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The Shot Peener

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

A New Age In Manufacturing Is At Hand

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

The Evolution of Specs

I ENJOYED READING Dr. Kirk's article on the evolution of SAE J 443 on page 24. It helps to keep a perspective on how technology changes over the years. We are now involved with more changes to AMS 2430, Shot Peening. This document was originally published by SAE in 1948. Soon after I joined the AMEC task group, I volunteered to make some minor changes (Revision L). I said it could be done in about six weeks. It actually took six years and 14 ballots. That was back in 1997.

JACK CHAMPAIGNE
Editor

Fast forward to 2012. James Kernan, U.S. Army Aviation and Missile Research, Development and Engineering Center, offered to make some minor changes to AMS 2430. It's almost ready to be published (Rev S) after several years of committee effort.

But, there is more work to be done. SAE adopted and then eventually cancelled the MIL-S-13165 shot peening spec and directed users to AMS 2430. Although the mil-spec did not allow manual peening, a significant amount of manual peening was practiced. The problem now is AMS 2430 specifically bans manual peening. This has resulted in "orphans" that don't have a spec. The net result is two volunteers from large aerospace companies have offered to write new documents, one for manual peening and one for batch peening (tumble blast, barrel blast).

When you consider this history, and the articles from Bandini (page 16) and Simmons (page 34), you might conclude there are opportunities for improvement to our industry standards. This is your invitation to join our SAE committees and help with these specs. If you wish to join please call me (1-574-256-5001) or send me an e-mail at jack.champaigne@electronics-inc.com.

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Kathy Levy | InfoProse

A New Age In Manufacturing Is At Hand

THIRTY CRITICAL MACHINE TOOLS at ITAMCO have been selected to provide real-time, accurate information about their performance. Improvement opportunities will become apparent to everyone, from machine operators to the Chief Financial Officer. "Right now, we don't know what we don't know," said Joel Neidig, an engineer at ITAMCO. That's a typical problem for manufacturing facilities that rely on verbal and paper records to evaluate machine performance and workflow. Machine statistics are very difficult to gather and organize into any kind of coherent picture. If machine data is tracked manually, the information might be outdated before it's compiled or inaccurate.

Making Their Machines Talk

ITAMCO's IT and engineering staff had made a commitment to plant data gathering and job scheduling software. What they lacked was the tool to pull the information from a diverse equipment inventory, including their shot peening machines, into a format that was readable by the software. Initial proposals for expensive and proprietary products were rejected because the ITAMCO staff didn't like the idea of being tied to one vendor and not having enough control over the system.

Joel found a solution at the 2008 International Manufacturing Technology show when he attended a presentation on a fledgling communications standard called MTConnect. MTConnect was the answer to a wake-up call at the 2006 Association for Manufacturing Technology (AMT) conference. David Patterson/ University of California, Berkeley and David Erdstrom/Sun Microsystems presented the need for an open communication standard to enable Internet connectivity for machine tools. Without it, they warned, the lack of control over manufacturing processes would hinder manufacturing's ability to keep up with global demand. AMT took on the challenge and invested $1 million in the MTConnect project.

When the MTConnect standard reached an acceptable maturity level, ITAMCO was ready to become one of its first implementers.

MTConnect Is a Free and Open Bridge

"To say MTConnect is revolutionary is a gross understatement. Connecting machines and collecting data using the same protocol not only gives in-plant management far greater agility and control; it also allows for a level of communications between suppliers, customers, OEMs, sales and international partners that could easily be the greatest achievement for manufacturing since CNC. Or even the Internet itself."

—A.J. Sweatt
AJ Sweatt Logic and Communications

AMT's MTConnect developers wanted a universal shop floor communications protocol and their solution was MTConnect's plug-n-play approach. We all appreciate the ease of plugging in a printer, cable modem, or thumb drive to our computer—MTConnect does the same thing for numerically controlled machine tools.

MTConnect is an open, extensible and royalty-free standard. Simply put, the MTConnect protocol is based on standard internet technologies: HTTP (Hypertext Transfer Protocol) and XML (Extensible Mark-Up Language)—the underlying language of most web sites. Extensibility, the consideration for future growth, is a key feature of the MTConnect standard since one standard can't address every data type needed on the plant floor now, or in the future. And to ensure MTConnect's acceptance in the manufacturing community, the MTConnect standard is free. It can be downloaded from the internet.

A system that uses the MTConnect standard is made up of five fundamental components.[1] (See Figure 1 on page 8.)

Device
The CNC machine tool.

Adapter
Think of it as a translator. The adapter is a software program that enables shop floor equipment to speak MTConnect's language—an adapter extracts the CNC's data and makes it

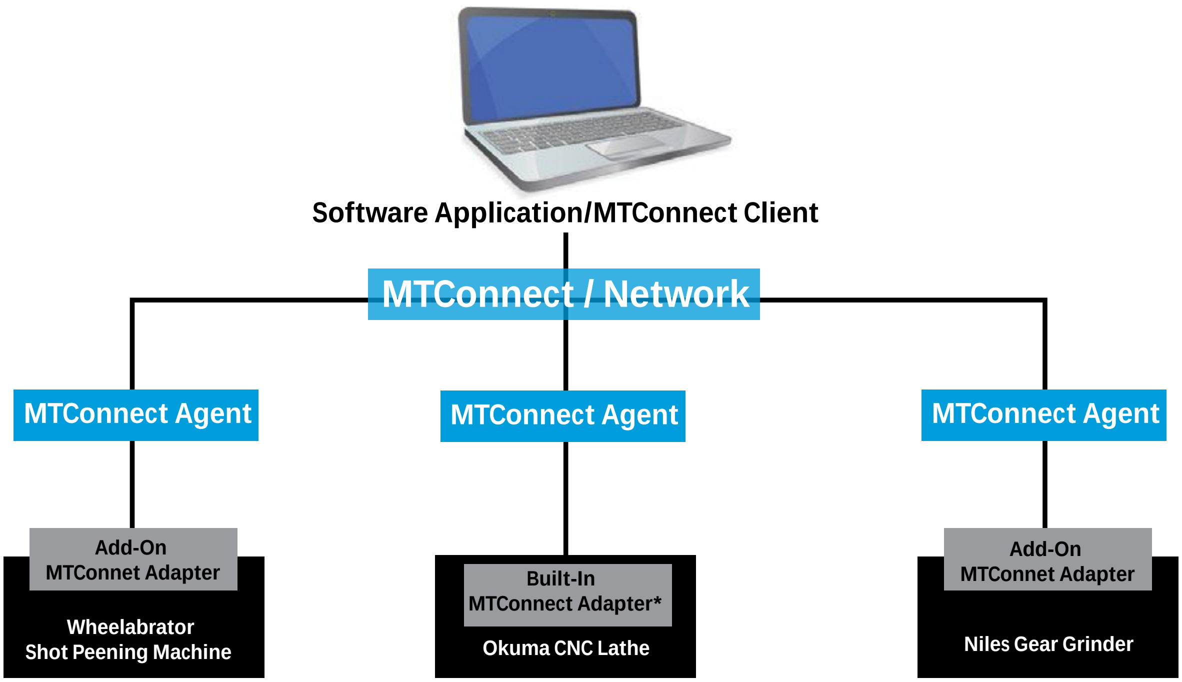


Figure 1. The fundamental components of a system with the MTConnect standard, using ITAMCO machine tools as examples.
**More and more OEMs, like Okuma, are building MTConnect adapters into their equipment.*

available to the MTConnect agent. For legacy machines, the adapter is a piece of hardware (see Figure 2). Many machine tool OEMs, like Okuma, are using MTConnect as their native language and adapters aren't needed with their products.

Agent
A software program that collects, arranges, and stores data from the adapter (or directly from the machine tool if it has a built-in adapter). The agent then takes data from the adapter, converts it into the terms and format defined by the MTConnect standard, and makes the translation available on the network in the same way a website makes data available. This formatting enables the data to be collected and transmitted by the corresponding MTConnect agent for use by an application.[2]

Network
The physical connection between a data source (machine tool) and the data consumer (software application). The communication on the network normally uses HTTP protocol, a standard network communications method. MTConnect structure is adaptable, however, and can be implemented in conjunction with other networking solutions other than Ethernet and internet protocols.

A connection from a machine tool to the MTConnect network can be as simple as an ethernet cable or a wireless network. A common question is, "Will my machine be connected to the internet?" No, HTTP is only a communication method

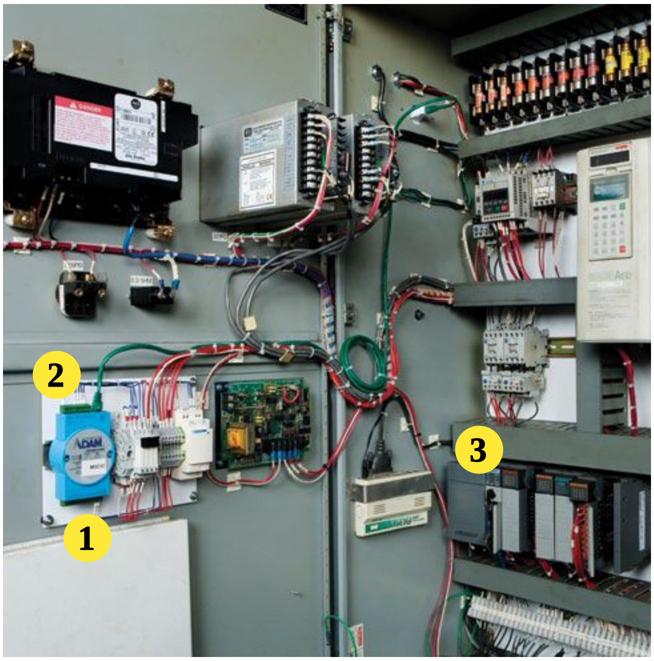


Figure 2. The adapter configuration for the Wheelabrator:
1. The adapter - the Wheelabrator is a legacy machine and requires a hardware adapter
2. An ethernet cable connects the adapter to the network
3. The adapter connects to the machine's PLC

and your data is protected by your network security standards, including firewalls or other popular security methods. If you want to collect and share data with your facilities in several countries, that is entirely possible and the data will be protected.

Application/Client

The application is the actual requestor and consumer of MTConnect data. Typical functions of the application are to request, store, manipulate and display data. The application includes a function called the client which initiates all requests for MTConnect data. Popular applications are shop floor monitoring and energy consumption tracking. An important fact to remember is that MTConnect isn't software specific, it can be used with a smartphone app or plant data acquisition software.

What Problems Will MTConnect Solve?

ITAMCO's machine monitoring system—MTConnect and shop floor data acquisition software—will provide "machine truths" so ITAMCO can make accurate assessments on production cycles. For example, a machine with excessive downtime and the reasons for downtime will become apparent. ITAMCO can then schedule repair and ongoing maintenance for the machine, evaluate upgrading or replacing the machine, or add an additional machine to accommodate heavy workflow.

ITAMCO's data will be available on office computers, LCD monitors on the shop floor and even iPhones and Androids. Joel developed a MTConnect smartphone app that displays machine status, cycle lengths, number of parts ran and tolerances. The data from the MTConnect app can be exported into an Excel spreadsheet.

After the monitoring program is implemented, ITAMCO will integrate the manufacturing equipment data with the their ERP (Enterprise Resource Planning) system to provide a complete view of their business operations and to compare the machine performance data to projections and targets.

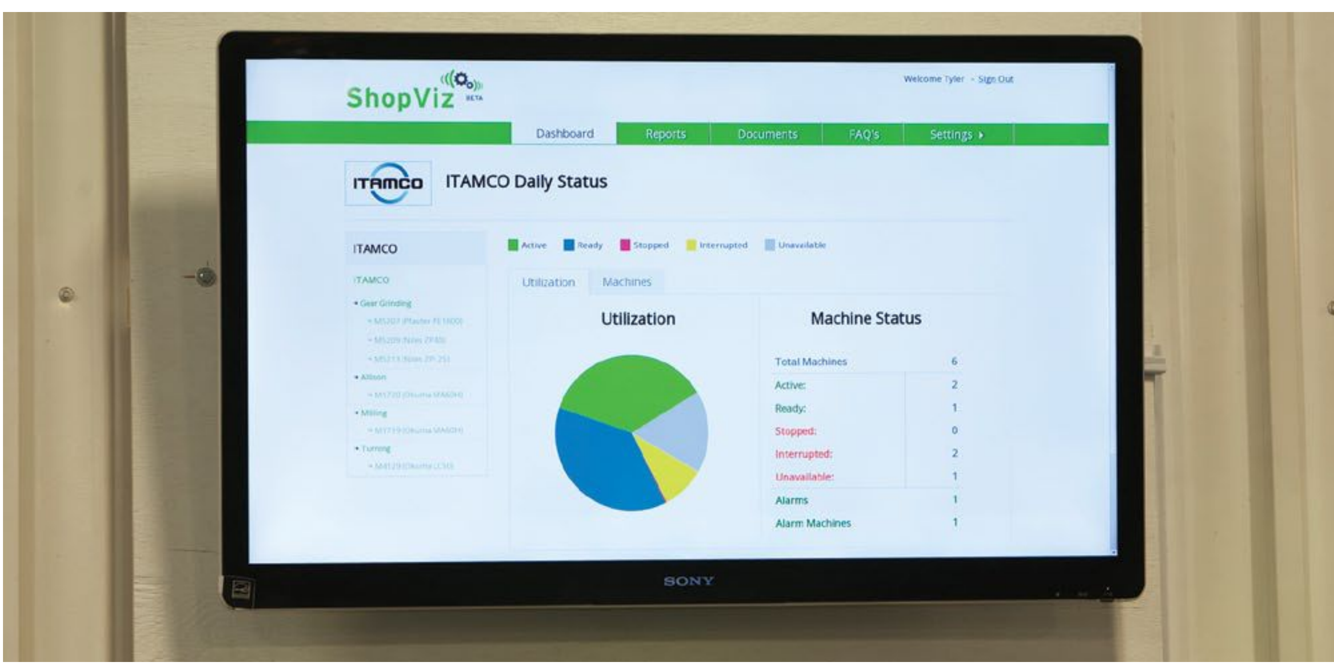
The following are some of the additional applications for data as available from current system integrators and software vendors.[1]

Dashboards for the Shop Floor

A shop floor dashboard, named for the dashboard of an automobile, provides at-a-glance views of key performance indicators (KPIs) gathered from software monitoring operations on the machine tools. Just as the driver can easily monitor the major functions of his car from its dashboard, every one on the shop floor can see what is going right and what is going wrong and quickly make adjustments. Dashboards are usually a series of graphics, charts, gauges and other visual indicators and can either be strategic, analytical, operational or informational. While a car's dashboard is the same on every car of the same model, business dashboards are unique to each business and the dashboard's design is driven by the business and the performance metrics it needs to track.

Alerts

Alerts are notifications of changes on the shop floor that



This LCD monitor on a shop wall at ITAMCO displays a dashboard with easy-to-read performance indicators of the gear grinding, milling and turning machines that are connected to its monitoring software. ITAMCO can customize their dashboards to display the performance metrics they want to track.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require the attention of management, maintenance, etc. Alerts are provided by alarm displays on a computer, email or text notices, or on a dashboard. Alert examples include:

- Machine down
- Parts running low
- Filters becoming clogged

A noteworthy point regarding alarms was made by Stephen Luckowski, Chief of Materials, Manufacturing & Prototype Technology with US Army ARDEC at the 2011 MTConnect conference: "*Typically when the machine alarms, it's too late, the tool is already broken. That means that just collecting and reporting alarms is only part of the problem. To prevent alarms that relate to downtime, we need to use MTConnect to understand the alarm and develop a pattern of what causes the downtime.*"

Equipment Availability and Usage
An analysis of each machine shows how effectively the machine is being used. Multiple machine states are typically pre-defined based on machine and process requirements. The machines are monitored by the data collation system and the time that a machine is in each state is accumulated for reporting.

Machine Downtime Analysis
From the machine usage information described above, each non-productive machine state can be further analyzed to determine the causes for lost production time. The downtime analysis can be broken down into planned and unplanned downtime with the unplanned downtime segregated into specific causes for the downtime.

Overall Equipment Effectiveness
Overall Equipment Effectiveness (OEE) combines machine usage information with quality measurements to gauge the end-to-end effectiveness of any process or machining operations. OEE is used to measure how a production operation changes over time, determine the impact of changes made on the shop floor, and to compare the effectiveness of different processes or machines.

Production Reporting/Tracking
Near "real-time" or periodic reports can be developed based on production data directly from the plant floor. Monitoring production levels, managing product flow through the production process, tracking inventory and raw material queues are a few of the possible applications.

Maintenance Tracking/Planning
Maintenance issues typically fall into two categories: Machine/Process Faults and Preventative Maintenance. Alerts warn maintenance staffs of issues that need immediate attention on the shop floor. Preventative maintenance plans have often been based on calendar time (monthly, quarterly and annually) with no consideration of actual production status or machine usage. Measuring operating times or number of operations directly from the machine will enable plant managers to effectively plan preventative maintenance programs.

Wheelabrator Shot Peening Machine Is One of the Chosen

Out of their inventory of 150 machine tools, ITAMCO chose 30 critical machines for the first phase of the machine monitoring system, including a 60-inch diameter Wheelabrator shot peening machine. "Since many of our products are shot peened, the shot peening machine is an integral part of the plant's workflow," said Joel. He explained the process to capture and identify the machine's productivity as follows: The machine operator will use an iPod Touch to scan the machine's barcode ID. He will scan his employee ID tag and then the barcode on the manufacturing order paperwork. He enters the quantity of parts to be peened in the iPod Touch and starts the machine. ITAMCO will track number of parts processed, cycle times, shot breakdown and maintenance scheduling for consumables like filters.

These transmission carriers are ready to be shot peened at ITAMCO.

As shot peening OEMs embrace the MTConnect technology, software applications will display, capture and record data on all shot peening parameters, thereby providing an electronic audit train to verify conformity to specifications or other process instructions. Members of the MTConnect Institute are already addressing topics relevant to shot peening OEMs including pulling data from closed-loop systems and sensors that aren't part of a CNC system, compliance testing/certification and robotics.

MTConnect's Early Adopters

The following organizations are members of the MTConnect Institute and are evidence of MTConnect's growing influence. Where available, implementation information as of November 2011 was added.

AMT - The Association For Manufacturing Technology

Bosch Rexroth Corporation

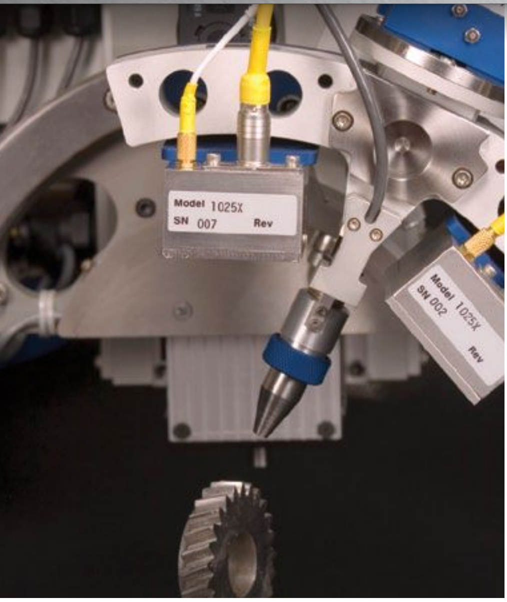
Curtiss Wright Controls Flight Systems *Eleven machines*

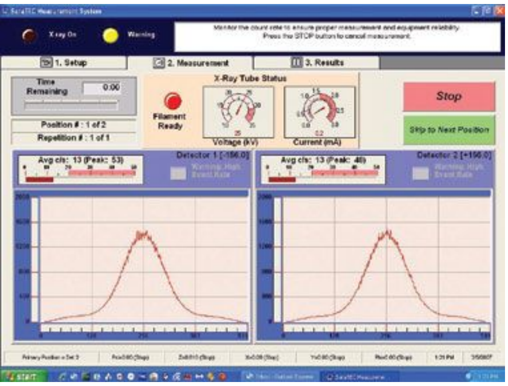
FANUC FA America

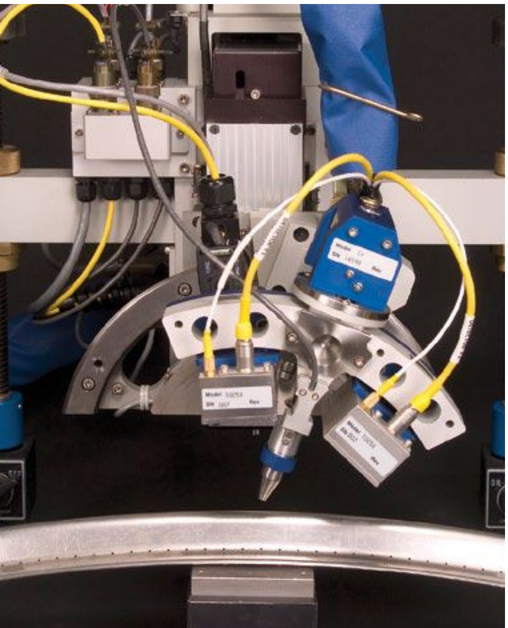
Foxconn Technology Group-China

FREBO-The Netherlands

Materials Testing Services







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ITAMCO *Thirty machines as of summer 2012 with 100 more to follow*

Jet Machine and Manufacturing Co. *Three machines as of November, 2011 with five more to follow*

Kennametal Inc.

Lockheed Martin Electronic Systems

National Center for Defense Manufacturing and Machining (NCDMM)

National Institute of Standards and Technology (NIST)

Okuma America Corporation

Optical Gaging Products, Inc.

Remmele Engineering *Thirty machines*

Sandvik Coromant Company

SCADAware

Task Force Tips *Sixteen machines*

TechSolve, Inc.

US Army ARDEC Materials, Manufacturing & Prototype Technology Division

US Army/Benet Laboratories

Yaskawa America, Inc., Motoman Robotics Division

A complete list of MTConnect Institute members is available at http://mtconnect.org/members.aspx.

The Experiences of an Early Adopter: The U.S. Military

As referenced earlier, Stephen Luckowski with U.S. Army ARDEC gave a PowerPoint presentation at the November, 2011 MTConnect Conference. Mr. Luckowski outlined ARDEC's trial run with MTConnect at Picatinny Arsenal, an ARDEC military base located in northern New Jersey.

For the test, ARDEC chose a Citizen lathe that builds 40 mm parts for Special Operations Command. Consistency and high production rates are expected from the lathe. The ARDEC staff felt the strain of machine downtime during the MTConnect installation and they had a steep learning curve on ethernet connections, MTConnect agents and adapters. The installation also had many positive benefits including:

- Achievement of 24/7 production monitoring
- Demonstrated 7% gain in cycle time and power
- Management of downtime to maintain production rates
- Development of a machine-specific adapter for Citizen lathe
- Acquisition of a knowledge base for future MTConnect installations

According to Mr. Luckowski, the ability to reduce downtime, analyze data, achieve higher part accuracy, get a real-time picture of capacity and capability, and plan for surges in need (i.e., wars, natural disasters, etc.) with MTConnect-enabled machinery is very real.

From an outsider's viewpoint, the boost to an anemic economy by the implementation of MTConnect technology in the U.S. Defense industrial base is also very real. Imagine the opportunities for OEMs, application developers and system integrators in a market as outlined by Mr. Luckowski:

- Tens of thousands of companies and their subcontractors
- Millions of square feet of manufacturing space
- Hundreds of machine tools and tens of thousands of machine controllers, from new to legacy machines
- Industrial bases ranging from shipyards to "mom & pop" shops

The payoff for facilities in the U.S. Defense network would be a competitive edge due to increased productivity and profitability and the ability to provide an electronic trail for military specification compliance and auditing. Then consider that the MTConnect Institute estimates that there are over 1.2 million machine tools that could be enabled with MTConnect and only four to five percent of all machine tools worldwide are connected to a data collection system.[1]

Will Shot Peening Make the Connection?

While the list of companies that have made a commitment to MTConnect is impressive, MTConnect and machine monitoring systems have to be cost-effective and economical for small shops, not just GE Aviation and the U.S. military. Even ITAMCO is not a typical facility as they adopt technology at a faster pace than companies twice their size. Yet the implementation of the standard and its components is within the skill level and resources of most facilities. It was designed with that intent and the ever-growing MTConnect community of manufacturers, application developers and educators is capable of supporting any organization that is ready to embrace it.

Please be encouraged to learn more about MTConnect and evaluate how it could benefit your company. A good place to start is www.mtconnect.org. The opportunity to participant in a new age in manufacturing is truly in your hands.

[1]Getting Started with MT Connect, Connectivity Guide. October 1, 2011.

[2]The Need to Know is Basic. Mark Albert, Modern Machine Shop, October, 2011.

Michele Bandini | Peen Service

ALMEN STRIP SATURATION CURVE NEEDS REVIEW

VERY DIFFERENT VALUES can be obtained when measurements or experiments are repeated. Sometimes the single values are very close to each other, other times they are far apart. Let's have a look at two batches of numbers. They could refer, for example, to experimental measurements of the same process at different times under different settings.

	Replicates										
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Average
Exp1	9.5	9.9	9.7	10.5	10.1	10.4	9.6	10.0	10.1	10.2	**10.0**
Exp2	7.0	8.0	12.0	9.0	11.0	14.0	8.0	12.0	10.0	9.0	**10.0**

Each experiment has 10 single measurements made at different times that we will call replicates. If we observe the averages of exp1 and exp2 we can notice that they are exactly the same value, but is easy to understand that those two experiments are far from comparable. Exp1 ranges from 9.5 to 10.5 and exp2 ranges from 7 to 14 but they have the same mean value. When we compare different batches of numbers we have to take either the average or the dispersion of the values around the average. The dispersion can be evaluated with a parameter known as "standard deviation." Standard deviation can be estimated as the root mean square of the difference of each single replicate from the mean value divided by the degrees of freedom as represented by the following formula.

$$S = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(x_i - \overline{x}\right)^2}$$

Where S is the estimate of the standard deviation, n is the number of replicates, X_i is the i_{th} replicate and $\overline{X}$ is the average of the n replicates.

From a statistical point of view, the lower the standard deviation of an experiment, the higher the probability of each single event or replicate to be close to the experiment mean value. From a practical point of view, the lower the standard deviation of the replicates the higher the robustness of the experiment and the higher the "reliability" of each single measurement.

When we compare different batches of numbers with different mean values to judge the robustness or reliability of each single batch, we should use relative standard deviation in place of standard deviation. Relative standard deviation is defined as the standard deviation divided by the mean value of the batch. Relative standard deviation is expressed in percentage. By that way we can say, for example, that a process with a mean value of 20, a standard deviation of 0.8 and a consequent relative standard deviation of 4% is more robust or reliable of a process with a mean value of 10 with a lower standard deviation of 0.6 but a higher relative standard deviation of 6%.

Once we clearly have in mind the meanings of standard deviation and relative standard deviation and how to use them, we can look at the saturation curve.

In his Fall 2012 Shot Peener article, Dr. David Kirk writes, "The most accurate method of estimating peening intensity is to produce and analyze a saturation curve constructed from the arc heights of four or preferably more peened Almen strips." All the recent specifications regarding this issue, included SAE J443, are in agreement requiring a minimum four Almen strips for the saturation curve. Unfortunately, none of the specs seems to suggest a way to distribute the strips within the curve. For what we know so far, once we have T and 2T within the range covered by the four strips it is enough.

After twenty years daily work, it is my personal opinion that the Almen saturation curve, in addition to what is expressed in SAE J443, should be made at least with one Almen strip before intensity point (the knee) and at least three Almen strips after intensity point. The reasons why are the following.

As shown in our experimental campaign on page 18 called "DoE + Production," the strips after the intensity point show lower relative standard deviation, thereby giving greater statistical meaning than the ones before the intensity point. For that reason, it's convenient to have the greater number of strips after the intensity point. In addition, it is also my personal opinion that we should use the saturation curve not only for determining the intensity value but, just as important, to assess our shot peening production process.

A good saturation curve should flatten after the intensity point but if we don't have enough points to discover and confirm it, we will have no idea if it will flatten. Recording several saturation curves can give us our standard deviation of


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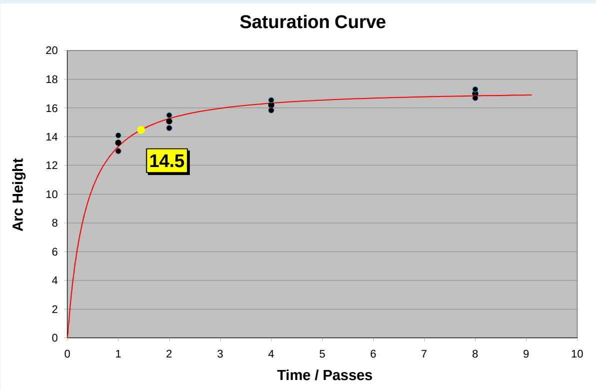
the strips, of the entire curve and, in the end, of the process. When something falls out of our standard ranges, we have an alarm bell. Once more, from a fatigue point of view, keeping our peening process under strict control is of the utmost importance. These are the reasons why I trust that keeping T and 4T within the range covered by the strips is a more accurate way than only T and 2T. I hope this approach can help to have more robust saturation curves and processes and that it could be a suggestion for a refinement of current specs.

Experimental Campaign "DoE + Production"

A design of experiment was run to investigate the variability of Almen strips. Several machine configuration were examined to simulate different plants and different setups. Design parameters were shot dimension, shot flow rate, hose diameter, and intensity. Sixteen saturation curves were run, each of them with 4 exposure times and each exposure time replicated 3 times. Twelve strips were run for each curve as depicted in the following figure.



A total of 192 Almen strips were used for the experiment. For each exposure time, the mean value, the standard deviation and the relative standard deviation as a percentage of the mean value have been calculated. The mean values and the relative standard deviations of the corresponding time units have been pooled in a "central saturation curve" (figure above) leading to the conclusion that the higher the exposure time the lower the relative standard deviation as shown in the following table.

Pooled Time Units	Pooled Mean	Pooled St.Dev.%
1	13.6	**1.29%**
2	15.1	**1.19%**
4	16.2	**1.03%**
8	17.1	**0.93%**

Shot S110 - S230
Shot flow rate: low - high
Hose diam. 13 - 25
Nozzle 8 mm
Distance 150 mm
Exposure times 7,5/60 to 40/320
Intensity: 8,4 - 21,2 Almen A

192 almen strips used

As a confirmation of the results shown by the experimental plan, two productions were analyzed. Twenty on-going verification curves, considered as 20 replicates, were examined for each single production. Each curve has been constructed by 4 Almen strips, as usual, for a total of 80 Almen strips for each production. In total, 160 Almen strips were analyzed.

Mean values and results are reported in the two following tables. In both production runs, it is possible to see a confirmation of the trend. In particular in those two production runs we have a global lower relative standard deviation in comparison to what obtained in the experimental plan. This can be explained by the fact that in the experimental plan very different machine setups were pooled and analyzed while similar single setups were used in these two production runs.

Production 1			
Time	Replicates MEAN	ST.DEV.	**ST.DEV. [%]**
4	14.6	0.17	**1.14%**
8	16.4	0.15	**0.89%**
16	17.8	0.15	**0.82%**
32	19.2	0.13	**0.67%**

Production 2			
Time	Replicates MEAN	ST.DEV.	**ST.DEV. [%]**
8	14.6	0.17	**1.14%**
16	16.4	0.14	**0.86%**
32	17.6	0.14	**0.79%**
64	18.6	0.13	**0.70%**

Michele Bandini is the General Manager of Peen Service in Bologna, Italy. He is also in charge of the shot peening technology transfer for Ipar Blast, an associate company of Peen Service in Spain. He is a specialist in residual stress measurements with the x-ray diffraction technique and offers his knowledge and experience to the design department of Peen Service's customers.

Mr. Bandini has been involved in numerous studies in shot blasting and shot peening surface treatments. He has co-authored several thesis and technical papers on the shot peening process, its benefits and applications.

In additon, he teaches at the Mechanical Engineering University of Bologna, Trento and Milan.

Mr. Bandini's latest achievement is the 2009 Shot Peener of the year award from *The Shot Peener* magazine.

Dave Barkley | Electronics Inc. Education Division

EXPANDED SHOT PEENING WORKSHOP IN GERMANY

GOSLAR, GERMANY
Hotel Niedersächsischer Hof

September 24 - 26, 2012

In Association With the Institute of Materials Science and Engineering (IWW) of Clausthal University of Technology

SPECIAL PRESENTERS

Professor Lothar Wagner
Clausthal University of Technology
Institute of Materials Science and Engineering
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Holger Polanetzki
Designated Process Specialist Shot Peening/Grit Blast
MTU Aero Engines GmbH
2008 Shot Peener of the Year

WORKSHOP WILL BE PRESENTED IN GERMAN AND ENGLISH

MORE INFORMATION
1-574-256-5001
dave.barkley@electronics-inc.com

Online registration:
www.electronics-inc.com/workshop_german.html

German translation is available at website

Three Days of Extensive Shot Peening Training

Since 1990, Electronics Inc. has conducted workshops around the world. This three-day training workshop covers all aspects of shot peening including techniques and applications. Our professional instructors will demonstrate what the process is, how to do it correctly and how to inspect the completed process. An emphasis on equipment and its maintenance will be included as well as the selection and quality control of media. Our courses are accredited by the FAA. If you are a FAA mechanic, call or email us to learn how you can receive credit for attending our workshop.

September 24 and 25 - Hotel Niedersächsischer Hof
We will present the most thorough training on shot peening available including equipment set-up, design and maintenance, media properties, specifications and selection, flapper peening, fatigue performance, Nadcap audit preparation, saturation curves, intensity, coverage, specifications, and much, much more. Of special interest to those in the aerospace industry will be classes with Holger Polanetzki, a shot peening specialist with MTU Aero Engines Gmbh. All of our knowledgeable and experienced instructors invite participants to ask questions and open discussion is encouraged.

September 26 - Clausthal University of Technology
The third day of the workshop will be dedicated to hands-on training on advanced topics as presented by Professor Lothar Wagner. Workshop attendees will perform shot peening to various intensities, take measurements of surface topography, make fatigue tests of peened and non-peened specimens using rotating beam machines, and plot fatigue performance using S-N curves.

Our Shot Peening Exam Programs

Workshop attendees will receive Certificates of Attendance. Our workshop participants also have the opportunity to take the Workshop Certification Exams: Level I, II and III and Flapper Peening. Upon passing the exams, participants will have earned Certificates of Achievement. Our exams identify a higher level of shot peening performance, elevate professional standards and spotlight a company's commitment to educational development.

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More information is being added regularly to our German workshop web page. Visit it today at www.electronics-inc.com/workshop_german.html.

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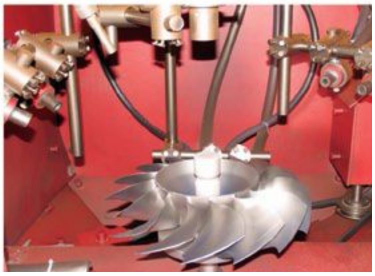

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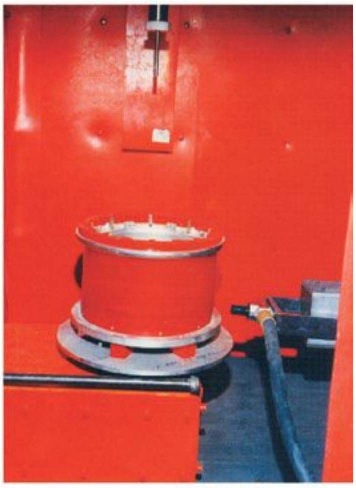

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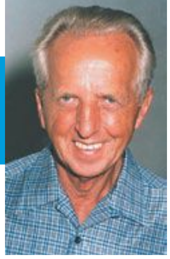

ACADEMIC STUDY
Prof. Dr. David Kirk | Coventry University, U.K.

J443 An Evolutionary Guide to Shot Peening Intensity Measurement

INTRODUCTION

J443 – Procedures for Using Standard Shot-Peening Test Strip, was first approved in January, 1952. As an SAE Recommended Practice document the principles that it enshrined were widely adopted by the then emerging shot peening industry. With accumulated experience and technological advancements several revisions became necessary. These were made in 1961, 1984, 2003 and 2010. A further revision is a "Work In Progress." J443 is an important, definitive, guide to shot peening intensity measurement.

This article attempts to trace the influence that the evolution of J443 has had on shot peening intensity measurement. Future developments will have to take into account new technology and a more universal input of ideas.

J443 1952

This original version was produced in radically different times from those that we have at present. The accumulated quantitative knowledge was, at that stage, limited and ideas were at a formative stage. These were the days of slide rules, logarithmic tables, stencils for lettering and graph paper. Statistical analysis, using manual procedures, was very laborious and therefore had limited application.

Two alternative procedures for peening intensity measurement were recommended – "*Procedure Based on Arc-height Exposure Time Relationship" and "Alternative Procedure Based on Coverage Measurement.*"

Procedure Based on Arc-height Exposure Time Relationship

This currently-familiar procedure is based on a graph of Almen arc height versus peening exposure time. The definitive graph was its Fig.1 which is reproduced here (as Fig.1 for this article).

Graph-drawing principles reigning in 1952 give an insight as to why Fig.1 appears today to be somewhat strange. Flexicurves and French Curves were readily available for producing segmented curves. There are six marked points that all lie exactly on a curve. Curves then were normally pencil-sketched by hand and often transposed in ink onto tracing paper. The curve in Fig.1 has a significantly-different shape

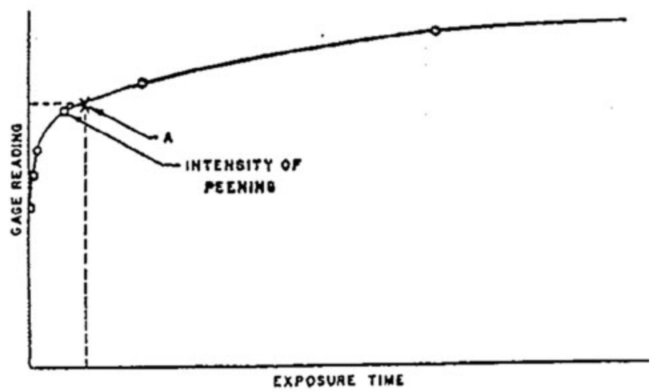

FIG. 1—INTENSITY DETERMINATION CURVE

from any that are normally encountered when using real data points – the initial rate of increase being far too steep. The exposure times indicated for the six graphed points are in the ratios 1 to 2.5 to 5 to 20 to 60 to 220. It seems unlikely that real exposures would have ranged by a factor of 220. For Fig.1 it therefore appears that six 'virtual' points were added to a previously-drawn curve – perhaps involving overlaying the traced curve onto graph paper. It is almost impossible to conceive that the six points were actual Almen strip data points. Curve-fitting, to allow for variability of real data points, has not been employed for Fig.1. One interpretation is that the curve was deliberately simplified – avoiding the complication of data point variability and the need to allow for that variability.

"Intensity of peening" and a point "A" appear in Fig.1. The "Intensity of peening" is the fourth of the six 'virtual' points that lie exactly on the curve. This fourth point happens to be the first for which doubling the peening time results in less than a 10% increase in arc height. It may be that an implicit, rather than an explicit, 10% concept was being considered as early as 1952. Point "A" is a point of the curve (not a 'virtual' point) and has no defined location, other than by a vague reference to the curve flattening out, which it doesn't, and it is hard to justify.

The actual text in J443 1952 reads "*The gage reading corresponding with the point A where the curve flattens out*

is generally taken as the measurement of the intensity of that particular peening. In some cases the point is difficult to pick out and requires some judgment." The indicated "intensity of peening" point, which is a 'virtual' point, is not mentioned anywhere in the text. This gives rise to ambiguity, to say the least.

Fig.2 is reproduced here. Data point variability is now indicated, though not mentioned in the text. The intention was to indicate how the production setup of a given peening machine could be varied to achieve the desired peening intensity. Three curves are shown involving nine, eight and seven points per curve. Each curve again involves a tremendous range of apparent exposure times.

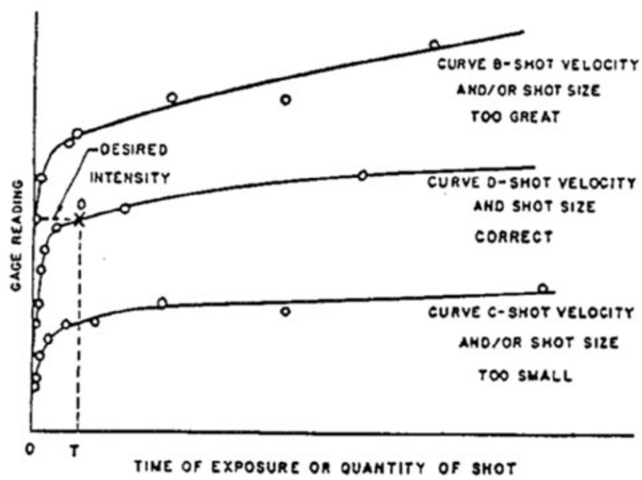

FIG. 2—INTENSITY DETERMINATION CURVES B, C, AND D

Alternative Procedure Based on Coverage Measurement

The mere presence of an alternative procedure indicates that peening intensity definition was in its formative stages. This alternative procedure assumes that a required peening intensity could be specified in three parts: Strip Type, Arc Height and Percentage Coverage for that arc height, e.g. "0.010, A-2 and 98% Coverage."

The recommended procedure may be summarized as follows:

(1) - One strip to be polished, peened to a known, reasonably-low, level of exposure and the coverage measured for that strip. Coverage measurement to be achieved by placing the strip in the field of a metallurgical camera, tracing the indented areas using a sharp pencil and tracing paper, measuring the indented areas within a circle of known diameter, using a planimeter, and finally calculating the ratio of indented areas to total area of the circle.

(2) - The measured coverage and known level of exposure to be used to determine the exposure required to meet the specification, e.g. 98%.

(3) - An unpolished strip to be peened for the exposure determined in (2), arc height measured and compared with the specified arc height requirement.

(4) – If the measured arc height does not meet the requirements then the machine settings must be changed and steps (1) to (4) repeated.

The relationship between coverage and peening exposure time was expressed as:

$$C_2 = 1 - (1 - C_1)^n$$

Where C1 = % coverage (decimal) after 1 cycle

C_2 = % coverage (decimal) after n cycles

n = number of cycles

A chart, Fig.3, was provided "*plotted to a convenient time scale.*"

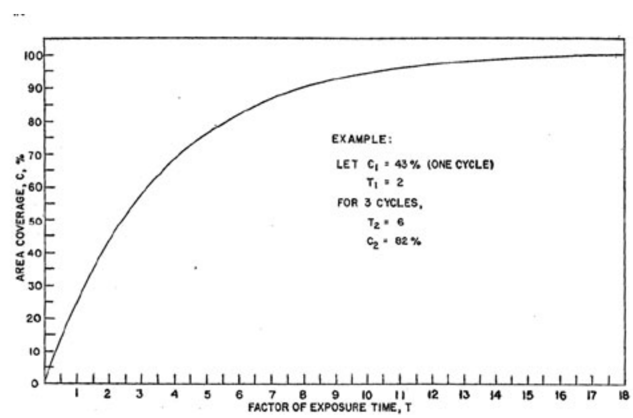

Fig.3. Relationship of Coverage to Exposure Time.

The chart, Fig.3, actually follows the exponential function:

$$\mathbf{C\% = 100(1 - 0.756^n)}$$

An example of using Fig.3 was given in section 7 as: "*Suppose, for example, the desired conditions are 0.010, A-2 and 98% coverage. Suppose further that the coverage measured in the first trial was 76%. Referring to the chart of Fig.3 the exposure time used in this test is equivalent to five units. At fourteen units, 98% would be obtained. Therefore, the exposure time must be increased in the ratio of fourteen to five, or 2.8 times the exposure used in the first trial. This is the exposure to be used in determining the arc height.*"

This procedure seems to be rather inappropriate for everyday shop-floor use. It does, however, have the advantage that a point does not have to be (vaguely) selected from an arc height versus exposure graph.

J443 1961

The only changes from the 1952 version appeared in the two introductory paragraphs where J442 was first mentioned together with suggested intensity ranges for N, A and C strips. The rest of the specification was identical so that this version was not to be regarded as superseding the 1952 version. Only minor improvements in graphical and computational aids

had occurred between 1952 and 1961. Pocket calculators had not yet appeared.

J443 1984

This version was issued with the declaration that it was to supersede the 1952 version.

A considerable expansion was involved – the document becoming six pages in length compared with the two of the 1952/1961 versions. Quite apart from being expanded to six pages this version included the requirement that "*Applicable Publications*" formed a part of the specification to the extent specified. These publications were SAE J442, SAE J784a and SAE J808a. A "*Related Publication,*" SP181, was stated to be for information only and was not to be a required part of the document.

The figures from the previous versions have simply been copied. An enormous change in availability of computational aids had, however, taken place since 1961. Science-driven procedures, such as x-ray diffraction were routinely deriving best-fitting curves in order to pinpoint diffraction peak location. These employed devices, such as PCs and even programmable pocket calculators, to eliminate the tedium of manual procedures. Older readers may remember the launch of the Commodore 64 which became the largest-selling computer of all time.

Fig.1 is reproduced here as Fig.1/1984. The curve in Fig.1/1984 has exactly the same six points and shape as in the previous versions. A dashed portion of the curve is included beyond the sixth point reflecting projection (rather than knowledge) of its location. All six points are still shown as lying on a hand-drawn curve – however improbable that might be for real data points. The double intensity indicators of "intensity of peening" and point "A" were also preserved.

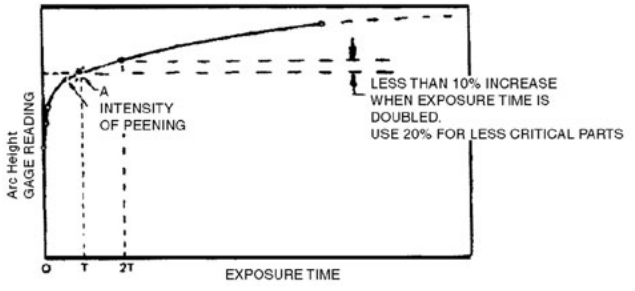

Fig.1/1984. Intensity Determination Curve.

A notable addition to Fig.1/1984 is that relating to "Less than 10% increase when exposure is doubled" together with "Use 20% for less critical parts." This definitely refers to the point marked as "A" - which is not one of the six 'data' points but has to be selected as a point on the curve itself. There is no mention of computerized curve-fitting, which was becoming commonplace in other technologies.

A different attempt was made to specify and define 'intensity' - as illustrated by the following extract:

"*Specification of an intensity (for instance, 12A) implies an arc measured when saturation has been obtained, as explained below*:

> *A plot of peening time versus arc height can be used to define saturation. By peening a series of test strips, using increasingly longer peening times, with all other conditions maintained constant, and plotting the series of points on a graph of time versus arc height, a curve will develop. These points define a curve with a general shape as shown by Figure 1. Saturation has been attained when the "knee" of the curve is passed and increasingly longer periods of peening time are required for a measurable increase in test strip arc height. The location of the knee, point A shown in Figure 1 can be defined as that point on the curve beyond which the arc height does not increase more than "X" percent when the peening time is doubled.*"

A crucial omission in this well-intentioned definition was of the one word "first" in the last sentence. If it had read: "The location of the knee, point A shown in Figure 1, can be defined as that **first** point of the curve beyond which the arc height does not increase more than "X" percent when the peening time is doubled" subsequent misinterpretation would have been avoided. With "first" added then a single point is being defined. Without it then the definition is satisfied by a region (not a point) of a curve.

Having defined peening intensity in terms of 'saturation' having been achieved, later parts of the text employ the phrase "saturation curve" to describe the general shape shown as Fig.1. This phrase is somewhat ambiguous since what is generally understood by the word "saturation" does not occur. "Saturation" is generally employed to describe any situation that has reached its absolute maximum – which does not happen at any stage of shot peening. It would, perhaps, have been better to stay with "Intensity determination curve."

Fig.2 in 1984 is again copied from that of the original versions - but with some modifications. These include the

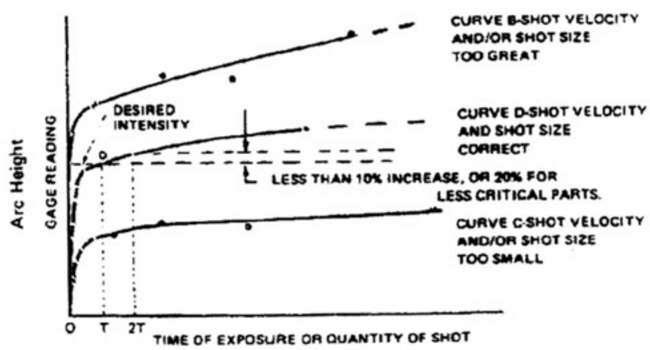

Fig.2/1984. Intensity determination curves B, C, and D.


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removal of some 'data points' below the indicated peening intensity, with a corresponding dashing of the curves, together with the addition of the "Less than 10% increase, etc." concept. The general instructions as to how to change the stream's peening intensity remain very similar to those of previous versions.

Determination of surface area coverage was expanded but not presented as an "Alternative Procedure Based on Coverage Measurement." Five methods of coverage determination were allowed, singly or in combination. These included the one method allowed in the 1961 version.

J443 2003

This version was mistakenly declared as "*Superseding J443 OCT 1997*" – which was never issued - officially it may be regarded as superseding J443 JAN84. The revised version has only four pages - coverage measurement procedures now being incorporated into 'J2277 Shot Peening Coverage' as an "Applicable Publication." The second 'applicable publication' was J442.

The curve in Fig.1 was changed (for the first time in over fifty years) and is reproduced here as Fig.1/2003. In terms of shape it is quite different from the previous version. It has, in fact, exactly the same shape as the coverage curve, Fig.3, of the original 1952 version of J443. It is labeled as being a "Saturation Curve" rather than "Peening Intensity Curve". An identical figure to Fig.1/2003 appears in the 2001 edition of the SAE Manual on Shot Peening, HS-84.

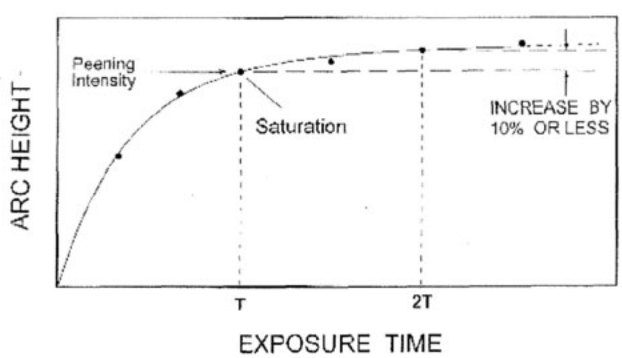

Fig.1/2003. Saturation Curve.

Six points are marked on Fig.1, all six being very close to the drawn curve. The small differences follow a sequence 'just below, on, just above, just below, on, just above' the curve. This sequence is statistically unlikely to occur with a set of six real data points.

The revised definition of peening intensity was encapsulated in the following extract:

"*Saturation has been attained when the "knee" of the curve is passed and increasingly longer periods of peening time are required for a measurable increase in test strip arc height. The location of the knee, saturation point shown in Figure 1, can be defined as the first point on the curve beyond which the arc height increases by 10% or less when the peening time is doubled.*"

The word "first" has, fortunately, been added but other problems now attend the definition. These are (1) that the simple exponential shape of curve shown does not have a "knee" and (2) that "*first point on the curve*" is ambiguous. "*Saturation*" in Fig.1 now coincides with a marked point – which it did not in previous versions. This ambiguity has led to different interpretations of the definition e.g. selecting the first data point from a set for which doubling the exposure time gives 10% or less increase in arc height. The critical exposure times marked on Fig.1, T and 2T, also appear to indicate data points.

Fig.2 of previous versions (indicating how machine settings affect peening intensity) has not been included. It may be concluded that users did not now need to be made aware of how to influence peening intensity by modifying machine parameters.

J443 2010

This latest version is declared as "*Superseding J443* JAN2003". Six pages in length the document has three "Applicable Publications":

SAE J442 Test Strip, Holder and Gage for Shot Peening,

SAE J2277 Shot Peening Coverage Determination and

SAE Computer Generated Shot Peening Saturation Curves.

The three major changes may be summarized by the following extracts from page 1 of the document:

"Figure 1 – Eliminate "or less" from the arc height criteria so one and only one numeric answer can be derived from a given saturation curve."

"Figure 2 – Demonstrates that special cases exist where… the Almen strip is saturated … at the least amount of exposure available."

"Section 7.3 – It is common to use a fixture with multiple Almen holders for intensity tests. The peening intensity at each holder position must meet the requested values. The saturation times for each holder will be unique…."

Figure 1

The latest version of Fig.1 is reproduced here as Fig.1/2010. The curve itself is a direct copy of the simple exponential curve used in 2003. Both sources of ambiguity (in the 2003 version) have, however, been removed. Two of the four points have been removed; those that previously were marked at exposure times of T and 2T. This, in turn, removed the ambiguity that these points might/should be data points. "*Increase by 10%*" is used to specify the unique point of the curve that is to be used to identify the level of peening intensity. This

removes the second source of ambiguity. The shape of the "*typical curve*" is now defined as "*Type 1*" – in order to distinguish it from a newly-introduced shape "*Type 2*." Computers are mentioned for the first time with the sentence: "*The use of computer generated saturation curves which comply with SAE J2597 is recommended.*"

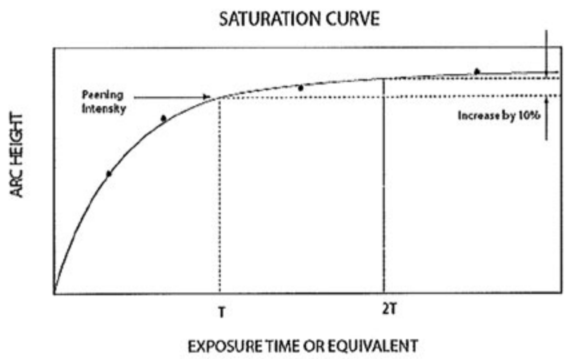

Fig.1/2010. Time Based Saturation Curve.

Figure 2

A different shape of saturation curve (from that in Fig.1) is specified - as shown here as Fig.2/2010. This is again an idealized shape, being based on 'virtual' points that show no variability. The different shape is intended to accommodate situations where even a single pass would exceed the previously-defined peening intensity point. Measured arc height after one pass is to be used as the peening intensity - provided that none of the multi-pass points have an arc height that exceeds it by more than 10%.

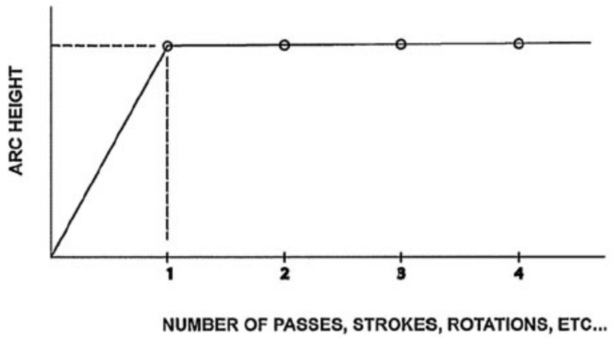

Fig.2/2010. Schematic Representation of Special Cases.

The peening intensity estimated using this "special case" method must normally be higher than that which would have been derived using the standard approach indicated in Fig.1. No guidance, however, is given as to any 'correction' that should be applied.

Section 7.3 Verification of Intensity when using Multiple Holders

This is another new topic, which needed specifying, as many operations involve multiple holders. The saturation time, T, will be different for each holder. For subsequent verification, involving only one strip per holder, it is therefore recommended that a single verification exposure time may be selected. This should be the longest of the previously-derived saturation times for the group of holders – or other value acceptable to the customer. For each verification strip a "target arc height" has to be derived from the corresponding saturation curve using the agreed single verification time. Each peened strip must repeat the corresponding derived value to within ±0.038 mm (±0.0015 inch).

DISCUSSION

J443 plays a central role in controlled shot peening. Its evolution from 1952 to date has several fascinating aspects. It is easy to be critical with the benefit of hindsight. Any implied criticisms in this article were not, however, intentional. Every committee in every sphere of activity meets problems caused by the disparate viewpoints of its members. Nevertheless the J443 Committee has succeeded in refining and improving intensity measurement procedures and accommodating new analytical techniques.


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Joe Simmons | Hartzell Propeller Inc.

BEWARE THE DODECAHEDRON

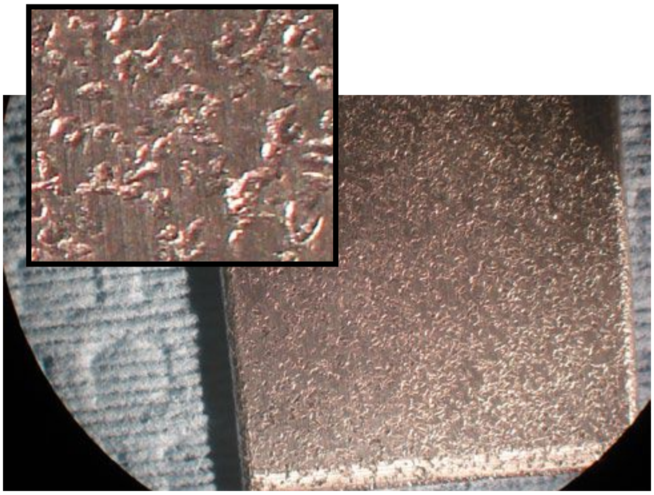
HARTZELL PROPELLER recently had an unusual experience that highlights the importance of defining appropriate media shapes. We think our findings will be helpful to everyone that buys, inspects and uses media and are worth consideration by members of the shot peening sub-committee of Aerospace Metals Engineering Committee (AMEC). This AMEC group is responsible for creating and updating the shot peening specifications used in aerospace.

A Process is Developed

It started when one of our propeller repair stations ordered a batch of conditioned cut wire shot. The media was shipped with certification for AWS-62 per AMS 2431/4. The media passed the repair station's receiving inspection and went on to their new shot peening machine. The media went into the machine, setup work began, and a process was developed. After the sample process was completed, the repair facility sent us a package for audit with a copy of the media certification, a set of Almen strips and an overhauled aluminum scrap part.

Our Internal Audit

The part coverage and masking on the aluminum part passed inspection. The certification document matched our requirements. Everything was on track until we got to the Almen strips and they looked...weird. Their surface was covered in sharped-edged strikes, almost like they had been dented by stabs from a flat-blade screwdriver. We requested a sample of the new shot.



The Almen strip with sharp-edged strikes

A Media Like We've Never Seen Before

We reviewed the shot per AMS 2430. A 10X microscope with single point lighting revealed a new shape of media we have not seen before. We would describe it as "faceted-gemstone-like." It certainly wasn't the typical spheroid with a slight hint of a barrel shape that we are used to with conditioned cut wire. Also, there were a number of smaller size shot particles and a few flat disc-shaped particles mixed in with the faceted shot. It was difficult to see on the aluminum part; however, that its dents were made by faceted shot.

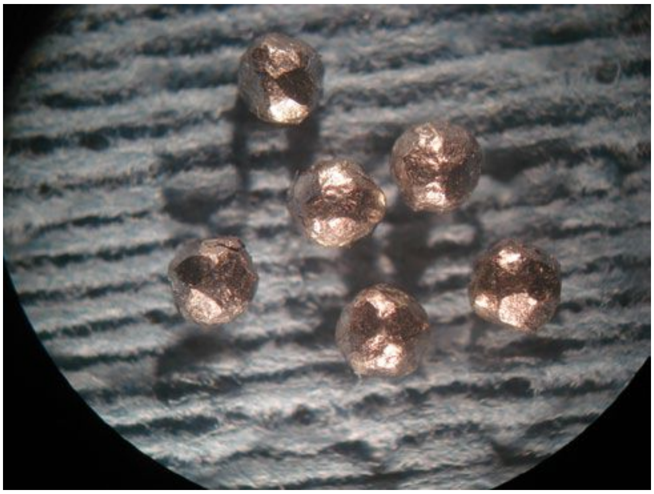
Our Theory

We think that the media supplier created an aggressive conditioning process that imposed a small number of very hard impacts to each particle, possibly as a quick way of conditioning it into something with a spheroid outline but only if you are willing to ignore the sharp edges where the facets meet. We also have to believe that the media manufacturer unknowingly packaged undersized and disc-shaped particles with their "conditioned cut-wire shot." Most of the undersized shot would eventually be wasted in the screening loop. We're not sure what would happen to the disc-shaped media long term but we don't want to use it to make dents in the short term.

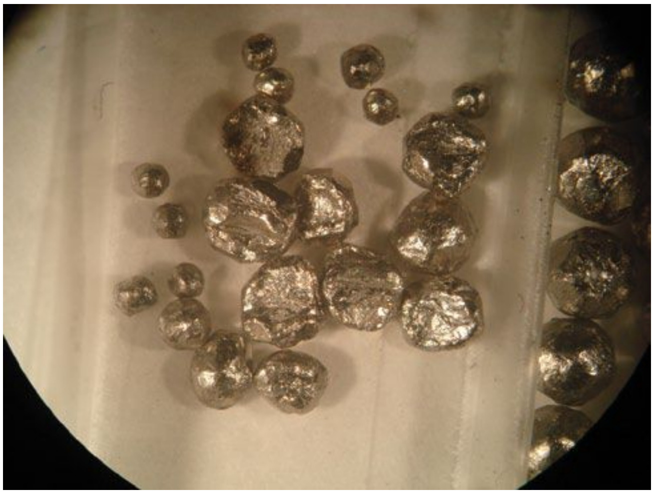
Why the Media Flunked the Audit

We had several reasons for not approving the new process because of the media:

1) A faceted gemstone-shaped sharp-edged particle can't make the desired near-spherical dent.
2) It's not desirable to make dents with flat disc-shaped media while waiting for the screening loop to remove them.
3) The media should have been rejected per AMS 2431/4 Table 2 because it contained more than two (we found eight) unacceptable particles and that's only considering the flat disc-shaped particles. The small sample size of an ounce allowed only four viewed fields instead of the required nine. (We found 20 unacceptable particles if we include the tiny particles that look like AWS 20 that was mixed in by the media manufacturer.) We were inclined to label the discs and AWS 20 as contamination. Note: The media passed the weight and length requirements if we excluded the discs and AWS 20.
4) The media should—would all shot peeners agree?—have been rejected per AMS 2431/4 Table 2 that calls for "shape shall be predominantly spherical." The media exceeds the 63 particle maximum because we judged the full-sized particles as marginal.



The faceted gemstone-shaped media



The undersize and disc-shaped media

Our Conclusions

The media was unacceptable on many levels. First, it's a waste of time and not practical to expect the end user to run his shot peening machine against hardened steel plate to finish conditioning the media, thereby removing the sharp edges and creating spheroid dent makers. Fortunately, other media manufacturers create cut wire shot that is capable of creating a decently shaped dent right out of the bag.

So what can we do to keep poor media from passing inspection, much less entering our shot peening processes? We can improve the intent of AMS 2431/4, AMS 2430 AMS 2431/3 and AMS 2431/8 by adding a new illustration of a partially conditioned particle. For such an illustration, I propose adding a wire frame drawing of a regular dodecahedron and a footnote that references its "facets meeting at sharp edges." Media purchasers, receiving inspectors and shot peening rookies would then be forearmed against the dodecahedron that will harm your shot peening process. The repair station that purchased the unacceptable media certainly could have benefited from additional information. They are new to shot peening and relied on the media's certification. As far as we can tell, they weren't aware of a problem.

As a member of AMEC, I will ask the committee to review my request to add this information to aerospace documents.

About Joe Simmons

Joe Simmons is an Engineering Technician/Shot Peen Developer with Hartzell Propeller, a major supplier of aerospace components. Simmons is an active member and frequent contributor to the Aerospace Engineering Materials Committee Surface Enhancement Committee (AMECSE). AMECSE is the custodian of aerospace specifications on shot peening such as AMS 2430 and AMS 2432.

What is a dodecahedron?

A dodecahedron has 12 faces and each face has 5 edges. It has 30 edges and 20 vertices (corner points) and at each vertex 3 edges meet. The dodecahedron illustrated at the beginning of the article is a "regular dodecahedron" because all of its faces are the same size and shape.

Jack Champaigne | Electronics Inc.

THE BENEFITS OF A CLOSED-LOOP SYSTEM

OPEN-LOOP AND CLOSED-LOOP are control systems. Open-loop systems operate in a "manual" mode (requires a person to manually review and make adjustments) while closed-loop systems operate in an "automatic" or self-adjusting mode. Here are automotive examples of the systems:

Open-Loop	Closed-Loop
Manual Transmission	Automatic Transmission
Manual Windshield Wipers	Rain-Sensing Wipers
Gas Pedal (Throttle)	Speed Cruise Control

The open-loop systems achieve an output state at some equilibrium (steady state) point. The closed-loop systems have the additional benefit of measuring the output and comparing it with the request, making adjustments as needed.

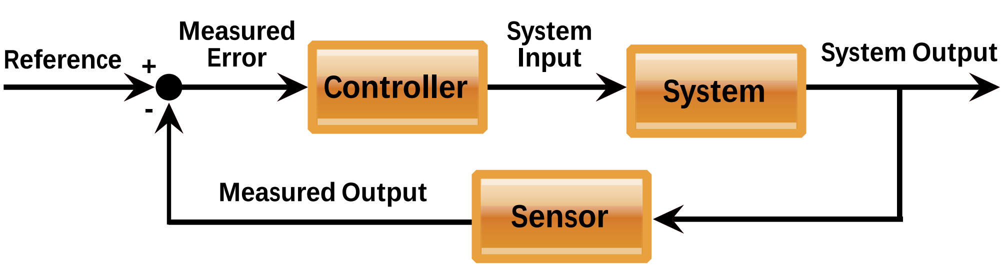
Consider a car's cruise control, which is designed to maintain vehicle speed at a constant or reference speed provided by the driver. The controller is the cruise control, the plant is the car, and the system is the car and the cruise control. The system output is the car's speed, and the control itself is the engine's throttle position which determines the RPM of the engine.

A primitive way to achieve speed control is simply to lock the throttle position. This is great if you are traveling on flat and level terrain. If the terrain changes, the car will travel slower going uphill and faster when going downhill. This type of controller is called an open-loop controller because no measurement of the system output (the car's speed) is used to alter the control (the throttle position). As a result, the controller cannot compensate for changes acting on the car, such as a change in the slope of the road.

In a closed-loop control system, a sensor monitors the system output (the car's speed) and feeds the data to a controller which adjusts the control (the throttle position) as necessary to maintain the desired system output (matches the car's speed to the reference speed). Now when the car goes uphill, the decrease in speed is measured and the throttle position is changed to increase engine power, thereby increasing the speed of the vehicle. Feedback from measuring the car's speed has allowed the controller to dynamically compensate for changes to the car's speed. It is from this feedback that the paradigm of the control loop arises: the control affects the system output, which in turn is measured and looped back to alter the control.

Is there an advantage to using closed-loop control in media feed rate systems? Yes. One of the biggest advantages is convenience. Just like with cruise control, you can achieve and maintain a desired condition. Another advantage is the simplicity of determining an optimum operating condition that allows you to reduce the flow rate to the minimum value that will achieve the desired results. This can be especially helpful in abrasive blast cleaning systems where annual media consumption and equipment maintenance are large expenditures.

Let's look at some examples of open-loop and closed-loop systems in wheel blast systems. (You can also apply these schemes to air blast applications.)



This closed-loop system maintains the desired system output at the reference input because the sensed value is subtracted from the desired value to create the error signal, which is amplified by the controller.

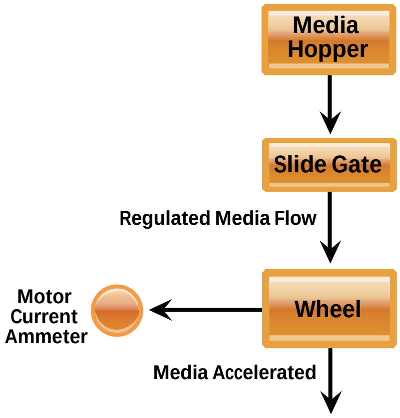


Figure 1. Open-Loop: Manual Slide Gate

In the open-loop system with a manual slide gate in Figure 1, the media flow rate is established by the position of a movable slide in the flow path between the media hopper and the throwing wheel. Opening or closing the slide will increase or decrease the media flow rate which will be reflected by the motor current needed to accelerate the media. An operator is expected to visually monitor the motor current on the panel ammeter and, if needed, make a manual adjustment of the slide gate. If the hopper is out of media, the ammeter will reduce to some low amperage (called no-load Amps, the value needed to spin the wheel with no media flow). The operator is then expected to replenish the media in the hopper. Conversely, if the media erodes the slide gate, the opening gets larger and the media flow rate increases. This will result in higher motor current, possibly exceeding its rated capacity.

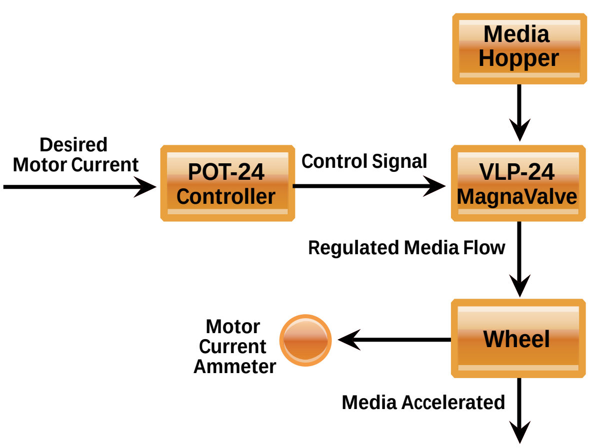


Figure 2. Open-Loop: Magnetic Valve

As shown in Figure 2, a VLP-24 MagnaValve can be installed with a manual controller, a Pot-24. The advantage of this valve is its inherent simplicity—there are no moving parts in the MagnaValve, only a strong magnetic field to regulate the media flow rate. The controller does not offer any feedback capability but it does provide for a convenient way of setting media flow rate from a remote location. Notice that once again there is no connection from the current meter back to the controller thus no feedback signal is available to compensate for changes in operation conditions.

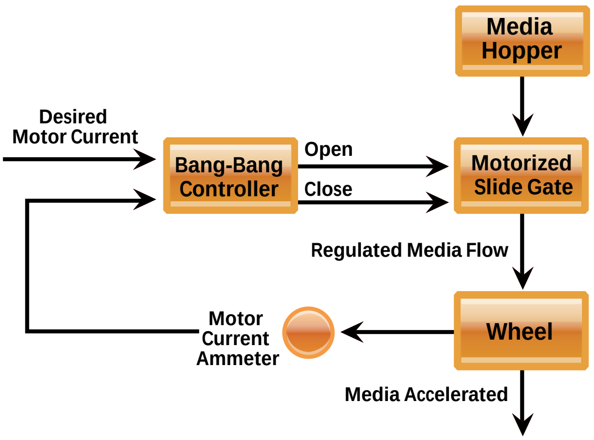


Figure 3. Closed-Loop: Motorized Slide Gate

In the closed-loop system with motorized slide gate in Figure 3, the motor current is monitored and if it is determined to be above or below the desired level, an output relay will momentarily energize a motor which will close or open the slide gate. This type of controller is informally called a bang-bang or on-off controller because it switches abruptly between an on or off state.

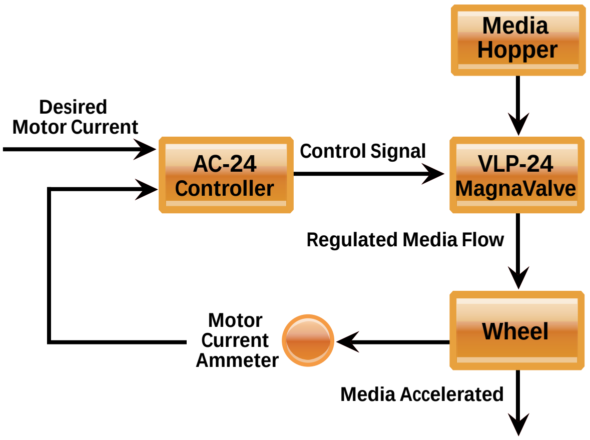


Figure 4. Closed-Loop Magnetic Valve (motor current)

In Figure 4, a VLP-24 MagnaValve is operated by a AC-24 Motor Current Controller. The motor current is treated as the system variable. The motor current signal is fed back to the controller which is compared to the requested operating point. The output of the controller to the MagnaValve is then adjusted in order to maintain the expected value.

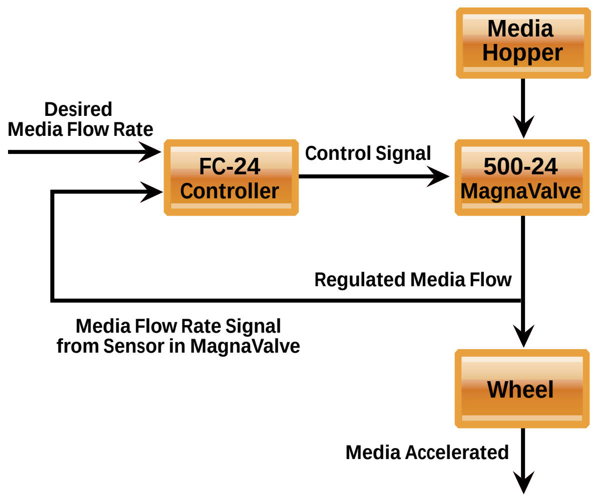


Figure 5. Closed-Loop Magnetic Valve (flow rate)

A closed-loop system with the 500-24 MagnaValve with an internal media flow sensor is illustrated in Figure 5. The 500-24 allows a lb/minute or kg/minute flow rate to be established and maintained. A model FC-24 Controller is used in this configuration. It accepts the flow rate signal from the MagnaValve and compares it to the requested flow rate and then adjusts the output signal to the MagnaValve.

THE ENGINEER SHORTAGE

An Excellent Career Choice for the Young

Do you have a young son or daughter with strong analytical, mathematical and problem-solving skills? If they choose engineering as a career, they could become one of the most sought-after job candidates in the world.

In the United States, hiring demands for all types of engineering jobs is rising with the highest in manufacturing, driven primarily by the heavy-truck, semiconductor, medical device, pharmaceutical, and aircraft manufacturing sectors.

According to a recent PRI/Nadcap report, the United Kingdom also needs more engineers, specifically in the aerospace sector. In 2009/10, of the 425 United Kingdom graduates who qualified in aerospace engineering, only 145 went on to work in manufacturing. Instead, they choose jobs in wholesale, retail, construction, finance and insurance. In addition, aerospace engineering as a degree was less popular for young people in the United Kingdom than other engineering fields such as civil engineering.

PRI's Vice President and Chief Operating Officer Joe Pinto commented, "This data only serves to highlight the tipping point of the aerospace industry at the moment: the ability to continually recruit qualified individuals to move the industry forward is becoming a critical concern."

Germany is experiencing an engineer shortage, too. "....young Germans have turned away from engineering. Ten years ago, there were twice as many engineering students at universities in Germany than today, cites the German Association of Engineers. According to the German Institute of Economic, there is a current need for 117,000 engineers, scientists, IT experts and technicians, causing grave concerns for German companies hoping to take advantage of the economic recovery," writes Barb Schmitz, a freelance technical writer.

Women students are still the minority in engineering schools. Employers need to improve corporate cultures and salaries to attract bright, talented women to the field, cites a recent study by the University of Wisconsin-Milwaukee.

While the global engineer shortage is well-publicized, the reasons are less clear. Many point to grueling and over-priced educations, the enticement of higher paying careers in fields like finance, and companies that are less willing to provide on-the-job training for new graduates. In the U.S., more women now go to college than men yet few go or stay in engineering careers due to unfriendly academic and work environments. But, as with many critical problems, the opportunities for problem solvers are immense. For example, PRI is working with industry to develop a global industry-managed system for qualifying special process aerospace personnel.

An optimist says the glass is half full.

A pessimist says the glass is half empty.

An engineer says the glass is twice as big as it needs to be.

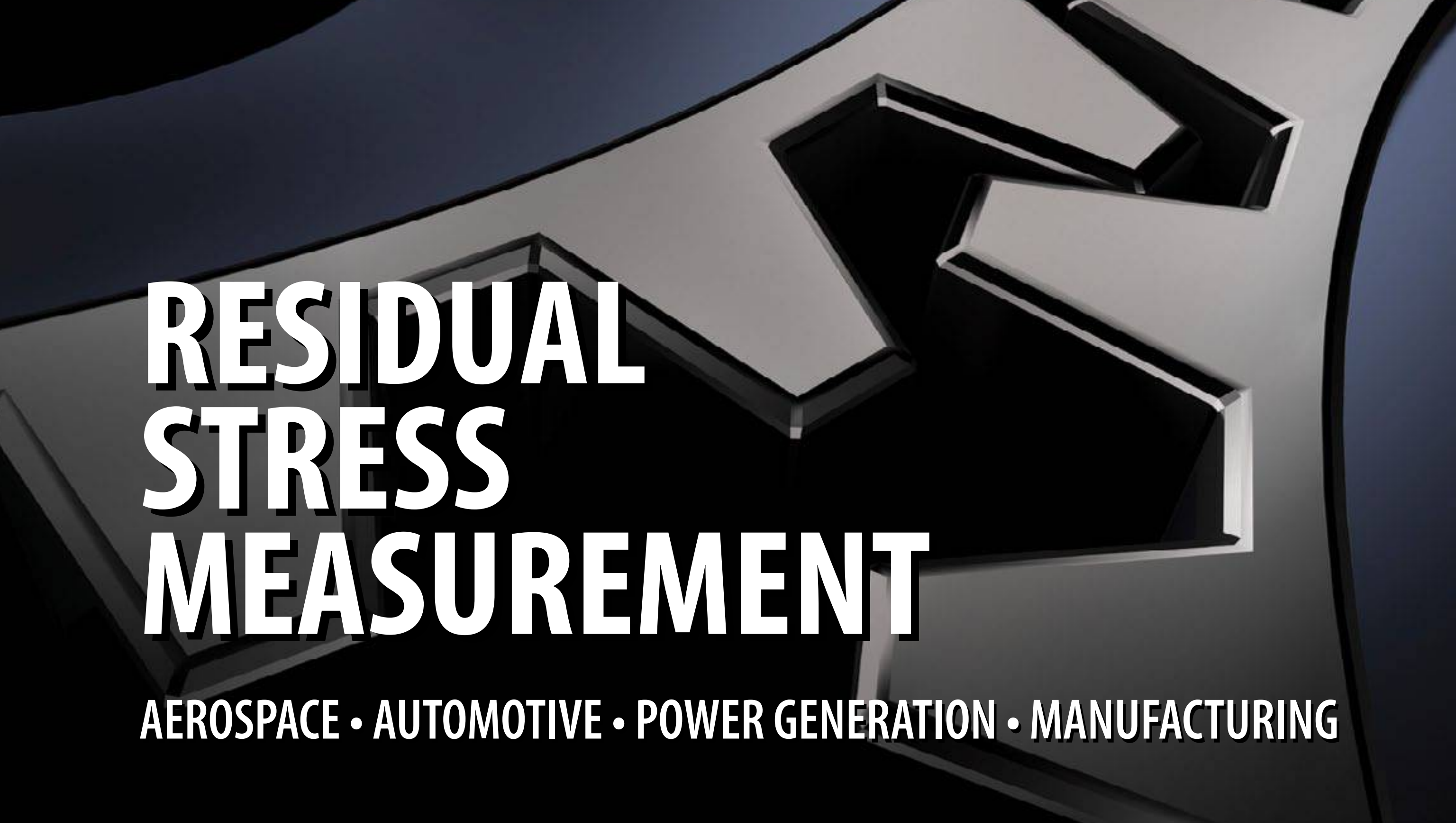
A Second Career for the Not-So-Young

If you're an engineer and you love your profession and would like to work beyond a typical retirement age, you have a better chance than most of continuing in a rewarding career. Not only is there an engineer shortage but you're in a field where experience and maturity count. For example, Chemic Engineers in Texas has this posting at their website:

Chemic Employment for Retired Engineers

"At Chemic we are looking for Engineers who are already retired or about to take that next step in life."

So for all of you that have borne the brunt of engineer jokes over the years, you may get the last laugh.



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