AN INSIDER'S PERSPECTIVE

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What Really Matters to Your Shot Peening Process

INTRODUCTION

Going back in time to the first shot peening workshop I attended, Jack Champaigne asked the question, "How does shot peening work?" He responded to his own question with "works very well"! After almost three decades in this industry, I've learnt that Jack's lighthearted response has considerable depth. Critical components peened properly assure me that I won't be food for the sharks when flying over the Pacific or stuck by the roadside holding a broken connecting rod from my car that cracked due to fatigue! These are common application/industry examples and shot peening has propagated to many industries outside of Aerospace and Automotive and it continues to grow in importance. Over the years, we've had several discussions about specification conformance, process controls, equipment design, maintenance, retrofits and training. With that background, I believe it's now a good time to narrow down aspects that users of peening equipment consider key in maintaining an efficient shot peening process.

For this exercise, I used the combined expertise of colleagues that design and sell shot peening equipment worldwide with feedback from users of equipment from a well-established industry base. Additionally, the discussion incorporates education from the supplier of a key input to the process. In responding to the question in the title, the following aspects were weighed by the respondents based on their unique experience:

- Vendor's understanding of the process and ongoing support
- Design of equipment and quality of inputs
- Ease of work handling
- Maintainability
- Adaptability for modifications
- Controls (mechanical and electronic process control)
- Technology and innovation
- Price and delivery (of equipment, spares and service)

DOES EVERYTHING MATTER?

The simple answer is "yes", but then that won't satisfy the word count requirement for this article! During a recent car rental experience in North America, I couldn't help noticing features of the car that we take for granted, such as Bluetooth for the phone, powered windows, rear-view camera, etc. Similarly, we can (and should) expect to take for granted certain features of shot peening machines, especially those supplied within the last ten years. Such features include a classifier to maintain consistent media size, flow control valves for constant media flow rates, a system to maintain constant media velocity, and an HMI with recipe creation, storage and retrieval functions. Of course, it's basic to expect a properly functioning reclaim system, well-routed blast hoses in an airblast machine, blast wheel blades balanced to tight tolerances in a wheelblast machine, wear-protection in exposed areas of the cabinet and work handling systems, a safety circuit to immediately stop blasting during accidental opening of the cabinet door, adequate part masking to protect specific part surfaces, and finally a ventilation and dust collection system that takes into consideration all necessary ventilation guidelines including fire and explosion protection.

Let's consider some scenarios where one or multiple systems malfunctioned:

- A broken screen in a classifier will affect the quality of media in your shot peening machine. If left unchecked, it will alter your expected peening result. This issue will lead to an undesired "operating mix" in your hopper that is detrimental to peening. Shot peening and blast cleaning rely on transfer of energy from the media particles on to the part, with a requirement for the transfer to be at a constant rate in peening. The ensuing "operating mix," though desirable in blast cleaning, will not transfer constant impact energy in your peening machine due to a mix of sizes and varied energy content in the particles/media. The hope at this stage is that you'll detect it soon enough when peening Almen strips and plotting the saturation curve—you will likely see the emergence of a double knee signifying media size contamination. With a properly established process and training, this can be identified before bad results reach catastrophic proportions.
- A faulty flow control device and incorrect velocity transfer caused due to inconsistent blast wheel speed or air pressure will cause similar disturbances with impact energy transfer. Your shot peening machine should have closed-loop controls to identify and correct or warn you of both incidents. Unlike the classifier screen damage, which could go undetected until the end of the shift, your machine should correct itself

unless there is a problem with the velocity source. In that case, the controls should shut down your process.

The above scenarios demonstrate the need for regular inspection, operator discipline, and a reliable controls system. In the next section let's discuss some of those factors that are semi-machine related, but with the potential to determine the efficiency of your shot peening operation.

QUALITY OF INPUTS

Your automobile's controls will trigger the "check engine light" when you continually fill it up with a lower octane rated fuel when it calls for one that's rated above 90 octane. The higher grade of fuel is intended to deliver superior performance, and the engine is designed to operate with it. A critical input to shot peening machines is the peening media, whether it be cast steel shot, conditioned cut wire, glass bead or ceramic. Machines will operate with sub-optimal levels of media quality, but there's always a catch!

Joe McGreal, Vice President at Ervin Industries, validated our discussion on impact energy by saying, "The molten metal chemistry of cast shot is critical to the "strength" formation of the grain structure when it is atomized. Using high quality steel scrap with low sulphur and phosphorus contents is imperative to help fortify the internal microstructure. At Ervin, we keep very close control on this attribute so that the final product conforms to SAEJ827 and AMS2431. The chemistry also determines the other characteristics of peening media such as hardness and controls physical imperfections such as voids, shrinkages, cracks and particle shape. In addition to controlling the primary scrap quality and chemical dosing, Ervin follows a proven water quenching process to manufacture cast steel shot which we have found to be most effective in maintaining consistent durability."

As we know, broken media with sharp edges is not desirable for shot peening due its potential to create nicks on the part, leading to local tensile stress risers. Quality of peening media is central to achieving repeatable results regardless of whether you use blast wheels or nozzles in your peening process. Now, if only machine controls were built with the smarts to recognize sub-optimal media quality in a machine before processing parts over and beyond the functionality of the classifier and spiralator!

Some of the aspects that didn't have a significant bearing in our respondents' assessment include:

- Blast nozzles and hoses – possibly because of their monetary value and the ease of switching to an alternate style and size to suit.
- Controls – except for preference of popular makes of components.
- Price – though all markets are price sensitive, respondents said that they placed greater emphasis on technical and service features before even evaluating the price proposition.

EXPERTISE AND ITS IMPORTANCE

The end-user is clearly the expert in manufacturing their product and none of us can claim dominance over that fact. With shot peening, however, the end-users were unanimous in passing on the "expert" badge to the supplier. To them, the supplier's understanding of the peening process and the way it applied to their product was very important. This included process set-up (media drop tests, saturation curves and coverage checks), and technique/recipe development. Robotics is relatively new to our industry, and an end-user I spoke with clarified their expectation that robot (path programming) training had to be in vendor's scope during machine start-up.

Though a significant point of discussion with vendors, Equipment Design was taken for granted by most end users. End users with years of experience and familiarity with a specific make of shot peening equipment expected proper design standards to be part of the machine and took for granted the machine performance. By contrast, new users took their time to learn about different design aspects of their machine and related them to their peening process.

The efficiency and effectiveness of pneumatic media recovery systems continues to be an issue with some users even though this feature should be well-engineered and standardized by now. Here's a real-life example: A vendor/supplier couldn't get a pneumatic media recovery system on a manual blast machine to work for his customer. The vendor finally bailed on the project, leaving the customer hanging. I was associated with the company that finally fixed the problem (which is why I know the story). The exasperated customer had almost given up on the pneumatic recovery system until we got it fixed.

I found this situation unfortunate and wished the vendor hadn't been the reason for the customer to misjudge some basic laws of physics! When designed properly, such systems are the most suited for airblast applications, particularly when working with multiple media types/sizes in your peening process. Mechanical reclaim systems, though commonly used for greater media flow rates and almost always with ferrous media, involve many moving parts with the need for regular inspection and maintenance.

End-users that work with a variety of part styles (job shops, for example) need their machine to be adaptable to their changing requirements. They place importance on large open cabinets with simple work handling systems and ergonomic access points and an efficient reclaim system that allow them to purge media without involving a lot of labor. Interestingly, this user-group prides itself on its extent of knowledge of the shot peening process and maintenance skills. Their reliance on vendors to help with their peening operation and/or equipment was minimal.

Most respondents worked with shot peening systems with controls and HMI with a minimum level of sophistication.

This level included a PLC, controlled nozzle (or wheel speed) and part movement. Some of them had upgraded their controls to conform to specifications. The response was unanimous—controls played a major role in helping them achieve repeatable peening results.

OPERATORS PLAY A KEY ROLE

A special mention needs to be made to the operators of peening equipment. The end-users I spoke to, particularly in the Aerospace, trusted their operators' expertise with the equipment and process. A validation to this fact can be seen at the US and other Shot Peening Workshops where companies regularly send their operators to get trained on the process and examined for different levels of expertise in shot peening. Maintaining a consistent team of operators is very critical since this process takes time to establish and is fraught with nuances that can be gathered only over a stretch.

Walter Beach, Vice President at Peening Technologies, manages a sub-contracted shot peening operation in Hartford, Connecticut. Mr. Beach, who serves on several SAE committees, understands the importance of training. "All our shot peening process engineers have qualified to the different levels of FAA approved certifications through the EI workshops in Canada and the US. This is a requirement with our customers that their parts be peened by qualified personnel only. We have found our trained engineers take total accountability for the process and come up with process improvements on a regular basis. They certainly play a key part and they matter in our shot peening process."

TECHNOLOGY AND INNOVATION

Nathan Bjornson is an industry colleague who manages the ZERO product line for Clemco Industries. Clemco has been an innovator in portable, manual, and automated airblast equipment since the 1940s. "Technology growth and innovation at Clemco is not restricted to shot peening. Over the years, our customers in sensitive sectors, such as the military, and conventional ones in automotive and aerospace, have pushed us to innovate in processes such as etching, paint stripping and de-burring. Some of these processes demand traceability that was until now only seen in shot peening projects." Nathan adds, "One of our product lines, Aerolyte Systems, pioneered paint stripping technology in the '80s using plastic media. This technology has now advanced and uses several other lightweight media, requiring media reclaim systems that work with extra-sensitivity to the particle's mass." The advent of newer media types for a conventional application is directly driven by input costs, reduced dust generation due to increased durability, local availability and other such factors. During a time when we focus on Industry 4.0 and cloud technology, Mr. Bjornson's experience tells us that there are still several opportunities available to optimize existing processes.

SO, WHAT DOES REALLY MATTER?

A consultative approach – a customer in the medical implant industry once remarked that their project was successful because by the end of it, the vendor almost functioned as their employee! Though not always possible to this extent, everyone I spoke to—industry colleagues and customers alike—benefited from each other's in-depth participation. Interestingly, such projects continued to thrive after the end-user took ownership of the process and equipment in the early stages.

Nimbleness and adaptability – Though the presence of structure and organization was important to all end-users, so was the vendor's ability to adapt and deliver to ever-changing circumstances. An industry colleague in Europe recounted his experience with a shot peening project where the intensity value was misinterpreted by their customer due to metric and imperial units being used interchangeably. The change required some major modifications to their wheelblast machine including replacement of blast wheels and re-tuning the process. The resulting "customer for life" was a feather in their cap and proving to be an inevitable requirement for success in the current landscape.

It is worth repeating that several items in my criteria list were taken for granted by the respondents. Most end-users work with sophisticated machines and processes and they expect nothing less from their shot peening machines and processes.

The equipment and process are catching up with the industry expectation, but there's an inherent weakness—skilled manpower. Most of us in my generation were fortunate enough to learn from more experienced peers. However, the rate of newcomers into this industry is alarmingly low. The retention rate, due to various reasons, is low and there are no easy solutions to change that. Our end-users have identified some interesting requirements from this process and its vendors. Maybe addressing these requirements will create an environment that's interesting enough to retain talent and help our industry grow.

About Kumar Balan

Kumar Balan is a shot peening and blast cleaning technical specialist. He assists industry leaders achieve business growth in North American and overseas markets. His expertise is in centrifugal wheel- and air-blast cleaning and shot peening equipment. Kumar has published many technical papers on blast cleaning and shot peening and is a regular contributor to *The Shot Peener* magazine. He is a speaker at industry conferences and training seminars worldwide. Kumar is also a Lead Instructor for EI Shot Peening Training at their international seminars and workshops. Please email him at kbalan13@gmail.com.