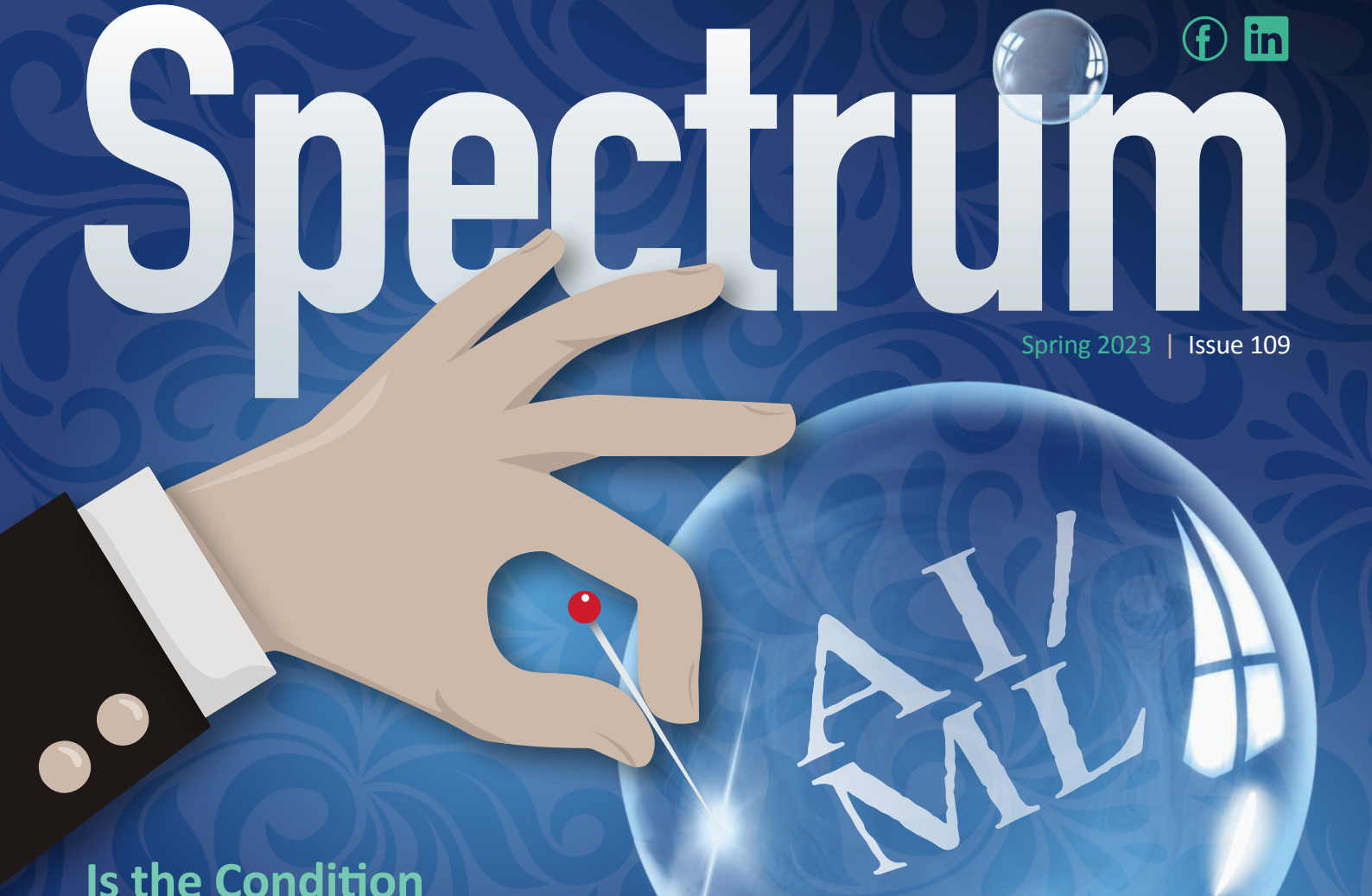
The official journal of the Vibrations Association of New Zealand

Spectrum

Spring 2023 | Issue 109



Is the Condition Monitoring AI/ML bubble starting to burst?

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Spectrum

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Spectrum is published by the Vibrations Association of New Zealand (VANZ). The magazine is produced in a quarterly cycle annually in both digital and printed mediums.

The magazine is designed to cover all aspects of the Vibration, Condition Monitoring, Reliability and the wider Predictive Asset Management field and distributed to all VANZ members, including corporate members.

Missed an issue?

Simply scan the QR code here to link your device directly to the VANZ website. There you will find Spectrum issues available to view or download*. You can also access previous issues by visiting our website online at: **www.vanz.org.nz**

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With over 40 years experience in rotating equipment, essentially centred on the repair, redesign and maintenance of electrical rotating plant. Mike has developed an intense academic interest in machine failure mechanisms and root cause analysis of electrical machinery failure and has presented papers throughout Australia, New Zealand, United States of America, South East Asia and South Africa. Visit www.emkecoach.com to find out more.

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Package	PRICE PER PERSON
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Package	PRICE PER PERSON
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Sponsorship on key online & offline promotional material before and during conference**	✓	✓	✓
Logo on VANZ conference publications & website***	✓	✓	✓
Post conference Spectrum advertising opportunities	✓	✓	
Conference entry for staff	x2	x1	x1

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Need to book accommodation? We've secured rooms at **Plymouth International** and **Auto Lodge Motor Inn** *(located just around the corner)* for a great rate – but only for a strictly limited time!
Use the code **VANZ** when booking to secure this special rate.

1. Phone **Plymouth International** direct on 0800 800 597, or visit www.plymouth.co.nz
2. Phone **Auto Lodge Motor Inn** direct on 0800 800 896, or visit www.autolodge.co.nz

Alternatively, you can simply scan the associated QR code to link directly to their booking site.

1.

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VANZ Membership

Full year membership for 2024/25 is still only $100/pp

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If you purchase a Main Conference (2 or 3-day) attendee pass, your membership for the next 12 months is automatically included and updated in that price.

For further info or to register, please contact our conference team: email us at secretary@vanz.org.nz

A Call for Papers

We are looking for papers on Vibration related topics, Reliability related topics and Asset Management related topics. It would also be great to hear about any new technology, technology advancements or research topics in these areas too.

Do you have a case study you could share?

You don't need to be a professional speaker, in fact we would like to encourage new people to present. The papers ideally need to be 15min in length or longer – its up to you. You could do a solo presentation, or you could even team up and do it as a small group!

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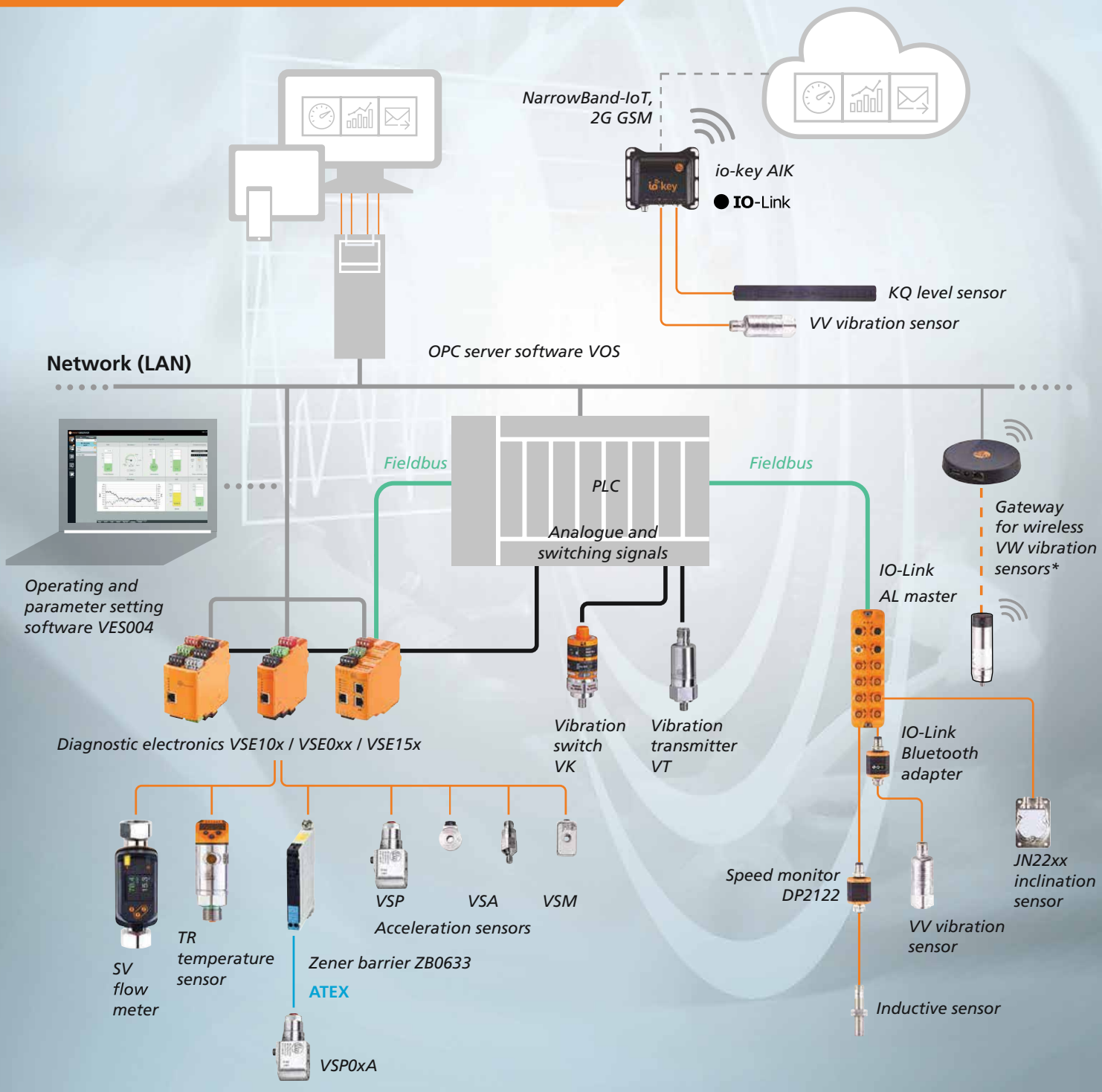

PRESIDENTS' REPORT

By Tim Murdoch | VANZ President

I don't know about you but for me, this year has just flown by! 2023 is already nearly coming to a close, summer is just around the corner, along with the holidays!

There are many places around the country where times have been tough through 2023 - especially those regions hit hard with cyclone Gabriel earlier this year, then battered with further extreme weather systems to follow. It was certainly one for the record books. I do hope 2024 is a much better year for you all.

Our 2024 conference will be held in the beautiful Taranaki region; New Plymouth to be exact, at the **Plymouth International**. Dates are **21–23 May**. Make sure you mark this in your diaries, and pop online to **www.vanz.org.nz** so you can register your interest. As with previous years, we have also arranged special accommodation rates for VANZ members during the conference at two hotels; The Plymouth, and AutoLodge *(located just around the corner)*. Be sure to book in early though if this is something you require, as rooms will surely sell out quickly. Details on page 7.

> **VANZ have a promotion running for first time presenters. The first five to register get a FREE 3-day entry to the conference!**

If you have any case studies or presentations you'd like to share please get hold of us on **papers@vanz.org.nz**. We would love to hear from you. VANZ have a promotion running for first time presenters; for which the first five to register will receive **A FREE 3-day entry** to the entire conference - worth over $1000!

A subject of recent times that seems to be gathering a lot of interest is the use of artificial intelligence. Have you used it in your workplace? Have you learnt anything new this year? Have you got an interesting case study? Do you have a current problem that you would like to put out to everyone for input? These are all great ideas that could make a fascinating paper around the conference or even to be published in our quarterly magazine, Spectrum.

Our first day of the conference is what we call our Awareness Day. We divide this day into two streams. The first stream is for apprentices, trainees and students to be able to learn about different condition monitoring tools like balancing, lubrication, vibration analysis and so on. **We make this available for them for FREE**. The second stream is based on Asset Management, this is open to everyone but mostly directed towards engineers, managers and team leaders.
Last year Mike Davis from EMKE was gracious enough to do a one-day course on electric motors for our 2023 conference. This had great uptake and we had positive feedback from those who attended. If you'd like to learn about motors, how they work – or how they may fail, register for Mike's course, which we will be holding on Wednesday 22 May as one stream of the conference. There are limited places available so get in quick! You do not have to be an electrician to attend this course, in fact, it is designed for everyone to understand.

I would love to see the skill level of trades people lifted. In recent years I have been surprised at the number of trades people I have come across that aren't aware of and/or haven't had experience in tools like vibration analysis, laser alignment, thermography or ultrasound just to list a few. If you know of anyone whom you think our conference will benefit, please bring them along, let them know about us, tell their managers about us. Forward our website details on to them. We are always looking for new members, and there is certainly much to gain from being part of an organisation such as ours.

If you haven't already please go to our Facebook and Linked In pages and follow us. We will be advertising our conference on there so please share this with your contacts.

Thank you to GVS, our platinum sponsor and to all our exhibitors and speakers for all your support in and around our annual conference. We also thank our many other advertisers who have contributed to the VANZ programme over the past 12 months, and also our very own VANZ committee, who work tirelessly behind the scenes. I really appreciate the hard work you all do.

Enjoy your summer, have an amazing Christmas break, New Year celebrations and stay safe. I look forward to seeing you next year.

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Lug crimping practices

Examination of failed crimps across the plant has revealed some common inconsistencies with regard to lug crimping practices. High temperatures detected on electrical crimps and connections highlight the potential for poor equipment reliability. Inspection of these crimp connections revealed inconsistencies such as;

- Crimp Lug selection incorrect.
- Crimping method not followed correctly.

These issues are DEFECTS, which have the potential to cause failures and reduce UPTIME. We remove these defects by careful crimp lug selection, preparation of the cable and lug, correct crimp tool/die selection and following the correct crimp steps. This initial experience shows that we need to be aware of the correct method for making lug connections, and that there are many more of these defects out there that must be eliminated.

Lug Material Selection

- Refer to Utilux® crimp selection guide.

- ALUMINIUM CABLE + ALUMINIUM LUG
  – ALUMINIUM BUS
  – Use a Utilux® – Aluminium Lug
- ALUMINIUM CABLE + BI-METAL LUG
  – COPPER BUS or COPPER LUG
  – Use a Utilux® – Bi-Metal Crimp Lug
- COPPER CABLE + COPPER LUG
  – COPPER BUS or COPPER LUG
  – Use a Utilux® – Copper Crimp Lug

Lug Size Selection

The correct lug size must be selected to suit the cross sectional area of the cable to be lugged.

Cable size is stamped onto the top of the lug palm - eg. UTILUX 120 mm2 . Refer to Utilux® crimp selection guide.

Article prepared by Rod Bennett.

EDITORS' CORNER

By Angie Delfino | Spectrum Editor

Season's Greetings to all our members, this is already our last issue for the year, 2023 has flown by!
For Conference '24 we're going to beautiful New Plymouth, the dates are 21st-23rd May so lock this into your diaries and come join us! We'll have more details for you as it comes to hand and in the next issue which will be the first for the new year, also check in with our LinkedIn and Facebook accounts that will have the latest updates.

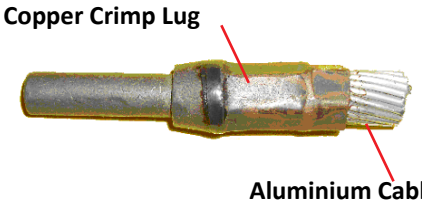
Check out the quiz from Carl and our President Tim Murdoch's latest musings in his end of year report, as well as having a read through the interesting articles that have been contributed for this issue.

As we start planning for the new year we have a busy team organising everything for the 2024 conference, the info we currently have available can also be found on our website www.vanz.org.nz so keep checking back for more details!

VANZ would like to wish you all a very Merry Christmas, Happy Holidays for whatever you're celebrating and a Happy and Safe New Year! Make the most of the holiday season by spending time with family and friends and take a well deserved break.

Many thanks go to the companies who continue to advertise with us, we really appreciated your ongoing support!

Poor Crimp – Why ? Over-crimping and tool die not aligned with lug resulting in lug damage.



Poor Crimp – Why ? Lug material not compatible with cable material. Also Note – 2nd Attempt at crimping lug at cable end.

Note: It is possible to fit the WRONG size lug over the cable, and crimp it, BUT a ***POOR connection*** *will be the result.*

Cable Preparation

The cable must be stripped back to the length of the barrel internal recess + approx 1mm to allow for barrel to spread when crimped.

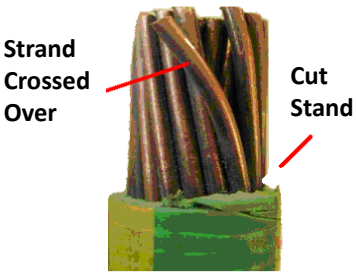
Safety First: Use the correct stripping tool.

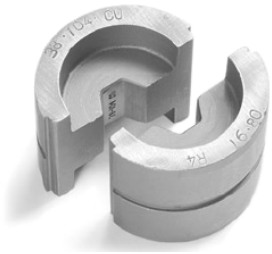
Do not damage the strands of the cable during stripping of the insulation as this will weaken the cable and it may break, particularly if the cable is weight bearing or subject to vibration.

Ensure all strands are OK before slipping on the lug. Check that the strands are not overlaying each other. Re-lay strands if required. If severely splayed, Start again and recut cable.

Note: It is possible to fit a lug onto a cable with overlayed strands, BUT a ***POOR connection*** *will be the result.*

Clean off any oxide layers from bared conductor strands using a scratch brush. Aluminium and Copper Oxide are non conductors and their presence will produce a high resistance joint.





Hexagon Die Set

Flat Die

Indent Die

Nest Die

For Aluminium Cable use a Stainless Scratching Brush. Immediately after cleaning exposed cable, slip the Aluminium lug over cable and commence crimping. Aluminium lug barrel is pre filled with correct type and amount of jointing.

Do not remove any compound from lug barrel.

Lug Palms

If using Blank Lug Palms, pre-drill the holes before crimping to the correct fastener size and de-burr the hole on both sides of the lug.

Continued over page >

VANZ would like to take the opportunity to wish all our readers and members a very

Merry Christmas and a safe & happy New Year!

Above: *The finished Crimp. Note: Crimping die Identification stamped into finished crimp (38-165 CU)*

Crimping Tool Selection
The correct Crimping Tool and Crimping Die must be selected to suit the Lug selected. Refer to Utilux® crimp selection guide.

Note: There are different Dies for Aluminium and Copper Lugs.

A Die Identification mark will automatically be stamped onto the Lug Barrel during crimping.

Crimping Steps
Align crimp lug in jaws of Crimping Die with cable inserted. Ensure jaws do not overhang lug barrel as this will produce a sharp edge that will damage the cable strands.

Keep applying crimp pressure until the jaws meet and the tool "clicks". If the jaws don't meet, then there is a problem with the tool set-up. This must be corrected.

If you find that the crimp isn't quite right, don't try to fix the situation by re-crimping the same lug. CUT THE LUG OFF AND START AGAIN. ■

Be sure to use right tool for the job!

Right: *UTILUX 38A – 12 Ton Crimping Tool*

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The official journal of the Vibrations Association of New Zealand

FEATURE

Control of Building Vibration with Dynamic Absorber

INTRODUCTION

High beating vibration was evident in the structure of a large (350MWe lignite) boiler structure and associated buildings. Although the amplitude was well below that considered to be unacceptable for machines for their integrity, the level increased to became high enough to be annoying to workers in the vicinity. Vibration analysis was used to identify the frequency of the exciting vibration and its likely source. As the vibration was concluded to be at the resonant frequency of the structure, reduction of the source was not a practicable to control the vibration. A vibration absorber system was designed. This paper describes the investigation, the identification of the source, and the successful control measure - design and installation of a series of dynamic absorbers. The feature used on later designs to avoid this problem is also described.

> **“Although barely noticeable initially, this (vibration) increased over some months to reach unacceptable levels from the viewpoint of its effect on people.”**

THE PROBLEM

An annoying vibration was present in the boiler steelwork structure of a large power generation unit. Although barely noticeable initially, this increased over some months to reach unacceptable levels from the viewpoint of its effect on people. The structure also contained a chemical instrument room, the plant control room, and motor control cubicles. Initially, laboratory glassware left on a bench would eventually bounce off and break on the floor! Eventually, the vibration caused annoyance to the shift operating staff. The amplitude of vibration was low, and at no stage

Article by Ray Beebe

Figure I: fan-type coal mill, showing impeller.

Figure II: main corner column and the two adjacent mills.

indicated a danger to the plant itself. However, vibration sufficiently high to be annoying to people is one of the valid reasons for eliminating or reducing it. (Ref 1)

Vibration was measured at selected places on the structure, and analysed to find its frequency as close to 8Hz. It would behave in a cyclical fashion, increasing to a maximum, then decreasing to almost nothing, over a two-minute period. Such behaviour is typical of classical "beating" behaviour, where two frequencies that are very close together move into phase and out of phase, as described in texts on vibration such as Ref 2.

Having read that the natural frequencies of large steel framed structures can be in this range, it was suspected that this structure, some 90m tall, was being excited to vibrate at its natural frequency. The regular vibration condition monitoring of the low speed fan-type coal mills meant that their nominally constant speed of 465r/min, or 7.8Hz, was well known, so they were quickly identified as the likely source.

The unit has eight such mills arranged around the boiler at ground floor level. These mills draw hot gas from the boiler at furnace exit level at a temperature of the order of 1000°C. The coal (lignite) is added just before entry to the mill, where it mixes with the hot gas as it impacts the blades of the mill wheel. The fan action then conveys the pulverised coal and hot wet gas mixture at approximately 160°C to the burners. Shown opened up through its entry door in Figure I, the impeller has a mass of about 20t, and wear occurs on the impeller blades in a fashion that is not unevenly distributed around the wheel. Unbalance therefore increases with service.

Study of construction drawings revealed that each of the four corner columns of the main steel structure was supported on a concrete raft. Each of these rafts also supported two of the fan-type mills. This foundation arrangement was not readily evident to observers (mechanical engineers!), as the only visible floor concrete was clearly not connected structurally to the mill foundations. The drawings showed that this reinforced concrete paving had been laid over the rafts and the area between them, as in Figure II, and was designed to carry only the maintenance loads such as vehicles and cranes.

It was therefore likely that the vibration from two corner-adjacent mills would be very well transmitted into the boiler steelwork via the shared mill and column supports. It was decided to investigate further at its source how the vibration varied with time. Therefore, a vibration transducer was fitted at the same location on the bearing casings of a pair of these adjacent mills.

The time traces of the vibration were arranged to be viewed on a twin-beam oscilloscope. The time traces clearly showed as sine waves of approximately 8Hz. As the time traces moved into phase, the structural vibration was at a maximum, and vanished when the traces were in anti-phase. This was the classic case of "beating" as suspected. The forces from the residual unbalance in each of the two impellers apparently balanced each other when in anti-phase, but added together when in phase to provide a large exciting force to the structure. It was also evident that the speeds of the mills varied slightly in service, possibly due to slight variations in the intensity of coal flow.

The levels of vibration as measured at the bearings of these mills were not high, and not of a concern for the condition of the mills themselves, according to available Standards (Ref 3). A common measure to reduce excessive vibration is to reduce the source, which in the case of rotating machinery usually means balancing.

Continued over page >

Balancing of these mills in-situ was possible, as it had been successful on smaller mills of a similar design, but here it was considered too lengthy and cumbersome a process. The state of balance would also be expected to decay as blade wear progressed, and frequent balancing was not practicable. Given the large structure, the other common control measures of a change in system mass or stiffening were also not practicable. It was decided to try the use of a vibration absorber.

THE SOLUTION

A vibration absorber consists of a mass connected to the original system by springs, such that is free to vibrate independently of the original structure. The springs can be of any type. An absorber is useful where a structure or machine that can be considered to have a single-degree-of-freedom vibrates at its natural frequency, usually due to some forcing or exciting vibration.

The "absorber" adds a second mass-spring combination to the system, converting in into a two-degree-of-freedom system. This new combined system now has two new natural frequencies, one above and one below the original natural frequency. When the absorber system is tuned to the driving frequency and has reached steady state, the force provided by the absorber mass is equal in magnitude and opposite in direction to the original disturbance force. With zero, or close to zero, net force acting on the primary mass, it does not move and the motion is "absorbed" by motion of the absorber mass.

For the method to be successful, the harmonic excitation must be known and not change much from its constant value. Damping must also be negligible. These conditions were considered to apply in this case. The theory behind the use of the vibration absorber is given in textbooks on vibration analysis, such as Ref 2.

Defining these terms:

- Ratio of mass of absorber to original system mass: μ (usually chosen in the range of 5% - 25% of the original system mass, where this is known)
- Natural frequency of the original system: ω_p (assumed here from the symptoms to be close to 7.8Hz)
- Natural frequency of the absorber system before it is attached to the original system

$$\omega_a = \sqrt{\frac{k_a}{m_a}} = \sqrt{\frac{Stiffness\ \ of\ \ absorber\ springs}{Mass\ of\ \ absorber}}$$

- Ratio of frequency of absorber system to that of original system:

$$\beta = \frac{\omega_a}{\omega_p} \quad \text{(which for a tuned system =1)}$$

The equation relating these gives the values of the natural frequencies of the new system normalised to the frequency of the absorber system (Ref 2):

$$\left(\frac{\omega}{\omega_a}\right)^2 = \frac{1+\beta^2(1+\mu)}{2\beta^2} \pm \frac{1}{2\beta^2}\sqrt{\beta^4(1+\mu)^2 - 2\beta^2(1-\mu)+1}$$

The values that indirectly specify the mass and stiffness of an absorber system can be seen as the ratio of the absorber mass to the initial system mass, and the ratio of the natural frequencies of the absorber mass system and the original system. The greater the absorber mass compared with the mass of the original system, the wider the useful frequency range of the absorber.

In the more usual applications of a vibration absorber, where the masses of both original system and absorber are known, and hence μ is readily found, the useful frequency range of the new system can also be calculated equating the following expression to 1, and also to –1 (Ref 2). This results in four roots, the central pair of which define the useful frequency range.

As long as the exciting force remains inside the useful frequency range, the absorber will be effective. (If this expression is greater than unity, the absorber will in fact increase the force to the original system).

With ω_{dr} as the frequency of the driving force:

$$\left[1-(\omega_{dr}/\omega_a)^2\right] \ \div$$
$$\left[1-(\omega_{dr}/\omega_a)^2\right] - \mu(\omega_a/\omega_p)^2\left[1+\mu(\omega_a/\omega_p)^2 - (\omega_{dr}/\omega_p)^2\right]$$

As in this case the effective mass of the total system was not known, and was too complex and too large to consider a single absorber at any one position, the team did some initial experimentation at a point of relatively high vibration in the chemical instrument room. A combination of masses and springs tuned to as close to 7.8 Hz as could be obtained was tried and eventually the correct combination was found to minimise the amplitude of vibration at that point. The same experimentation was applied at mid-span of the steel floor supporting beams under the control room.

The final mass/spring system was designed as a frame holding lengths of scrap steel (a supply of worn mill lining plates was readily available). Several of these arrangements were installed in locations at about mid-span of the beams underneath the control room, with compression springs resting on the bottom flange of the beams as shown in Figure III.

Another simpler table design – a plate supported on springs - was installed in the chemical instrument room.

The systems were successful in controlling the vibration in the areas where it had been causing annoyance. Detailed measurements of the amplitudes were not necessary, as the criteria for success was to remove the annoyance, and this was achieved. The systems have been operating successfully since.

THE FUTURE DESIGN

The design of future boiler-turbine units was well advanced, and it was not possible to redesign the structures, which in any case were of a completely different arrangement to the earlier plant. The new mills were also to be variable speed.

It was decided to install the fan-type mills on vibration isolating foundations, designed by a specialist company. Each mill was mounted on its own concrete block foundation, but instead of being supported directly connected with the main structural system as in the plant described in this case study, the foundation blocks are supported on several large springs. Large simple dampers are also provided. The effectiveness of these proprietary systems in service is readily apparent when standing with one foot on the mill block and the other on the adjacent floor. It was not practicable to modify the initial plant to such an isolating system. ■

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(1) *Beebe, RS Machine condition monitoring MCM Consultants 2001 reprint.*
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(3) *ISO 18016 Series on vibration severity assessment.*

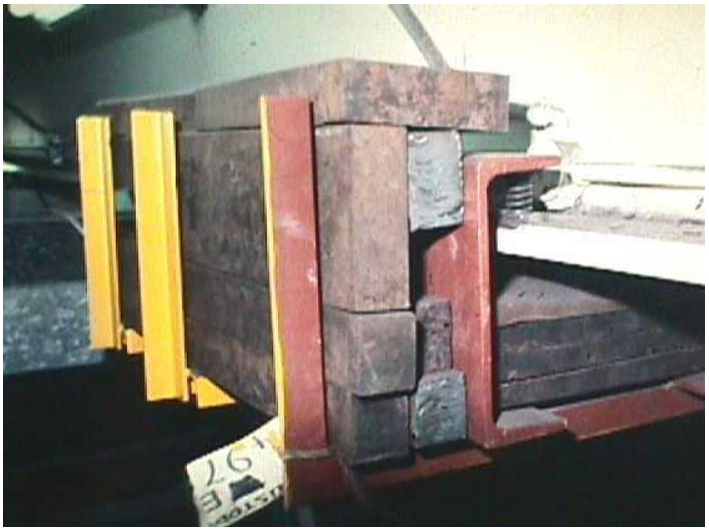
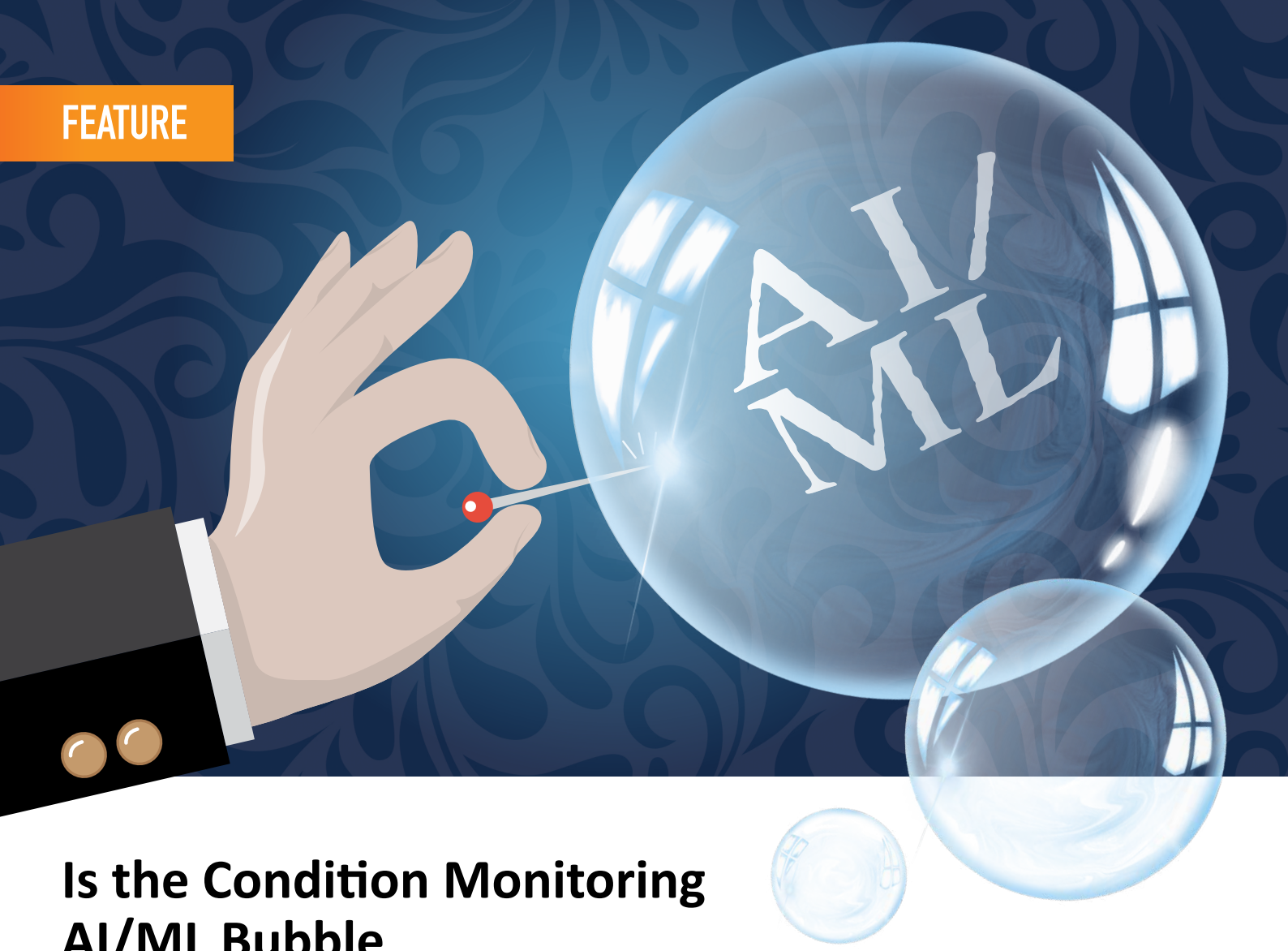


Figure III: typical absorber supported on lower flange of control room beams.

FEATURE



Is the Condition Monitoring AI/ML Bubble

Starting to burst?

No computer program developed to date can beat first hand human machinery domain expertise when it comes to vibration-based condition monitoring and evaluation.

Artificial Intelligence and Machine Learning have been heavily promoted as the next generation of condition monitoring technology. Hundreds of millions of dollars have been invested over more than two decades trying to develop an ultimate solution. But like the dot-com bubble that burst 20 plus years ago, it's starting to look like AI/ML in the condition monitoring space is soon to follow that same path – huge investment but no serious path to success or profitability.

A recent conversation on LinkedIn has referred to AI in the condition monitoring space not as Artificial Intelligence but rather, "Automated Incompetence" which was based on blind focus on algorithms and data science over actual hands-on machinery operating and failure experience. Perhaps a more appropriate term would be "Alleged Intelligence" since the providers are the only ones proclaiming that there is any intelligence or the ability to think in their systems. These suggested changes in the meaning of the letters in the condition monitoring and evaluation space are somewhat legitimate when the focus is more on software development and data science than it is on industrial machinery domain expertise.

Continued over page >

Bob Craft was the keynote speaker for the 2015 VANZ annual conference. He has over 40 years experience, half as an end-user and half as a supplier, with multi-technology condition monitoring and evaluation systems and programs. Bob is Managing Member and Principal Consultant with Consultants for Condition Monitoring, LLC. Located on the east coast of the USA, Bob can be reached at +1.860.213.9076 or bobc@consult4cm.com.

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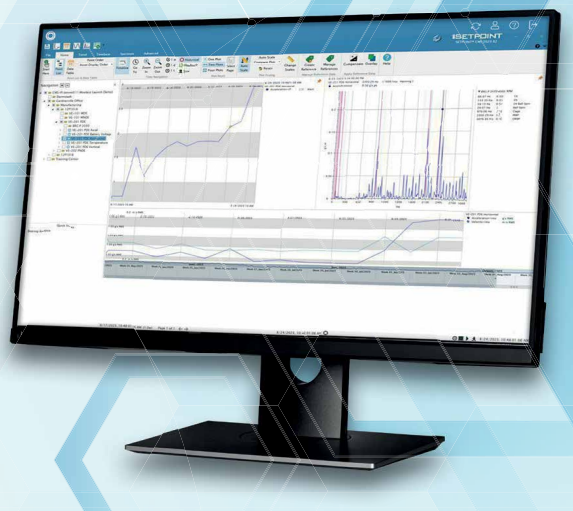

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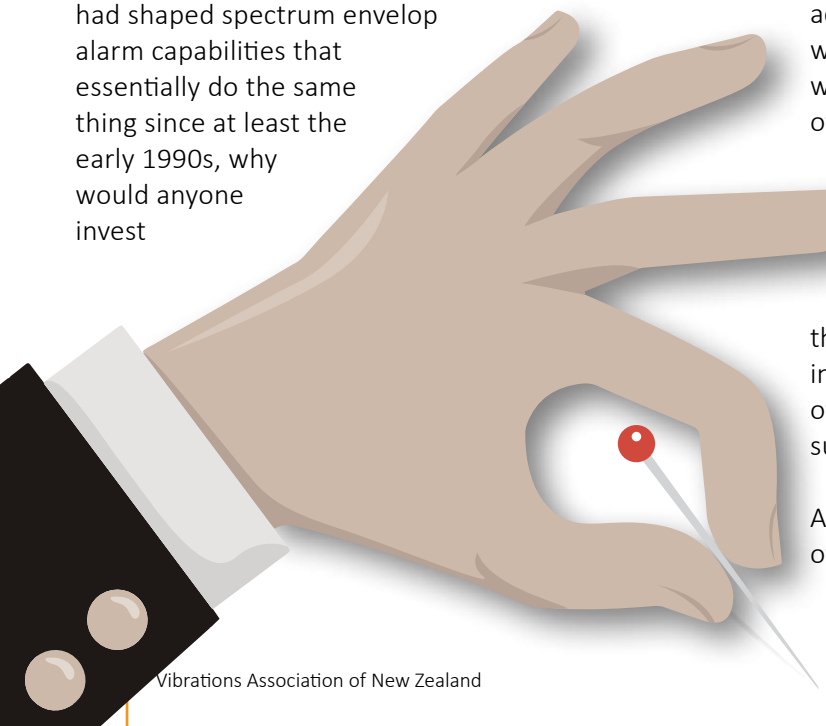
AI/ML has been the new favorite marketing buzz-phrase for the last few years, with just about every industry jumping on the bandwagon. AI/ML is promoted as making every part of our lives easier, from dating Apps through our refrigerators automatically ordering more milk from the on-line home delivery grocery store and even to clergy looking to spend less time writing their Sunday sermons. All this to require less thought on our parts.

Machine Learning is also taking on new twists. Several well written PhD thesis papers that have recently been published have focused on unsupervised learning.

How does a machine – meaning a computer - actually learn without human domain expertise as an input? They all presented some excellent spectrum anomaly detection methods and demonstrated the fact that they work well at detecting anomalies in the collected data without any kinematic or operating details of the machines they studied. These algorithms they had developed had no "knowledge" of the spectral characteristics of expected forcing frequencies and therefore had nothing to offer in their results in terms of what the anomaly might be trying to tell about the running condition of a machine.

> **The lack of machine kinematics and domain expertise on the part of the developers alone should be a huge red flag.**

The candidates all were awarded their PhD's based on developing algorithms that absolutely recognized the difference between two sets of spectra where the machine speed had changed without any understanding of the normal speed variability of the machine that was the source of their test data samples! Considering the fact that many machine vibration focused condition monitoring software packages have had shaped spectrum envelop alarm capabilities that essentially do the same thing since at least the early 1990s, why would anyone invest in recreating that same capability with involved computations that know nothing about the system being monitored and simply flag a spectral anomaly? The lack of machine kinematics and domain expertise on the part of the developers alone should be a huge red flag.



Nearly all of the dynamic data-based condition monitoring instrument and software providers are developing and promoting AI/ML applications, with spins unique to the markets they sell to. The most successful of these, with actual credible product offerings, are the companies who focus on a particular machinery component type where they have very specific domain expertise. The best example is in the motor monitoring space where AI/ML has been successfully embedded into dedicated motor condition monitoring systems that "learn" the normal behavior of each unique motor as part of a specific machine system and monitor for anomalies and relate those anomalies to specific failure mechanisms. These companies all started with deep motor-specific domain expertise which included how to detect specific failure mechanisms and then applied advanced computational methods to alert users when fault conditions were recognized as having begun. Their success has come because their focus has been narrow and well within the lane of their domain expertise.

The problem comes in when companies without machine specific domain expertise try to apply software and data science with more of an academic than a practical approach. They proclaim that their advanced algorithms, developed by data scientists who are not machinery experts, can correctly identify your machinery problems. These results, they say, should be expected well enough in advance of a functional failure to be able to tell you exactly what is wrong so that you can get the problem corrected with minimal impact on your productivity. Significant sums of money have been invested over more than 20 years by over a hundred companies without the promised all-things-to-all-people solution.

The profitability for the developers just isn't there consistent with the marketing hype, which is why the bubble is likely to burst and do so soon. Just like in the dot-com days around the turn of the millennia, over investment in promises with little actual revenue substance behind them is already challenging the space.

A company that had already been working on this for over 10 years achieved Unicorn status with a 9 figure

investment for a small, minority ownership stake in the business a couple of years ago. At that time, said company had not yet achieved profitability and even now, two years later it is still not yet profitable. Sure, they have plenty of money to burn through to support their marketing, data science and algorithm developments, but investors are likely getting restless, particularly given the two rounds of layoffs that they have recently gone through as they strive for profitability.

The bottom line is that AI/ML systems are only as good as the domain expertise that is embedded within them and the machinery problems that have already been seen and characterized. Sure, they can identify the easy problems, but do we really need to invest in an AI/ML solution for the easy ones? When will the ability to actually think and ask the right follow-on questions when the data itself does not present a single clear problem/recommendation solution set, and temper the recommendations based on those answers be available?

AI/ML still needs the ability to ask the critical questions that we all do, as machinery domain experts, when we first encounter anomalies in data or get that call from the operating floor that "XYZ Machine sounds funny?"

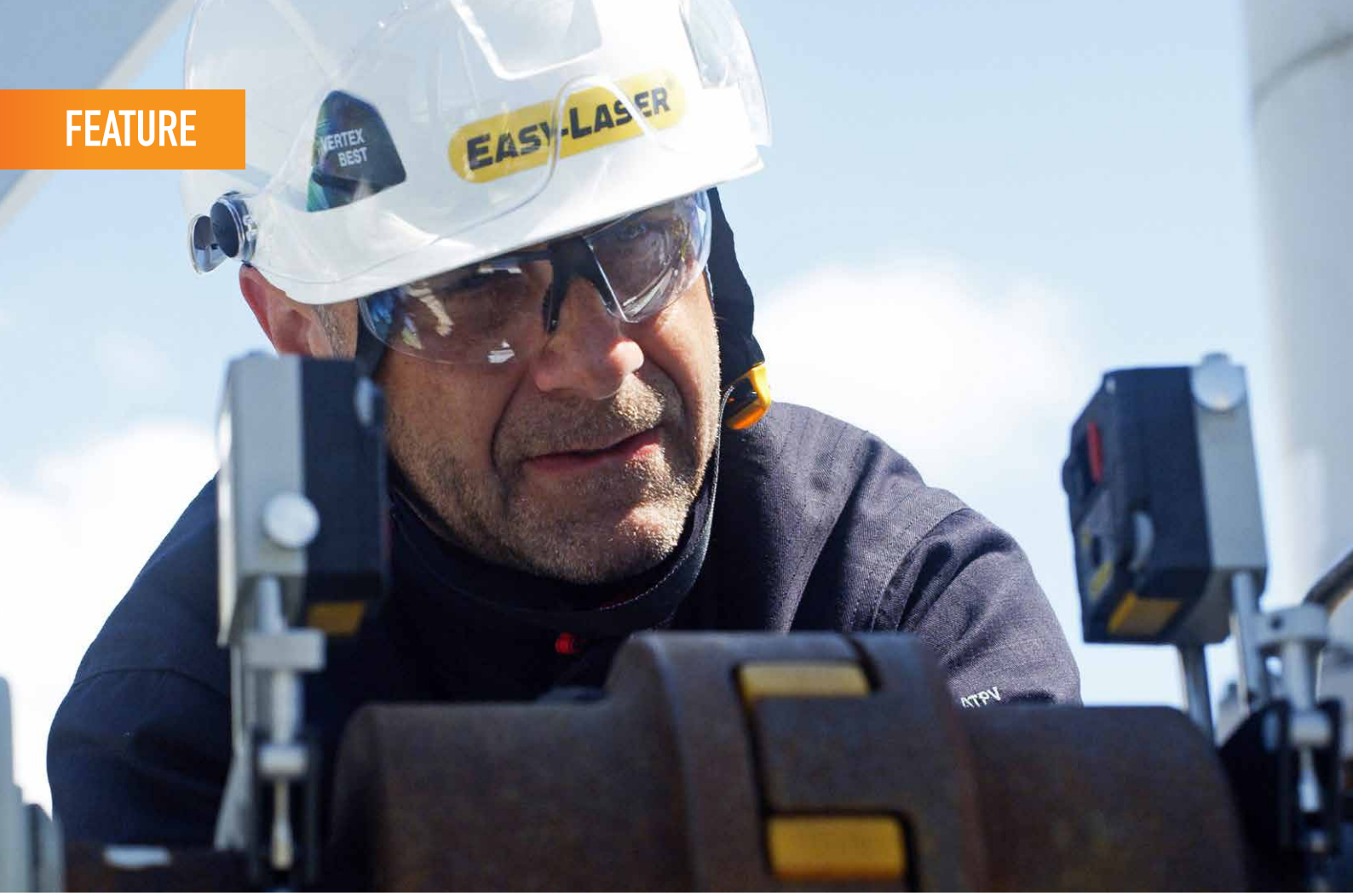
The bottom line is that AI/ML systems are only as good as the domain expertise that is embedded within them.

(My favorite question before grabbing a data collector and rushing to the scene has always been, "What did you do to it??!") Many vibration changes on operating machinery are normal when things like speed and load or product changes take place, either planned or unplanned. When will AI be able to recognize that maintenance was recently performed that altered the vibration signature, or an upstream or downstream valve position was changed or cooling flow was altered?

Nothing today beats the knowledge and experience of the human who understands the machine they are monitoring at the gut level. The best approach is to have machinery domain experts who can literally stand next to a machine with mental x-ray vision and visualize the internal components and how they relate to each other in operation and make the connection between what they see in the vibration data and what is going on inside the guts of the machine.

Given today's level of AI/ML technology, with very few notable exceptions, your investment to improve your operational reliability through condition monitoring and evaluation would be better spent on people with machinery domain expertise than on an AI/ML system. ■

FEATURE



How to be a strategic Installation Leader

It is very important to choose the right strategy when moving into the assembly and installation phase of rotating machinery. The definition of a strategy is a high-level plan to achieve one or more goals, under conditions of uncertainty. To choose the right strategy you need to take a few things into consideration and get ready for constant changes.

By Roman Megela
Reliability Engineer, Easy-Laser AB

ANTICIPATE

In installation of rotating machinery, it is very important to anticipate change. As an Installation Leader, you need to anticipate every possible situation. You might think, you have it all figured out. In many cases, the site is located far away from the supply warehouses and workshops which you might need during the installation.

Many parts of assembly are delivered from different countries, even continents which will make it challenging for you to get the original replacement parts, in case you need it. It is essential you can talk directly to the suppliers, vendors, and all your partners involved in the installation. The assumption itself is not going to provide you with the real facts, which you need to know. Assumptions is your worst enemy. Do not assume. Calculate and measure.
To anticipate potential situations will provide you with the data to put together a strategy on how to confront those situations, but also how to avoid mistakes. An example: If you are doing onsite assembly and installation for offshore industry, breaking the paint coat on the asset for example will cause your installations to no longer be approved due to very important painting codes. In many cases you cannot re-paint on site because the painting procedure needs to be performed in a proper paint shop. Use this scenario to anticipate possible, unexpected obstacles. As a good rule of thumb, to add 20% of additional time for the installation process.

CHALLENGE

Challenge yourself and challenge your partners. Take out

the assumption that everything is going to go as planned. Think about the possible solutions. Ask questions to your team and everyone who is involved. If we find out our foundation is twisted or is not flat, how do we fix it? Can we shim, or mill it? Where do we find a millwright to get it done?

Normally your equipment was delivered to the site a long time ago. What can happen if your equipment was not properly identified and it's on the wrong storage list and as a result you get wrong box? You might be delayed for hours, even days until the correct box is in place.

Challenge the contractors and ask questions. Their answers will give you an idea about the organization and their quality management system. In those questions lay hidden answers. If you do not trust their quality system, do the inspections yourself.

> **When the deadline is approaching and stress levels go up, people tend to lose their integrity and they start cutting corners.**

DECIDE

You will be involved in decision making. In the time of uncertainty, the installation needs a leader who can make the decision. When the deadline is approaching and stress levels go up, people tend to lose their integrity and they start cutting corners. You, as a leader, must point out the direction. Keep the quality and standards at a high level, integrity matters.

ADAPT

When delays occur, problems appear. Think positive, manage your teams, and change their designation to get the best out of them. Constantly evaluate the situation and if you cannot proceed with the planned work, change your plan. Act dynamically and quick. Take advantage of the situation. To design your strategy, you need to adapt to the new situation.

LEARN

Try to evaluate every installation work once it's finished. The more challenges you face, the more you learn. To achieve your goals, you also need to learn who to speak to and who to partner with during the installation. It is very important your decisions and ideas are positively considered and accepted. In the end, the most important goal for you is to complete A proper Reliable installation which will operate for time to come.

Through **anticipation, decisiveness, adaptability, willingness** to learn and by not forgetting what should be your guiding star in all of it (your work and personal life): **integrity.** That's how you become a strategic installation leader. ■

Roman Megela Gazdova works as a Reliability engineer at Easy-Laser AB. He has 20 years of experience in assembly, commissioning, and service of gas compression systems all over the world, from Europe to Asia and USA, in all kinds of industries: glass production, stainless steel production, oil and gas, oxygen, petrochemical, natural gas, biogas, hydrocarbon. He is now on a mission to teach good practice for reliable machinery installation.

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TEST YOUR KNOWLEDGE - PART 73 OF A SERIES

1 When carrying out a single-plane balance, the original (reference) reading was 12 mm/s pk at 030 degrees. You add a trial weight of 30 grams at 000 degrees and the readings for that trial run are 6 mm/s pk at 210 degrees. Based on this, the balance correction (trial weight removed) will be...

a 60 grams at 180 degrees.
b 60 grams at 000 degrees
c 20 grams at 000 degrees
d 20 grams at 180 degrees

2 In a dairy factory, there is a vertical steel column that has a cantilevered horizontal beam welded to it 3 metres above the ground. Both the vertical and horizontal beams are vibrating at a single frequency. A phase and amplitude reading is taken on the vertical column using a transducer mounted horizontally at a point 1 metre above the horizontal beam, with the transducer pointed away from the horizontal beam. A vertical reading, with the transducer pointed downwards is taken on the horizontal beam 1 metre out from the base. The amplitudes are similar for both points, but the phase is 180 apart. If the engineer is considering adding a 45-degree brace between the two points with the goal of reducing the vibration, which of the following is true?

a The mass per metre of the brace should match the existing structure to reduce the vibration
b The mass per metre of the brace should be twice that of the existing structure to reduce the vibration
c The mass of the brace is not critical – a brace of any mass should reduce the vibration
d A brace between these two points is unlikely to have an appreciable effect on the vibration.

3 At what amplitude is oil whip considered to be severe?

a When the amplitude reaches 10 to 20 % of the bearing clearance
b When the amplitude reaches 40 to 50 % of the bearing clearance
c When the amplitude reaches 70 to 80 % of the bearing clearance
d When the amplitude exceeds the bearing clearance

Answers on page 33

Further enquiries can be directed to: Carl Townsend at Carlton Technology Ltd.
Phone: 64-6-759 1134 | Email: ctownsend@xtra.co.nz | Address: P.O. Box 18046 Merrilands, New Plymouth 4360, NZ

4 Availability, performance and quality are three factors influencing which of the following?

a OEE
b BEP
c MTF
d GST

5 Which of the following is true about hard-bearing balancing machines?

a They generally need to rotate the rotor at higher speeds than soft-bearing machines to achieve the same balance precision
b Special foundations may be required
c Neither a nor b is correct
d Both a and b are correct

6 Which of the following might indicate to you that there is looseness in a rotational assembly?

a Unsteady phase
b The existence of running speed harmonics in the vibration spectra
c The crest-factor of the waveform might be high
d Any or all of the above could be correct

7 You are about to undertake an in-situ 2-plane balance correction on a belt-driven fan. You decide to collect vibration signals from the horizontal and vertical planes of both the DE and NDE bearings. Assuming that your balance program allows you to collect the readings sequentially, what is the minimum number of vibration sensors that you would need to do this job?

a 1
b 2
c 3
d 4

8 Some firearms are suited to the use of sub-sonic ammunition. Which of the following projectile velocities is likely to be the highest whilst still being regarded as sub-sonic?

a 50 m/s
b 100 m/s
c 200 m/s
d 300 m/s

9 Which of the following windows would you most-likely use when carrying out modal impact testing?

a Exponential
b Hamming
c Hanning
d Uniform

10 Hanning windows are commonly used for routine vibration measurements. What is the maximum possible amplitude error that could result from the application of this filter?

a 0 %
b 10 %
c 15 %
d 20 %

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Shaft alignment precision at every turn with the Acoem AT series

Acoem – a global leader in Industry 4.0 augmented mechanics for enhanced industrial reliability – continually invests in research and development to improve the customer experience and make the process of aligning and balancing your critical machinery easier and more dynamic. As technology advances becomes available, Acoem adapts and integrates them into their shaft alignment solutions to provide an even greater range of capabilities and functionality.

With four different versions of its innovative AT series now available, Acoem gives you the choice of alignment tools with varying degrees of sophistication and monitoring parameters, depending on your individual needs.

In 2023, Acoem introduced the latest addition to its AT series – the next generation, revolutionary AT-400. As it did with the previous AT models (the AT-100, AT-200 and AT-300), Acoem considered its customers' feedback and evolving industry needs when developing its newest solution.

The fully integrated Acoem AT-400 system comes complete with a robust storage/transportation case, new M9/ S9 dual-axis sensors, the powerful AT-400 app, an enhanced display unit, accessories and long-life power supply.

You asked and we listened, incorporating everything you wanted in a shaft alignment tool

The AT-400 delivers:

- Repeatable and reliable measurement accuracy
- Highly responsive and intuitive file manager interface with extended battery life
- Single screen displays all data, reports and apps in one place
- Faster reporting functionality and job history retrieval
- Wireless communication protocol between the sensors and your interface
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- Direct access to online help with manuals and quick guides
- Features for indicating/measuring thermal growth, soft-foot, feet lock, vertical alignment and machine train between individual machinery relative to your operational network.

Dual-axis technology combined with the Acoem integrated ecosystem equals a superior solution

This is the first time that Acoem has integrated dual-axis technology into its class-leading ecosystem of alignment solutions that features seamless connectivity, app-based intuitive data management and reporting, cutting-edge sensors, WebPortal, and the service and support Acoem that comes with being an Acoem customer.

With dual axis technology, precise shaft alignment is in your hands.

- Secure accurate measurements of large-scale machinery with significant distances (over 15 metres) between sensors

Continued over page >

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CREATING ENVIRONMENTS OF POSSIBILITY

AT-400

DUAL PRECISION AT EVERY TURN

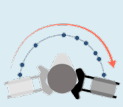
Acoem, a trusted name in condition monitoring and predictive maintenance, has been a pioneer in laser shaft alignment technology for decades. That tradition continues with our latest innovation - Acoem AT-400 dual-axis shaft alignment solution. With this cutting-edge system, precise laser alignment is easier than ever before.

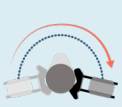
What makes the AT-400 remarkable is its ability to effortlessly blend precision with simplicity. This advanced alignment solution ensures your machinery operates with unmatched accuracy and efficiency.

Maximising alignment performance

AT-400 integrates dual-axis technology seamlessly, offering unrivaled precision for large machinery. With extended sensor distances, it outperforms traditional line lasers.

- DualXL PSD detectors
- 7 measurement methods
- GuideU™ 3D shaft alignment interface
- 20 metres measuring distance


Dual Sweep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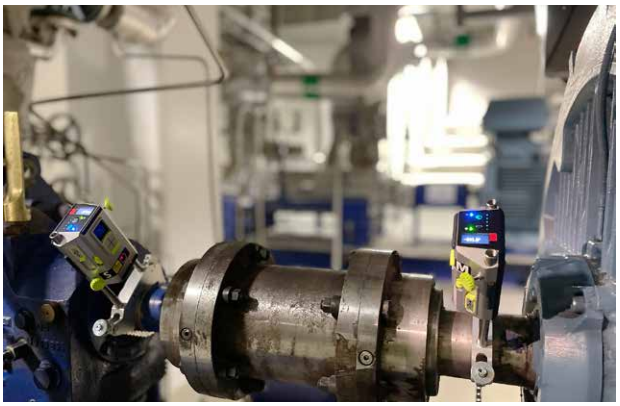
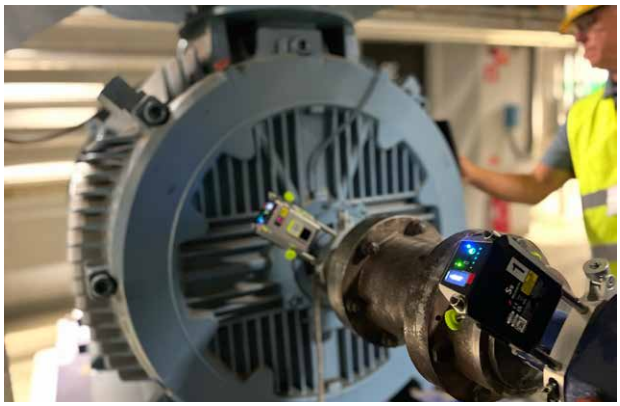
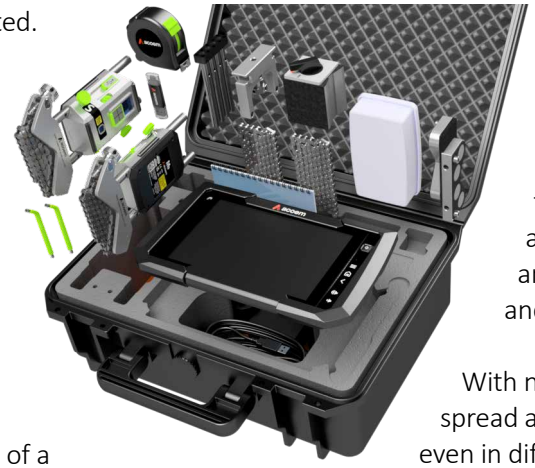




- Capture critical sweep and flatness measurements easily and more precisely
- Gain accurate multipoint alignment data – vertically and horizontally –in any rotational position simultaneously over greater distances
- Monitor complex machines that can't be easily accessed or manually rotated.



According to Mathew Smart, Acoem Australasia Reliability Solutions Manager, the Acoem AT-400 solution unlocks the potential for faster and more precise alignment decisions – ultimately saving your business time and resources.

"With less maintenance downtime and advanced functionality that simplifies data capture and diagnosis of a wide range of complex machines, you'll increase operational productivity and be able to focus on your key output functions instead of reliability challenges," he said.

Maximise alignment performance over a diverse range of applications

The multipoint measurement system of the AT-400 makes shaft alignment of power plant turbines simpler and more accurate, especially for uncoupled shafts, coupled shafts with sleeve bearings, shafts with jerky rotation, white metal bearings, journal bearings or difficult-to-rotate/ non-rotatable shafts.

High-speed compressors and turbines require exact measurements, and the multipoint capability of the dual axis sensors lets you rotate shafts at any position with an infinite number of turns.

For spacer shaft alignment in cooling towers the new extended laser distance gives you accurate measurement over distances of 20 metres or more, even in bright sunlight and under extreme heat conditions. You no longer need to position the shaft at the 3 o'clock position, saving you time and resources.

Short haul and yard diesel locomotives traditionally required special alignment procedures like the complex dials method, but the AT-400 makes things easier with the alignment tool automatically measuring and adjusting the angular misalignment between the engine and alternator shafts.

With non-rotatable shafts, additional readings spread around the shaft improve reliability, even in difficult situations and for machine train alignment, the AT-400 provides a solution with the smallest possible move for the bolt-bound machine.

Precision alignment diagnoses for all types of machinery

- Compressors
- Cooling towers
- Energy generation turbines
- Mainline, short-haul and yard diesel locomotives
- Machine trains
- Maritime
- Non-rotatable shafts.

To learn how the AT-400 can help solve your machinery alignment challenges, or to view our entire AT series, visit acoem.com/australasia/ranges/proactive-maintenance/shaft-alignment-tools or contact info.au@acoem.com to arrange a demonstration.

PUZZLE CORNER

Solutions on page 29

WORD BUILDER

How many words of **three or more** letters can you make using the five letters below? You can only use each letter once. Plurals are allowed, but no foreign words or words beginning with a capital.

Word scores expected...

15 - Good | 20 - Very Good | 25+ - Excellent

O	T	A	S	B

There is four 5 letter words in this puzzle.

WORD LADDER

A Word Ladder has two words in the ladder, one at the top and one at the bottom. You must form a sequence of words going down. On every step of the ladder (1-6), you must unscramble and create a new word that only differs by one letter from the word above it until you reach the destination word on line 6.

We've started it off for you...

1. MINE
2. MINT
3.
4.
5.
6. COAL

SUDOKU

To solve, each number from 1 to 9 must appear once in:

- **Each of the nine vertical columns**
- **Each of the nine horizontal rows**
- **Each of the nine 3 x 3 boxes**

No number can be repeated twice in a box, row or column. **We've started it off for you...**

58.6% of puzzlers can solve this. Can you?

Puzzle difficulty: **Hard**

			8				2	6
6	5	8						7
	9						8	3
			9					
	6	2						4
		7		2		8	1	
5			7		2			
		4				6		8
				6			4	

Meet Debbie, a robotics expert in the making. During her 2020/2021 Summer Internship with Facteon, Debbie worked alongside our Design and Automation teams to develop a new semi-automated method of teaching user frames* for a robot. Here, Debbie discusses the process and what this means for manufacturers.

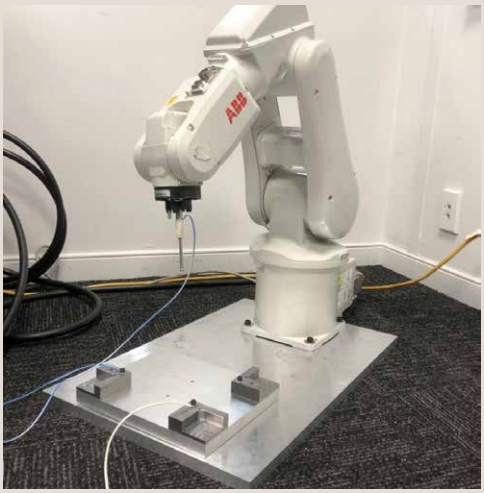
THE ROBOTICS TEACHING OF YESTERDAY

Prior to the development of this new technology, teaching a robot a user frame was a largely manual process which needed to be completed by a technician with an automation background. The commissioning stage was often slowed due to the complexities of the robot teaching process. The Facteon team identified an opportunity to revolutionise robotics teaching as it is both time consuming and vulnerable to human error.

THE MODERN APPROACH

The technology we have developed simplifies the process of teaching a robot a user frame. Rather than a human operator manually driving the robot to different points so it learns the point of origin for a user frame, a touch probe and software program are utilised to teach the robot semi-automatically.

The deployment of touch probes to analyse and record 3D surfaces of a workpiece for CNC machines is common place throughout industry. This ability to analyse a surface was built upon to develop the software used for robot teaching. The robot establishes its parameters by searching for and recording certain points on a work surface. A separate program is then run to calculate the user frame. This is a relatively simple development which has the potential to achieve significant time and cost savings during the commissioning phases.



Above: *Robot and touch probe during the testing phase at Facteon's facility.*

As Facteon integrates and programmes robots on site prior to pack down and shipment to the customer's site, it is critical to speed up the robot teaching process. As the COVID-19 pandemic simultaneously calls into question the business rational behind sending multiple experts to a customer site to manage commissioning, the need for a robotics expert on-site is also problematic. By simplifying the teaching process, manufacturers ultimately have greater certainty that their production line will be delivered on-time and to specification.

Teaching a robot manually can take over a day depending on how difficult it is to align the robot to the surface of the fixture or object and how skilled the operator is at driving the robot. With this new technology, these time-consuming factors are no longer an issue and teaching time could be cut down to less than half the original time taken.

THE ROLE OF SMART MANUFACTURING

The purpose of smart manufacturing technologies is to improve the efficiencies of the manufacturing process. The current method is very much dependent on the skill of the operator. The slightest movement of a work piece or station means that the robot must be re-taught. With this new technology, you would have to reteach the robot but the process of doing so is far simpler.

With AI technologies consistently adding value to the manufacturing industry, the ultimate goal is that the process will be fully automatic and the robot will teach itself the parameters of its user frame. AI has, and looks to continue, shaping the future of the manufacturing industry. Smart manufacturing technologies are making operational excellence increasingly achievable for manufacturers of all sizes. Powered by this innovation, manufacturers can now have certainty in their ability to meet market demand on time with accurate robotics solutions.

Ultimately, this technology has the potential to evolve to a customer-friendly program where an expert would not be required if the robot needed to be retaught. The customer simply needs to attach the probe to the robot and run the program. In the future, there is clear potential for this technology to be offered as an after-sales service for manufacturers. ■

**A user frame is an x, y, z coordinate system that is aligned with an object's location and rotation. It is defined with respect to the robot's own world coordinate system and is useful for teaching the robot points on a fixture or work piece.*

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The small print...

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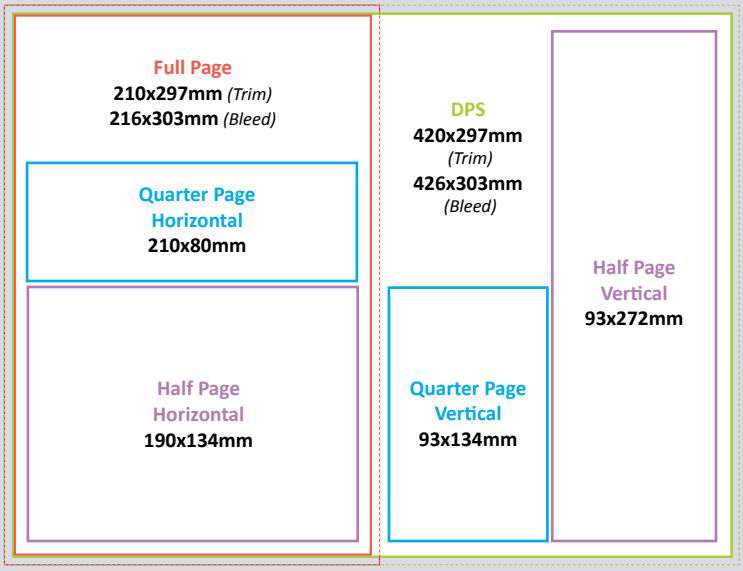

Carlton Technology Quiz 73: 1C, 2 D, 3,B, 4A, 5 D, 6D, 7A, 8D, 9A, 10C
Word Builder: boast, boats, botas, sabot
Word Ladder: 1. mine 2. mint 3. mont 4. moat 5. coat 6. coal

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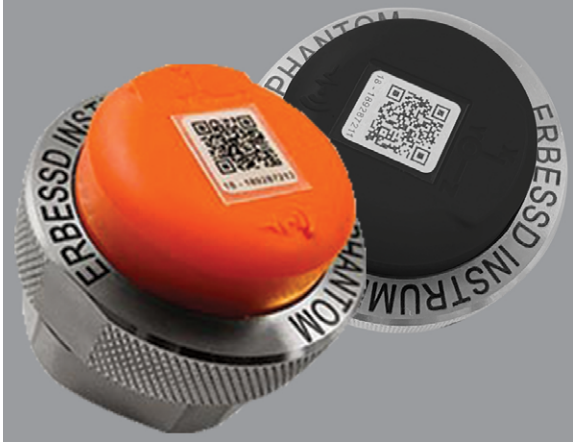

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