOLIC BENDING OF STRIPS

"Hi guys. This tutorial is about how bending moments induce parabolic bending of rectangular strips. You will find it useful if you ever aim to be an expert shot peener.

Consider a simple model of an office ruler supported near to each end (as shown in fig.5). Press down on the ruler at a point close to A, using a reasonable force that we will call "**F**". The ruler will hardly bend at all. As we move our finger to a distance **x** we observe that noticeable bending now occurs. If we continue moving the finger we note that maximum bending probably occurs halfway along the ruler at a distance from **A** of **L/2**.

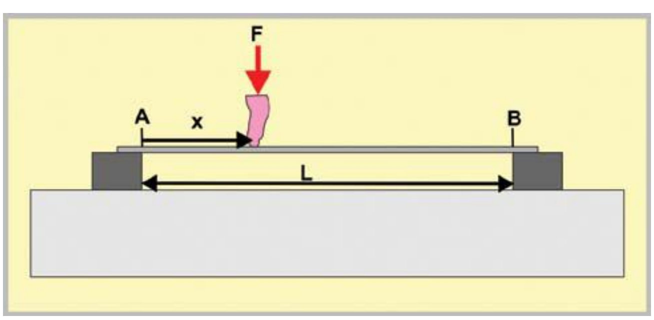

Fig.5. Finger bending of an office ruler.

The combination of **F** and **x** generates what is called a "Bending Moment". Bending moments are so important to engineers that they are given the letter **M**. Next let us think about how we can quantify the variation of **M** with distance **x**. The variation of **M** with a single applied force, **F**, is given by the equation:

$$\mathbf{M = F.x\,(L - x)/L} \text{ so that} \qquad (1)$$

$$\mathbf{M/F = x\,(L - x)/L} \qquad (2)$$

Equations (1) and (2) are vertical axis quadratics.

Keeping **F** and **L** fixed, the bending moment will vary only with **x** and has a magnitude **(L – x)/L**. Time now for some mental arithmetic! Assume that the fixed length **L** is 100. Pressing down with **x** equal to 1 unit **x(L – x)/L** becomes 1(100 – 1)/100 or 99/100 which equals 0.99. Now, for example, if **x** equals 10, **x (L – x)/L** becomes 10(100 -10)/100 which equals 900/100 or 9. The bending moment has therefore been increased by a factor of just over 9. At halfway along the ruler **x** equals 50 so that **x (L – x)/L** becomes 50(100 – 50)/100 or 2500/100 which equals 25.

We can show how the bending moment, **M**, varies continuously when applying a single fixed force **F**, at different distances, **x**, by plotting a graph. Assume that **F** is unity and **L** is 100 so that equation (2) becomes:

$$\mathbf{M_x = x(100 - x)/100} \qquad (3)$$

Use 'Easyplot' (supplied to everyone by University), to graph equation (3). Set the x-axis to go from 0 to 100 and the y-axis to go from 0 to 30 - we already know that the maximum value for **M** will be 25. You should then all get the same graph (fig.6):

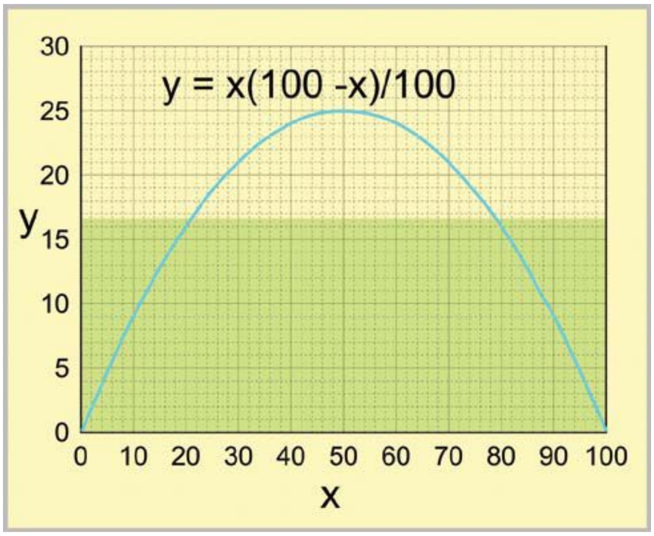

Fig.6. Variation of Maximum Bending Moment for a single applied force.

The total of the bending moments being suffered by the strip is the same as that of the green rectangle included in fig.6.

So far we have only considered how bending moment varies for a single applied force, F. What happens if tiny forces are applied continuously and uniformly along the beam? We have what engineers call "uniformly distributed loading". For example, consider 1N per mm applied uniformly along a beam that is 100 mm long. The total loading will therefore be

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100N but what is the magnitude of the bending moment? To tackle this problem we can use a standard textbook equation used by mechanical engineers. The origin of the equation is illustrated in fig.7. **q** is the "uniform loading" equivalent to force per unit length.

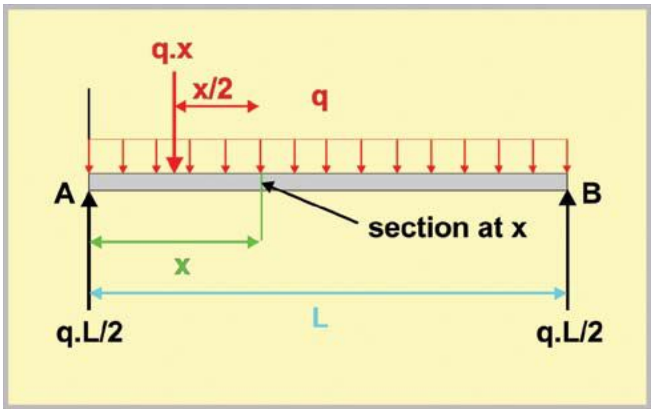

Fig.7. Forces and Bending Moments in a uniformly-loaded beam.

Consider what is happening at the section of the strip that is at a distance **x** from **A**. The upward force at **A** (in Newtons) is **q.L/2** generating a clockwise bending moment of **q.x.L/2**. Between **A** and the section at **x** we have a total downward force of **q.x**. This force acts as if it was at a distance **x/2** from the section at **x**. Hence it generates an anti-clockwise bending moment of **q.x2/2**. The net bending moment at the section **x** is therefore:

$$M_x = q.x.L/2 - q.x^2/2 \text{ or}$$

$$M_x = q.x\,(L - x)/2 \qquad (4)$$

Using 76 mm (the length of an Almen strip) for **L** and unity for **q** gives:

$$M_x = x\,(76 - x)/2 \qquad (5)$$

Plotting equation (5) yields Fig.8. Again we have a parabolic shape.

We could explore uses for the distribution shown in fig.8. However, tutorial time is up—let's go for a beer."

BENDING MOMENT DIAGRAM APPLICATIONS

Applications relating to peened Almen strips depend mainly on the relationships that exist between bending moment, deflection and curvature. The fundamental relationship is given by:

$$M = E.I.1/R \qquad (6)$$

where **M** is bending moment, **I** is the rigidity factor and **1/R** is the curvature. The rigidity factor for a rectangular beam is

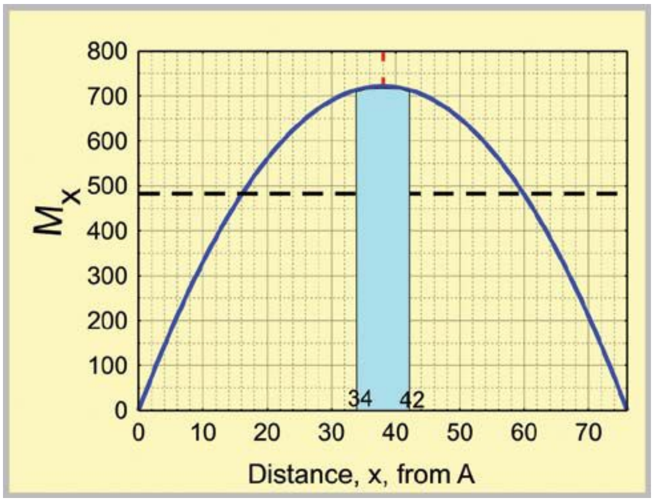

Fig.8. Bending moment distribution for a uniformly loaded Almen strip.

width times thickness cubed divided by 12. The curvature of a strip is therefore related to its arc height, **h**, by:

$$1/R = 8h/L^2 \qquad (7)$$

Combining equations (6) and (7), together with the rigidity factor, gives:

$$M = E.I.8h/L^2 \qquad (8)$$

One important inference from equation (8) is that:

Arc height is directly proportional to the induced bending moment

There are several ways in which we can utilize bending moment diagrams of peened Almen strips. Just three of these ways are detailed as follows:

(1) Almen Gage Measurement Sensitivity

The observed parabolic shape of peened Almen strips has an important effect of gage measurement sensitivity. We know intuitively that it is best for the measuring tip of an Almen gage to be on the center line of the strip. This point is illustrated by Fig.9 for which the peened strip is assumed to have a center line deflection of 722 µm. We can quantify the effect of a small deviation from the center line by substituting into the corresponding parabolic equation $h = (76x - x^2)/2$. For example, for x = 36 mm, 38 mm (centerline value) and 40 mm we get h values of 720, 722 and 720 µm respectively. This shows that a deviation of as much as 2 mm from the center line would only result in an error of 2 µm. Modern Almen gages physically restrict such offsetting to a tiny fraction of a millimeter.


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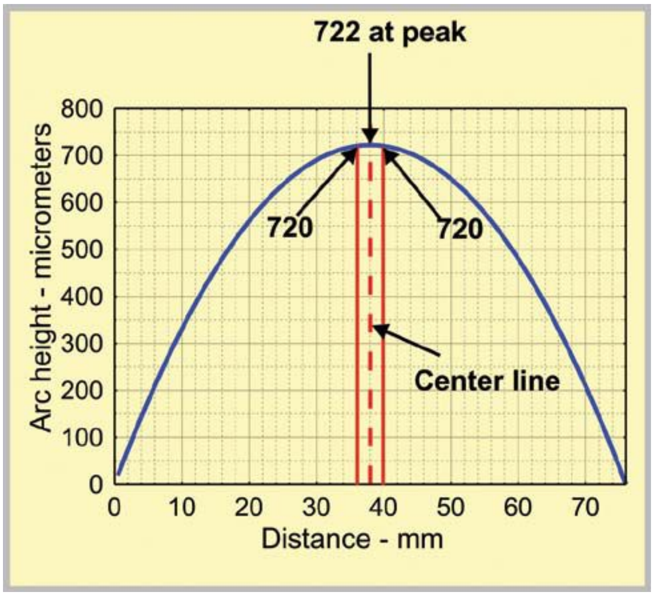


Fig.9. Effect of major point displacement on arc height indication.

(2) Relative Contribution

We see from fig.8 that the bending moment is highest at the center of the strip and disappears at the ends of the strip. The relative contribution to bending of any given portion of the strip is its corresponding area under the curve. One such contribution has been included in fig.8 representing a portion 8 mm wide straddling the center of the strip. The area in blue is some 8 mm x 720 = 5760 (in arbitrary units). Four millimeter-wide portions at the ends of the strip would each contribute (as "half base times perpendicular height") some 2 mm x 135 = 270 giving a total of 540. This is less than a tenth of the contribution by the same width of central portion. These areas can, however, be determined more precisely by using integral calculus.

Every equation has a corresponding derivative that mathematicians describe as its "integral". These are readily obtained nowadays by using web sites. Decades ago integral equations had to be derived using established precepts such as that the integral of $y = x$ is $y^* = x^2/2$ and that the integral of $y = x^2$ is $y^* = x^3/3$. Just those two precepts are all that we need to derive the integral of our Almen strip bending moment equation:

$\mathbf{y\ (or\ M_x) = x\,(76 - x)/2}$ so that its integral equation is

$$\mathbf{y^*\ (or\ M^*_x) = (76x^2/2 - x^3/3)/2} \qquad (9)$$

Equation (9) is what we need to be able to calculate relative contributions to the bending of a peened Almen strip.

Every integral equation can be used to derive the area under a selected portion of the curve. The method is to substitute the smaller value of x, **a**, into its equation and subtract it from the value obtained by substituting the larger value of x, **b**. These larger and smaller values of x are commonly called "limiting values". For those unfamiliar with calculus consider the following example:

"What is the area under a curve of $y = x$ between limits of 1 and 2?" The integral of $y = x$ is $y^* = x^2/2$. The smaller limiting value for x is 1 which, on substitution, gives us ½. The larger limiting value of x is 2 which, on substitution, gives us 2. Subtracting ½ from 2 gives us 1½ which is the correct area. The general equation for solving areas under $\mathbf{y = x}$ can be expressed as:

$$\mathbf{Area = b^2/2 - a^2/2}$$

Consider next the area of the blue region shown in fig.8. The "limiting values" are 34 for a and 42 for b. The equation for the integral is more complicated than that for the straight line of the previous example.

$$\mathbf{Area = (76x^2/2 - x^3/3)/2}$$

Substituting the limiting values of 42 and 34 for **b** and **a** into $\mathbf{(76x^2/2 - x^3/3)/2}$ gives us that the required area = $(76x42^2/2 - 42^3/3)/2 - (76x34^2/2 - 34^3/3)/2$. This (with the aid of a calculator) gives us 5,755. This just happens to be very close to the previous manual estimate of 5,760. In order to determine the relative contribution of this strip portion we need a value for the total area under the bending moment curve. This is obtained using 76 mm and 0 mm for the larger and smaller limiting values of x. Hence:

$$\mathbf{Total\ bending\ moment =}$$
$$\mathbf{(76x76^2/2 - 76^3/3)/2 - (76x0^2/2 - 03/3)/2 = 36{,}580}$$

The relative contribution of the 8 mm-wide central portion is therefore 5,755/36,580 = 0.157 or 15.7% of the total. We can compare this contribution with that for two, 4 mm-wide, end portions of our peened Almen strip. Using b = 4 and a = 0, we get that the corresponding area under the fig.8 curve is 293 which is the same as when using b = 76 and a = 72. Hence the combined contribution of the two 4 mm-wide end portions is 586. This is only a tenth of the contribution to deflection being made by the central 8 mm wide portion thereby agreeing with the previous manual estimate. As an important practical point we can conclude that:

The contribution to bending made by the central region is far greater than that for equal-area end portions of a peened strip.

This point has previously been established by a study, under the auspices of Electronics Inc., for which the end portions of Almen strips were masked. This masking was found to have only a very small effect on measured deflection when compared with that for unmasked strips.

(3) Shot Stream Intensity Variability

The intensity within every shot stream varies within itself.

Declared peening intensity values are an average of shot stream inherent variability. The origin of this inherent intensity variability is schematically illustrated by fig.10.

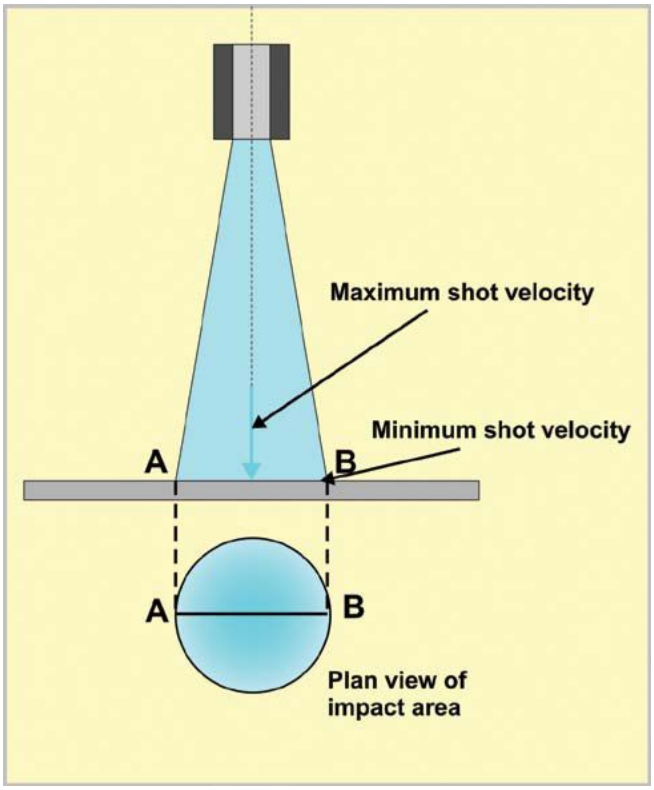


Fig.10. Inherent variability of shot stream velocity.

The maximum shot velocity occurs at the center of the impact area where the impelling air velocity is highest. Minimum shot velocity occurs at the edges, **A** and **B**, of the impact area where the carrying air velocity is lowest. The higher a shot particle's velocity the higher will be its contribution to bending moment. It follows that in order to induce a reasonably uniform peening intensity on actual components there must be substantial overlapping of passes. This effect is very similar to that of trying to achieve reasonably uniform coverage (see "Coverage Variability", The Shot Peener, Winter, 2017).

The effect of shot stream intensity variability on deflection can be studied using a combination of integral equations. One such study is illustrated in fig.11 where it has been assumed that the peening intensity varies by a factor of two (from 10 to 20 units) for a shot stream held constant over a narrow strip. The shape of the bending moment contribution curve is no longer a simple parabola but is now a quartic. With a quartic shape the contributions of end portions become even smaller.

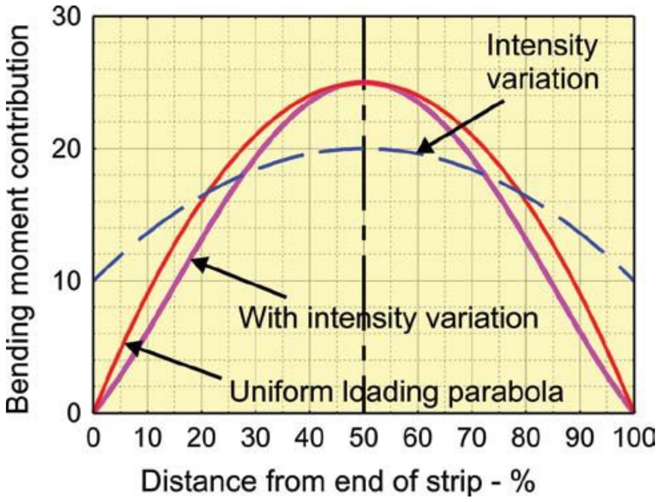


Fig.11. Predicted effect of shot stream intensity variability.

DISCUSSION

This article, being essentially "educational", has sought to show how mathematical techniques can be employed to underpin our understanding of shot peening. Peened Almen strips, being readily available, are particularly useful and their curved shapes can easily be determined. Only longitudinal curvature has been analyzed but the same principles can be applied to crosswise curvature. A very simple (to mathematicians) use of calculus has been included that demonstrates the quantification of curvature contributions. Analysis has been restricted to a limited number of situations largely because of space restrictions for a single article. The relative contributions of residual stress and plastic deformation to measured arc height and studies of the variation of curvature contribution along the length of a peened Almen strip are examples of omissions.

The author showed in 1984 (ICSP2, Kirk D, "Behavior of Peen-formed Steel Strip on Isochronal Annealing") that the two contributions to strip deflection (plastic deformation and residual stress) were roughly equal, giving a ratio of 1:1. This early study involved just one coverage condition. It is disappointing that no institution appears to have carried out more substantial investigations. Theoretical considerations would indicate that the ratio will increase with increase in the amount of coverage. It is probable that the residual stress contribution to curvature peaks at about a nominal 100% coverage and that further bending is due to continued plastic deformation. There is a growing weight of argument that the maximum benefit of shot peening occurs at or below a nominal 100% coverage. A study involving the peening of sets of strips at a range of coverages followed by isochronal annealing would confirm (or otherwise) the theoretical prediction and add weight to the argument about optimum coverage.








Summary of the 5th China National Conference and International Seminar on Shot-Peening Technologies and the 2nd China National Conference on Abrasives and Shot Media

THE 5TH CHINA NATIONAL CONFERENCE and International Seminar on Shot-Peening Technologies and the 2nd China National Conference on Abrasives and Shot Media were held in Shanghai, China from June 11th to 14th, 2018. The conference was organized by the Failure Analysis Branch and the Materials Branch of the Chinese Society of Mechanical Engineering, along with host organizations Shanghai Jiao Tong University and Shanghai Liangshi Intel-robot Technology Corporation. Two-hundred thirty-three participants representing 107 organizations from around the world attended the conference.

The conference focused on the following topics: (1) Conventional stress strengthening technologies such as shot peening and shot blasting, ultrasonic peening, grinding and rolling; (2) New surface strengthening technologies such as laser peening, liquid shot-peening and composite shot-peening; (3) Residual stress fields induced by shot peening and characterization of deformed structure; (4) Influence of shot peening on fatigue properties and stress corrosion resistance; (5) Shot peening forming technologies; (6) Theoretical analysis and digital simulation of shot peening process; (7) Shot peening strengthening and failure prevention of mechanical parts; (8) Advanced shot peening equipment and their applications; (9) New abrasives and shot media and their applications; (10) Residual stress measurement and analysis technologies.

During the conference, experts and scholars gave valuable special reports, and the representatives all claimed to have had a wonderful experience. One notable aspect of the conference is the number of high-caliber young researchers that took part in the academic discourse to make their personal statements at the meeting. All representatives sincerely hoped that the senior experts and scholars will continue to pay attention to and guide the research and applications of shot peening technology, and to ensure the sustainable development of shot peening technology in China.

Thanks to the organizers of the conference, Shanghai Jiao Tong University and Shanghai Liangshi Intelrobot Technology Corporation, and all the companies and organizations for their great support and hard work.

Abrasive Blasting of Medical Implants

MARKET: Medical

APPLICATION: Abrasive blast cleaning of hip and shoulder implants

THE CHALLENGE:
A major manufacturer of hip and shoulder implants in the medical industry wanted to automate their abrasive blast cleaning procedure in order to improve the overall production process. The goal of the medical manufacturer was to increase the production rate by at least five hundred (500) hip and shoulder implants per eight-hour shift as well as to improve part consistency and quality.

The existing process consisted of manually blast cleaning the implants using a bank of four individual blast cabinets manned by four operators working two shifts a day. Due to the nature of parts being processed, the manufacturer was required to meet stringent FDA specifications with regard to part traceability and lot integrity. Unfortunately, with the current equipment and procedures in place, the manufacturer was experiencing inconsistent results and a high level of rejects as well as issues with frequent manpower turnover and training.

THE SOLUTION:
Empire technical sales personnel and application engineers met with the manufacturer to evaluate the current process and determine their requirements.

After careful analysis, Empire recommended, developed and installed a custom engineered automated in-line blast cleaning system designed specifically for processing the implants.

To improve productivity, the machine featured an automated conveyor system and two individual blast cabinets; one utilizing standard aluminum oxide media and the other using a proprietary formula developed by the manufacturer specifically for implants. To further increase throughput, Empire designed a custom parts handling system that enabled the machine to hold up to ten fully loaded parts baskets with each individual basket capable of holding and transporting ten parts at a time into the blast chambers. Each blast cabinet employed a six-axis robot with custom designed part gripper. The robot arm was mounted inverted in each blast cabinet and was designed to grip the parts from the active baskets and present them to the stationary blast nozzle one at a time following a preprogrammed path, and then return the part to the basket.

To help meet FDA requirements for part traceability and to preserve lot integrity, Empire developed a system to enable the parts to be processed as a lot. The system would automatically scan each lot's barcode that would then instruct the machine to set the parameters for that specific lot. This included which blast cabinets to utilize (aluminum oxide, proprietary media or both), all of the preprogrammed paths for the robot motion and the setting of blast pressures. To further help meet FDA regulations, a machine vision system was used to verify that the part and the quantity in the basket was correct prior to entering the blast chamber. To ensure part consistency and quality the system incorporated fault sensors and a reporting system that would notify the operator if any part was found to be out of specification. If so, the operator could immediately rerun the part to bring it within the appropriate parameters.

To eliminate the potential for cross-contamination of media, a blower was employed to blow-off any remaining aluminum oxide media from the parts as they travelled from the first cabinet to the second where the proprietary media was used. In addition, media reclaimers with screening assemblies made sure the media remained within the required size range so the highest quality finish could be achieved.

Automatic profile verification, real time data acquisition and collection as well as power failure recovery was included in the system. The overall enclosure measured 30" wide x 50" deep x 86" high.

BENEFITS:
Empire was able to supply an automated abrasive blast cleaning system with precise robotic control of blast areas and material-handling features that not only increased productivity, but also assured repeatability—a major concern in this quality-intensive application that affected the manufacture of critical FDA regulated medical implants. The medical implant manufacturer was able to reduce manpower from four operators to one, a 75% reduction in labor, while improving finish quality and reducing the number of rejects. Overall, the Empire system was instrumental in helping the manufacturer reduce costs, maintain greater control over final product quality and meet regulatory requirements.

Shaping the Aerospace Workforce of the Future

ON JUNE 21, 2018, aerospace industry experts gathered in London, United Kingdom to discuss their perspectives on the future of special process personnel at a free event, "Shaping the Aerospace Workforce of the Future." Organized by the not-for-profit Performance Review Institute (PRI), the focus was eQualified, an international collaborative aerospace program that harnesses the technical expertise in the industry to address two key challenges: A critical shortfall of qualified special process personnel and the skills gap created by an increasingly globalized workforce.

"eQualified represents a way to safeguard and improve our training and qualifications, which ultimately impact on the future success of our organisations as a whole. Everyone who participates will be contributing to a legacy of helping future generations with aerospace process quality."
—Richard Blyth, Rolls-Royce PLC

The eQualified approach to these issues is two-fold. Firstly, technical experts from across the industry—including representatives from Suppliers, Prime Contractors, Training Providers and Airlines—work together to determine the baseline knowledge and experience required to be considered competent for a target position, such as a heat treating operator working with titanium alloys. Their input is used to develop and maintain special process Bodies of Knowledge, which are made available without charge on the PRI website at https://p-r-i.org/professional-development/qualifications/bodies-of-knowledge. The Bodies of Knowledge are based on global industry standards and best practices. The intent is for the industry to leverage this shared knowledge to secure the future of the manufacturing workforce by using these Bodies of Knowledge for training, recruitment, and personnel evaluation. The eQualified program approves Training Providers to deliver courses aligned to the Bodies of Knowledge ensuring the training materials delivered reflect current industry requirements.

Secondly, eQualified members utilize the Bodies of Knowledge to develop assessments which validate the competency of aerospace special process personnel. Theory assessments can be taken securely online by candidates to objectively verify their understanding of the Bodies of Knowledge content. In some cases, practical assessments are also conducted.

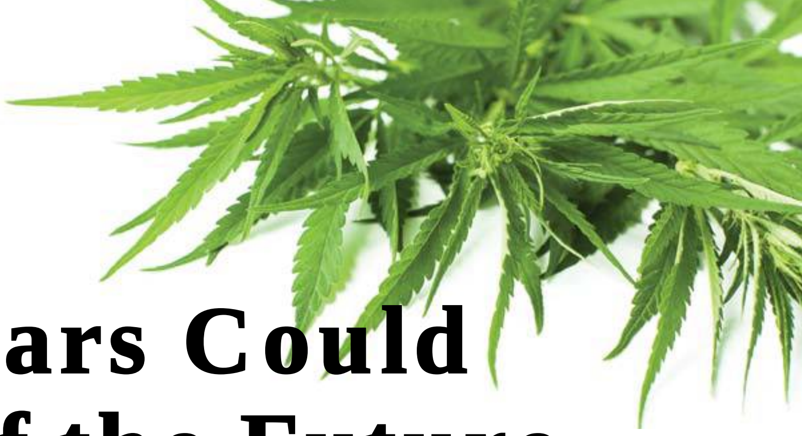
Attendees at the event in London heard from a number of industry representatives who are actively involved in the eQualified program. They included Mark Binfield, Nadcap Lead for Actuation Systems at UTC Aerospace Systems (Goodrich); Richard Blyth, Engineering Manager External Laboratories at Rolls-Royce PLC; Michael J. (Mike) Hoke, President and owner of Abaris Training Resources, Inc; and Charles Parker, Senior Manager of Materials Engineering for Honeywell Aerospace.

"For those not yet involved in this area, this is a great opportunity to network and learn about how the industry intends to utilize the framework of eQualified to address the difficulties we all face with the recruitment, training and qualification of aerospace special process personnel."
—Mark Binfield, UTC Aerospace Systems (Goodrich)

This conference and networking session was repeated on October 25, 2018 at The Engineers' Society of Western Pennsylvania in Pittsburgh, Pennsylvania USA. For more information, send email to eQualified@p-r-i.org. You can also keep up to date with eQualified activity through LinkedIn.

The conference addressed two key challenges in the aerospace industry: A critical shortfall of qualified special process personnel and the skills gap created by an increasingly globalized workforce.

Amanda Onion | ABC News | www.abc.com



Hemp Cars Could Be Wave of the Future

A CAR MADE FROM GRASS may not sound sturdy, but scientists say plant-based cars are the wave of the future.

Researchers in Australia and England are working on developing materials from plants like hemp and elephant grass to replace plastic and metal-based car components. Scientists say the materials are biodegradable and can increase fuel efficiency since they weigh about 30 percent less than currently used materials.

"The lighter the car, the less fuel you need to propel it," explains Alan Crosky of the School of Material Science and Engineering in the University of New South Whales (sic) in Australia.

Use, Then Bury

Crosky and his partners have been developing tough material from hemp, the reedy, less controversial cousin of the marijuana plant. "Hemp fibers have higher strength to weight ratios than steel and can also be considerably cheaper to manufacture," he says.

The hemp used in car construction contains only traces of the narcotic tetrahydrocannabinol, which lends marijuana its psychedelic effect.

Crosky explains building cars — even their outer shells — from plants like hemp could reduce the number of rusting car bodies and rotting car parts on old lots. The plant fibers are cleaned, heated, in some cases blended with small amounts of biodegradable plastics and molded into hardened paneling and filling.

Each year in the United States, 10 million to 11 million vehicles putter out and reach the end of their useful lives. While a network of salvage and shredder facilities process about 96 percent of these old cars, about 25 percent of the vehicles by weight, including plastics, fibers, foams, glass and rubber, remains as waste.

A car made mostly of heated, treated and molded hemp, says Crosky, could simply be buried at its life end and then consumed naturally by bacteria.

Europe Leading the Way

The idea has already taken firm root in countries like Germany and Britain, where manufacturers are required to pay tax for the disposal of old vehicles. As environmental issues become more pertinent, researchers believe natural fibers are likely to become a major component of cars around the world.

"Manufacturers pay a lot of money here to landfill something," says Mark Johnson, an engineer at the University of Warwick Manufacturing Group in England. "If it's made from degradable parts, you don't have to pay."

Johnson and his team have been creating parts from elephant grass, a bamboo-like plant that, he says, requires less processing than hemp to harden and mold into car components.

German car companies including Mercedes (Daimler/Chrysler), BMW and Audi Volkswagen have been leading the way in incorporating plant fibers in their models. Since the introduction of jute-based door panels in the Mercedes E class five years ago, German car companies have more than tripled their use of natural fibers to about 15,500 tons in 1999.

The next trend could be in building the shells of cars from plants. Crosky says he and his team are now looking at building exterior car panels from hemp.

In the United States, automobile companies have approached the idea more gingerly.

"We use natural fibers only when it makes sense technologically," says Phil Colley, a spokesman for the Ford Motor Co.

Colley says Ford has used flax, recycled cotton and a 14-foot tall, fibrous crop called kenaf in some parts, including under front hoods to dampen the sound of slamming them shut. Deere & Co. has used soy-based fiberglass composites in the panels of some of its tractors. By 2010, the New Jersey consulting firm Kline & Company anticipates natural fibers to replace a fifth of the fiberglass in current U.S. car models.

While researchers tout their benefits, Colley points are there are some drawbacks. Smell can become a problem, he says, particularly with hemp which can produce a musty odor when incorporated into a vehicle.

"You have to take into account all the tradeoffs," Colley says.

Inspirations in History

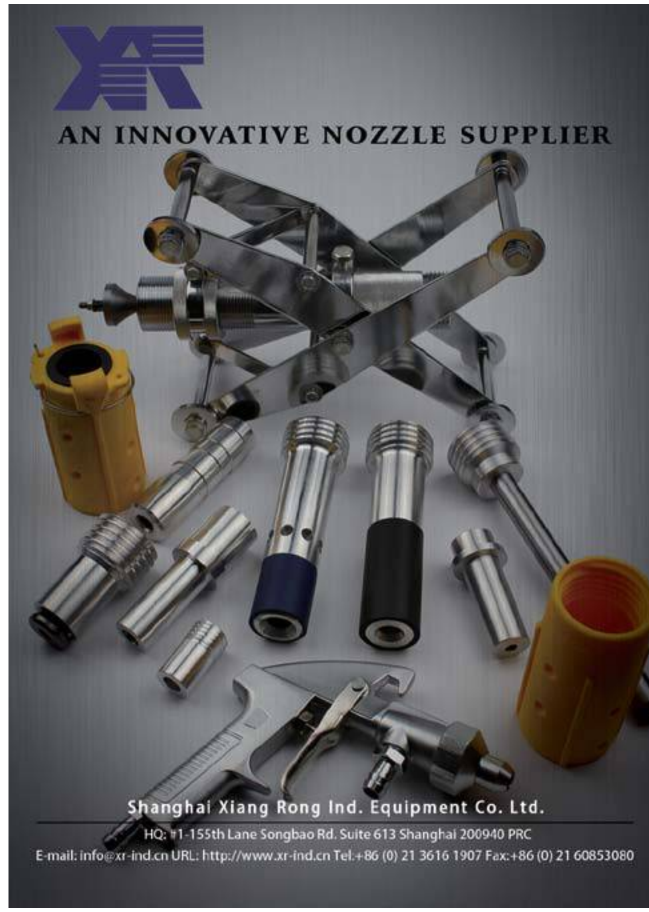
Although fiber car components may be a thing of the future, the idea of manufacturing material from fibrous plants dates back to even ancient times. Fragments of fabric woven from hemp have been found from 8,000 BC. Bamboo and sturdy

grasses have been used in construction for centuries and plots in Japan still provide hemp to weave the emperor's religious robes.

Henry Ford, founder of the Ford Motor Co., first toyed with the idea of plant-based car parts in 1940, when he took an ax and whacked the hood of a car trunk made from a soybean-based material to test its strength.

The car hood reportedly withstood the blow and now, 70 years later, car companies, including Ford's own, have finally begun to put the concept to use.

"Increasing the use of biodegradable and recycled materials will lower the impact of vehicle disposal," says Jim Kliesch, a researcher at the American Council for an Energy-Efficient Economy, a nonprofit, Washington-based organization dedicated to improving the environmental impact of technologies. "And that can only be a good thing."



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The Counterfeit Avoidance Accreditation Program

The Counterfeit Avoidance Accreditation Program (CAAP) has released a new checklist as part of the ongoing aerospace industry activity to address and disrupt the presence of counterfeit parts. AC7403 – Audit Criteria for Accreditation to AS6496 is focused on authorized distributors of electronic, electrical and electromechanical parts.

Based on AS6496, the AC7403 checklist was developed by the CAAP Distributors Task Group, a group of experts from industry including representatives from The Boeing Company, DCMA, GE, Lockheed Martin, Northrop Grumman and UTC. Aerospace distributors/suppliers TTI Inc. and Mouser Electronics are also represented on the CAAP Distributors Task Group and participated in the development of the new checklist.

AC7403 was created in response to aerospace industry demand and joins AC7402 – Audit Criteria for Accreditation to AS6081 in the potential audit scope available to distributors seeking CAAP accreditation.

CAAP also conducts audits to AC7401 (for AS5553) and AC7401/1 (for DFARS 252.246-7007 and 7008). While AC7402 and AC7403 are both for distributors, the AC7401 series is for people purchasing parts and/or assemblies for use, not for distribution. Together, the checklists represent a robust defence against counterfeit parts in the aerospace industry.

The first audit to AC7403 has taken place at Mouser Electronics of Mansfield, Texas on August 2018.

About CAAP

The Counterfeit Avoidance Accreditation Program is a cooperative industry effort to mitigate the risk of introducing counterfeit parts into the supply chain and the cost for compliance throughout the aviation, space, and defense industries. The program has been established to enable organizations that purchase components and assemblies to demonstrate that they have systems in place to identify counterfeit products, and to minimize the risks associated with them. CAAP accreditation will reassure their customers of their vigilance and ability to act appropriately. The Defense Federal Acquisition Regulation Supplement issued by the US Department of Defense has made this activity even more important. CAAP is administered by the not-for-profit Performance Review Institute (PRI). Learn more at https://p-r-i.org/other-programs/caap/ or contact caap@p-r-i.org.

About PRI

PRI is a global provider of customer-focused solutions designed to improve process and product quality by adding value, reducing total cost and promoting collaboration among stakeholders in industries where safety and quality are shared goals. PRI works closely with industry to understand their emerging needs and offers customized solutions in response. Learn more at http://www.p-r-i.org or contact PRI at pri@p-r-i.org.

Colin McGrory Featured at autosport.com

Colin McGrory, the Technical Director at Sandwell UK and the 2016 Shot Peener of the Year,* was recently featured in an online article by James Newbold at www.autosport.com. The article is a fascinating look into Colin's 20-year career in Formula 1 racing that included working as an Engineering Manager for Jaguar Racing and Stewart Grand Prix. An interesting revelation from Colin was that the thriving surface engineering company—Sandwell UK—was only ever meant to be a fallback option in the event that Jackie Stewart's efforts to launch a grand prix team for 1997 didn't come to fruition. The following quotes from Colin gives additional insight into Colin's move from Formula 1 (F1) to shot peening:

> "I loved the engineering in F1, the positive, 'we can do anything' culture, but to me it comes down to the basic materials, the basic grain structure, the heat treatment, the processing that gives you that performance of a component."
>
> "Shot peening is such a low-cost added value to the performance of a component. What we're essentially doing is putting a negative stress into the surface so the material can take increased loads, or you can increase the life on it."
>
> "It does change the look of the surface appearance of the material, but most people would not know that a part had been shot-peened unless you were an engineer. It's really hard explaining to people the difference between a smooth finish and a blasted shot-peened finish. In a way, it is an invisible advantage."

The article in its entirety is available at https://www.autosport.com/engineering/feature/8379/the-story-behind-f1-invisible-advantage.

*The *Shot Peener of the Year* award is given to individuals that have made significant contributions to the advancement of shot peening.