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The Shot Peener

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

Industrial Robot Now Does the Heavy Lifting

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

Keeping Pace with Change

SOMETIMES CHANGE is exhausting, sometimes it's exhilarating.

JACK CHAMPAIGNE

Our new industrial robot exemplifies both sides of change. The implementation wasn't fun but now that it's installed, I enjoy watching the robot work. It makes the whole process of handling media so effortless and we definitely needed a faster way to test and calibrate MagnaValves. The improvements in our testing process will make an expansion of our product line so much easier. And so it goes.

The ever-quickening pace of technology developments gets tiresome. I love my electronic toys as much as anyone but when did the tablet replace the computer as the most popular web-searching device? Have you visited an older website that didn't load quickly or properly on your smartphone or tablet? Truly, as soon as you launch your new website, you'd better be thinking about its next evolution. Profile Industries is doing a good job of staying on top of digital business trends. Read about their website and the eight things they're doing right on page 40.

Your website is probably not keeping you up at night, but "disruptive innovation" might. If you're unfamiliar with the term, Wikipedia explains it like this:

> A ***disruptive innovation*** is an innovation that helps create a new market and value network, and eventually disrupts an existing market and value network (over a few years or decades), displacing an earlier technology. The term is used in business and technology literature to describe innovations that improve a product or service in ways that the market does not expect, typically first by designing for a different set of consumers in a new market and later by lowering prices in the existing market.

I wonder how soon the research and development of new metals will affect our industry...maybe in decades, maybe in years. Nonetheless, the accelerating pace of R&D is why we publish research on new materials in almost every issue of *The Shot Peener*. In this issue, we dedicated a small section to innovation and trends titled "Keeping Pace with Change." Not only is it important to know what's going on in R&D but most research is just plain interesting. Who knew that limpet teeth are now believed to be the strongest biological material? (See page 38.) Who knew limpets have teeth?

Even more rewarding is sharing product innovations from companies like TEC, Rösler and Haver & Boecker. We're very fortunate that aerospace, automotive and medical companies—all advanced industries—depend on our services and push us to continually enhance our products and services.

THE SHOT PEENER

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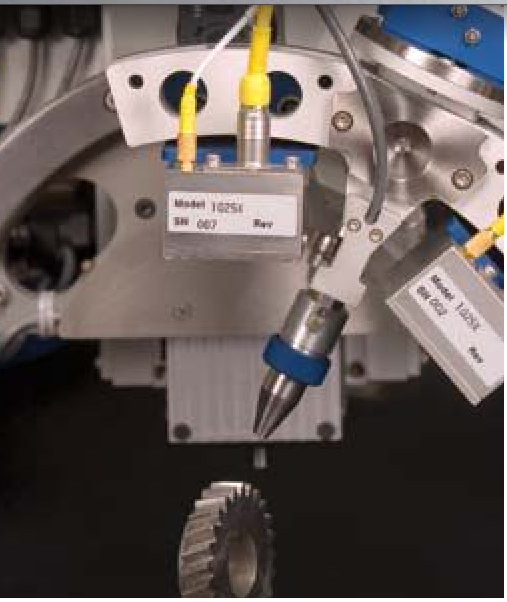

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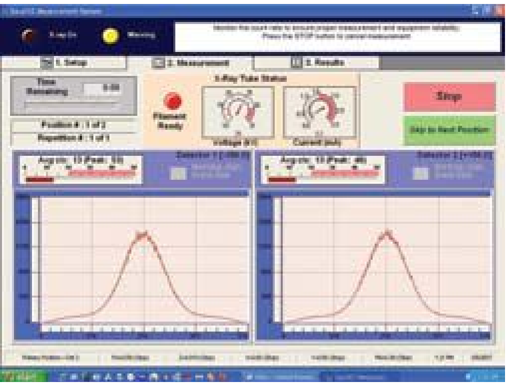

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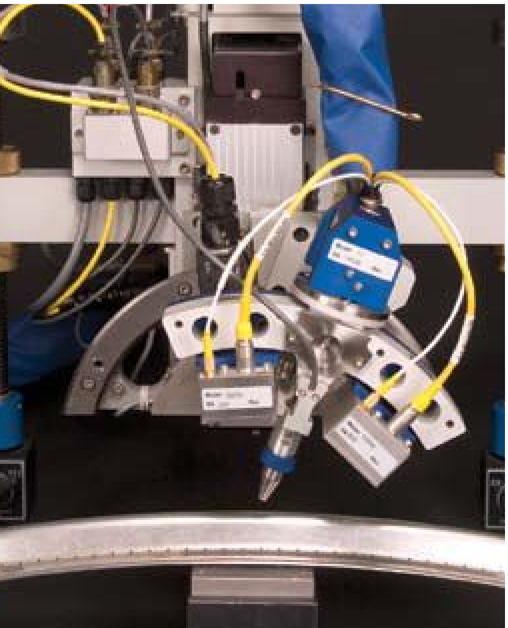

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Industrial Robot Now Does the Heavy Lifting

EVERY MAGNAVALVE® is flow-tested and calibrated to the customer's required media type and size before it's shipped. In the past, depending on the required flow rate of the MagnaValve, it was tested on a test stand with a hopper or an elevator. In either case, an Electronics Inc. (EI) technician was responsible for pouring the media into the hopper or elevator, monitoring the process and documenting the results. A flow test with an elevator could take up to four hours if the elevator had to be cleaned because the next MagnaValve required a different media.

There's Got To Be a Better Way

EI has enjoyed steady growth in its MagnaValve product line, but they were coming up on a problem. Most wheel-blast machine MagnaValves required a test stand with an elevator due to their high flow rates. MagnaValves for air-blast machines could be calibrated on a test stand with a hopper but since a customer orders multiple units for one machine, prepping air-blast machine MagnaValves for delivery was just as time consuming as prepping wheel-blast machine valves. EI technicians were spending too much time handling media and monitoring the test stands, and there was always the risk of media contamination in the elevator. In addition, the elevator was noisy and distracting to workers in the nearby Almen strip testing station. Most importantly, EI wanted to eliminate the safety hazards associated with lifting media and, even though EI maintains an extremely clean plant floor, there was always the chance for media spillage that could result in falls. A material-handling robot became the obvious solution.

"Shotzie" the Robot Takes Center Stage

"Shotzie," so named in an employee contest, was installed in early 2015. The industrial robot navigates in the center of a circular testing station with shelves for containers of media and two testing platforms with hoppers—one for air-blast machine valves, one for wheel-blast machine valves. The hoppers can hold 100 to 700 pounds of media. Tests for both types of valves can run at the same time and the test platforms allow easy access to the MagnaValves so they can be changed quickly.

During a test, the robot picks the correct media and pours it into the hopper. If the test requires a large volume of media, Shotzie picks up the media bucket from under the test platform and pours it back into the hopper. A process that once took up to four hours is now completed in 20 minutes with no risk of injury to employees or chance of media contamination.

Shotzie, the EI industrial robot, lifts a bucket of media up to a hopper while Bryan Chevrie, an EI engineer, watches.

The Advantages of a PLC-Driven Robot

Because it is PLC driven, Shotzie has additional advantages such as common programming controls, software interfaces, backup and restore methods, and program documentation. EI's engineering team wrote the operating procedure and they didn't have to learn a robot programming language to do it. Technicians program the test and then go back to other tasks.

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Every MagnaValve's test results are saved and stored. The system has one control panel with HMI (Human Machine Interface) and AC-24 and FC-24 controllers.

Clean Media, Clean Floor

In Shotzie's work area, there are 50 containers of several sizes of four kinds of media (cast steel shot, conditioned cut wire, special conditioned cut wire, and stainless steel conditioned cut wire). Each container is covered by a shelf to prevent airborne contamination. In addition, EI maintains an inventory of grit, shot for specific customers, custom blends, and other special media (microbead, ceramic, aluminum oxide, glass bead), totaling 75 different medias. The work station is quiet, clean and safe and every container holds pure, clean media.

The Benefits to the Customer

"We didn't want to get to the point where we couldn't keep up with demand or have to sacrifice quality," said Tom Brickley, Vice President of Electronics Inc. "Now we can calibrate a valve and get it back to a customer in 24 hours upon request."

Since Shotzie has come on board, EI is looking forward to increasing productivity and ramping up its research and development of new MagnaValves.

Shotzie "presents" the media for inspection. A SWECO ensures that the media is kept in top condition.

The control console has a large monitor and holds several EI controllers. Bryan Chevrie demonstrates how easy it is to install a MagnaValve.

by Kumar Balan | Engineer | Empire Abrasive Equipment

What Is Your Machine Trying to Tell You?

IF YOU ARE READING THIS, there is a good chance you work in Aerospace, Automotive or a similar advanced manufacturing sector. You might be engaged in shot peening, grit blasting, etching or another value-added surface preparation operation on your component. Furthermore, if your machine is less than ten years old, and automated, it likely has a PLC, HMI and diagnostics to help you identify, or at least narrow down, issues when they arise.

With all that taken into consideration, most users of shot peening and blast cleaning equipment will also agree that there are more than the obvious reasons and causes when it comes to machine issues. Just as it is difficult to quantify what "exactly" happens to each pellet of abrasive after it leaves the blast nozzle or wheel, the same is true for the machine and process feedback we receive during regular use.

Our discussion will focus on some of the machine feedback and categorize it as having *obvious* or *not-so-obvious* causes. When we do so, let's bear in mind that peening and cleaning machine technologies continue to evolve. The process variables are constantly impacted in positive ways by technological advancements, and the resulting machine performance will be a continuing debate.

Problem: Media Leakage Around the Machine

Most of us share the same opinion on the propensity of cleaning and peening machines to leak abrasive. An astute, albeit facetious, solution that many offer to this ancient problem—stop adding media and this problem will go away! Unfortunately, this solution isn't very practical. Media leakage can occur in multiple locations in the machine. Typical areas are through openings such as work doors, access doors, the roof of the cabinet and near the reclaim system components. Each location has its own reason(s) for leaking media.

A well-designed machine will attempt to direct media from a nozzle or blast wheel away from an access door, work door or protected opening (Fig. 1). In addition, most cabinets are lined with wear-resistant material for protection from the incidental media stream or rebound media bouncing off the component. However, these features don't always prevent media leakage and then we must look into the causes.

Fig 1. Nozzles targeting specific areas on the component and away from the door.

Obvious causes

1. Faulty/worn nozzle holding arrangement or worn blast wheel part (typically the control cage or blades) that misdirects the abrasive towards the cabinet opening
2. Worn door seals or curtains (in the absence of doors) that allow abrasive to escape the cabinet
3. Worn seal on the cabinet roof slot provided for the purpose of nozzle carriage arm entry into the cabinet
4. Sharp radius of the blast hose resulting in rapid wear in tight areas, softening of the hose and an eventual tear
5. Loose hose fittings and gradual dislodgement at connection points

For the not-so-obvious causes of media leakage, let's start with a real-life occurrence:

> A customer who shot peens a high volume of automotive components reported that passersby in an aisle behind the machine were being hit by abrasive. Though this is not uncommon when standing in front of a badly leaking machine work door, in this case there was a solid machine cabinet wall in back of the machine where the leakage was reported. Within a few hours of machine usage, this leakage got more pronounced and a narrow opening was visible in the wall. The culprit was a cabinet liner that had come loose in the rebound area inside the blast cabinet, exposing the bare wall to abrasive impact. At 300 feet per second (91 meters per second), it did not take long for damage to exacerbate.

From every peening workshop we have attended, we have learned that the abrasive particle loses very little of its impact energy within the first few rebounds. Moreover, we also know that less than 100% of the media stream hits the target. The percentage that doesn't hit the part could be hitting a liner or deflector that is likely misdirecting abrasive towards a cabinet opening. The same holds true for parts with complex geometries and features that tend to deflect the abrasive as they spin on a satellite table.

Other not-so-obvious causes

1. Another classic source of leakage, typically on the cabinet roof, is from abrasive escaping through the air inlet. Steel shot, given its spherical shape, commonly exhibits this tendency, more so with smaller shot sizes such as S70 and S110. The round profile of steel shot allows it to effortlessly roll along the walls of the air inlet and make its way outside the cabinet. The solution could be a taller air inlet and multiple layers of internal baffles.
2. In an airblast machine with vacuum recovery, the media stream from the cabinet (reclaim duct) enters the reclaimer at almost 4500 feet per minute or greater. The tangential entry into the reclaimer is the first point of potential wear. Most reclaimers are built with wear plates at this first point of entry and lined with wear-resistant material where the media swirls. It is critical that the wear plate be inspected regularly for erosion or damage.

The most serious consequence of media leakage is that it's a safety hazard due to injuries from falls. Other problems include:

- Loss of media (if leaked media is recycled back into the machine, it should be thoroughly cleaned offline of large size contaminants before reuse)
- Insufficient coverage (particularly in peening applications)
- Longer cycle times

A lip below the access door will reduce media leakage onto the floor.

Problem: Finished Part (Peened or Cleaned) Has a Brown Residue

An aerospace customer complained that their shot peening process gave repeatable results but the parts exited the machine with a rust-colored coating on them. The diagnosis commenced with examining the obvious areas of concern. Being a wheelblast machine with high flow rates, it had a mechanical reclaim system with an airwash separator. The separator openings, the velocity of ventilation stream and all other obvious areas were checked and eliminated as possible culprits that could cause discoloration. Another potential problem area was the initial condition of the parts. Any oil or moisture on the part could lead to abrasive contamination and potential discoloration of the finished product. This reason was eliminated, too, since the parts were completely dry when introduced to the machine.

Upon further investigation, it was discovered that the machine had not been used for an extended period of time. If a machine is mothballed for time periods greater than two to three weeks, abrasive left in the machine could develop flash rust and transfer the rust to the component being blasted. In addition, rust from the insides of reclaim system components could also enter the media stream and cause further contamination.

Two possible solutions are recommended, with the first preferred over the second. A machine should never be idle for extended periods of time. It should be operated with blast media for at least an hour or two every five to seven days, more frequently in humid environments. This keeps the abrasive in circulation and reduces the possibility of rusting. The second method is to clean out all the abrasive from the machine and store it in a dry location. However, this doesn't eliminate the possibility of reclaim system transfer rust.

Problem: Process Parameters Haven't Changed but Arc Heights Have Dropped

This is a common complaint from regular users of this process. Most of these users are aware of potential causes, but lose track of them when focusing on routine production tasks. However, we know that all peening processes are critical and the implications of a non-repeatable process can be disastrous to the end product.

Obvious causes

1. Air pressure in a nozzle machine and wheel speed in a wheel machine are directly proportional to arc height (and intensity). A drop in air pressure or wheel speed will result in reduced arc height. Air leakage, faulty PID loop for air pressure, or faulty speed controller (inverter) in a wheel machine are some of the common causes.
2. Blades that are too short were installed in a wheelblast machine during machine maintenance and blade replacement. Media velocity is directly proportional to the wheel diameter.

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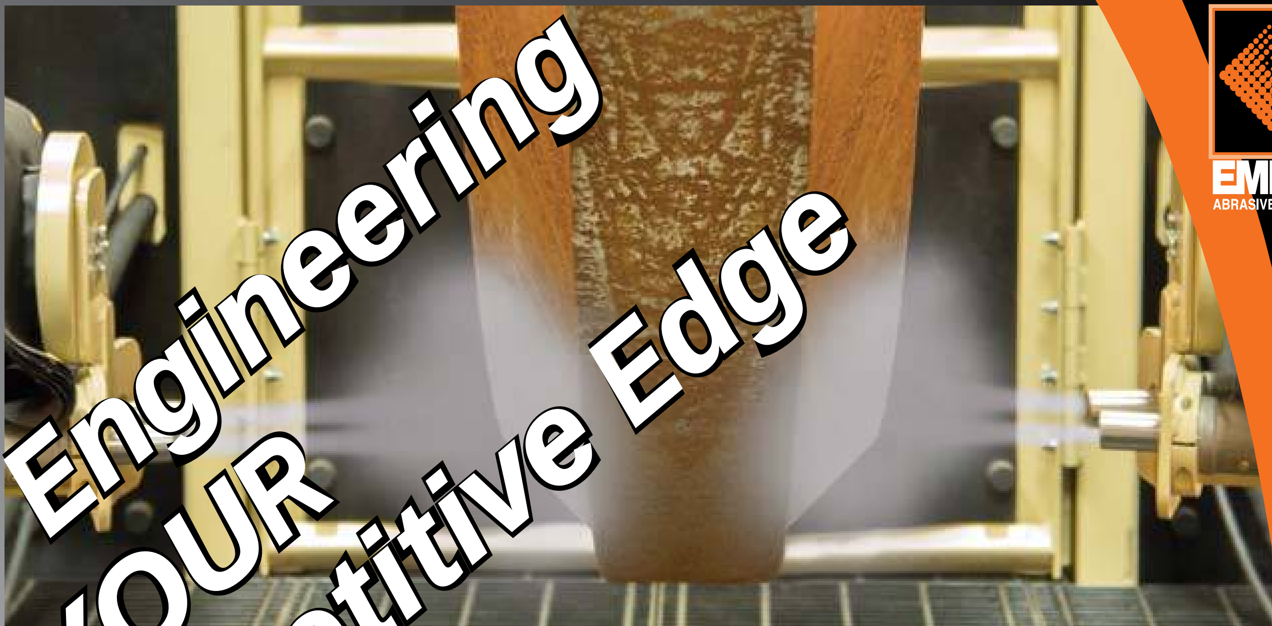

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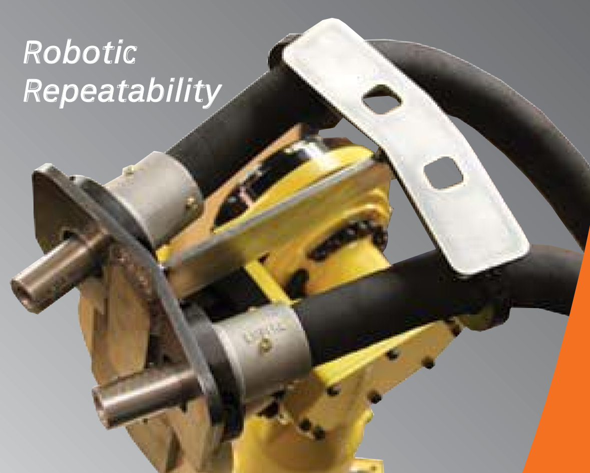

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3. The wear of nozzles and hoses will impact arc height. Similar results can be expected with wear of wheel components such as blades, control cage and impellers.

Not-so-obvious causes

A customer in aerospace had a very efficient peening operation with over 20 Almen blocks in a part verification tool (test fixture). The customer maintained arc heights within 0.002" over the set of Almen strips. After several years of peening with this stellar record, they started experiencing a drop in arc heights even though all parameters remained unchanged. Several days of fault diagnosis bore no productive result until it was disclosed that they were trying out a new media supplier. The new media supplier was supplying media that conformed to SAE specification so this is not to say that the new media was of poor quality. Though seemingly innocuous, it simply means that any change in media could lead to different impact energy, possibly because of a difference in the metallurgy of the metal. Process parameters will require tweaking and new saturation curves will need to be plotted.

Other not-so-obvious causes

1. Wrong type of Almen strips used for testing (A instead of N, or C instead of A). There is also the possibility of a faulty Almen strip due to a manufacturing error.
2. Change in the hardness of the part. This reason doesn't necessarily belong in this category since we only peen strips for verification and not the actual parts, but yet worthy of mention in context. However, it is important to note that given the same set of process parameters, a hard part will bear different results than a softer part when peened. This is amply demonstrated in coverage times and residual stress results.
3. The Almen gage needs to be calibrated.

Problem: Process Parameters Haven't Changed but Cycle Time Has Increased or Coverage Is Insufficient

Arc height (i.e., intensity) is a function of air pressure, wheel speed or wheel diameter; it has nothing to do with the actual part. Coverage and cycle time (the latter in cleaning applications) is observed on the part and is a function of the amount of abrasive propelled onto it (lb/minute or kg/minute). Other than specific applications where high flow rates could result in flooding the part, an increased flow rate will generally result in a shorter cycle time in most applications. Increased flow rates have different reactions in a wheelblast and airblast machine, where it has to be matched with proportional changes to air pressure (in the air-blast machine).

Here are some of the obvious and not-so-obvious causes:

1. Is the part now made from a harder material?
2. Has there been a change in your media supplier or abrasive quality?
3. Have you changed the size of the abrasive? Smaller abrasive provides better coverage. (2:1 Size = 8:1 Impact Value and 1:8 pellets/lb. Source: *Effective use of steel shot and grit for blast cleaning*, E.A. Borch, Ervin Industries, Inc. April, 1999)
4. Issues with the work-handling arrangement such as a slipping belt that improperly presents the part to the blast nozzles/wheels, a faulty bearing, a broken chain, etc.

It's advisable to conduct a Media Catch test for each nozzle and blast wheel in your machine to validate the results and ensure consistency.

Summary

Our discussion here merely scratches the surface of the issues you face in your blast cleaning or shot peening operation. Such is the nature of cleaning and peening. Importantly, the point of this article is to recognize that there is more than the obvious when it comes to recognizing the causes of common machine issues. If the problem is sorted out by addressing the obvious, that might be it. However, recurrence indicates that you have to drill deeper, and the past may not necessarily be a good predictor of the future when it comes to fault diagnosis.

Blast cleaning and shot peening machines follow very basic principles. With a clear understanding of the relationship between mass, velocity and resulting impact energy, you will be on the right track to correcting issues that surface with your machine during routine operation.

The Role Played by Specifications

When taking a honest look at the process and equipment, it's not uncommon to conclude that there is still sufficient mystery in its operation. This mystery, particularly in shot peening, is not desirable. This is where we can take refuge in established specifications because they have been created with the intention of providing uniformity and repeatability to your process.

For example, AMS 2430 clearly identifies every aspect of a peening process including media quality, media maintenance in your machine, the plotting of saturation curves, and more. Following this document will help pinpoint machine issues before they become catastrophic to the end product.

Specification conformance is onerous, but the cost of non-conformance is much higher. Faulty machine design, however, cannot be fixed by specification conformance. Therefore, a thorough knowledge of relevant specifications will help you identify the features you need in a machine before making a purchase.

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TECHNOLOGY FOR ENERGY CORPORATION'S (TEC) Materials Testing Division proudly introduces MAX, a Miniature Advanced X-ray Diffraction System, which promises to have a profound effect on the stress and retained austenite measurement industry. TEC meets customer needs and offers unparalleled compatibility, convenience, and reduction in time and costs with this compact, portable device for measuring surface residual stresses in previously inaccessible locations. This innovative, powerful new product was developed under an Air Force SBIR program to measure residual stresses in hard-to-access locations on aircraft.

The miniaturized system measurement head fits within a space 8 inches in diameter and uses x-ray diffraction to measure stresses in common engineering materials. This third generation version of miniature diffractometers now uses the $\sin^2 \Psi$ technique which improves the precision of the measurement. This system is unique in its ability to measure retained austenite in accordance with ASTM E975. MAX's versatility in other industrial and real world applications seems limitless. It is compact, effortless and accurate.

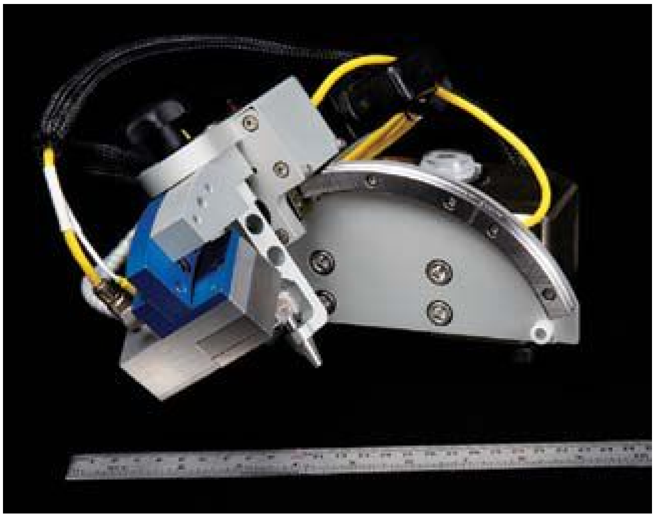
The MAX system consists of hardware and software packaged in two rugged traveling cases plus a laptop PC. The hardware contains a measurement head, safety system and electronics. The measurement head includes a low-powered x-ray tube with a 4-Watt high-voltage power supply and a miniature position-sensitive proportional counter (PSPC) detector. Data obtained by the detector are analyzed with re-designed electronics that incorporate the capabilities of a full-sized electronic module on two integrated circuit boards. The measurement head is small enough to fit inside an 8-inch opening. Accurate measurements can be made in as few as 2-3 minutes.

Designed for field use, MAX only requires 110V/15A service. The entire system is controlled by software from a laptop computer. Rigorous peak fitting routines provide excellent data analysis for this low-powered system. Users may choose from several commonly used routines to optimize analysis accuracy. Software guides the user through the entire measurement and analysis routines with simple, easy-to-use visual guides. An interlocked optical beam provides a barrier to protect personnel from the emitted x-rays during system operation.

The addition of retained austenite measurement capability makes MAX a versatile tool for any industry using ferrous materials (steels and cast irons). MAX uses the "4-peak" method which measures two separate austenite and two separate martensite/ferrite peaks. The measurement of at least two different austenite peaks is required by ASTM E975. MAX can measure engineering metals and ceramics through the proper combination of x-ray tubes and detector positions. Currently, chromium and copper x-ray tubes are available. Additional tubes may be available in the future. MAX has the ability to measure diffraction peaks in the high back-reflection region of 120˚ to 170˚.

This innovative new product will be available later this year.

The MAX system is portable and compact for measuring previously inaccessible locations.



The Max measurement head fits easily within an 8-inch diameter space.

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The Rösler Gamma® 400 G

SHOT BLASTING for surface cleaning and surface preparation represents an indispensable manufacturing phase in many metal-processing industries. Generally, blast turbines are the most expensive component of many shot blasting systems, requiring significant upkeep in terms of maintenance and wear parts.

At the GIFA exhibition in Duesseldorf, Rösler presented its newly developed and extremely versatile Gamma® 400 G blast turbine which will be setting new standards in cost efficiency. For example, compared to conventional turbines, the Gamma® 400 G offers a 100% higher uptime and a significantly improved blast performance together with drastically reduced maintenance costs.

Distinctive features of the Gamma® 400 G are the Y-shaped throwing blades, providing many technical advantages for this innovative turbine, for which a patent application is pending. By simply turning the blades around, both sides of the throwing blades can be utilised. This design helps double the uptime and results in drastically lower wear part costs.

Quick and simple exchange of the throwing blades

With conventional twin disk blast turbines, the replacement of worn throwing blades is complicated and time consuming. The impeller and control cage must be completely disassembled before the old blades can be loosened, removed and new blades inserted through the center of the twin disks. With the new Gamma® turbine design, the worn throwing blades can be easily loosened, taken out from the side and replaced with new blades after simply removing a maintenance side cover. This quick blade exchange with easy access to all wear components makes turbine maintenance not only simple but also saves a significant amount maintenance time, further helping to increase that all important uptime and reduction in operating costs.

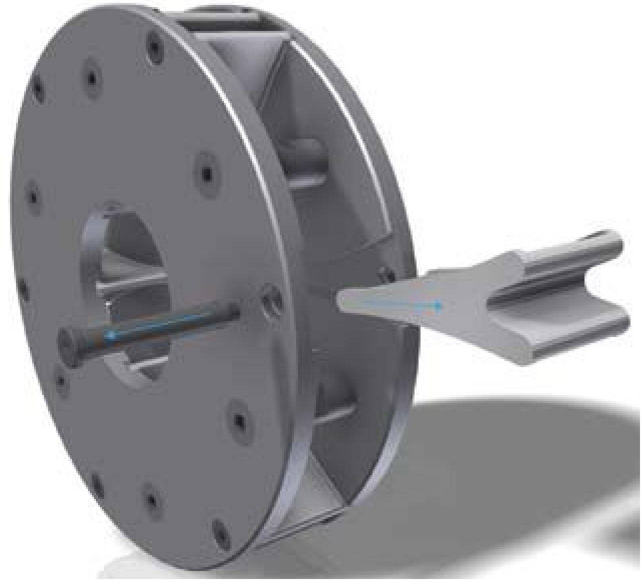
Blast performance improvement by 15% - 20%

Another key feature of this unique blade design is the improved turbine efficiency. Compared to straight blades, the curved throwing blades of the Gamma® 400 G allow a much more fluid flow of the blast media. Without increasing the turbine diameter this improves the media acceleration and produces significantly higher throwing speeds. The end result: A 15%-20% percent higher blast performance with, subsequently, shorter processing times for many shot blasting applications!

Flexible turbine drive power and media throughput

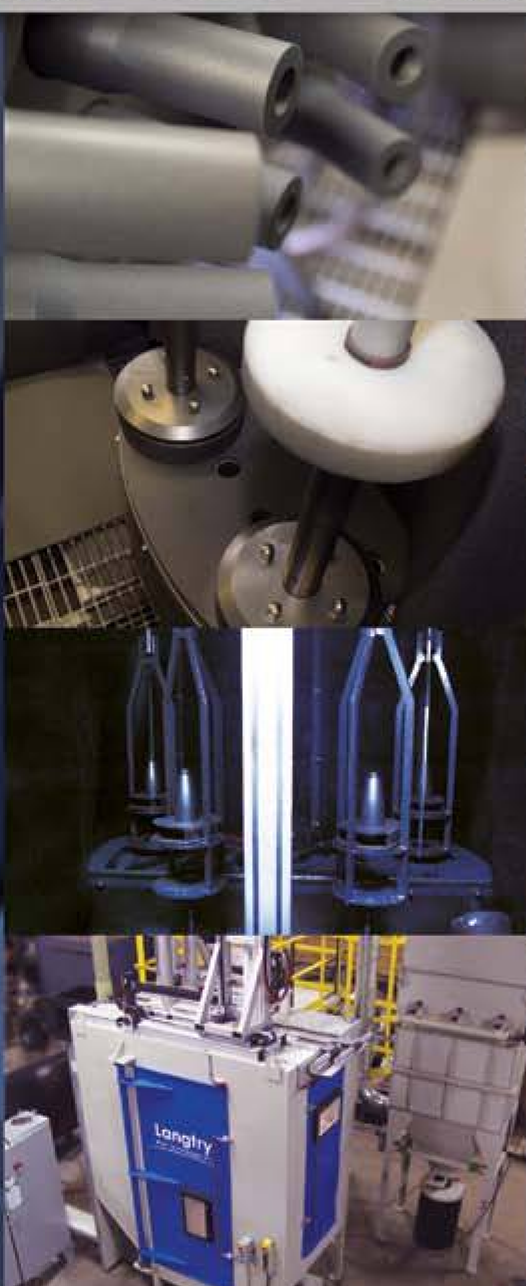
The new Rösler blast turbines have a diameter of 400 mm (about 16"). They can be equipped with drive motors from 11 up to 30 kW and generate media throughputs of up to 400 kg/min (880 lb/min). With this wide range of power options, the Gamma® 400 G is suitable for practically any shot blasting application. The Y-blades are produced by a special manufacturing process that also allows fabricating the turbine components in a highly wear resistant tool steel.

Rösler GmbH is an international market leader in the production of surface finishing, shot blasting machines, painting systems and preservation lines as well as process technology for the rational surface finishing (deburring, descaling, sand removal, polishing, grinding…) of metals and other components. Besides the German plants in Untermerzbach and Bad Staffelstein, the Rösler Group has branches in Great Britain, France, Italy, The Netherlands, Belgium, Austria, Switzerland, Spain, Romania, Russia, China, India, Brazil, South Africa and USA.



After simply removing a maintenance side cover, the throwing blades can be easily exchanged. Mr. Jan Reinmann, R&D manager at Rösler, explains: "Compared to conventional turbines, the technical and economic advantages of our new turbine design are so convincing that within the near future we will introduce a version with a diameter of 300 mm (about 12").


POWER ON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The HAVER CPA 2-1 Is the Ideal Solution for an Abrasive Blasting Media Manufacturer

ABRASIVE BLASTING uses many different compositions and particle sizes of abrasive for a wide variety of applications. Examples include cleaning, rust removal, matting, and surface hardening. Users do not only distinguish between the size and shape of the particle, from cubic to almost spherically round, they also analyze the abrasive blasting material's compliance to the normative quality requirements or how much it exceeds them.

As a manufacturer of abrasive blasting media, VULKAN INOX GmbH has to meet these requirements. The company, founded in 1985, is in Hattingen, Germany. It produces and markets cast stainless steel abrasive blasting and special granules based on iron-carbon alloys and it is certified to EN ISO 9001:2000. The production of abrasive blasting media for the surface treatment of screws is just one example of the application-related products developed by the company. This application requires a uniform surface that provides conditions suitable for an anti-corrosion coating. In order to achieve the defined roughness of the screw surface, the abrasive blasting agent Chronital S10 with a grain size of 90 µm to 200 µm is used (Fig. 1). The special feature of this premium value stainless steel abrasive blasting agent is that the maximum size of 200 µm is not exceeded. Together with a good circularity of at least 95% of the particles, this fulfils the most essential requirements for optimum processing of the screws. In addition to the size distribution, precise shape accuracy is essential in the analysis. These specifications were previously checked using traditional sieve analysis and a visual examination of a small amount of material.

Because the results of this shape analysis are considered to be more subjective and thus vary from person to person, VULKAN INOX GmbH purchased a HAVER CPA 2-1. The

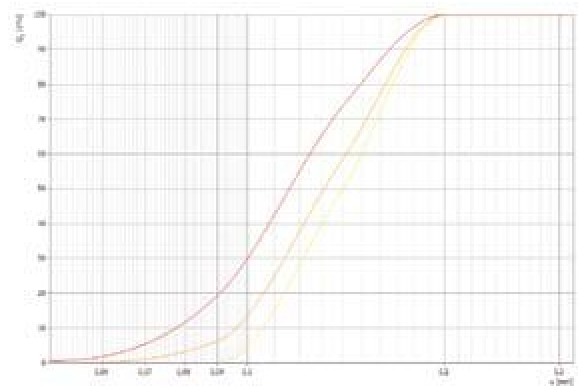


Fig. 2. The result of three analyses of the abrasive blasting agent Chronital S10 using the HAVER CPA 2-1. The throughput distribution (Q3[V-%]) clearly shows that the main part of the abrasive blasting media is made up of particles with a size between 90 and 200 µm. Also for very narrow distribution ranges, the smallest differences and deviations are clearly shown by the various depiction possibilities that are offered by the HAVER CpaServ.

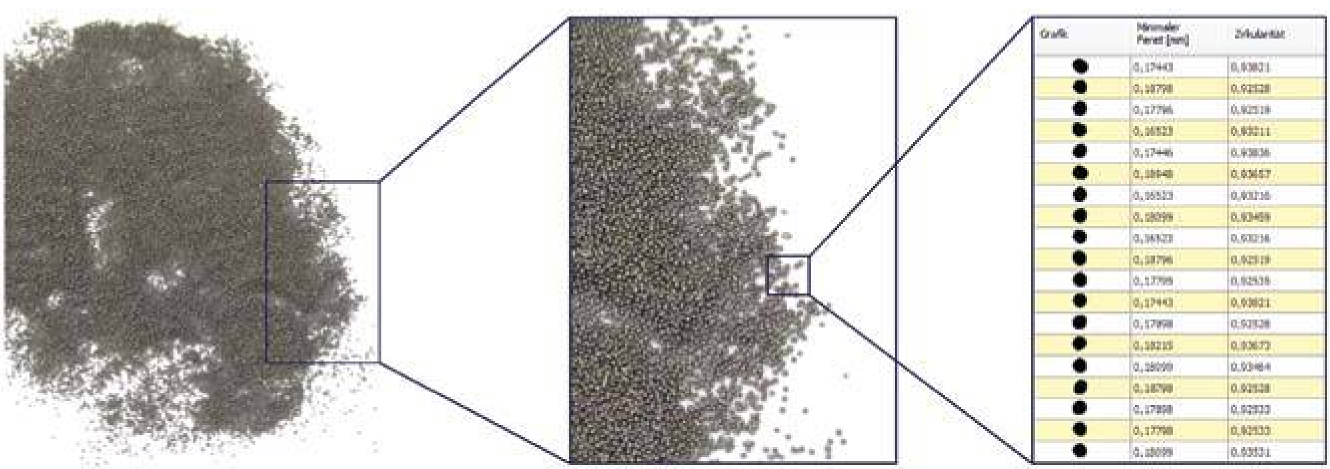


Fig. 1. Abrasive blasting material Chronital S10 with shape values over the normative standard is used for the surface treatment of screws. The standard assures short blasting times in addition to long lifetimes. The figure shows the macroscopic and microscopic imaging of the Chronital material with an example excerpt from the particle list from the HAVER CpaServ software.

precision and reproducibility of results is excellent for this dynamic image analysis. Also, the speed at which the HAVER CPA analyses large abrasive blasting materials is impressive due to its wide channel and high-resolution camera. HAVER CPA technology enables all particles to be measured and evaluated in real time. Even the finest differences are measurable. The HAVER CpaServ software performs the check and assessment of the shape and size using a variety of possible size and shape definitions (Figs. 2 and 3). The results provided by the HAVER CPA unit contribute to optimising production control. Whilst the S10 particle size can be regulated by the application of pressure during spraying in the production process, granulation and circularity are highly dependent on the melting process. Over the option of the particle list, the results of the abrasive blasting media analysis and a graphic display of each article can be carried out, checked over, and proven.

Additionally, VULKAN INOX GmbH can analyze the abrasive blasting media online. Like all HAVER CPA systems, the HAVER CPA 2-1 is prepared for online measurements and can be utilised for automatic checking of production. The HAVER CPA 2-1 ONLINE, which is continuously ready for measurement, is connected with a sample taker that continuously extracts abrasive blasting material during the running process. The sample taker and the CPA unit may be activated either by a memory-programmable controller or manually. The sample can returned directly into the process after measurement.

Precise results from the HAVER CPA, with just a short measurement time, allow VULKAN INOX GmbH to continue to offer an assured level of abrasive blasting material quality despite increased requirements by the users. It allows production to benefit from optimisation and the optional connection in an inline and online application.

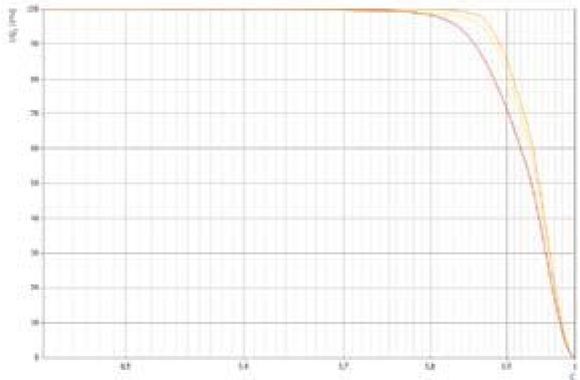
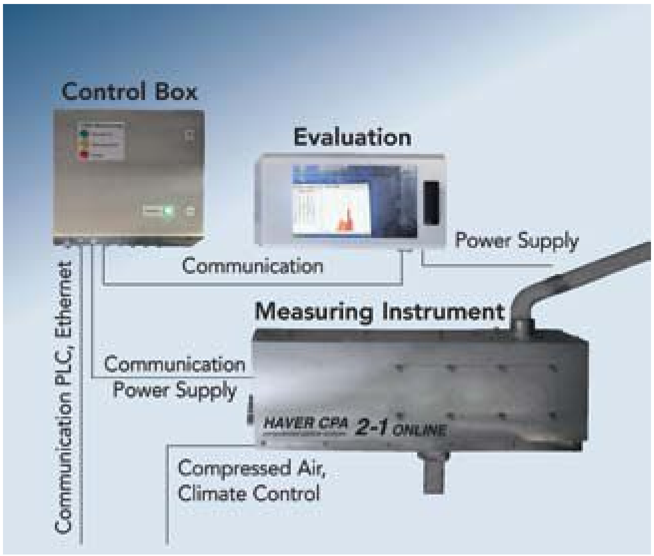


Fig. 3. The result of three samples of the abrasive blasting agent Chronital S10 using the HAVER CPA 2-1. The residue distribution (1-Q3[V-%]) clearly shows that with good samples (yellow and orange) over 95% of the abrasive blasting media is made up of particles with a circularity of over 0.86. The deviation clearly shown here cannot be detected using a manual optical check.

For the size and shape analysis of abrasive blasting material, the HAVER CPA 2-1 with a measurement range starting at 0.034 mm and a channel width of 65 mm is suitable for rapid and reliable analysis.



The HAVER CPA 2-1 ONLINE (with maintenance and control unit and a notebook housing) can be used for the automatic check of abrasive blasting material production.

About HAVER & BOECKER

HAVER & BOECKER is a traditional family-managed, midsize company with headquarters in Oelde, Westphalia, Germany. The Wire Weaving and Machinery Divisions are under the umbrella of HAVER & BOECKER OHG. Together with over 50 subsidiary companies on all five continents, they make up the HAVER Group which has more than 2,898 employees and 150 representatives. In 2014 the HAVER Group posted a sales turnover of 428 million euros.

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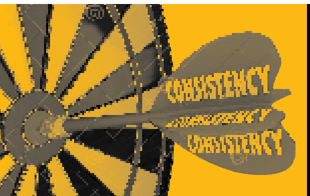

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The largest 5-Axis CNC 96" Shot Peening Index Table made. Two-media capacity with MagnaValves® for large rings and pinions up to 33" O.D. Designed for higher volumes. (GE 31-i Series Controller)

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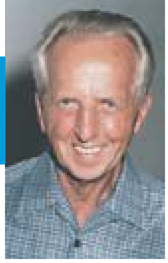

ACADEMIC STUDY
by Dr. David Kirk | Coventry University

Principles of Peening Intensity Selection

INTRODUCTION

The most difficult shot peening question to answer is, probably, "What peening intensity should I apply to my component?" For any specific component, an answer should be based on a combination of prior knowledge and an understanding of the basic principles that are involved. Five basic principles are discussed as illustrated in fig.1. Prior knowledge is being aware of peening intensities that have previously been applied to similar components.

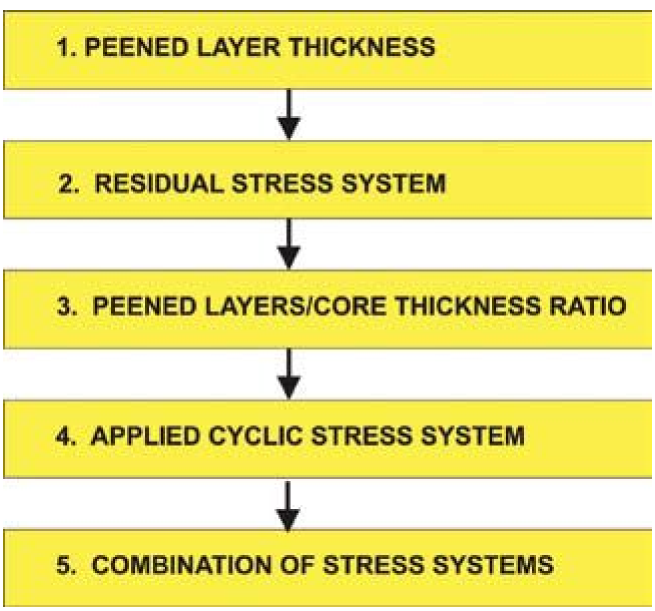

Fig.1 Basic principles affecting Peening Intensity Selection.

"Peening intensity" is, of itself, a confusing term. We all know how it is quantified—as the arc height at a particular point on a "saturation curve" produced using one of three thicknesses of Almen strips. But what does that really imply? A reasonable interpretation is that it is a measure of the "indentation capability" of the individual particles that make up a shot stream. One analogy is that of a stream of machine gun bullets. Each bullet is capable of making an indentation where indentation size depends on the velocity, size, shape and density of the individual bullets.

All of the factors affecting peening intensity selection are quantifiable. It is therefore necessary to consider them quantitatively. Only basic calculations are used in this article. These are mainly applied to components having the simple geometry of leaf springs. Several readings of the article may be needed in order to appreciate all of the diagrams that have been included—unless one is a mechanical engineer!

BASIC PRINCIPLES

1 Peened layer thickness

When a shot stream covers a component's surface with indentations it produces a work-hardened surface layer that contains compressive residual stress. This surface layer has a thickness that is directly proportional to the peening intensity (indentation capability) of the shot particles. The induced work-hardening and compressive residual stresses combine to improve the service performance of the component, especially its fatigue life in bending situations. That does not, however, mean that "thicker is better" when referring to the peened surface layer.

Fig.2 illustrates the effect of applying low and high peening intensities to a given component's surface. Low peening intensities are normally produced when using relatively-small shot particles and high peening intensities by using relatively-large shot particles. Shot velocity and density have an effect regardless of shot size—higher velocity and

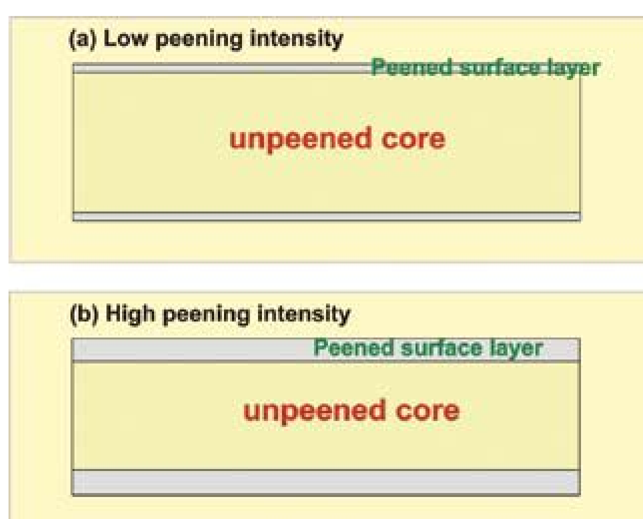

Fig.2. Low and high peening intensities producing thin and thick surface layers respectively.

density both giving greater peening intensities.

The peened layer thickness has an important effect on the residual stress system that is a vital feature of all shot-peened components.

2 Residual stress systems

The Heyn Spring Model is a very useful way of describing a residual stress system. Consider the following analogy of how a spring model of a residual stress system could be generated.

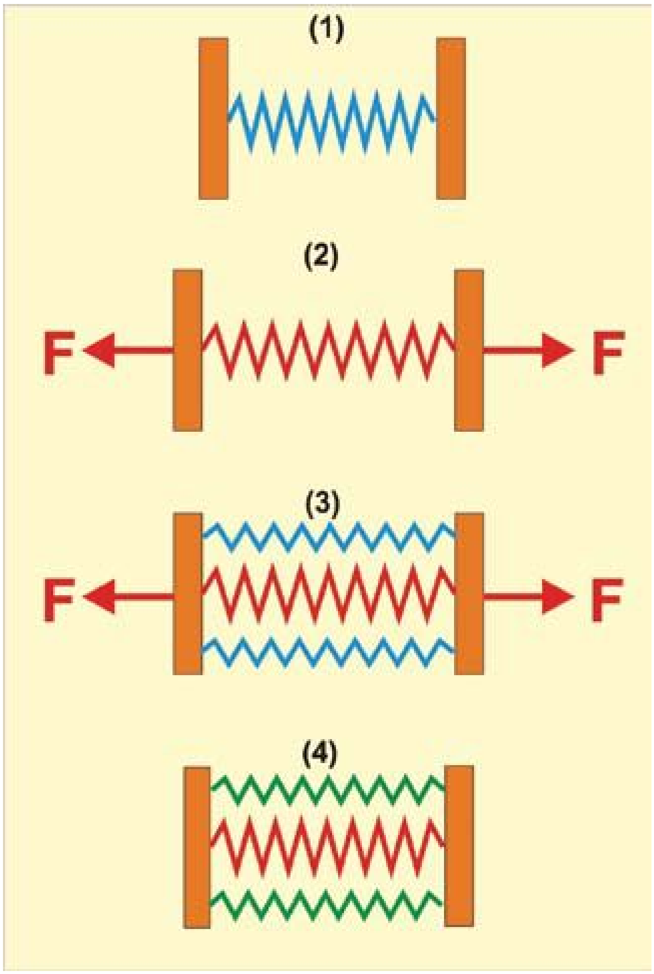

Fig.3. Sequence leading to the spring model of a residual stress system.

Imagine that (1) in fig.3 represents a spring attached to two handles. The spring is colored blue to indicate that it is not being stressed. This corresponds to a "zero stress system". Now imagine that a "Strong Man of the Circus" exerts a very large tensile force, F, by pulling on the handles—(2) in fig.2. The central spring stretches and the spring is colored red to indicate that it is now in tension. We now have an "applied stress system" because an applied force is responsible for the stress. Imagine next that the Strong Man's assistants slot two springs on either side of the stretched central spring. These two springs are of the same length as for the stretched-apart handles and are therefore not stressed—hence colored blue as in (3) of fig.2. We still have an "applied stress system". Finally, imagine that the Strong Man stops exerting the force, F, so that the handles move towards one another. As they do so the two outer springs become compressed—colored green. A stable position is reached when the sum of the compressive forces on the outer springs is equal to the remaining tensile force on the central spring—colored red. For any stable system the universal law that "For every force there must be an equal and opposite force" applies. We now have a "residual stress system" because no external force is involved.

Fig.4 shows the shot-peening equivalent of the foregoing spring model. Peening introduces compressive forces, F/2, in the surface layers, shaded green, which must be balanced by a tensile force in the unpeened core of the component, shaded red. The example shown is equivalent to the cross-section of a leaf spring that has been peened on both major faces.

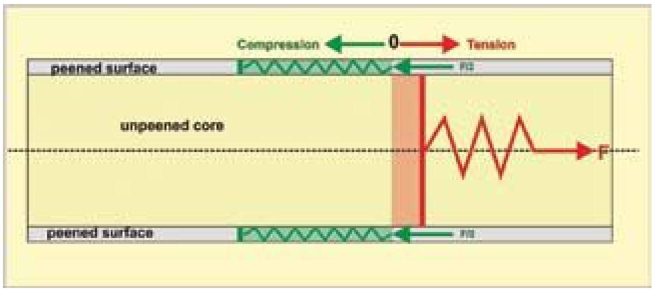

Fig.4. Peened leaf spring section showing balanced forces.

We must note that force is stress multiplied by the area over which it acts. Fig.5 includes the stress distribution that corresponds to the situation in fig.4. Two compressive surface forces, F/2, are present. These are equal to the average compressive stress multiplied by the area over which they act. That area is the depth of the compressed layer, d, multiplied by the fixed width of the leaf spring, W. The balancing tensile force, F, in the core is equal to the average tensile stress in the core multiplied by the area over which it acts. That area is the thickness of the core, c, also multiplied by the fixed width of the leaf spring, W.

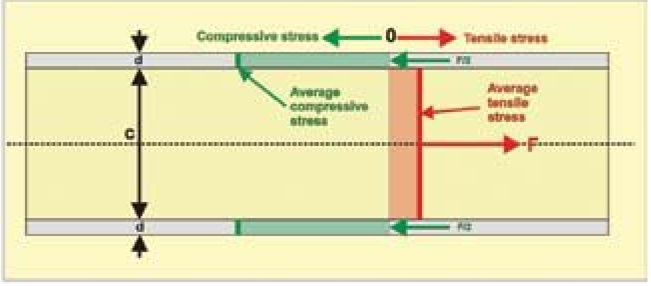

Fig.5. Force generation in leaf spring due to stress multiplied by area over which it acts.

Example:

*Assume that a 12 mm thick by 100 mm wide steel leaf spring has been peened on both major faces to a depth, d, of 1 mm. The unpeened core thickness, c, is therefore 10mm. A typical average compressive stress in the peened surface layers could be 500 Newtons per square millimeter (MPa). The force, F/2, generated in each surface layer is therefore given by: F/2 = 500Nmm^{-2} * 1mm * 100mm or F/2 = 50,000N. The balancing tensile force, F, must therefore equal 100,000 Newtons! 100,000 Newtons is approximately the force exerted by a mass of 10 metric tons. For the "Strong Man of the Circus" analogy, applying a force of just 1,000 Newtons would probably be more than he could manage to maintain. Even if the peened depth was only 0.1 mm the required tensile force would be 10,000 Newtons.*

*Working backwards, we can estimate the average tensile stress in the unpeened core. This is the required force, F, divided by the area over which it acts. For the 10 mm thick unpeened core this area is 10 mm * 100mm. Hence, when the force is 100,000 Newtons the average tensile stress in the core is 100,000 N/1000 mm^2 or 100 Nmm^{-2}. Fig. 5 is 'true to scale' for this situation, showing the average balancing tensile stress as being a fifth of the average surface compressive stress level.*

3 Peened layers/ core thickness ratio

The ratio of the thickness of the peened layers to that of the unpeened core is crucial for deciding peening intensity. That very important ratio, **R**, is given by equation (1) for two-sided peening:

$$\mathbf{R = 2d/c} \qquad (1)$$

Where **d** is the thickness of both peened surface layers and **c** is the thickness of the unpeened core. The magnitude of **R** is so important because it also tells us the ratio of the average residual stress in the core to that of the average residual stress in the two peened layers. For the previous example, with **d** equal to 1 mm and **c** equal to 10 mm, the ratio **R** is given as **0.2** (one-fifth).

Imagine next that a leaf spring had been peened with such a high intensity that the depth of the compressed surface layer, **d**, was half of **c**. The ratio of stresses predicted by equation (1) is now **1** (2*½/1). In other words the average compressive residual stress in the surface layer is equal to the average tensile residual stress in the core. Fig.6 shows the corresponding effect on distribution of average residual stresses.

Peening intensity must, however, be selected to give an **R** ratio that is appropriate for specific components. It is shown later that **R** is commonly about 0.025 for double-sided peening and 0.0125 for single-sided peening of real components.

The significance of having a very high tensile stress in the core becomes apparent when we consider its superposition on applied bending stresses.

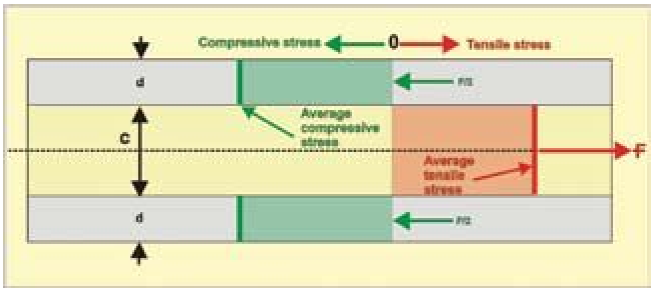

Fig.6. High core tensile residual stress in a deep-peened leaf spring.

4 Applied cyclic stress systems

Shot peening is most effective when cyclic bending stresses (rather than push-pull) are being applied to the peened component.

Imagine gripping an office ruler and applying different cyclic bending stress regimes – simulating the loading of a leaf spring. As the ruler is bent the convex side is put into tension and the concave side is put into compression. The maximum stress level, ±A, is at the surfaces and is zero along the centerline. This is illustrated in fig.7.

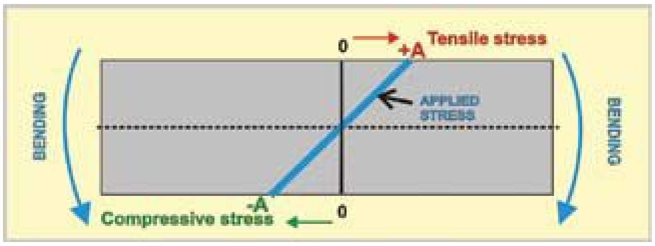

Fig.7. Simple bending applied to a rectangular section.

The simplest cyclic bending stress regime can be simulated by bending the ruler in one direction, relaxing the applied bending and then re-applying it. This produces the type of cyclic stressing regime shown in fig.8.

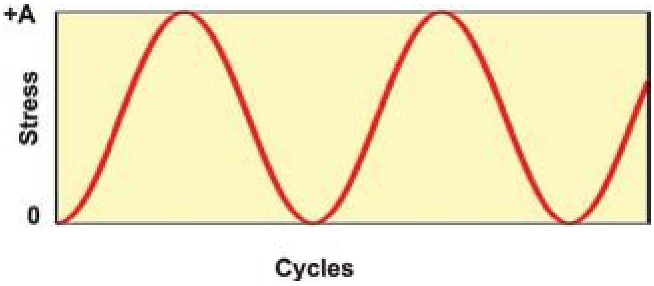

Fig.8. Stress cycling induced by one-way bending.

Repeated bending of the ruler by equal amounts in opposite directions will generate a cyclic stressing regime of +A to –A for both sides of the ruler. The corresponding cyclic stressing regime is shown in fig.9. (There are, altogether, seven different types of cyclic stressing regimes that can be applied. These

are: +A/+B, +A/0, +A/-B, +A/-A, +B/-A, -A/0 and –A/-B where B denotes a lower stress level than A.)

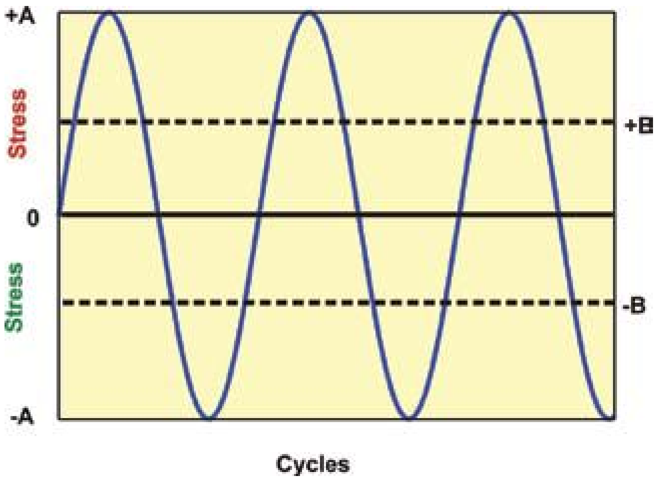

Fig.9. Stress cycling induced by reversed bending.

5 Combinations of applied service stresses and residual stresses

A key feature of applied service stresses and residual stresses is that they are additive. This feature is illustrated in fig.10. These are simplified diagrams - showing average core and surface residual stresses (rather than the smooth curves of varying residual stress) - together with an applied bending stress distribution. The simplification allows the combination of residual and applied stress to be estimated visually.

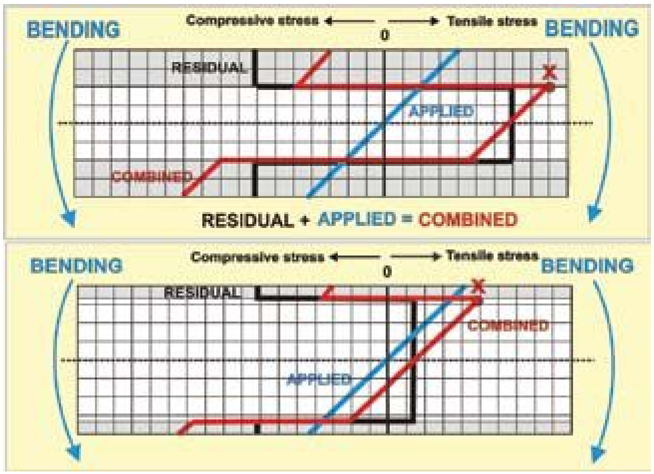

Fig.10. Combination of Applied and Residual Stresses in peened leaf springs.

For the upper diagram in fig.10 we can see that the combined stress at the upper surface is (using the graphical units shown) -7 plus +4 which equals -3. Below the upper surface the combined stress falls (because the applied stress is falling) reaching -5 at the interface with the core -7 plus +2). Just into the core the core stress of +7 now adds to an applied stress of +2 to give a total of +9 – shown as the spot marked "X". That is more than double the maximum stress applied at the surface and is a source of potential component failure. Below the point "X" the combined stress falls until it reaches a maximum of -11 graphical units at the lower surface. This would cause severe problems if it exceeds the compressive yield strength of the peened surface's material.

For the lower diagram in fig.10 there is a much thinner compressed surface layer. The shape of the combined stress pattern is similar to that for the thicker compressed layer. One important quantitative difference is that the combined stress at the critical point "X" is now only +5 graphical units. This is only one unit higher than the maximum applied stress (+4 at the surface) and does not pose the problem of the +9 units of the thicker compressed surface layer. This example shows, in a quantitative way, why we must control the relative depth of the compressed surface layer by correct selection of peening intensity.

PRIOR KNOWLEDGE

Prior knowledge is a 'two-edged sword'. Correct application of prior knowledge allows satisfactory estimates to be made. Incorrect application, on the other hand, will lead to unsatisfactory estimates. Decisions based on prior knowledge rely on the quantity, relevance and quality of that prior knowledge. Multi-national and large aerospace companies have the luxury of enormous amounts of prior knowledge and experience to call upon. Beginners to shot peening and small companies have relatively limited access to prior knowledge. They may have to rely upon advice given by either consultants or by outsourced shot peening companies. That advice should be consistent with the five basic principles described previously.

Any search for prior knowledge on optimum peening intensity is facilitated by employing the internet. A vast amount of information is, however, available and the main problems are to separate 'wheat from chaff' and not to get overwhelmed.

The information given in fig.11 is copied from an article by H. O. Fuchs published in the Mechanical Engineers' Handbook 1986. The effect of thickness appears as being linear because of the log-log scales that have been used. These log-log scales allow inclusion of most component thicknesses that might be encountered. At the same time the corresponding peening intensity ranges for steels are also accommodated. For any given thickness of component a range of applied peening intensities is indicated. That is because steels themselves exhibit a wide range of hardness. For 12.5 mm thick components (0.5") the specified peening intensity ranges from about 200A (metric) for soft steels up to about 600A (metric) for hard steels.

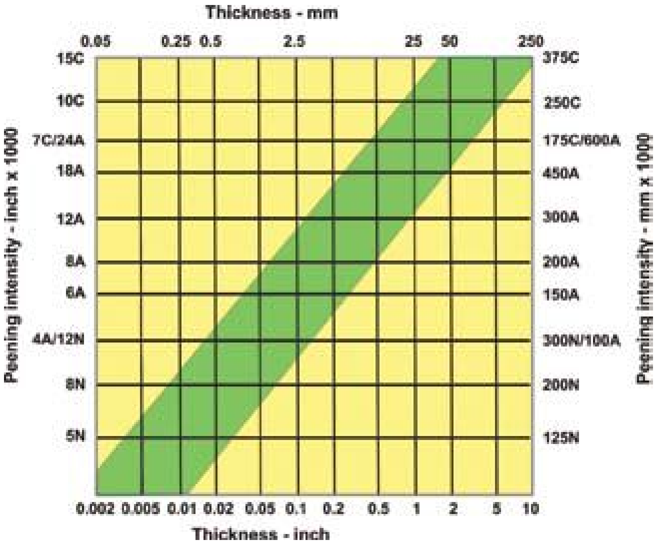

Fig.11. Peening intensities commonly used on steel parts of different thickness.

It is clear from fig.11 that as the thickness of a component increases so does the peening intensity that is usually applied. That is consistent with the basic principles previously described.

Fig.12 is copied from the Charts section of the EI library. There is an almost linear increase of depth of compression with increase of peening intensity. The depth of compression increases with increasing softness of the impacted material.

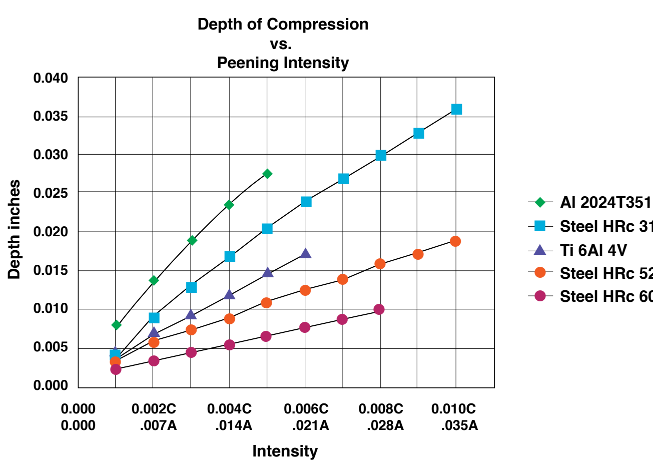

Fig.12. Variation of Depth of Compression with Peening Intensity.

As an example of using figs.12 and 11 consider a steel of hardness HRc 52 peened to an (imperial) intensity of 0.021A. The corresponding depth of compression is 0.0125" (using fig.12). Fig.11 indicates that an intensity of 0.021A is commonly applied to 1" thick steel components of average hardness. Hence we find that the compressed layer depth, d, is some 1.25% of the component thickness.

Fuchs pointed out (ASTM Special Technical Publication 196, 1962) that depth of compression is governed by the diameter of individual indents. For Almen strip hardness steel he showed that the depth of compression is approximately half of the indent diameter and approximately equal for aluminum (alloy?). Measurement of indent diameter on peened components is therefore a quick method of indicating the depth of the compressed layer. This depth can then be correlated with a peening intensity requirement.

DISCUSSION

Thickness of the peening-induced compressed surface layer is obviously the prime factor when deciding on peening intensity. This thickness depends upon the applied peening intensity and the softness of the component material. A layer/core thickness ratio of about 0.0125 appears to be a 'norm'. Any substantial deviation from that ratio should be questioned. Secondary factors, such as shot properties, also influence optimum peening intensity.

It has been shown that huge forces are normally developed by shot peening, especially when high intensities are involved. These forces can induce undesirable bending moments and hence distortion of components.

In an ideal situation a large range of peening intensities could be applied to a number of identical components. Required property enhancement, such as fatigue strength, could then be measured as a function of applied peening intensity. Plotting of these measurements would indicate an optimum peening intensity value. Such an ideal situation involves huge expenditure—which can, however, be minimized by an application of prior knowledge and a consideration of the basic principles involved.

MANUFACTURING TRENDS

by Abigail Phillips | Manufacturing Global | www.manufacturingglobal.com

The Top 10 Manufacturing Trends in 2015

2015 is shaping up to be a pivotal year for the global manufacturing industry. Manufacturing plants are not longer dirty, dark and dangerous places to work; they house some of the world's most sophisticated equipment, are managed using complex data and software, and run on powerful technology systems. As the concept of a 'smart factory' becomes more of a reality, we take a look at the manufacturing trends shaping the industry in 2015.

10. INTERNET OF THINGS (IOT) TECHNOLOGY

The Internet of Things (IoT) allows devices to communicate with one another automatically without human input and is having a profound effect on the manufacturing sector. The benefits of IoT technology include, reduced down time due to the fact that machines can notify mechanics about defects and required maintenance; increased quality; less waste; and greater visibility of the manufacturing floor via big data analytics, which in turn leads to improvements across the board.

9. SOCIAL MEDIA

Communicating thoughtfully through social media and other new and secure technologies can help manufacturing firms enhance visibility and improve reputation. In 2015, there will be a much greater emphasis on social communication and Internet marketing due to the fact that manufacturers can monitor concerns, track customer trends and demands, and promote successes for a marginal cost.

8. ADDITIVE MANUFACTURING

Additive manufacturing, or 3d printing, is big news in the manufacturing sector. The new technology has captured the imagination of the general public and manufacturing executives alike, however it has also proven to be a game-changer for the industry.

Additive manufacturing technology has evolved so much in recent years, to the point where it can produce components made of metals, mixed materials, plastics and even human tissue. The benefits of 3d printing include shorter lead times, improved quality and reduced waste, flexibility and cost savings. Additive manufacturing is creating a shift in the way engineers and designers think about product development, therefore changing the way we train future manufacturing employees.

7. NANOTECHNOLOGY

Nanotechnology is one of the most interesting – and potentially game changing - technologies to come to the fore in recent years. Nanotech, or the manipulation of matter on atomic and molecular scales, is currently used to describe micro-scale technology in everything from space technology to biotech. As such, nanotech has already changed the world. But the fruition of atomically precise manufacturing (APM) — nanotech's next phase — promises to create such 'radical abundance' that it will not only change industry but civilization itself.

6. NEXT-SHORING

The rise of a more technical labor force to manage supply chain operations — combined with rising wages in Asia, higher shipping costs and the need to accelerate time to market to meet retailer and consumer demands — has led to more companies shifting their manufacturing strategies from outsourcing overseas to developing products closer to where they will be sold. "Next-shoring," as this tactic has been dubbed, allows manufacturers to increase the speed at which product is replenished on store shelves. The faster inventory can be moved to the consumer, the sooner the costs to warehouse, ship and dock goods can be freed up.

5. 'SMAC STACK'

A manufacturing comeback is being driven by SMAC — social, mobile, analytics and cloud. The SMAC Stack is becoming an essential technology tool kit for enterprises and represents the next wave for driving higher customer engagement and growth opportunities. The need to innovate is forcing cultural change within a historically conservative "if it's not broke don't fix it" industry, and SMAC is helping early adopters in the manufacturing market increase efficiencies and change.

4. MARKETING

More than in any other industry, manufacturing relies on


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innovations in technology to drive efficiencies, reduce production costs and help bring products to market. But can the same be said of manufacturers' use of technology to help drive their marketing and sales? The answer up until now is a resounding, 'no'. For a long time, manufacturing and marketing have been worlds apart and manufacturers have left it to external PR companies to sell their products – not any more. In 2016, marketing and manufacturing will become one and the same.

3. CAPITAL INVESTMENT

Though the slow economic recovery continues to hinder expansion and growth opportunities, recent government and industry reports show an uptick in capital investment funding. As manufacturers become focused on capturing value through innovation, original design and speed to market, they are increasing spend for upgrading plant, equipment and technologies. 2016 looks set to be the year of the big spenders.

2. GREATER FLEXIBILITY

Consumers expect products on-demand and to specification. With the rise of smart factories, manufacturers will increasingly look towards manufacturing equipment that is adaptable and flexible to appease the needs of consumers, while saving waste and downtime.

1. GREATER VISIBILITY

The Internet, social media and big data are forcing manufacturers to become more customer-centric. The traditional business-to-business model is becoming outdated because today's connected consumers are better informed and expect products on-demand. Consumers compare, select or buy multiple products with a tap of their smartphone or tablet, and online channels have become their preferred communication platform. This consumer purchasing style is not only having an impact on brand-oriented value chains, but is transforming traditional B2B to B2B2C models.

Furthermore, consumers are becoming acutely aware that manufacturers can measure every aspect of their production, from energy consumed to waste managed and cost saved. With this in mind, consumers are demanding visibility from a sustainability, labour, cost and production perspective, and there is no excuse for not making this available.

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Limpet Teeth: The Newest Strongest Material Known to Man?

IN THE LAST ISSUE of *The Shot Peener*, we listed the Top Ten strongest materials known to man with Darwin Bark spiders' silk as the toughest biological substance. Well, move over Darwin Bark spider, your silk may be replaced by the teeth of the limpet, an aquatic dome-shaped creature.

These findings come from researchers in the U.K. "Until now we thought that spider silk was the strongest biological material because of its super-strength and potential applications in everything from bullet-proof vests to computer electronics," Professor Asa Barber who led the study said in a statement. "But now we have discovered that limpet teeth exhibit a strength that is potentially higher." One of the unique aspects of limpet teeth is that their strength stays the same no matter the size. "Generally a big structure has lots of flaws and can break more easily than a smaller structure, which has fewer flaws and is stronger. The problem is that most structures have to be fairly big so they're weaker than we would like." said Barber.


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DIGITAL MARKETING
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Profile Industries Separates Itself From the Crowd

WHILE MANY MANUFACTURERS are still using traditional marketing methods, Profile Industries has developed a strong digital and social media presence. Their online marketing efforts are geared to engineers, which isn't surprising, but the age group is: 20-35 years old.

"Google Analytics showed us that 50% of the visitors to our website are 18-35 years of age, 25% are 35-45 and the rest are 45+," said Steve DeJong, Vice President of Profile Industries. This youthful age group validated their decision to make the website visually engaging rather than filled with lots of text. "I think people would rather watch a short video than read," said Mr. DeJong. "That's why we developed a YouTube page and we release a new video every month." Mr. DeJong is also committed to Facebook, LinkedIn, Google+, Vimeo and Twitter as a way to share information with his customers and prospects.

The website was developed in responsive web design, meaning that it provides an optimal viewing experience across most devices, including computer monitors, smartphones and tablets. Based on a quote by Rebecca Murtagh, a technical marketer, Profile Industries' website is right on trend. "In early 2014, the landscape in which businesses operate changed forever when Internet usage on mobile devices exceeded PC usage," wrote Ms. Murtagh in a recent blog.

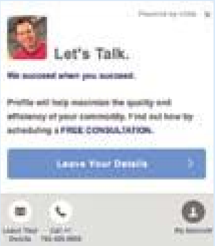
Mr. DeJong is able to gather critical data including contact information and consumer trends through three call-to-action points: A newsletter sign-up, a pop-up contact window and a Request for Estimate contact form. All three methods are delivered in a friendly format. These techniques are providing impressive results: "We get 25 hits a day from the website and 25% of our annual sales come from it," said Mr. DeJong. We'd say these stats classify Profile Industries as a successful online marketer.

Profile Industries manufactures spiral separators and shape classification products for surface metal finishing and agriculture. Even though their markets are very different, the Profile Industries' home page lets visitors know they're in the right place in a matter of seconds.

Eight Reasons Why Profile Industries' Website Is Successful

From a design and marketing viewpoint, Profile Industries' website has several successful attributes.

1. A prominent call-to-action on every page makes it quick and easy to contact the company.



2. The home page is clean, inviting and attractive.
3. Even though Profile Industries serves two different markets, surface metal finishing and agriculture, the distinctions are handled well and even made into an asset: "Shape Sorting Solutions No Matter the Field."
4. The benefits of doing business with Profile Industries are clearly defined on the home page.
5. Testimonials on the home page—with photos of the customers—provide trustworthiness.
6. A blog provides keywords for search engine optimization and adds credibility as a leader in their industry.
7. A professionally produced video on how spiral separators work is available on all product pages.
8. The site has high-end photography that enhances the products and professionalism of the company.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MATERIALS: RESEARCH AND DEVELOPMENT
Source: NASA Jet Propulsion Laboratory | www.jpl.nasa.gov

Metal Made Like Plastic May Have Big Impact

OPEN A DOOR and watch what happens—the hinge allows it to open and close, but doesn't permanently bend. This simple concept of mechanical motion is vital for making all kinds of movable structures, including mirrors and antennas on spacecraft. Material scientists at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, are working on new, innovative methods of creating materials that can be used for motion-based mechanisms.

When a device moves because metal is flexing but isn't permanently deformed, that's called a compliant mechanism. Compliant mechanisms are all around us—in springs, surgical instruments, paperclips, clothespins, and even micro-devices.

Researchers at JPL, Brigham Young University in Provo, Utah, and the California Institute of Technology in Pasadena, describe a new methodology for creating complex, low-cost complaint mechanisms using a combination of novel materials and manufacturing techniques in a recent paper featured on the cover of the journal *Advanced Engineering Materials*. They demonstrate that materials called "bulk metallic glasses" have highly desirable properties for these mechanisms. These "glasses," as the scientists call them, are metal alloys designed to have a random arrangement of atoms.

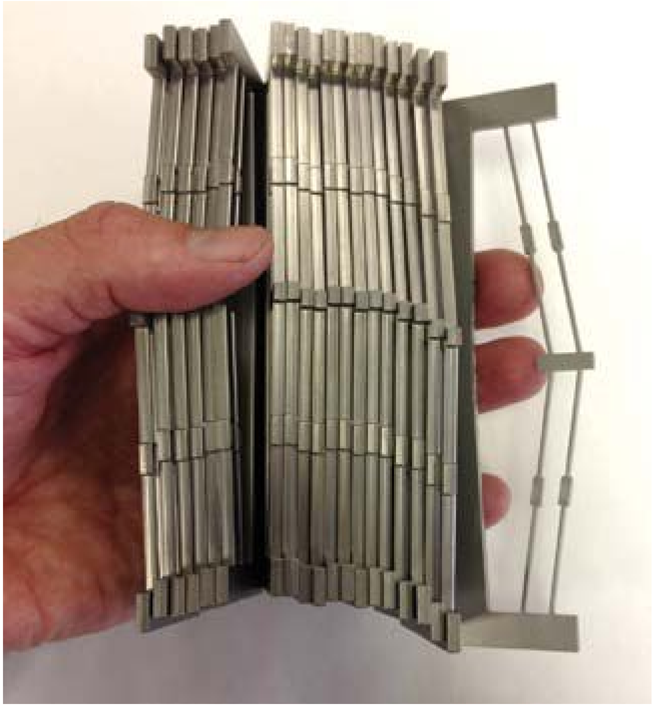
"We've demonstrated that these metals not only have desirable properties for applications where flexibility and durability are required, but can also be injection-molded like a plastic and made cheaply," said Douglas Hofmann, principal investigator of the research at JPL. Hofmann is a researcher in material science and metallurgy at JPL, and visiting associate at Caltech. "It offers an entirely new industry for high-performance metals," he said.

"Traditionally, titanium alloys have been used in compliant mechanisms because they were the best materials for the job, but titanium was also difficult to work with," said Larry Howell, professor at Brigham Young University and study co-author. The new research shows that bulk metallic glasses have twice the strength and conventional flexibility of titanium alloys, while also boasting low melting temperatures.

"I had been working on flexible mechanisms for a long time, and I said, that's the perfect material we've been looking for all along," said Brian Trease, a mechanical engineer at JPL who was a co-author on the study.

Although material scientists have been focusing on the 3-D printing of titanium alloys, the new research shows that complex shapes can be molded at low cost, while maintaining their performance, when using bulk metallic glasses.

These components of a mirror structure can be rotated very precisely by flexing parts made of a material scientists call "bulk metallic glass." A single point of applied force can rotate the mirror. This technology showcases a use of bulk metallic glasses in space optics. (Image Credit NASA/JPL-Caltech)



This stack of structural components is called bistable springs. JPL researchers worked with two commercial companies to fabricate over 30 identical versions of this device, utilizing a brand new injection-molding technology available in industry. (Image Credit NASA/JPL-Caltech)

MATERIALS: RESEARCH AND DEVELOPMENT *Continued*

"You could start making robot bearings or artificial limbs out of these if you want," said Eric Homer, assistant professor of mechanical engineering at Brigham Young and lead author of the study. "These materials are ideal for mechanisms where you're looking for flexibility and high strength."

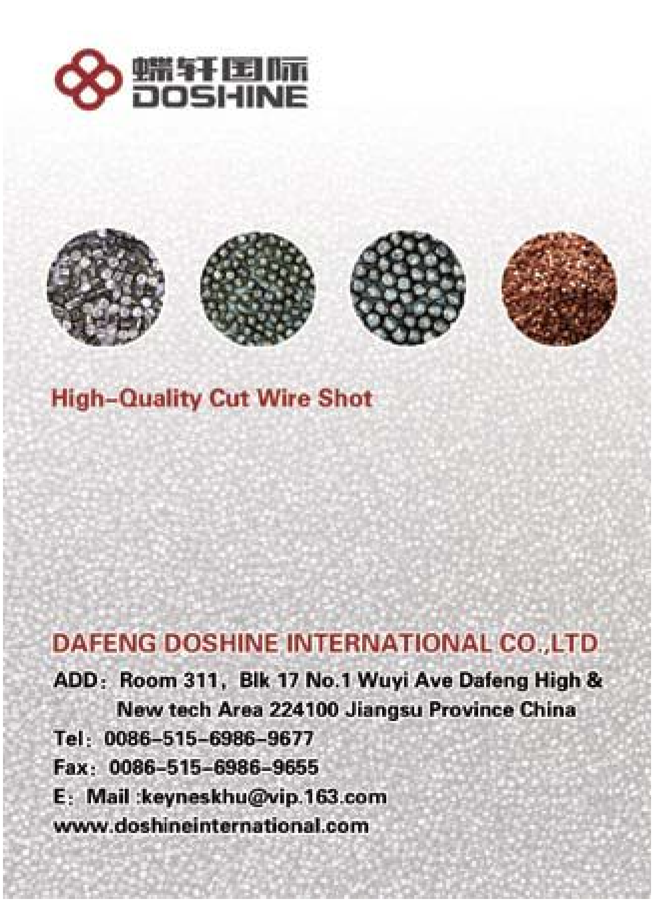
In the new study, the researchers modeled the performance of a number of compliant mechanisms and predicted that bulk metallic glasses would be the highest performing material in those applications, typically doubling the predicted performance of titanium. To verify the model, a bistable spring, a device that can lock in two different positions, was made out of both titanium and metallic glass and mechanically tested to show the benefits. The researchers then worked with two commercial companies to fabricate more than 30 identical versions of the new mechanism, utilizing a brand new injection molding technology available in industry.

"Demonstrating that these complex devices can be designed and prototyped using basic science is one thing. Taking the next step and working with industry to actually fabricate them will, we hope, bridge the gap between what we do in the lab and what we can deliver as actual spacecraft hardware," said Hofmann.

The researchers also demonstrated the assembly of various bulk metallic glass components into a larger mount used to rotate a mirror. "We hope that using these mechanisms in space will allow us to increase precision in our instruments and decrease their mass," Hofmann said. "They may also prove useful for storing elastic energy that can be used in space to deploy components without having to use motors."

Hofmann and co-authors from JPL and Brigham Young envision applications for aerospace and defense. Sporting goods such as golf clubs could be made of these materials, and so could medical implants that need to flex in the body such as hip replacement components. On spacecraft, metallic glasses could be used for tilting and positioning mirrors, or for structures that open antennas or shoot cube satellites out of spacecraft. If metallic glasses can be made en mass like plastics, but retain robust properties of metals, they could also be used for a wide assortment of consumer devices, from laptops to robots to cars.

The Jet Propulsion Laboratory is a NASA Center in Pasadena, California that manages robotic spacecraft in the exploration of Earth, the solar system and the universe.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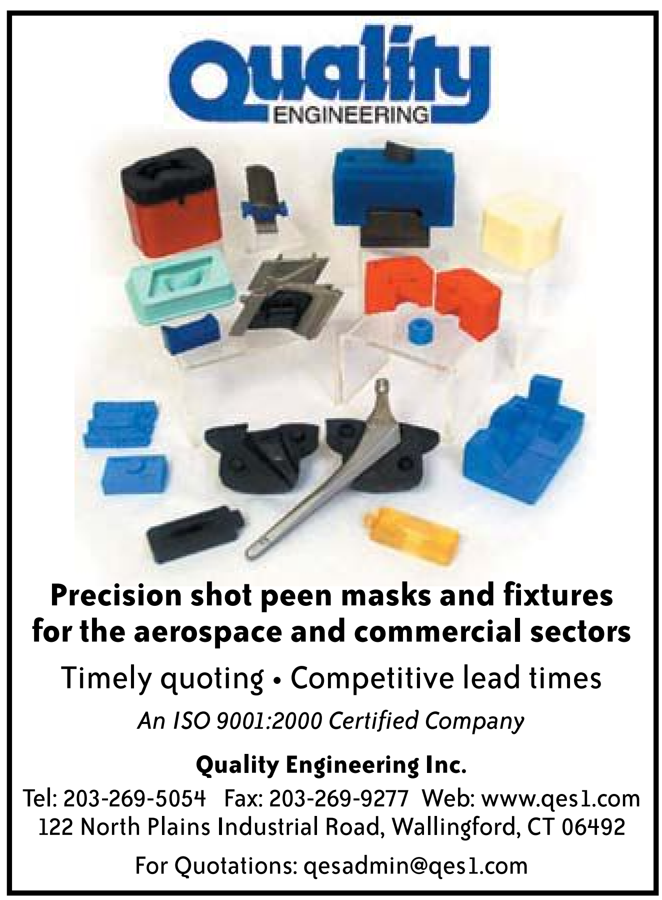
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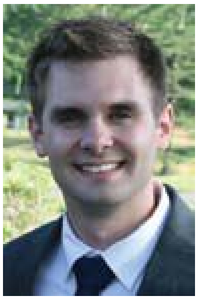
ITAMCO Engineer Receives SME Award

Eleven outstanding young manufacturing engineers, age 35 or younger, were recognized for their exceptional contributions and accomplishments in the manufacturing industry. Each year, the award is named in honor of a specific individual who has made lifelong contributions to manufacturing and SME. The 2015 award is named after 2013 SME President Dennis S. Bray, PhD, FSME, president and CEO, Contour Precision Group LLC.



Joel Neidig

Joel Neidig, Engineer and Technology Manager at ITAMCO/Indiana Gear, was one of the recipients of the 2015 Outstanding Young Manufacturing Engineers Award. Mr. Neidig has a bachelor's degree in operations management and has had 11 years of experience integrating manufacturing technology and software development. Neidig sits on the Technical Advisory Group for MTConnect, an open-source royalty-free standard that is intended to foster greater interoperability between devices and software applications. He has been an active member of MTConnect since 2009.

Mr. Neidig developed the first iOS and Android-compatible MTConnect apps, and has developed over 65 manufacturing apps for the App Store and Google Play, which have been downloaded over 250,000 times. He has been named as a manufacturing "Thought Leader" by IMTS Insider. Neidig recently won second place in the MTConnect Challenge at the 2014 MC2 Conference for his application: "Expanding Manufacturing's Vision: MTConnect + Google Glass," sponsored by the National Center for Defense Manufacturing and Machining and the Office of the Secretary of Defense.

Mr. Neidig has previously been the manufacturing keynote speaker at Autodesk University and recently presented at the 2014 Automotive Innovation Forum. Neidig is very involved in an advisory role at the ITAMCO Manufacturing Education Center located at Plymouth High School, which was started by his company to prepare students for the challenges of careers in manufacturing. He has been a SME member since 2014.

New Pass-Through Shot Peening System

Viking Blast & Wash Systems announces the release of their newest peening system in its industrial line of pass-through blasters called the RT 2412. This unit has a blast width of 24" wide by 12" tall and brings new efficiency to consumers.

The redesigned blast wheels are arranged to blast leading and trailing edges of the work area. The redesigned unit also has a peening package with abrasive volume control and velocity control from the operator panel.

The abrasive classifier screens out non-conforming abrasive at the upper and lower end of the sieve analysis while conforming abrasive is returned to the boot of the bucket elevator for reintroduction to the system. Most applications are covered by the standard offering, but can also be fitted with a rotary scalping drum, auxiliary abrasive hoppers and 20 HP, 25 HP or 30 HP blast wheels verses the standard 15 HP. This specific unit is equipped with four (4) 15 HP VK Powermax 1500 blast wheels to deliver high volume abrasive at 295 feet per second velocity to clean parts.

All Viking cartridge style dust collectors are sold with NFPA required deflagration panels as standard.

Viking Blast & Wash Systems offers industrial cleaning solutions for all sizes and shapes of metal parts. To receive a copy of the new brochure or for information on any of the shot blast, wash, or vibratory equipment offered by Viking, please call 1-800-835-1096, email sales@vikingcorporation.com or visit their website at www.vikingcorporation.com.

The RT 2412 Pass-Through Shot Peening System has a blast width of 24" wide by 12" tall and brings new efficiency to consumers.

EI Shot Peening Training Student Receives College Credit

Grace College, in Winona Lake, Indiana, awarded college credit to an EI Shot Peening Training student for her participation in the EI Shot Peening training program. The student took the shot peening program and passed the Level One certification while working at Medtronic. Grace College gives one hour of credit for every 20 hours of job training and recognized the EI Shot Peening program as job training.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