Fall 2022
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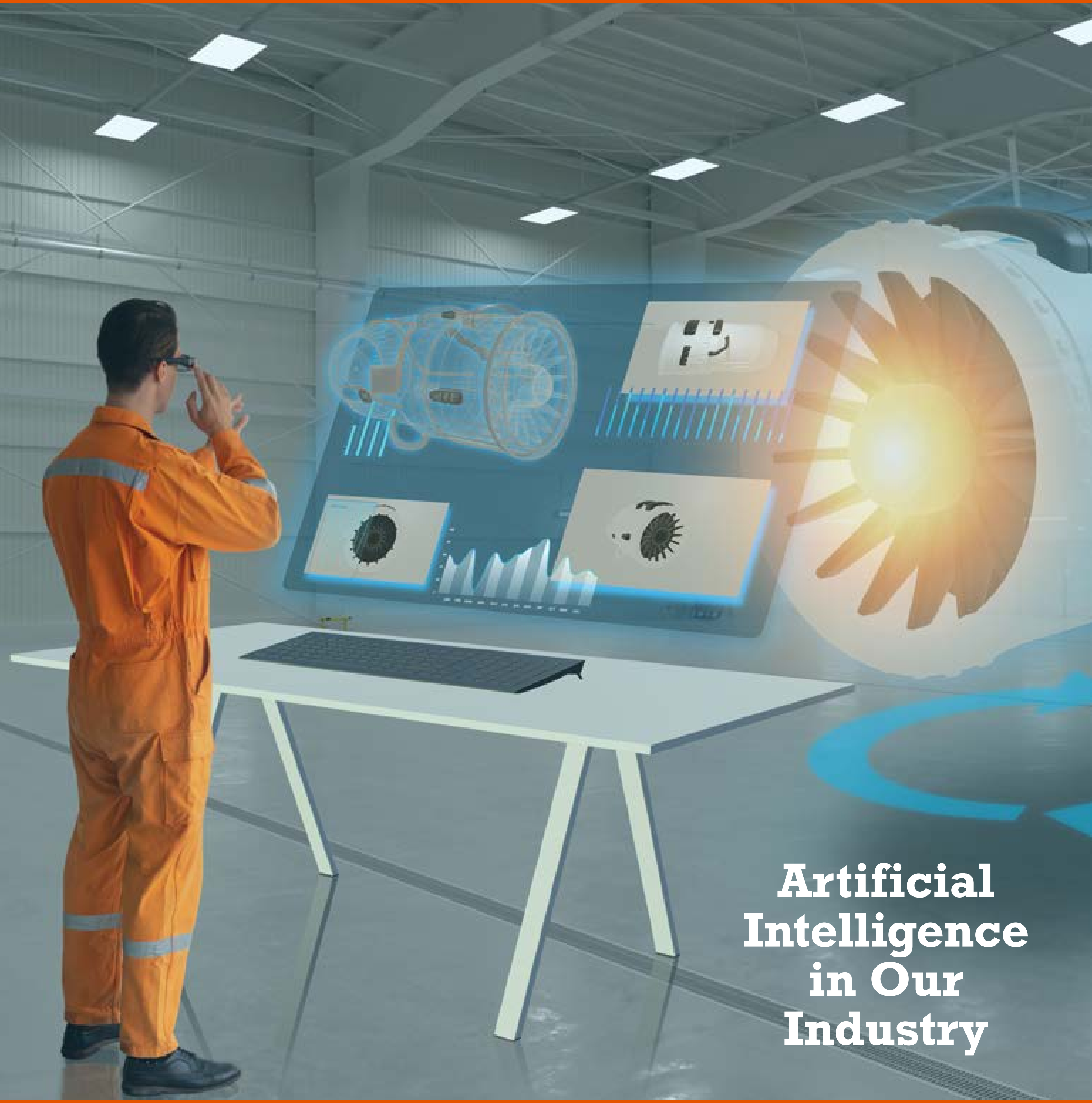
The Shot Peener

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



Artificial Intelligence in Our Industry

PLUS: NEW PEENSOLVER PRO ▮ THE AVIATION RELATED SHOT PEENING FORUM
▮ BACK TO BASICS: ENERGY CONTROLS SHOT PEENING EFFICIENCY

Peening Innovation

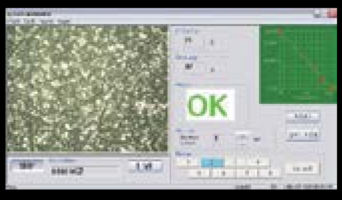
COVERAGE CHECKER

COVERAGE CHECKER the device for easy and precise coverage measurement

UV Light version
New arrival!

- UV light version Coverage Checker measures coverage by the fluorescent paint peeling rate, using UV light.Therefore, measurement result will not be affected by surface condition.
- UV light version Coverage Checker can measure the coverage even on oxidized surfaces and uneven peened surfaces, which was difficult to measure with normal version.

Coverage Checker (Original)
Easy USB connection to your PC



※PC is not included ※Device image

※Specifications of this device may be changed without notification.

Positron Surface Analyzer

PSA Type L-Ⅱ

PSA Type L-P

Non-Destructive Inspection

by Anti-coincidence System

US Patent : US 8,785,875 B2

Application

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

Specification

Device size : Type L-Ⅱ W400 X L400 X H358 [mm]
Type L-P W125 X L210 X H115 [mm]

Positron source : Na-22(under 1MBq)

Option : Autosampler function (4 - 8 stage)

Distributor

Country	Company	TEL	E-MAIL
USA	Electronics Inc.	+1 574-256-5001	sales@electronics-inc.com
CANADA	Shockform Inc.	+1 450-430-8000	sales@shockform.com
EUROPE	SONATS	+33 251-700-494	sonats@sonats-et.com

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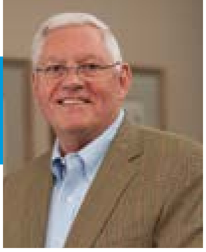
THE SHOT PEENER
Sharing Information and Expanding Global Markets for Shot Peening and Blast Cleaning Industries



Remembering Ronald John

DECEMBER 4, 1930 - APRIL 29, 2022

I don't remember the first time I met Ron John but our records indicate his company, Tealgate, was mentioned in a 1990 Shot Peener magazine. By the end of the decade, we became distributors of each other's products.

As I recall, Ron worked at VacuBlast when a media flow monitor was needed. Professor Maurice Beck, a VacuBlast consultant, developed a series of sensors for various concentrations of media used in abrasive cleaning operations. At some point, Ron created Tealgate to manufacture and sell the devices; first to VacuBlast and then to other companies including Electronics Inc.

Ron received an order for his Precifeed system from an American company headquartered in Seattle and they needed his help with implementation. I agreed to meet Ron in Seattle. I collected him early one morning at the airport and took him to breakfast at a Denny's restaurant. Ron was so impressed with the photos in the menu that the manager let him keep it. Ron was also amazed at the unending coffee supply, explaining to me that in England each additional cup of coffee incurred a charge.

The reason for the trip was to help a customer feed plastic media for the purpose of stripping paint from aircraft. Ron quickly spotted the difficulty and solved the customer's issue.

His efforts to sell his Precifeed system always included extensive drawings of how everything would fit into the customer's application. He was very diligent and made sure the customer could clearly see the benefits.

I made several trips to England and Ron proved to be an expert travel guide. I was fascinated by his stories of watching American films while he worked as a projectionist in the movie theater when he was a teenager. He also had a love for stories about the Lewis and Clark expedition and the exploration of the American Northwest.

My daughter, Amy, and I visited England in 1996 and Amy kept a diary about her experiences. There are several mentions of Ron and how he took such good care of us on our trip.

On another trip to England with Pete Bailey, we visited Ron at Stoke on Trent and we had Fish & Chips. We had a picnic with the newspaper-wrapped delicacy and watched the swans swimming so gracefully in the river.

I can still imagine Ron's smile and great humor. He was such a good friend. I have so many fond memories of Ronald John. I feel blessed that I had the privilege to know him. Rest in peace, Ron.

This caricature of Ron captured his love of photography. Ron photographed many beautiful scenes in England, Wales and France.

THE SHOT PEENER

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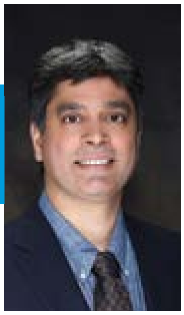

AN INSIDER'S PERSPECTIVE

Kumar Balan | Blast Cleaning and Shot Peening Specialist

Artificial Intelligence in Our Industry

DISRUPTIVE TECHNOLOGY

Shot peening is the result of millions of media particles impacting and plastically deforming the impacted surface while altering its metallurgical characteristics. Therefore, disruption is hardly new to us shot peeners! However, when disruption could do more than just alter metallurgical state from austenite to martensite, it is time to take notice! A casual Google search will reveal the topmost disruptive technology currently to be Artificial Intelligence (AI).

I suggest that AI is a phenomenon that will continue to influence our lives in unprecedented ways and not just be acknowledged as a new technological experience. It is already showing its presence everywhere, starting with the above example of a Google search result, self-driving cars, and as a key element in a modern, automated factory. AI has gained enough prominence that the McKinsey Global Institute estimates the value of its financial impact to be about $13 trillion by 2030. Its rapid spread is also noticed outside of the IT sector.

To learn more, I expanded my research on AI through an online course at coursera.org/learn/ai-for-everyone. Though the information is fundamental, it provided sufficient reasons for me to present this topic to you and explore its impact on the blast cleaning and shot peening industries. I have often expressed my opinion in these columns about the pace of change in our industry and even likened it to watching paint dry! However, change is inevitable. We are about to be presented with a different landscape to operate in.

Currently, some Automotive or Aerospace customers specify residual compressive stress and surface roughness targets post-peening instead of, or in addition to, intensity and coverage. This is categorized as being uncommon, and a new and developing trend. Imagine the same customers demanding that they be alerted 40 hours in advance about a potential nozzle failure in the machine? Or in another instance, what if the same customers would like to know the probability of operator X causing part failure due to incorrect technique selection? Maintenance alerts and warnings about certain impending situations already exist in certain sophisticated machines. However, it can hardly be denied, especially by my programming friends, that we have barely scraped the surface of a machine controller's (PLC, CNC, etc.) capability. AI is challenging us to do exactly that. Terms such as "big data" and "Internet 4.0" are being brought up more frequently in discussions and machine readiness to address these requirements are being questioned. This takes us to the stage of discussing certain key terminology when referring to AI.

MACHINE LEARNING

One of the key tools driving AI is Machine Learning (ML). Some examples of ML in our everyday life are Siri/Alexa, Google translator, and the alarming accuracy with which Netflix knows what I want to watch next! ML works with data, and simultaneously also helps generate data for AI. We are aware that accuracy of results is enhanced by the volume of data and the power utilized for its analysis. ML does exactly that. It constantly gathers, compresses, and analyses data to determine the best required action.

Let us look at a simple example in our shot peening machine to see how this applies. The commonly used proximity sensor is a data gathering tool used in ML. This sensor, when located at one of the extremities of a nozzle carriage travel axis in an airblast peening machine, will instruct the nozzle to stop traveling upon reaching that location. This results in the part being peened within the required physical area. However, let us take a situation where the machine vibration has caused the proximity sensor to slide down to a lower elevation along the travel path of the carriage. Machine controls, oblivious of this change, will stop the carriage motion prematurely, resulting in the part being processed incorrectly.

Data, though important, should be correct data and not be tainted by other process-based inaccuracies. The next level of ML can be expected to use data from previous peening cycles and alert the operator of a potential issue with the carriage travel range. This will save large volumes of parts from being peened incorrectly.

ML is process intensive, but not hardware intensive. In fact, for shot peening and blast cleaning, the hardware necessary to process information, i.e. ML, is likely already there. There is more. AI introduces us to another concept called "Deep Learning." Predicting the weather or playing your favorite music through Alexa demands a simple algorithm, whereas analyzing medical records, creating music, and other art forms fall under "deep learning." This part of AI is still in its infancy and is not relevant to our discussions at this stage. Let us delve deeper into our current status with AI/ML and potential opportunities.

WHERE ARE WE WITH AI?

We are faced with a paradox within our industry. We have sophistication as well as blast cleaning and shot peening machines being operated with not as much regulation and control. The choice depends on many factors such as end-user requirements, industry criticality, etc. I often question our blast cleaning equipment users on their gage of performance parameters such as volume of parts cleaned, quantity of abrasive used, and replacement frequency of wear parts. Given the price of steel, users definitely intend to track such critical data, but the accuracy of such information and frequency of its collection is still not well-validated. In other words, we are faced with gaps at recording basic process information.

Though majority of machines built in the last 25 years have a PLC, the controller is designed to just control the programmable features of the blast machine. This includes sequencing of different components, establishing, and maintaining cycle timers, and safety circuits. The PLC's accomplishments are complimented by a TouchScreen HMI which does little more than replace pushbuttons and indictor lights that used to adorn older control panels like a Christmas tree! No active and useful data was drawn from such control systems. In the blast cleaning world, the above describes majority of the machines in use.

The advent of CNC shot peening machines with controls comprising of PID loops started giving us a brief taste of ML. Consider a recipe/technique created to peen a component at 40 PSI. If availability of air at this pressure is interrupted due to an unexpected need for compressed air upstream to the machine, this closed loop (PID) arrangement will attempt to correct the pressure. It will, within short duration, shut down the process if the situation continues. ML would have taken this to a deeper level and predicted this possibility by "learning" that the upstream perpetrator is likely to utilize the compressed air. This prediction would be made given a set of connected events also known as relevant data points. This is the potential future of ML in its simplest form in our shot peening machine.

Senior year and graduate students at Purdue University, through the CSEE (Center for Surface Enhancement and Engineering) and guided by Professor Paul Mort, have worked on imaging models to determine the sphericity of cast steel shot and conditioned cut wire. These students have utilized image analysis to determine the form factor—ratio of area of the block to that of the circumscribed circle, with one being the perfect sphere—of individual particles of peening media.

Weighted regression analyses of the data are used to calculate and visualize both size and shape distributions of the media. Note that regression is one of the foundations of machine learning. (Regression analysis is a statistical technique that allows us to determine which factors matter the most, factors that don't matter, and how these factors influence each other). The ultimate goal is to use these distributions in tolerance specification for media sphericity when sampling/analyzing new and in-use peening media. This is currently accomplished by visual examination with considerable subjectivity in the assessment, not to mention the time commitment to this exercise.

Further, this study will also help characterize the degree of conditioning (rounding) achieved with cut wire before being deemed fit to be used in a shot peening machine. If you can expand on this technique, visualize a protocol where results from shape analysis could predict the peening results and alert the user on the possibility of surface damage (nicks, etc.) on the component. As we know, this will ultimately have its effect on fatigue life. This prediction would signify advancement in our industry along the path of AI.

OTHER POSSIBILITIES WITH ML

ML offers tremendous opportunities for our industries, both in cleaning and shot peening, and every touchpoint of the media particle in the process demonstrates that. Here are some possibilities:

- The life of a coating is only as good as the surface preparation process. The effectiveness of mechanical surface preparation (blast cleaning) is dependent on the organic generation of a work-mix or operating mix in the machine. The abrasive being used for cleaning should be a suitable blend of large and small particles. Diligent operators test this operating mix at least once a week by obtaining a sample at the airwash separator and screening it to compare with recommended percentage distribution prescribed by abrasive manufacturers using field data.

  Creation of this working mix is reliant on other factors such as selection of the correct hardness, size and potential blend of abrasives, replenishment practices and frequency of returning leaked abrasive to the machine, to list a few. When done right, an effective working mix will (a) optimize cycle time, (b) minimize re-blast, and (c) impact operating cost. In other words, it is a critical parameter to control.

PRO-LOADER

BARREL/DRUM MEDIA TRANSPORT

DESIGNED FOR BULK MEDIA TRANSFER

*Empire's **Pro-Loader** is designed for bulk media transfer in an Empire blast system, with no lifting and minimal attention by an operator.*

- Now imagine a ML protocol which monitors each of these variables. For example, a sensor could be alerted when adding abrasive, a scanner could identify the type of abrasive being added (with the possibility of alerting the operator on current inventory levels in the warehouse as well as in the machine storage hopper), a prompt that informs the operator to obtain a media sample for routine testing and so on. The data collected could be used to develop a predictive model that addresses (a), (b) and (c) above. I acknowledge that this activity will involve significant discipline in the operator's role, but emphasis on his/her role in the profitability of the cleaning operation is bound to generate interest.

- The performance of blast cleaning or shot peening machines that form parts of a larger cell can be optimized through ML. High-output inline machines generally tend to operate continuously without any interruption to media flow to the blast wheels or nozzles in anticipation of a steady input of parts to be cleaned/peened. Unfortunately, this is not always the case, especially during disruptions to upstream processes. ML is already in use where a potential interruption to receipt of parts is identified in advance, leading to shutting down media flow in the blast machine. This timely stoppage of the blast machine that might be operating with eight blast wheels and discharging 5000 lb of abrasive per minute saves the cabinet's interior from unnecessary wear and the abrasive from unproductive breakdown.

- Inline measurement of residual stress and surface roughness offer opportunities in ML. SAE recommended practices and your own specifications might require you to run verification strips to check intensity at defined intervals. But the possibility of measuring residual compression at a rapid rate holds greater promise. Data from such readings directly correlate to machine operating parameters just as they assist you in quantifying the fatigue life of components being peened. This valuable data when recorded and compared constantly with the process helps generate yet another predictive model.

- A computerised curve solver software about to be released identifies points that don't reside on the best fit curve. In this situation, the software prompts the user to re-peen some of those ill-fitting values/strips and fine-tune the process. This is another example of ML.

- Inventory management, especially in machines that are fitted with complex components that are subject to wear, could be assisted with ML. A nozzle lance that is susceptible to wear within a specified number of hours could be regularly checked (automatically) for variation in air flow/pressure within a tolerance range. The operator/vendor could be alerted on the requirement well in advance without the need for manual intervention to check nozzle condition.

PRACTICALITY IN OUR INDUSTRY

Most advancements in our industry are driven by advanced manufacturing sectors such as Aerospace and Automotive, and these demanding customers are already deeply involved in ML to enhance their operating efficiencies in their production environments. Traceability is critical with aerospace components and many of us have adapted machine protocols to conform to AMS 2432 and Nadcap audit requirements. ML in many forms will continue to proliferate our shot peening and ultimately blast cleaning operations. It is best that we start thinking about different aspects of our machines and processes to implement this thinking into our routine activities.

In 1959, Arthur Samuel, an American scientist and pioneer in this field, provided a clear definition of ML as being a "field of study that gives computers the ability to learn without being explicitly programmed." Therefore, the application of AI and ML in our industry does not have to be restricted to a select few machine programmers. Anyone with working knowledge of the process and the desire to make it function better is capable of developing this emerging concept.

I often relate to the example of the operator who installed a webcam near the airwash separator curtain in order to monitor its completeness along the length of the lip. This was the operator's foray into developing a basic ML protocol leading to manual intervention when adjustment was needed! Complex AI/ML starts with application of such simple models and each of us can contribute to its adoption in our industry. I hope to report more on this to our readers as we progress along this path.

About Kumar Balan

Kumar Balan is a shot peening and blast cleaning technical specialist. He is currently assisting Ervin Industries achieve business growth in North American and overseas markets.

Mr. Balan has published several 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 and air-type blast cleaning and shot peening equipment. He is a regular speaker at industry conferences and training seminars worldwide. He is also an EI Shot Peening Training Lead Instructor at their international seminars and workshops. Mr. Balan's contributions to the industry were recognized when he was named the 2006 Shot Peener of the Year.

Introducing the Aviation Related Shot Peening Forum in Europe

A FEW WORDS of introduction: I am Ralf Zimmermann and I am the Level 3 for Airfoil Shot Peening at MTU Maintenance in Hannover, Germany. I joined MTU in 2002 and so I will celebrate the 20th anniversary this year. I am a member of the forum and I want to present what the forum does, what it did in the past, and what it will do in the future.

WHO WE ARE

To keep it short, I will use ARSPF instead of "Aviation Related Shot Peening Forum". We are a group of Level 3 shot peener and process engineers in the aviation industry and our community grew up over the last six years. It's not an exclusive group and we meet without any commercial background. It is an open discussion forum about shot peening and the technology, experience and knowledge behind it. For sure we are all more or less competitors but in matters of shot peening we share our expertise. All the current members are closely connected to aviation but we are not limited to this.

The forum was established in 2017 and its current members are the following organizations:

- cargolux
- LIEBHERR Aerospace
- Lufthansa Technik
- Lufthansa Technik – AERO Alzey
- mt-Propeller
- MTU
- N3 Engine Overhaul Services
- Nehlsen-BWB Flugzeug-Galvanik Dresden
- Rolls-Royce Deutschland
- sentenso
- SR Technics

Participants of an ARSPF meeting at sentenso in March 2022. Photographed from left to right are: Hinrich Severin, Martin Brötz, Gerd Trefzer, Nadine Goertz, Christian Peutler, Daniel Schmid, Wolfgang Hennig, Steffen Beckert, Manfred Kiser, Volker Schneidau, Holger Polanetzki, Alfred Pirker, Christian Koerbs, Lukas Gerner, Jens Borrmann, and Lea Mainberger. Not photographed is Ralf Zimmermann.


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Email: weydert.s@hmt-cera.com
URL: http://www.hmt-cera.com

The relationship between members is an important pillar for targeted discussions. The purpose of the group is to create a forum for the exchange of ideas and knowledge related to developments, inventions and also nomenclature in the field of shot peening. To have discussions on a good level a prerequisite to be a member is working as Level 3 process engineer.

Our objectives are to influence OEM design and specifications, to address development issues within the technology field, to present a unified approach to suppliers, and to coordinate development and testing in order to optimize the process.

There's no membership fee for the group and each member is responsible for his/her own costs for attending the meeting.

During the pandemic we missed one meeting and we held another one virtually. In 2022 we followed our intentions to meet together and were supported by sentenso in Datteln to hold the meeting in person. Meetings are held once a year. Each meeting is hosted by a ARSPF member who will organize meeting locations, activities, lunch and refreshments. A meeting coordinator will be appointed to prepare and distribute an agenda prior to each meeting. The task of meeting secretary will rotate among all members. A meeting secretary will write the minutes of each meeting and distribute them to members after the meeting. For each meeting a guest speaker will be invited from suppliers, universities or institutes, if available.

WHAT WE DISCUSS

Our special interests are related to aviation and we always have different discussions about specifications, their interpretations and training from new and experienced staff. Various company specifications describe individual topics; for example, process development tasks or intensity verification methods with varying degree.

Additionally, we discuss manufacturing issues like masking tapes and covers or semi-automated "Masking Just in Time" to protect areas where peening is not allowed. Sometimes it could be an improvement to figure out what is the following process after shot peening, to be able to choose an alternative media for the shot peening process, and to gain savings for the subsequent treatment of the part.

We always have opinions and we discuss new technologies as shown in specific magazines like *The Shot Peener*. Typical examples are solutions to measure media velocity or to measure the peening energy with a weight-based energy absorber in order to achieve continuous process control.

Other topics, for example, are Almen gauges, Almen test strips, test strip holders, test strip simulation, residual stress measurement (X-Ray), staff education, certification, specifications, future process development, machine concepts, equipment and different methods of achieving compressive stress, etc.

Finally, education and training for different functions such as operator, process engineer, and also process authority are part of the discussions as well.

HOW WE WORK TOGETHER

Some may wonder how we can be so open within the group, sharing information and still be competitors. One of the key rules within the group is that the membership is not an opportunity to promote commercial interests. It's very important that all members both "give and take" information. It is necessary to not only to be a listener, but also to be a contributor to discussions in the group and with other members.

For information about the Forum, please contact:

- Wolfgang.Hennig@Rolls-Royce.com
- Christian.Koerbs@mtu.de
- Ralf.Zimmermann@mtu.de

Symposium on Residual Stress in Fatigue and Fracture

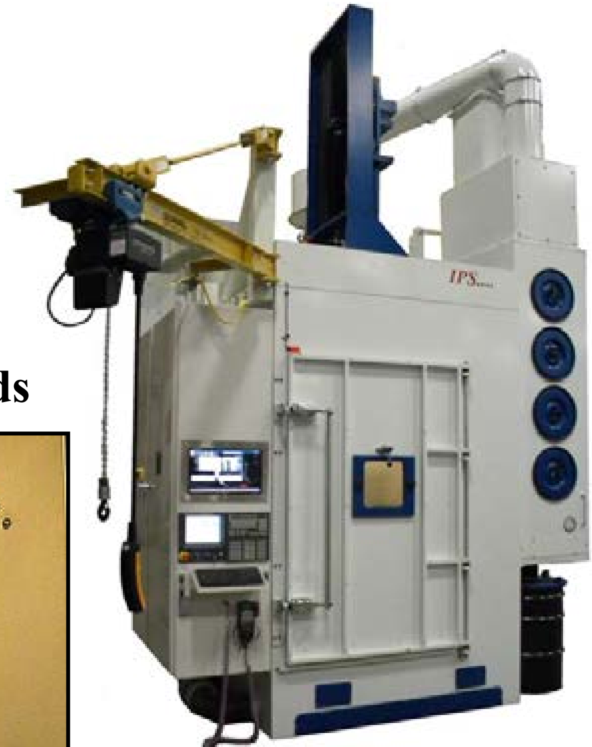
15th International Conference on Fracture
Atlanta, Georgia USA • June 11-16, 2023

Atlanta, Georgia USA is the location for the premier conference on mechanics and mechanisms of fracture and strength of solids. This conference will focus on the latest interdisciplinary research in the field of fracture and is a must attend event for senior and young researchers, students, post-doctoral fellows, and industry professionals working in the field of fracture throughout the world. The general topics covered in the event include:

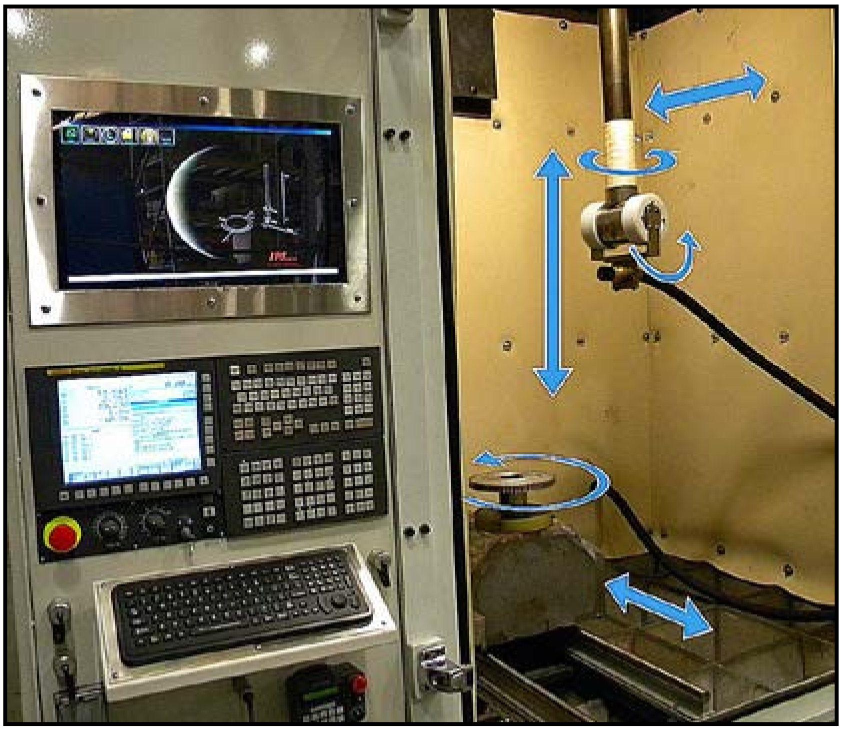
- Fracture and fatigue of advanced materials
- Failure mechanisms
- Fracture and fatigue of MEMS and NEMS
- Fracture at atomistic and molecular scale
- Fracture and fatigue of thin films
- Failure of nanocomposites and nanodevices
- Physics of fracture
- Brittle fracture and ductile fracture
- High-temperature creep fracture
- Fretting fatigue
- Thermal-mechanical fatigue
- Stress corrosion and corrosion fatigue
- Environment-assisted fracture
- Fracture in ceramics and polymers
- Test methods in fracture
- Nonlinear and linear fracture mechanics
- Computational fracture mechanics
- And much more

Visit https://www.icf15.org for more information and to register.

Innovative Peening Systems



High Performance for High Standards



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

IPS....

Innovative Peening Systems
5425 Progress Court, Braselton GA 30517
Phone: 770-246-9883
Web: www.ipsmachines.com
Email: info@ipsmachines.com

PRODUCT ANNOUNCEMENT

Kenneth Derucki | Engineer | Electronics Inc. | www.electronics-inc.com

The New PeenSolver Pro

SINCE ITS UNVEILING at the 2021 USA Shot Peening Workshop, the new PeenSolver Pro (PSP) has received positive reviews from beta testers in the shot peening community. People have come to love the application's useful features.

POPULAR FEATURES

The following are highlights of the original features that were especially helpful to our beta testers.

Type-2 Curve Detection

PSP will notify the user if a Type-2 curve is detected and provide the correct intensity value per SAE J443.

Error Checking

- Invalid curve detection
  The user will be notified if the longest peening time input is shorter than the solved 2T value, thus being an invalid curve/solution.
- Process quality detection – exclusive feature
  PSP will compare each data point's arc height to the generated curve's arc height. The user is warned if percentage of error exceeds a configurable limit.

Intensity Verification

- Target arc height support
  The user can input a verification exposure time other than the solved saturation time. The PSP will provide the target arc height for the user's time.
- Process file storage
  Process verification arc height values are logged in a file that can be re-loaded into the program.

Superimposed Curves for Multiple Test Strip Locations

Multiple saturation curves can be displayed with individual verification arc heights based on a single exposure time.

Process Parameter Documentation – Exclusive Feature

Each part process can have a stored file that may be re-opened when the part is run again. Verification values are logged in a continually updated file. The logged data can be cleared if parameters are changed; the file can then be saved as a new process.

Additional Features

- Windows OS Based - designed and tested with Windows 10
- Testing verification integrated into the same screen as intensity calculations, keeping curving solving and testing verification on one print out
- Graphs can be zoomed in and out and rescaled
- Ability to individually choose which graphs are displayed
- File location on printout, preventing misplacement of data

NEW FEATURES

After receiving feedback from the beta testing users, it was clear that the app could provide additional benefits. This led to a complete rework of the backend structure of the app. This was managed without sacrificing the simple user interface people have come to love. In addition, the curve solver can now easily grow into the future. Here are some of the additional improvements.

Addition of the 2PF Curve

Dave Barkley, EI's training director, requested this feature! This curve is a great alternative to the standard 2EXP and 3EXP equations.

Reduction in file size

The structure of the new application is much smaller, putting less strain on networks

Smoother and faster operating speed

Another benefit of the updated application structure

Customized peening location names

Allows for practical names to be used for strip locations, making the process easier to understand

Adjustable upper and lower specification limits for curve verification

Allows for the upper and lower specification limits for curve verification to be set independently from one another, providing better tailoring the curve solver to the users needs

IN CLOSING

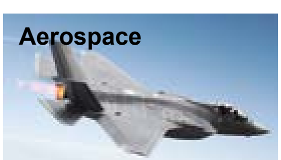
We are excited to now share the updated PeenSolver Pro with the entire shot peening community. The intuitive user interface and the ability to customize its parameters means this curve solver is easy to learn and it can be tailored to any process. The updated version is available for download at www.electronics-inc.com. We would also love to hear your ideas on how to make the curve solver even better. Please reach out to Ken Derucki at kenneth.derucki@electronics-inc.com with any questions or comments and our team will gladly investigate them for future updates.

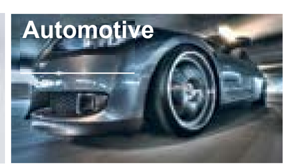
Read a review of the new Peen Solver Pro and see a screenshot on page 18.

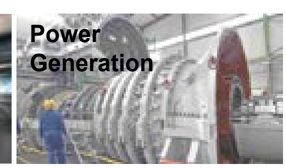
SINTO SURFACE TECHNOLOGIES

Your Technical Solution Source

Shot peening	Highly customer focused for superior service
Peen conditioning	Mobile services to support you in the field
Mass media finishing	On-time, every time; your dependable provider
Superfinishing (<10Ra µin, <0.25 Ra µm)	Quality without compromise
Blast and pyrolysis cleaning	Cutting-edge solutions and technology







SEVEN Surface Enhancement centers located in the **Northeast, Midwest and Southeast!**

New Harmony » New Solutions ™

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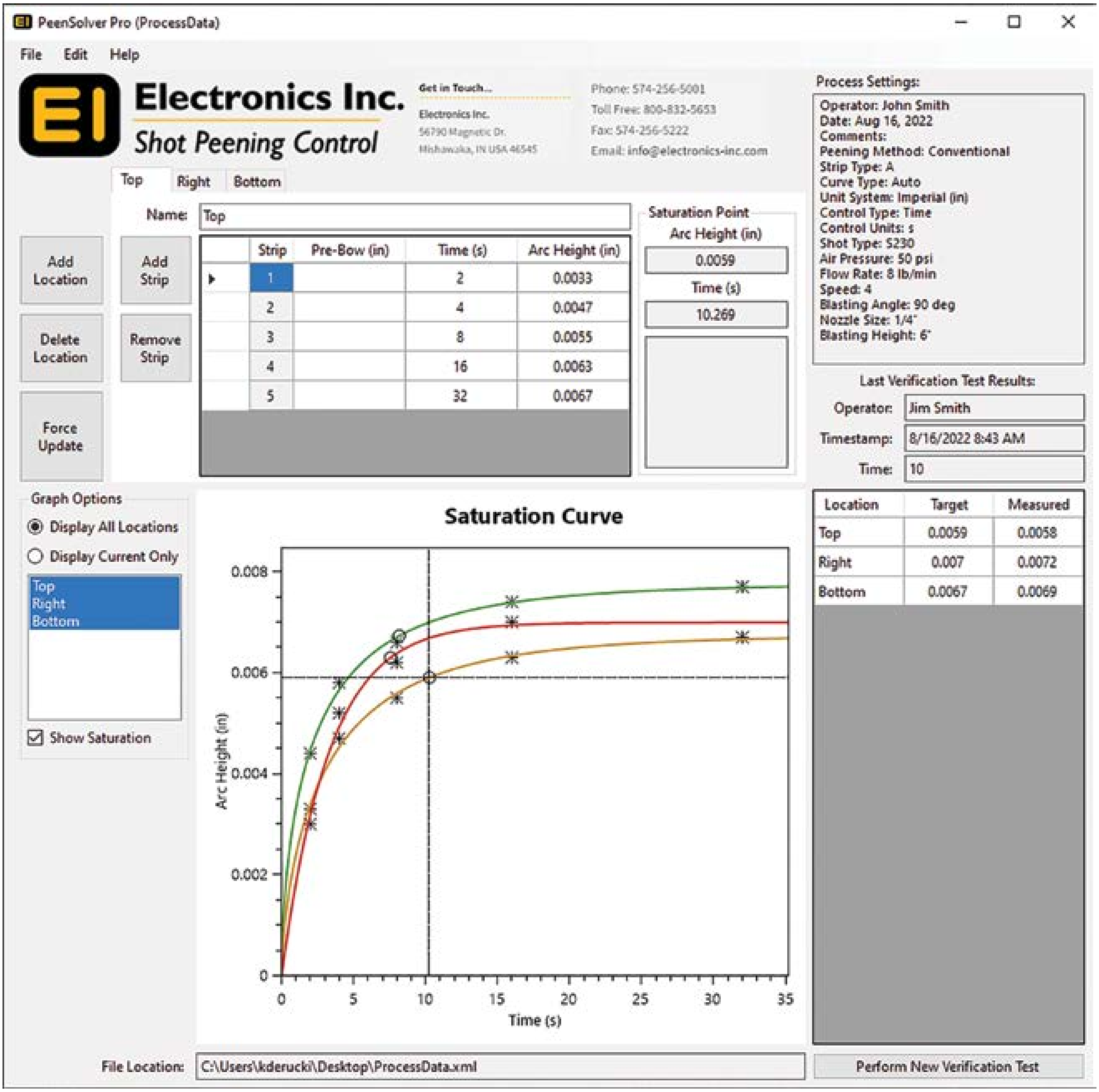


PeenSolver Pro Review by Kumar Balan

I had the opportunity to use the PeenSolver Pro for a peening project and was immediately drawn to its simplicity and practicality of use. The intuitive program seemed to know exactly where I was heading with the arc height values with progressive exposure time. To clarify my point (since I am sure you might claim that to be the sole purpose of a curve solver program!), though a curve could be plotted even with "not-so-great" points, this solver identifies these points and marks them for the user to review and then repeat with one or more strips, if desired. The data fields to record process and machine parameters are very well thought out and purposeful. The program allows the user to add and delete strips as well as to add multiple locations (strips) that are required in most applications.

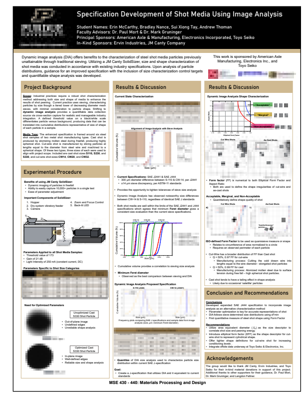
As this goes to press, I understand the developers are working on enhancing features, including the addition of helpful suggestions to guide the user along the correct path during practical process events such as insufficient strip coverage—longest peening time is shorter than 2T—identification and labeling of Type 2 curves, etc.

Overall, I am happy to recommend this program to the novice as well as to an experienced shot peener.

Specification Development of Shot Media Using Image Analysis

A RECENT POSTER SESSION was the culmination of a senior research project for engineering students at Purdue University. The participating students are Erin McCarthy, Bradley Nance, Andrew Thoman and Sui XiongTay. The research project was sponsored by American Axle & Manufacturing, Electronics Incorporated, and Toyo Seiko.

Project Introduction



Dynamic image analysis (DIA) offers benefits to the characterization of steel shot media particles previously unattainable through traditional sieving. Utilizing a JM Canty SolidSizer, size and shape characterization of shot media was conducted in accordance with existing industry specifications. Upon analysis of particle distributions, guidance for an improved specification with the inclusion of size characterization control targets and quantifiable shape analysis was developed.

Conclusions

Developed expanded SAE J444 specification to incorporate image analysis as an alternative characterization method

- Parameter optimization is key for accurate representations of shot
- DIA follows sieve determined size distributions using xFmin
- First quantitative measure of steel shot shape using Form Factor

Recommendations

- Utilize area equivalent diameter (X_A) as the size descriptor to correlate shot size and peening energy
- Introduce elliptical form factor (EFF) as the shape descriptor for cut-wire shot to represent cylindrical shape
- Offer tighter shape definitions for cut-wire shot for increasing conditional levels
- Integrate offsite data underway at Toyo Seiko and Electronics Inc.

Acknowledgements

The group would like to thank JM Canty, Ervin Industries, and Toyo Seiko for their in-kind material donations in support of this project. Additional thanks to other supporters for their guidance: Dr. Paul Mort, Dr. Mark Gruninger, and Langdon Feltner.

Download the poster at https://www.shotpeener.com/wp-content/uploads/9-Electronics-Inc-Toyo-Seiko-American-Axle.pdf.

2021 Almen Strip Consistency Testing Results

QUALITY CONTROL TESTING SINCE 2007

Electronics Inc. (EI) developed a performance consistency testing program on their A and N Almen strips in 2007 to ensure they are consistent in thickness, flatness and hardness. The purpose of EI's testing program is to verify that the strips will perform consistently, from lot to lot, from year to year.

TESTING METHOD

EI uses their own custom-built air blast cabinet with a variable speed rotary table with 39 Almen strip holders, a fixture for adjusting nozzle distance from the strips, a MagnaValve® for media flow rate control, and controls to adjust air pressure and table rotation.

During testing, the table is rotated at a fixed speed, and the cabinet is set for a specific pressure and constant media flow rate so each strip passes under the blast nozzle at the same angular velocity for the same predetermined number of revolutions. In addition, test strips from each lot are intermixed proportionally for each shot peening session. EI does this because all the Almen strips can't be peened at once, so an equal amount of strips from each lot is peened in each session. This way a slight process difference, if any, between peening sessions is "distributed" over all the test lots.

For each test, a sample size of 36 strips is used. EI measures and records the flatness of the strips before testing. After each test cycle, the arc heights are measured on a calibrated Almen gage and the flatness compensation is applied. The values are put into histograms for analysis. A histogram is a graphical display of tabulated frequencies, shown as bars. It shows what proportion of cases fall into each of several categories. A histogram differs from a bar chart in that it is the area of the bars that denotes the value, not the height of each bar.

TEST RESULTS

Histograms exhibit nearly identical lot-to-lot arc height results, thereby verifying the uniformity of the product. Test results from 2007 to 2021 are available at www. electronics-inc.com.

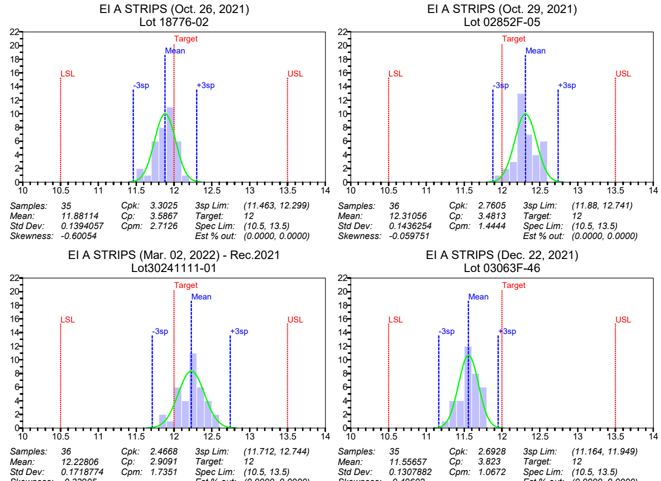
Each histogram represents a test to verify the performance of an individual lot. The results illustrate the performance consistency of the strips as defined by the nearly identical mean values and the narrow standard deviations. The mean is the sum of the observations divided by the number of observations. The mean describes the central location of the data, and the standard deviation describes the spread. The standard deviation is a statistic that tells how tightly all the examples are clustered around the mean in a set of data.

When the examples are tightly grouped together and the bell-shaped curve is steep, the standard deviation is small. When the examples are spread apart and the bell curve is relatively flat, it signifies a relatively large standard deviation. In the case of the Almen strip testing, the tight standard deviation signifies the consistency of the arc height reading.

In addition to documented consistency results, this testing program has provided a substantial technical support base for EI's Almen strip customers. EI has available:

- Current lot-to-lot comparison data on EI strips
- Comparisons of EI strips to other strips
- Performance data on other strips

EI's research is thoroughly documented. For each test, EI records the scope, setup parameters, procedures, test results and analysis, histograms, saturation curves (where applicable), and a summary conclusion. EI uses the performance data to answer customers' questions related to process variables and to help customers identify performance problems such as arc height variations and out-of-spec results with non-EI strips. When EI does not have data available on a unique problem, EI will perform tests to analyze a customer's problem or even duplicate, as closely as possible, their process setup.



The histogram represents a 40-piece sample size with the x-axis as the arc height of the strip after peening and the y-axis indicating the number of samples measured at that value (arc height values x .001 inches).

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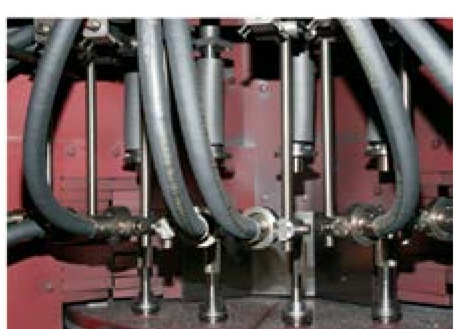

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ACADEMIC STUDY

Dr. David Kirk | Coventry University

Back to Basics

Energy Controls Shot Peening Efficiency

INTRODUCTION

Energy is arguably the most important factor in shot peening. Without energy there would be no shot peening. It follows that energy has to be controlled in order to maximize shot peening efficiency. Energy is the capacity for doing work. The law of conservation of energy states that "Energy can be converted in form, but not created or destroyed."

Air-blast shot peening relies upon potential energy stored in compressors. Compressed air provides the means for accelerating shot particles. Wheel-blast peening allows shot particles to be accelerated dynamically via rotating blades.

Energy is essentially quantitative and therefore has corresponding units depending upon whether we are considering potential or dynamic energy. This article starts with a consideration of energy units and continues with considering the role of energy in various aspects of shot peening. Minimizing the required energy input maximizes shot peening efficiency.

ENERGY UNITS

Potential Energy Unit

Potential energy is stored energy. A simple way to envisage stored energy is to visualize how an air compressor works. Fig.1 illustrates the relevant principle. A piston is forced down on air in a closed container. The compressed air then has the potential energy required to accelerate shot particles.

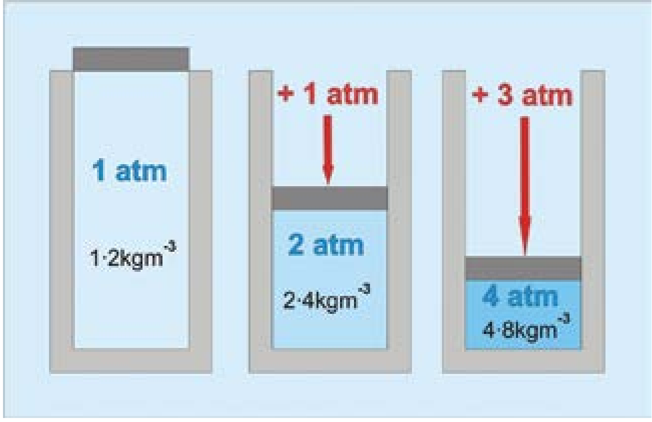

Fig.1. Air compression generating potential energy.

The units for potential energy are the same as those for work done, i.e., force multiplied by distance. Force is expressed as **Newtons**, **N**, and distance as **metres**, **m**. Hence the basic unit for potential energy is **Newton metres**, **Nm**. Consider, as an example, lifting an apple by a distance of one metre. A medium-sized apple exerts a force of one Newton (at the Earth's surface). We have therefore done 1 Nm of work in raising the apple.

Weight is a force and so is measured in Newtons (N).

On earth, the downward force of gravity on a 1 kg mass is 10 N. So, if ten apples weigh 1 kg then one such apple exerts a force of one Newton.

Kinetic Energy Unit

An accelerated shot particle has a kinetic energy, **K**, conveniently defined by:

$$K = \tfrac{1}{2}mv^2$$

Where **m** is the mass of the shot particle and **v** is its velocity.

As shot peeners, we use both potential and kinetic energies. The following case study is an example of their interplay.

Case Study: How does work done lifting an apple compare with the same work done accelerating shot particles?

Joe, approaching retirement and with thirty years of shot peening experience behind him, thought he could catch out Tom, the firm's newest recruit. "Tom, I've read that it takes about 1 Nm of work to lift an apple by 1 metre. About how many S170 shot particles could be accelerated to $50 ms^{-1}$ using the same amount of expended energy?"

"I'll have to do some sums," said Tom. "Firstly, I have to work out the kinetic energy required to accelerate one S170 particle to $50\ ms^{-1}$. Secondly, work out how much kinetic energy is equivalent to 1 Nm. Finally, divide that by the energy requirement per particle. Here goes:

Kinetic energy, K = ½mv². S170 is listed as having an average mass of 0.33134×10^{-3}g.

Therefore, $\mathbf{K_{S170} = \tfrac{1}{2} \times 0.33134 \times 10^{-3} \times (50ms^{-1})^2}$ which comes to $\mathbf{0.414175m^2s^{-2}g}$.

1 Nm of energy is equal to $\mathbf{1000g.m^2.s^{-2}}$. Dividing $\mathbf{1000g.m^2.s^{-2}}$ by $\mathbf{0.414175m^2s^{-2}g}$ gives us the required answer of **2,414** particles."

"I can see why the CEO hired you," said Joe, with a sigh. "Shot peening seems to have a lot more science to it now than when I started out. Perhaps it's time that I thought of retiring." "Not before you teach me the practical side of peening," said Tom, diplomatically.

POWER – RATE OF USING ENERGY

Shot peening energy requirements depend upon the rate at which we need to use energy. This rate is called "power"—the rate of transfer of energy between sources. For air-blast peening, we use an air compressor to maintain a reservoir of compressed air. Wheel-blast peening uses electric motors to maintain required speeds of revolution.

The energy input required to accelerate individual shot particles is of basic significance. Shot peeners are more concerned with the rate of energy input required to accelerate all the particles in a given shot stream. For air-blast peening, we must also input the energy needed to accelerate the air. Shot stream power, **P**, therefore has two components; shot power, **S**, and air power, **L**. Hence: **P = S + L**. Shot power is the sum of the kinetic energies of those shot particles that cross a defined plane, **AB**, per second (see fig.2). Air power, **L**, is the kinetic energy contained by the volume of air that crosses the corresponding area, **A**, of that defined plane per second.

Shot Power, S

Shot power is kinetic energy per second summed for all of the particles crossing a defined area. Each shot particle crossing the area contributes its individual kinetic energy, $\frac{1}{2}mv_s^2$. The shot feed rate, **M**, sums the mass of all of the particles fed during one minute. Hence we have, when using metric units, that:

$$S = M*v_s^2/120 \qquad (1)$$

where **S** is in watts, **M** is in kg/minute and v_s is shot velocity in metres per second.

As a typical air-blast example: if **M** = 10 kg/minute and v_s = 50 ms^{-1} then **S** = 208 watts.

Use of imperial units requires a different divisor from that given in equation (1). Hence:

$$S = M*v_s^2/2848 \qquad (2)$$

where **S** is still in watts but **M** is now in lb/minute and v_s is in feet per second.

Converting the values used for the metric example gives that M = 22 lb/minute and vs = 164 ft/second. Substituting these values into equation (2) again gives that S = 208 watts, as it should.

Air Power, L

Air power, **L**, is the kinetic energy contained by the volume of fluid that crosses the defined plane per second. The volume

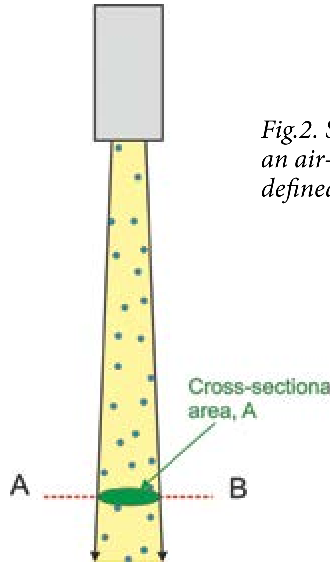

Fig.2. Schematic representation of an air-blast shot stream crossing a defined plane, AB.

of air passing across the plane per second, **V**, depends upon its velocity, v_A, and the area of intersection, **A** (see fig.2). Now $V = v_A*A$. The mass of any object is its density, **ρ**, multiplied by its volume. Hence: Air mass flow per second is given by $\rho*v_A*A$. Air power, **L**, is its kinetic energy, $\frac{1}{2}mvL^2$ summed for the mass of air crossing the plane per second. Therefore:

$$L = \frac{1}{2}*\rho*v_A^3*A \qquad (3)$$

where **L** is in watts, **ρ** is in $kg.m^{-3}$, v_A is in meters per second and **A** is in square meters.

The density, **ρ**, of air at atmospheric pressure, is 1.225 kgm^{-3}. For a stream of air passing through a standard area, A, of 0.001 m^2 (1000 mm^2) at a velocity, v_A, of 50 ms^{-1} equation (3) indicates that its power is 77 watts.

If, however, the fluid was water, with its density of 1000 kgm^{-3}, then for the same area and velocity used for the preceding example, the fluid stream power becomes 62.5 kilowatts!

Combined Shot Stream Power, P

The combined shot stream power, **P**, is the sum of shot power, **S**, and air power, **L**, as shown pictorially in fig.2. If we assume that shot and air velocities are almost equal we get, as a very close approximation, that:

$$P = M*v^2/120 + \frac{1}{2}*\rho*v^3*A \qquad (4)$$

where **v** is the shared shot and air velocity.

Equation (4) quantifies the power that must be put into the shot stream to generate the required shot velocity. Equation (4) can be approached either by direct calculation or using it to produce graphs. Direct calculation is illustrated by the Excel worksheet shown as Table 1. For the example shown, the fluid is travelling at the same velocity as the shot particles. The worksheet program does allow for them having different velocities.


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Table 1. Excel worksheet being used to estimate Shot Stream Power Requirement.

A	B	C	D	E
1	Feed Rate	M	5	kg/minute
2	Shot Velocity	v - shot	50	m/second
3	Fluid Velocity	v - fluid	50	m/second
4	Fluid Density	ρ	1.225	kg/cubic metre
5	Cross-section of shot stream	A	0.001	metres squared
6	Shot Power	S	104	watts
7	Fluid Power	L	77	watts
8	Shot Stream Power	P	181	watts

The power needed to accelerate the shot particles in a desired shot stream is much less than the overall power requirement. No plant can be 100% efficient. Efficiency estimates are complicated by having intermittent energy inputs to compressed air storage facilities. There is, however, a fairly steady relationship between shot stream and overall power requirements. For example, doubling the feed rate doubles the power requirement. Doubling the required shot velocity quadruples the power requirement.

RELATIVE VELOCITY OF AIR AND SHOT PARTICLES

For air-blast peening, the relative velocities of air and shot particles in the shot stream are very important. The relative velocities are illustrated in fig.3. As the shot stream forms at the nozzle, the air is flowing faster than the shot particles. The shot particles continue to be accelerated until the air and shot velocities are equal— point N in fig.3. Thereafter, the air velocity is lower than that of the shot particles so that the air decelerates the shot particles. For the specific example shown in fig.3 (obtained in the author's shot peening laboratory) this occurs at some 200 mm from the nozzle with a maximum shot velocity of 50 ms^{-1}.

The point N is then the optimum peening distance from a component.

The shot velocity varies only slightly on either side of the optimum distance. The range from 100 mm to 300 mm is indicated by the green arrow in fig.3. Within that range, shot velocity varies by only 1 or 2 ms^{-1}. At 500 mm from the nozzle the shot velocity has virtually halved. Attempting to peen with a nozzle-to-component distance of 500 mm would, however, impart a much lower peening intensity than if applied at 200 mm. The useful distance range (100 to 300 mm in this example) means that we do not have to continually make fine adjustments of nozzle-to-component distance in order maintain a steady applied peening intensity.

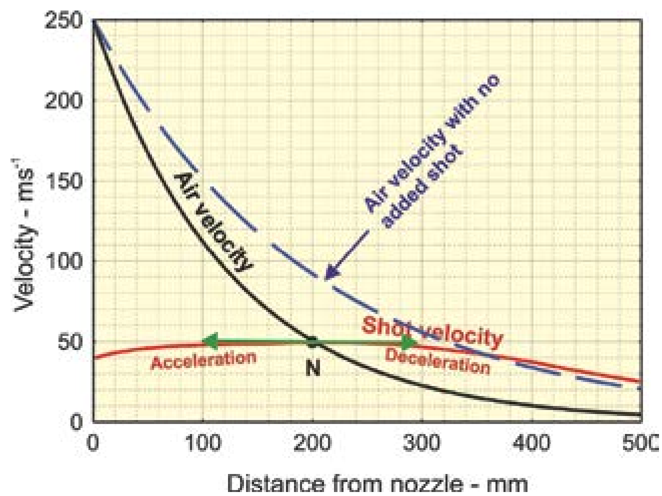

Fig.3. Relative velocities of air and shot in shot stream.

For wheel-blast peening, shot particles continuously decelerate after leaving the wheel. Shot velocity on component impact is more variable than it is with air-blast peening.

ENERGY SOURCES

Compressed air and rotating wheels are the basic energy sources for the majority of shot peening. Compressed air accelerates shot particles indirectly whereas rotating wheels accelerate shot particles directly. Figs. 4 and 5 represent the difference schematically.

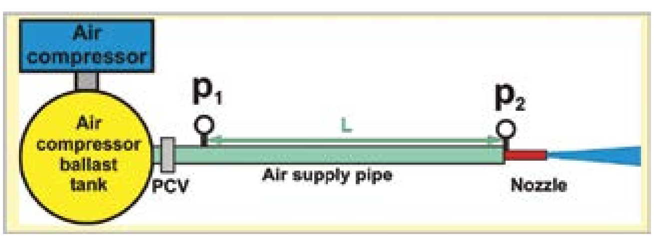

Fig.4. Compressed air supply system.

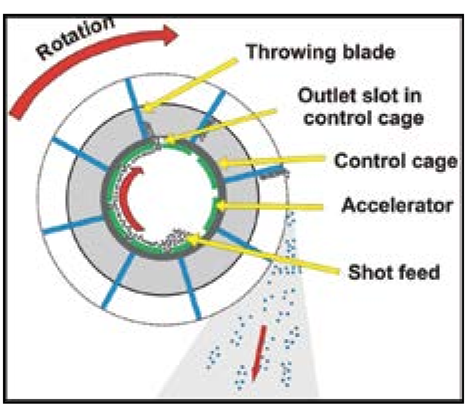

Fig.5. Wheel-blast shot acceleration.


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Compressed air supply systems are liable to air velocity fluctuation. Normally the air compressor reacts to signals from the air ballast tank that the pressure has fallen below a set level. The compressor switches on and pumps up the pressure in the ballast tank until it is told to switch off. The net effect is that the outlet air pressure from the ballast tank fluctuates between the set limits. This can be monitored via a pressure gauge—**p2** in fig.4. Long-term fluctuation of air pressure is caused by factors such as the conditions of the supply pipe and nozzle.

The rotational speed of a wheel-blaster tends to be constant. Energy transfer to shot particles depends to a small extent on the position of particles within the batches released onto the blades. A second factor is that there is a variable amount of distance to a component. This means that shot particles are slowed to varying degrees by surrounding air.

ENERGY TRANSFER ON SHOT/ COMPONENT IMPACT

Energy transfer from particle to component is of basic importance. The first significant question is "What proportion of the flying particle's energy is transferred on impact?" Fig.6 represents an experimental explanation. If a ball bearing is dropped from a height of **H1** and rebounds to a height of **H2** then the loss of energy is simply **H1-H2**. Experiments have indicated that the energy loss is approximately 50% for steel components. The softer the component the greater will be the energy fraction transferred on impact.

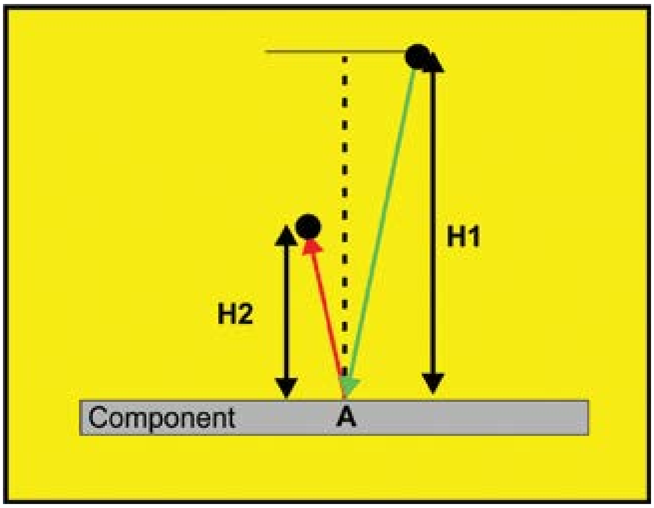

Fig.6. Energy loss as particle impacts component.

A second significant question is "What happens to the energy transferred to the component on impact?" Basically, energy is eternal. It cannot be destroyed. It can only be transferred. When a flying shot particle impacts a component's surface, energy is transferred in four ways:

Work needed to create dimple
Work-hardening underneath dimple
Residual stress profile creation and Heat generation

These four ways are shown schematically in fig.7. Heat generation accounts for most of the total energy transfer. Perhaps surprisingly, dimple formation, residual stress profile, and work hardening account for only small fractions of the total amount of energy transferred. Their relative proportions vary according to peening parameters but they are always small when compared to that of heat.

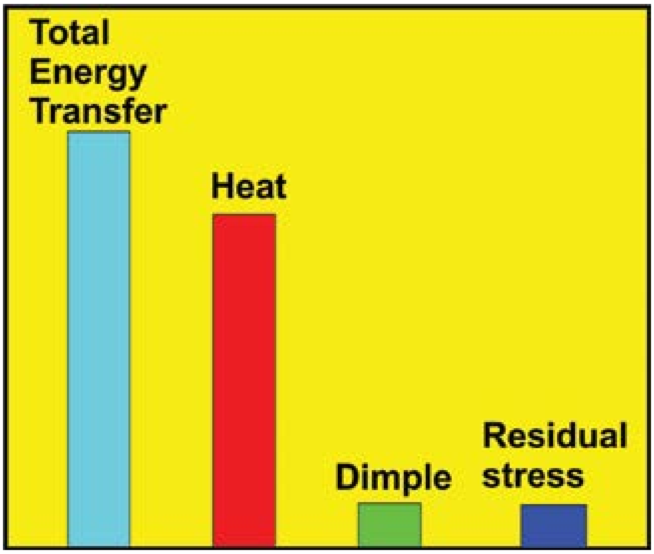

Fig.7. Components of energy transfer on particle impact.

Heat generation
Heat generation can be appreciated by considering the following analogy:

Analogy of heat generation by friction
As a simple office/home experiment, rub bare hands together slowly. No significant temperature rise occurs. Now rub them together vigorously. A detectable skin temperature rise now occurs. Finally, try to imagine rubbing bare hands together at thousands of times per second. A substantial skin temperature rise would be predicted. The moral is that the rate of sliding determines the temperature rise. When flying shot particles impact, planes of atoms move over one another at astronomical rates. This causes significant temperature rises at the component's surface. Japanese researchers even managed to induce rises of hundreds of degrees Celsius by employing highly-selective peening parameters.

Heat generation was described in a previous TSP article (Summer 2003). In that article the author described finding that surface temperature rises of up to 60˚C occurred when employing conventional air pressures and flow rates using a shot size of S170 on Almen strips (see fig.8). The shape of the surface heating curves is very close to that of a two-exponent

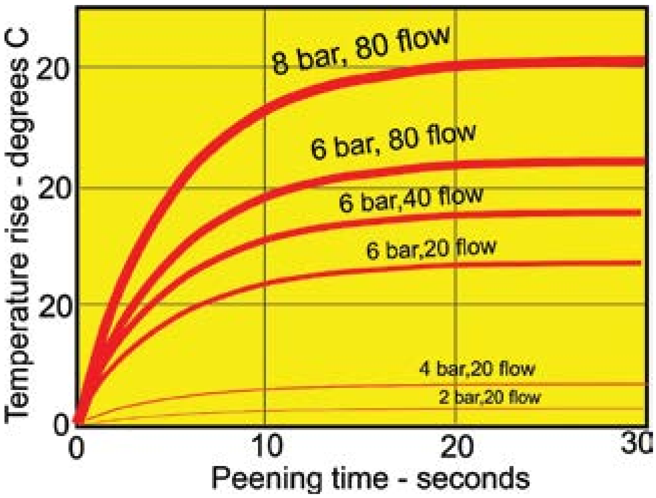

Fig.8. Surface heating by shot peening, using S170 shot.

saturation curve. Line thickness has been used to emphasize how heating increases with shot velocity and shot flow rate. A temperature rise of 20˚C would be sufficient to slightly increase Almen intensity having lowered the surface's yield strength.

Work needed to create dimple

The work needed to create a dimple is the product of component hardness and dimple size. Dimple size is its volume, **V**—approximated by the following equation.

$$\mathbf{V = \tfrac{1}{3}\pi h^2(3R - h)}$$

Where **h** is the depth of the dimple and **R** is the shot particle's radius.

Work-hardening underneath dimple

Fig.9 is a schematic representation of the work-hardened zone underneath a peening dimple. The degree of work-hardening varies in the zone—being a maximum at the dimple's surface and falling to zero when impact stressing only just reaches the material's elastic limit. Hardening mechanisms are described in a previous TSP article (Summer, 2007).

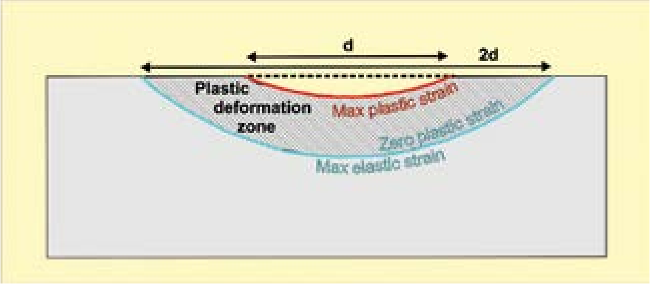

Fig.9. Zone of work-hardening caused by plastic deformation as dimple is created.

Residual stress profile creation

The residual stress profile induced by shot peening has long been recognized as promoting component life. The conventional shape is illustrated as fig.10. A beneficial zone of compression occurs at the component's surface. This must be balanced by a tensile zone. The amount of energy required to generate the residual stress profile increases with component hardness and required depth of compression zone.

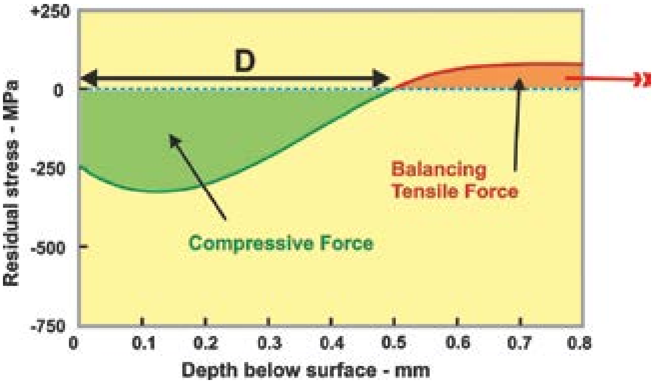

Fig.10. Conventional shape of residual stress profile created by shot peening.

Several effects are associated with the residual stress profile. Primarily, compressive stress at the surface offsets applied tensile service stresses. The compressed zone also induces bending—contributing approximately half of Almen arc heights. This bending is the essential element in peen forming. Post-peening heating must be minimized; otherwise stress-relief will occur.

SUMMARY

This article, the last in the Back-to-Basics series, has attempted to summarize the vital role played by the energy requirements of shot peening. Energy sources are generally compressed air and rotating wheels. Energy input increases as the square of the required velocity and increases linearly with shot particle mass. Increased component hardness increases the energy input needed to produce a given size of dent. Residual stress in the surface zone is beneficial to component life but also induces bending that is noticeable in very thin components. All aspects of energy input should be managed to improve process efficiency.

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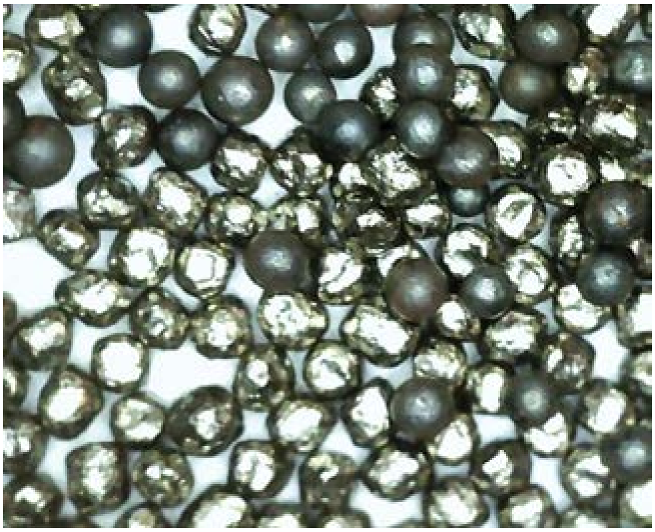
Frohn North America is offering the latest technology to improve shot blasting efficiency and cut blast cleaning costs.

The new Rapid Blast™ abrasive features:

- Cast shot and cut-wire blend in proprietary ratio
- Designed to reduce abrasive consumption by as much as 40% and increase blast cleaning efficiency
- Shorten cycle time by as much as 30%
- Savings in energy, labor, maintenance, wear parts and freight

As Rapid Blast™ is used and consumed, the ratio of cut wire shot in the operating mix will increase. This increased ratio of cut wire abrasive will clean parts faster than a 100% cast operating mix.

If today's prices of steel shot have you looking for alternatives, Rapid Blast™ may be the solution. If you need more blasting done in less time, Rapid Blast™ can help. Get the benefits of cut wire shot without the expense!



Empire Introduces Its Pro-Loader Bulk Media Transport System

EMPIRE'S PRO-LOADER is designed for bulk media transfer with no lifting and a minimum of attention by an operator. The system consists of a 55-gallon or 30-gallon drum-lid, drum-empty sensor, and an adjustable carburetor pick-up tube. A customer supplied bulk media steel barrel or cardboard drum can be used for media replenishment. The drum-lid is secured to the barrel/drum by a lever-lock closing ring and a 1½" heavy-duty Exair Line Vac™ siphons media out of the barrel/drum into the transport hose. The drum-empty sensor is programmed to automatically sense when the storage hopper is low and siphons fresh media into the blast system.

Empire's Pro-loader design takes inspiration from our Vacutrans® and Vacuum Recovery System (VRS). The adjustable carburetor pick-up tube found on the VRS siphons fresh media out of a barrel/drum, thus negating the need for an operator to pour media into a replenishing hopper. By enabling media recovery via a barrel/drum, Empire's Pro-Loader eliminates the need to collect media manually, resulting in safer and cleaner blasting.

Pro-Loader Components:

55 Gallon or 30 Gallon Drum-Lid
The drum-lid features rugged welded construction and a durable finish.

Lever-Lock Closing Ring, 55 Gallon or 30 Gallon
The closing ring overlaps to ensure the seal completely encircles the lid and eliminates gaps.

Exair Line Vac™ – Heavy Duty 1-1/2"
The compressed air operated Exair Line Vac™ connects to the 1-1/2" media transport hose to create a powerful in-line conveyor material handling system.

Adjustable Carburetor Pickup Tube
Designed for bulk media transfer, with a minimum of attention by an operator.

Media Transport Hose, 1-1/2"
Conveys fresh media from the customer supplied barrel/drum to the blast system.

Drum-Empty Sensor
Programmed to automatically sense when the storage hopper is low; a sensor will also be provided to alert the operator that their drum (fresh media) is low.

Compressed Air Regulator and Gauge
Regulates compressed air drawn from the blast system to the Exair Line Vac™.

30-Gallon Drum Lid

55-Gallon Drum Lid

Pro-Loader System

Adjustable Carburetor Pick-up Tube

PRODUCT ANNOUNCEMENT

Micah K. Johnson, Ph.D | Co-founder and Chief Science Officer | Gelsight | https://hubs.li/Q01kf4L20

Shot Peened Surface Analysis With GelSight Mobile™

INTRODUCTION

For a shot peener, it might seem intuitive to run the process for an extended amount of time to achieve full coverage. However, excessive peening wastes time and materials and can have adverse effects on the surface [2]. Accurate characterization of the rate of coverage increase can more precisely predict the time required to achieve the desired coverage specification.

One common method for characterizing shot peen coverage and intensity is to insert an Almen strip into the process. The Almen strip can be taken to the lab and evaluated under a microscope to track the shot peening process. However, material differences between the Almen strip and the component, as well as component geometry can lead to different coverage amounts on the component when compared to the Almen strip [3]. A system that can assess shot peen coverage on the component itself while it is being processed will provide a more accurate assessment of the shot peen coverage and save time.

This article provides the results of qualification studies performed by GelSight, a company pioneering tactile intelligence technology,

Fig. 1 (a) The GelSight Mobile™ system.
(b) Measuring the shot peening coverage of a component using GelSight Mobile™.

GELSIGHT TECHNOLOGY

GelSight Mobile™ is a handheld portable 3D measurement system that can be used directly on components to measure microscale 3D surface texture and shape. The system uses a unique elastomeric sensor that conforms to the surface of a component to control the optical properties of the surface during measurement. The GelSight Mobile™ can be used on shiny metals, composites, glass, and other optically complex materials without any modifications to the 3D measurement process. With the click of a single button, a detailed 3D measurement can be captured for analysis.

The system, shown in Fig. 1, consists of a handheld probe and a tablet. The probe has a five Megapixel CMOS camera, a telecentric lens, and six LED light sources in different directions. After the button is pressed, the system captures six

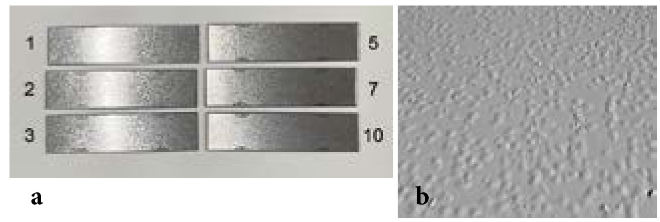


Fig. 2 (a) Almen strips peened with S390 shot at 60 psi for different exposure times (1, 2, 3, 5, 7 and 10 revolutions). The Almen strips were prepared by Electronics Inc. (b) Rendering of measured 3D surface topography for Almen strip #3.

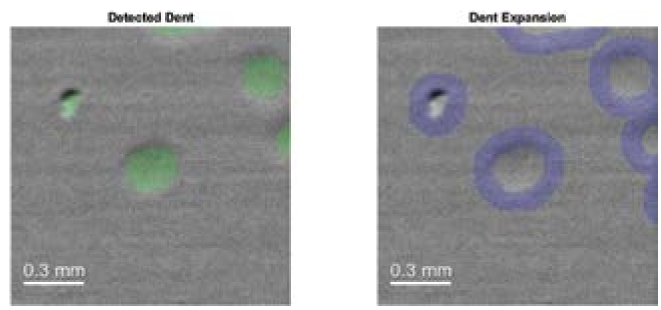


Fig. 3 The shot peen coverage algorithm detects negative surface regions with a nominal input diameter (left) and expands the detected regions by a fixed percentage of the nominal diameter (right).

pictures at a speed of 50 frames per second with different light directions for each image. Custom 3D processing algorithms convert the images into 3D surface topography within seconds [4]. The telecentric lens has a 0.5X magnification and a fixed focal length. This lens provides a diagonal field-of-view of 17 mm x 14 mm with an X-Y resolution of 6.9 microns.

After the 3D measurement is captured, custom image processing algorithms can be developed to extract valuable information for different industries, including the characterization of shot peened surfaces.

SHOT PEENING SURFACE ANALYSIS

A custom analysis method was developed to assess shot peen coverage. The method has two input parameters: 1) the expected dent diameter and 2) a dent expansion parameter.

These two parameters can be tuned to match a visual assessment of coverage. For the Almen strips processed with S390 shot, the nominal dent diameter was 0.3 mm, and the dent expansion parameter was set to 33% (0.1 mm). Close-up views of the detected and expanded regions are shown in Fig. 3. The coverage algorithm detects dents by finding regions that have negative depth as compared to the surrounding region. The algorithm then expands these dents by a fixed

size to estimate the influence region of the dent—a region including both the crater and crater rim. The crater rim is not detected in the first step since it consists of the positive regions displaced from the crater.

The coverage algorithm was analyzed for accuracy using a shot-peening simulation. The simulation picked random locations on a surface to dent with a virtual dent shape at a depth randomly selected within a narrow range of depths. The dent shape had equal positive and negative volume so that no material was lost in the simulation. An example of a simulated surface is shown in Fig. 4(a). The coverage algorithm could accurately estimate the known coverage within a few percent. As shown in Fig. 4(b), a slight bias is introduced for coverages above 80% since the reference surface can no longer be accurately measured from the dented surface. It is also interesting to observe that as the coverage approaches 100%, the probability of hitting undented surface decreases. Under the parameters of the simulation, 100% coverage was achieved after denting the surface with dents that would cover 400% of the surface area if arranged without overlap, as shown in Fig. 4(c).

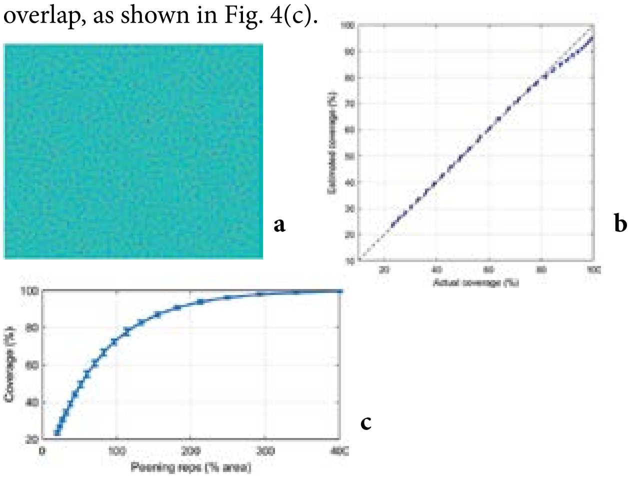


Fig. 4 (a) A shot-peening simulation was developed to evaluate the coverage algorithm. (b) The coverage algorithm was able to accurately detect and measure the coverage on simulated surfaces. (c) The stochastic nature of the shot-peening process leads to diminishing returns as the surface approaches 100% coverage.

MEASUREMENT SYSTEM ANALYSIS

The coverage algorithm was evaluated following a traditional measurement systems analysis with multiple parts and operators. For this study, a batch of Almen strips was prepared using an S390 shot at 60 psi using ten different exposure times. The samples were prepared by Electronics Inc. following a standard shot-peening process with the number of revolutions (exposure time) indicated on the back of each strip. The ten revolutions used were 1, 2, 3, 5, 7, 10, 15, 20, 30, and 50. The samples for 1, 2, 3, 5, 7, and 10 revolutions are shown in Fig. 2. These samples were measured using the GelSight Mobile 0.5X system to produce a detailed 3D map of the surface, as shown in Fig. 2(b).

Two gel cartridges were calibrated using the standard calibration procedure in the GelSight Mobile software. One gel cartridge was used for an experiment to assess precision and the second gel cartridge was used for a three-operator gage repeatability and reproducibility (GRR) study.

	#1	#2	#3	#5	#7	#10	#15	#20	#30	#50
mean	36	57	66	78	83	87	89	91	93	93
standard uncert.	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
U	0.5	0.6	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.3

Table 1 The uncertainty U is calculated by expanding the standard uncertainty term at a 99% confidence level. All values are displayed in percent (%).

PRECISION STUDY

To assess precision, each Almen strip was measured twenty times by the same operator. An expanded uncertainty score was calculated by multiplying the standard uncertainty of the mean by a coverage factor. The uncertainty measurements are shown in Table 1. They are all below 1% indicating good precision in the coverage estimate.

GAGE REPEATABILITY AND REPRODUCIBILITY STUDY (GRR)

To assess repeatability and reproducibility, a three-operator GRR study was conducted. Each operator measured the ten Almen strips three times each. The coverage algorithm was run on each measurement using a dent diameter of 0.3 mm and a dent expansion of 33%. A tolerance of 20% was used for the study. The GRR analysis of variance was calculated using Minitab software with the results shown in the table below. The Total GRR as a percent tolerance is below 20% in this study.

Gage Evaluation

Source	StdDev (SD)	Study Var (6 x SD)	% Study Var (%SV)	% Tolerance (SV/Toler)
Total Gage R&R	0.005959	0.03576	3.21	17.88
Repeatability	0.004950	0.02970	2.67	14.85
Reproducibility	0.003319	0.01991	1.79	9.96
User	0.000000	0.00000	0.00	0.00
User*Part	0.003319	0.01991	1.79	9.96
Part-To-Part	0.185414	1.11248	99.95	556.24
Total Variation	0.185510	1.11306	100.00	556.53

SUMMARY

GelSight Mobile™ is a handheld portable 3D measurement system that can be used directly on components in-situ to accurately and repeatably assess shot peen coverage as part of a shot peening quality control process.

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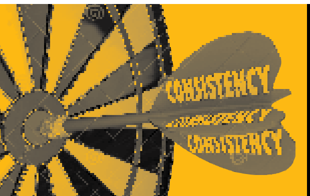

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Shot Peening Control

Selected Methods and Applications of Anti-Friction and Anti-Wear Surface Texturing

Slawomir Wos, Waldemar Koszela and Pawel Pawlus • Rzeszow University of Technology

The following is an edited version of the paper. The complete paper is available in the library at www.shotpeener.com.

Abstract: The constant development of environmental protection causes the necessity to increase the efficiency of machines. By increasing the efficiency of machines, energy losses can be limited, leading to lower energy consumption. Friction reduction leads to an increase in efficiency and a decrease in wear. In this paper, selected surface texturing methods, such as burnishing and abrasive jet machining, with their limitations are presented. Thanks to those processes, various surface textures can be obtained. Examples of applications of these methods for friction and wear reduction are shown.

Introduction

Surface texturing, due to the creation of dimples acting as reservoirs of lubricant in the contact zone, leads to an increase in wear resistance and to a change in friction from dry or boundary to mixed or full film lubrication. Dimples manufactured on frictional surfaces can also act as traps for wear debris, reducing wear. With special-shaped oil pockets and a sufficient amount of lubricant, surface texturing can cause the generation of a hydrodynamic lift, leading to a decrease in the coefficient of friction. By the proper selection of texture parameters such as oil pocket shape and depth, oil consumption, and pit-area ratio, a friction reduction effect can be obtained [1–6].

There are many texturing techniques [7]. Laser surface texturing [2,8–10] is the most common method of dimple creation. This technique is precise and allows for the easy creation of dimples. However, surface heating by the laser beam can lead to the creation of a heat-affected zone. In some cases, this disadvantage is unacceptable, especially for coated sliding elements. In most cases, after laser texturing, burrs occur around oil pockets and additional operation is required to remove them. Other techniques, such as burnishing (embossing) [11], mechanical polishing, milling [12], etching [13], abrasive jet machining [14] or a combination of these methods [15], can be used for dimple creation. It is not difficult to create oil pockets of comparatively large dimensions, applied, for example, in the sleeves of slide bearings, contrary to micro-dimples formed on thin-walled or coated elements.

In this work, two methods of dimple creation by burnishing and abrasive jet machining developed by the authors will be presented. In the surface layer after burnishing and abrasive jet machining, compressive residual stresses are created. They have positive effects on wear resistance and fatigue strength. These methods are supplements to laser surface texturing. They can be used for critical elements affecting the safety of construction where laser treatment was not approved. There can be problems with the creation of deep dimples by the burnishing of thin-walled elements, in contrast to abrasive jet machining. The selected tribological applications of these techniques will be given.

Conclusions

1. Burnishing changes the treated surface by plastic deformation. Dimple size and shape are the result of the shape of the tool. The burnishing process is fast. The zone near the dimples is not affected by heat. The positioning of the tool with regard to the treated surface needs high precision. Therefore, special devices for surface texturing by the burnishing process should be developed.

2. Abrasive jet machining is an interesting alternative to laser texturing. The erosion process caused by speeded abrasive particles was used. Abrasive jet machining can be applied for all types of materials. Similar to burnishing, this process is fast and the zone around the oil pockets is not influenced by heat. In addition, burrs around dimples were not created and multiple usages of masks and abrasives are possible. However, precision in the positioning of the masks is needed.

3. Surface texturing by burnishing of the block from bronze caused a decrease in the total linear wear of ring-on-block assembly up to four times. The beneficial effect of surface texturing was related to an increase in running-in time. This effect depends on the oil capacity. Dimples were traps for wear debris, leading to wear reduction.

The dimensions of the dimples should be selected taking the operating conditions into consideration.

4. Disc surface texturing of the steel disc caused a decrease in the coefficient of friction of the pin-on-disc pair in unidirectional sliding up to five times. This beneficial effect was larger for higher speeds and smaller normal load. In addition, surface texturing led to lower variations of the coefficients of friction, especially for high sliding speeds.

New Sinto Airless 3 cu. ft. Drum Blast Unit

SINTO AMERICA is excited to announce the newest addition to its drum blast product line—the DB-3 Series. The DB-3 joins the CNDR and CNDX in the drum blast line up for Sinto America.

The DB-3 is a 3 cu. ft. drum blast machine specifically designed to process small parts found in multiple industries. A unique design eliminates part jamming/part loss as all parts are contained in the drum during the blasting process and carefully dumped after the process to ensure no part loss. This DB-3 has a drum weight capacity of 300 lb and load height of 56" and discharge height of 40".

"This new addition to our blast equipment line provides a lower cost alternative for many applications. The DB-3 is currently the only 3 cu. ft. airless drum blast unit made in the USA that is available in the North American markets," said Charlie Gorman, VP Sinto Surface Treatment.

About Sinto America

Sinto has long strived to be the leader in the design and manufacture for all foundry, metal finishing, and shot blasting applications. From standard to custom, simple or complex, or a single piece of equipment to a full system, that's the Sinto difference, your one-stop solution.

Sinto America, Inc. is the North American group holding company, of Sintokogio, Ltd., Japan. The Sinto group of companies has an international reputation for excellence in the foundry, manufacturing and surface treatment industry. Sinto America focuses on six primary markets: Foundry, Mold and Core Making, Sand Processing, Automation, Surface Technologies and Surface Treatment.

Sinto also provides contract blasting and precision shot peening services through our National Peening and Technical Metal Finishing divisions and cut wire abrasives through our Frohn North America division. Learn more at: www.sintoamerica.com.

The Standard Features of the DB-3 Series:

- 5 HP direct drive D-10 blast wheel
- Automatic AR500 dumping drum
- 480 V / 60 Hz / 3PH
- Pitless design
- VFD on drum
- PLC controlled
- Digital cycle timer

This model will also come with options for other industrial features such as: abrasive adder, hydraulic parts loader, discharge conveyor, airwash separator, rotary screen, manganese drum, VFD for blast wheel, shot trap, 10 HP blast wheel and 800 CFM dust collector.

Sinto is looking forward to extending its product line offerings to even more assembly process-based manufacturers and customers' various needs. These new offerings expand Sinto's foundry, automation, and surface treatment product lines.

Optional take away conveyor

Optional hydraulic loader

Media Flow Detectors for Non-Ferrous Media
for economic and efficient media control

• Requires little maintenance due to no moving parts • Operates from 24 Vdc
• Relay contact output • Push-button setup
• LED indicators • CE compliant • For non-ferrous media only

The sensors use a charge-coupled amplifier that is connected to a sensing pin (MFD-4 and MFD-250) or a sensing ring (MFD-P1). The pin or ring is inserted into the flow path of the abrasive blasting media. Each particle passing the pin or ring shares a minute charge with the pin or ring. This charge is converted to a voltage that is used to activate an output relay contact.

MFD-4

Media Flow Detector for Suction-Type Abrasive Blasting Machines

The MFD-4 is enclosed in a rugged aluminum housing. It can be attached to the media blast hose at any location and in any orientation via a sensing pin that protrudes from the bottom of the mounting base. A sensing pin is included with the MFD-4. Replacement pins are available from Electronics Inc.

MFD-250

Media Flow Detector for Suction-Type Abrasive Blasting Machines

The MFD-250 is enclosed in a 3.6" x 1.5" x 1.5" aluminum housing and is attached to a sensing pin in its mounting base. Its 6-pin plug allows for easy connection of the sensor to the power supply and machine controls.

The sensor is placed in the blast hose near the mixing chamber. LEDs on the top of sensor indicate green for "Flow OK" or red for "No Flow". The internal relay is activated during green "Flow OK".

MFD-P1

Media Flow Detector for Pressure-Type Abrasive Blasting Machines

The MFD-P1 is enclosed in a 3.6" x 1.5" x 1.5" aluminum housing and is attached to a sensing ring in its mounting base. The mounting base is available in various sizes to fit most abrasive blast machine configurations. Its 6-pin plug allows for easy connection of the sensor to the power supply and machine controls. LEDs on the top of sensor indicate green for "Flow OK" or red for "No Flow". The internal relay is activated during green "Flow OK".

Setup is simple for these sensors. The zero and span functions are automatic—pushing the "zero" button acquires zero for the no-flow condition and pushing the "flow" button sets the sensor gain and activates the relay. The relay contact will transfer whenever the flow is 50-100% of the programmed setting.

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