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The Shot Peener

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

The Top Five Things My Customers Are Doing Right

1. CHOOSING THE RIGHT MEDIA
2. USING ALMEN TEST STRIP HOLDERS THAT MEET SAE SPECS
3. PAYING ATTENTION TO IMPACT ENERGY
4. VALIDATING BLAST CLEANING WITH ALMEN STRIPS
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PLUS: BEST PRACTICES | QUESTIONS & ANSWERS | ESSENTIAL ELEMENTS OF SHOT PEENING | INDUSTRY NEWS

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Coverage Measurement Device

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Industry News

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

A Process Is Validated

IN THE SUMMER OF 2001, I wrote an article for the Electronics Inc. *Abrasive Blast Cleaning News* magazine titled "Blast Cleaning Process Control Using Almen Products." I had the crazy idea that Almen strips, used in the same way they're used in shot peening, could monitor a blast cleaning operation—without the plotting of a saturation curve, of course. So it was with great satisfaction when I read Kumar Balan's review of the top five things his customers were doing right and the use of Almen strips in blast cleaning was on his list.

JACK CHAMPAIGNE

I concede that my article had nothing to do with it; Kumar notes that the adoption of Almen strips in blast cleaning is happening in facilities that already use the test coupons for shot peening. Still, I'm pleased more and more organizations are discovering that taking the time to closely monitor their blast cleaning operations pays dividends in increased productivity.

Kumar wrote the article from the perspective of someone in the field which is valuable because it is unusual in our industry. *The Shot Peener* staff has a large collection of success stories and interesting applications but can't publish them due to confidentiality agreements. We appreciate Kumar's "insider" look at the trends in our industry.

Seasoned shot peening professionals probably wonder why we tackle the same topics again and again from all different angles. The answer is found in the questions we receive from our readers. Many of our readers are new to shot peening and even experienced shot peeners get stumped from time to time. We share some common questions with answers from our staff and other experts on page 18.

If you have a new shot peening technician on your team, hand him Dr. Kirk's article "Essential Elements of Shot Peening," starting on page 28. It's a great primer on shot peening that proves there is more to this process than turning on a machine. Every shot peening technician should be proud of his contribution to a quality procedure.

Speaking of Dr. Kirk, each of his articles could be a chapter in the ultimate shot peening textbook. That's why we make them easy to find in the online library at www.shotpeener.com.

And, finally, several of our recent magazines have jumped from 44 to 48 pages. Thank you to all of our advertisers, new and loyal repeat advertisers, that make it possible to share more and more information with the shot peening and blast cleaning community. We appreciate each and every one of you.

THE SHOT PEENER

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BEST PRACTICES

by Kumar Balan | Director, Global Sales | Empire Abrasive Equipment

The Top Five Things My Customers Are Doing Right

MY JOB IS TO HELP MY CUSTOMERS with their shot peening and blast cleaning challenges. In the course of my work, I have reviewed many shot peening operations. While I can make sure that one aspect of a quality shot peening procedure —the equipment—is properly suited to the application, I often view their shot peening process with skepticism. I've sometimes felt a compelling desire to suggest that a peening operation start all over again. The truth is there has been enough dialog about such misgivings. That said, I am seeing more and more facilities doing numerous things right and it's only fair (and encouraging) to recognize and credit such users for making an effort to create a stable peening operation.

Observations here are not restricted to a specific geography or industry, though by personal exposure, a large part happens to be in Aerospace. There are more than five things being done correctly; this discussion is about five critical ones.

#1 CHOOSING THE RIGHT MEDIA

The market for peening media has been inundated with multiple sources from all over the world. New sources of cast steel shot have emerged, adding to those we have known over the years. An increasing number of suppliers are introducing conditioned cut wire to the industry and promoting its practical benefits. Every peening operation is now faced with more choices than before. However, the specification continues to dictate the type and size of peening media to be used.

I'm seeing more and more operations use the right quality of media in their peening process. Users who would formerly make their purchasing decisions on price alone are realizing the impact their choice will have on their end result. This is an interesting trend because the effect of bad media is immediately seen in the saturation curve, which means such users are following the practice of plotting a proper curve, again as per specifications.

Peening media, as we know, can be classified into "New Media" and "In-Use Media." New Media is further classified into SAE Industrial Grade and SAE Aerospace Grade. Industrial Grade media is dictated by the following specifications: J441 Cut Wire, J444 Cast Steel Shot, J2303 Ceramic Bead and J1173 Glass Bead. Aerospace Grade media ties its conformance to: AMS 2431 (\1 – Cast Steel 42 to 52 HRc, \2 – Cast Steel 55 to 62 HRc, \3 – Cut Wire, \4 – Stainless Cut Wire, \5 – Peening Balls, \6 – Glass Bead and \7 – Ceramic Bead.

Customers in the Aerospace sector are working towards meeting specification requirements for size (vibratory classifier) and shape (spiral separator). It's common now to see a Rotap machine, for verification of size distribution, located within close proximity of the Almen gage. The Almen gage is used to measure the arc height of their test strips when establishing peening intensity.

Some important points about media for facilities that want to improve their shot peening operation:

- Use of non-spec peening media results in inconsistent peening results, affecting repeatability and overall quality of a peening operation.

Kumar Balan is the Director of Global Sales for Empire Abrasive Equipment. He is responsible for growing Empire's airblast cleaning and shot peening business outside of North America. As part of his job responsibilities, he visits shot peening and blast cleaning facilities around the world. While most of his customers are in Aerospace and Automotive industries, he also services foundries and other high-volume blast cleaning operations.

Mr. Balan has published numerous technical papers on blast cleaning and shot peening and is a regular contributor to *The Shot Peener* magazine. His expertise is in centrifugal wheel-type as well as air-type blast cleaning and shot peening equipment. He is a regular speaker at industry conferences and training seminars worldwide. Mr. Balan was awarded **The Shot Peener of the Year** Award at the 16th annual Shot Peening and Blast Cleaning Workshop in 2006.

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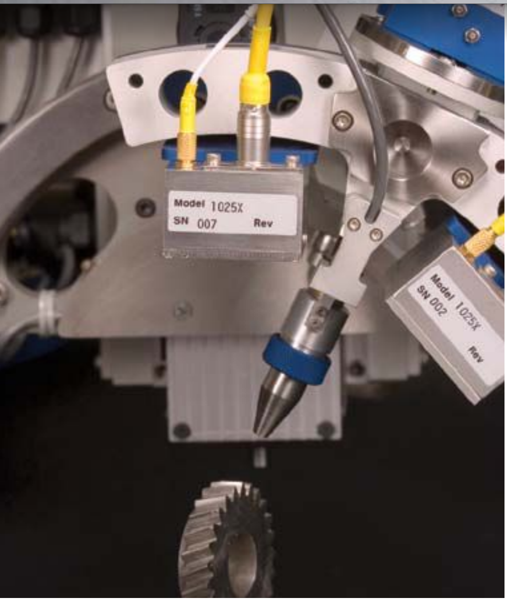

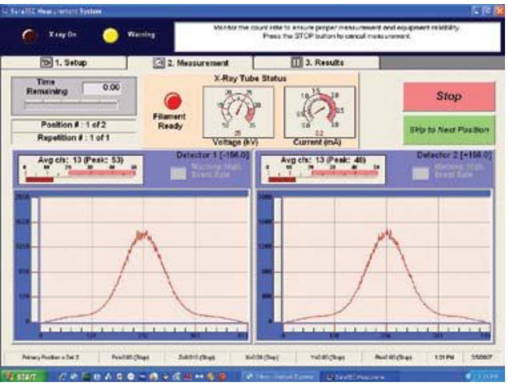

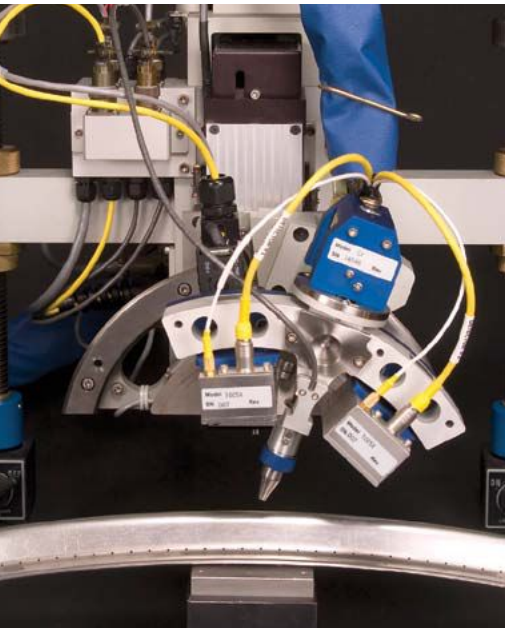

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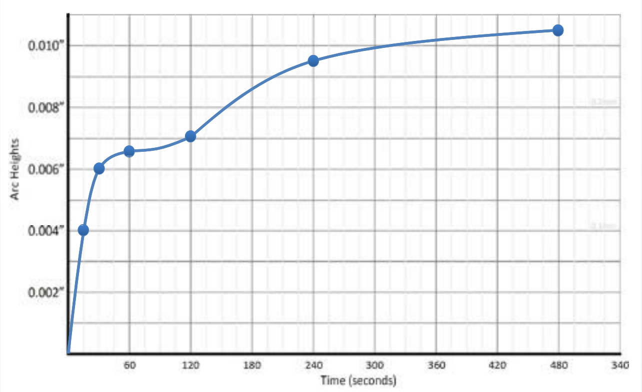
- Leaving broken media with rounds causes nicks and cuts on parts, leading to localized stress risers and rejected parts.
- Non-spec peening media, when processed through properly sized screens of a vibratory classifier, results in almost half the quantity being rejected and separated to trash.

A proactive user of both shot peening and blast cleaning equipment in Automotive mentioned that their rejected media from a peening process is re-utilized in their cleaning machine which works very well with the resulting blast cleaning operating mix. They added that "operating mix" are bad words in their shot peening operation.

- Improper classification (or in some cases, the lack of classification) of peening media leads to difficulty in plotting saturation curves and achieving saturation. The problem surfaces in the form of a double-knee on the saturation curve due to contamination caused by two different sizes of peening media.



A saturation curve with a "double-knee" caused by contamination from two different kinds of peening media. (Image courtesy of EI Shot Peening Training)

#2 USING ALMEN TEST STRIP HOLDERS THAT MEET SAE SPECS

A majority of customers that shot peen their parts use test strips manufactured to specifications (SAE J442). That leaves us with the other variable in this family; the test strip block or holder.

As per SAE J443 Procedures for Using Standard Shot Peening Test Strip (Rev 2003), point 6.1, "Provide fixture which supports the test strip(s) in a manner to simulate the selected surfaces of the part to be peened. Test blocks shall be mounted on the fixture to duplicate the angle and location of these areas. Setup shall be qualified by placing the test strip setup fixture in the machine in the same orientation to the shot stream that the part will be exposed during processing..."

SAE J441 (point 6.2) cautions the user to monitor the condition of the test fixture for problems such as an uneven surface of the test strip contact area since this could skew arc height values. This also includes any damage to the surface of the test fixture (block/holder), and the possibility of contaminants, including stray peening media, that gets left behind from a previous cycle.

The second part of this variable pertains to mounting the holder onto the test fixture. Though it isn't stipulated, welding is not a suitable means of attaching the block to the fixture. Excessive welding (which is subjective) could warp the block and alter the flatness specification of the block.

Many of my customers have taken notice of all the above. It is now common to see test strip holders that are to spec and, instead of being welded, are screwed on the underside of the test part. Customers are also measuring "pre-bow" values of the test strip before mounting it to the test block. Screws are being checked for wear and replaced when the threads are not able to fasten the strip to the block.

One of my customers mentioned that they no longer find loose test strips in their reclaim system—something that they used to discover on a regular basis!

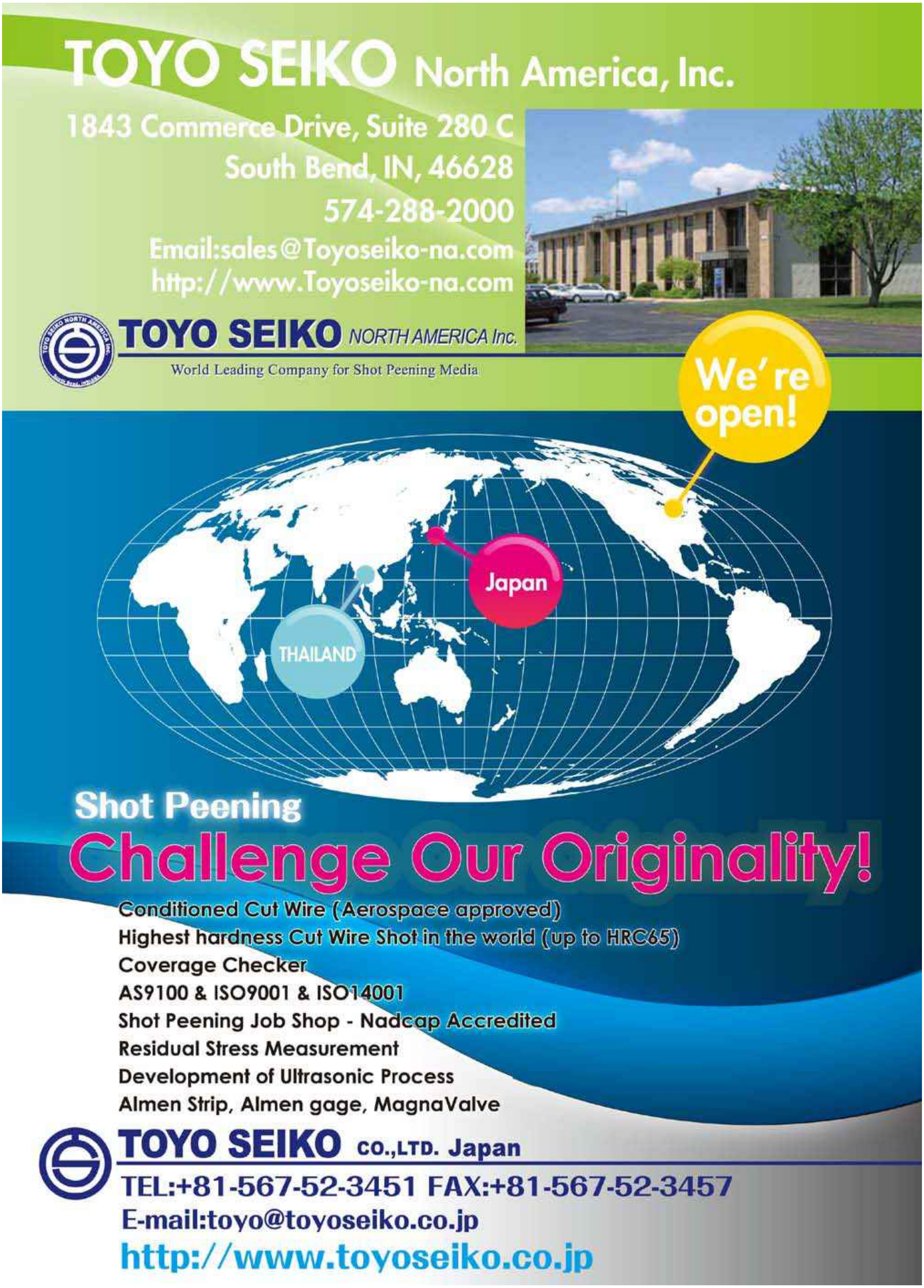
In addition, and this is important, the condition of test strips and blocks also form part of Nadcap Audit Criteria (AC 7117). This might very well be the driving force for this change.

#3 PAYING ATTENTION TO IMPACT ENERGY

Today's shot peener is equipped with more information than ever before, including the informational website, www.shotpeener.com, workshops conducted around the world, and on-site training programs. Many organizations now recognize the importance of keeping their peening process parameters in check. Through these various forums, it has been well established that the most important aspect we are dealing with is Kinetic or Impact Energy. Its transfer to the component being peened is what shot peening is all about.

Customers are now taking a proactive approach to understand the influences of impact energy rather than jumping to conclusions. They understand the influences of impact energy are the mass of the peening particle and velocity of impact. The mass is determined by the size of peening media and the velocity is determined by the air pressure in an air-peening machine or the wheel speed in a centrifugal wheel type machine. The size of peening media is dictated by the drawing/specification. Therefore, the variable that renders itself to change is the velocity of the stream.

A commercially available velocity meter, the ShotMeter by Progressive Surface, is used in many of the facilities that I visit. Customers are now able to carry out their process with a great amount of predictability even before plotting time-consuming saturation curves.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#4 VALIDATING THE BLAST CLEANING PROCESS WITH ALMEN STRIPS

This section relates to blast cleaning (and other related processes such as etching) and not as much to shot peening, though it's the direct result of lessons learned from shot peening. When shot peening, we use the deflection of the Almen strip as a measure to ultimately determine the impact energy transferred on to the part. Some customers in niche cleaning applications, and those that are familiar with this practice, have also adopted this technique to quantify and validate their cleaning operation.

The results of cleaning can be highly subjective in nature. Validating the quality of cleaning by visual comparators (SSPC/NACE/ISO 8501-1, BSI BS 7079, etc.) though common, are not applied to all cleaning applications. Once again, knowledgeable customers have caught on to the concept of impact energy and use Almen strips to compare arc heights at different times during a shift. They have then used this information to test the consistency of their process.

Though cast steel shot, conditioned cut wire, glass bead and ceramic are the only media types used for shot peening, these customers have used abrasives such as aluminum oxide with Almen strips to validate their cleaning process with acceptable results.

One customer reported an additional benefit to using Almen strips in their blast cleaning process—their operators obtained an acceptable cleaning quality at a lower air pressure. By virtue of this exercise, they reported being able to maintain this pressure (and quality of finish) throughout their shift with a subsequent reduction in operating costs due to lower abrasive and compressed air consumption.

Some blast cleaning operations are using Almen strips to quantify and validate their cleaning operation.

#5 UTILIZING X-RAY DIFFRACTION

Why do we shot peen? A seemingly innocuous question with a straightforward answer—to increase the working life of a component and reduce chances of failure. Drilling down further—the purpose is to introduce residual compressive stress onto a component. We measure this using our representative Almen strip. I'm seeing sophisticated users of this process, particularly in the automotive industries, which have not stopped at Almen strip (and intensity) results. Their goal is measurement of residual compressive stress. Though they continue to use strips for validation, they realize the strips don't tell them about the residual stress, they don't account for upstream processing, and they don't always address shot peening's effects on the geometry of a complex part.

Determination of part coverage (represented as 98% and greater) results from a visual evaluation of the part. Uniformity of coverage is checked with 10X to 30X magnification and through alternate means. Even though visually confirmed uniform coverage means uniform peening, it doesn't necessarily indicate that the process has resulted in a uniform stress state. This is because multiple crystalline planes could exist in a metal that has been shot peened to a particular intensity. A definite measure of the results of shot peening (or residual compressive stress) can be achieved only through X-ray Diffraction.

Therefore, this process has evolved to the point that some users validate with more than Almen strips and saturation curves. X-ray Diffraction techniques can now measure residual stress, not only in a lab environment, but also inline with the shot peening process. As an example, I see equipment from Proto Manufacturing in the field and they are experts in lab, handheld and portable residual stress measurement systems.

SUMMARY

There exist several other aspects of the peening and blast cleaning process that customers are now doing differently for the advancement of their operation. The five identified above were chosen for reasons of criticality and their promise of a new approach to these well-worked processes. Shot peening is gaining popularity outside the traditional Aerospace and Automotive industry sectors, too. On an even more optimistic note, new adopters of the process are "doing it right" the first time. The efforts of professionals to develop peening specifications in such industry sectors outside of Automotive and Aerospace, such as SAE J3020 for Medical Device Shot Peening, are showing encouraging results.

To summarize the requirements for the furtherance of this process, it can be done in three simple terms: Accuracy, Repeatability and Consistency. As long as the initiatives of your peening operation are directed to the achievement of these goals, you will be closer to deriving its valuable benefits.


High precision peening equipment for aerospace

How to Achieve Blast Cleaning Process Control with Almen Products

*Many of our readers use Almen strips and Almen gages to measure the intensity of their shot peening processes. It could come as a surprise, however, that the same tools and techniques are used to make blast cleaning operations more productive and profitable. (Thank you, Kumar Balan, for pointing this out in your "The Top Five Things My Customers Are Doing Right" article.) The following is based on an article first published in the Summer, 2001 issue of **Abrasive Blast Cleaning News** by Jack Champaigne. Here Mr. Champaigne outlines how Almen products can monitor the blast cleaning procedure.*

IS THERE A SPC FORMAT that allows you to monitor the blast cleaning process? There sure is. And it's simple and economical to do. Some people start their SPC program by keeping a record of motor Amps and that is a good beginning. However, tracking motor Amps won't tell you if the wheel target or hot spot pattern has changed. It also won't detect problems with the media such as a poor working mix or the consequences of using a different hardness or size of media.

A far better method of SPC control is to run an Almen strip on an Almen holder mounted on a sample part through the blast stream. Since the condition of the wheel blast machine and the media affect the blast stream intensity, the Almen strip will react the same as it does during a shot peening procedure—it will exhibit a slight curve that can be measured on a #2 Almen gage. This curvature measurement can be recorded in a SPC chart.

Here's a complete list of the factors that will affect the curvature of the Almen strip:

- Targeting (hot spot location)
  - Control cage wear
  - Impeller wear
  - Blade wear
- Media quality
  - Contaminated working mix
  - Incorrect media hardness
  - Wrong shot size
- Cleaning rate
  - Incorrect exposure time
  - Incorrect media flow rate (i.e., motor Amps)

It isn't practical to constantly monitor each of the above items. You can, however, use an Almen strip twice a day to quickly spot a change in the curvature measurement.

Ideally, the curvature measurements should be the same every day. However, as wheel parts wear, the hot spot pattern shifts and the curvature reading will change. As mentioned before, a substitution of shot size or hardness, or even the conveyor speed, will also cause the Almen strip reading to change. In fact, the nice thing about this technique is that changes in the most important elements of a controlled blast cleaning procedure will be detected by the Almen strip readings.

Again, changes in the process, such as using a different media or the slow wear of equipment components, will affect the readings. Here's a checklist of problem areas.

- Shot/grit
  - Working mix
  - Hardness
  - Contamination
  - Availability (hopper is clogged or empty)
- Targeting
  - Wheel hot spot pattern shift
  - Change in part placement
- Blast exposure time
  - Conveyer speed
  - Cycle time setting
- Motor Amps
  - Ammeter calibration
  - Media flow rate
- Wheel speed / Speed setting

As demonstrated, the blast cleaning process can be quantified and part of the SPC program. The Almen strip and gage are valuable resources for your ISO 9000 quality program and SPC program.

by Jim Whalen | Vice President Sales and Marketing | Progressive Surface

The ShotMeter and the Aerospace Industry

THE SHOTMETER is a success story for Progressive Surface, particularly due to its acceptance in the aerospace industry where it improves accuracy while reducing the development time of a shot peening process. For example, a major aircraft engine manufacturer recently benefitted from reduced development time, thanks to the ShotMeter. The manufacturer purchased a Progressive Surface 6-axis robotic shot peening system and required process recipes for five different intensity ranges at three different impingement angles with three different nozzles. Utilizing traditional methods, developing the 45 distinct saturation curves would have taken several weeks to complete. But with the use of previously developed process models and the ShotMeter, preparing a new development methodology consisted of a few simple steps.

Step 1. Collect a velocity fingerprint for the machine using the velocity profile factors that are unique to that machine (for example, hose length and diameter).

Step 2. Enter the desired angle of impingement and required intensity into our empirically developed process model for the specific media size and type. The output of this model is a target velocity needed to achieve the required intensity.

Once the target velocity for a particular intensity is known, the process engineer uses the fingerprint data developed in Step 1 to select his air pressure and shot flow. Using this methodology, no trial and error was needed. We reduced the time required to complete this task from several weeks to just a few days. The customer was able to take delivery of their machine weeks earlier, and was presented with a process model and machine fingerprint to use now and in the future.

Another advantage of the ShotMeter is its ability to integrate with machine process monitoring software. PRIMS Pro, Progressive's updated software released earlier this year, has many new features including enhanced user-friendly graphics, part queuing, expanded process/image association for individual parts, alarms with diagnostics, and simplified scheduling and tracking of preventive maintenance. To date we have several customers in varying industries, including medical, aircraft engine and airframe, enjoying the improved level of in-process control offered by an integrated ShotMeter.

Before and after each part is processed, the nozzle is moved in front of the ShotMeter sensor head and the velocity is measured, recorded with the process record for that part, and checked against the pre-established process limits. This ensures that the process is consistent and the same as previously determined. If the velocity is recorded outside of the approved range, the part processing is halted and maintenance is called to correct the problem. If the velocity is out of range at the end of the process, then quality is alerted and the part quarantined until proper engineering disposition is made. This new level of process control is becoming the standard for today's lean, quality-driven manufacturing environment.

THE SHOTMETER G3 was developed in collaboration between Progressive Surface and Tecnar Automation. It uses a simple method of particle illumination and two electro-optical sensors of a known spacing to sense particles as they exit the shot peening nozzle. The signals from the two sensors are compared and the resulting phase shift is used to calculate velocity, with accuracy within 1%. There are currently more than 40 ShotMeters in use worldwide.

The ShotMeter system is offered as a portable configuration, or integrated with PRIMS Pro, Progressive's process control and integrated monitoring system. Both configurations provide the user with adjustable setpoints and alarms for shot velocity.

by Glyn Richards | Proto Manufacturing

Residual Stress Measurement in Process Control

FROM THE INTRODUCTION of John Almen's shot peening process control tool in the 1930s to the present day, Industry has been faced with a difficult question: How can we know that today's peened product is truly the same as the first production part and the last part to enter service? The answer we accept is to rely on process control. Almen's method is used to set up and regularly verify the intensity of the stream of peening media, and a set of parameters (peening time, nozzle and part movements) is independently selected to achieve predetermined coverage on the parts.

The residual stress profiles generated by shot peening are a fundamental characteristic of the part. The profiles can be used as a baseline to evaluate future changes in the manufacturing process, repair schemes for parts in service, the effects of excursions from normal operating conditions, and in a 'retirement-for-cause' environment, to help to assess suitability for future service at overhaul inspections.

In an example from an aircraft engine manufacturer, an established family of engines was to be expanded to include a larger and more powerful model. The supplier of a forged, machined and shot-peened Titanium alloy part for the earlier model was selected to produce similar parts for the new model. The new components were larger, but of the same general shape, and the peening intensity required in one area was increased from 6A to 11A. The supplier had developed his business during the years of production of the original components, and had recently installed a shot peening line. He had successfully added his own shot peening to the original process, and included it in the proposed process for the new parts. When the pre-production parts were submitted for evaluation, the peened surfaces in the 11A areas were visibly rougher than the equivalent areas peened to 6A on the original parts.

Fortunately, the test plan had correctly included residual stress measurements. Proto Manufacturing used their X-ray diffraction method with electro-polishing to generate residual stress profiles through the shot peened surface and into the underlying material. The profiles were significantly different from others in the experience of the engine manufacturer, having unusually large compressive stresses near the surface, and shallower residual stress fields than others of the same Almen intensity. The X-ray diffraction peaks from the regions of high compressive stress were also broader than typically seen in the Titanium alloy, suggesting severe mechanical distortion of the material.

Scanning electron microscopy and metallographic sections later revealed extensive rolled edges and peened surface extrusion folds. These features can provide origin sites for future fatigue cracks, and are extremely undesirable in peened surfaces. Conversations with the supplier revealed that this was the highest intensity of shot peening he had attempted to date. He had experimented with increased shot velocity and exposure time, and could achieve the required intensity on Almen strips without increasing shot size. The Titanium alloy of the parts did not interact with the high intensity, small diameter shot in the same way as the steel of the Almen strips, generating a rougher surface texture, the heavily worked sub-surface layer and a resultant unusual residual stress profile.

The Proto LXRD Residual Stress Measurement System

There are lessons and benefits for both the customer and the supplier in this. Some customer and Industry specifications mandate the shot sizes to be used for given peening intensities, rather than leaving the choice to the supplier. Similarly, the lack of a specified coverage probably led the supplier to use the same extended peening time he used for the Almen strips. The importance of correct interpretation of saturation curves was highlighted for both supplier and customer. The supplier gained a valuable insight into the details of his own process, and incorporated those insights into a much improved and satisfactory process.


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You Asked, We Answered

We receive many emails requesting advice on shot peening processes and we try to answer as many as we can. By far, most of the questions pertain to the confusion between saturation, coverage and intensity so we've included a very good explanation by Dr. David Kirk. We've simplified the questions so that they do not reflect upon one particular company in respect for requests for confidentiality. These topics are a compilation of the questions we get on the same subjects.

Q

If the specified coverage level is achieved, why is saturation important?

A

by Dr. David Kirk

Peening intensity curves (a.k.a. saturation curves) are designed to establish the peening intensity of the shot streams. They are not designed to establish coverage requirements. The time, T, defines the peening intensity point—it does not define coverage. Coverage has to be established using a separate procedure as described in specifications and discussed in my Shot Peener magazine articles. (Editor's Note: Dr. Kirk's articles are available for download from the online library at www.shotpeener.com.)

Some experts state that there is absolutely no connection between the Almen peening intensity and coverage. I do not subscribe to that view because I believe that there are some secondary relationships between T and the coverage achieved on parts. The following account illustrates these relationships.

> "Joe (a fictional character) sets up a peening procedure. Using prior experience he sets the machine parameters and runs a peening intensity test. This shows that he has succeeded in achieving the customer's required intensity range. This intensity occurs with a range of two-minute passes varying between 1 and 4—depending on location of the strip holders. Joe's next problem is to satisfy the customer's requirement for 80% coverage. Knowing that peening intensity occurs when the coverage on Almen strips is well over 80%, Joe predicts that fewer than 4 passes will be needed on the actual parts. This is because he is also aware that the parts to be peened are softer than Almen strips. After using just one pass on the actual parts Joe found that almost complete coverage had been achieved. Eureka—a very economical solution.
>
> If, however, the customer complains that the coverage was excessive, Joe knew that he would have to carry out a proper coverage assessment procedure—modifying the flow rate to reduce the coverage without significantly affecting the peening intensity. Having satisfied both of the customer's requirements, Joe was able to shot peen a large order profitably. Suddenly, months later, the Almen peening tests (carried out daily) showed that the time T had shot up while still indicating that the peening intensity requirement was being satisfied. Joe realized that this was an alert signal because the coverage requirement might not be satisfied. He therefore tested for coverage and made appropriate adjustments to the flow rate."

Regarding the word "Saturation." It is firmly imbedded in shot peening's vocabulary. It is both ambiguous and confusing which is why I have campaigned for years to have it expunged. Saturation does not occur during shot peening in terms of either arc height or coverage. Unfortunately we have to live with the word because it is so firmly imbedded. In order to understand what is intended by "saturation" consider the following:

A "saturation curve" is a plot of arc heights induced by different amounts (time or passes) of shot peening. This curve allows a defined point to be deduced. That unique point is defined as the one on the curve for which the arc height increases by 10% when the amount of peening is doubled. The coordinates of this point are its corresponding arc height and amount of peening (T). "Saturation intensity" is, unfortunately, commonly used to describe that arc height. Better terms would be "Almen Peening Intensity" and "Almen Peening Intensity Point".

At the Almen Peening Intensity Point the coverage of the Almen strip is high—well above 90%. It would require a much smaller amount of peening to induce only 80% coverage of an Almen strip—roughly half. If the parts had the same hardness as Almen strips, then only about half of the Curve Solver analysis time T would be needed to achieve 80% coverage on your parts. If the parts are softer than Almen strips, then even less time is needed to achieve the specified coverage. That explains why you achieve 80% coverage in a fraction of the predicted 'T times'.

Continued on page 22

IPS....

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Q
How does "T" relate to the peening process?

A
by Dr. David Kirk
There are no direct applications of T values in everyday peening. They simply define the peening intensity point. Indirect applications can apply – see previous explanation.

You should not peen actual parts to the derived Almen test T times. You have to peen them for times, separately determined, that result in the specified coverage rate being satisfied. Excessive peening can cause part deterioration.

Q
If the requested intensity is 14-18A, what happens when I need 200% coverage and the intensity goes out of the range?

A
by Jack Champaigne
The requirement 14-18A intensity is met when the arc height value is within the .014 inch to .018 inch when the "A" thickness strip is used. If you've met that requirement, then the arc height value of the curve at time T2 may, or may not, be within the 14-18 tolerance band. As long as the arc-height of the T2 data point is 10% (or less) than the arc-height value of the T1 point then you have determined "intensity." It is VERY common for the T2 data point to actually be above the tolerance band.

Q
What does 200% coverage mean?

A
by Jack Champaigne
Peening for twice the time needed to achieve 100% coverage as determined by examining the actual peened surface—not twice the time for the Almen strip to reach intensity. Peening soft aluminum parts will take much less time than the intensity time of the Almen strip because the aluminum is softer and therefore has larger dimples than the Almen strip.

Conversely, hard gears will require much greater peening time since the dimples will be very small compared to the Almen strip. The part's hardness compared to the Almen strip HRc 44-50 range is the key factor in determining coverage time.

Q
Why isn't there a "B" Almen strip?

A
by Charles Barrett, former Chairman of the SAE Surface Enhancement Division - Fatigue, Design and Evaluation Committee
We all know that there are three strips used to qualify the intensity of a shot peening machine. Each of the strips has a different thickness. The "A" strip (.050" thick) was probably named for J.O. Almen who conceived the idea of using a strip of C-1070 cold rolled spring steel to qualify the intensity of peening on coil springs. The "N" strip (.030" thick) was developed by Charles Noble as the "A" strip was not sensitive enough to measure the low intensities used on jet engine parts. The "C" strip is .094" thick and used to measure high intensity shot peening.

I attended a dinner at an SAE Fatigue, Design & Evaluation Committee meeting some years ago. The entertainment for the evening was an amateur magician named John Straub. What some of you may not know is that John Straub was J.O. Almen's assistant at the GM laboratories, and was involved in much of the early experimental shot peening. Later on he directed the Wheelabrator R&D shot testing laboratory, where he developed the Wheelabrator shot testing machine. Among other things, John was a proponent of excluding fines in operating shot mix for optimum peening results. He also authored many papers in the late 1940s and also holds a patented dual intensity peening process.

When he finished his astounding demonstration of magic, John was asked by Dr. Ralph Stevens, University of Iowa, to relate some of the early events of shot peening in which he was involved. The question was asked why there was no "B" strip. John replied that during World War II the government was investigating the attributes of the German "Tiger" tank over U.S. tanks at the Aberdeen proving grounds. It was found the Tiger had shot peened torsion bars, which gave them a greater fatigue life over U.S. tanks. A deep depth of compression was required in the surface of the bar. The peening intensity was too high for the "A" strip, which warped under the shot impact. So a "B" strip of approximately .078" thick was tried. But it was also too thin.

The "C" strip of .094 was finally developed for the application. The "B" strip was superfluous as the "A" and "C" strips cover the intensify range. The "B" strip was discarded and not used again. There was another "B" strip used by the Douglas Aircraft Company. However, it was made from aluminum and used primary to determine coverage on aluminum aircraft parts.

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New Lightweight Springs in 2015 Audi A6 Avant

Audi put new lightweight suspension springs made of glass fiber-reinforced polymer (GFRP) in the 2015 Audi A6 Avant Ultra. Since these new springs won't require shot peening, the success of components made from composites should be noted by the shot peening industry.

THE GFRP SPRING, which Audi developed in collaboration with the Sogefi Group, even looks different than a steel spring. It is light green, the fiber strand is thicker than the wire of a steel spring and it has a slightly larger overall diameter with a lower number of coils.

Most importantly, however, it is some 40 percent lighter. Whereas a steel spring for an upper mid-size model weighs nearly 2.7 kilograms (6.0 lb), a GFRP spring with the same properties weighs just approximately 1.6 kilograms (3.5 lb). Four GFRP suspension springs together reduce the weight by roughly 4.4 kilograms (9.7 lb); half of which pertains to the unsprung mass. "The GFRP springs save weight at a crucial location in the chassis system. We are therefore making driving more precise and enhancing vibrational comfort," said Dr. Ulrich Hackenberg, Member of the Board of Management for Technical Development at AudiAG.

The composite spring, on the left, is thicker than the wire of a metal spring with fewer coils.

The core of the springs consists of long glass fibers twisted together and impregnated with epoxy resin. A machine wraps additional fibers around this core — which is only a few millimeters in diameter — at alternating angles of plus and minus 45 degrees to the longitudinal axis. These tension and compression plies mutually support one another to optimally absorb the stresses acting on the component. In the last production step, the blank is cured in an oven at temperatures of over 100˚ C (212˚ F).

The GFRP springs can be precisely tuned to their respective task, and the material exhibits outstanding properties. It does not corrode, even after stone chipping, and is impervious to chemicals such as wheel cleaners. Last, but not least, production requires far less energy than the production of steel springs. Energy efficiency is crucial because the springs were used in the 2015 Audi A6 Avant Ultra—this Audi is marketed in the United Kingdom where it's sold with an EU6-compliant engine. The EU6 is an European emission standard that defines the acceptable limits for exhaust emissions of passenger vehicles sold in EU member states.

What is Glass Fiber-Reinforced Polymer?

GFRP is a versatile material used in construction and architectural products including columns, roofs, cornices, sculptures and cupolas. It was first developed in the 1930s and its many advantages have been exploited over the years. Its strength and durability became widely publicized in the demolition of Disneyland's "House of the Future" in 1967—the wrecking ball simply bounced off the fiberglass walls of the building. Audi's announcement of their GFRP suspension springs is one of the product's most public debuts in the automotive industry.

GFRP and Shot Peening

Sogefi Group, an Italian automotive components OEM, jointly developed the GFRP springs with Audi. According to the company's website: "The coil springs industry for mass production applications is currently based on steel. Despite some weight reduction during the last 20 years, this material has reached its physical limits. Steel's manufacturing process is also labor intensive with high energy consumption for heat and surface treatment, shot-peening, etc." These reasons inspired the Sogefi Group to invest in the development of a the GFRP coil spring.

Even though composites have advantages over metals, the biggest drawback is their high production cost. Given that manufacturers are always looking for faster and better ways to produce their goods, the composite industry is worth watching.

ACADEMIC STUDY
by Dr. David Kirk | Coventry University

Essential Elements of Shot Peening

INTRODUCTION

Shot peening is a very important metalworking process–mainly used to substantially improve the fatigue life of components. There is now such a wealth of information about the process that often one cannot "see the wood for the trees". This British idiom carries a dictionary definition: "If someone **can't see the wood for the trees**, they get so caught up in small details that they fail to understand the bigger picture." This article explains shot peening in terms of six essential elements as illustrated in fig.1. on page 26.

1 Components, such as trailer leaf springs, are subject to cyclic loading.
2 Cyclic loading leads to corresponding cyclic stressing.
3 Cyclic stressing can lead to fatigue failure - if the stresses and number of cycles are high enough. Stresses must be tensile for cracks to grow.
4 The incidence of fatigue failure is often reduced by shot peening.
5 Shot peening induces a "magic skin" of compressively-stressed, work-hardened, material. The thickness of this skin depends upon the peening intensity.
6 Coverage is the amount of shot peening that is applied. Coverage is the percentage of the component's surface that is indented.

Specifying an appropriate shot peening treatment involves inter-related decisions. These are summarized in fig.2.

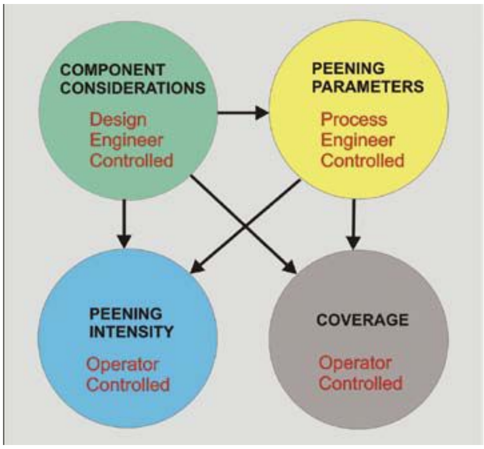
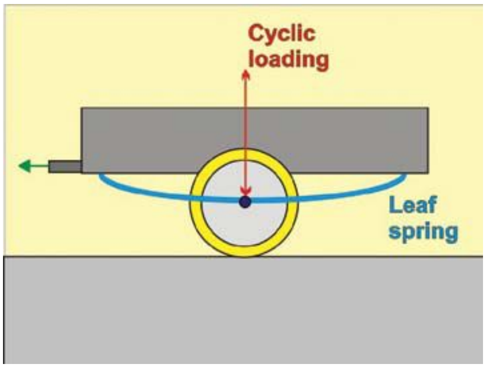


Fig.2. Shot Peening Decision-making.

Generally speaking, the customer is responsible for component considerations and setting of peening parameters–intensity and coverage. Customer decisions may involve experts such as design and process engineers. The peening company's operators are responsible for applying the customer's specified peening intensity and coverage levels.

1 CYCLIC LOADING



Cyclic loading occurs in almost all engineering components but most significantly (for shot peening) in auto and aero components. This loading has four distinguishing features:

1. Frequency of occurrence,
2. Variability,
3. Magnitude and
4. Type of loading.

1. Frequency of Occurrence

Sometimes the loading is obvious as with compression springs and leaf springs. Other times cyclic loading is much less obvious as with an aircraft fuselage (alternately pressurized and de-pressurized in flight). Springs may be cyclic loaded trillions of times, whereas an aircraft fuselage (landing gear, etc.) may only be cyclic loaded a few thousand times – in the same period of time. The frequency of loading can therefore vary enormously. This has an effect on component design. Some components have to be designed to withstand thousands of cyclic loadings whereas others have to be designed to withstand trillions of loadings.

2. Variability

Component loading can vary substantially. An empty truck

Continued on page 28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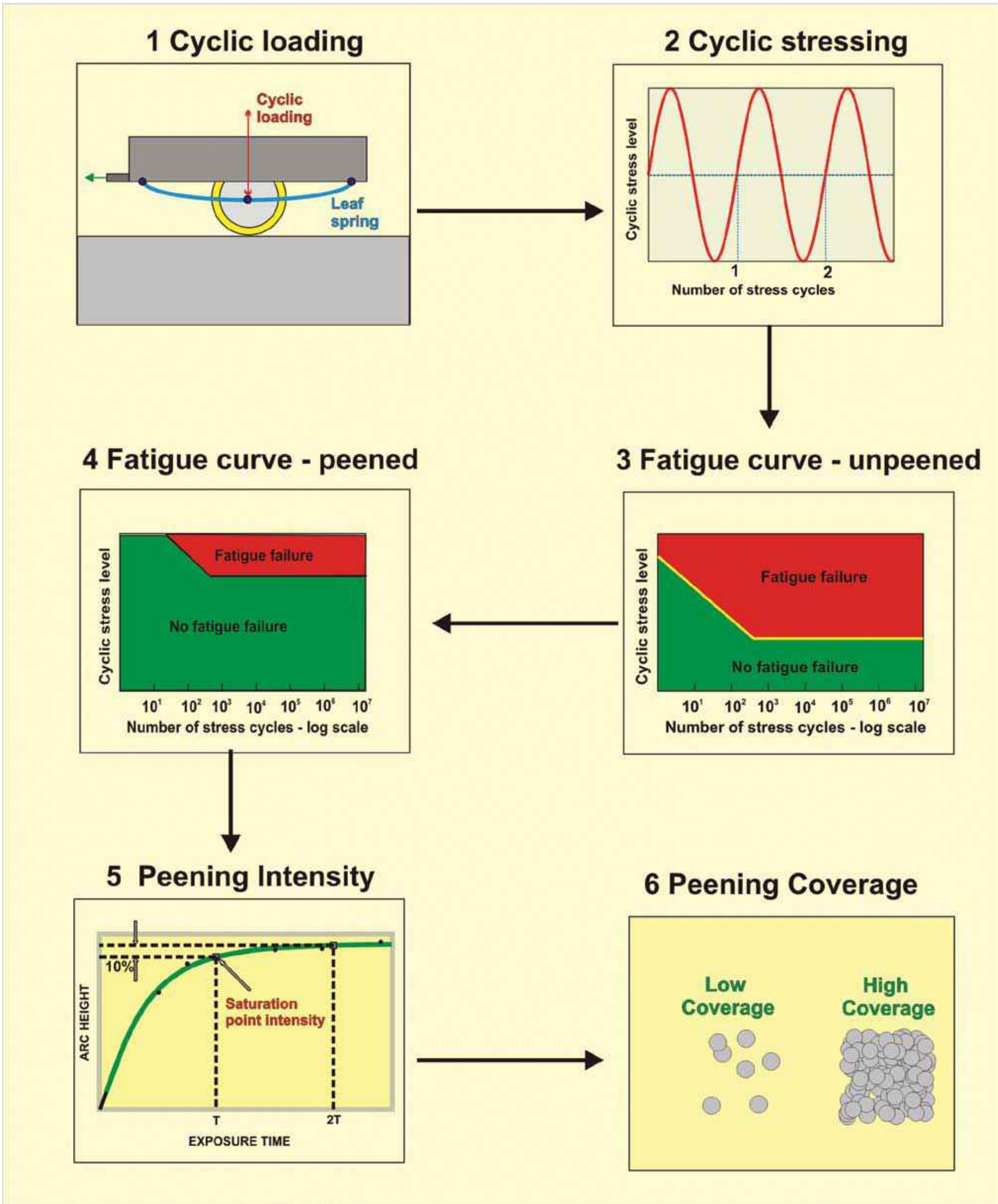


Fig.1.Shot Peening considered in terms of six essential elements.

imposes lower cyclic loads than does a fully-loaded truck. A trailer being pulled along a smooth tarmacked road will experience lower loads than when pulled on a pot-holed mountain track. An aircraft making a heavy landing imposes higher loading than with a normal landing. This variability adds a complication to component design and to the effectiveness of shot peening in preventing failure.

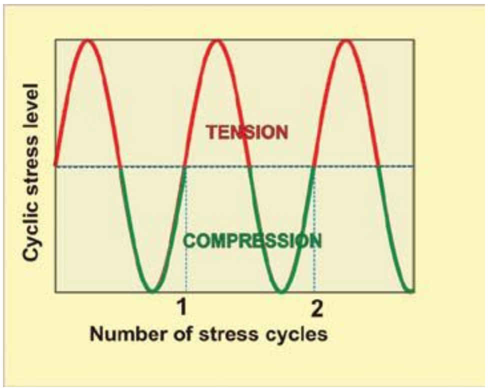
3. Magnitude

The magnitude of the cyclic loads affects how long a component will last before it fails. Larger loads equate with shorter component lives in terms of the number of cycles that can be withstood. Estimating the magnitude of cyclic loads is a subject in its own right!

4. Type of loading

The 'black and white' extremes of cyclic loading are 'push-pull' and 'repeated bending'. All components have a proportion of each type of loading. Shot peening works best when the cyclic loading is mainly repeated bending.

2 CYCLIC STRESSING



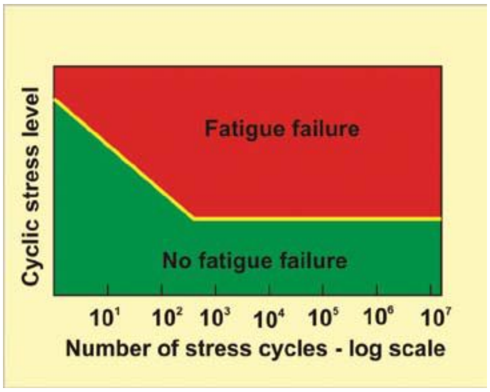
Cyclic loading of any component gives rise to corresponding cyclic stressing. The stress may vary between tension and compression as shown above. It is the tension part of stressing (shown in red) that can cause fatigue failure.

Stressing of components is normally "elastic stressing" because the stress disappears if the load is removed. Applying a tensile load to a component means that it must stretch. Conversely a compressive load compresses the component. The amount of stretching or compression is called the "strain". For elastic stressing of components there is a linear relationship between stress and strain. This relationship is a cornerstone of mechanics, being known as "Hooke's Law" (published in 1660). The ratio of stress to strain is the elastic modulus, E, of a material.

The number of stress cycles that are applied in service varies enormously according to the type of component. Components can be designed to withstand an expected number of known stress cycles before they fail due to 'fatigue'. In the nineteenth century, component design in the UK lead to the phrase "Victorian Engineering". Components were designed with such a huge margin of safety, and therefore low stress levels, that some of them are still working in the twenty-first century! Such over-engineering cannot normally be tolerated in modern transport vehicles – the corresponding weight penalty would make them uneconomic.

An important element of cyclic stressing is "stress-amplification". If a component contains a notch then the derived stresses are amplified. The degree of amplification depends on the sharpness of the notch. That is why smooth "fillets" are normal for areas such as axle-to-flange. Shot-peening has to minimize the effect of its dimples which are themselves stress-amplifiers.

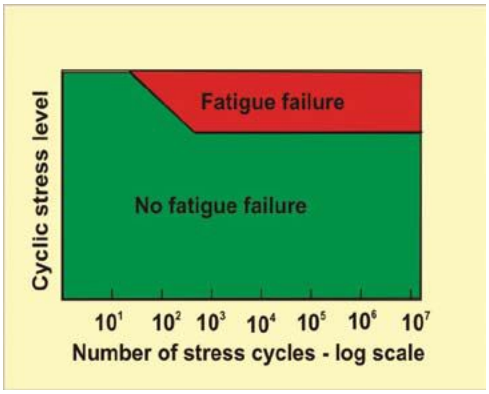
3 FATIGUE CURVE – UNPEENED



Metals have an inherent ability to withstand cyclic stressing. This is generally represented in the form of a fatigue curve. For ferritic materials the general shape of a fatigue curve is shown above. The first thing to notice is its simplicity – just two straight lines separating failure from survival. That is because a 'log scale' has been used for indicating the number of stress cycles that have been applied. A log scale is necessary because of the huge range of applied stress cycles that may be encountered – say tens to many billions – depending on the component's application.

For ferritic materials the number of cycles to failure decreases with increase in cyclic stress level. Below a certain stress level fatigue failure never occurs. That stress level is called the "fatigue limit". In the diagram shown this occurs at about 500 stress cycles, but that number will vary considerably with type of material and type of testing. The main objective with shot peening is to raise the fatigue limit stress level. Imagine a ferritic component that is repeatedly stressed to just above its fatigue limit. Fatigue failure will occur when a critical number of stress cycles have been applied. If the cyclic stress level never exceeds the fatigue limit then fatigue failure will never occur.

4 FATIGUE CURVE – PEENED



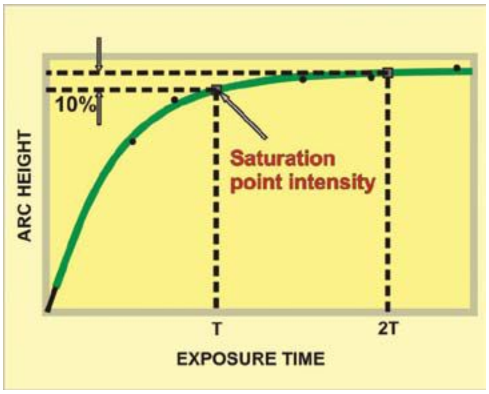
The general effect of shot peening is to raise the cyclic stress level that can be withstood for any given number of applied stress cycles. This raising of the stress level is illustrated above – compare it with the fatigue curve for the same material in the un-peened state.

Impacting shot particles plastically-deform the surface of a component. This generates a work-hardened, compressively-stressed surface layer on the component. It is this surface layer that improves the fatigue resistance of components. Fatigue cracks can only form and grow during the tension part of applied stress cycles. The stress applied to a component is greatest at the surface – especially in bending. Compressive residual stress at the surface reduces the applied tensile stress by the same amount.

The reason for compressive stress in the surface layer being effective is not always obvious. As an analogy, consider a rubber sleeve being stretched over the handle of, say, a cricket bat (hockey stick, etc.). The rubber sleeve is in tension. Now imagine cutting a slit into the surface. As the cut is made, the tension will pull the slit open. If, however, the rubber sleeve was somehow in compression, then that compression would keep the slit closed.

Peening intensity directly controls the thickness of the work-hardened, compressively-stressed surface layer.

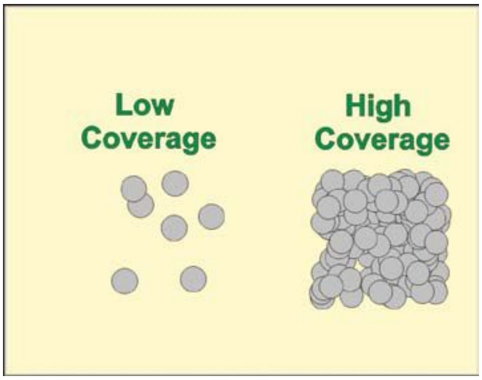
5 PEENING INTENSITY



"Peening intensity" is a quantity that is directly related to the depth of the compressed surface layer. The greater the peening intensity value, the greater will be the thickness of the compressed, work-hardened layer. Estimation of the peening intensity value requires that a set of standard steel strips, Almen strips, have been peened for different amounts. The induced bowing of the strips allows a curve to be plotted – arc height versus amount of peening. Peening intensity is defined as the arc height at a point on the curve that is increased by 10% when the amount of peening is doubled.

The effect of bombarding particles depends on the angle of impact. Imagine a machine gun firing at a vertical steel plate. The bullets will make certain impacts on the plate's surface. If we now incline the plate at an angle the impact effect will be reduced. This phenomenon is utilized in battle tank design! If Almen strips are inclined at an angle to the shot stream then the impact effect will similarly be reduced, lowering the measured peening intensity.

6 PEENING COVERAGE



"Peening Coverage" is defined as the percentage of the peened surface that is dented by impacting shot particles. The percentage of coverage increases with the amount of peening that has been applied to a given area of the component. Small amounts of peening impart a low percentage of the area that has been indented. Conversely, large amounts of peening will produce a high coverage – as shown above.

An analogy to the evolution of peening coverage is that of repeated bombing runs over a target area. Imagine one bomber drops seven identical large bombs that explode, producing craters that correspond to the low coverage shown. It is quite possible that one bomb explodes so that its crater partly overlaps a previous crater – as shown. The total area of the seven craters is now slightly less than seven times the size of an isolated crater. A second bombing run over the same target area will produce a greater proportion of overlap. The greater the coverage with craters the less will be the new crater area that will be created by an extra bombing run. This represents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an example of "The Law of Diminishing Returns". Note that even with a large number of bombing runs it is probable that a tiny proportion of the target area will be un-cratered.

DECISION-MAKING

Decision-making depends on where the customer/peener is on the spectrum of shot-peening knowledge. At one end of the spectrum, a single person has to bear all of the responsibility armed with only an elementary knowledge of what shot peening is all about. At the other end, the customer/peener has a team that includes design engineers, process engineers, computer experts, staff trained at shot peening workshops, etc. The complexity and value of the components involved directs the optimum position on the spectrum.

The several elements of shot peening that have been outlined in this article combine to highlight the enormous complexity of the decisions that have to be made. Three essential decisions have to be made:

1 Peening Media

2 Peening Intensity and

3 Peening Coverage.

1 PEENING MEDIA

The most popular shot peening media are cast iron shot, cast steel shot, cut steel wire shot, glass beads, ceramic beads and stainless steel shot. These share some common characteristics: near sphericity, high hardness, durability and reasonable cost.

Choice of peening medium depends mainly on the component's composition. Ferritic steel components are normally peened with either cast iron, cast steel or conditioned cut steel wire shot – all of which are themselves ferritic. Peening stainless steel components with ferritic shot invites the danger of galvanic corrosion. Dissimilar metals and alloys have different electrode potentials, and when two or more come into contact in an electrolyte, one metal acts as anode and the other as cathode. Aluminum alloy components, being relatively soft, normally require the use of glass or ceramic beads – which also obviate the galvanic corrosion problem.

There are strict specifications governing the quality and size of peening media. Shot deteriorates in use because of size reduction due to wearing and shape problems occurring due to fracturing on impact. There is a direct connection between the specified size of shot and the peening intensity that can be induced. Sieving is employed to control the size range for each grade of shot. Media sizes vary from about 0.2mm diameter up to about 3.4mm diameter. Most peening is carried out with media less than 1.0 mm diameter.

The customer decides on the size and type of media that have to be employed.

2 PEENING INTENSITY

Customer specification of the peening intensity to be applied to a particular component is of critical importance. This requires that peeners must apply an intensity that lies between upper and lower limits, e.g., 0.20 – 0.26mm using A strips. A limiting range is necessary because peening intensity is very difficult to control to within precise limits. The optimum mean intensity that should be applied depends on a large number of factors – type of material, type of loading, thickness of component, etc. – so that its selection has to be carefully determined.

A shot stream striking a component's surface 'head on' will have a higher intensity than if it strikes at an angle. Customers often specify that their required peening intensity must be measured, for certain locations, with strip holders at an appropriate angle to the shot stream. For those locations only, the shot stream must be accelerated.

The 'magic skin' of work-hardened, compressively-stressed material can be up to about 1 mm in thickness. Charts are available that indicate how this thickness varies with applied peening intensity and component composition. As a rough guide: the skin depth is approximately two-thirds of the Almen A intensity value for steels.

Optimizing the intensity to be specified is complicated by the number of factors that affect component life improvement. As long ago as 1958, Fuchs advised that an intensity range of 0.25 to 0.35mm using A strips (0.010 – 0.014" A) was appropriate for general applications. He also detailed some of the complicating factors such as component thickness, material, notches and possibility of sub-surface crack initiation. These indicate that the optimum intensity varies considerably. Even after taking into account the several complicating factors, there is no substitute for practical assessment of component life improvement.

3 PEENING COVERAGE

Customers must specify the amount of coverage that they require to be applied to their components. Again there is no substitute for practical assessment if optimum coverage is to be specified. One school of thought assumes that 'more is better'. This has resulted in rather vague requirements such as "300% coverage" – being three times the amount of peening that produces a nominal "100%" coverage. Another school of thought believes that the optimum coverage for most applications is less than a nominal "100%".

It is generally recognized that it is very difficult to measure changes in coverage above 98%. Hence it is accepted that a value slightly less than 100% is to be regarded as "full coverage".


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DISCUSSION AND CONCLUSIONS

This article has presented a 'Big Picture' of shot peening especially in terms of the decisions that have to be made about the several important parameters. Of necessity, simplifications have had to be included. There is extensive literature that provides the theoretical and practical implications of parameter change.

In the majority of practical applications, shot peening is proposed because premature component failure has occurred. Again, there is a wealth of literature detailing the substantial improvements to component life brought about by applying shot peening. As an 'add-on' process, it is normally more economical than having to either change component dimensions and/or component material.

Editor's Note: The online library at www.shotpeener.com is a great resource for articles on the benefits of shot peening. For example, a search for "benefits of shot peening" gives 86 articles.

The website is also the place to download Dr. Kirk's free Curve Solver and Coverage Predictor programs.


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Ervin Steel Abrasives Now Made in Germany

PRODUCTION IS NOW in full swing at Ervin's new state-of-the-art manufacturing plant in Glaubitz, Germany. "Making quality steel abrasives is a specialty business," says Phil Ripley, Commercial Director for European Operations. "We have successfully worked to make sure that we continue to offer the same high quality products from all of our plants. We are particularly pleased with progress towards full production at Glaubitz and are very flattered by interest within the industry."

The Glaubitz plant has been built from scratch with the goal of optimizing production processes and to provide local access to Ervin's Amasteel products to Germany and neighboring markets. The Ervin product is characterized by consistent high quality, founded upon production processes that ensure consistency of supply measured against SAE standards. This is based upon nearly 100 years of practical experience. The resulting high-carbon, finely tempered martensite offers the 'sweet spot' in terms of transmitted energy and durability in a wheel- or air-blast machine. This combination can generally offer significant savings in process time, in power consumption, and in abrasive consumption.

"The Glaubitz plant represents a significant step in Ervin's long story in the abrasives business" says John Pearson, President of Ervin Industries. "We have always been committed to offering the best solutions to customer requirements and now we have the best located plant to deliver it."

Ervin Amasteel abrasive is the global product of choice for leading steel, automotive and aerospace industries for the removal of scale and rust, and for use in granite cutting operations. Ervin Industries has three plants in the U.S. where they are the leading provider in this sector. Europe is currently supplied from a facility in Tipton, UK. Now Glaubitz will supply Central and Eastern European regions, adding a further annual production capability of approximately 60,000 ton of material.

Headquartered in Ann Arbor, Michigan USA, Ervin Industries maintains Amasteel manufacturing facilities in Tipton, UK; Adrian, Michigan and Butler, Pennsylvania USA; a machrome stainless steel in Sprockhövel, Germany; and Amacast stainless steel and speciality powders at Ervin Technologies in Tecumseh, Michigan USA.

1st International Workshop on Cavitation Peening and Related Phenomena

OCTOBER 27-29, 2015
SENDAI INTERNATIONAL CENTER, SENDAI, JAPAN

The 1st International Workshop on Cavitation Peening and Related Phenomena, hosted by Society of Surface Mechanics Design, will be held October 27-29, 2015, at the Sendai International Center, Sendai, Japan, in corporation with 12th International Conference on Flow Dynamics ICFD2015.

Cavitation peening and related mechanical surface treatment such as shot peening, laser peening, ultrasonic peening, deep rolling, combined processes and other cold work processes including evaluation methods of surface treated layer are within the scope of the workshop.

Workshop Contents: Keynote lecture, Invited lectures, Oral presentations, Poster presentations, Banquet, Laboratory tour (Cavitation peening system), Plant tour (Toyota Motor East Japan, Inc., Iwate Plant)

Workshop Topics: Hydrodynamic cavitation, Ultrasonic cavitation, Laser cavitation, Conventional mechanical surface treatment (Shot peening, Laser peening, Ultrasonic peening, Deep rolling), Numerical simulation, Residual stress measurement, Nondestructive testing, Material testing, Practical applications

Keynote Lecturers: *Prof. Mamidala Ramulu* with Boeing and the Pennell Professor of Engineering, Professor of Mechanical Engineering University of Washington. *Dr. Mohamed Hashish* with Flow International Corporation.

Important Dates
June 15 Deadline for paper title / author's name / keywords
August 1 Deadline for short paper (2 pages)

Registration Fee (includes the banquet fee)
September 1 Deadline for Advanced Registration

- Advanced Registration Fee (on or before Sep. 1): General 21,000 JPY Student 6,000 JPY
- On-site Registration Fee: General 31,000 JPY Student 9,000 JPY

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Sonats Publishes White Paper on Ultrasonic Needle Peening

Numerous articles have been written on needle peening apparatus, usually for descaling welds. Sonats has developed a more efficient device that imparts an extremely deep compressive stress. When applied to steel structures, such as bridges, the life span can be increased by four to five times. This should be of interest to those concerned with critical infrastructure. We have reprinted the abstract and introduction; the white paper in its entirety may be downloaded at www.shotpeener.com (paper #2014042).

Fatigue Life Improvement of Welded Structures By Ultrasonic Needle Peening

Abstract
Conventional Hammer Peening is a well-known post-weld treatment for fatigue life improvement. This method is applied to the weld toe only.

Ultrasonic Needle Peening (UNP) (also called Ultrasonic Impact Treatment (UIT) or High Frequency Mechanical Impact (HFMI)) is a process achieving the same effect, but with much process control compared to conventional needle peening. UNP is also faster and far less harmful for the operator. Moreover UNP process can be used by any operator after only one day of training. For these reasons many industries have shown a strong interest for this innovative technology.

This document describes SONATS research, in-field experiences and knowledge about Ultrasonic Needle Peening. It is dedicated to any people (engineers, welders, operators, controllers) who are interested in this process.

NOTE: Many designations are used to describe the process which consists in using high frequency mechanical vibrations to put in movement impactors or needles to throw against the metal surface area to be treated:

- UIT for Ultrasonic Impact Treatment,
- UNP for Ultrasonic Needle Peening,
- UP for Ultrasonic Peening,
- or HFMI for High Frequency Mechanical Impact treatment).

In this document we will, most of time, use "Ultrasonic Needle Peening" or "UNP".

2. UNP Effects

According to P. J. Haagensen and S. J. Maddox, "The weld toe is a primary source of fatigue cracking because of the severity of the stress concentration it produces". For this reason, the weld toe can be considered as a "notch".

Hammer Peening or Needle Peening is an ancestral process, which consisted in striking manually a weld by the means of a hammer, to improve its surface finish and resistance. Later, pneumatic and magnetostrictive tools have been developed to help the operator. Nowadays, the principle is still the same but the equipment design has been improved. The latest technologies are using piezo effect for electrical to mechanical vibration. The vibrating element, named Sonotrode, is then use to provide the kinetic energy to a needle (or impactor). Thanks to those modern tools, the influence of the operator on the process application is close to zero, with little efforts and high treatment speed.

Research about UNP started in the late fifties and sixties in the USSR. Extensive research have been carried out later in the nineties, on structural steels, high strength steel and aluminum, showing each time a high level of improvement in term of fatigue life. In 1996, the International Institute of Welding published a specification and in 1999 the first "Guide for application of UIT."

On this basis, many industries started to pay attention to this effective and user-friendly post-weld improvement techniques. The weld toe improvement methods rely on two main principles:

- Weld toe geometry modification
- Residual Stresses Modification

Ultrasonic Needle Peening acts on both phenomenon to finally achieve high level fatigue life improvement of the treated welded detail.

Wheelabrator Group Technology Centre in Ontario, Canada Celebrates Grand Opening

METALLIC SURFACE PREPARATION EXPERT, Wheelabrator Group (Canada) Ltd., celebrated its grand opening with a ribbon cutting ceremony and luncheon after moving to a new location and office complex in Burlington, Ontario. The ceremony was held on February 23, 2015.

This brand new office facility offers spacious conference rooms and modern work stations for engineering and sales to help the team offer state-of-the-art technology for standard and custom wheel and airblast equipment. Wheelabrator also offers complete equipment services on a global level, which is unique in the industry, providing the necessary support to keep equipment running at optimum capacity. Replacement parts, services, equipment modernization, maintenance and training help customers to reduce operating costs, maximize productivity and upgrade to the latest technologies to support manufacturing improvements.

"Wheelabrator continues to see steady growth in all of North America. Our new facility will allow our dedicated team of service and sales engineers to respond even faster to customer queries." Said Andrew Carmichael, President & COO, Wheelabrator Group.

From left to right: Marty Magill, Dave Taylor, Jennifer Taylor, Dave Foster, Mark Lambrix, Andrew Carmichael, Shawn Horton, Pierre Tanguay, Neil Moseley, Tim Ogden

ITAMCO Releases Three New App Bundles for Machinists

ITAMCO (Indiana Technology and Manufacturing Companies) has released three new bundled apps: CNC Machinist, Practical Machinist and Ultimate Machinist. These app bundles contain ITAMCO's most popular apps and are offered at reduced prices through the Apple App Store.

CNC Machinist

The CNC Machinist App Bundle has four apps that will help users build a CNC program and the settings to send to a CNC machine tool, including:

- Feed Rate Calculator – calculates feed rate and speeds
- Grid Pattern Support – gives X and Y positions for a grid pattern program
- Bolt Hole Circle Calculator – calculates coordinates of a bolt hole circle based on the number of holes and X, Y coordinates
- iDNC – the first iOS DNC settings app for CNC machine tool controls. DNC settings for multiple machine controls and types including, but not limited to, Fanuc, Siemens, Mazak, Okuma, Haas, and many more. Also includes FTP (file transfer protocol) client server for part programs for CNC controls such as Fanuc.

The price of the CNC Machinist App Bundle is $1.99. (Individual apps are $1.00 each.)

Practical Machinist

These four apps cover the basic tasks for the machinist, including:

- Feed Rate Calculator – calculates feed rate and speeds
- Drill Tap - calculates different size drills, taps, bolts, screws, and nuts
- Metal Weight Calculator – calculates weights of different types of metals in various shapes
- Measure Threads – measures threads with wire and calculates the best wire size

The price of the Practical Machinist App Bundle is $1.99. (Individual apps are $1.00 each.)

Ultimate Machinist

The Ultimate Machinist contains the 10 apps that every machinist needs, including:

- Feed Rate Calculator – calculates feed rate and speeds
- Drill Tap - calculates different size drills, taps, bolts, screws, and nuts
- Metal Weight Calculator – calculates weights of different types of metals in various shapes
- Measure Threads – measures threads with wire and calculates the best wire size
- Bolt Hole Circle Calculator – calculates coordinates of a bolt hole circle based on the number of holes and X, Y coordinates
- Ball Nose Calculator - calculates step-over and depth of cut for a ball nose end mill
- Sine Bar Calculator - calculates the gage block stack, 1st angle, and/or 2nd angle given the sine bar size and one of the other variables
- Drill Point Calculator - calculates drill point depth and countersink depth or angles
- Thermal Expansion Calculator - calculates changes in dimensions or thermal expansion coefficient of a substance related to its thermodynamic property when heated, and expanding or contracting when cooled
- Surface Finish Calculator - converts values between speed, corner radius, and surface finish value

The price of the Ultimate Machinist App Bundle is $4.99. (Individual apps are $1.00 each.)

The apps require iOS6.1 and can be purchased through the Apple App Store in iTunes. They are compatible with the iPhone, iPad and iPod Touch.

A 250,000 App Download Milestone for ITAMCO

ITAMCO isn't a newcomer to app development. The company is currently releasing a new app every two weeks and has released over 65 apps for iOS, Android, Windows and

Blackberry mobile devices since 2009. The development team recently celebrated 250,000 downloads in 155 countries. Joel Neidig, an engineer at Indiana Gear (a division of ITAMCO) is the lead developer in a team of three. The development team is uniquely qualified—all three have shop floor experience and are software developers. "We're committed to building our applications on platforms that bring a user-friendly experience to our customers at an affordable price," said Mr. Neidig. "We started developing apps because we needed tools on our shop floor that we couldn't find in the marketplace," he added.

Mr. Neidig and his team have also released iBlue—the first industrial handheld bluetooth transmitter—and an award-winning Google Glass application. All of these innovations are integrated into Indiana Gear's plant monitoring system.

About ITAMCO
Since 1955, ITAMCO has provided open gearing and precision machining services to many heavy-duty industries including mining, off-highway vehicles, marine, and aviation. Learn more about ITAMCO at www.itamco.com or call (574) 936-2112.

10 Strongest Materials Known to Man

Have you ever heard of Buckypaper? It is one of the strongest materials known to man. This carbon nanotechnology material is 500 times stronger than steel and ten times lighter. Believe it or not, spider's silk is also on this list. And one is from outer space. Are you familiar with any of them?

10 Spiders' Silk. Darwin bark spiders' silk is considered the toughest biological substance. It is 10 times stronger than Kevlar.

9 Silicon Carbide. Forms the basis of Chobham armor used in battle tanks. Highly effective — not one British Challenger tank was destroyed in Operation Desert Storm.

8 Nanospheres/Nano-Kevlar. Self-assembling nanospheres are the stiffest organize material ever created and they could lead to the development of printable body armor.

7 Diamond. The hardest material on earth. It has unrivaled resistance to scratching.

6 Wurtzite Boron Nitride. This material is created during volcanic eruptions and is theoretically 18% harder than diamond. However, large enough quantities don't exist to test this theory.

5 Lonsdaleite. Formed when meteorites containing graphite hit Earth. Simulations show it to be 58% harder than diamond, but, again, it's too rare to test.

4 Dyneema. High-performance polythene marketed as the strongest fiber in the world. Lighter than water, it can stop bullets and is 15 times stronger than steel.

3 Metallic Glass. Palladium microalloy glass has the best combination of toughness and strength. It's thought to be the most durable material on the planet.

2 Buckypaper. Nanotechnology material made from tube-shaped carbon molecules 50,000 times thinner than human hair. It's 500 times stronger than steel and 10 times lighter.

1 Graphene. One-atom-thick sheets of carbon are 200 times stronger than steel. It would take an elephant balancing on a pencil to break a sheet as thin as Saran wrap.