Volume 22, Issue 4 **Fall 2008**
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The Shot Peener

Dedicated to sharing information and expanding markets for shot peening and blast cleaning industries

A Big Machine
WITH A LEAN ATTITUDE

PLUS:

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A Big Machine

WITH A LEAN ATTITUDE

Engineered Abrasives, Alsip, Illinois, has constructed one of the biggest rotary index machines in manufacturing history. The machine will clean the internal oil passages and the entire external surface of V6 aluminum engine blocks at an incredible speed of 90 engine blocks per hour. The machine, built to customer specifications, is 45 ft. tall, weighs over 40 tons and was completed in seven months. Engineered Abrasives not only had to meet customer specs but also had to design a large machine that would be built in-house, disassembled, transported and reassembled at the customer's site. Engineered Abrasives skillfully handled that mammoth task, too. The machine was designed with seven major components that could be shipped on three trucks. Every part was marked on blueprints and photographed. The disassembly took seven days and Engineered Abrasives' staff supervised the three week installation. Engineered Abrasives then provided on-site training that included nozzle alignment, preventative maintenance, changing of Sweco screens, hose replacement and more.

A Controlled Large-Scale Operation

The sheer size of the machine isn't the whole story—the really impressive aspect is the brains behind its bulk. Every action is controlled and monitored. Its closed loop system ensures foolproof and safe operation and no media or energy is wasted at any point in the operation. And while this machine's footprint is 1,500 sq. ft., it is doing the work of up to eight smaller machines that would have a much larger combined footprint, use more shot, more energy and require more operator time. Let's look at the components that make this big machine so lean:

- Parts are loaded from an incoming conveyor with a Fanuc robot.
- The blasting stations have 6-8 nozzles each. The blast nozzles are mounted to a vertical and horizontal oscillator. Media feed and blasting pressures are adjustable. Mutable strokes of the blast pattern and travel are adjustable. Nozzles are precisely aimed for intended blasting. Blasting is turned off at the end of each cycle so there is no wasted blast (i.e., no wasted media, no excess energy usage or excess wear and tear on machine cabinets).
- The two pressure vessels can have their own air pressure and each vessel holds up to 30,000 lbs of shot. Each pressure vessel feeds 14 guns. Each vessel has a MagnaValve, with a 1000 lb per minute flow rate, and the MagnaValves are attached to a media bin. The pressure of the vessel and shot level are monitored and when shot is running low, the MagnaValve feeds shot from the bin to the pressure vessel.
- Each of the 28 guns is controlled with a 0-100 lb per minute flow rate MagnaValve and controller and an air-pressure transducer. During the blast cycle, 1,530 lbs of shot are used per minute.
- 100% of the shot is run through a 72" Sweco screen separator and the clean shot is put into the system. A bucket elevator system returns the spent shot to

- **45' tall**
- **Weighs over 40 tons**
- **Throws 1,530 lbs of shot per minute**

Machine Components

- Eight stations
- Two pressure vessels with 14 guns each
- One MagnaValve, controller and air pressure transducer for each gun
- 1000 lb/min MagnaValve to monitor media level in pressure vessels
- 72'' Sweco screen separator
- Bucket elevator system for media return
- Fanuc robots to load/unload parts

the Sweco. Another elevator system takes the shot from the Sweco and empties it into the media storage bin for the pressure vessels.

- Parts are returned to the load/unload station where they are removed by a Fanuc robot.

Customer Feedback

The machine has exceeded the customer's expectations. The specification mandated that no more than three grams of sand could be left in the passages and Engineered Abrasives' machine removes 100% of the sand from the casting. I guess we could say that this big machine has a lean, clean attitude.

About Engineered Abrasives

Engineered Abrasives is a ISO/TS 16949, ISO 14001, Ford Q1 certified job shop. Founded in 1935, Engineered Abrasives designs and fabricates standard or custom automated abrasive and shot peening systems. Engineered Abrasives can analyze any situation and design a machine to meet production requirements. Complete turnkey systems are also available. All design and fabrication is performed at Engineered Abrasives' plants.

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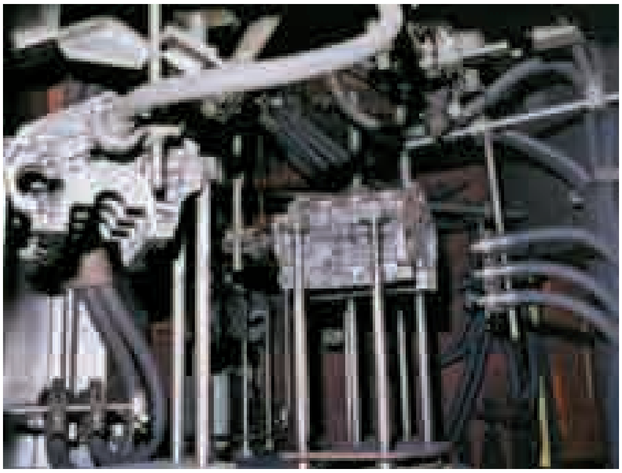
Before: A cross-section of an engine block casting before blast cleaning.

After: A cross-section of an engine block after blast cleaning. The customer specification states that there is to be no more than three grams of sand in the passage after cleaning. Engineered Abrasives' machine removes 100% of the sand from the casting.

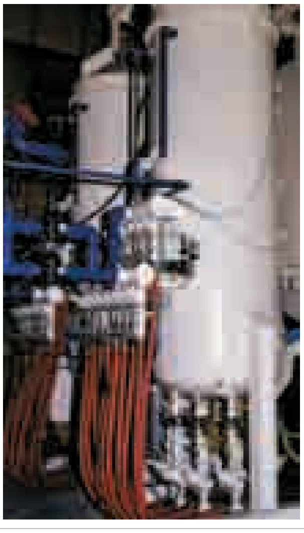
Media bin with MagnaValves. During a blast cycle, 1,530 lbs of shot are used per minute.

The 72" Sweco. To get an idea of its size, note yellow ladder to the left.

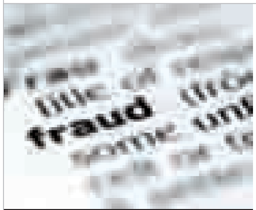


Each blasting station has 6 - 8 nozzles. Blasting is turned off at the end of each cycle so there is no wasted blast (i.e., no wasted media, excess energy usage or excess machine wear and tear).

Pressure vessel control panel.



Each pressure vessel holds up to 30,000 lbs of shot.



A Case of Shot Peening Fraud

File Name: 06a0766n.06
Filed: October 17, 2006
Case No. 05-3267
United States Court of Appeals for the Sixth Circuit

United States of America, Plaintiff-Appellee, v.
Se Keun Oh, a.k.a. JIMMY OH, Defendant-Appellant

On appeal from the United States District Court for the Northern District of Ohio

Before: Batchelder, Griffen, Circuit Judges; and Zatkoff, District Judge.

This Circuit Court decision validates your quality shot peening processes

ALICE M. BATCHELDER, Circuit Judge. Defendant-Appellant Se Keun "Jimmy" Oh ("Mr. Oh") was indicted on charges of wire fraud in violation of 18 U.S.C. § 1343 (Counts 1, 2 and 3) and making false statements with regard to several government contracts for military parts, in violation of 18 U.S.C. § 1001(a) (Counts 4, 5, 6 and 7). The jury acquitted him on Count 4 and convicted him on all other counts, and Mr. Oh appeals, claiming that the evidence was insufficient to support his conviction on Count 1and that the district court erred in permitting the jury to consider certain evidence to which Mr. Oh timely objected. Finding no error in either regard, we **affirm** the conviction.

On September 1, 2004, a federal grand jury issued a seven-count indictment against Mr. Oh and the companies that he owns, Euclid Machine, Inc., and Forex Inc., d.b.a. KMT Eastern Machine Tool Co. Count 1 charged Mr. Oh and Euclid Machine with wire fraud involving a contract to provide to the Air Force T-38 aircraft brakes, in violation of 18 U.S.C. § 1343. Count 2 charged Oh and Forex with wire fraud concerning contracts for twelve housing assemblies for use on Air Force KC-135 aircraft, in violation of § 1343. Count 3 charged Oh and Forex with wire fraud concerning seventy KC-135 housing assemblies, in violation of § 1343. Count 4 charged Oh and Euclid Machine with making false statements regarding "shot-peening" of four hundred axles for Army Black Hawk helicopters, in violation of 18 U.S.C. § 1001(a). Count 5 charged Oh and Euclid Machine with making false statements regarding shot-peening for six hundred Black Hawk helicopter axles, in violation of 18 U.S.C. § 1001(a). Count 6 charged Oh and Forex with making false statements regarding twelve KC-135 housing assemblies, in violation of § 1001(a). Count 7 charged Oh and Forex with making false statements concerning seventy KC-135 housing assemblies, in violation of § 1001(a).

Mr. Oh was convicted by a jury on Counts 1, 2, 3, 5, 6, and 7, and acquitted on Count 4. He filed a timely Motion for Acquittal and Motion for a New Trial on Counts 1 and 5, which were denied. The district court sentenced Mr. Oh to concurrent terms of 28 months in prison for Counts 1, 2, and 3, and 28 months in prison for Counts 5, 6, and 7, and payment of restitution in the amount of $172,201.46. This timely appeal followed.

I. Factual Background

Mr. Oh's companies produce and provide various parts, primarily for the United States military. Between 2002 and 2004, the federal Government awarded Mr. Oh's companies seventy-eight manufacturing contracts. In 2004, the Government began scrutinizing many of these contracts; with respect to three of them, the Government found irregularities that warranted criminal prosecution. Under the first of these contracts, Mr. Oh was to produce speed brakes for the Air Force's T-38 aircraft. The second contract called for Mr. Oh to supply the rear landing axles for the Army's Black Hawk helicopter; and the third contract required Mr. Oh to provide another Government contractor, Western Pacific Enterprises, with housing assembly castings for the Air Force's KC-135 aircraft.

Defense procurement contracts for military parts are typically awarded to a prime contractor and often involve subcontracting for processing, parts, or finishing. These procurement contracts include the requirement that the contractor certify that the parts meet all of the specifications of the contract. The Defense Department relies upon the accuracy of the contractors' certifications and without the necessary certifications a contractor cannot sell its parts to the military. Once a contractor has material ready for delivery, the contractor must coordinate an inspection visit with the Defense Contract Management Agency (DCMA). Inspectors examine procured parts and either accept or reject them using standardized DD-250 forms. The DD-250 form shows that the material was inspected and accepted by an authorized Government official. After a DCMA inspector approves a product, it can then be sent to the customer.

If a customer discovers that the parts do not conform to specifications, a complaint may be issued and several remedial steps taken. If the Government ultimately determines that the products are non-conforming, it may terminate the contract "for convenience," which means that the Government refuses to accept further products or to remit further payment, but does not necessarily pursue restitution against the contractor. Often when the Government terminates for convenience, it simply scraps the products.

A. T-38 Talon Speed Brakes

Count 1 of the indictment involved a 2003 contract between Mr. Oh and the Government calling for Oh to

provide the military with forty-six aircraft speed brakes for the T-38 Talon. These were brakes that Mr. Oh had left over from two earlier contracts. The Government alleged that Mr. Oh represented and certified that the speed brakes complied with Government specifications despite his knowing that they did not. The Government further alleged that the speed brakes had been rejected earlier as non-conforming, and that Mr. Oh resold them to the Government over a decade later, trying to pass them off as conforming parts.

The history of these particular speed brakes goes back to 1988, when Mr. Oh received two Government contracts to supply the Air Force with speed brakes for its training jet, the T-38 Talon ("The T-38 contracts"). The first contract required Mr. Oh to produce the left speed brakes at an approximate total cost of $670,000, and the second contract was for production of the right speed brakes for approximately $700,000. Mr. Oh subcontracted with Cast Right, a Texas-based company, to produce the brakes.

Cast Right produced the speed brakes casting, and Euclid Machine's former quality manager, Boyd Taylor, examined them. Taylor could not measure the brake's contour and began developing a computer program to do so. Taylor never completed the program, but was able to take preliminary measurements that showed the brakes to be "consistently out of tolerance," that is, they did not meet the Government specifications. Taylor informed Mr. Oh of the findings before shipping the parts to the Air Force. Euclid Machine then asked for certification from Cast Right, and Cast Right complied. However, Taylor still could not confirm that the parts met the Government specifications and refused to "sign off" on the parts' being "accurate." Taylor testified that Mr. Oh responded to the problem by saying, "well, we'll use a certificate of conformance of Cast Right to prove that the parts were correct." Mr. Oh then assigned Taylor to the company's "inspection room" to finish the computer program that he had started. Shortly thereafter, Taylor was fired.

In 1991, Euclid Machine prepared to ship the speed brakes to the Air Force. The company completed the DD-250 forms indicating that a Government quality assurance specialist had inspected and signed off on the parts. Jim Hartman, one of the Government's quality assurance specialists, testified that he signed off on some of these forms in January 1991. He stated that in early 1991 he arrived at Euclid Machine intending to meet with Taylor to verify the contour data on the speed brakes. When Hartman arrived, Mr. Oh told him that Taylor was no longer with the company. Hartman stated that he still wanted to validate the contour data and that he knew Taylor had been creating software to test the brakes' contour data. Hartman testified that Mr. Oh responded that Taylor had been upset and had "wiped out the software." Taylor, however, denied wiping out the software and testified that he had left it with Euclid Machine. In any event, without the computer program, Hartman signed off on the DD-250 report, relying on the certification provided by Cast Right. The DD-250 report enabled Euclid Machine to ship the speed brakes to the Air Force.

Euclid Machine began shipping the T-38 speed brakes to Kelly Air Force Base (KAFB) in 1991. After Euclid Machine had shipped approximately 70% of the speed brakes for which the Government had contracted, KAFB filed a product quality deficiency report ("PQD report") stating that it was rejecting the speed brakes because they did not fit properly. Hartman provided Mr. Oh with the PQD report and made repeated attempts to persuade Oh to evaluate the brakes and to resolve the problem, but Mr. Oh refused, insisting that the brakes conformed to the contract specifications. Hartman testified that, in his experience, this was very unusual for a contractor.

KAFB then agreed to host a meeting with Mr. Oh so that, together, the parties could determine the source of the problem. Hartman and Mr. Oh's brother, Dustin Oh, attended the meeting, which, according to Hartman, began with Air Force officials' asking Dustin Oh to explain how Euclid Machine had inspected the product and found it within specifications. Dustin Oh refused to answer, stating that he was there to get answers from them, not to give answers. Air Force officials then showed Dustin Oh how they had inspected and tested the product and found it unacceptable. They again asked Dustin Oh to explain how Euclid Machine had reached the opposite conclusion, but Oh refused to cooperate. After this meeting, despite having already received and paid for 70% of the non-conforming speed brakes, the Air Force terminated the contract for convenience and kept the parts already received, allowing Mr. Oh to keep the money already paid. The Government refused to accept or pay for any additional parts under the contract on grounds that the parts did not conform to contract specifications.

Some years later, the Air Force sold to Alamo Aircraft six of the speed brakes that Mr. Oh had provided KAFB under the 1988 contract. At trial, the parties stipulated that the Government sold these parts to Alamo Aircraft as "surplus," thereby indicating that the brakes in fact met Government specifications. The Government conceded that the "surplus" label was a mistake. In 2002, Alamo Aircraft sold these same brakes back to the Government. Mr. Oh learned of this transaction, contacted Alamo Aircraft, confirmed that the Government had sold the parts as surplus and that Alamo Aircraft then sold them back to the Government as good parts.

In 2003, the Air Force solicited new contract bids for T-38 speed brakes. With an inventory of speed brakes that the Air Force had rejected in the early 1990s, Mr. Oh submitted a bid to supply forty-six speed brakes for $2300 each, and stated that he could deliver the parts in forty-five days. Charles Hall, a Government procurement agent, testified that the only other bid from an approved manufacturer was for $15,000 per part, and that they could not be delivered for two hundred and seventy days. Hall asked Mr. Oh how he could provide the parts so quickly, and Mr. Oh replied that the parts were remnants of the 1988 contract. At Hall's request, Mr. Oh provided the contract number from the 1988 contract and faxed to Hall the original DD-250 forms for the 1988 parts.

The DD-250 forms that Mr. Oh sent Hall represented that Euclid Machine had manufactured and delivered several sets of air brakes, and that they had been inspected and accepted by the DCMA in February 1990 and January 1991. Hall testified that he took this to mean that they were good parts. Hall also testified that the DD-250s represented that Mr. Oh offered the parts as good material. The Government investigated the earlier T-38 contract and discovered two minor quality deficiency reports, and a technician researched the contract history and found no negative remarks as to quality. Only later did the Government discover that these parts suffered from the same contour nonconformance problems as the earlier speed brakes.

B. Black Hawk Helicopter Rear Landing Axles

Counts 4 and 5 of the indictment concern a second contract, solicited and obtained by Euclid Machine in June 2002, to provide the Government with rear landing axles for the Black Hawk Army helicopter. Under the contract, Euclid Machine was to provide two thousand axles. The axles were to have undergone a hardening process known as "shot-peening" in which a metal part is pelted with small BBs to increase the part's fatigue strength without increasing its weight. Shot-peening cannot be visually detected on a finished part; it can be discovered only by cutting the part open. The Government alleged that Mr. Oh represented that the axles he eventually provided had been shotpeened, when, in fact, he knew that they had not.

Euclid Machine subcontracted the axle manufacturing to McNeil Industries. According to Justin McNeil, the director of operations for McNeil Industries, this was McNeil Industries's first Government contract, and the company was unfamiliar with how the system worked. Mr. Oh met with McNeil Industries representatives to explain how to manufacture the axles based upon the Government specifications. In August 2002, Oh provided McNeil Industries with a document detailing the Government specifications for the axle parts, but this document did not contain all of the information necessary for making the part. In particular, this document omitted the shot-peening requirement.

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A second document, not delivered to McNeil Industries until December, specified the shot-peening and contained all of the necessary specifications. However, between September and December 2002, McNeil Industries had some four hundred axles manufactured, using other subcontractors pre-arranged by Mr. Oh. According to Justin McNeil, those axles were heat treated, cadmium plated, and chrome plated as per the original specifications, but they were not shot-peened because McNeil Industries was unaware that the contract contained any shot-peening requirement.

In late November 2002, McNeil Industries delivered approximately four hundred of the contracted axles to Mr. Oh. On November 27, 2002, Euclid Machine shipped 400 axles to the DCMA, certifying in the shipping documents that the parts conformed to the contract requirements, including shot-peening. Justin McNeil testified that Mr. Oh called him on December 2 and asked for certification for the shot-peening. Justin McNeil said that he told Mr. Oh both that the delivered parts were not shot-peened, and that the price he had quoted Mr. Oh for the parts had not included shot-peening because he was not aware that the contract required it. Shot-peening would have cost McNeil Industries an additional $1.50 per part to perform initially, and would have cost far more to perform after the chrome and cadmium plating had been applied. Following this conversation, Mr. Oh faxed McNeil Industries the second document detailing the axles' manufacturing process and indicating the shot-peening requirement, and told Justin McNeil to shot-peen the remaining parts. On learning that more than five hundred of the remaining six hundred parts were already chrome plated and would have to be stripped and redone in order to shot-peen them, Mr. Oh told McNeil that he would arrange for the shot-peening of those parts, and that McNeil Industries should ship the remaining eighty-six unchromed parts to Atom Blasting, another subcontractor.

During his cross-examination by the Government, Mr. Oh disputed Justin McNeil's testimony. Mr. Oh testified that he never provided the Government with certifications that the shotpeening had been performed on the first four hundred parts sent by McNeil Industries, but that as the primary Government contractor it was his responsibility to maintain the certifications. Oh maintained that he received certification from McNeil Industries that the other six hundred parts had been shot-peened, and although he could not produce evidence of this, he claimed that he thought "it is an exhibit or document" that he had already provided. He denied knowing in early December that the first set of parts had not been shot-peened, and he also denied knowing that the vast majority of the last six hundred parts were never shot-peened. Mr. Oh testified that it was not until he was indicted in this case that he first learned that the parts were not shot-peened.

The Government charged Mr. Oh in Count 4 with making false representations regarding shot-peening for the initial shipment of four hundred axles, in violation of 18 U.S.C. § 1001(a), and 10 in Count 5 with falsely representing that six hundred axles had been shot-peened, also in violation of 18 U.S.C. 1001(a).

C. KC-135 Housing Assemblies

Counts 2, 3, 6, and 7 of the indictment charge that Mr. Oh committed wire fraud and made false representations with regard to a contract that Mr. Oh had with Western Pacific Enterprises ("WPE"), another Government contractor, to manufacture the aircraft "housing assemblies" for the Air Force's KC-135 Stratotanker fueling plane. In November 2002, the Government awarded WPE a defense contract to provide housing assemblies for the KC-135 aircraft. The contract specified that a casting was to undergo fluorescent penetrate testing and x-ray testing. The Government alleged that Mr. Oh misrepresented to WPE that the requisite testing had been performed and that he falsified the certification documents in an attempt to prove it.

At trial, WPE president, David Capulopo, testified that the parts he received on March 12, 2003, were not stamped and could not have been inspected. Capulopo testified that on March 21, 2003, Mr. Oh had faxed him certifications which indicated that the parts had been tested on March 10, 2003. Christian Scheel, an inspector with the Advanced Quality Group whose signature appeared on the certification, testified that he had not performed the testing on March 10, but had done so on March 20. Scheel testified that Mr. Oh admitted to him that he had forged and falsified the certification. The Government also produced evidence that Mr. Oh had provided a report purporting to be from U.S. Inspection Services, indicating that testing had been performed on 15 parts. A U.S. Inspection Services employee testified that the company had no record of ever completing such a report, and the Government contended that Mr. Oh forged the report.

Prior to trial, Mr. Oh sought to plead guilty to the counts involving the housing assembly contracts, Counts 2, 3, 6, and 7, maintaining that his intention had not been to defraud WPE or the Government, but to prevent WPE from learning the identity of Oh's supplier. The district court rejected the plea because Mr. Oh would not admit to all of the elements of the offenses charged in those counts, and Mr. Oh proceeded to trial. He was found guilty on Counts 1,2,3,5,6 and 7. Although presented as four separate assignments of error, Mr. Oh's appeal advances two basic arguments. First, Mr. Oh claims that the trial court erred in denying his Motion for Acquittal as to Count 1because the Government presented insufficient evidence to support his conviction for wire fraud as charged in that count. Second, Mr. Oh claims that he was prejudiced by certain evidence that the district court erroneously permitted the jury to consider, and his Motion for a New Trial on Counts 1 and 5 should therefore have been granted.

II.

A. Mr. Oh's Motion for Acquittal

We review de novo a district court's denial of a motion for acquittal. United States v. Keeton, 101 F.3d 48, 52 (6th Cir. 1996). We "must determine 'whether, after viewing the evidence in the light most favorable to the prosecution, any rational trier of fact could have found the essential elements of the crime beyond a reasonable doubt.'" Id. (emphasis original) (quoting Jackson v. Virginia, 443 U.S. 307, 319, 99 S. Ct. 2781, 2789, 61 L.Ed. 2d 560 (1979)).

The wire fraud statute, 18 U.S.C. § 1343, provides:

> Whoever, having devised or intending to devise any scheme or artifice to defraud, or for obtaining money or property by means of false or fraudulent pretenses,representations, or promises, transmits or causes to be transmitted by means of wire, radio, or television communication in interstate or foreign commerce, any writings, signs, signals, pictures, or sounds for the purpose of executing such scheme or artifice, shall be fined under this title or imprisoned not more than 20 years, or both.

To obtain a conviction of Mr. Oh for wire fraud, the Government needed to prove "(1) a scheme or artifice to defraud; (2) use of interstate wire communications in furtherance of the scheme; and intent to deprive a victim of money or property." United States v. Daniel, 329 F.3d 480, 485 (6th Cir. 2003); see also United States v. Prince, 214 F.3d 740, 747-48 (6th Cir. 2000).

Although the second element is uncontested, and is easily satisfied by Mr. Oh's faxing of three DD-250 forms to Charles Hall, Mr. Oh contests the sufficiency of the evidence to prove the first and third elements of wire fraud. He argues that the Government failed to show that he "developed a scheme to defraud the Government" or that he "intended to defraud the Government of money or property." We disagree.

The district court concluded that as to the first element, a scheme or artifice to defraud, the Government presented sufficient evidence to prove that Mr. Oh knew that the speed brakes he supplied pursuant to the 2003 contract did not conform to the Government's specifications and that he deliberately kept this information from the Government. The Government put on evidence that included testimony that Mr. Oh received letters from military officials explaining the problems with the

speed brakes; testimony regarding the meeting at Kelly Air Force Base with Mr. Oh's brother in which officials explained how the brakes failed to conform to the Government's specifications; and Boyd Taylor's testimony that he told Mr. Oh that the parts were out of tolerance even before they were shipped the first time. From this evidence a rational jury could conclude that Mr. Oh intended to sell to the Government brakes that he knew did not meet the contract specifications.

The district court also concluded that the jury had sufficient evidence to determine that under the 2003 contract Mr. Oh intentionally withheld information from the Government regarding the defects in the brakes. The jury heard that Mr. Oh did not inform Mr. Hall that in 1991 Kelly Air Force Base had issued a product quality deficiency report indicating the brakes' non-conformance or that the Government had terminated the 1988 contract because the parts did not meet the contract specifications.

Mr. Oh argues that the jury lacked sufficient evidence to convict because he disclosed the 1988 T-38 speed brake contract number on his 2003 bid for the speed brakes contract. He maintains that both he and Charles Hall understood that the only reason that Mr. Oh could deliver the speed brakes so rapidly and so cost effectively was because he had spare brakes from the 1988 contract. Mr. Oh claims that he provided the Government with all of the information it needed to determine if there were any problems in accepting his bid for parts that he admitted he manufactured pursuant to the 1988 contract. He contends that he made no false statements or material misrepresentations that would have misled the Government about the parts.

We have some sympathy with Mr. Oh's implicit contention that the Government failed to undertake the kind of investigation that would have revealed the entire history of these speed brakes. We conclude, however, that because Mr. Oh's failure to disclose a material fact to the Government constitutes a misrepresentation for purposes of the wire fraud statute, the Government's failure to investigate is not material to the issue of Mr. Oh's guilt. In United States v. DeSantis, 134 F.3d 760, 764 (6th Cir. 1998), we held that in the fraud context an affirmative misstatement is not required. Rather, a scheme or artifice to defraud may simply involve a knowing omission of a material fact. Id. To be sure, that knowing omission "must have the purpose of inducing the victim of the fraud to part with property or undertake some action that he would not otherwise do absent the misrepresentation or omission." Id. The district court relied on DeSantis, and concluded that from the evidence presented at Mr. Oh's trial, a rational factfinder could reasonably have believed that Mr. Oh deliberately sought to conceal material information from the Government when he failed to provide the results of subsequent product quality deficiency reports, that he misled the Government by omitting this information, "the one piece of information that likely would have affected the government's choice whether or not to accept Mr. Oh's bid."

We find no error in the district court's conclusion that the jury's verdict on Count 1 is supported by sufficient evidence.

B. MR. OH'S REQUEST FOR A NEW TRIAL

Mr. Oh argues that he should have been granted a new trial on Counts 1 and 5 because of the admission of prejudicial evidence during his trial. The district court denied Mr. Oh's motion and we affirm.

Mr. Oh offers three reasons that a new trial should have been granted: (1) the admission of evidence concerning prior contracts not at issue in this case prejudiced Mr. Oh; (2) James Stec's testimony prejudiced Mr. Oh, despite the court's instruction that the jury disregard the testimony; and (3) because the court rejected Mr. Oh's guilty plea as to Counts 2, 3, 6, and 7, the jury heard facts and circumstances of charges that Mr. Oh did not dispute.

First, Mr. Oh argues that the district court improperly admitted testimony regarding earlier contracts related to bell housing tanks and Inconel parts, which were not part of this indictment. Mr. Oh contends that the testimony of James Hartman and Boyd Taylor was admitted in violation of Federal Rule of Evidence 404(b), and that he was unfairly prejudiced by this testimony because it tended to confuse the jury. Mr. Hartman testified inter alia that in inspecting a Euclid Machine contract to supply the Government with bell housings, he discovered that the parts did not meet the Government's specifications, even though the parts had been previously inspected, provided with a DD-250 form, and were ready to be shipped. He testified that when he informed Euclid Machine, the company conducted further testing and terminated the contract when the parts continued to fail the tests. Mr. Taylor testified to an incident involving replacements for Inconel parts. According to Taylor, Mr. Oh wanted to buy non-certified material to use in the parts, and when Taylor informed him that using the non-certified material would violate the contract, Mr. Oh replied: "How are they going to know?"

Under Rule 404(b), evidence of other acts is "not admissible to prove the character of a person in order to show action in conformity therewith . . . ." But evidence of other acts is admissible "for other purposes, such as proof of motive, opportunity, intent, preparation, plan, knowledge, identity, or absence of mistake or accident." FED.R.EVID. 404(b). The Government introduced testimony of Hartman and Taylor to demonstrate that Mr. Oh had a working knowledge of the certification process and the need to produce parts that comply with Government specifications, and that he understood that there were ways to deceive the Government by using nonconforming material. The district court properly instructed the jury that it could consider the testimony only to the extent that it provided evidence that Mr. Oh did not make a mistake in how he handled the T-38 speed brakes, but that he was well aware of the Government's process for buying parts and demanding specification compliance. We find no error here.

Second, regarding James Stec's testimony, Mr. Oh argues that he was unfairly prejudiced because the jury heard some of Stec's testimony before the district court judge determined that the testimony was inadmissible. Stec testified that Mr. Oh had asked him to backdate a gauge to reflect a particular thermometer calibration in order to show that a part had been tested under proper conditions of temperature and humidity. The court ruled the testimony inadmissible and instructed the jury to disregard Stec's testimony. Mr. Oh now argues that the jury was likely unable to disregard the testimony, and that he was therefore prejudiced. The Supreme Court has determined that courts should "presume that a jury will follow an instruction to disregard inadmissible evidence inadvertently presented to it, unless there is 'overwhelming probability' that the jury will be unable to follow the court's instructions." Greer v. Miller, 483 U.S. 756, 767 n.8 (1987). Mr. Oh has failed to demonstrate anything resembling an "overwhelming probability" that the jury could not follow the court's instruction, and the district court did not err in denying a new trial on this ground.

Finally, Mr. Oh argues that he was prejudiced because the jury heard additional, "spillover" evidence about his culpability as to the counts in his indictment to which he attempted to plead guilty. This evidence pertained to the 2003 contract to provide KC-135 housing assemblies to WPE, and the doctored certifications that suggested that testing had taken place on particular dates when it had not. The district court rejected Mr. Oh's guilty plea after determining that he had not actually acknowledged his guilt. Fed. R. Crim. Proc. 11. This contention is meritless. The district court properly determined that in light of Mr. Oh's insistence that he had not intended to defraud the government, pleas of guilty to these four fraud counts were inappropriate. The Government was therefore entitled to present the evidence relative to these counts to the jury. The court did not err in denying a new trial on these grounds.

CONCLUSION

Accordingly, we **AFFIRM** the judgment of the district court.

Unconventional But Just What the Customer Needed

The Problem:

A tubing manufacturer needed to de-scale the interior of various sizes of stainless steel tubing that ranged in size from 1/8-inch ID to 2-inch ID and from eight feet up to 40 feet long. The customer was currently processing them manually with no recovery of used media and wanted to improve the process efficiency and production rate.

Green scale from the heat furnace covered the tubing interior, requiring pressure-blasting with aluminum oxide to remove it. The customer wanted to be able to blast up to five tubes at a time. Additionally, they were concerned about preventing scratches on the tubes during the process. Blasting was the final production process and the tubing would go immediately to packing and shipping, so it was imperative that the tubing be clean, dust-free, and customer-ready.

The customer sells their tubing into many different industries for a wide variety of applications, such as heat exchangers, military and aircraft applications, chemical processing, mechanical applications, heat transfer and monitoring, automotive, medical, and food processing applications.

The tubes must speed through the cleaning process and at the same time be handled gently within the manufacturing plant.

The Solution:

With decades of experience designing and building machines for tube blasting, we worked closely with the customer to incorporate features that suited their particular needs. The system included a 4 foot by 4 foot by 5.5 foot cabinet with a 40 foot long track equipped with nylon rollers. At the end of the rollers was the blast nozzle carriage with attached control panel. The carriage slides easily on rails pulling or pushing the rollers with it to accommodate any length of tubing. We incorporated two pipe-staging racks for holding the tubes pre-blast.

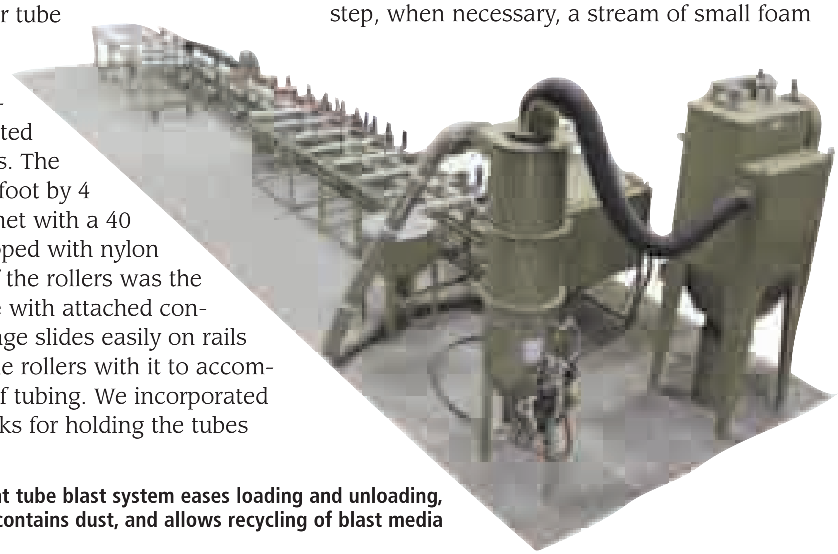
The system was fitted with two pressure blast machines of different capacities to accommodate their range of tube sizes. For the smaller tubes, a half-cubic-foot capacity machine with ½-inch piping, hose, etc., could blast up to five small tubes simultaneously. For the larger tubes, the second machine was a high-production six cubic foot capacity with 60-degree conical bottom.

The operator would load tubes in bundles of 50 or more on the racks. They would then roll each tube onto the track rollers made of UHMW nylon to protect the tube from external scratches. The exit end of the tube slides through a sealed opening on the side of the cabinet. After blasting, the operator rolls the tubes onto the support brackets attached to the side of each roller, allowing the control panel and blast nozzle carriage to be moved easily with one hand, and tying the support rollers and brackets all together. This system runs large quantities of tubes of varying lengths with virtually no setup time between parts.

Rubber nozzle inserts adapt the nozzles for different tube diameters so that the aluminum oxide media moves into and through the tubes, cleaning them in the process. Unlike a typical blast cabinet, in which blasting normally takes place, this system uses the enclosure to contain the media as it exits the tube. After blasting, the operator cleans the tubes by moving the end of the tube to a compressed air hose mounted next to the blast nozzle. As a final step, when necessary, a stream of small foam

Got a question about shot peening, abrasive blasting, or sample processing? Clemco can help.

Call Herb Tobben at 636 239-8172 or submit your request online at www.clemcoindustries.com Herb Tobben is Sample Processing Manager for Clemco Industries Corp. He is a regular speaker at the EI Shot Peening Workshop.



Efficient tube blast system eases loading and unloading, contains dust, and allows recycling of blast media

plugs is blown through the length of the tube to remove residual media and dust. The cabinet floor captures the foam plugs but allows the media to filter through, into the cabinet sump. An access door on the side of the cabinet allows workers to remove accumulated plugs periodically.

The system includes a media hopper with sight glass so that the operator can easily monitor the media supply, and a media-add system to refill the system automatically with new media. A 900 cfm rubber-lined reclaimer cleans the media for reuse and returns it to the blast machine. A reverse-pulse dust collector with photohelic sensor automatically pulses the cartridges clean and keeps the process environment free of dust.

Once we built the system, the customer tested the system in our facility and requested a few modifications before delivery. After installation, one of our field service engineers thoroughly checked the operation of the system and trained the customer's operators and maintenance personnel. The new blast system greatly increased the customer's production rate and quality, and reduced the amount of media waste and dust contamination around the blast system. And thanks to the ongoing communication between us, the new system was well-integrated into their existing plant.

Tubes enter a sealed opening on the side of the cabinet ensuring that media and dust are contained in the enclosure.

One of several special bolt-on nozzle adaptors, sized to suit tube ID, holds the tube in place at media-entry end.

eQuaLearn News

Second Quarter eQuaLearn Customer Satisfaction Reports

eQuaLearn reports on customer satisfaction with its professional development programs: 99% of attendees rated the instructors as excellent, very good or good and 99% of attendees responded that the instructors were extremely responsive, very responsive or responsive to their needs as students.

Eighty-three percent of attendees found the class they attended provided all or most of the information they needed. Ninety-eight percent found the quality of the course materials and presentation to be excellent, very good or good.

Ninety-nine percent believe that the course they attended was extremely effective, very effective or effective in helping them to acquire new skills.

The data is based on responses to post-class feedback forms from 401 eQuaLearn professional development course attendees for the period January – March 2008.

eQuaLearn is part of PRI's Customer Solutions and Support, which aims to identify and meet customer demand in all areas of business relating to quality.

eQuaLearn Launches New Problem Solving Tools Course

On July 1, 2008, eQuaLearn introduced Problem Solving Skills, a new course designed to teach participants to conduct a rigorous problem analysis, provide a structure to assist with small and large problems, and introduce tools that will help structure and make problem solving easier. Problem Solving Skills was developed by subject matter experts and has been designed to assist quality industry professionals. This new course complements the existing quality-focused courses already offered by eQuaLearn, such as Internal Auditing and Root Cause Corrective Action.

The first session was held in Pittsburgh, Pennsylvania USA on July 21, 2008. eQuaLearn is part of PRI's Customer Solutions and Support, which aims to identify and meet customer demand in all areas of business relating to quality.

About eQuaLearn

Having been involved quality industry auditing since 1990, the Performance Review Institute (PRI) has a unique and in-depth insight into opportunities for improvement in quality industry training and personnel qualification. With input and approval from quality industry leaders such as Alcoa, SAE International, Goodrich, Honeywell Aerospace and Rolls-Royce plc, eQuaLearn offers professional development courses in subjects such as Internal Auditing, Root Cause & Corrective Action and Introduction to Pyrometry. For more information, visit www.eQuaLearn.com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External Characteristics of Shot Peened Surfaces

INTRODUCTION

Shot peened components have two important external characteristics. These are:

SURFACE ROUGHNESS and
DIMPLE COVERAGE.

Surface roughness depends mainly upon the size of shot used. There is a simple analogy with the use of emery papers. The coarser the grit size the rougher will be the final finish. Two-stage shot peening involves using a finer grade of shot after a coarser grade. That is equivalent to using a finer grade of emery after using a coarser grade. Average roughness is easily measured and is well understood. The commonest roughness parameter is $\mathbf{R_a}$ which is the average vertical deviation from some reference line. Measurement techniques can be either two-dimensional or three-dimensional and may involve either direct contact or non-contact sensors. Peening is normally applied as a final treatment. The change of surface roughness induced by shot peening will therefore depend on the initial roughness of the component.

Dimple coverage is our prime indicator of the amount of peening that has been applied. The factors affecting coverage are reasonably well understood. Dimple coverage is usually quantified by using the parameter **C**. This is the ratio of dimpled to undimpled area. Measurement techniques vary from simple optical assessments to sophisticated image analysis procedures. J2277 is a standard specification for shot peening coverage determination.

Both surface roughness and dimple coverage change with increasing amounts of applied peening. This article considers the assessment and significance of these changes.

The use of digital scanning to assess the effect of peening is described. It is proposed that this can provide useful, objective, quantitative, information at low cost.

Dr. David Kirk is a regular contributor to The Shot Peener. Since his retirement, Dr. Kirk has been an Honorary Research Fellow at Coventry University, U.K. and is now Visiting Professor in Materials, Faculty of Engineering and Computing at Coventry University.

SURFACE ROUGHNESS

Roughness Assessment

Qualitative assessment of surface roughness is very familiar. We can sense substantial differences in roughness using a simple fingernail test. As a fingernail is drawn across a surface, electrical signals are generated and passed to the brain for analysis! Peened surfaces can be distinguished from unpeened ones blindfold. Commercial instruments involve similar principles to that of the fingernail test. A diamond stylus is drawn across the surface that senses vertical changes in its position, see fig.1. The profile of vertical height changes is displayed relative to a derived datum line, **A-B**. The vertical movement of the stylus is electronically amplified relative to its horizontal travel (mountains are made out of molehills!).

The commonest roughness parameter is **Ra** – which is simply the arithmetic average of deviations from a derived datum line. This datum line is automatically derived from the gradual change of displacement that is caused, for example, by roundness of the component. The actual estimation of **Ra** is done by adding up the absolute values of vertical displacements from **A-B** and dividing by the number of measurements. 'Absolute values' are those with the plus or minus sign being ignored. The accuracy of measurement increases with the number of points taken.

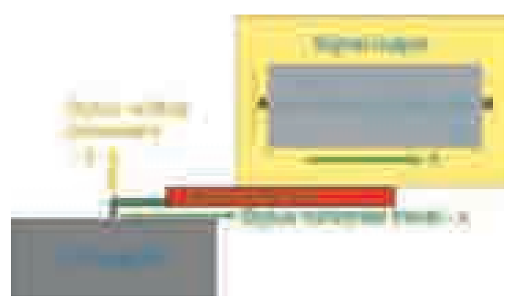

Fig.1 Schematic representation of a 'profilometer' instrument.

Roughness induced by Machining and Peening

Most components submitted for shot peening are 'finish-machined'. Shot peening is normally a final stage of processing. The roughness imparted by machining is quite different from that imposed by shot peening. Machining involves deforming a chip until it fractures away from the surface.

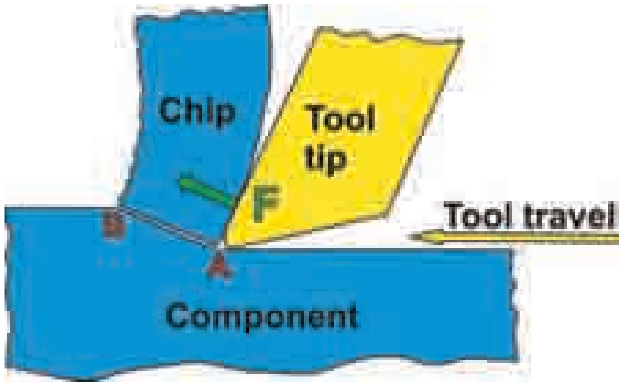

Fig.2 Chip formation during machining.

The phenomenon of chip formation is similar for all types of machining - including grinding, honing, lapping, planing, turning, and milling. Chip formation is illustrated in fig.2. The tool tip presses against the chip with a force **F** causing severe plastic deformation near the tip with consequent shear fracture along a line **A-B**. This mechanism is quite different from shot peening where indents are produced by plastic flow.

The difference in roughness generation mechanisms means that we have different 'textures' for machined as compared with peened surfaces. This is illustrated in fig.3 - showing model profiles of machined and peened surfaces that have the same **Ra** values.

Fig.3 Comparison of machined and peened surface cross-sections.

Although the **Ra** values are the same for the hypothetical situation of fig.3 the 'textures' are different.

Roughness Evolution during Shot peening

As a general rule the roughness of machined components will be less before peening than after peening. During peening the roughness of the component will therefore increase. The evolution of this roughness increase is illustrated in fig.4. For this example, standard and fine-polished Almen A strips have been peened for different numbers of passes. The conditions were maintained as constant as possible using S230 shot, at 20 psi air pressure, 9·4 lbs/min. and a 0·36" nozzle 5·75" directly above clamped strips.

Fig.4 indicates that roughness evolution has the same exponential shape as does saturation intensity curves. Roughness steadies at a maximum value with an amount of peening equivalent to that needed for 'full coverage'. The saturation 'time' of 5·7 passes (same for both sets of strips) was derived using Curve Solver and is shown in fig.4 for comparison purposes.

It is of passing interest to note that the fine polishing treatment actually roughened the strips! In terms of Ra values that for the Standard strips was 0·249μm and for Pre-polished strips 0·327μm. This difference is preserved

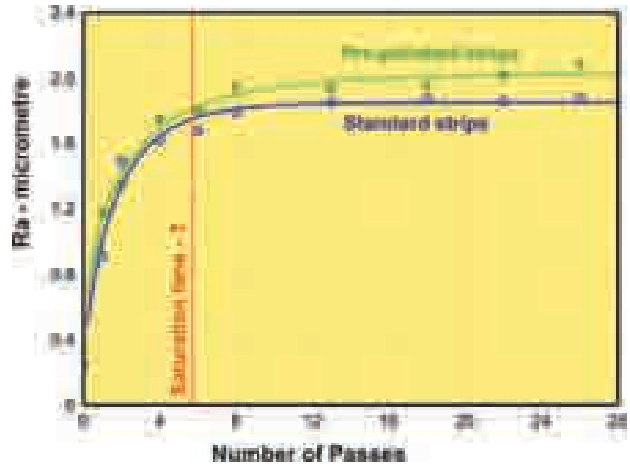

Fig.4 Roughness evolution of Standard and Pre-polished Almen A strips using S230 shot.

during peening so that the pre-polished strips end up with a slightly greater roughness than do the standard strips.

DIMPLE COVERAGE

Dimple coverage is very familiar, with coverage, **C**, being a specified parameter. The mechanism of dimple production and the evolution of coverage have been dealt with in previous articles in this series. The intention here is to concentrate on dimple coverage measurement.

Area versus Linear Measurement

Fig.5 illustrates the essential difference between area and linear dimple measurement.

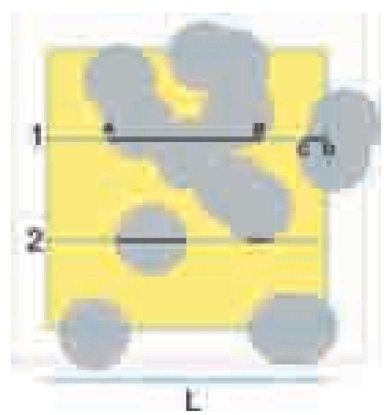

Fig.5 Area versus Linear measurement of coverage.

There are fourteen randomly-placed 'dimples' in the model shown in fig.5. The problem is to estimate, accurately, the coverage within the blue square of side, **L**. Area measurement is a direct comparison of the areas occupied and not occupied by dimples. A simple visual comparison involves the same procedures as those used by a sophisticated image analysis system. The eyes act as a camera producing a retinal image which is then analyzed by the brain. Most readers would perceive that the coverage by 'dimples' in fig.5 is about 50%.

Lineal measurement is a well-established procedure for quantifying coverage. Consider line **1** in fig.5 that has a length **L**. Two parts of the line, **AB** and **CD**, pass through 'dimples'. If **L = 100mm and AB + CD = 62mm** then

lineal analysis indicates that the area proportion ([AB+CD]/L) is 62mm/100mm which is equivalent to **62%**. If we apply the same procedure to line **2** the two segments have a combined length of 32·8mm. 32·8mm/100mm is equivalent to **32·8%**. If we now take the average from the two lineal measurements we have (62+32·8)/2 = **47·4%**. That is very close to the 'true' value for fig.5 - which happens to be **49·7%**. This example is intended to indicate the need to take several line measurements because of 'statistical fluctuation'. Lineal analysis is very easy to carry out. Any picture on a computer screen, magnified if necessary, can be scrolled up to the top border and a ruler then used to take measurements of an **L**. **AB**, **CD**, etc.

Lineal measurements only depend on identifying line/dimple-edge intersections.

Area measurements using image analysis is a complex subject and has been discussed in a previous article in this series. A very important point is that the accuracy of image analysis depends on being able to (a) delineate all of the dimple-edge positions and (b) to separate dimpled from undimpled regions.

Delineation of dimple edges severely restricts the accuracy of image analysis.

Several procedures have been developed to try and overcome the delineation problem. One such procedure involves using Adobe Photoshop to manually 'paint' black those areas judged to be dimples. The resulting image is then capable of being image analyzed. Unfortunately a subjective factor is introduced and the technique is very time-consuming.

Lineal analysis can be applied either to enlarged images of peened surfaces (requiring only a ruler as equipment) or directly to the peened surface (using a microscope equipped with a vernier micrometer eyepiece).

Delineation Problem with Dimpled Surfaces

Fig.6 illustrates the delineation problem that besets dimple coverage analysis. It is very difficult to differentiate between peened and unpeened areas! Using a scanning electron microscope, S.E.M., has its advantages and disadvantages (apart from non-availability on the shop floor). A major advantage of an S.E.M., for most studies, is that it has a greater depth of focus than has an optical microscope. Dimples, however, are shown up by their depth as much as by their edges. Hence an S.E.M. does not offer any significant advantage over a simple optical microscope.

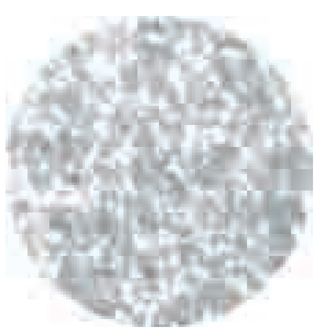

Fig.6 Digital optical microscope photograph of Almen strip peened with S230, x8.

The main reason for our delineation problem is the wide-angle 'field of view' that is inevitable with either optical microscopes or the human eye. We see light from a wide range of angles, all at the same time.

Fig.7 illustrates the origin of the wide-angle field-of-view feature. Light reflected from any particular point on the surface will enter the microscope's objective lens – provided that it lies anywhere within a (three-dimensional) cone angle of 2α – about 70°. This means that light from a wide range of angles around a dimple will be imaged – resulting in low contrast.

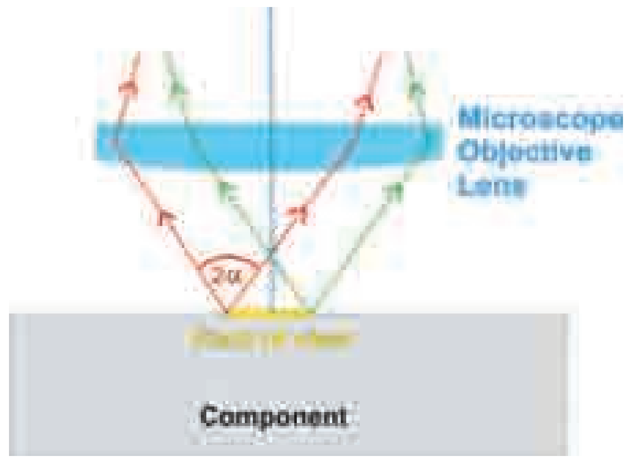

Fig.7. Wide-angle field of view for optical microscopes.

SCANNED IMAGES

Scanning involves a very narrow-angle field of view—leading to much higher dimple resolution than is obtained using conventional optics. Scanners are readily available, so that scanned images are a viable alternative to camera images. Scanned images can be quantitatively analyzed using graphic image manipulation. Hence we have a low-cost, simple, technique for assessing coverage. The term "graphic image manipulation" is the main part of "G.I.M.P." which is a freeware program downloadable from the internet.

Image Resolution and Delineation

A grayscale scanned image is different from that of an optical photograph. Fig.8 illustrates the difference when compared with fig.6. Scanned images are very dark when high coverage levels have been imposed. The dimples deflect incident light much more when scanned than when photographed.

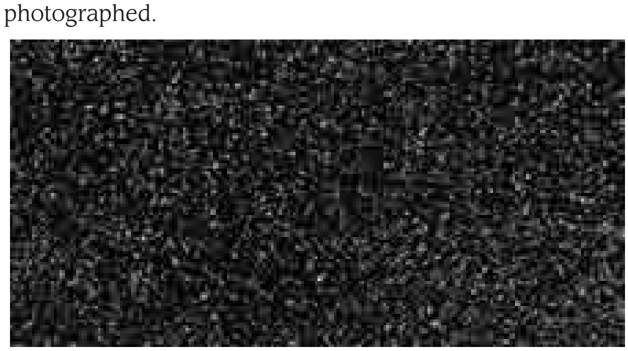

Fig.8 Scanned image of Almen strip peened with S230, x8, 1200 dpi.


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The reason for the high deflectivity of scanned peened surfaces lies in the mechanics of scanning. Thousands of CCD (charge coupled device) elements are arranged in a long thin line. The 'field of view' is therefore very restricted (at a given instant of the scanning) leading to enhanced delineation. Each CCD samples a minute area of the surface generating an analogue voltage that is converted to digital values by an analogue-to-digital converter. The scan head is moved along lines and to new line positions using precision stepper motors. Image brightness is remarkably constant for a given deflectivity of scanned area.

Scanned Image Manipulation

Scanned images are stored as, for example, jpeg files that can subsequently be analyzed. Image manipulation programs allow the image to be analyzed for 'pixel darkness' - with the results being presented as a histogram. Fig.9 shows an image of a set of Almen strips produced using a standard scanner at 1200 dpi.

Fig.9 Scanned image of a set of pre-polished Almen strips having progressive peening levels.

All ten strips in the set were scanned at the same time and are arranged left to right in terms of increasing amounts of peening. The 'darkness' of the strips increases with increased peening - readily discernable to the naked eye.

Quantitative analysis of strip darkening is readily done by using the histogram feature of a graphic image manipulation program. Keen photographers may well be very familiar with histogram analysis. Fig.10 shows histograms for two of the strips shown in fig.9 – corresponding to unpeened and fully-peened conditions respectively.

(a) Unpeened (b) Fully-peened

Fig.10. Grayscale histograms of unpeened and fully-peened Almen strips.

For the type of histogram shown in fig.10 the horizontal scale represents 'reflectivity' on a scale of 0 to 255. The 'gradient bar' shows a corresponding variation from perfect black to perfect white. For the unpeened strip the mean value of the histogram corresponds to a 'light gray' whereas the fully-peened specimen has a mean value that is a 'very dark gray''. Quantitatively we are told that the reflectivity has gone down from 139·21 to 36·69 (mean values).

Scanned Image Analysis

Histograms of scanned samples represent a new way of analyzing the external surface changes induced by peening. Consider, for example, the histogram means for the ten strips shown in fig.9. These are presented in fig.11 as a function of the amount of peening that has been applied. There is a progressive reduction in reflectivity (equivalent to the histogram mean) as peening proceeds. The reduction is a close approximation to the exponential function that has been included in fig.11.

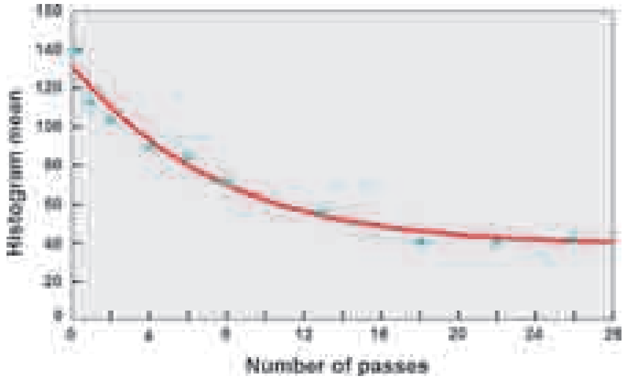

Fig.11. Histogram means as a function of amount of peening.

DISCUSSION

Shot peening changes the external appearance of components. Quantitative assessment of appearance change on the shop floor is, however, difficult. Coverage assessment is normally a specification requirement. Fortunately we are not normally required to provide quantitative coverage assessments. The photogenic quality of peened components varies enormously. Published photographs of peened surfaces are invariably from relatively-photogenic components. The specimens imaged in fig. 12, on the other hand, defy accurate analysis – even when armed with state-of-the art digital optical microscopes, scanning electron microscopes and sophisticated image analysis software.

Profilometers provide an accurate, quantitative, method of determining roughness changes. These are, however, normally too expensive to be an acceptable option. Optical measurements based on simple portable magnifiers are essential for qualitative coverage measurements. Digital cameras provide images that can be analyzed using image analysis techniques. Camera images, however, have very low resolution (mainly due to the wide angle field of view) for most peening situations. Fig.12 is a digital camera photograph of the same set of strips shown in fig.9. This clearly shows a relatively low level of contrast. Image analysis of most peened surface pictures is very time-consuming and also has a subjective element.

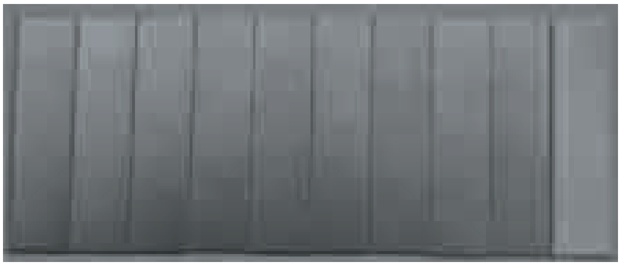

Fig.12. Digital optical photograph of a set of Almen strips peened after pre-polishing.


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Digital scanning shows considerable promise as a technique for measuring, quantitatively, surface appearance changes. It must be stressed that it is change that can easily be measured. Hence we must determine the histogram before and after peening – using the same scanner and scanner settings. The reflectivity of the unpeened component depends on several factors – especially machining. Conventional flat-bed scanners restrict the range of components that can be examined. Portable 'pen' scanners are now available and are becoming more refined. Much more research will, however, need to be carried out before scan procedures can be implemented as standard practice.

Surface roughness, coverage and scan reflectivity all follow an exponential path as more and more peening is applied. This implies that all three parameters are directly related.

It has been shown that surface roughness increases (for fine-machined or polished surfaces) with increased peening. The roughness is exponential to a value that will be directly proportional to the size of shot that has been used. Surface roughness can therefore be used by the user as a measure of the shot size that has been applied to fully-peened components.

The increase in surface roughness induced by most peening operations is not necessarily detrimental to service performance. Consider the situation presented schematically in fig.13. A 'furrow' produced by machining will force applied tensile stress lines around its tip. Hence the furrow acts as a stress raiser. The concentration of stress lines is analogous to the isobars on a weather map. Very close isobars indicate severe weather!

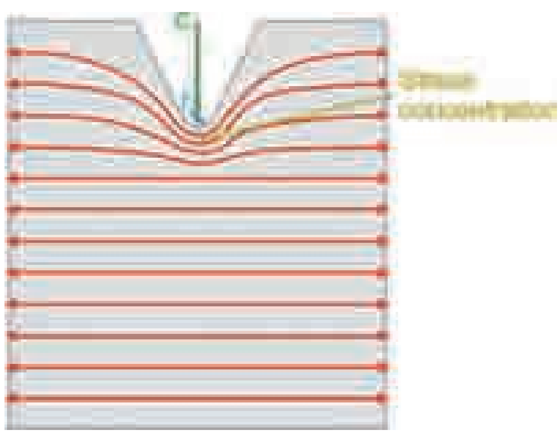

Fig.13. Concentration of 'stress lines' around the tip of a machined furrow.

Standard theory indicates that the stress concentration factor, **S**, is given by:

$$\mathbf{S} = \sqrt{(\mathbf{c}/\mathbf{r})} \qquad (1)$$

where **c** is the depth of the crack and **r** is the crack tip radius.

If the depth of a machined furrow is some nine times that of its tip radius then application of equation (1) would predict a stress raising factor of three. With peened surfaces the radius of the dimples is much larger than the dimple depth so that stress concentration is negligible. Very fine machining imparts correspondingly-small values of **c** and therefore smaller stress concentrations than for coarse machining. A fully-peened surface will have dimples replacing all of the machining furrows.

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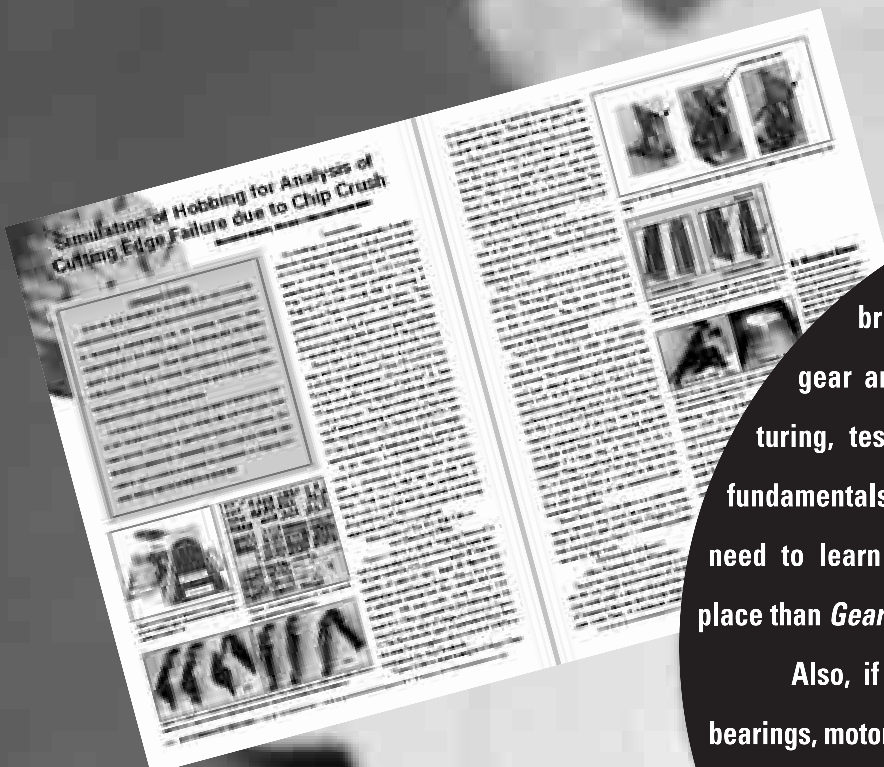

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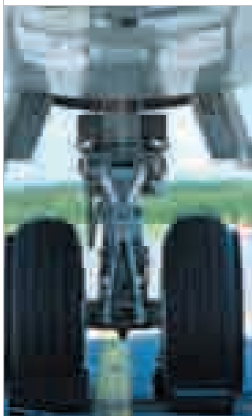
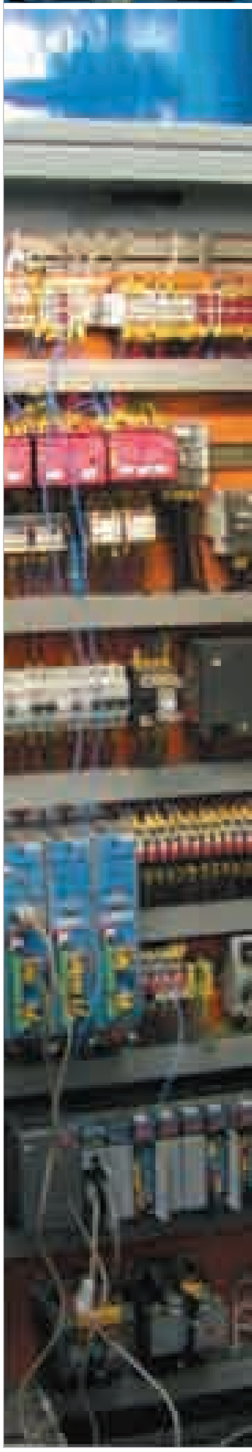




The Modernization of a Shot Peening Machine for Goodrich Krosno

The Goodrich company in Krosno, Poland has received good service from a 36-year-old machine built by Wheelabrator Corporation of Canada. The machine has a large two-wheel blasting cabinet equipped with a 96-inch rotative table and a vertical lance unit for shot peening pipe interiors. The machine was due for a routine renovation and Goodrich decided it was a good time to also update the machine's control and shot flow system. The aim was to improve the efficiency of the machine, reduce production costs, increase its reliability and improve ease-of-use for the operators. Goodrich expected the renovation to simplify the calibration and measurement procedures and reduce the time required to change production parts. Goodrich chose EL-Automatyka in Rzeszow, Poland for the modernization project.

Scope of the Project

The project, prepared by EL-Automatyka, assumed the complete renovation of mechanical systems of the machine, the improvement of the recovery system, and the installation of a dust collector that would meet the current environmental regulations. The most important goals of the project were to meet Goodrich's requirements for controlling the process.

To better control the machine's wheel blasting functions, the old mechanical shot flow control valves were replaced with a MagnaValve VLP1000 with an amperage controller. The applied PLC controller was equipped with EL-Automatyka's software which converts the given values of the power of the engine charges to the values of the shot flow in pounds/min. The counts are based on the data from the last calibration which is also supported by software. In order to increase the accuracy of the shot flow regulation for the individual wheels, the value of the presently measured power of the wheel charges went under the modernization subtracting the value of the power of no-load run in engines of blast wheels. This step allowed Goodrich to get rid of the nothing-giving information part of the value of the power of the engine charges called as the power of no-load run, and, in this way, to improve the accuracy of indications and regulations. It has its special meaning in the rate of low rotative speeds (600 to 1200 rpm) where the whole opening (1000 lb/min) of the VLP valve causes a slight increase of the charge power.

The motors of the blast wheels of the 18 kW power are driven from the frequency converters for enabling the regulation of their rotative speeds which were required by the applied Goodrich shot peening technologies. The rotative speeds are measured and displayed on the control panel. Also, the drives of the table rotation, lance rotation and its line movement are powered from the converters.

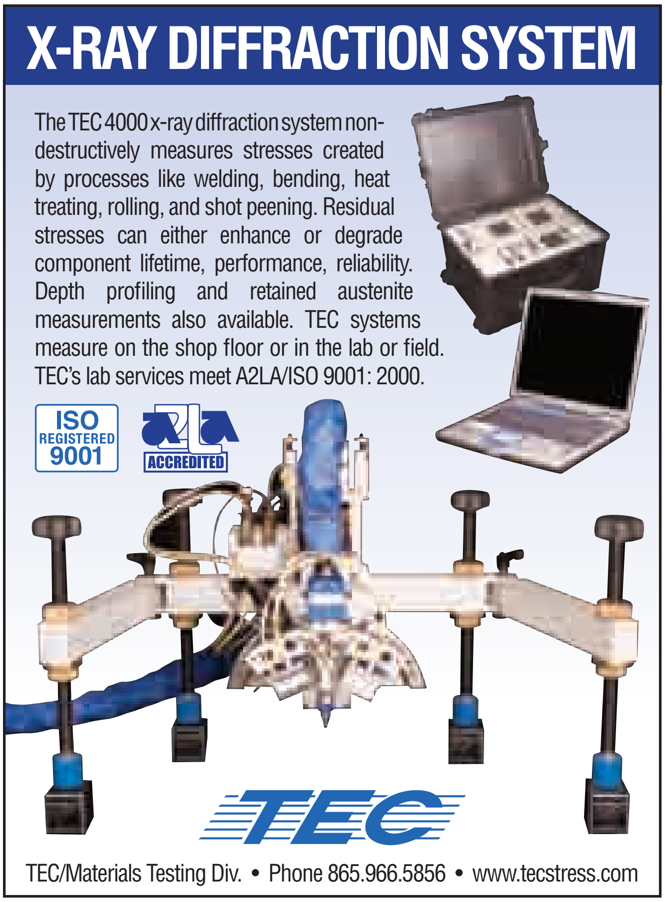
The touch panel control system allows the programming of the parameters of the blasting cycles in the chamber of the two-wheel basting cabinet and in the air blasting unit of the lance used for shot peening the inside details in the pipe shape. The PLC controller also supervises and controls the dust collector, classifier and the recovery system. All tooling parameters are measured by periodically certified devices as required by the regulations at Goodrich.

Results

The following information was provided by Wojciech Cmok who is a Special Process Engineer at Goodrich.

Energy Savings

Thanks to the opportunities available to us because of the precision shot flow control, it is now possible to lower blasting time approximately 15-30%, depending on the dimensions of the part. Moreover, due to getting the proper combination of parameters, (the flow versus


X-RAY DIFFRACTION SYSTEM
The TEC 4000 x-ray diffraction system non-destructively measures stresses created by processes like welding, bending, heat treating, rolling, and shot peening. Residual stresses can either enhance or degrade component lifetime, performance, reliability. Depth profiling and retained austenite measurements also available. TEC systems measure on the shop floor or in the lab or field. TEC's lab services meet A2LA/ISO 9001: 2000.
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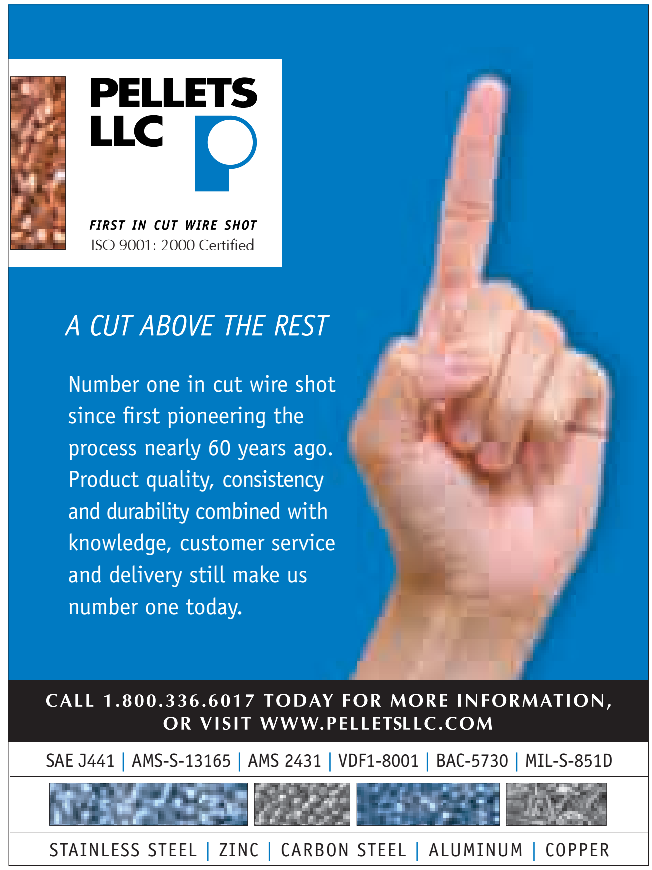
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the rotational speed of blasting wheels) the enlargement of the batch was possible.

Ease-of-Use

The machine is simple in use because it is controlled from one place—the touch-panel. The operator sees in one place all parameters of the machine including the elapsing time of the process. The setting of the process parameters is very simple and intuitive (i.e., the flow of the shot, speed of the blasting wheels, the rotation and the lance movements). Before the modernization, the change of the shot flow was a time-consuming operation, because it needed the change of the plate position with calibrated openings. Generally, all the steps taken by El-Automatyka resulted in the improvement of the ergonomics of the work and visualization of process parameters.

Reduced Shot Usage

The quantity of the shot in the machine did not undergo changes, instead, thanks to the use of the magnetic valves, its usage became better. The possibility of the adjustment of the flow for every wheel in wide limits made it possible, with the maintenance of all qualitative requirements, to shoot both small parts (approx. 2 inches) and large (above 50 inches) easier and quicker. What is more, this adaptation of the value of the flow to the kind of treated material (alloys Al, alloys Ti, and steel) eliminated defects typical for soft metals, such as "rollover" and "bulging".

Reduced Maintenance and Repairs

The modernized system of the shot handling and controlling practically does not demand service. The use of the new dust collector and recovery system improved the quality of the work — the environment is clean and free from dusts. Additionally, we are capable of working parts from alloys of Titan during which inflammable/explosive dusts are created. The periodic calibration shows that the characteristics of the system of the shot administration of the shot does not change— it remains in a field of the tolerance. Also, the PLC software is superbly efficient. Definitely the machine requires less service.

Compliance

Thanks to the solutions applied by EL-Automatyka, the shot peening process in Goodrich Krosno meets all the requirements held in the aviation industry and also in Nadcap.

About Goodrich - Krosno, Poland

- Small components gear manufacturing
- 98,799 square foot facility
- Employs 198 people

Goodrich designs, manufactures and services complete landing gear systems for commercial, military and business aircraft. With major landing gear facilities in the U.S., Canada and Poland, Goodrich handles jobs worldwide.

About El-Automatyka

El-Automatyka provides control systems and re-engineering to machine tools and other machinery. The company also designs and manufactures control systems for waterworks and pumping-stations. Other services include control systems for shot peening and blast cleaning processes. El-Automatyka distributes Electronics Inc. products including Almen strips and gages. For more information:
Telephone (+48 17) 85 47 198 Fax (+48 17) 86 22 539
Email: el@pro.onet.pl www.el-automatyka.pl

Industry News

Jodhpur, India. MecShot is introducing new five shot peening machines for various applications.

CNC ROBOTIC SHOT PEENING MACHINE FOR AEROSPACE COMPONENTS
A Robotic machine for shot peening of various components of aviation industry, in which the small components are placed on the Turn Table manually and clamped and bigger, lengthier components kept on the idler roller and brought in the reach of the Robot.

A Blast Nozzle or Rotary Lance, mounted on a robotic arm, completes the pre-programmed operation. The shot peening media get recycled in the reclaimer through size and shape classifiers and fed to the continuous blast generator through deflector valve and storage hopper. The fine dusts are trapped over filter cartridge and are cleaned through reverse jet action in dust collector.

CNC SHOT PEENING MACHINE FOR ROCK DRILL BITS
This mechanical nozzle reciprocation system with pre-programmed automation enhances the fatigue life of rock drills. To achieve uniform shot peening intensity, finish and shape, it is essential that shots are periodically classified. Shot separator is suitable for separating usable shots from a charge of used shots, containing round shots as well as broken grits. Used shots are charged in a hopper. Usable sized shots/grits are then discharged at the top of a spiral separator. This mix rolls down along the spiral and gets separated into round shots and broken or malformed shots. Round shots are transferred into dual pressure pots for reuse. The dust generated gets trapped on cartridge filter element in dust collector and clean air is discharged in environment.

CNC SHOT PEENING MACHINE FOR CYLINDER BLOCKS
Mec Shot has manufactured an acoustic dry shot peening machine for earth movers industry. The machine operates on the direct pressure feed principle where a pre-masked cylinder block, mounted on a work car, gets shot peened automatically in a sequence. The nozzle reciprocates by XY Manipulator. The speed of work car, the reciprocating nozzle is variable with AC Drive Units and reciprocating stroke is adjustable by limit switches. The shot flow is controlled using a Magna Valve. The operating sequence is preprogrammed through PLC. The spent media gets reclaimed by Bucket Elevator. The shot is sized and classified for the shape in vibrating screen and shape separator where broken shot is separated from spherical shot. The classified shot is transferred to a pressure vessel for re-use. The dust particles get trapped in the dust collector's filter elements and the clean air escapes into the atmosphere.

CNC ROBOTIC SHOT PEENING MACHINE FOR AERO ENGINE

The automated shot peening acoustical enclosure has a 6-axis industrial robot located outside the cabinet with rotary head for internal peening of aircraft components. The machine is fully programmable and operates in auto mode. The front door, equipped with CNC Turntable interpolates with industrial robot, provides a total of seven adjustable axis. The nozzle is mounted on robot arm to provide even intensity and coverage over the width, length and height of the part envelope. From enclosure shots are conveyed by reclaimer/cyclone to remove dust and other contaminants, the media is passed through stage classification. Size classifier separates the media according to size and is passed to double chamber (continuous pots) peening machine. The dust particles get trapped in filter elements in dust collector and the clean air escapes into the atmosphere.

ROBOTIC SHOT PEENING MACHINE FOR TURBINE BLADES
This shot peening cabinet has an acoustical enclosure and six-axis industrial robot for shot peening of turbine blades. The machine is fully programmable. A turntable interpolates with industrial robot and provides seven adjustable axis. The nozzle is mounted on robot arm gives even intensity and coverage over the width, length and height of the part envelope. A special cloth is provided to protect the robot arm. From the enclosure, shot is conveyed by reclaimer/cyclone to remove dust and other contaminants, the media is passed through two stage classification. At first stage, size classifier separates the media according to size. After size classification, media is transported by bucket elevator to second stage "shape separator" so that media with a perfect spherical shape is passed to double chamber (continuous pots) peening machine. The dust particles get trapped in the filter elements in the dust collector and the-clean air escapes into the atmosphere.

For more information on these products, contact Vivek Mehra, Vice President of Marketing with Mec Shot Blasting Equipments, by email: mail@mecshot.com

Along with new technology comes the challenge of "how do you assure that the performance is appropriate and repeatable?"

Turning Technology into Useable Tools

New technology is changing the shot peening community. We've watched laser shock peening make significant contributions to very deep compressive stresses on blade leading edges. We've also seen a serious reduction of sliding friction due to Fine Particle Shot Peening and the Fine Particle Shot Peening Society in Japan. Rotary Flapper peening has been around since the 1960s having been developed for helicopter repair in Vietnam. Now we see some techniques to accomplish peening of small areas without the rotating flaps. Sonats in France has developed a unique ultrasonic vibrating plate that will agitate small peening balls which will strike your target surface with sufficient impact to create a large range of compressive stresses. This equipment is available in either stationary or mobile format. Sonats also has a device that uses ultrasonic vibration to activate a series of small needles; a modern version of pneumatic needle peening.

Along with new technology comes the challenge of "how do you assure that the performance is appropriate and repeatable?" The answer is simple. You turn to SAE and the AMEC sub-committee on surface enhancement, created last January at AMEC's annual meeting in Asilomar, California. The two-day conference was attended by 29 charter members. This year, during a two-day meeting hosted by Lockheed Martin in Marietta, Georgia, the 19 members who attended the special committee were able to address a number of outstanding issues. These need action by SAE Aerospace committee but here are some of the topics that were discussed.

- AMS-S-13165's cancellation notice was revised to allow continuation of existing technical plans already approved and in service.
- AMS-2430 was revised to accommodate technical plans previously approved in AMS-S-13165.
- AMS-2430 has multiple revisions, still in progress, to continue to improve the control of the peening process.
- AMS-2431 has multiple revisions to accommodate differences in media size inspection when using sieve shaking devices, adjustments to several glass bead sizes, addition of several ceramic bead sizes, introduction of a new low sodium glass bead of high durability for fine particle shot peening, and many more issues.
- NEW: An AMS version of a flapper peening specification intended to displace the MIL-R-81841 specification which has several erroneous concepts and requirements.
- NEW: An AMS specification for ultrasonic activated ball peening.
- NEW: An AMS specification for ultrasonic activated ball peening media.
- NEW: An AMS specification "Word for Word" adoption of the recently cancelled MIL-W-81840 spec "Wheels for use with Rotary Flap Peening".

If you wish to become active on this committee, you can join with the other 62 leading experts on shot peening by contacting Al Patterson at Lockheed Martin at a.patterson@lmco.com.

The surface enhancement meetings convene in January and August. Not all of the traction on specifications takes place at the AMEC meeting. Many of the industry and proprietary specifications refer to the SAE "J" series of standard practices. On October 14th the SAE Fatigue Design and Evaluation Committee Surface Enhancement Division, custodian for the "J" practices, will meet for its semiannual meeting at the University of Toledo to discuss changes to J442, J443, J444, J2277 and J2441. To participate in this committee, email me at jack.champaigne@shotpeener.com. Applicants do not have to be U.S. citizens and you do not have to join SAE (but joining SAE is encouraged).