Fall 2020
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# The Shot Peener

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

## The Impact of COVID-19 on Training

PLUS: MACHINE LEARNING AND SHOT PEENING | SENTENSO | TRIBAL KNOWLEDGE IN BLAST INDUSTRY | BACK TO BASICS



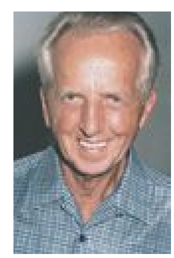


*A TUBACEX shot peening machine in their facility in Spain*



*sentenso offers process development services and sets up shot peening processes for their customers*







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

**OPENING SHOT**
*Jack Champaigne | Editor | The Shot Peener*

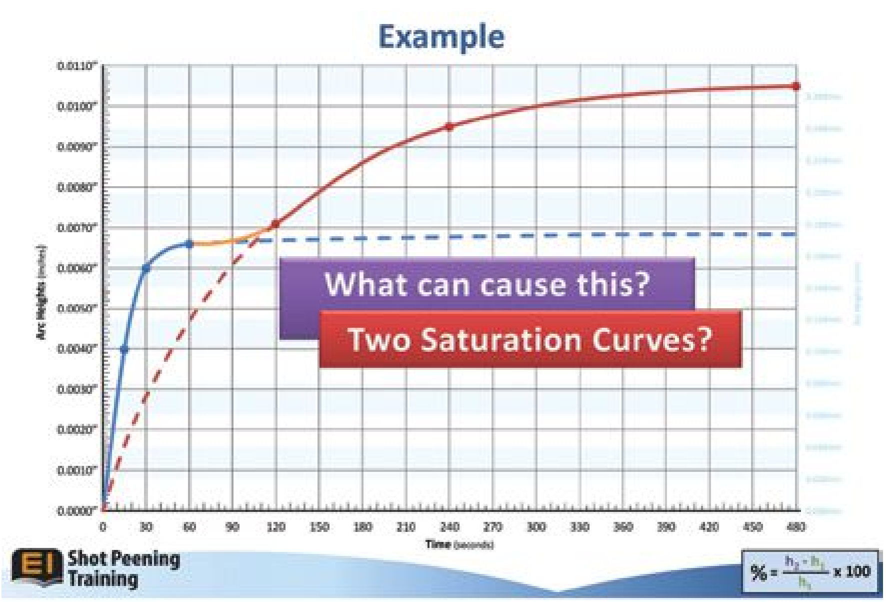
# Tribal Knowledge

**THANKS TO KUMAR BALAN** for sharing what he learned from "Tribal Lore." This prompted me to reflect on my own stories. On-the-job training is often the only introduction to peening practices for a new hire. Depending upon the skill level of the mentor, this could be okay but sometimes things can go wrong.

I remember an incident many years ago when I received a call for help from a new hire trying to get a higher peening intensity on a glass bead peening project. I went through all the normal metrics of media classification, nozzle size, blast hose wear, air pressure and media flow rates but just could not achieve the desired results. I was very frustrated that I could not figure out the problem. Records showed that the required intensity had been achieved for many years. Something drastic was wrong but what was it? Surprise. It was Pinocchio. None of the predecessors had been able to reach the intensity but not wanting to upset the quality system, they recorded false data. Someone forgot to tell the new hire. Sometimes tribal lore can be very dangerous.

I remember another incident that took several days to resolve. Peening intensity tests with saturation curves were exhibiting unusual profiles. The curve seemed to have two maximum levels. After several days of conversation, the caller asked, "Does our shot mix have anything to do with this?" I asked him to explain and learned that they would often throw in a bag of larger size media just before a test. This was to make up for the broken media that had accumulated in the cabinet. The graph below is from our training presentation that shows what happens with multiple media sizes. The smaller media, with more pieces per pound, dominated the early impacts. Eventually the smaller quantity of larger media would get a chance to make larger impacts thus pushing up the curve to a higher level. This was such a good lesson it became part of our curriculum in our training programs.

Speaking of training, don't miss Dave Barkley's article on how he is managing the EI Shot Peening Training program during the COVID-19 pandemic.

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*Kathy Levy | Associate Editor | The Shot Peener*

# The Impact of COVID-19 on Training

**EVERY 2020** workshop and seminar after February was cancelled due to the COVID-19 pandemic. Dave Barkley, Director of Training for Electronics Inc., shares how he manages EI's training program during these trying times in the following interview.

**The Shot Peener:** Describe the challenges of scheduling and re-scheduling workshops and seminars in 2020.

**Dave:** The biggest challenge was not knowing when this will be over, and where. I held on to dates for as long as I could hoping things would get better, but it kept dragging on. Hotels were accommodating; some more than others.

**The Shot Peener:** Are you conducting on-site training programs this year?

**Dave**: Yes, but the financial strain and lockdowns keep things mostly quiet. It's no secret that it's a difficult time for the aviation industry, and they make up the majority of our private trainings. Budgets are restricted and parked aircraft have led to reduced tech staffing. Normally, a reduction in staffing leads to training as those taking on new roles need to be properly trained in critical processes. This is where the lockdowns are slowing us down, which may be dangerous. A shop realizes they have need for our training, but facilities are preventing outside visitors. Then there is the problem with crossing borders. Some countries, as well as some states in the U.S., are requiring quarantine periods. In most cases I'm willing to do this, but companies aren't willing to pay for me to watch movies in a hotel for days before a training.

**The Shot Peener:** How do you organize on-site training sessions during the pandemic?

**Dave:** During private trainings, I follow the requirements outlined by my on-site contact. It is usually a commonsense approach such as maintaining a social distance and using hand sanitizer. If requested, I'll wear a face shield. It is also important to recognize and explain any action that might be misunderstood. For example, talking all day is hard on my voice, so I often take cough drops during the day to prevent my throat from drying out. Once a student reported that I was "seriously ill." Taking the cough drops and using copious amounts of hand sanitizer left him with that impression.

**The Shot Peener:** Do you take an alternative approach to training? For example, do you use Zoom video conferencing?

**Dave**: No. I'm not a fan of online training for many reasons. Mostly, because being on-site personalizes the training. It's beneficial having the training group on their shop floor and examining their own equipment. Often one of the group already has knowledge or experience with their process, and I enlist them to share relevant information to the group throughout the training. Everyone gets more information than what can come through a camera.

Then there's the value of personal interaction. Training sessions last only a couple days and being physically present allows me to gage the students' comprehension and react accordingly. If I notice someone isn't keeping up, I can give them individual help. I often ask another student that "gets it" to get involved which promotes teamwork. If most of the group is having a hard time with a topic, I can go over the material again from a different angle using scenarios based on their process.

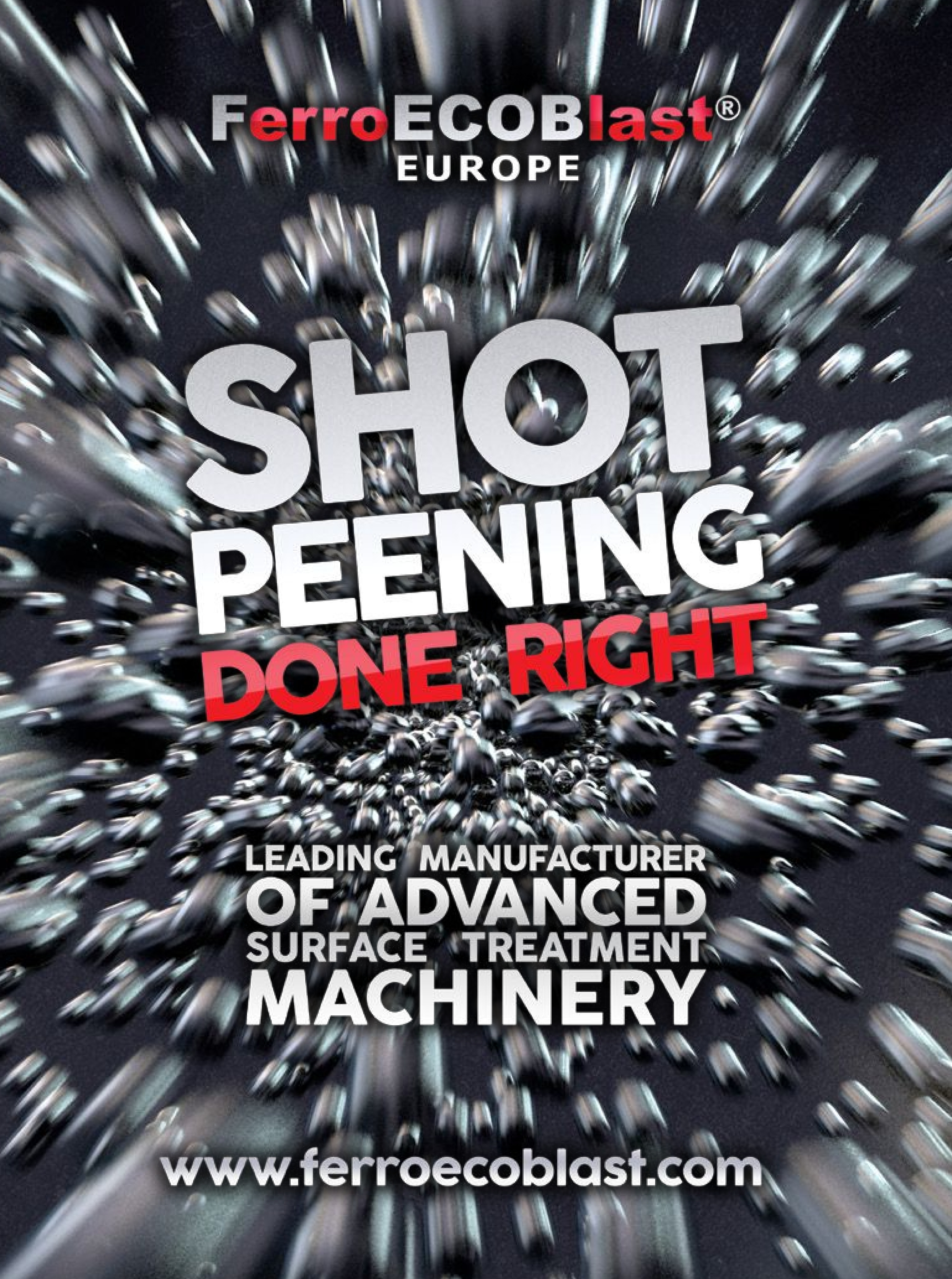
The last point I'll make concerns the quality of our certification. We train people in a critical process and an individual is expected to have a certain level of understanding when we're done. With the probability of a student using "exam aids" during online training, accurate evaluation and certification of an individual are not guaranteed. There are a few managers that only want a piece of paper stating their employee is qualified, regardless if they are or not. In-person testing maintains the integrity of our certification program.

**The Shot Peener:** When do you anticipate workshops and seminars to return?

**Dave**: When pandemic fears subside. Once things start getting back to normal, there will be a big need for training. With help from our training partners around the world, I'm scheduling our 2021 training events. It's still a fluid situation, so I suggest people visit shotpeeningtraining.com to keep up to date.

**The Shot Peener:** Thank you, Dave!

*Dave Barkley leads an on-site training class*



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# Machine Learning and Shot Peening: The Beginning of a Beautiful Friendship

*Ruth Gonzáleza[a], Diego Ferreñob[b], Isidro A. Carrascal[b], Federico Gutiérrez-Solanab[b]*

*[a]TUBACEX SERVICES, Spain*
*[b]LADICIM (Laboratory of Materials Science and Engineering), University of Cantabria, Spain*

*A recent research collaboration between TUBACEX and the University of Cantabria has revealed the potential benefits of implementing Machine Learning with Artificial Neural Networks for problem solving, know-how generation, and cost reduction in the metallurgic sector of shot-peened parts.*

## WHY SHOT PEENING?

TUBACEX is the second largest producer worldwide of seamless tubes in stainless steel and high-nickel alloys. It is one of the few companies that has integrated all production stages including steel manufacturing, hot extrusion and cold rolling of tubes. TUBACEX has industrial facilities in Spain, Austria, India, Thailand and the United States, and a network of commercial offices all over the world.

TUBACEX researchers have been working on the development of new stainless steel tubes for high added-value applications such as boilers for the so-called supercritical and ultra-supercritical thermal power plants. Shot peening the internal surface of these tubes has been identified as the key process for this application because of its ability to improve the mechanical and fatigue behavior as well as the oxidation resistance. These aspects are extremely important under in-service conditions. Two protective mechanisms develop after shot peening: first, a layer of steel with a thickness of hundreds of microns is plasticized, inducing compression stresses that delay or even remove the appearance of fatigue phenomena, and second, the high in-service temperature enhances chromium diffusion giving rise to a Chromium Oxide (Cr2O3) enriched layer on the inner surface of the shot-peened tube. This protective layer prevents the formation of iron oxides which tend to exfoliate. Figure 1 shows a picture obtained through Scanning Electron Microscopy (SEM) where the ~100 microns layer formed after shot peening can be appreciated.

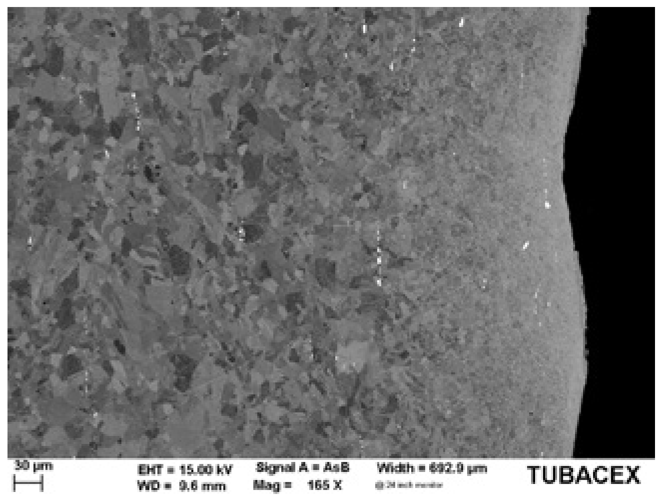


*Figure 1.*

Considering that the shot used in the process maintains its hardness, grade and size (which is guaranteed through the system of filters of the machine) over time, the outcome of shot peening depends on the four working parameters of the blasting machine, namely, the pressure, shot flow, line speed and rotation speed. A peened tube is accepted if the increase in hardness with respect to the initial hardness of the material (bulk) belongs to a certain interval, which was selected to avoid either underpeening or overpeening. It would be extremely advantageous to have some kind of procedure to estimate the correlation between the processing parameters and the final hardness of the material after peening, thus avoiding the use of resources and time-consuming destructive tests.

**Machine Learning**
Machine learning is the study of computer algorithms that improve automatically through experience. It is seen as a subset of Artificial Intelligence. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so. (Source: Wikipedia)

**Artificial Neural Network (ANN)**
Artificial Neural Network (ANN) is a group of algorithms that are used for machine learning. (Source: Wikipedia)

## THE QUALITY CONTROL OF SHOT-PEENED TUBES

Shot peening is, to some extent, a stochastic process. To ensure the homogenous quality of the final product, a destructive experimental characterization is needed. Thus,

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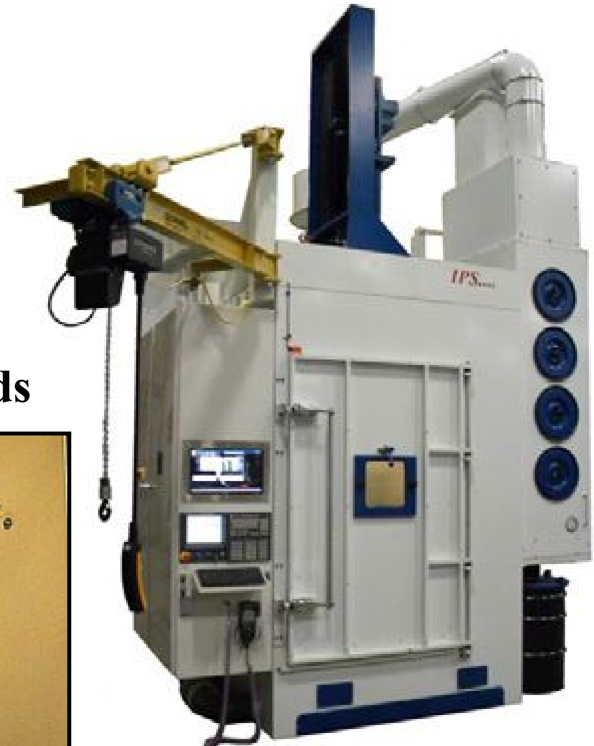

## High Performance for High Standards

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.


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small and randomly selected samples are taken from peened tubes and after a careful preparation, they are subjected to microhardness Vickers tests at a depth of 40 microns from the internal surface of the tube. The increase in hardness from the bulk (not peened) condition is considered as a proxy for the intensity of the shot peening. This process is expensive and time consuming and cannot be implemented online. Our research was aimed at developing a novel inspection device to ensure the full coverage of shot peening on the internal surface of the tubes, and validating a Machine Learning algorithm for the prediction of the microhardness of peened tubes as a function of the manufacturing parameters. Hereafter we will focus on the details of this algorithm.

## MACHINE LEARNING COMES INTO PLAY

Two research groups of the University of Cantabria in Spain—LADICIM (Laboratory of Science and Engineering of Materials) and GTI (Group of Information Technologies)—have successfully collaborated with TUBACEX to implement Machine Learning methods as a tool for decision-making during manufacturing. There are many references in the scientific literature that provide details about the local response of a material subjected to the impact of an individual shot as well as the interaction between impacts using statistical and numerical (Finite Element in particular) methods. The importance of this bottom-up approach to provide insight about the physical details of the process cannot be underestimated. However, the extrapolation to the actual fabrication conditions is far from clear. For this reason, our approach has been top-down. The idea is quite simple: a number of parameters are tuned during fabrication, namely, rotation speed, line speed, material flow, air pressure and nozzle size. In addition, the internal diameter of the tubes is also considered as a variable. Due to the intrinsic complexity of the process and the interactions between variables, it is difficult, if not impossible, to quantify the influence of each of these parameters on the final hardness of the tube. This is precisely the type of problem in which machine learning can bring enormous added value. The dataset collected by TUBACEX over the years, including the manufacturing parameters previously mentioned and the final hardness of the material, was employed for the training and testing of an Artificial Neural Network (ANN) to provide the mean and the standard deviation of the hardness for each of the combinations of input variables. This neural network was able to faithfully reproduce the experimental results and, as can be seen in Figure 2, there is a strong correlation between the experimental results and the predictions provided by the neural network.

Machine Learning with ANN seems to be a good and accurate alternative to predict process outputs, based on the inputs (process parameters).

## WHAT'S NEXT?

Nobody knows. Accenture, a global services and consulting company, foresees that current AI technology can boost business productivity by up to 40%. According to a recent survey by Deloitte, a multi-national professional services network, machine learning is reducing unplanned machinery downtime between 15-30%, increasing production throughput by 20%, reducing maintenance costs 30%, and delivering up to a 35% increase in quality. Our research is ongoing but the

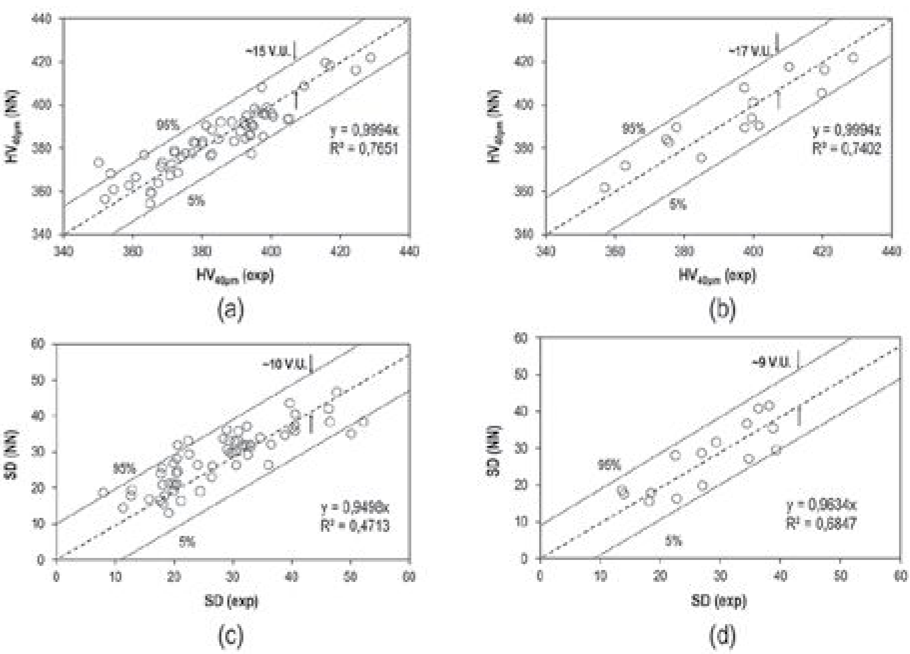
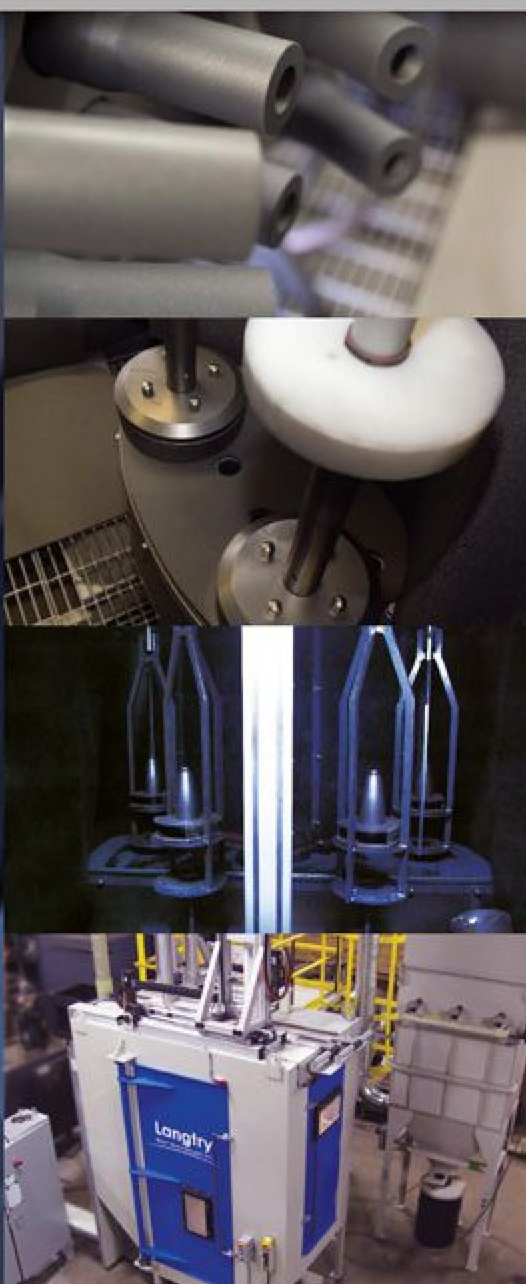



*Figure 2.*
*Comparison between experimental (X-axis) and ANN-predicted data (Y-axis).*
*(a) Mean values, training data set*
*(b) mean values, test data set*
*(c) standard deviation, training data set*
*(d) standard deviation, test data set*


POWER ON

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results are already promising. Now, TUBACEX has a tool to predict the final quality of the product in real time and to make decisions during fabrication in order to avoid underpeening or overpeening. Machine Learning provides countless possibilities that are now being explored. Once more, the collaboration between a company and a research group leads to a successful outcome.

**About TUBACEX**

TUBACEX SA manufactures exclusively seamless stainless steel and nickel alloy tubes and pipes.

The company has its own industrial facilities in Spain, Austria, the USA, Italy, India, Thailand, Saudi Arabia, Norway and UAE; a global distribution network; as well as sales offices located around the world.

The main demand segments for the tubes manufactured by TUBACEX are the Oil & Gas, Powergen and Petrochemical industries, among other industries.

TUBACEX SERVICES is the business unit of the Group devoted to service and customized solutions applied to steel products. TUBACEX SERVICES provide complete project management improving organizational efficiency working in collaboration with key industry stakeholders, cultivating win-win relationships.

One of the main activities of TUBACEX SERVICES is shot pening, applied inside stainless steel tubes. Our experience and know-how assure a complete control on the process and results, always satisfying customer specifications and requests.

*This is one of the shot peening machines in the TUBACEX SERVICES facility located in Spain. These seamless stainless steel tubes are specially designed to be used in industrial processes where high temperature, pressure and corrosion conditions take place. Some of these tubes are shot peened and used in industries where those conditions cause a major impact.*

# sentenso

## *From Equipment Supplier to System Engineering Provider*

**SINCE 2009,** sentenso in Datteln, Germany has provided intelligent and innovative tools for process and quality management in shot peening. With the ongoing digitalization in industry, plus increasing complexity and growing demands at the same time, the company is rapidly developing from an equipment supplier to a system engineering provider with strong R&D activities.

The sentenso team has two engineers; one physicist; four technicians for product design, electrical control systems and programming; one quality inspector; and three employees for marketing, sales and administration. sentenso's founder and manager Volker Schneidau describes the company this way: "Our evolution is the consequence of challenges that customers brought up. For our development it has always been crucial that we do not just resell products from a limited range. Our customers expect advanced services such as product support, calibration and repair. Moreover we need to introduce and develop new equipment that fulfills extended technical requirements. Finally we are facing growing demands in automation and digitalization for smart peening solutions."

*Volker Schneidau, Founder and Manager of sentenso*

The basis for all this is sentenso's process know-how that was developed over time. Volker Schneidau himself is looking back at more than twenty years of experience in shot peening. Starting as product designer at Schlick resp. Wheelabrator, the mechanical engineer left the company as sales manager for wheelblast machines in 2006. In 2007, he started his engineering firm, strahlportal, which is still active today.

In the summer of 2019, the sentenso team celebrated 10 successful years of sustainable work in shot peening with their best business partners who supported a remarkable donation to SOS Kinderdörfer for worldwide projects in children's education. "Education and sustainable development are the keys to progress in the whole world, we just follow the same principles in our company," says Volker.

With sentenso's commitment to excellence in shot peening, the young team of engineers, technicians, marketing and sales will carry on to improve their products and services. So product development, automation and digitalization in blast cleaning and shot peening processes are in sentenso's focus for the next 10 years.

*Wolfgang Hennig*

In fall 2019, sentenso strengthened its competence in shot peening process development and training when Wolfgang Hennig joined in. Wolfgang has been engaged in surface enhancement for aircraft landing gears and engines for almost 30 years. He is well known in national and international peening circles like the ISPC and his innovative ideas led to several patents. Before coming to sentenso he was the shot peening process owner from Rolls-Royce worldwide. Wolfgang said, "I am excited about the open atmosphere to develop shot peening solutions in the motivated sentenso team." The other main part of his activities is shot peening training which he started in 2005 for MFN. Wolfgang will further develop training concepts and contents for sentenso in close co-operation with Electronics Inc. Shot Peening Training.

The sentenso shot peening portfolio is divided into products and services for **Process Management** on one side and for **Quality Management** on the other side.

### PROCESS MANAGEMENT

The Process Management takes care of clearly defined and reproducible peening operations. To achieve this it has to be clear which parameters have to be controlled by suitable actuators and sensors, how the machine and alternative equipment should operate, and how the process itself should be designed.

**Process Technology**

In peening machines, the process is mainly controlled by combination of actuators and sensors for air pressure or wheel speed and media flow rate. sentenso provides MagnaValves for steel media but has also developed flow sensors for any kind of media. The capacitive FlowScout sensor measures the flow rate in free-fall condition whereas the microwave-based FlowScale/FlowGrade sensor can be used in the media flow path.

However, the flow rate control system can only work as well as the precision of its adjustment procedure. Changing media properties over the time and contamination can falsify flow rate measurement and control. Furthermore, a flow rate check by complete and continuous detection of the media emerging from the nozzle is useful. Such flow rate charac-

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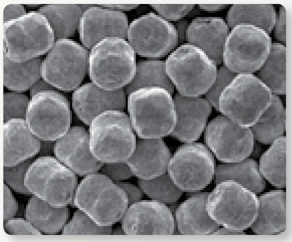
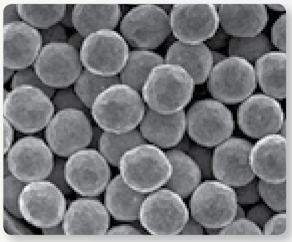
- **Improved Part Life** Parts exhibit higher and more consistent life than those peened with equivalent size and hardness cast steel shot.
- **Substantial Cost Savings** The increase in useful life of Premier Cut Wire Shot results in savings in media consumption and reclamation, dust removal and containment, surface contamination and equipment maintenance.

As Cut



Normal Conditioning



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*The patented flux:on Media Flow Management system*


*The new RotoFlapMaster from sentenso*

teristics can be used for a calibration, but possibly also for a readjustment of the control system. The patented flux:on Media Flow Management (U.S. patent No. US 10,513,010 B2) provides a fully automated system for this purpose which can be integrated into the peening machine.

### Machine Technology

sentenso offers engineering support on special machine components which need to be redesigned or optimized. The company can also build and deliver components such as part fixtures, Almen fixtures, drives or robots for the suitable movement of parts and nozzles, as well as peening equipment with pressure pot and fully controlled media flow management.

### Special Processes

One important alternative for mechanical surface enhancement is Rotary Flap Peening. The process is not only used for repair purposes on aircraft but can also be applied for small spot repair for minor damages like scratches in part production. The available tools in place did not fully satisfy the customers' requirements, so sentenso decided to develop their own tool. The new RotoFlapMaster provides compact design, speed control, various setting options and, above all, a fully mobile use by its long-lasting battery.

### Process Development

Process development is an engineering service that sentenso offers to customers to setup their peening processes. Very often when new parts have to be peened, the time and available machines to run saturation curves, coverage development and tests is not sufficient. sentenso and its partner strahlportal own a wide range of testing machines for air and wheel peening with PLC control and visualization of all peening parameters as well as motion control of parts and nozzles with automized drives and robots. Additionally sentenso has aerospace customers for which processes need to be developed on machines at their own site. Nozzle design and optimization is one other feature of the advanced services. In any case customers receive full documentation of their process with all required quality parameters from media properties up to residual stress.

## QUALITY MANAGEMENT

The Quality Management in shot peening takes care of the inspection of peened parts but also covers the provision of proper peening media, reliable condition and calibration of sensors and measurement equipment, as well as education and training—if possible with practical exercises.

### Quality Control

sentenso's portfolio in quality control equipment for shot peening covers all related parameters such as media properties, intensity and coverage, as well as hardness, surface topography and residual stress. sentenso has composed special kits such as the Intensity Kit and the Coverage Kit to provide ease of use of measurement and inspection equipment.

A special tool that sentenso provides is the μ-X360s X-ray stress analyzer from Pulstec in Japan. This unique device introduced an area detector for recording diffraction rings (Debye-Scherrer) and for evaluation of residual stresses using the cos-alpha method that now allows for mobile, user-friendly and extremely fast measurements of typically less than one minute on shot-peened steel surfaces.

sentenso puts special emphasis on the automation of measurements, using various small robot types such as from KUKA or Universal Robots. The automation provides batch measurements and stress mappings with visualization of results. The system can easily be integrated into production environments.


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*The µ-X360s X-ray stress analyzer from Pulstec in Japan*

**Operational Supplies**

If needed, sentenso provides peening media and additives according to customers' requirements. sentenso helps to define the suitable media characteristics and performs media testing with the Ervin tester but also more realistic test procedures in its own airblast media testing machine.

**Services**

Since the beginning sentenso has performed calibrations for MagnaValves and Almen Gages to make sure that these devices operate according to specifications. All calibrations of MagnaValves and flow sensors are performed in Datteln prior to shipment. In most cases machine OEMs and peening facilities provide the operating media mix of their machines to achieve the best possible accuracies.

The determination of residual stresses is one new service that was started after a long period of training and practice. sentenso's engineer Jörg Behler has developed measurement procedures to receive best possible results for various materials and surface conditions, using a robot and a software tool of his own development. One special feature of the service is a precise depth determination by 3D measurement of the electropolished holes for residual stress profiles.

**Training**

Volker Schneidau and his team have been very active in shot peening training in the past years. These events are performed as customized onsite trainings or in sentenso's facilities in Datteln. As an education partner with Electronics Inc., sentenso developed a specific workshop with an additional practical training and exercises performed on real peening machines. This unique emphasis of shot peening practice led to growing numbers of students from Germany and Europe. sentenso is now offering two Workshops per year with Level 1, 2 and 3 and rotary flap peening; one of these in German and English language.

Alternatively to the workshop program, experienced students can book recertification courses with concentrated content at reduced time and cost.

## FIRST EAST EUROPE WORKSHOP

sentenso is now expanding training activities to eastern Europe where a growing need of education can be seen. Together with EI and the media manufacturer KrampeHarex, a three-day workshop with practical training will take place in the Czech Republic in March 2021.

## SMART PEENING

When looking into the near future it is obvious that more data will be needed to meet the challenges of a fully digitalized production process. For shot peening this requires the collection of all relevant machine, process and quality parameters as well as other machine-related data in real time to allow for:

- Records of the shot peening process to enable complete traceability of peened components (traceability)
- Investigation into technical relationships between machine parameter stability and peening results (cause and effect chain analysis)
- Recognition of required maintenance (predictive maintenance)

This data will also support lean peening concepts with reduced energy consumption which is getting more and more relevant with the growing problems of global heating.

However, there is still a lack of consistent use of these technologies and their implementation in intelligent control systems. With the utilization of the available data, blast cleaning and shot peening processes or programs could be made much more adaptive and flexible. A greater diversity and individualization of the surface properties would be possible, even down to only one single manufactured custom part. The quality of each single part would still be completely documented by its digital twin.

sentenso is working to provide further technologies for process and quality management in shot peening for the realization of smart peening concepts for the 4th industrial revolution in progress.

**Contact Information**

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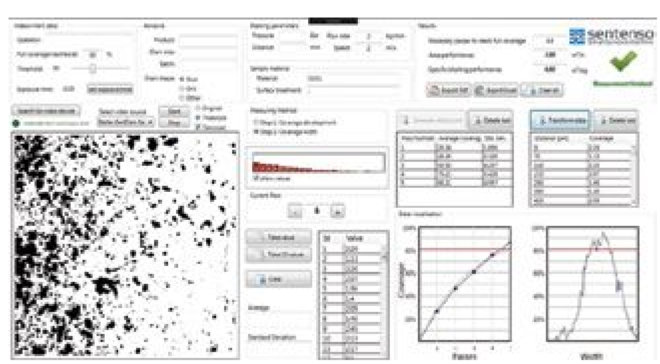
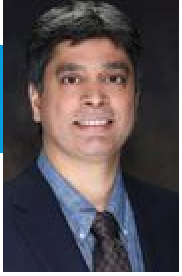



*sentenso's camera-based tool for coverage determination*



AN INSIDER'S PERSPECTIVE

*Kumar Balan | Blast Cleaning and Shot Peening Specialist*

# Tribal Knowledge in the Blast Industry

**Part One of Two Parts**

## INTRODUCTION

The online Business Dictionary defines Tribal Knowledge as "A set of unwritten rules or information known by a group of individuals within an organization, but not common to others, that often contributes significantly to overall quality." Sound familiar? How often have you remarked, "it makes no sense, it defies all laws of physics, but it seems to work?!" That was one of the effects of tribal knowledge being applied. I distinctly remember my introduction to this phenomenon about three decades ago during my first job as a Trainee Engineer at Wheelabrator in India. Within the first few hours of staring blankly at a drawing board (yes, machines were designed even before ACAD and Inventor), I realized that there was more I had to learn from experienced draftsmen than accumulated through four years of university education!

The journey since then has been remarkably interesting. I have had the fortune of working with some of the best designers, sales and applications professionals in the blast industry, all of whom are difficult to come by now. These fine folks gave me the opportunity to learn what I know today. More importantly, this type of information could never have been found in any relevant technical publication, other than possibly company-specific engineering handbooks. Though I doubt that ours is the only industry with this unique feature, I suspect and hope the lack of replenishment is not as endemic in others. Retirements, retrenchment, and unfortunate demises too have affected this knowledge bank in our industry. It is also not reasonable to expect new talent to come up to speed and catch up on a technical level, assuming this talent chooses to show interest and sustenance in the product and process.

I can hardly expect to capture this tribal knowledge within the word count restrictions of this article, but I do hope to give you a flavor of what is involved. In this journey, I spoke to four of my colleagues, all of whom are retired from the industry, to gather information for this article. Interestingly, I found their eager responses to not just fill the gap about tribal knowledge, but also to provide insights into the origin of some established practices in the industry. The first and foremost topic that came up in all four discussions was pertaining to media velocity. Let us start with that.

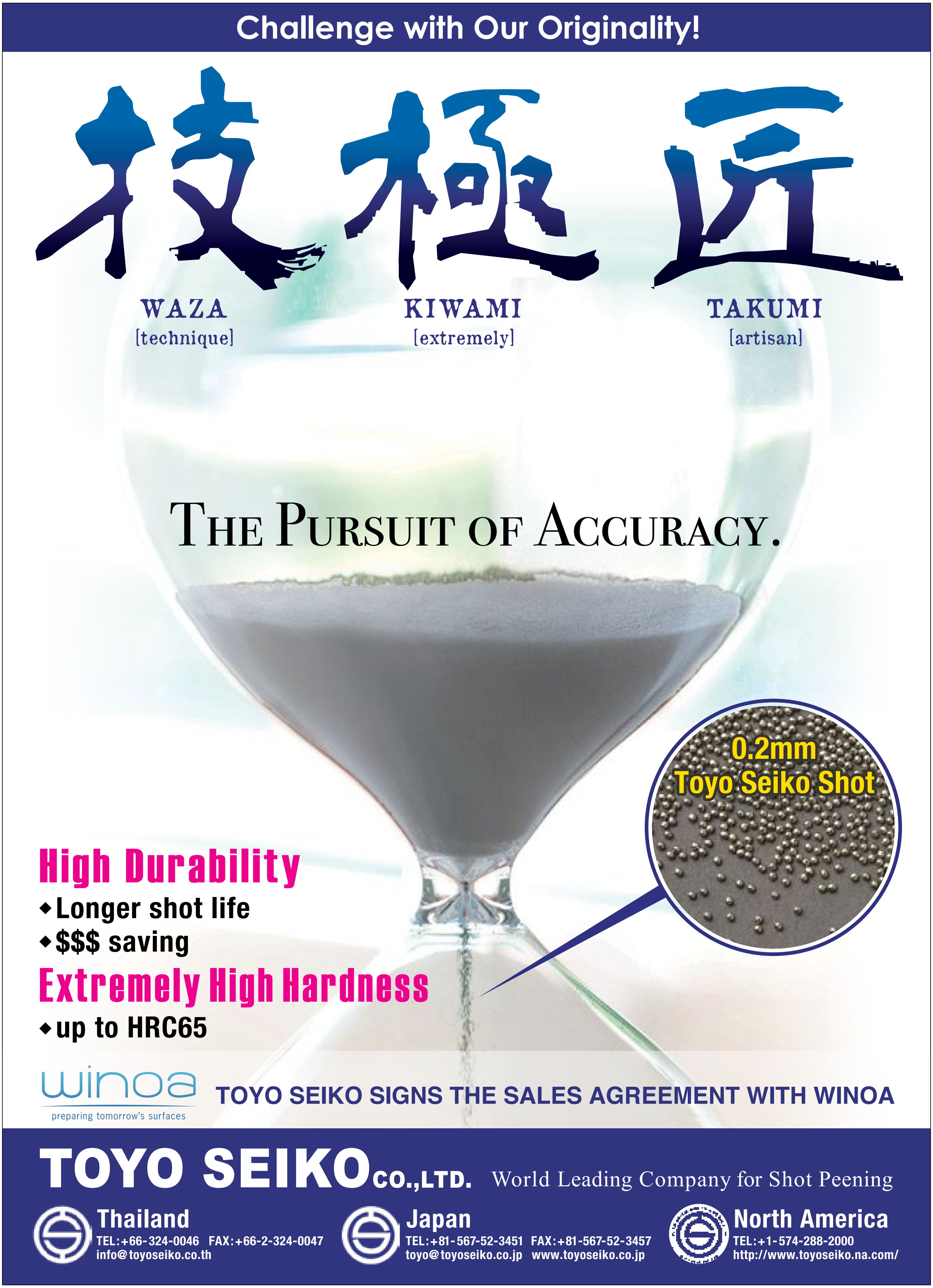
### 240 Feet Per second

Jay Benito and I worked together at Pangborn and Wheelabrator, from where he retired almost a decade ago. During one of my customer visits with Jay, he was effortlessly bombarding wheel velocity values at the customer while dazzling him and puzzling me with the delivery! Jay explained, "Velocity keeps our spare parts and shot business going." He taught me an easy-to-remember approximation to calculate velocity in feet per second as diameter of wheel in inches x speed in rpm/180. His favorite calculation phrase involved an 18" diameter wheel that when spinning at 3000 RPM will generate a velocity of 300 feet per second, to which he added, "This is about 60 feet per second more than anyone ever needs!"

Bill Rhodaberger retired from Ervin Industries as their VP Sales & Marketing. With Bill's assistance, I first experienced the fascinating science and technology that underlines shot manufacture. He invited me to Ervin's shot plant in Adrian, Michigan where I witnessed their 40T furnace pouring molten metal and multiple nozzles spraying cold water to atomize the metal into shot particles. Bill said, "Good quality shot is like fuel for your car—the best of blast machines will suffer in performance with bad shot." To emphasize the importance of velocity in the process, Bill took me to the Ervin labs in Adrian and Tecumseh, Michigan to demonstrate the Ervin Test Machine—an industry standard in testing media durability. This machine propels shot in a controlled atmosphere with the flexibility of varying shot velocity to study durability under such conditions. He explained that velocity had a direct bearing on media durability, and exacerbated if media chemistry and physical characteristics fail to meet SAE J827 requirements.

*So, what is the magic behind 240 feet per second?*

Bill Raby and I also worked together at Pangborn and Wheelabrator. A well-respected authority in foundry applications, Bill spent over 40 years in the industry prior to his retirement last year. He noted, "The one big difference in the industry now versus when I started is the blast velocity. Standard blast wheels had V-belt drives, and in North America, most blast wheel motors were 1800 rpm. Wheel diameters were 18", 19.5" or 21" and the required velocity was achieved by selecting the proper sheave diameters for motor shaft and blast wheel spindle assembly (unit bearing). For example, a 19.5" diameter wheel would have a sheave ratio that raised the speed from 1800 rpm at the motor to about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2250 rpm at the blast wheel. Operating a 19.5" wheel at 2250 rpm produced a shot velocity of about 240 fps which was satisfactory for most scale and sand removal requirements."

It seems like things simply fell into place with this magic value of 240. Availability of wheel diameter, sheaves and motor ratings all played a role in arriving at this velocity figure. To top that, the suitability of this velocity for most applications made it the standard. Who can argue with that? We can, we will, and we did!

Ron Barrier and I worked together at Wheelabrator until his retirement a few years ago. In Ron's role as the Demonstration Manager, he has helped customers over multiple decades by simulating their processes with test machines in LaGrange, Georgia. Ron used to live and breathe blast machines and was known to regularly set off metal detectors at Atlanta's Hartsfield International Airport due to the presence of fugitive shot in his hair when he took a plane right after a customer demo! "Everything since 1974 has been about shot velocity and blast wheels—240 to 250 feet per second was good for everyone, until someone decided that high-speed wheels were needed to address demands of high production," he said.

Let us pause for a second here to evaluate Ron's statement. Does high velocity necessarily translate to increased (faster) production? Like Ron, most of us will beg to differ. Though increased ***shot flow*** will lead to higher production rates, even that is not always true, particularly when working with parts that have intricate geometries, holes, cavities, etc. There are applications that benefit from high velocities, but those are exceptions.

Ron continues, "High shot velocities bring with them the issue of shot breakage, dust and fines generation. There is always a price to pay, and the net worth of high velocity and production over machine maintenance and operating costs is debatable. If you like to drive a Corvette, don't complain about the operating cost!"

**The History for High Velocity**

Providing more insight into this, Bill Raby adds, "For more difficult cleaning requirements, increasing the sheave ratio produced higher wheel speed and greater media velocity. Operating a 19.5" blast wheel at 2700 rpm yielded media velocity close to 290 fps. Similar sheave ratio selection for media velocity was applied to lower HP, smaller diameter blast wheels used on smaller tumble blasts, rotary table machines and spinner hangers. These 13", 14" and 15" diameter wheels had 3600 rpm motors and sheaves sized for operating at 2700 to 3500 rpm for roughly the same 240 to 290 fps blast media velocity range as the larger diameter, higher HP wheels."

Tumblasts continue to be one of the most popular machines, closely followed by rotary tables and spinner hangers. All three machine types are commonly seen in peening applications just as for cleaning castings in foundries. Some of the largest landing gear in the industry are shot peened in spinner hanger type machines and on tables prior to hangers gaining popularity. In addition to cleaning tenacious contaminants in foundries, velocity is essential to be controlled in peening applications which could also explain the popularity of variable speed drives for wheel motors.

Ron Barrier urged me to not forget the "Reeves Drive" that was commonly used to vary the wheel speed, particularly in automotive peening applications where peening first started.

Over the years, the drive arrangements for such wheels got simplified with the advent of the direct drive wheel. Though they started off by being used primarily for special requirements, they are now ubiquitous in presence in common applications.

By the late 80s and early 90s, direct drive was gradually becoming the standard for most North American suppliers. Wheel assemblies of 1800 and 3600 rpm were developed and by the mid to late 90s, machines in many high production foundry and steel descaling requirements were being supplied with direct driven wheels. Wheels with 15" diameter produced 300 fps media velocity. Fast and effective cleaning was rarely a problem for these 15" wheels. In the early years of the new millennium, the latest generation of 3600 rpm blast wheels grew larger with 16", 17" and 18" diameters producing media velocities ranging from 320 to 360 fps.

**Is High Velocity Essential?**

A recent visit to an airblast installation revealed another aspect of shot velocity that I had understood differently until then. Upon talking to the operator, I learnt that his productivity was greatly enhanced when cranking up the pressure to 120 PSI, and here I was, advocating that higher velocity was wasteful unless required for specific reasons. I enquired with this operator further on the type of parts he was processing and other influential process parameters such as media size, type, target angle, nozzle design, etc. His response was clear and likely synonymous with at least 80% of such shops. He was faced with such a variety of part styles and degrees of contamination that he did not see the value in taking the time to experiment whether a lower velocity would also give him the same cleaning efficiency.

While we are debating 240 feet per second, consider a wide throat long venturi nozzle blasting at 80 psi. This nozzle will generate a velocity of close to 400 feet per second, taking us farther away from answering our question—is high velocity essential?

For cleaning, the simple answer is negative. For shot peening, there are several applications where high intensity requirements will demand high shot velocities. Shot peening mining bits, truck transmission, railway wheels and parts for the Oil & Gas industry require intensity measurements using C strips, typically greater than 6C, all the way to 15C. Such intensities, in addition to larger-sized shot (S550 and S660), will require velocities as high as 500 feet per second. Such velocities can only be generated using a blast nozzle at pressures close to 90 psi. Velocity and its measurement will continue to play a critical role in controlled shot peening of components, particularly in Aerospace. In "Visions of the Future" (*The Shot Peener*, Winter 2016), Jim Whalen of Progressive Surface commented that their ShotMeter G3 Particle Velocity Sensor was gaining in popularity as customers were interested in a direct approach to velocity scanning as opposed to solely relying on downstream verifications of intensity. Velocity monitoring and measurement will continue to gain importance.

**The Evolution of Shot Peening**

The velocity discussion is indeed profound and one could go on for hours. But my respondents had other interesting stories also to share! "During the 70s, it was common to say that peening was more of an art than a science," says Bill Rhodaberger when talking about its evolution. "North America had two distinct markets, Aerospace and 'everyone else.' A common belief was that the 'everyone else' group viewed shot peening as an added insurance factor whereas the aviation industry used peening as a design tool to ensure performance of the part. It was a real challenge in the *go-go* days of the auto business to have them adopt the aviation attitude towards process controls of shot peening. In too many cases, shot peening outside of aviation was a mixed bag of going through the motions versus process control. Production was more important."

Ron Barrier of Wheelabrator adds that without an experienced engineer in charge of peening, he was often met with the "1000-yard-stare" look when he explained shot peening to them in the 70s, let alone process control. We have certainly come a long way since then. Training has been formalized, equipment design has become more versatile and more industries are taking an active interest in the benefits of the process. Bill reminded me of an anecdote about the college intern of an auto supplier who pounded used Almen strips to flatten and re-use them in order to impress his supervisor with his money-saving tactic on strips! Such incidences have not been reported since!

**Not a Conclusion, a Continuation**

When I started writing this, I thought I was going to list the tips that my retired colleagues gave me, all in one article, but it turned out to be more than that. But then, one must know where we came from to know where we are headed! Therefore, this is not a conclusion. My colleagues have talked about several other aspects of blast cleaning and peening that I think deserve a sequel to this article! In the next issue, we will discuss topics related to blast patterns affected by shot size, media breakdown rate rules of thumb, a special section on tumblast techniques, targeting blast wheels, fixturing, and shot maintenance.

**INSIGHTS**

Mike Hockett | Managing Editor of *Industrial Distribution*

## Siemens Announces Remote Work as Permanent Fixture for 140,000 Employees


*The Siemens logo on a door of the Siemens headquarters in central Munich. Siemens is the largest engineering company in Europe.*

**SIEMENS**, the Germany-based manufacturing conglomerate, announced in July that it is establishing remote working as a key part of its "new normal," making it a permanent component of the company's employee operations.

The provider of intelligent infrastructure for buildings and energy distribution systems said it will implement a system for its global workforce to be able to work remotely two or three days per week on average. The new work model applies to over 140,000 of Siemens' employees, spread across 125 locations in 43 countries. The company has about 385,000 employees in total. "The coronavirus crisis and social distancing measures have shown that working independently of a fixed location offers many advantages and is possible on a much wider scale than originally thought," Siemens said in a press release, adding that a global employee survey confirmed their desire for more flexibility as for where they work.

Siemens said employees taking part in the new working model consult with their supervisors when choosing the work locations where they are most productive. The system will account for local legal requirements, the needs of specific jobs, and individual preferences.

The company said it has enabled 300,000 employees to work from home during the COVID-19 pandemic, and that they've been able to effectively collaborate and hold over 800,000 online meetings per day — all while being in different locations. Siemens also noted that the change will coincide with a different leadership style that prioritizes outcomes rather than on time spent at the office.

While many large corporations have encouraged and instituted temporary working from home procedures amid the pandemic, Siemens is one of the first to make it a permanent fixture. (Source: www.thomasnet.com)

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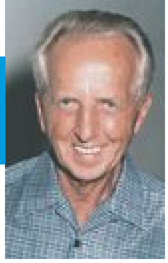


**ACADEMIC STUDY**

*Dr. David Kirk | Coventry University*


# Back to Basics: Dent Formation and Coverage

## INTRODUCTION

The aim of this mini-series is to cover the basic scientific principles of shot peening. Fundamental principles are presented together with relevant theoretical explanations. You do not need to understand the mathematics—they are only needed to justify the ways in which quantification and prediction can be achieved.

A necessary feature of shot peening is that dents are produced on the surface of the component. It is these dents that induce the beneficial effects of surface work-hardening and compressive residual stress to form the "magic skin." This article deals only with dent formation and coverage, leaving these beneficial effects of dents for later articles.

Dent formation requires work being done. A very important scientific principle is that energy is indestructible—it can only be transferred. In our case we have the kinetic energy of a flying shot particle available to carry out the work needed to create a dent. During dent formation two types of kinetic energy transfer are involved: plastic and elastic.

Kinetic energy and work energy are identical in terms of units. Every impacting shot particle has a kinetic energy—$\mathbf{½Mv^2}$ where **M** is mass and **v** is velocity. Work done is force times distance so that its units are **Nm** where **N** is force and **m** is distance. Mass can also be expressed as **kg** and **v** as $\mathbf{ms^{-1}}$ so that $\underline{\mathbf{Mv^2}}$ becomes $\mathbf{kgm^2s^{-2}}$. One Newton, **N**, can also be expressed as $\mathbf{kgms^{-2}}$ so that $\underline{\mathbf{Nm}}$ becomes $\underline{\mathbf{kgm^2s^{-2}}}$—the same as $\underline{\mathbf{Mv^2}}$.

Shot peening induces vast numbers of dents. These dents give us progressive coverage. The greater the number of dents per unit area the greater will be the coverage. Because coverage is a specified requirement it has been thoroughly analyzed. This article includes a summarized version of the relevant theoretical explanations of coverage evolution.

## DENT FORMATION

### PLASTIC AND ELASTIC ENERGY TRANSFER

Imagine dropping a tennis ball onto a steel plate. The ball will rebound but not to the same height indicating a loss of kinetic energy. No dent is formed so that all of the kinetic energy loss has been elastic. A steel ball bearing dropped from a height of several meters will also rebound but will form a dent. Kinetic energy loss is now a mixture of plastic and elastic energy transfer. The higher the ratio of plastic to elastic energy transfer the greater is the efficiency of kinetic energy usage.

### DENT DIAMETER

The controllable variables that influence indent diameter are well-known to shot peeners. For a given type of shot they are shot diameter, shot velocity and component hardness. These variables influence three interrelated factors: the volume of the indent, **V**, the amount of work done by the shot particle, **W**, and the amount of work, **B**, that has to be done to create each unit of indent volume. A simple equation connects the three variables:

$$\mathbf{V = W/B} \tag{1}$$

As a "hole digging" example for equation (1), if **W** represents 80 man-hours of digging work and **B** represents a situation where 10 man-hours of work are needed to create 1 cubic metre of hole, then 8 cubic metres of hole are created.

### DENT VOLUME, V

Shot particles are almost spherical so that dent shape is close to what mathematicians call a "spherical cap". The volume of a spherical cap, see fig. 1 on page 30, can be represented by the following equation:

$$\mathbf{V = \pi d^4/32D} \tag{2}$$

### WORK, W, DONE IN CREATING DENT

A flying shot particle has a kinetic energy, E, given by the expression E = ½$Mv^2$ where M is the mass of the particle and v is its velocity. The mass of a sphere is its volume, $D^2\pi/6$ multiplied by its density, ρ. Hence:

$$\mathbf{M = D^2 .\pi. \rho./6} \tag{3}$$

Therefore:

$$\mathbf{E = D^2 .\pi.\rho.v^2/12} \tag{4}$$

After the shot particle has struck the component it bounces off at a lower velocity thereby losing some of its kinetic energy. The proportion, P, of energy lost is the work, W, done in creating the dent. W is therefore given by W = P.E.

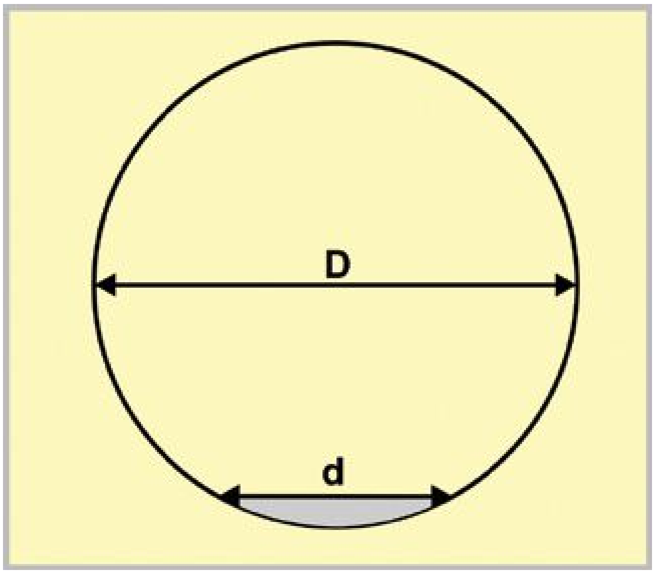


*Fig. 1. Indent of diameter d, created by sphere of diameter D.*

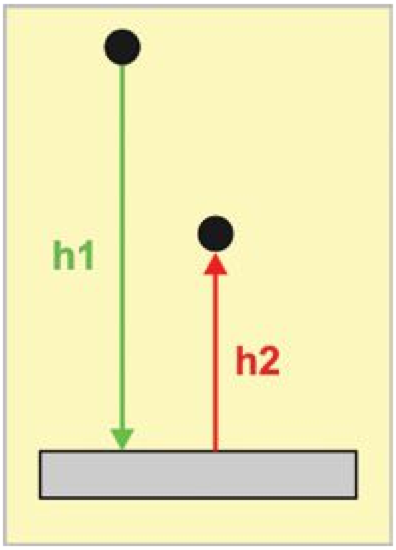


*Fig. 2. Ball dropped from height h1 and then rebounding to height h2.*

The proportion of energy lost varies with the hardness of the component. If the component was made of modelling clay it would not rebound at all! A very simple experiment to find a value for P is illustrated in fig. 2. A ball bearing is dropped from a known height, $h_1$, onto a metal plate. The rebound height, $h_2$, is measured using a rule held vertically and monitored using the video function of a smartphone. P is then given by:

$$\mathbf{P = (1 - h_2/h_1)} \qquad (5)$$

If $h_2 = h_1$ then $h_2/h_1 = 1$ so that P = 0. This means that no kinetic energy has been lost at all—perfect elasticity. More realistically if $h_2/h_1 = ½$ then P = 0.5.

Knowing, or assuming, a value for P we can incorporate it into equation (4) to give that:

$$\mathbf{W = P.\, D^2 .\pi.\rho.v^2/12} \qquad (6)$$

**WORK DONE PER UNIT VOLUME OF INDENT, B**

The indent strength, B, is equivalent to the work done during a Brinell hardness test. Brinell hardness values are normally quoted in $kgf/mm^2$ but can be converted into MPa by multiplying by 9.8. A Brinell hardness value for mild steel of 200 $kgf/mm^2$ is equal to 1,960 MPa. The theoretical basis for assuming indent strength to be equal to the Brinell hardness value is described in a previous article (TSP, Spring, 2004, "Prediction and Control of Indent Diameter").

**EQUATION FOR PREDICTION OF INDENT DIAMETER**

Combining equations (1), (2) and (6) gives that:

$$\mathbf{d = 1.278D.P^{0.25}.\rho^{0.25}.v^{0.5}/B^{0.25}} \qquad (7)$$

Equation (7) is absolutely fundamental to shot peening control. Experienced shot peeners already know that the factors in the equation are important. Indent diameter does increase with shot diameter, shot density and particularly shot velocity but decreases as the hardness of the component increases—other factors being kept constant.

Science is based on a combination of theory and experimental verification. Experimental verification of equation (7) was presented in a previous article (TSP, Summer, 2004, "Actual and Predicted Shot Peening Indentations"). Fig. 3 illustrates one factor, velocity, that was investigated. A 2 mm weighted ball bearing was dropped from different heights onto mild steel. The diameters of the indentations produced were measured optically and then plotted as a function of drop height. Indentation diameter was found to be proportional to the fourth root of the drop height. Impact velocity, v, is proportional to the square of the drop height. This means that the data proves that indentation diameter is a function of $v^{0.5}$ as given in equation (7).

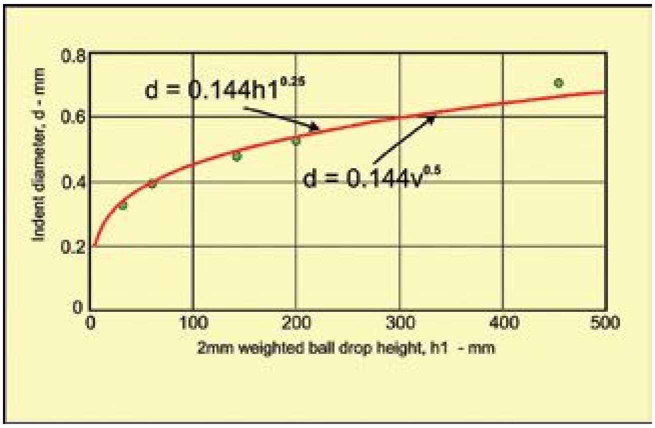


*Fig. 3. Effect of drop height on indent diameter using 2 mm diameter weighted ball.*

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## COVERAGE

### INDENT RATE

A key factor in coverage control is the number of dents that are being produced per unit area per unit time, i.e., rate of denting. The rate of denting is controlled by the shot feed rate and the average size of the dents. As an example, assume that an average of 50 dents, with each dent having an area of $1mm^2$, are being produced every second for each area of $100mm^2$. The rate of denting is therefore $50 \times 1mm^2 \times s^{-1}/100mm^2$ or $0.5s^{-1}$. Note that the units for area cancel each other out.

The rate of denting can easily be measured. A polished strip of the same hardness as the component can be peened for a short time so that individual dents can be counted. For a known area of strip, the number and average size of dents can therefore be measured and converted into a denting rate.

### COVERAGE

Coverage is generally defined as "The percentage area of the peened surface that has been dented." This sounds very simple but "the devil is in the detail." As a definition, it is incomplete! On a microscopic scale, coverage is a mixture of 100% and 0%—either dent or not a dent. A more precise definition would therefore be: "For a specified area of a peened surface, coverage is the percentage of that area that is comprised of dents." If the defined area is reasonably large, statistical variation of denting will then be averaged out. Estimation of high levels of coverage is so tricky that the term "Full Coverage" has been included in specifications as corresponding to 98%.

A major practical problem is to define the precise area of each dent. Life becomes much simpler when using models with clear defined edges. Coverage is then commonly explained using a model based on the random distribution of identical circular dents. Fig. 4 is a typical example. Seven and forty-two circular dents have been distributed randomly with their centers all inside the outer square. In order for the model to be accurate, coverage has to be measured using the amount of "greying" inside the specified red square. Coverage then becomes:

**% Coverage = 100 x total "greyed" area/specified "red" area**

The larger the number of dents within the specified area the greater will be the coverage. This will correspond to either an increase in the length of the peening time or an increase in shot flow rate.

Fig. 4 illustrates the characteristic features of increasing coverage. At a low coverage level, individual dents can be identified and there is only a small proportion of dent overlap. As coverage level increases there is a much greater chance of dent overlap and also of multiple overlapping. There is also a much greater chance of tiny uncovered areas being present. These features can easily be seen using this type of model but difficult to identify for real peened components.

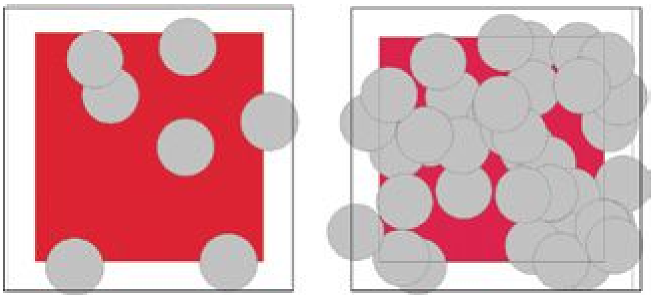

*Fig. 4. Seven and forty-two "craters" distributed randomly.*

### COVERAGE ESTIMATION

In the author's opinion, coverage can only be estimated. It cannot be measured with a high level of accuracy. Estimation techniques fall into three categories: **manual comparison**, **manual measurement** and **computer-based image analysis**.

**Manual comparison** involves simply comparing an image of a peened area with reference images that span a range of coverage levels. Fig. 5, copied from J2277, is a typical example of this useful, quick, but rough method. There is, obviously, a subjective element to this technique. An image of a selected peened area can be photographed, via say a smartphone, and then downloaded to a computer for side-by-side comparison with stored reference images.

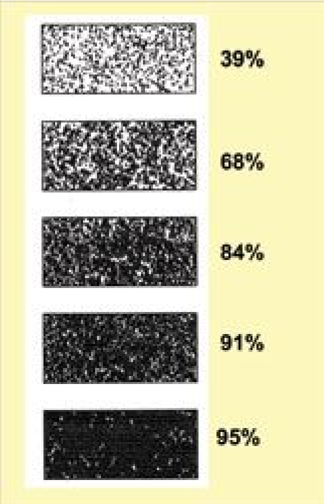


*Fig. 5. Manual comparison images.*

### Manual Estimation

Every shot peener should be capable of carrying out a manual estimation of actual coverage for a shot-peened component. Fig. 6 illustrates the procedure, using identical spherical dents whose centers lie within the defined greyed rectangle. To show how easy it is: photograph fig. 6, download the image to

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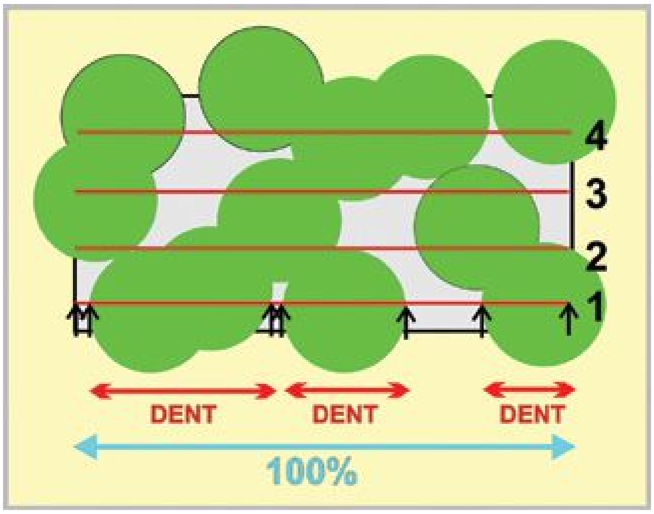


*Fig. 6. Manual technique for estimating coverage.*

a computer, adjust the image to a width of say 200 mm, print in landscape and then measure and add the green distances between the black arrows using a metric office ruler. I found lengths of 158, 158, 136 and 178 mm for lines 1 to 4. Dividing by two (to allow for 200 mm as the reference length) gives 79, 79, 68 and 89% for coverage. The average is 79%. Variation between test lines inevitably occurs over micro distances.

The lineal manual technique just described does contain a small element of subjectivity. This is mainly due to having to decide where a line intersects a dent. It is, however, much more precise than the manual comparison technique.

Applying the lineal manual technique to actual shot peened components requires a slightly different approach. First photograph a test area of the peened component and paste it into, say, Word. Crop a suitable rectangle after appropriate image magnification. In landscape mode, magnify the cropped area to give a convenient reference width (say 200 mm). Horizontal lines can then be drawn on a printout at convenient equal intervals. Measure (a) the length of the reference line and (b) the intersections of each line with dents. Sum the intersections for each line and divide by the length of the reference line. Multiply by 100 to obtain percentage coverages.

Fig. 7 illustrates the use of manual lineal analysis for an actual peened specimen. For the lines L1 to L4 the coverages were 31, 30, 34 and 42%, giving an average of 34%. Nine dents appear on the photograph, together with two artefacts—marked X. The artefacts should be ignored as not corresponding to actual dents.

**Computer-Based Image Analysis**

Computer-based image analysis is very similar in principle to the manual technique just described. The main difference is that thousands of lines can be measured very quickly.

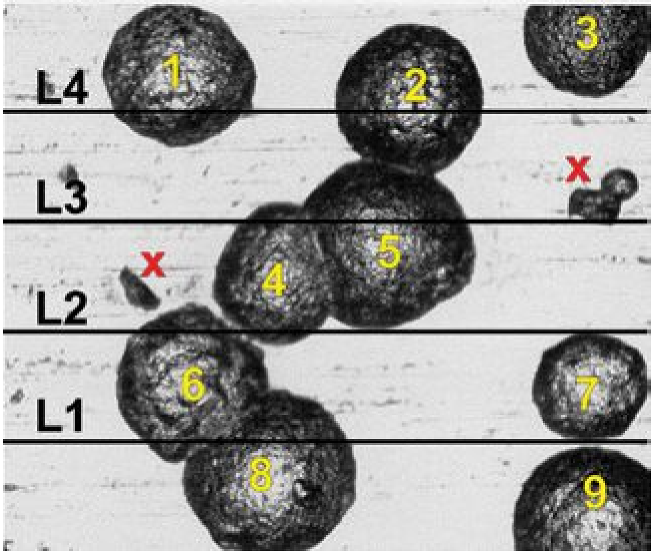


*Fig. 7. Lineal coverage analysis of a shot-peened specimen.*

Drawbacks are that the identification of artefacts becomes difficult and dent edge location can be imprecise. Image analysis programs are readily available but require training and experience to be effectively employed. At least one company provides a complete unit for coverage estimation.

**COVERAGE PREDICTION**

Coverage prediction is a jewel in the crown of shot peening science.

As peening progresses, coverage increases but becomes less and less effective as more and more of the surface is already dented. Fig. 8 on page 36 (the figure is copied from a previous article) is a graphical representation of the changes in coverage rate that occur for a constant indentation rate. As is universally recognized, the coverage rate decreases with increase in shot peening time (or number of passes). The mathematical shape of the curve is called "inverse exponential". This shape can be expressed as:

$$\mathbf{C_t\,\% = 100[1 - exp(-A{*}t)]} \qquad (8)$$

where $\mathbf{C_t}$ **%** is the coverage after a peening time **t** and **A** is the indent rate.

A single measurement of coverage can be used to predict the amount of peening (time or passes) needed to achieve a required level of coverage. An Excel-based program is available free from Shotpeener.com as "Coverage_Predictor.xls". Fig. 9 on page 36 illustrates how the program can be applied. Entering the measured value of coverage after one pass, say 42%, automatically predicts coverage after different numbers of passes. It also calculates the indent rate, A.

## DISCUSSION

Experienced shot peeners are well aware of the effects of shot

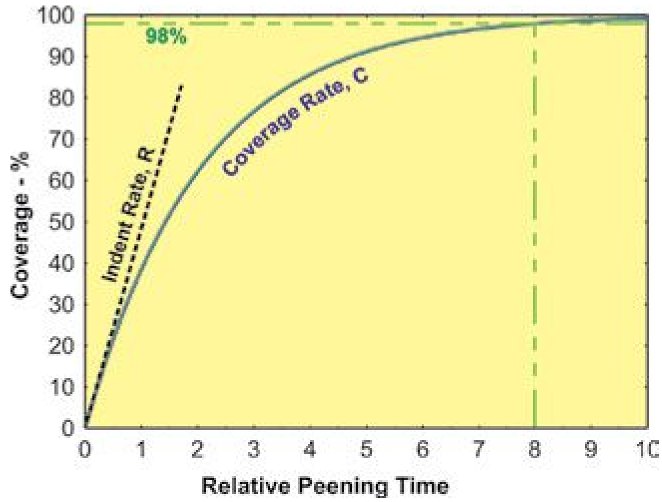


Fig. 8. Variation of coverage rate with peening time.

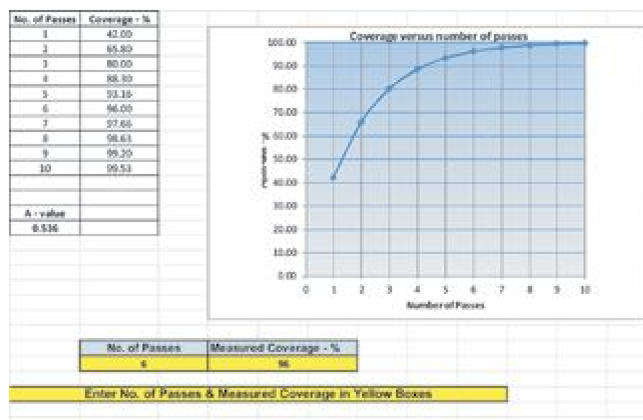


Fig. 9. Example showing application of Coverage Prediction program.

size, velocity, density and component hardness parameters on the dent size that is induced. Semi-quantification is achievable through experience and, importantly, the ability to refer back to stored data. Hopefully, the relationships presented in this article will increase understanding of quantitative parameter effects.

Coverage has a long history of published explanations and has its own standard specification, J2277. One significant feature in this article is the challenge to readers to actually carry out quantitative measurements. The lineal method proposed has been used by the author ever since his undergraduate days. A simple explanation of the method has been included based on that long experience. Somewhat surprisingly, a Google search revealed only very complicated accounts.


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# What Are ASME and NBBI—and What Does That Metal Plate on My Pot Mean?

### ASME, NBBI, and Blast Machines

The American Society of Mechanical Engineers (ASME) is a nonprofit organization. It provides technical information for many engineering fields, including pneumatically powered blast machine pressure vessels—sometimes called pressure pots. ASME Chapter VIII, Division 1 lists the standards that nearly all U.S. states have adopted for the design, manufacture, and inspection of blast machine pressure vessels, such as Clemco pressure vessels. Canadian provinces have adapted similar standards. After a pressure vessel passes an ASME inspection, it receives a certification number that is maintained by the National Board of Boiler and Pressure Vessel Inspectors (NBBI).

### Explained Simply

1. ASME writes the standards for pressurized vessels. These standards are accepted just about everywhere in Canada and the United States.
2. A pot is certified as meeting ASME standards after it meets the design, manufacture, and inspection standards in ASME code.
3. The NBBI maintains records on pots that have been certified as meeting ASME standards.

### That Metal Plate

If a pot meets ASME standards, either a U or UM is stamped on its metal compliance plate. Larger vessels receive the U stamp while smaller or miniature vessels receive the UM stamp. Likewise, if repairs to a pot meet code, an R is stamped on its compliance plate. Repairs must meet NBBI inspection code and be performed by a welder certified to ASME standards.

### Check with Your State's Governing Body

In addition, several U.S. states publish schedules that list which pots must be inspected and which are exempt from inspection for use in the state. Most often, state departments of public safety enforce these requirements.

### About Clemco Industries

Clemco Industries is headquartered in Washington, Missouri. It is the world's largest manufacturer of air-powered abrasive-blast equipment used to clean, deburr, shot peen, remove coatings, finish, or otherwise improve surfaces being blasted. The company manufactures abrasive blast machines, blast cabinets, and complete blast facilities, as well as safety equipment and blasting accessories.


*Every Clemco pot has a U or UM stamped on its compliance plate, which certifies that it has met ASME design, construction, and inspection requirements*

### Photograph Key

1. ASME certification stamp—either a U or UM. (U for larger vessels, UM for smaller or miniature vessels.)
2. The pot's model number.
3. The pot's NBBI number. It references all NBBI documentation for this blast machine's design, construction, and testing. To retrieve this information, send an email to the National Board of Boiler and Pressure Vessel Inspectors at information@nationalboard.org
4. Maximum operating pressure at highest allowable operating temperature.
5. Maximum operating pressure at lowest allowable operating temperature.
6. Year pot was built.
7. The pot's capacity in cubic feet.
8. Canadian certification number for a pot being used in Canada.


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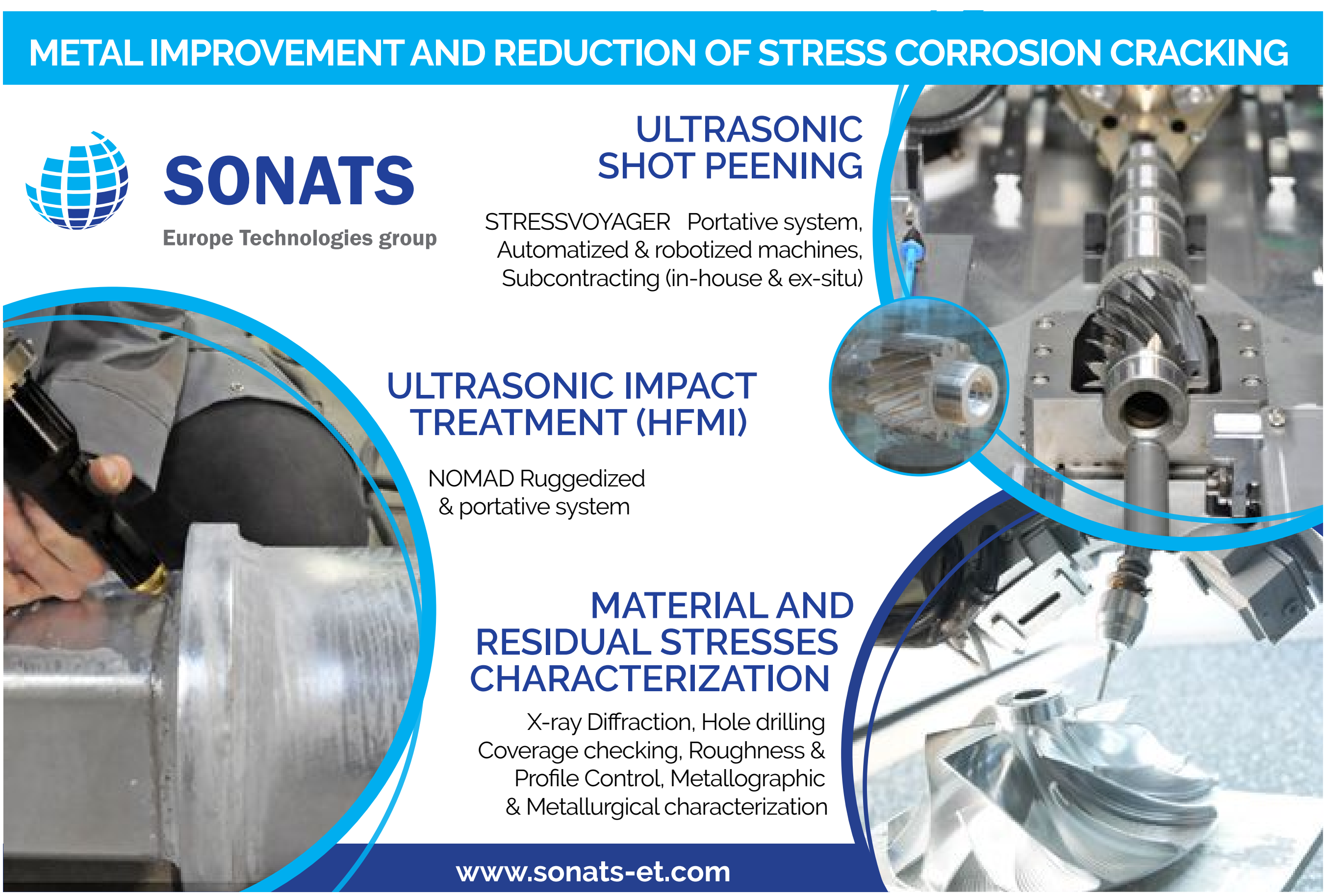
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# The 72T Shot Peening Table from Viking

**VIKING** continues its growth path as it expands to offer peening equipment to the aircraft industry.

Viking has been making shot blast systems since the 70s but only ventured into precision peening applications in 2005 with a large conveyor system for airplane spars and structures. That machine is still in operation today. As the applications started to broaden, Viking increased its capability through dedication of an in-house expert to study the industry's technology and the specific equipment involved.

Viking now announces the release of its newest peening table—the 72T—for the Metal Finishing Company of Wichita, Kansas. The Metal Finishing Company is well known to the aircraft industry in Wichita and has been serving the industry since the 40s. Metal Finishing has four locations in Kansas and one in Mexico. It is approved with all the major aircraft suppliers. This is Metal Finishing's third Viking unit—the first was purchased in 2013.

The machine has the full capability of managing shot velocity, abrasive flow rate, and table speed with the use of a PLC and HMI control screen. Shot flow is displayed on the read-out in pounds per minute and is controlled through the MagnaValve 500-24 and FC-24 controller from Electronics Inc. Viking has successfully used the MagnaValve numerous times in the last few years with trouble-free service.

Abrasive velocity is very important for all Nadcap suppliers and this is displayed on the HMI control screen in wheel RPM (see image on page 44). It is also controlled from the HMI controller, and can be stored as a recipe along with the other parameters including table speed or it can be modified for a single job.

To maintain consistent abrasive size for repeatability, a two-step process is used. First the overhead airwash separation system is tuned to the chosen abrasive size to remove fines from the abrasive stream. A percentage is then pulled out of the storage hopper for additional classifying to assure that the proper size of abrasive is returned to the system. The classifier is a vibrator screen type that separates into three sizes: oversize, undersize and middlings, which only return to the bucket elevator for re-use.

Viking Blast and Wash System manufactures a broad range of specialized engineered and standard wheel type peening and blast cleaning equipment from its Rose Hill, Kansas-based manufacturing plant.

*The 72T Shot Peening Table from Viking has been delivered to the Metal Finishing Company in Wichita, Kansas*

*The 500-24 MagnaValve and FC-24 Controller regulate the flow of steel shot in the 72T Shot Peening Table*


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**72T Shot Peening Table Blaster Specifications**

The blast cabinet is constructed of 1/2" plate steel. A removable safety screen protects the abrasive system from oversize contaminants. The doors are gasketed to provide a positive seal during operation.

A pneumatically controlled latch locks the door "CLOSED" during the blast cycle. Cabinet is lined with 1/2" thick cast alloy plates with blast stream and manganese alloy on the other walls. The doors are made of manganese alloy.

The 72T has three VK PowerMax 1500, 20 horsepower, 15" diameter center-fed direct drive blast wheels lined with 1" thick cast chrome/moly perimeter planes and manganese steel front and back wear plates. Wheel components are dynamically balanced and matched to assure smooth operation. An adjustable pneumatic abrasive-metering valve controls the abrasive flow to the blast wheels.

Part loading access is achieved by one swing open-hinged doors exposing the entirety of the blast chamber.

Abrasive leakage is minimized with a positive gasket seal. The workload is supported on a 72" diameter steel table rotated by a two horsepower drive motor at 1-4 RPM variable. The table and abrasive resistant liner have slotted openings to drain abrasive into the recovery system. An initial abrasive charge of 2500 pounds will be required.

The air wash separation system consists of a two HP horizontal abrasive auger to feed abrasive into a vertical bucket elevator. The 5 HP vertical abrasive elevator delivers the abrasive shot into an adjustable 20" single lip separator. The cleaned abrasive is then deposited into the abrasive hopper for re-use. A refuse tube carries separated contaminants to a customer-supplied trash container.

*The 72T Abrasive Classifier*


*The HMI Control Panel for the 72T*


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