Flapping My Lips

on the importance of a controlled shot peening process

Daryll McKinley

I was recently asked to review/develop a rotary flap peening certification program by a company in the aerospaoce industry. For the purpose of this article, I'll call them Company X. This company performs repair work on critical components, very few of which are shot peened by the original equipment manufacturer. The repair areas consist of slight damage that has been blended out and the areas are less than one square inch. Their need for shot peening is not vast, and the relatively small repair areas on the parts are well-suited to rotary flap peening.

Flapper peening is a manual shot peening process so artisan training is crucial.
(Photograph courtesy of Electronics Inc.)

What's that? You are not aware of rotary flap peening? Well, don't feel like the Lone Ranger! It doesn't make the list of the top ten metal treatment processes. However, it does exist, and has very useful applications. Now, you may be thinking, "Hey, I may have a need for this flap peening to do minor touch-up work on my parts." Or you may be thinking, "Hey, this is an article about a process that I don't need; no thanks." If the latter thought belongs to you, please stick with me. This is not an article about the process of rotary flap peening. If the first thought is the one that came to you, and you would like more information, please contact the staff at Electronics Incorporated and they can give you an information dump on the process and equipment. Also, Electronics Incorporated always lectures on and demonstrates rotary flap peening at their workshops. If you haven't attended an EI shot peening workshop, I highly recommend it. Not only will you get a lot of useful information about shot peening in all of its forms, but you'll get to meet a lot of nice people who have collectively been in the industry since dirt was invented. A nice network of smart people is a good safety net in the small circles of the shot peening industry. Well, that's enough commercial time…

For now, let me say that rotary flap peening was developed by 3M™ for repair of small areas on aircraft and the tools are basic and portable. The equipment consists of a rotary tool with a slotted mandrel, peening flaps, a magnetic Almen strip holder, and a RPM meter. The peening flaps are fabric strips that have one millimeter tungsten carbide balls adhered to their ends. The flaps slip into the slot of the mandrel and the rotary tool is used at a constant RPM to "flap" the balls against the surface of the workpiece. This causes the formation of peening dimples and imparts a compressive stress layer, just like in "normal" shot peening. Of course, as with "normal" shot peening, the intensity is measured by the use of Almen strips and an Almen gage. The key process controls are RPM of the rotary tool and tool stand-off distance. U.S. military specification MIL-R-81841 is the primary document used for process control of rotary flap peening.

So, what are the key elements of establishing a rotary flap peening certification program? Well, it's not that far off from establishing a certification program for any type of shot peening. It is similar to manual shot peening in that the peening tool is in the hand of the artisan, which means that the artisan is the most important link in the process. Feel free to review my previous article, "Of Audits and Artisans" (Summer 2006 issue of **The Shot Peener**), in which I affirm that the most important piece of your shot peening puzzle is your artisan, regardless of the peening method(s) that you use.

With rotary flap peening, since the peening tool is actually in the hand of your artisan, his training must be top-notch. Additionally, training your inspectors in how to detect proper coverage is paramount. The training program should include the artisans, inspectors, shop foremen, and anyone else who has a stake or a role in your peening process.

Classroom and hands-on training for everyone involved in the process is crucial to a successful shot peening program

One of the critical aspects of training is classroom lecture, in which the fundamentals of shot peening are taught, namely why it is done and how to do it correctly. I believe that at least four hours of classroom training is required. When I asked to see Company X's classroom training materials, I was wonderfully surprised to find out that they actually had these materials, and had used them! The lesson material was mostly correct, but was on the skimpy side. I suggested a revision and an expansion of the material.

Subsequent to the classroom training, the artisan should receive practical, hands-on training. This training may be obtained through a third-party or given by an experienced artisan within the company whose method has been reviewed and approved by engineering. Each artisan in training should perform the peening, demonstrate proper peening technique, demonstrate the use of Almen strips and an Almen gage, develop a saturation curve, and inspect for complete coverage. Each phase of this training must be witnessed and recorded by the training authority. Again, Company X was on the ball (pardon the pun) and was able to show me their documents used to record the events during practical training of the artisan. Their training document had check boxes to mark

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satisfaction of each required activity. Needless to say, I was impressed.

Artisans and inspectors must be able to pass written tests on all aspects of the shot peening process

When the classroom and practical training have been accomplished, each artisan and inspector must take and successfully pass a written examination. This examination should cover all aspects of shot peening, ranging from its purpose to its application. Tests that I have used are typically about two pages and twenty questions, including a graph and peening data to be used by the artisan/inspector to generate a saturation curve and to determine the pertinent information on it, such as intensity and exposure time. A passing grade should be established, and I like to use 80%. If the artisans complain, you could ask, "Don't you want to be above average?" Their answer usually consists of a grumble. Again, Company X came through and was able to produce written test materials as well as test results. They had indeed maintained proper training documentation.

By the way, SAE AS7117 is the NADCAP standard that establishes the requirements for shot peening, peen forming, and glass bead peening. Section 7 covers the training and evaluation of personnel, and delineates the activities that an artisan must demonstrate during his or her evaluation. Not all of these activities are applicable to all peening methods, but those that are applicable to your process should be addressed.

Successful shot peening programs are supported by good documentation

Another yardstick of a successful shot peening program is the documentation that defines and controls it. Any company that performs shot peening must have an overarching specification that defines all aspects of the program. This document is the backbone of the program and addresses, at a minimum, equipment, part preparation, training, certification, recertification, decertification, documentation, record-keeping, and fishing (just seeing if you are paying attention). In addition to this program specification, it is advisable to develop and maintain job-specific specifications that describe the tooling and process for each part that gets shot peened. These job specifications will often refer to the program specification, but are much more detailed in their scope with respect to performing peening on the parts. Finally, a logbook should be kept that records the details of each job that was performed. This logbook can be physical (i.e., on paper) or electronic. It should contain the following information for each job: part name, part number, serial number, date of peening, intensity determination, the artisan's identification, and the inspector's identification. (Again, SAE AS7117 contains this information). Company X had both a program specification and a job specific specification, although they were somewhat flawed. For instance, the coverage requirement in the job spec was defined as 2.0. I have no idea what this meant and I'm sure the person that wrote it didn't know either. I recommended a full review and revision of their specifications.

The third leg in the shot peening program tripod is tooling and equipment. We all know that tools and equipment must be maintained and kept in calibration. But, are you using the proper tools? Could your peening process be

Are you using the proper tools? Are they in good working order?

improved by the use of different, or better, tools? In a paper published by Mr. Pete Bailey of Electronics Incorporated titled "Manual Peening with the Rotary Flap Process"[1], he shares the results of his tests regarding rotary tools and their consistency, which certainly affects the quality of a rotary flap peening job. Mr. Bailey determined that, out of three types of rotary tools tested, a medium-speed air drill provided the most consistent RPM. This is valuable information for Company X, and they could use the information to substantiate their process to a real auditor. The only requirement stated for flapper peening equipment in SAE AS7117 is that the tool is capable of maintaining the required RPM and that it consistently reproduces intensity values. By the way, I also inspected their Almen gage and found it to be of current design, in good repair, and calibrated.

Stay informed on the newest technology and processes

How does one happen to find the latest shot peening technology information and advice? Well, being involved in the shot peening community will certainly keep you abreast of the latest and greatest. This can be done by participating in workshops and seminars or by becoming involved with the SAE committee on surface enhancements. At a minimum, I advise you to subscribe to newsletters and get on mailing lists of companies that provide information or services regarding shot peening. I make of habit of bookmarking every peening site that I find on the Internet. And, as with Company X, it wouldn't hurt to have someone come in, look over your shoulder, and provide a positive critique of your program.

Have my ramblings provoked any noteworthy thoughts? I hope so. I'll wrap up by saying that regardless of your method of peening, it is imperative that you establish, maintain, and document every thinkable aspect of your process. Training of personnel should be a major portion of your process, as well as documentation. Your documentation should be easily accessible and clear. These are things that an auditor will certainly look for, likely immediately upon his arrival, with the exception of the coffee pot. Thanks for your attention, and, as always, happy peening!

[1] Manual Peening with the Rotary Flap Process, P.G. Bailey, 7th International Conference on Shot Peening, Warsaw, Poland

Daryll McKinley has a Bachelor's Degree in Mechanical Engineering, a Master's Degree in Materials Engineering, and he is a Registered Professional Engineer. During his career, he has developed and conducted shot peen artisan training and certification programs for the U.S. Navy, which were later adopted by private industry. During his employment with the Department of Defense, he conducted shop audits, authored peening process specifications, and wrote equipment specifications. Mr. McKinley's background includes mechanical design and testing, hardware failure analysis, aircraft accident investigation, materials processing, and corrosion control.

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