TECHNOLOGY

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The Future of Cleaning and Peening

INTRODUCTION

How do you characterize an industry that has been active for over a century? Relatively uncomplicated and practical, the closely-related techniques of blast cleaning and shot peening have cleaned surfaces and enhanced the useful life of metallic components.

Even though the pace of technology growth in the surface preparation industry has been slower than related manufacturing sectors, shot peening and blast cleaning equipment is used extensively in advanced manufacturing processes. Aerospace, automotive, and medical devices have derived benefits from these surface treatments and advanced industries have played a major role in defining the accuracy and repeatability of the processes by developing specifications and audits. These sophisticated manufacturing sectors have also been the driving force for equipment manufacturers to innovate, grow and attempt to align with related industries.

Still, the unanimous opinion is that the growth rate should have been higher and faster. What were the deterrents? Mark Ziegler, a Foundry Specialist with The Profile Group in Wisconsin, works with professionals in one of the most intense production environments for blast equipment. He echoes a common theme when discussing the blast cleaning industry. "The lack of need for growth, price-sensitivity, reduced importance attached to the process and equipment maintenance are all part of the recurring theme," he said. He was also quick to point out, however, that the growth initiatives that did take place over the past 25 years have greatly enhanced productivity and continue to be widely embraced by its users.

The future can neither be static nor follow the pace of the last 25 years. There is fertile ground for the brightest and the best talent to innovate. Here exists tremendous potential and opportunities to take this technology to the next level. Rather than buying into the parochial beliefs of it heading towards low-cost production venues, diminishing profit margins and commodification of technology, it is our obligation to dig deeper into our individual expertise and structure the future.

This discussion will attempt to visualize the future of the blast cleaning and shot peening processes without the encumbrance of perceived limitations. We will trace some of the larger scale developments from the past that have taken the industry through quantum leaps and test their propensity to lead us into the future. Status quo is not acceptable and the risks associated with it are too many to mention and don't warrant space in our discussion.

HISTORY

The following list identifies major events in terms of their contribution towards technological growth and not necessarily by historical timeline.

- The first stream of blast media was propelled from a blast nozzle well over a century ago. This type of media propulsion continues to be popular in many applications. However, the invention of the blast wheel was a game changer of historic significance in our industry. With over ten times the media flow rate capabilities of blast nozzles, this 85+ year-old invention redefined productivity standards in many applications.

  Since then, the blast wheel has evolved into advanced designs, providing laminar flow patterns, increased velocity, reduced media consumption, and built with favorable metallurgical properties to optimize wear. Blast wheels are used in blast cleaning and shot peening alike. It is not uncommon to see modules of blast cabinets fitted with multiple blast wheels, cleaning hot rolled strips at over 150 feet per minute (over 45 mpm). Shipyards, steel plants, fabricators, foundries and several other sectors have benefited from this type of media propulsion technique because it fulfilled their need for speed and productivity. In the world of shot peening, wheelblast machines peen landing gear and large auto transmissions, to list a couple examples.

  Conscientious wheelblast equipment manufacturers continue to research the specific areas of wear-resistant material properties, ease of maintenance, monitoring of wear characteristics leading to predictive analyses, etc. When we further integrate control technology into our equipment, these initiatives show great promise for the future of blast wheels.

- Until about 20 years ago, the Programmable Logic Controller (PLC) was a revered option in shot peening machines with an adoption rate of less than 10%. It was almost non-existent for cleaning applications. The myriad of wires inside a control panel was every programmer's nightmare, but they continued to tolerate it. Transformation came gradually. Accessibility in terms of price and the PLC's general acceptance within the industry changed the way cleaning and peening equipment manufacturers designed controls. Critical process parameters could then be monitored and controlled; the overall process could be fine-tuned and made repeatable. This also led to the development of graphic user interfaces, alarm screens, recipe creation, storage and retrieval. Intelligent nozzle motions became the norm for automated airblast machines with different styles of motion control systems, resulting in greater predictability of the cleaning or peening outcome.

Have we capitalized on everything our PLCs, motion-control systems and robots can offer? Robert B. Heaton is the Product Support Manager at Empire Abrasive Equipment and specializes in automated airblast equipment. He has worked with several versions of controls in cleaning and peening equipment over the years. "Our industry's use of the PLC, PC and motion controls compares to a high school student's limited use of a simple yet powerful scientific calculator. Controls have tremendous potential to make cleaning and peening processes intuitive. They can play a much greater role in equipment maintenance in ensuring the downstream collation of process information. What's currently being done on a small scale could be expanded for greater functionality of control systems," said Mr. Heaton.

- Advancements in wheel / nozzle technology, blast media, and controls have facilitated newer applications such as medical implants and composites, and have increased the value in existing applications, such as the dual peening of automotive gears.
- The venturi-style nozzle is a notable evolution in the airblast style of media propulsion. The venturi-style nozzle produces a higher velocity and greater abrasive impact with a uniform spread of abrasive. Its straight-orifice counterpart concentrates abrasive in the center of the pattern with little abrasive spread on the pattern's outer edges. Though straight-bore nozzles do have their own special applications, the venturi-style nozzle delivers better results with the same energy consumption.

  Blast nozzle technology seems to have suffered from the same issues that slowed the growth of the overall industry. Though the industry saw the introduction and adoption of multiple discharge nozzles, angled discharge nozzles and lances, and deflector pins for small bore and slot peening, there is still room for growth in this sector. How about cost-effective designs for better access to intricate areas? What about nozzles made from better quality materials with automated wear indicators so that we don't have to rely on incorrect peening results as an indicator of nozzle deterioration?

This is not all. Our industry has seen other areas of growth, arguably of lesser impact, in the following:

- Insulation initiatives to contain source noise, sometimes under 75dbA, using innovative materials and cabinet designs.
- Tagging along with advancement in controls, we have pressure monitoring and control through PID loops, closed-loop media flow control valves, both ferrous and non-ferrous, and media size and shape control.
- The remote monitoring of a machine's health that links the supplier and end user.
- Adoption of newer types of blast media for peening applications, such as conditioned cut wire and ceramic. Improved media would give lower breakdown rates, lower dust generation and a more efficient transfer of impact energy, ultimately improving repeatability and consistency of results.
- Cleaner ventilation and dust collection techniques, including advanced fire-retardant cartridge filter material and filter design.
- At the downstream end of shot peening equipment, X-ray diffraction techniques that allow almost real-time measurement of residual compressive stress.

THE NEXT QUANTUM LEAP

Let's start with blast cleaning. This process is utilized for (a) cleaning contaminants such as rust or scale for the purpose of a downstream coating process, and (b) removing heat treat scale off casting in foundries. We cannot do much with the latter except in terms of maintenance initiatives, but let us look at the former.

What if there was a technique to coat the part downstream from blasting either within the blast machine itself or in a similar set-up? What if a counterpart to the blast wheel could cover the part with paint or any other coating just like a blast wheel cleans the component? This will allow sharing of blast cleaning technology with coating technology—a natural progression of industry groups! A visit to your local paintball facility will demonstrate that this thought is not all that far-fetched.

We are already able to analyze the component being blast cleaned in terms of geometry and surface area and then estimate the exact amount of paint consumption, allowing for waste. What if this technology was applied to shot peening and it allowed us to estimate the time required to achieve 100% and multiples of coverage in the form of an algorithm? Production rate estimates for peening applications will gain better accuracy, particularly for automotive applications.

Shot peening has enjoyed more technological growth than blast cleaning. Advancements in this sector have been duplicated in less critical applications such as etching, de-burring and cleaning. With all this, users continue to rely on a standard strip of spring steel to provide them with assurance on the fatigue life of critical components. There is no doubt that the Almen strip does its job of representing the residual compressive stress on the component being peened. However, it is now getting common for the end user to specify requirements and assurance of residual compressive stress values without the traditional considerations to arc heights and intensity measurement on the Almen strip.

Is this the future of how suppliers will have to prove-out their shot peening equipment and the process? Would this mean our allegiance to the Almen strip will take a backseat to sophisticated X-ray diffraction or some other technique to measure residual compressive stress through non-destructive means?

Saturation curves are the shot peening industry's measure of process reliability and stability. If we were able to directly and reliably measure residual compressive stress on a component, is there a need for plotting these saturation curves? With the real-time ***reliable*** and ***repeatable*** measurement of residual compressive stress, saturation curves wouldn't be necessary.

Are there other techniques to impart/transfer energy on to a component that undergoes cyclic loading? How about steam? If vapors have the strength to cause cavitations, can this be harnessed instead to create residual compressive stress? A 3/8" nozzle consumes about 175 CFM of compressed air at 90 PSI. Is there any way to capture the energy remaining in the shot particle after it has bounced around the part being peened or cleaned? Much like a supercharger in our cars?

Even as we review the technologies that will take us to the next levels, we can't ignore the fact that this is a maintenance intensive process. We also cannot underestimate the impact of human interaction. This carries equal importance before and after the sale. "Before" in order to recommend the right machine, and "After" to assist with trouble-free operation. Let us look at some of the possible machine features that could ease maintenance concerns:

a. Predictability of machine component life and visual indicators of stages of deterioration. This feature already exists in blast wheel designs with some wheelblast machine manufacturers. Expanding it to other critical components will help predict component wear.

b. End-users embracing the concept of sharing their machine performance electronically with the equipment/spare part manufacturer in order to maintain a lean inventory of spares at site. This would benefit the end-user as well because the supplier would maintain requisite levels of spares inventory for immediate dispatch.

What role does temperature of the component play in peening coverage? There has been some research in this area with springs. Is there a benefit in expanding our research in this area? Perhaps this can reduce processing time if coverage benefits from elevated temperatures.

WHERE DO WE GO FROM HERE?

If growth is our goal, status quo is not a choice. Development is no longer the domain of a particular global geography. This industry thrives from lessons learned in the field. This means there has to be a mechanism to transfer the lessons back to the design office. Once again, machine controls could play a larger role and reduce dependence on manpower to close this feedback loop. The industry's future will benefit from a collaborative approach between its equipment, consumable suppliers and end-users. We cannot afford to rest on our past experiences and stay within our comfort zone. If we have to benchmark our industry among related equipment sectors, the attributes of faster, less expensive and better quality scream out loud.

As I see it, all of us have a vision of what features will be in our automobiles in another 10 years—why not visualize where we want our cleaning and peening equipment to be?