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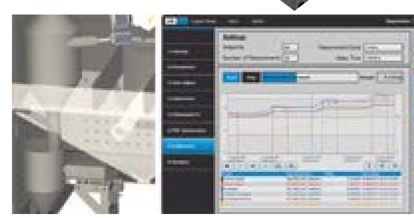
The Shot Peener

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

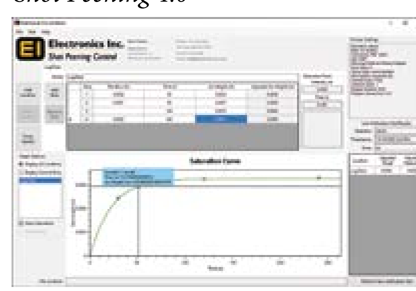
The 2022 Shot Peener of the Year Dr. Yoshihiro Watanabe

PLUS: THE NEW LM SERIES MAGNAVALVES ▮ SHOT PEENING 4.0
CONTRACT SERVICES ▮ SHOT PEENING MATHEMATICS ▮ PEENSOLVER PRO™ REVIEW

LM Series MagnaValves



Shot Peening 4.0



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ICSP14

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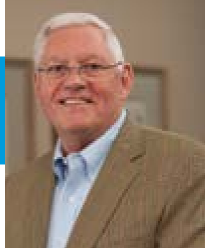

OPENING SHOT

Jack Champaigne | Editor | The Shot Peener

In This Issue

The Shot Peener of the Year

It was a privilege to give the 2022 Shot Peener of the Year award to Yoshihiro Watanabe at the USA Shot Peening workshop. His keen understanding of the needs of the shot peening industry and his contribution to various academic organizations have greatly benefitted this community. Read more about Dr. Watanabe on page six.

ICSP14 Review

The International Scientific Committee on Shot Peening (ICSP) has held conferences every three years since 1981. After being delayed by Covid by two years, the 14th meeting was held in Milano, Italy with 168 attendees and 20 commercial exhibitors.

The international committee meets during the conference to conduct business such as accepting new members and selecting the site for the next event. Three members have resigned from the committee: Emmanuelle Rouhaud (France), Professor Katsuji Tosha (Japan) and Professor Martin Levesque (Canada). Three new members were inducted into the committee: Delphine Retraint (University of Technology of Troyes, France), Professor David Bahr (Purdue University, Head of School of Materials Engineering) and Dr. Yuji Sano (Board Member Japanese Shot Peening Technology). Professor Mario Guagliano (Politecnico di Milano) was elected as new chairman and Professor David Bahr will serve as host for ICSP15 in September 2025 at Purdue University.

See a photo review of ICSP14 in this magazine.

New Product Announcement

The new LM Series MagnaValves for wheelblast machines have completed field trials and are now available for 25 Hp and 50 Hp machines. Installation uses the same electrical plug as the LP-24 and VLP-24 series. The polycarbonate case is lighter in weight for easier installation. The mounting pattern is the same for 1000 lb/min and the 2000 lb/min versions of the valve thus making changes very easy. Built-in air aspiration provides cooling of media and internal valve components. Learn more about the new MagnaValves on page eight.

These attendees are enjoying a champagne toast at the beautiful ICSP14 gala. From left to right are myself, my wife Yuko, Mario Guagliano (ICSP14 Conference Chairman), Martin Lévesque (President of ISCSP), Sara Bagherifard (Coordinator of the Organizing Committee), and Michele Bandini (General Manager of Peen Service).

THE SHOT PEENER

Editor
Jack Champaigne

Associate Editor
Kathy Levy

Publisher
Electronics Inc.

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The Shot Peener
56790 Magnetic Drive
Mishawaka, Indiana, 46545 USA
Telephone: 1-574-256-5001
www.theshotpeenermagazine.com

2022 Shot Peener of the Year Yoshihiro Watanabe

CONGRATULATIONS to our 2022 Shot Peener of the Year—Dr. Yoshihiro Watanabe. Since 1992, *The Shot Peener* magazine has recognized individuals for their contributions to the shot peening industry.

Dr. Watanabe is the President and CEO of Toyo Seiko. Toyo Seiko manufactures and markets shot peening media and shot peening related equipment.

Dr. Watanabe has contributed to the advancement of shot peening throughout his career by volunteering his time to the International Scientific Committee for Shot Peening, the Japan Society of Spring Engineers, and the Aerospace Metals Engineering Sub Committee (AMESC) of the Aerospace Materials Division of SAE. He is a board member of the Japan Society of Shot Peening. Dr. Watanabe has been appointed Secretary of the International Scientific Committee for Shot Peening and as President of Toyo Seiko, he hosted the Tenth International Conference on Shot Peening in 2008. Dr. Watanabe graduated from Gifu University in Japan with a Ph.D. degree in Mechanical Fracture in 1995 and has worked in the shot peening industry since he joined Toyo Seiko in 1989.


Dr. Yoshihiro Watanabe received "The Shot Peener of the Year" plaque from Jack Champaigne at the 2022 USA Shot Peening and Blast Cleaning Workshop

"Toyo Seiko's slogan at their website is to 'turn anti-peening fans into fans'. Under Dr. Watanabe's leadership, Toyo Seiko is excelling at this and that's why he was chosen as the 2022 Shot Peener of the Year," said Jack Champaigne, Editor of *The Shot Peener*. "Toyo Seiko's products, like their cut-wire shot and Coverage Checker, have enhanced the integrity and repeatability of the shot peening process and thereby gained the trust of demanding industries like aerospace and automotive," he added. "We also recognize the experience and knowledge he brings to our SAE committee with his guidance on media properties."

The following interview gives more insight into Dr. Watanabe's contribution to the shot peening industry.

***The Shot Peener*: When did your interest in shot peening begin?**

DR. WATANABE: I became involved in shot peening 33 years ago when Toyo Seiko and Toyota Motor Corporation developed conditioned cut wire shot which had the highest hardness at the time for the application of carburized gear. We conducted joint research with a university to see if this cut wire shot had any merits compared to the popular cast steel shot.

***The Shot Peener*:** Which of your products do you feel have contributed the most to "turning anti-peening fans into fans"?

DR. WATANABE: Feeling doubts that coverage has been measured accurately by visual inspection, Toyo Seiko developed the Coverage Checker that automatically measures coverage. We have sold about 100 units so far and I think that this contributes very much to improve the reliability of shot peening. I am very pleased that our efforts and research have been recognized and evaluated.

In addition, since 2007 I have supported the annual Shot Peening Workshop in Japan for the Japanese people by a collaboration between the Japanese Society of Shot Peening and Electronics Inc. (EI). During this period, more than 500 Level 1 and Level 2 students have been certified. We will continue to work to spread shot peening technology in Japan with the cooperation of EI.

***The Shot Peener*:** *The Shot Peener* staff was very pleased and appreciative that you came to the USA Shot Peening Workshop to receive the award. Please share with us your thoughts on receiving the 2022 Shot Peener of the Year award.

DR. WATANABE: I am very honored to have been selected as Shot Peener of the Year. I was very surprised. I believe that my mission is to be an ambassador of shot peening and I will develop what is necessary for peening technology in order to contribute to the perpetuation of peening technology.

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PRODUCT ANNOUNCEMENT
Kathy Levy | Associate Editor | The Shot Peener

Introducing the LM Series MagnaValves

LM1000-24 and LM2000-24

ELECTRONICS INC. (EI) is introducing their newest valves—the LM1000-24 and LM2000-24 steel shot MagnaValves for wheelblast machines. These valves are an addition to the popular low-profile MagnaValve® family. The following are some of the benefits of the new valves.

Built-In Air Aspiration Inlet (Patent Pending)
The LM1000-24 and LM2000-24 MagnaValve have an aspiration air inlet built into the valve body. An air inlet is necessary in almost all wheel applications to prevent media leaking through the MagnaValve when the valve is off and the wheel is running. This problem is typically discovered after machine assembly and requires costly changes.

The built-in air aspiration inlet allows air to enter the system without allowing media to exit the system. This is achieved by having air inlet holes on the bottom of the MagnaValve that are routed to ventilation located directly below the pole pieces.

The holes on the bottom of the MagnaValve prevent dust and debris from entering the system. At the same time, the long narrow vents below the pole pieces prevent media from leaving the system. The shielding of the pole pieces and the downward angle of the vents reduce the media's ability to escape through the air inlet.

One-Size Footprint
The LM2000-24 shares a footprint with the LM1000-24, making it easy for the end-user to upgrade if a higher flow rate is needed in the future.

OEMs also benefit from the shared footprint because they can design machinery to accommodate either valve.

Polycarbonate Casing
The new casing is lighter than cast aluminum making installation and maintenance easier. In addition, the polycarbonate housing prevents heat transfer from heated shot to the electrical components, ensuring the electronics stay cool.

Easy Retrofit Installation for the VLP-24 and LP-24 MagnaValves
A minimum of mount changes are needed when end users want to replace their VLP-24 or LP-24 with a LM Series MagnaValve.

Replaceable Wear Plate (Patent Pending)
The ability to replace the wear plate will prevent erosion to the valve body and thereby increasing the life of the MagnaValve. The wear plate is made of a durable erosion-tolerant urethane material. The shape of the pole pieces has been redesigned to reduce the amount of erosion to the valve body. With the proper installation, the LM Series MagnaValve will offer years of low-maintenance operation.

Switching Technology
The LM1000-24 and LM2000-24 utilize a newly redesigned electronic module. The new electronics use switching technology and this results in less energy wasted as heat. The LM1000-24 has a 33% improved efficiency.

Increased Flow Rate
Both MagnaValves in the LM Series have received a boost in their maximum flow rate. The LM1000-24 has a 15% increase in flow rate and the LM2000-24 has a 12% increase, taking the maximum flow rate using S-230 to 1390 lb/min and 2280 lb/min respectively.

Controller Options
The LM Series MagnaValves can be controlled by an EI AC-24 Controller or Pot-24 (both sold separately). The AC Controller will detect the current load on the wheel motor and regulate the flow of media to the LM Series MagnaValves for an "automatic" closed-loop operation. This closed-loop system will provide accurate and repeatable flow rates. The EI Pot-24 Controller provides "manual" open-loop control.

If you think a LM Series MagnaValve is right for your application, please contact Electronics Inc. at 1-800-832-5653 or 574-256-5001 for more information.

The LM-100024

Dipl.-Ing. Volker Schneidau | *sentenso* | www.sentenso.com

On The Way to Shot Peening 4.0

Advanced process and quality management for digitisation in automated pressure peening systems

SHOT PEENING is a special process with free-flying spherical particles as tools. The work of the balls on the surface can therefore not be controlled as easily as in a machine tool. Accordingly, the digitisation of process and quality parameters for the requirements of Industry 4.0 is difficult to achieve.

Generations of engineers have been working for more than 150 years to gain control of the flying shot peening balls and their effect on the surface. The goals of shot peening are, in particular, safe and reproducible processes in order to achieve reliable cold work effects and the introduction of residual compressive stresses that significantly increase the service life of components under dynamic loads. For the future, the simulation of shot peening processes is a promising approach to reduce development time, optimise processes, and save energy.

In order to clarify the fundamental development steps of blasting and peening technology against the background of the three phases of industrialisation up to the present day, it is first worth taking a brief look at historical records.

Industry 1.0 - Water and steam power

The first industrial revolution from around 1800 onwards was characterised by the introduction of water and steam power as energy sources for processes and drives. It was not until 1870 that Benjamin Tilghman showed with his first sandblasting blower how steam could be used in an injector nozzle for blasting medium to mechanically process surfaces. However, these blasting applications could by no means be represented in a stable manner in terms of process technology.

Industry 2.0 - Electrification

In the second industrial revolution, the advancing electrification around 1900 allowed for the first time the realisation of decentralised drives that were used to generate compressed air in compressors. This enabled the development of much more powerful blasting systems, which made stable processes possible in the first place. Subsequently, it was also possible to develop closed pressure blasting systems which are still very similar to today's design. Nevertheless, continuous monitoring of the processes was hardly possible.

Industry 3.0 - Electronics and control technology

With the third industrial revolution around 1970, electronics and control technology also found their way into shot peening technology. The sensory recording of data in programmable logic controllers (PLC) allowed the targeted control and also the regulation of manipulated variables in the shot peening process. For example, the introduction of the MagnaValve for electromagnetic flowrate control of peening media was a milestone in this development. With computer technology and increasingly smaller and more powerful processors, the control possibilities were further improved. However, work is still being done today on a conclusive technical concept for the complete recording of the actual process and quality parameters.

Systematic process and quality management for Industry 4.0

With the fourth industrial revolution now underway, far-reaching challenges are coming up with the complete digitalisation of process and quality management in shot peening machines. This results in a multitude of tasks to be solved such as the development of extended sensor technologies on the one hand and the digitalised mapping of the relationships between machine parameters, process parameters, and quality parameters on the other.

From machine parameters to process parameters

The kinetic energy and amount of media accelerated by the compressed air in the nozzle determines the impact characteristics of the media in the process (see figure 1). Since these process parameters cannot be set directly, they must be controlled via the machine settings. Thus, only the control of the machine parameters will provide a stable shot peening process.

The **nozzle-to-part configuration** as spatial arrangement (distance and direction), as well as temporal allocation (movement) of the peening nozzle to the workpiece, essentially influences the impact angle as one process parameter—it also indirectly influences the impact speed. For complex workpieces, robots are therefore often used for path-guided movements of the nozzle (Figure 2).

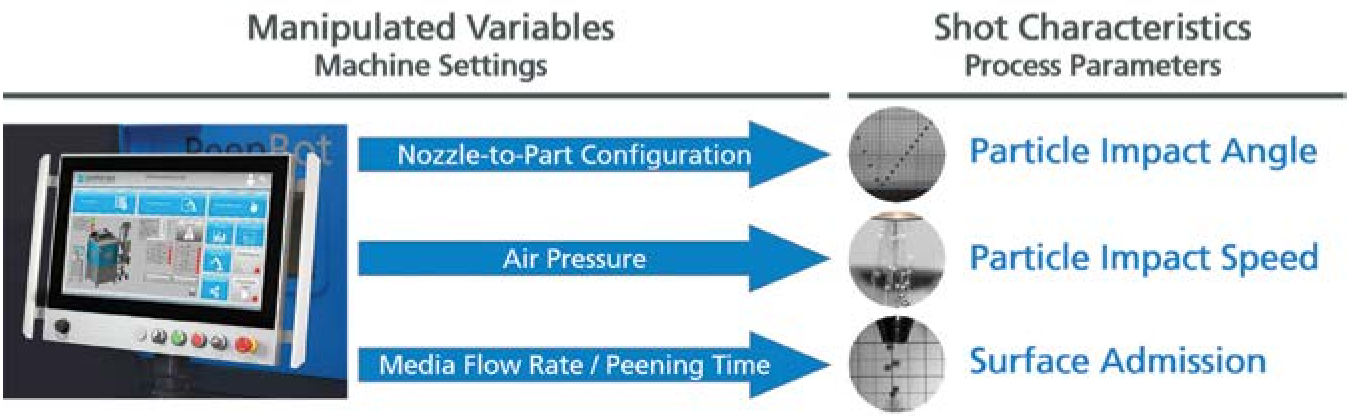

Figure 1: Machine parameters and their influence on the process parameters

The manipulated variable or the machine parameter **air pressure** influences the particle velocity and thus the process parameter impact velocity. The adjustment is carried out by means of pressure control, if necessary, for several independent peening nozzles. Monitoring of the air flow rate serves to detect possible leakage and wear conditions of the peening system, including the nozzle, which will have unintended influence on media acceleration.

The **media flow rate** through the peening nozzle determines the amount of particles per area on the surface, and must be controlled. Depending on the type of media, different actuators and sensors are used to adjust and measure the throughput. The MagnaValve combines an actuator and a flow sensor in one unit. As a rule, the peening time or cycles need to be set properly so that the surfaces to be processed are fully covered.

Figure 2: Spatial and temporal assignment of peening nozzle and workpiece

Direct monitoring of process parameters

The compliance and control of set machine parameters is the general state of the art in process technology and does not pose any fundamental technical difficulty in digitisation as all the control variables mentioned are physically measurable variables that can be mapped digitally.

But beyond that, how helpful would it be if the process variables could also be directly monitored and digitally mapped? With such a direct mapping, the digital twin of the process would no longer be just an image of the machine settings, but an image of the shot peening process itself. The technologies required for this are already available even if they are still being fine-tuned for serial use.

The main process parameters to be mentioned here are the **media properties** grain material, grain hardness, grain size and grain shape. While the first two can only be meaningfully checked before the blast machine is filled, measuring systems with cameras and software that dynamically check the size and shape of grains in free fall have been available for years. Such systems become even more interesting if they constantly monitor the medium circulating in the peening machine. The first solutions for permanent grain size monitoring of free falling media in the flow path are already on the market (Figure 3).

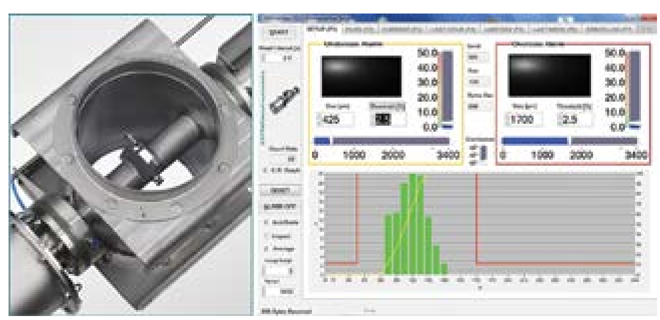

Figure 3: Dynamic analysis of the grain size of circulating abrasive (DYNA Instruments)

The **impact angle** of the peening particles can be monitored with a high degree of process reliability by permanently logging the movement paths of a robot for peening nozzle guidance and the movement of the workpiece digitally via the robot's axis drives.

Several systems based on the evaluation of laser signals are already on the market for the direct determination of the **impact velocity** or the grain velocity at a certain nozzle distance. An unprotected installation in peening systems is only possible to a limited extent. sentenso offers a completely different approach with the evaluation of live video images

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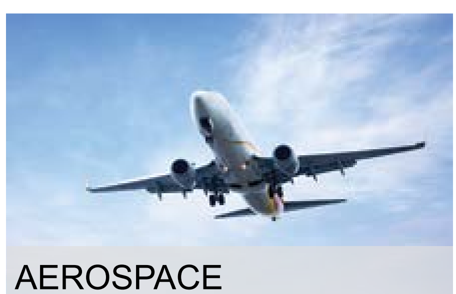
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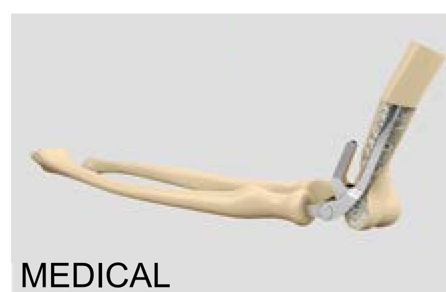
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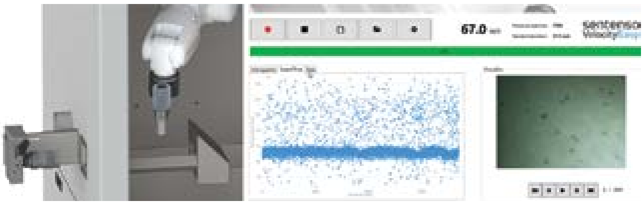


Figure 4: Process-related media velocity measurement with high-speed camera and VelocityEasy (sentenso)

from a high-speed camera. With the help of the evaluation software named VelocityEasy, the media movement is made visible and evaluated in detail (Figure 4). With the associated vector:on Media Speed Management, a peening system can adjust and calibrate itself completely independently to the desired value via the correlation between peening pressure and particle speed.

The **media flow** rate control at the machine works with adjusted and calibrated sensors or control systems. The problem here is the dynamic change of the media properties due to use or refilling, which in turn can significantly influence the sensor values and thus falsify these values. In addition to the peening time, which is easy to monitor, it is required to continuously recalibrate the flow control system to ensure that the surface is properly impacted. sentenso offers a fully integrated and automated measurement and control system for this purpose—the flux:on Media Flow Management. It is based on a cyclone fixed in the peening chamber and a weighing container located outside. By automated insertion of the peening nozzle into the cyclone, this system measures the real media flow rate through the nozzle. The measurement can be recorded and evaluated at any time and as often as required for calibration. The system is also able to readjust itself as the deviation between target and actual values increases (Figure 5).

Figure 5: Process-oriented throughput monitoring with flux:on Media Flow Management (sentenso)

Furthermore it needs to be stressed that regular and conscientious maintenance of the peening machine plays another important role for process stability which can be supported by tools such as predictive maintenance supported by the machine control system.

Determination of quality parameters at the workpiece

The quality or surface parameters to be set with the shot peening process at the workpiece—such as peening intensity, degree of coverage, and residual stress—are also very special and require different measuring techniques ranging from simple subjective-visual assessment using a magnifying glass to complex residual stress analysis using X-ray diffractometers. Digitalised measuring systems are increasingly entering the market in this area as well. The aim is to achieve the most automated, objective, and quantifiable recording of the radiation effect on the surface.

Simulation of shot peening processes

In the future, shot peening processes can be simulated in advance of process development on the basis of continuous digitisation from machine to process and quality parameters. Accordingly, the effects on the component surface can be predicted more reliably on the basis of material-specific and empirically obtained digital data when varying process parameters. For example, expected shot peening intensities and degrees of coverage on the surface can be displayed in false colours (Figure 6). Artificial intelligence (AI) can make further contributions by determining the data model via an AI algorithm from measurement series. The AI model can be subsequently refined with the help of additionally generated data. The model can be simplified if media and material surface conditions are being kept constant during one series of data acquisition.

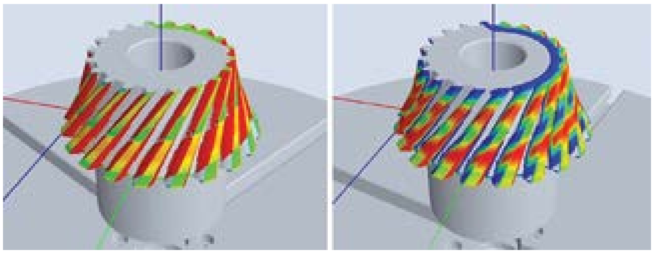


Figure 6: Simulation of quality parameters like shot peening intensity and coverage

An approach that goes beyond this is the solution of the inverse problem of peening process technology. It is desirable that, again with the help of artificial intelligence algorithms, we were able to set a desired target condition of the peened surface directly via automatically determined process parameters and with machine parameters derived from these (Figure 7).

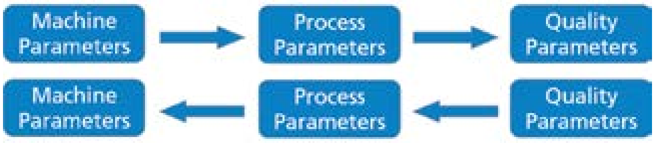
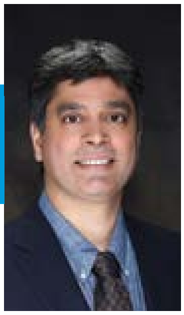


Figure 7: Reversal of simulation through AI-based determination of machine parameters from quality parameters



AN INSIDER'S PERSPECTIVE

Kumar Balan | Blast Cleaning and Shot Peening Specialist

Contract Services Cleaning and Peening

INDUSTRY STRUCTURE

Most of us are familiar with the two primary segments in our industry—equipment manufacturers and end-users. However, there is a third segment that governs a significant part of the industry's revenue, Contract Service Providers. Of course, all three sectors are supported by a team of service and consumable providers that are key in keeping them performing at their peak

Contract service providers could be of two types: metal "laundries" that blast clean parts, and the companies that specialize in shot peening services. Shot peening service providers, the unsung heroes of our industry, play a pivotal role for several reasons. Equipped with certifications and up-to-date audits, they complement those companies that may not have the part volume to justify the purchase of a new machine and the manpower to maintain certification that would allow them to peen mission-critical parts. Contract service providers are often involved in the initial stages of determining the validity and value of cleaning or peening a component before an end-user decides to invest capital in equipment purchase.

If you are reading this, you might be a service provider, or perhaps looking to use such a service in the future and our topic will certainly interest you. We will discuss salient features of this sub-sector, the type of industries that commonly use this service, the economics of operation, machine types employed by these shops, issues faced, and supplementary services offered. The material here has been gathered by interviewing multiple providers in Canada and the United States. This business offers considerable barriers to entry, some of which will also be elaborated upon here.

WHY CHOOSE CONTRACT SERVICES?

In my career, I have been fortunate to work for companies that were equipped with fully functional test/demo labs. During demos, the consensus among my colleagues was that any test carried out for a prospect almost always resulted in an equipment sale in our favor. The reasoning is flawless—customer arrives with a problem; the solution is in the visual affirmation of the part being cleaned or peened in a demo machine. A combination of satisfying evidence and the prospect's investment prowess helped make the sale.

I spoke to end-users in the automotive industry who explained that this process is a lot more involved since all new projects required more than a sample test of five or ten parts. Automotive requires five levels of PPAP (Production Part Approval Process) to be successful before certifying a process as being capable of generating a production part. When multiple batches of parts must be cleaned or peened while developing a process, contract service providers offer a viable alternative.

For those of us in the automotive and aerospace industries, our expectation of cleaning and peening processes is well-established. This is typically not the case in industries such as power, medical, nuclear, etc., that are relatively new adopters. Such industries rely on service providers to take on this responsibility at least until the point this expertise can be brought in-house.

Most peening projects are driven by specification requirements. Though a specification may not be current in terms of information, adherence is a non-compromising expectation. Whether it is MIL-13165-C or the latest version of AMS 2430 and 2432, the purpose of specifications is to ensure consistency, repeatability and accuracy of the process. OEM specifications such as BAC5730 (Boeing) and P11TF3 (GE Aircraft Engines) are all derived from the documents listed earlier. Therefore, knowledge of these specifications, their applicability and proper usage is important. Contract peening services that work with these specifications on a regular basis are better placed to interpret and explain their nuances when you must get your parts processed to these specs.

Though cleaning and peening machines are differentiated on several functional factors such as the type of media propulsion (wheel/air), media reclaim (mechanical/vacuum), a primary differentiation is the type of work handling. This is determined by the part style and area of the part needing processing. Non-metallic media types such as AlOx in grit

blasting and glass bead in peening are best propelled from an airblast nozzle. This is yet another reason a contract service provider will come in handy. Job shops often offer a variety of machine types; each with its unique characteristic based on the differentiations listed earlier.

An example is Latem Industries in Cambridge, Ontario (Canada). Liam Nother, President and his team regularly collaborate with Tier 1, 2 and 3 suppliers to the automotive industry in North America by providing cleaning, peening and other complementary services. "Build it and they'll come, is what I've always told my people. We are often challenged with applications that are out of the ordinary in terms of work handling. It's not always the traditional tumblasts (Latem has three such machines dedicated to specific media sizes) and spinner hangers that are employed in a job shop. We installed a skew roll machine to cater to the needs of a customer that wanted to outsource processing of rods. When we started processing parts for shot peening automotive parts, we installed multiple airblast peening machines," explained Liam.

As a side note, Latem engineers and production personnel are graduates of the Electronics Inc. on-site Shot Peening Training program.

MACHINE MIX MATRIX – NEEDS AND CHALLENGES

Dedicating machines for specific cleaning or peening projects might seem like a luxury. However, operationally speaking, it makes the most sense. Efficient cleaning relies on the selection of the correct media size and maintenance of a balanced operating mix in the machine. This can only be accomplished if the machine is filled with the same size and type of media (while permitting different part styles that require this media type and size). In certain cleaning applications, the type of contaminant being cleaned should also be a consideration when dedicating machine types since reclaim systems must be tuned appropriately to handle the contaminant. For example: Sand loading in foundry applications.

The need for machine dedication is of great importance in shot peening applications. Even the smallest machine type will be threatened with cross-contamination when changing over from one media size to another to cater to two different peening projects requiring different media sizes. Several hours of time investment for the changeover and the ordeal of an impossible saturation curve will add to the frustration of your operators!

In the wheelblast world, the machines commonly seen in blast cleaning are tables, tumblasts and spinner hangers. For airblast applications, multi-tables (main table with satellites), batch type robotic machines provide efficient processing in job shops. Every machine and process developed by a job shop for shot peening will need to be audited and approved prior to processing parts. Innovation in machine design in the form of hybrid machines (wheel and airblast combination) could help reduce the inventory count of machines, particularly in a small facility. This will also help pivot from one process to the other when part styles demand so. For example, parts requiring complete processing versus those that need certain areas protected/masked from the impact of media. However, this can only work when the media type and size remain the same between the two propulsion systems. Controls (PLC, sensors, HMI, programming, etc.) in a peening machine have the greatest impact on capital cost. A hybrid concept could eliminate the need for two separate machines to invest in and certify for use.

Fixture design adds to the operating cost and ultimately the profitability of the process. Universal fixture design is a "nice-to-have" concept, but seldom works in the practical world. Controlling different fixtures by way of unique identification and stipulating/maximizing their use for common part styles are general challenges commonly faced by most contract peening services.

ESTABLISHING A CONTRACT SERVICE

Zach McGillivray is Director of Operations at VibraFinish. VibraFinish is a large contract services provider located near Pearson International Airport in Toronto, Canada. He is part of the latest generation of blast cleaning and shot peening professionals that is a much-needed asset in our industry. "The recent situation with non-availability of micro-chips and other supply chain challenges has impacted several of our customers. Adding to that is the perfect storm of the pandemic and culminating in a labor shortage. VibraFinish has been fortunate over the years with a stable workforce, and we ensured that this talent is retained during difficult times. One of the ways we managed to do that was by diversifying our portfolio of services. Companies that plan for the stretch often invest in re-tooling during downturns. At VibraFinish, we invested in developing Vibratory Peening as a process with key aerospace customers. This has opened new avenues and enabled offering enhanced services to our cleaning and vibratory finishing customers."

Zach's comments give us insight into how traditional technologies need to be expanded for sustainability and growth. VibraFinish operates 18 traditional blast cleaning machines, eight high-output washing machines and 65 vibratory finishing machines. The company is also Canada's only manufacturer of vibratory finishing machines. VibraFinish recently commissioned an automated lab for vibratory peening.

But what does it take to establish a contract service from scratch? My analysis is based on insights from several industry professionals. A common theme that supports establishment of this business is fulfilling a "need" or bridging a "gap". Most

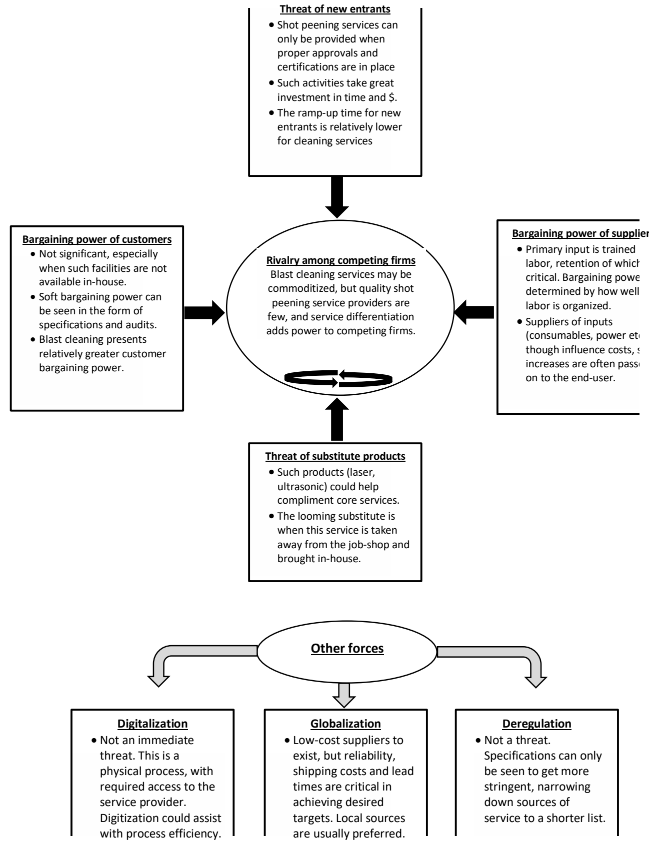
job shops established themselves to address a need expressed by an end-user.

Walter Beach is Vice President at Peening Technologies in East Hartford, Connecticut with a second facility in Georgia. "We have been processing parts for aerospace companies in our geography for over five decades. Our customers regularly conduct audits on our operations and our operators are highly conversant with conformance to commonly used aerospace specifications." Walter is the vice-chair of SAE and AMEC committees and most recently finalized the latest version of AMS 2432, Shot Peening, Computer Monitored.

Walter adds, "There is no 'cutting corners' when peening critical aerospace components. Regardless of whether an audit is conducted or not, one can never ignore key points such as regular media inspection for shape, size and other attributes. Calibration of the process in terms of media flow, velocity (air pressure/wheel speed), etc., must be maintained as prescribed." Peening Technologies have taken their offering one step further and are currently also a manufacturer of computer-controlled shot peening machines.

In addition to job shop services and equipment manufacture, Peening Technologies also offers a complete package of machine programming services, part holding and masking fixtures, machine maintenance and calibration, as well as operator and maintenance technician training.

Valuable comments from industry professionals prompt me to utilize a Five Forces model by Michael E. Porter, a Harvard Business School professor, to understand and explain the five competitive forces that shape our industry. Created in 1979, this model is very effective for our discussion in spite of certain known limitations such as the impact of globalization, and industry overlap.



The Five Forces Model by Michael E. Porter: Competitive Forces Influencing Contract Services

CONCLUDING SUMMARY

- A large part of the industry's revenue is derived from blast cleaning in terms of equipment and services. Therefore, establishment of a quality peening services may have to be through the route of a metal laundry for economic and recognition reasons.

- Design of components for electric vehicles, increased use of high-strength alloys, and the high-residual compressive stress demands created by newly designed auto parts create opportunities for equipment manufacturers and contract services alike. Though it is not a race to the finish line, it certainly places the onus on such contenders to devise unique techniques to address updated peening requirements in a timely fashion.

- In the current environment, capital is expensive and investment in new equipment is likely to be subdued for the immediate future. The incubation period for newly installed equipment to be production-ready is an additional six to eight months with the need for audits and certification. This presents a unique opportunity for established contract providers to grow their business without the above-mentioned lag.

- I dislike highlighting the distressing fact that we are part of an industry that does not attract new talent in droves. This increases the reliance on existing talent to not just sustain but also grow into new areas. For a contract service, such areas could include X-ray diffraction, specialized thermal spray techniques, exploring the practical benefits of digitization. (For example: Industry 4.0 / IOT.)

- Build-Operate-Transfer. Consider the possibility of "expertise transfer". Nothing is more valuable to an OEM than a robust, developed process. Companies that prefer to bring the process in-house in the future could "acquire" the process and equipment developed by the contract service provider at a suitable time.

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ACADEMIC STUDY

Dr. David Kirk | Coventry University

Shot Peening Mathematics

SHOT PEENING is, necessarily, quantitative. It therefore relies on the application of a large number of mathematical principles. These principles vary from simple arithmetic procedures to the use of complex equations to predict the effects of peening variables. Examples include estimating particle size variation and curve fitting for peening intensity prediction.

This article aims to show how mathematics is involved in relevant areas of shot peening. The most important factor is the application of established equations. Equations express the interrelationship of variables. As such they can be regarded as being models of behavior.

MODELLING

All models have to be based on a set of assumptions that reflect established knowledge. This requirement is illustrated by the following case study.

Case Study: RESIDUAL STRESS DISTRIBUTION

As is well-known, shot peening induces a thin surface layer of compressed material. This is one of the two major benefits of shot peening—the other being the corresponding work-hardening of the surface. The distributions of residual stress and work-hardening are very similar. The general shape of the residual stress distribution is known to be as shown in fig.1.

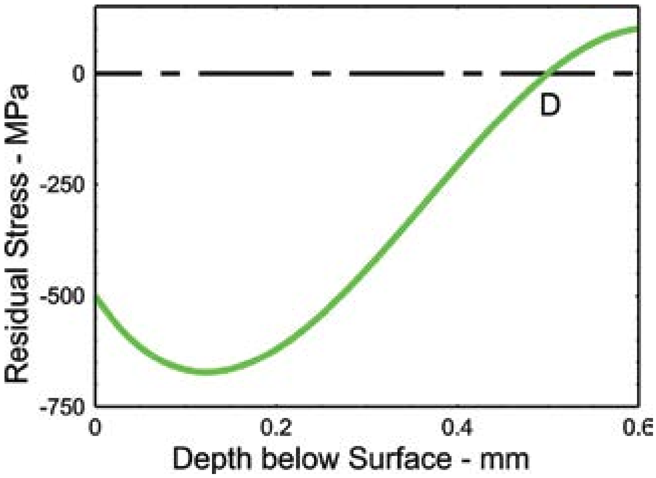

Fig.1. General shape of residual stress distribution in single-peened components.

Fig.1 therefore represents a model of the residual stress distribution. For the illustrated model, the following assumptions were made:

1. The level of surface compressive stress is half of the yield strength of the as-peened material, Y.
2. The maximum level of compressive stress is two-thirds of Y and occurs at 20% of the depth of compressed material.
3. The depth of compressed material, D, is shown, for this illustration, as being 0.5 mm.
4. A balancing tensile stress of 10% of Y is reached at 1.2D (0.6 mm).
5. A cubic polynomial interpolation will be appropriate.
6. The peened material is assumed to have a yield value of 1000 MPa.

The problem to be tackled, as with all models, is to enable predictions to be made. For this case study, it is to enable prediction of residual stress profile curves by varying the assumed parameters.

The model may be extended in several ways to make it more generally applicable:

1. Because we rarely know the yield strength of the as-peened material we can use some other measure. It is suggested that the ultimate tensile strength (U.T.S.) of the unpeened component material is a good indication of the yield strength of as-peened material. That is because the U.T.S., as measured in a tensile test, indicates the strength of material deformed to the point of plastic instability. After the U.T.S. is reached, further strengthening (true strength) occurs up to the point of fracture. During peening the material is subjected to multiple impacts that strengthen the material to about the U.T.S. level without any chance of plastic instability occurring.
2. Because we cannot know the depth of the compressed layer in advance we can make an assumption that it is equal to the dimple diameter. Dimple diameter can either be measured for a given peening situation or can be predicted.

This case study is an example of developing a model that will predict a given type of curve without having to produce any actual experimental data. The reliability of the predicted curve is only as good as the assumptions that have been made. Hence extreme care has to be taken before any reliance can be put on the predictions. Conversely it can be a very good guide as to the peening parameters that may lead to a required residual stress depth profile. Measured residual stress profiles can be used to confirm the applicability of the model.

ARC HEIGHT VARIATION WITH PEENING TIME

The variation of arc height with peening time forms the basis for estimating peening intensity. In the early days of intensity, estimation hand-drawn graphs were produced. These enabled a subjective point to be selected as representing intensity, using as a guide "10% or less". Nowadays mathematical models have taken over, allowing objective estimates to be made of peening intensity. "Objective" means that everyone gets precisely the same value when using the same set of peening data and model equation.

Again we require that intensity prediction models should to be based on a set of assumptions that reflect established knowledge. Numerous intensity curves indicate that their general shape is similar to that of a coverage/peening time curve tending to approach a maximum. The most useful data is probably that published by Wieland (R. C. Wieland, "A Statistical Analysis of the Shot Peening Intensity Measurement, ICSP5, 1993, pp 27-38). A total of 388 Almen strips were shot peened using the same closely controlled conditions but with varying exposure times. The averages of about thirty deflections, measured at each different exposure time, have been plotted as fig.2. As would be expected, such averages smooth out measurement variability.

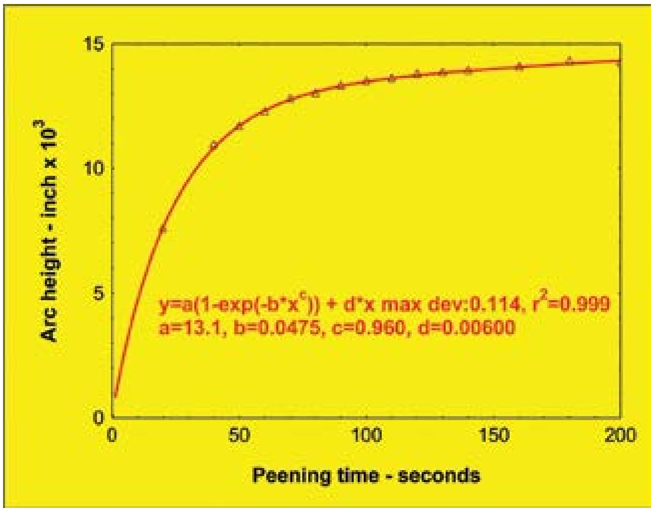

Fig.2. Variation of Arc Height with peening Time.

The mathematical equation included in fig.2. is based on the assumptions that:

1. The general shape is that of a three-exponent exponential function, together with
2. A very small linear element (d only equalling 0.00600x).

The goodness-of-fit is indicated by the value of r^2 being virtually unity. It should be noted that some sixteen different peening times have been involved—far more than would be available with routine intensity curve testing. The four-parameter equation used to establish the precise shape, but involving sixteen points, is therefore inappropriate for routine testing. The author's Solver Suite of appropriate fitting equations cuts out the very small linear component. Two choices are offered: One with just two parameters and the other with three. The three-parameter equation gives a closer fit but is best used with more than the bare minimum of four data points in a set. Corrections can be applied for pre-bow of Almen strips.

VARIABILITY OF INDIVIDUAL ALMEN ARC HEIGHT MEASUREMENTS

All arc height measurements have some degree of variability. Consider the two hypothetical sets of Almen arc height data, A and B, given in Table 1. These are for sets of twelve identical strips peened using the same conditions but by different operators. The objective in both cases was to impose an arc height of 0.0063".

Table 1. Variability indicated by two sets of Almen arc height data.

Strip Number	Arc heights (inch x 1000) SET A	Arc heights (inch x 1000) SET B
1	6.2	6.3
2	6.3	6.5
3	6.3	5.9
4	6.2	6.7
5	6.5	6.0
6	6.3	5.9
7	6.3	6.4
8	6.4	6.3
9	6.2	6.2
10	6.3	6.5
11	6.3	6.7
12	6.1	5.9
AVERAGES	**6.3**	**6.3**
STANDARD DEVIATION	**0.1**	**0.3**

It can be seen that both operators were successful on average. The variability of arc heights for operator A was, however, much less than that for operator B. This difference is quantified by the respective standard deviations of 0.0001" and 0.0003". (Standard deviations are easily calculated using Excel. We highlight a cell and insert, for example, "=STDEV(A1:A12)" where A1:A12 contains our twelve arc height values.) We do not need to understand the mathematical basis of "standard deviation" in order to use it effectively. (We can drive within speed limits without knowing how a speedometer works.) The term standard deviation refers to the "spread" to be expected from a set of values that are "normally distributed".


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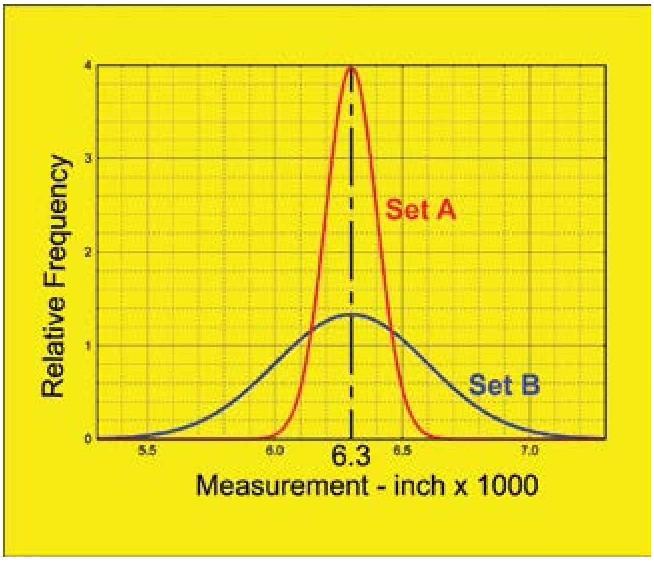

Fig.3. Normal distributions for Sets A and B.

Fig.3 shows the normal distributions representing Sets A and B. The wider spread of measurements for Set B becomes very apparent. It was assumed that the two sets of data were normally distributed. Close examination reveals that this is not necessarily correct.

SHOT PARTICLE KINETIC ENERGY

Shot particles, when accelerated by air or wheel, gain kinetic energy, $\frac{1}{2}mv^2$, where m is mass and v is velocity. Mass is volume multiplied by density with volume equal to πd3/6. One way of visualizing the enormous range of available kinetic energies is to use information such as that contained in Table 2. For cast steel particles there is a range of 6,700 to 1 in the mass of the particles. Hence, for a given shot velocity the kinetic energy will vary by 6,700 to 1.

As an example of kinetic energy calculation, consider S170 accelerated to 50 ms^{-1}. The kinetic energy, K_{S170}, is given by:

$$\mathbf{K = \tfrac{1}{2}*0.33134*10^{-3}g*(50ms^{-1})^2 \text{ or}}$$
$$\mathbf{K = 0.414m^2s^{-2}g}$$

COVERAGE

Coverage of a component by shot-induced dents is a vital feature of peening. The development of coverage, C, with peening time, t, closely follows the curve:

$$\mathbf{C = 100\ (1 - \exp(-A.R.t))} \qquad (1)$$

Where **A** is the area of each dent and **R** is the rate of creation of dents.

We can use equation (1) to plot how coverage increases with peening time. As an example, if A = 1 mm^2, R = 0.2 dent per second per square millimeter and t is 1 second (see fig.4 on page 32).

Table 2. Variation of Size, Mass and Particles per 100 g of Cast Steel Particles.

SHOT	DIAMETER		MASS	PARTICLES
	- inch	- mm	- mg	PER 100 g
S70	0.0070	0.1778	0.02313	4322983
S110	0.0110	0.2794	0.08976	1114037
S170	0.0170	0.4318	0.33134	301808
S230	0.0230	0.5842	0.82055	121869
S280	0.0280	0.7112	1.48046	67547
S330	0.0330	0.8382	2.42362	41261
S390	0.0390	0.9906	4.00052	24997
S460	0.0460	1.1684	6.56441	15234
S550	0.0550	1.3970	11.22045	8912
S660	0.0660	1.6764	19.38894	5158
S780	0.0780	1.9812	32.00414	3125
S930	0.0930	2.3622	54.24643	1843
S1110	0.1110	2.8194	92.23404	1084
S1320	0.1320	3.3528	155.11154	645
Ratios				
highest/ lowest	19:1	19:1	6700:1	6700:1

More examples can be accessed from Proceedings of ICSP5, "Theoretical basis of shot peening coverage control", pp183-190.

In order to use equation (1), the area, **A**, of each dent can be estimated by direct measurement of the dents in a lightly peened component. Getting a good estimate of **R** is more involved. **R** = **M/m** where **M** is the feed rate per unit area of the peening contact zone and **m** is the average mass per particle.

SHOT VELOCITY

Shot velocity is obviously of prime importance because it governs shot's ability to create dents. The control factors for shot velocity are completely different for air-blast and wheel-blast peening.

Air-Blast Shot Velocity

The outlet from an air compressor goes into a ballast tank and thence to an air supply pipe, preferably via a drying unit. The compressed air flows as a stream through the pipe. This can then be connected to a shot feed and nozzle system. Ballast tanks even out pressure fluctuations from the compressor and provide a reservoir of compressed air. One or more pressure control valves, **PCV**, will be present in the air supply line. The compressed air, at a pressure, $\mathbf{p_1}$, is fed into a blast hose of length **L**, at the other end of which is a nozzle where the pressure will then be $\mathbf{p_2}$, see fig.5.

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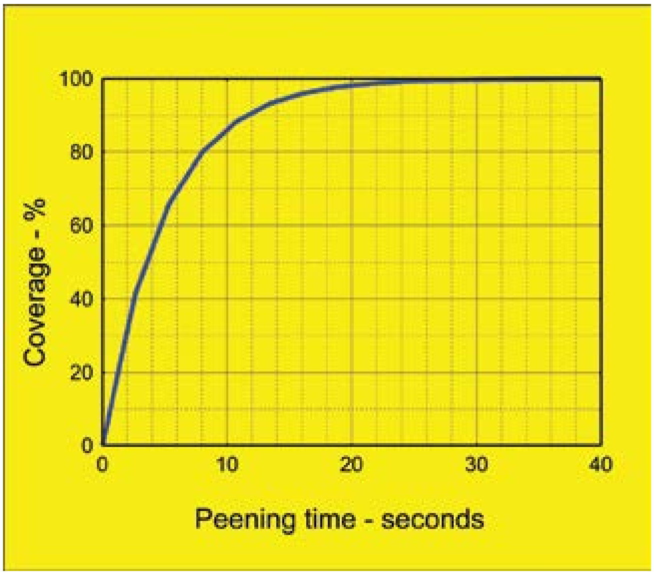


Fig.4. Variation of coverage with peening time.

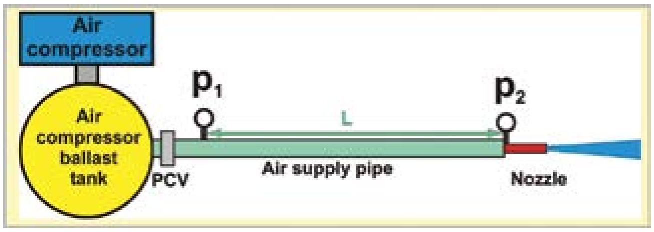


Fig.5. Schematic representation of air stream component elements, not to scale.

Fig.6 is a simplified schematic representation of how the nozzle air velocity changes with increase of nozzle air pressure (assuming that the nozzle vents to 1 atm pressure in a peening unit). A "sonic barrier" exists at the narrowest part of the nozzle, caused by the difference in pressure in the nozzle as compared with that in the peening unit. This barrier occurs when the air pressure difference is about 1.9 atm. Because all practical peening involves a pressure difference of more than 2 atm (29.4 psi), we have a fixed limited air velocity in the nozzle regardless of nozzle pressure and nozzle diameter.

The constancy of air velocity exiting the nozzle begs the question: "What effect does air pressure have if it does not affect air velocity?" The answer is that at higher pressures the air is more compressed so that it has a greater density but has the same velocity. Increasing the nozzle pressure increases the "mass flow" of air. Alternatively we could say: **"As we increase nozzle air pressure we are firing heavier air but at a constant velocity."**

A previous article (TSP, Winter, 2007) described the derivation of a formula for estimating air-blast shot velocity, **vs**:

$$\mathbf{v_S = (1{\cdot}5.C_D.\rho_A.s/\pi d.\rho_S)^{0.5}\ (v_A - v_S)} \qquad (2)$$

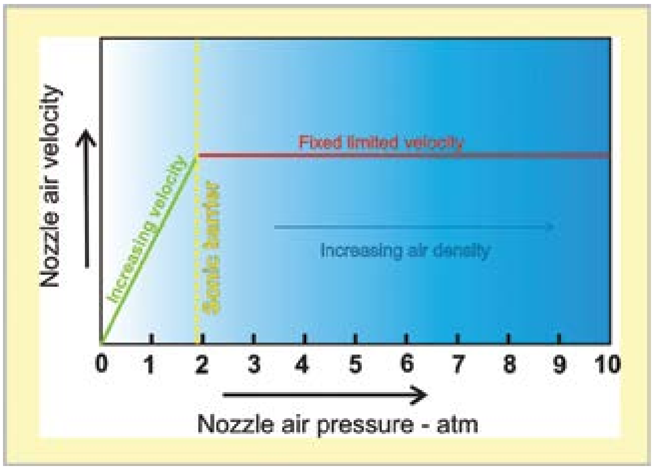


Fig.6. Schematic representation of air velocity variation with applied air pressure.

where **C_D** is the "drag coefficient" (a dimensionless number that depends upon the shape of the object and for a smooth sphere **C_D** ≈ 0.5), **ρ_A** is the density of the **compressed** air (1.2 kgm^{-3} times the compression ratio), **s** is nozzle length, **d** is nozzle diameter, **ρ_S** is shot density, **va** is the velocity of the air stream and **vs** is the velocity of the shot particle. **($v_a - v_s$)** is termed the "relative velocity" of the particle compared with that of the air stream.

Equation (2) represents a model of air-blast shot velocity generation. Its best use is for estimating the effect on shot velocity of changing the value of the variables.

Wheel-Blast Shot Velocity

The physical components of a wheel-blast machine are quite different from those for air-blasting as illustrated by fig.7 on page 34.

Wheel-blast velocity is generated by employing two components—tangential velocity, **V_T**, and radial velocity, **V_R**. Again, the relevant formulae were described in a previous article (TSP, Spring, 2007). Fig.8 shows how the two components combine to give **V_S**.

Tangential velocity, **V_T**, is given by:

$$\mathbf{V_T = 2\pi.R.N} \qquad (3)$$

Where **R** is the blade length and **N** is the number of revolutions per second. As an example, if **R** = 0.250 m and **N** = 50 r.p.s. then **V_T** = 78.5 m.s^{-1}.

Radial velocity, **V_R**, is given by:

$$\mathbf{V_R = 2.\pi.N(2.R.L - L^2)^{0.5}} \qquad (4)$$

The combined wheel-blast shot velocity, **V_S**, is given by:

$$\mathbf{V_S = 2.\pi.N(R^2 + 2.R.L - L^2)^{0.5}} \qquad (5)$$

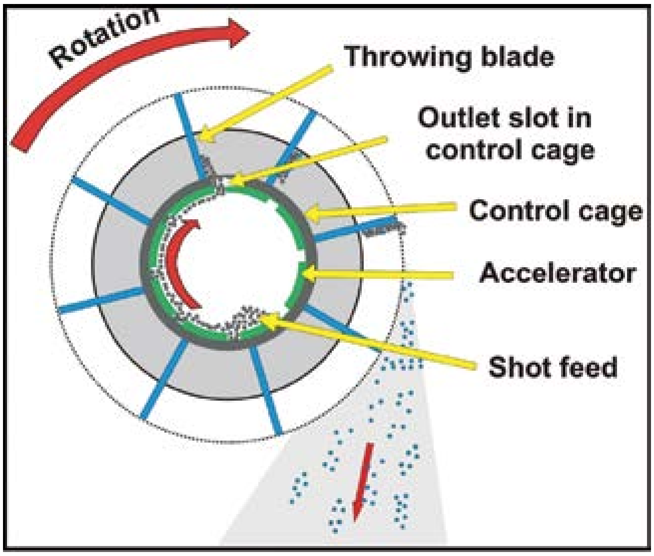


Fig.7. Wheel-blast system with "open" throwing blades.

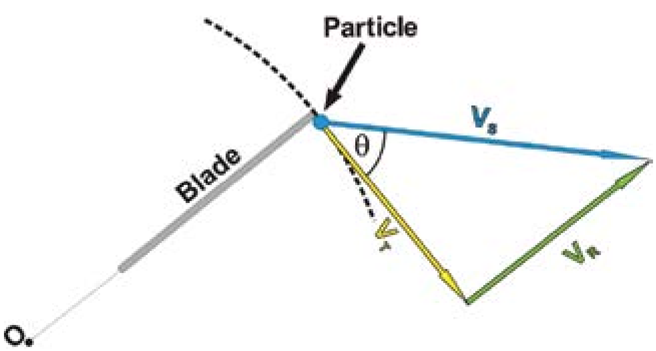


Fig.8. Individual particle leaving blade tip with vector-combined velocity, **Vs**.

DENT SIZE

Dent size can, of course, be measured directly. However, a previous article (TSP, Spring 2004) presented an equation that shows how different parameters influence dent size:

$$\mathbf{d = 0.02284{*}D{*}(1 - e^2)^{0.25} {*}\rho^{0.25}{*}v^{0.5}/B^{0.25}} \qquad (6)$$

Where **d** = dent diameter, $\mathbf{(1 - e^2)}$ = proportion of absorbed impact energy, **D** = shot diameter, **ρ** = shot density, **v** = shot velocity and **B** = Brinell hardness of component. All of the parameters in equation (6) are known except for the proportion of absorbed impact energy. This can be assumed to be close to 0.5. Dent diameter is directly proportional to shot diameter with other parameters remaining constant. Shot velocity is the next most influential parameter followed by the others.

SURFACE HEATING CAUSED BY PEENING

Energy cannot be destroyed—it can only be transferred. For example, some 90% of the energy absorbed by impacting shot particles is transferred into heat. Fig.9 shows experimental results obtained when air-blasting Almen N strips using different combinations of air pressure and flow rate with S170 shot.

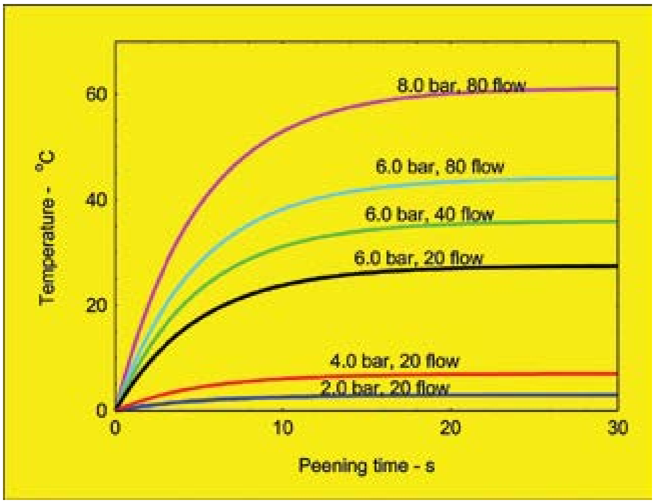


Fig.9. Surface heating curves for Almen N strips and S170 shot.

Surface heating was described in a previous TSP article (Summer, 2003). The measurements indicate that significant surface heating can be expected when shot peening.

DISCUSSION

An attempt has been made to show how mathematics pervades all aspects of shot peening. Mathematical techniques have allowed shot peening to graduate into a technologically advanced process. Most of the techniques are models that approximate, more or less closely, to real-life situations.

A fundamental advantage of mathematical techniques is that they are objective. Unless we make a mistake, we should all get the same answer.

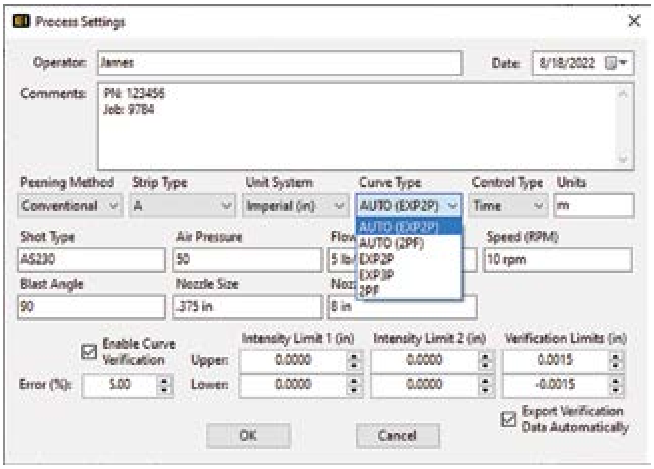
James Kernan | Materials Engineer / Nadcap℠ Auditor / Shot and Flapper Peening Instructor

The New PeenSolver Pro™

I OPENED the PeenSolver Pro™ from my desktop and was impressed right from the start. It has a smooth interface showing the Process Settings, Almen Strips, Saturation Curve, and Intensity Verification all on the main page. I went to the Help tab on the top left and opened the Instructions. After starting to read, I realized it was good to get familiar with the PeenSolver, but to us shot and flapper peeners, the software is self-explanatory.

Some awesome points of the software include doing either Conventional Shot Peening or Rotary Flapper Peening, use of five (5) different Curve Type AMS2597 compliant algorithms to calculate the Saturation Curve, adding an error limit to highlight Arc Heights way off the Saturation Curve, and adding the Intensity Verification tolerance limit which will automatically tell you if you are within the tolerance limit (you don't have to do the math or get your calculator out). You can also add as many locations as needed to the same file and view multiple Saturation Curves at once.

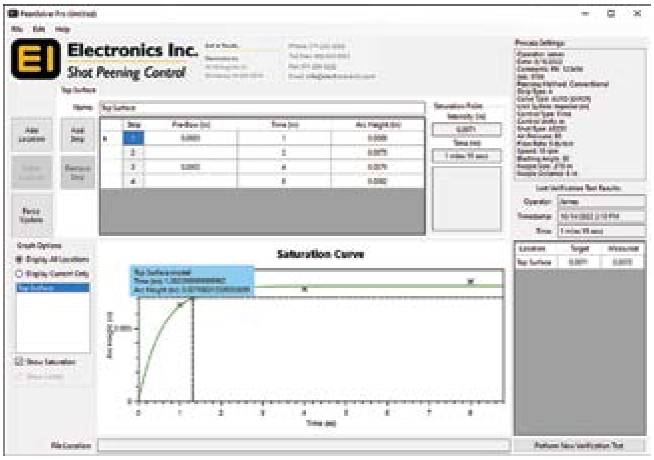
From the main page, I started with File > New and the Process Settings opens a new window. I entered the information for the Operator, put the Job and Part Number in Comments, peening method, Almen strip type and process parameters. The Process Settings default to a 5% Error Limit and standard +/- 0.0015 in Verification Limits. Clicked OK. The Process Settings showed up on the top right of the main page for reference.



On the main page, there is a Name box that defaults to Location 1. You can update the Name to whatever you want. I changed it to read Top Surface and then ran the shot peening process and started entering Arc Heights for Strip 1. Entered Pre-Bow, Time ran—which instantly populated the time at doubles for the other three strips—and then my Arc Height. Hit Tab and it automatically moved to Strip 2. Went through the same steps for the other three Almen strips. After entering the Strip 4 Arc Height, you can hit Enter or Tab and—BAM!—the Saturation curve is instantly displayed along with the Saturation Point Arc Height and Time. Another feature is that you can click on the curve or the arc heights on the Saturation Curve and the Arc Height and time will be displayed.

The next step is to set up the Intensity Verification process. Click on the bottom right button Perform New Verification Test. The pop-up box defaults to the Saturation Point Time and provides the Target Arc Height from the Saturation Curve. If the time at Saturation is not convenient for production, enter the time you want to run and the targeted Arc Height derived from the curve is instantly updated. Run the process and then enter the corrected Arc Height in the Measured box, then click on Save. Click File > Export > Verification Data and you will have a spreadsheet of all Verifications completed to date.

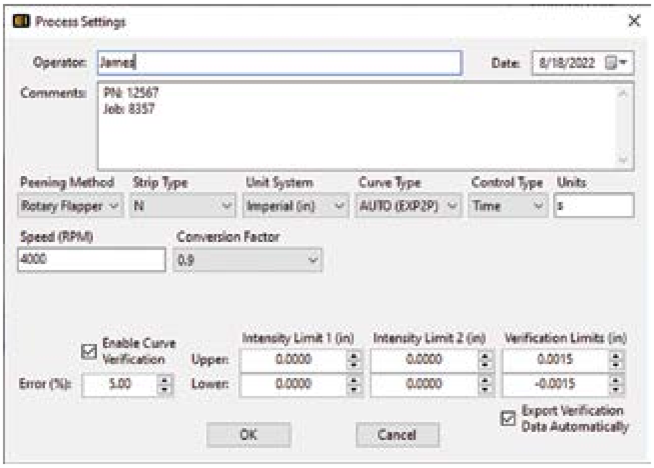
At this point, if you had only one Almen block, you have completed the Saturation Curve and Intensity Verification process steps. Click File > Save which saves the core XML file. Click File > Export > Screenshot and you have the entire process documented for your Part Process documentation.

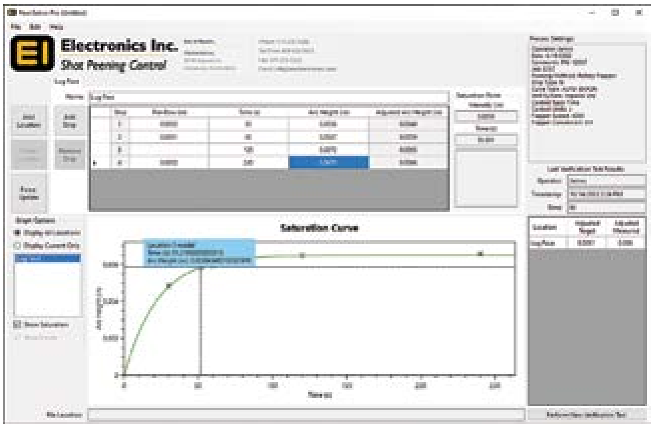


During shot peening production, the user can open this same part file in PeenSolver Pro to validate the process and equipment settings as well as use the Verification Test button to enter the production Intensity Verification Arc Heights. Each time a verification is saved, the base Verification Excel file is updated with date and time, Operator, Peening Time, Target, and Measured Arc Heights. The Excel file record could easily be used for historical quality records. The continuous record can also be used to show deviations from the Targeted Arc Height over time which the user can translate into potential equipment or other maintenance.

The PeenSolver Pro has additional capabilities for Rotary Flapper Peening with both N and A Almen strips. The process is the same as described above for conventional shot peening except for selecting Rotary Flapper Peening, Almen Strip type and conversion factor in the Process Settings. The

software includes automatic Adjusted Arc Height as required by AMS2590. You will save time and increase efficiency with the PeenSolver Pro by not having to do the peened Arc Height conversions using the correct AMS2590 table!





One last point that should be made is when you are developing a Saturation Curve from scratch, the PeenSolver Pro provides actionable information for the user. The software is remarkably quick to show the Curve and Saturation Point along with a Warning if it is a Type 2 curve, showing Arc Heights that are far from the calculated curve, and if the Saturation Point occurs prior to the first Arc Height or if a Saturation Point could not be found. You can easily add another strip after the first four with any time value and the curve will be recalculated. You can rerun strips and update the Arc Height for that time. You can also Display all Locations and all the Saturation Curves will populate the curve area. There are surely many other benefits that will save us time that we have yet to find.

I found the new PeenSolver Pro software very straightforward to use. The auto fill of time and the saturation curve is remarkable and the exceedingly fast Intensity calculation along with documentation of the shot peening Process Settings and Intensity Verification all in one place will make our work much easier. Thanks Electronics Inc.!

IKK SHOT Celebrates Anniversary and New Name

Iann Bouchard | Corporate Communication Director | Winoa

IKK SHOT CO., LTD, a division of Winoa, recently celebrated two very important events.

First, IKK SHOT, a spin-off from ITOH KIKOH, celebrated its 25th anniversary. Established in October 1997, the company has serviced over 1,000 customers. It has produced more than 700K tons of steel media for products such as UFS (Ultra Fine Shot), Dummy Balls (conductive media for electroplating), Steel Abrasives, and a well-established premium media brand called IKK SHOT™. IKK SHOT has become the leader in the Asian market for peening, cleaning and surface preparation applications.

Second, proud to be part of the Winoa group for 25 years (formerly Wheelabrator Abrasives), IKK SHOT takes the initiative to fully align with the group values, culture, and objectives by rebranding the company in the name of "WINOA IKK JAPAN Co., LTD.".

WINOA IKK JAPAN will continue to produce and promote the IKK SHOT™ brand while offering W Abrasives™ products, the new service brand called W Care and the parts and equipment under W Tech.

Visit our website at www.winoagroup.com and www.ikkshot.com for more details and to view the full range of products and services.

ICSP14 Photo Review











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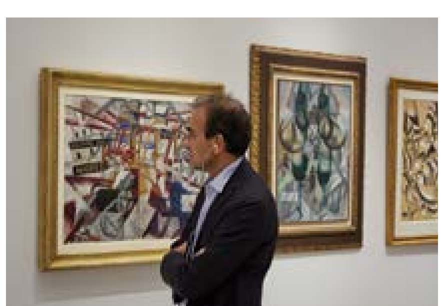

After Five Years, Finally ICSP14!

THE 14TH International Conference on Shot Peening (ICSP14), initially planned in 2020 and then postponed to 2022 due to the COVID emergency, was finally held five years after the last ICSP13 in Montreal, Canada.

ICSP14 was hosted at Politecnico Milano in the buildings of the Campus Bovisa from September 4th to the 7th, 2022. ICSP was hosted in Italy for the first time and not without fears for the organizers. Indeed, it was not easy to foresee how many delegates could come and how many people were willing to come due to the continuous and uncertain news given every day by the media. However, the decision to have the conference in-person was the right decision.

"Last January," says Mario Guagliano, chair of the conference, "My colleagues and I were wondering if organizing the ICSP14 in person could be a good idea or if a virtual conference would be a better and less risky choice for us and for the people interested in attending. Finally, we decided to go with the in-person option and now I can say it was the right decision. We missed most of the Chinese delegates due to the strict COVID restrictions in China, and it is a pity. However, we organized remote sessions for speakers from China and they were happy to present their work in this way. Apart from the problem with Chinese delegates, the overall participation was more than satisfactory."

More than 160 delegates participated in ICSP14, coming from North America (USA and Canada), Asia (Japan, Singapore, Korea), Europe (large delegations from Germany, France and Italy) and South Africa.

Five plenary lectures were given by leaders in the field. Martin Levesque, the President of the International Scientific Committee on Shot Peening, talked about the many activities on shot peening and peen forming at the École Polytechnique Montréal, ranging from multi-scale approaches for modelling to impressive experimental tests. Domenico Furfari and Yongxiang Xu gave their presentation on the development of laser shock peening at Airbus and at Shanghai Jiao Tong University, respectively. Emmanuelle Rouhaud talked about Surface Mechanical Attrition Treatment (SMAT) and the research done in the field at Université Troyes and, finally, Pierangelo Duó, described how shot peening is implemented at Rolls Royce Germany.

Nineteen exhibitors participated in ICSP14 with a booth, showing the new products and the latest advancements in the field.

More than 90 scientific presentations were discussed during the thematic parallel sessions. One of the subjects that attracted great interest is the application of shot peening as a post-treatment for additive manufactured parts. The great diffusion and development of additive manufacturing and the quality of the surfaces that are obtained requires the definition of new approaches and new sets of parameters to successfully apply shot peening. The studies presented on Al alloys, Ti alloys, Inconel, stainless steels, as well as the methods developed for assessing the improvement of the fatigue endurance and strength of additive manufactured parts, attracted the interest and the curiosity of the audience with many questions and interesting discussions.

In the session dedicated to laser shock peening (LSP), organized by Domenico Furfari, more than twenty presentations were presented, giving a 360˚ view on the most recent developments of this treatment. Interesting talks addressing multiple aspects of the treatment were given including tailored laser peening to anisotropic residual stresses, fast laser peening, the application of nanoindentation for residual stress measurement, the application of laser peening to improve the corrosion resistance of aluminium alloys, and many more.

The traditional sessions dedicated to fatigue, experimental analysis, process development and case studies exhibited the multiple applications of shot peening and its flexibility in new industrial environments, confirming the increasing interest for the treatment and showing the innovative solutions developed in the last few years.

Modelling of shot peening was another successful session. It is interesting to underline that until a few years ago, the simulations were done mainly to assess the final residual stress state. Now there is a great effort devoted to more comprehensive simulations that can assess the final surface finishing and the microstructural modifications after shot peening.

Finally, there were sessions dedicated to other peening processes. The session dedicated to characterization of shot peening showed alternative ways to peen materials, such as cavitation peening or acoustic peening, that can be used in special applications. New methods for a more accurate characterization of the treatment were presented.

The Student Best Paper Award, managed by Dr. Sara Bagherifard with a Jury Panel, has been assigned to Ivan

Bogachev (University Cambridge, UK) for his presentation entitled "Shot peening and deep rolling of a single crystal nickel superalloy" (1st place); Jan Kaufman (CTU Prague, Czech Republic) for the presentation on "Laser Shock Peening to enhance stress corrosion cracking and corrosion fatigue resistance in marine aluminium alloys" (2nd); and to Maxime Paques (Ecole Polytechnique Montreal, Canada) for the presentation on "Control of the vibratory peening machine using the Almen intensity procedure" (3rd). Congratulations to the three of them!

The ICSP14 delegates also appreciated a very active social program. On Sunday evening, a welcome reception was organized in the garden of the historical campus at Politecnico, giving people the chance for meeting again after so many years and networking with new friends. The Gala Dinner was hosted at Triennale Milano, a permanent centre for design expositions, with an amazing view of the park. The honorary member of the International Scientific Committee on Shot Peening, Dr. Abbas Niku-Lari, recalled during the dinner the history of this series of conferences, from the first meeting in Las Vegas to ICSP14, while the guests enjoyed a taste of delicious Italian food and wine.

The cultural visit at Museo Novecento, in downtown Milan, allowed the delegates to admire many masterpiece paintings and sculptures by artists of the 20th century.

Finally, during the conference, the meeting of the International Scientific Committee on Shot Peening (ISCSP) agreed that Delphine Retraint, David Bahr, and Yuji Sano should be accepted as new members. In addition, the group evaluated the proposals for hosting the ICSP15 in 2025. The winner was the University of Purdue (USA) and the group led by Professor David Bahr.

Congratulations to the new members of the ISCSP and to Professor Bahr and his team!

Looking forward to meeting you at ICSP15 in 2025!

Dr. Abbas Niku-Lari, ISCSP Honorary Life Member and 2003 Shot Peener of the Year, recalls how the concept for the conferences started in 1980 when he convened a meeting in Las Vegas, Nevada USA to organize the first International Conference on Shot Peening in Paris.

Purdue University Chosen as ICSP15 Venue

Purdue University's School of Materials Engineering (MSE), located in Lafayette, Indiana USA, was chosen to be the 2025 host for the 15th International Conference on Shot Peening (ICSP15).

Purdue has many qualifications for hosting the event, including:

- Infrastructure for meetings, classrooms, and lodging in place (the university manages 500+ conferences per year with 100-2500 people)
- MSE faculty conducts $20 million of research annually in metals, ceramics, polymers, composites, coatings and more
- MSE is home to the Center for Surface Engineering & Enhancement (CSEE)
- CSEE encompasses Doctoral, PhD theses, graduate and undergraduate work in shot peening
- Many area shot peening companies will be available for industrial expositions
- Dedicated staff to manage conference logistics

The conference management team is as follows:

Chairman: Professor David Bahr

- BS & MS (Purdue), PhD Materials Engineering at University of Minnesota
- Professor and Head of MSE at Purdue (nine years)
- Professor of MSE at Washington State University (15 years)

Vice-Chairman: Professor David Johnson

- BS, MS and PhD Metallurgical Engineering at University of Tennessee
- Purdue Associate Professor of MSE (23 years)
- Post Doctorate and Research Associate at Kyoto University (four years)

Vice-Chairman: Dr. Mark Gruninger

- BS, MS and PhD Ceramic Engineering at Rutgers University, MS Management at Purdue
- Managing Director Industrial Consortia at Purdue (four years)
- 25+ years of Industrial Management