

Spectrum

Spring 2021 | Issue 101



Rethinking the House of Reliability

What events in history have caused us to perform the way we do?

Electric Motor Fault

– a case study from India



Clayton's Spanner

– learn more Skills and Practices





Machine Vibration & Plant Condition Monitoring Solutions



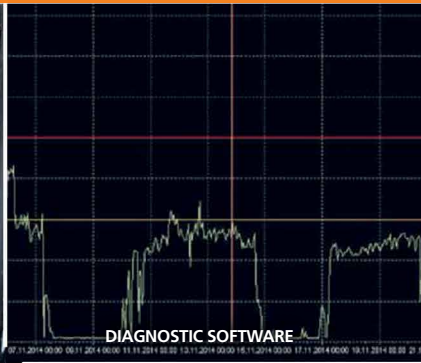
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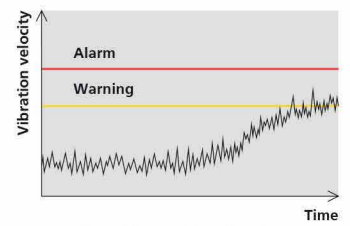
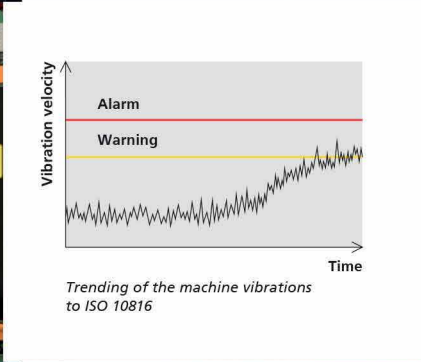
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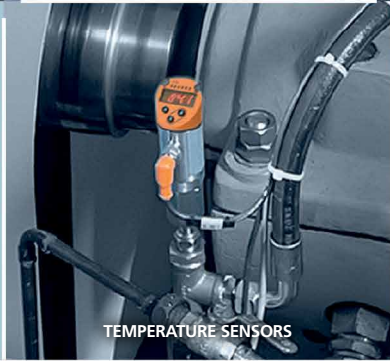
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Trending of the machine vibrations to ISO 10816



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Looseness, unbalance



Misalignment



Rolling element bearing



Gearbox Meshing, tooth fault



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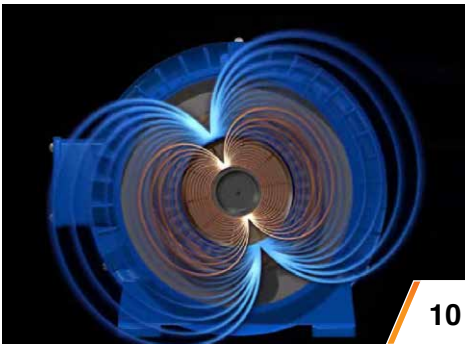


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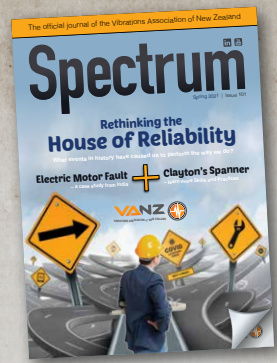
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Editor

Angie Hurricks
Ph 021 239 4572
Email: spectrumeditor@vanz.org.nz

Design

Eddie van den Broek
Flashpoint Design and Marketing
info@flashpoint.design

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Please address material to:

Angie Hurricks
Spectrum Editor
c/o 358 Waerenga Road,
R.D.1, Te Kauwhata, 3781
Waikato, New Zealand

or email: spectrumeditor@vanz.org.nz

Statements made or opinions expressed in Spectrum are not necessarily the views of VANZ or its Officers and Committee.

President

Rodney Bell
Email: rodney@mbs.net.nz

Treasurer

Graeme Finch
Email: G.Finch@auckland.ac.nz

Secretary

Bill Sinclair
Email: bill.sinclair@valas.co.nz

Please address all VANZ correspondence to:

VANZ
PO Box 2122
Shortland Street
Auckland

Web Site
www.vanz.org.nz



PRESIDENTS' REPORT

By Rodney Bell, VANZ President



Hi to you all. Well, this is the first time I have prepared a Presidents report post the termination of the August 2021 VANZ Wairakei Resort conference.

This passage has been very interesting to say the least, but I do wish to give thanks to the Wairakei Resort with the difficult process they have managed from the initial Government announcement through to the outcome of VANZ receiving a partial refund. This terrible mess has come at a financial cost to us all that attended as Delegates, Exhibitors and the VANZ organisation. While the refund was as expected to be only partial, VANZ is a not-for-profit society, and we want to ensure we give back where we can.

At this stage we are planning to offer a discount to all 2021 Attendees that register for the 2022 conference. While we still need to work through the package options, we are hoping to offer a 20% discount to Delegates and 10% to Exhibitors that attended the Wairakei Resort 2021 Conference.

With appreciation for the Wairakei Resort and management/staff the location and the ongoing support, VANZ has decided to plan our 2022 Conference to again be held at the Wairakei Resort on 17th, 18th and 19th May 2022. These dates are in line with previous conferences and we expect Covid will be playing a much lesser role in our lives by then. We will be adding new information to our website www.vanz.org.nz plus emailing out to all on the VANZ electronic email list as this planning progresses.

This information will also feature in the next two issues of Spectrum, the last issue before Conference will be a hard copy which is expected to be delivered to all members early/mid April 2022.

At this time, I would like to welcome back CSE-W Arthur Fisher as our Corporate Sponsor for our VANZ 2022 3-day Predictive Asset Management

Conference and we all thank them very much for their ongoing support to VANZ and this annual Reliability Condition Monitoring event.

Those of us that attended in 2021 will remember their stand running a large, high-definition live TV while we were waiting for the NZ Government to make the latest Covid announcements. Hopefully during 2022 we can find some much more appealing viewing from this system, there's a challenge for you Alan Wang. Welcome back to the BK Vibro Team.

For now, I wish you all good health as we move through Spring, and I will update you further in the next early summer addition of Spectrum. Until then I hope you all enjoy the upcoming Christmas celebrations and holidays. ■

“ While we still need to work through the package options, we are hoping to offer a 20% discount to Delegates and 10% to Exhibitors that attended the Wairakei Resort 2021 Conference. ”

Below: COVID-19 was an uninvited guest at the 2021 conference. Unfortunately after only the first day, NZ was to go into a snap level-4 lockdown with a sudden outbreak of the more deadly Delta variant detected, bring an abrupt end to the conference.



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Well... that didn't exactly go as planned did it? We had a great 1st day of conference, brilliant tradestands eager to connect with customers, interesting papers using the technology resources that have become a necessity in these times and we were trucking along... until that night when Covid-19 v2.0 Delta wave decided to invade the country and everything came to a screeching halt.

Pandemic fatigue can set in when not just our personal lives get flipped over but when our business and corporate livelihoods are yet again thrown into disarray by circumstances out of our control. New Zealand had a taste of what it's like to eliminate this threat and have our lives back to some semblance of normal, our tourism industry while still taking a big hit was being supported as best we could by local dollars and seeing parts of our own backyard, experiencing what our own country has to offer but the only

way to get back to that place is for everyone to step up and do their part to protect not just each other but our businesses, our customers and our industries, get fully vaccinated, use common sense health and safety measures and keep pushing forward with the

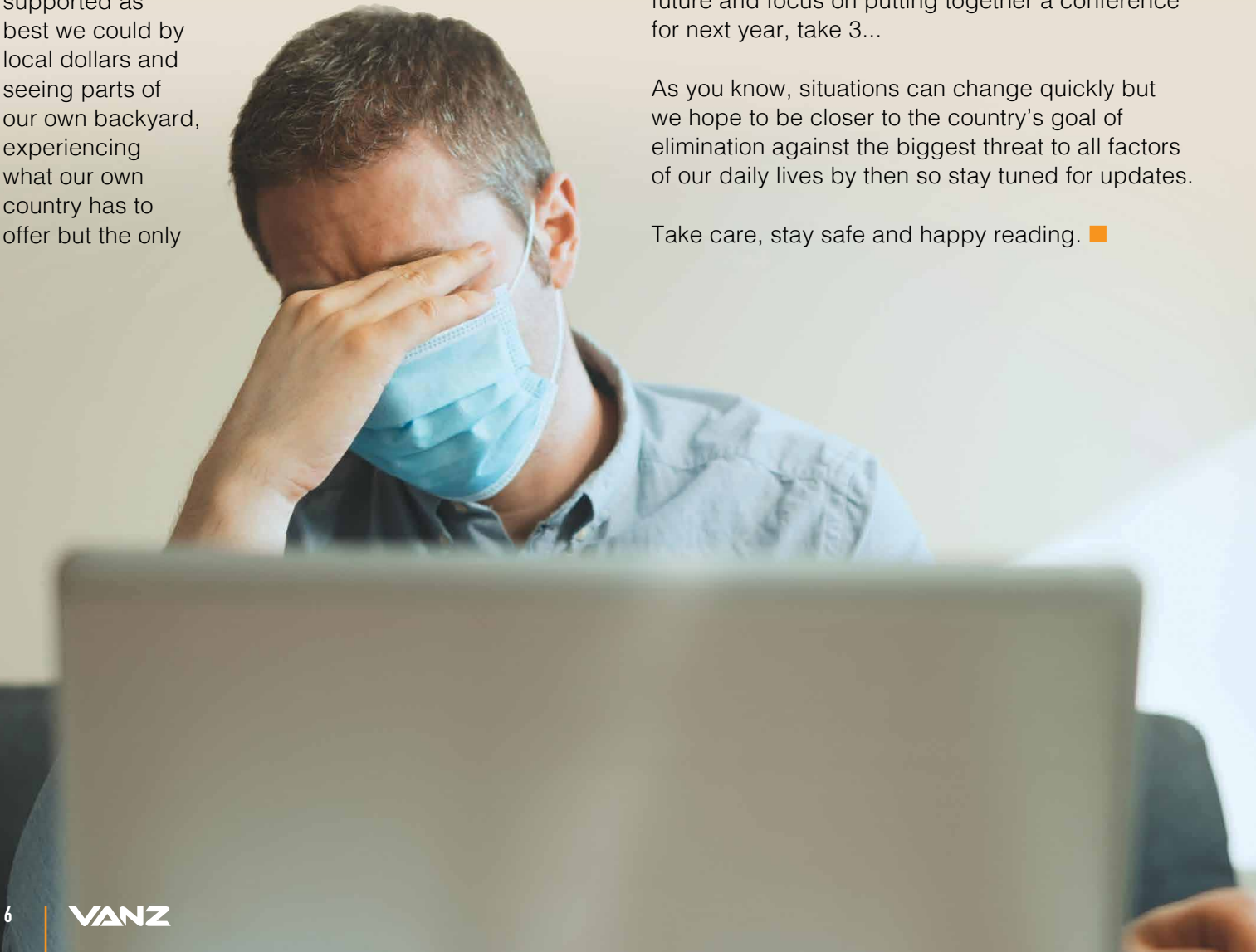
guidelines set up to try and keep this virus at bay. Everyone is hurting, financially and otherwise, yes it's going to be confusing and frustrating at times but this is the way we eradicate this horrible disease and get closer to putting this chapter in the rear view mirror. Take a stand.

Pandemic fatigue can set in when not just our personal lives get flipped over but when our business and corporate livelihoods are yet again thrown into disarray by circumstances out of our control.

VANZ greatly appreciates the ongoing support from not just companies who took a chance on signing up for tradestands and conference attendees but those who continue to place advertising with us during this uncertain time. We are doing our utmost to get the loose ends from this year sorted before we look to the future and focus on putting together a conference for next year, take 3...

As you know, situations can change quickly but we hope to be closer to the country's goal of elimination against the biggest threat to all factors of our daily lives by then so stay tuned for updates.

Take care, stay safe and happy reading. ■





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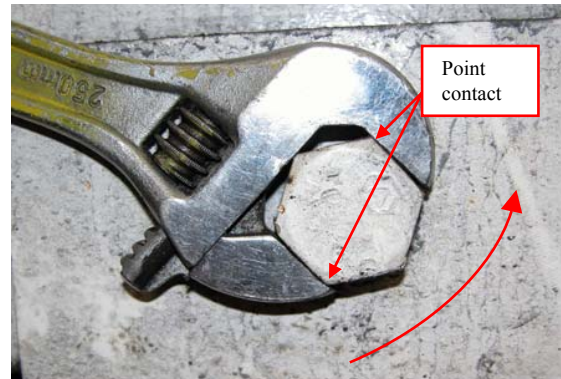
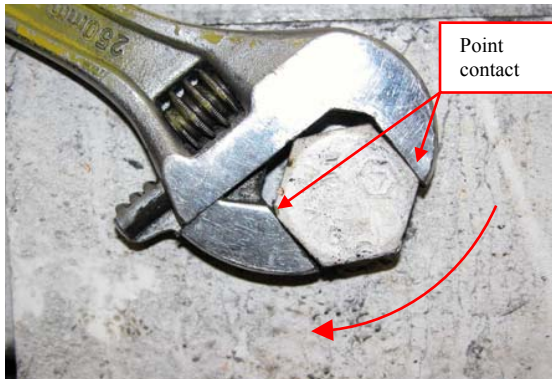
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SKILLS AND PRACTICES



Shifters: The Clayton's Spanner

To prevent the introduction of DEFECTS into our equipment, we need to apply PRECISION to everything we do. One way we can do this is to always use the right tool for the job.

Shifting spanners are not the right tools for the job! Why pick on shifting spanners?

"The adjustable wrench is not a precision tool; it is merely a substitution for a properly sized wrench. More than any other tool, it has been responsible for damaging nuts and knuckles and promoting an easy-way-out attitude for performing maintenance."
(JC Robertson. Strategic work Systems Inc.)

Eight reasons why we shouldn't use shifting spanners:

1. It is easy to injure yourself (1).

A shifter does not allow clearance for your knuckles, whereas a spanner with an offset does.

2. It is easy to injure yourself (2).

A shifter can slip off the nut or bolt, whereas a ring spanner cannot.

3. It is easy to injure yourself (3).

Repeated application of a shifter results in the jaws opening further each time. This increases the likelihood of the shifter slipping and causing an injury.

4. A shifter can cover a wide range of sizes, so most of the time it is either too long or too short to provide the correct tightening torque.

This results in stripped, broken or loose fasteners. Ring spanners and open ended spanners are the correct length to provide the correct tightening torque.



5. Shifters damage fasteners (1).

Shifters often cannot be used with the jaws perpendicular to the fastener. This results in point loads on the corners of the fastener, and subsequent damage (rounding off) to the nut / bolt.

6. Shifters damage fasteners (2).

Due to clearances and wear in the adjusting mechanism, it is not possible to get a good fit on the fastener. Regardless of the direction of rotation of the shifter, the jaws of the shifter won't stay parallel to each other, or to the fastener. This results in point loads and fastener damage.

7. Shifters damage fasteners (3).

Repeated application of a shifter results in the jaws opening further each time. This increases the likelihood of fastener damage.

8. Shifters are particularly bad for tightening and loosening fasteners.

This is where large forces are involved and the problems already mentioned are magnified. Loosening of fasteners is of particular concern as the force required to loosen a fastener can be up to 3 times that used to tighten it.

The challenge

Make changes to your practices (and tool kit) to eliminate shifters from your work. Make this one of your steps towards eliminating defects and making precision part of your approach to every job. ■

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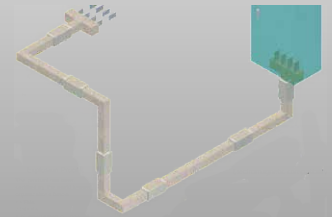
Visual camera

Infrared camera

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Detects defects before arc flashing



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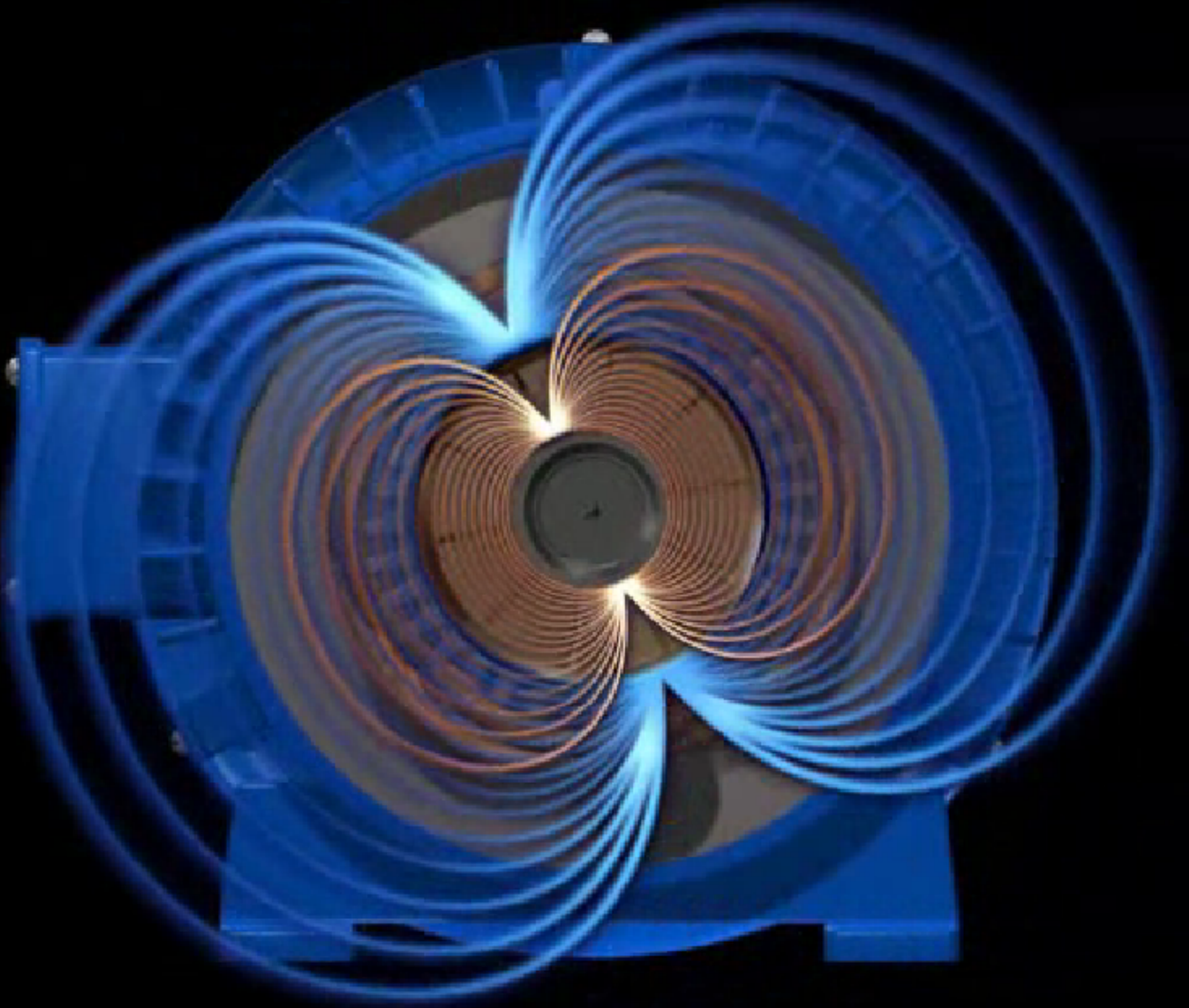
Medium voltage busway

Low voltage busway

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Electric Motor Fault

– a case study from India

In this article we are going to take a look at a fault on an electric motor and then attempt to explain why the vibration changed in the way that it did. First, let's take a look at the motor from a steel plant in India.

It is a four-pole AC induction motor running at 1500 rpm supported by sleeve bearings. The motor drives a gas exhauster through a speed-increasing gearbox.

I was sent some spectra and asked to explain why the vibration changed. You can see the spectra below taken with an Fmax of 30,000 CPM. Clearly there are a series of 1X harmonics. What do you think that means?

Of course, it is looseness. Or could it be something else? Let's find out before we jump to conclusions. I asked for a high resolution spectrum with a lower Fmax to be taken as this was not normally collected as part of the route. The spectrum below has an Fmax of 12,000 CPM and with 6400 lines. You can now see that those peaks we saw are not simple peaks - they are broad because of the sidebands surrounding each of the peaks. With limited resolution there is no way to tell that those sidebands are present.



So now what do you think the fault condition is? Well, I thought there must be a broken rotor bar or damaged end rings or some sort of fault of that nature. In other words, the current was not able to flow through the rotor bars properly.

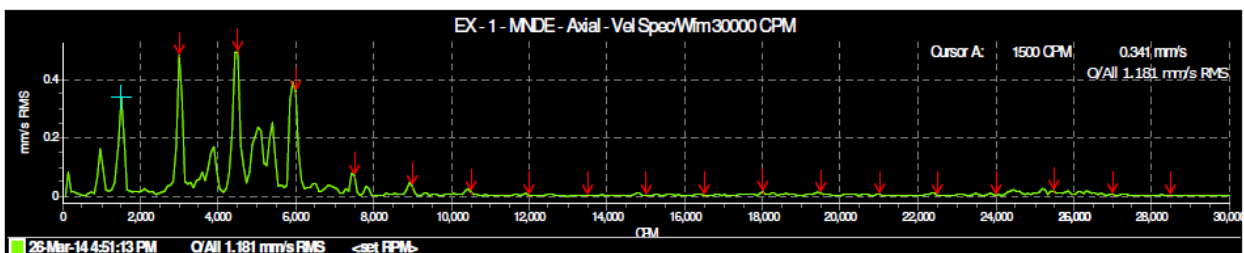
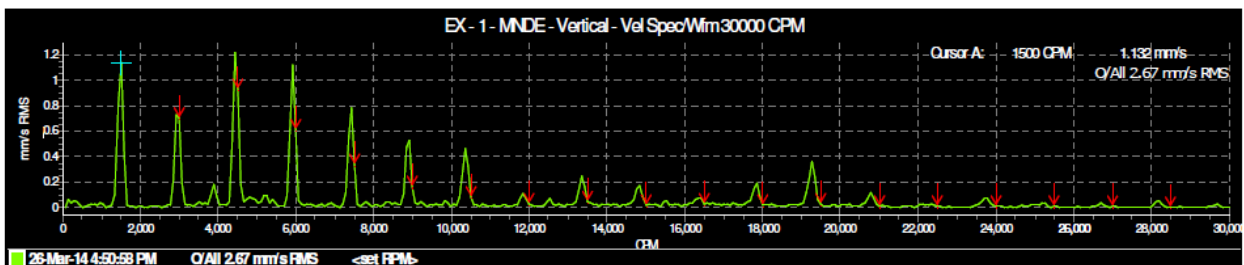
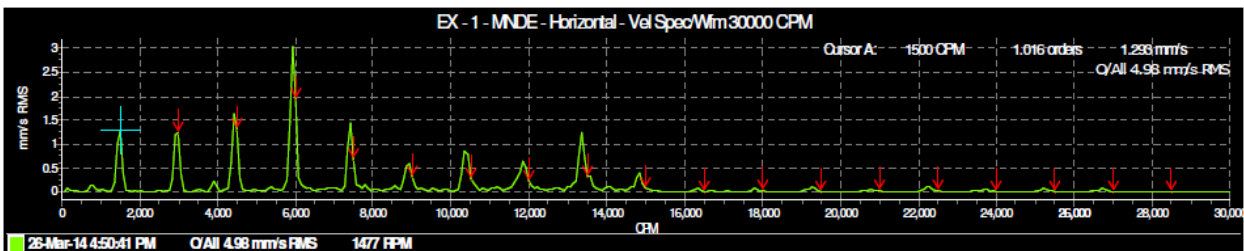
There was either a high level of resistance or a break that did not allow current to flow through the rotor bar

at all. Unfortunately it was not possible to take a motor current signature because that would have told us exactly what was happening. If you are not sure what I mean, then you will enjoy the rest of this article.

I emailed my suggestion to my friend in India and they decided to stop the motor and check the rotor. You can see the photos following.

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First set of spectra





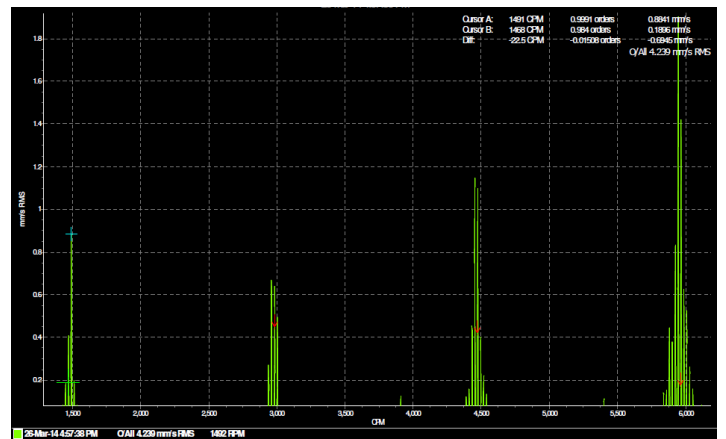
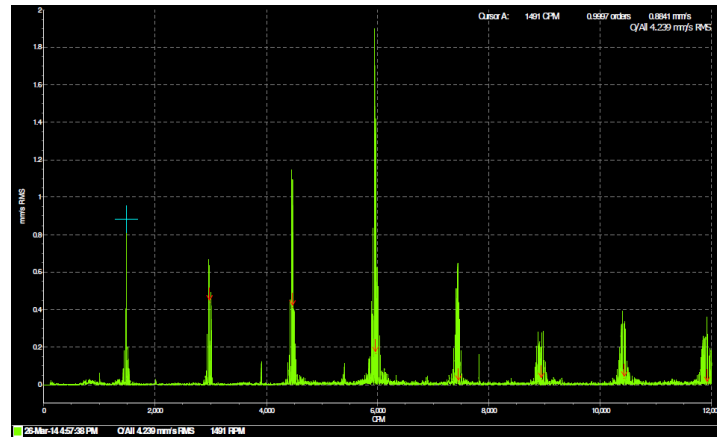
It is pretty easy to see the damage which obviously needed to be corrected.

That's a pretty quick case study, but as always with vibration analysis you have two choices of how you treat vibration patterns like this one. You can simply remember that sidebands sitting around the first few harmonics of running speed represent a broken rotor bar (or some other damage that relates to current flow through the rotor bars) or you can attempt to understand what is actually happening and therefore understand why the sidebands appear (and be better prepared for this and other induction motor fault conditions).

Let's try to do that. Let's climb inside the electric motor, experience the magnetic field, and figure out why we are experiencing amplitude modulation (after all, that's why we see the sidebands). The first thing that you need to understand about an induction motor is that the stator is actually spinning. Well, not physically, but magnetically. If you have a two pole motor then the magnetic field spins at 3000 RPM. If we had more time I would explain exactly why that is, but in this short article I am going to ask you to take my word for it. But you can think of the stator of an induction motor as a spinning magnet. It is a two pole magnet (because it's a two pole motor) and therefore you can imagine a North and South pole spinning round and round at 3000 RPM. Our motor was a four pole induction motor, so it spins at 1500 RPM. That is its synchronous speed.

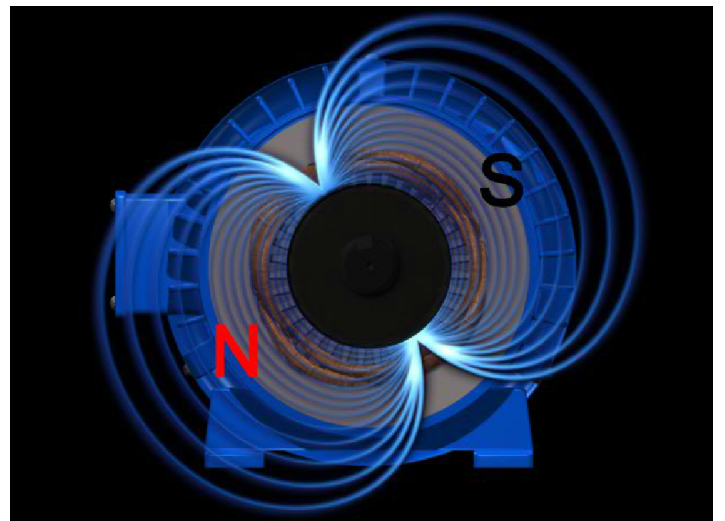
The magnetic field was created because an AC voltage (which is a sine wave) was applied to a set of windings. Think of the windings as just a coil of wire, or a solenoid. When a fluctuating voltage source is applied to a solenoid, a magnetic field is created.

A close-up of the first four harmonics






But it turns out that if you put a coil of wire near a fluctuating magnetic field, current will be induced in that coil of wire. The fluctuation is due to the AC voltage, which is sinusoidal - it rises and falls 50 times per second (in NZ and other countries with 50 Hz voltage).

So imagine, if you will, a stator with voltage applied, but without a rotor installed. If you were to insert a compass where the rotor should go, the needle of the compass would spin at the synchronous speed (a compass needle is a magnet - it has a North Pole at one end and a South pole at the other end). ■






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Rethinking the House of Reliability...

What are the events in history that have caused us to perform the way we do? Why is it we respond the same way to performance needs or machinery failures? How have we got to where we are today? How can we use discovered failure patterns to redefine where we need to be? In using all of the present advances in technology and machinery how do we begin to identify the right order for all of the required pieces within our maintenance organizations?

This presentation will use as an introduction just what the “House of Reliability” model and thinking is, with a discussion on building or rebuilding the “Reliable and Predictable Plant”. The presentation will include what a blueprint for reliability improvement could include, with considerations given to laying the correct foundation, developing managing metrics, improving existing skills and technologies, and including high level performance tools to assist in re-evaluating and strengthening your reliable manufacturing model within your maintenance organizations. This may be just the time to rediscover where your manufacturing management systems are and where you want to be in the future.

The 21st Century Analyst ...

Over the last three decades the vibration and condition monitoring industry has witnessed many changes. While these changes have been technically positive, some have resulted in poorer analytical performance today than in earlier times. Many condition monitoring programs almost exclusively focus on the early identification of bearing defects, (with great rewards to business profits), but with little or no emphasis on identifying the underlying failure sources, required asset improvements, or skill set changes to alter/improve the failure cycle. In essence, the typical condition program today still utilizes the same “reactive” approach we have worked so hard at to remove or reduce.



This of course begs several questions; what have we really achieved, how do we step up a gear and what are the processes needed to ensure analysts can provide the best return on our investment? The session examines the history of vibration analysis in modern times, and offers a potential road map for the future so that Analysts of the 21st Century become more effective players in the “Reliable Manufacturing” effort.

A Beginning Discussion on Measurements and Metrics

Currently there is a need to understand ... how to effectively review current plant manufacturing information, determine real measures and metrics and more successfully apply correct training, predictive maintenance and other valuable initiatives, to positively affect facility reliability.

As facilities begin to move towards “Improvement Based” work we sometimes run into roadblocks concerning the field application of that which was taught and what value did the effort return. Now this is not because people weren’t excited or that the work to be accomplished was not of the correct nature or that the information presented was incorrect, but more often than not, it simply is that the manufacturing organization while supporting the effort full heartedly doesn’t know the complete impact that can be realized and secondly doesn’t understand that there is a process of work with measurements to gain, prove and sustain the cultural work changes and financial ROI they desire.

One of the barriers is sometimes the; “we and they” thinking. In our experience there should be no “we or

they” ... there are no stand-alone groups in product manufacture that cause all others to be of no or little value. In reality then there is just manufacturing and the delivery of a product that our customers strive for simply because, for its value, there is none better!

This means then, what we deliver and the reliability concerning its manufacture is paramount to business success. The way that metrics and measures are developed, created, and implemented on the floor need to be tied to the product.

This entry paper will review how others have found success in tying management to and with them and provide ideas to precision or improvement areas of how “value” provided can be proved. It is meant as a starting point in the journey and introduces “Reliable Manufacturing Thinking”, with thoughtful and insightful ideas for predictive maintenance teams for the future.

The Emerging Role of the Operator / Maintainer ...

During the early days of recent manufacturing ... when production demands were lower and technology was simple the machine operator completed many of the tasks that ensured continuous operation. As the need for output rose and control technology improved the role of the production operator began to change. With continued advances in computer controlled and automated systems, machine complexity grew at exponential rates and with all of this our production and maintenance needs and demands also changed and grew.

“ Over the last three decades the vibration and condition monitoring industry has witnessed many changes. Some have resulted in poorer analytical performance today than in earlier times. ”

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In today's manufacturing market we find reduced workforces in both realms and a constant need to increase output and reliability. In most cases some of the load can be correctly reduced by creating or in some cases returning to the role of the operator / maintainer.

Today's operator has to be savvier to respond to machine and line changes with timely reliability inspections, minor checks, adjustments and troubleshooting responses. With so many complex systems operation organizations are discovering the need for an "operating technician" and while there is no way we can or should employ all of the craft skills to the operator there are "maintaining" tasks that they should perform to assist manufacturing in an ever increasing demand on a continually reduced maintenance workforce. This session will take a first and cursive look at just how we might be able to correctly use existing technology, redefine required asset strategies and fill this emerging need by challenging and changing where required these historical roles to improve manufacturing and meet future profit demands.

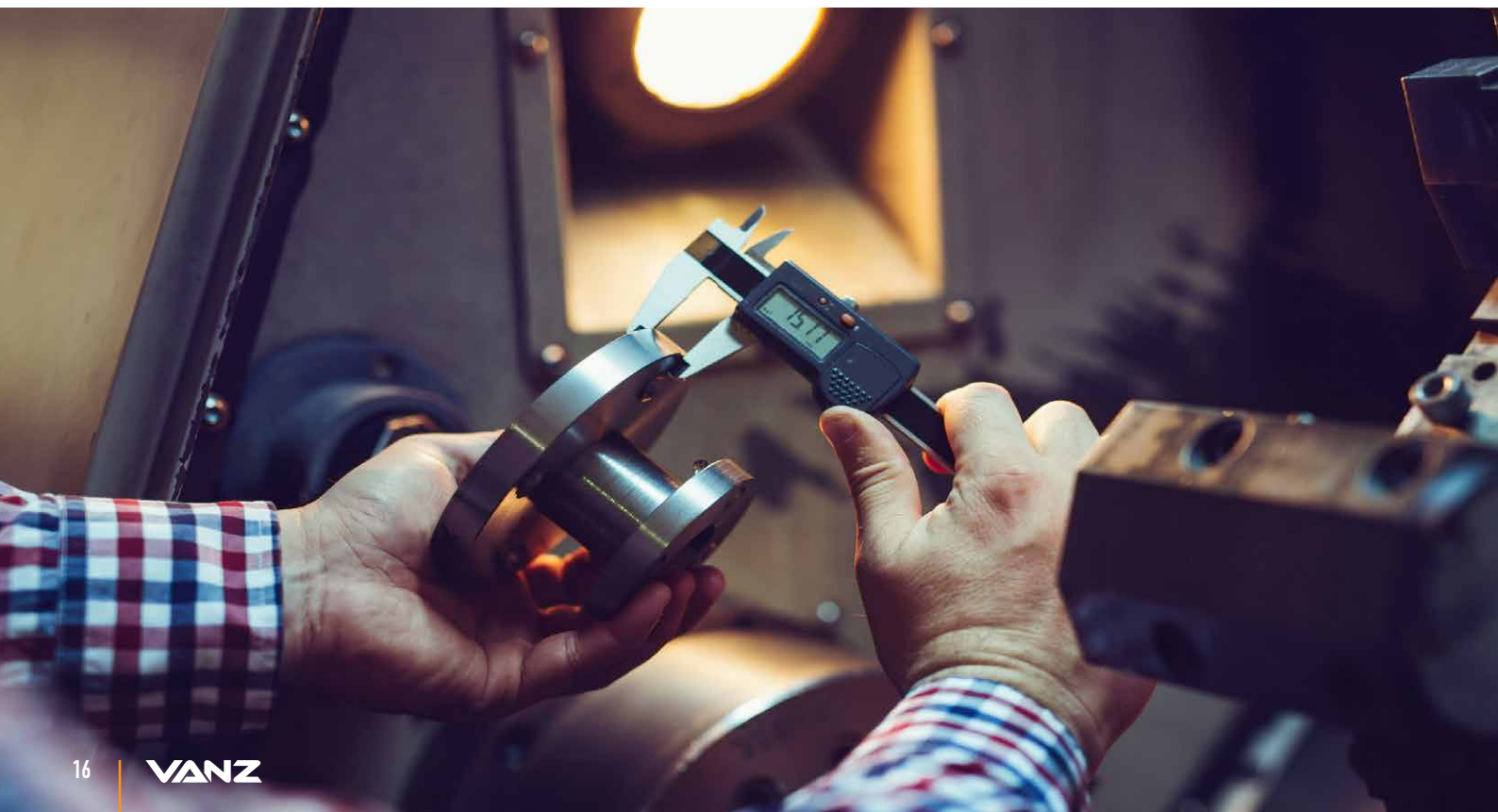
Precision Maintenance ... Essential Craft Skills

Manufacturing and process facilities worldwide have implemented huge technological and process changes to continue to meet the ever increasing demands of competition and profitability. Within today's manufacturing processes though we have not always strived to determine where and how required craft skill sets on the floor may need to be changed. Although, craft technicians well employ a "basic" set of skills, what might be required as we begin to

recognize the continued need to move forward in manufacturing?

Due to increased production demands, our society and craft technicians have become much more of parts or assembly changers rather than "repairers" of machines and in some cases much of the intuitiveness of correct assembly/repair has been lost. Many times mechanics no longer think about how a machine might be "fixed" but are forced to react to failures by changing out component sub assemblies, parts etc. Production and the importance of product output have created situations where the priority becomes "how fast we can change out the suspected part" rather than "how well can we repair/improve the machine so that we don't have this same failure happen again". Here is an area that with a just a little extra care and attention a lot of improvement to enhance reliable manufacturing and machine life can be realized while we return some of the "art" back to the craft.

The presentation will review and present ideas for how "essential" skills need to be practically implemented with commentary as to how do we redevelop current craft workforce requirements to meet, outperform and join together with our predictive maintenance teams to move from failure based to improvement based philosophies. The session will use dynamic models in various pre-set states to review how analyst and technician need to work together to better meet today's continuous manufacturing demands with correct field observations, "hard skill" training requirements, with real and meaningful "on-the-floor" implementations that will produce documented bottom line performance results. ■



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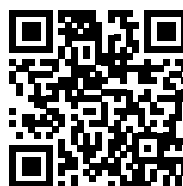
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www.emerson.com/AMSVibrationMonitor, or contact your local Emerson representative.



AMS

Condition monitoring in a portable device powered by Artificial Intelligence – Acoem Falcon



Vibration diagnostics are critical to safeguarding your machinery – such as electric motors, fans, pumps, compressors and conveyor rollers – from potential safety incidents or breakdowns.

With accurate vibration data captured by the Acoem Falcon portable analyser, you can alert your maintenance team to impending defects, such as unbalance, misalignment, bearings or even gear defects. Easily assess the possibility of future damage before your equipment becomes unrepairable and avoid incurring replacement costs that will negatively impact your business.

The predictive maintenance and diagnostic tool you need

Acoem has been offering its customers proactive maintenance solutions with vibration sensors and automated software analysis tools for more than two decades. As a signature vibration measurement instrument in our range, the Falcon portable analyser is an all-in-one wireless vibration sensor and data logger system that provides the highest level of protection for your rotating assets.

Falcon is the only instrument of its kind, featuring a patented three-axis wireless sensor that takes simultaneous vibration measurements in all directions in as little as eight seconds per bearing. It also has a built-in strobe light for rotation speed measurement, a laser pyrometer for bearing temperature measurement and a camera for easy machine identification via QR code, sensor positioning and report illustration. Four analogue channels provide synchronous measurement in addition to the trigger input and, in an industry first, Falcon offers embedded Artificial Intelligence (Accurex™) automatic diagnostic capabilities.



Falcon's Accurex™ automatic, real-time diagnostics

Integrating Falcon and Nest i4.0 software with its Accurex real-time automatic diagnostic matrix into your industrial maintenance process is a giant leap forward in terms of diagnostic capabilities, connectivity, improved performance, better management of risk and greater flexibility. The automatic diagnostic module provides instantaneous results – outlining where the fault is, which machine is affected and what the actual fault is, all in real time. This extended functionality gives you the ability to control the health and efficiency of your entire network in a single screen, informing decisions to prioritise maintenance actions without delay. It will save you significant time on periodic analysis and help your business avoid damage to your critical equipment.

Enhanced safety and user experience

All commonly encountered industrial faults, such as unbalance, misalignment, defective mountings, looseness, friction, structural resonance, lubrication defects, bearing defects, gear defects or pump cavitation can be detected and rectified in priority order. Faults are identified in clear and accurate language, displayed on an intuitive colour touchscreen with an associated level of Artificial Intelligence (AI) confidence. Wireless Falcon reduces the time and cost associated with on-site intervention, allowing technicians to safely capture data 10 to 20 m away from the dangerous and hot machinery environment. Its shock resistance design withstands the harshest industrial conditions. "Whether you want to detect a bearing defect or prevent gearbox damage, the combination of your Falcon sensor with superior diagnostics from Accurex™ AI is your guarantee of a holistic and actionable solution," commented Michael Roinich, Reliability Solutions Manager, Acoem Australasia. "With Acoem Falcon, our focus is on improving the user experience and the value that we can add to empower you to take action sooner and improve your business's capabilities and productivity," he added.

To learn more about Acoem Falcon or any other proactive and predictive maintenance solutions in the Acoem range, please visit acoem.com and contact Michael Roinich at email@acoem.com.

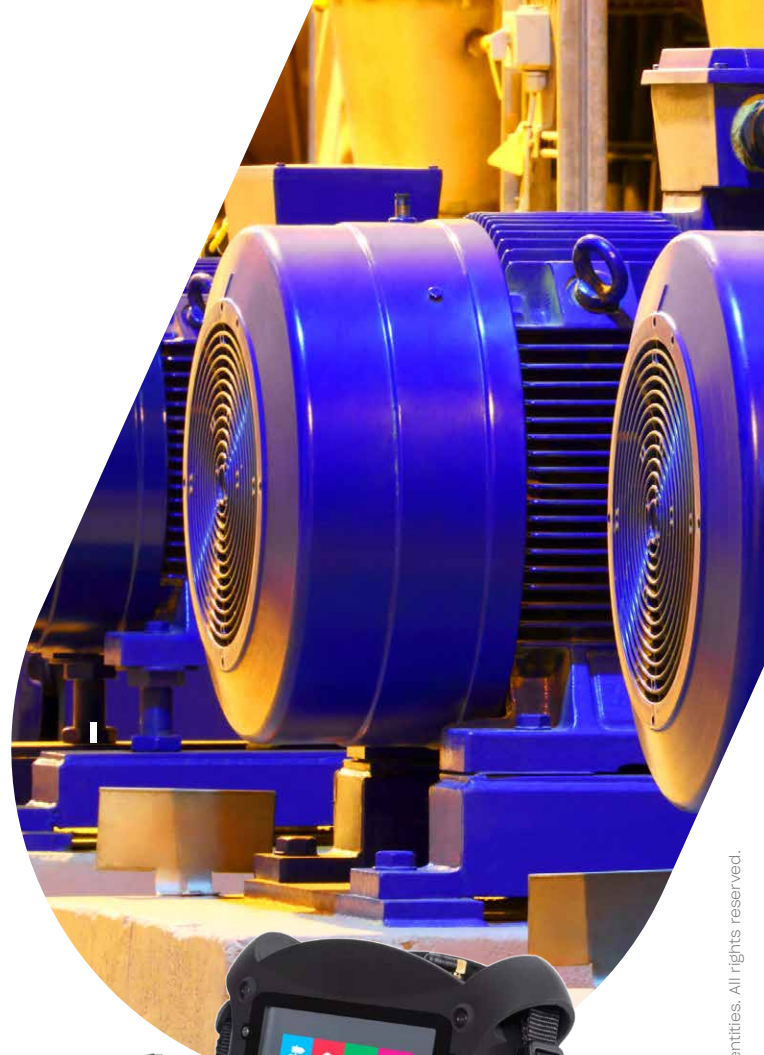
Falcon

Next generation predictive maintenance solution

A portable and easy to operate wireless vibration analyser for rotating assets, Acoem Falcon is the only data logger that features built-in Artificial Intelligence. AI-powered automatic diagnostic module provides accurate, reliable data and identifies potential risks to help you prioritise maintenance on critical machinery.

Every fault detected is displayed by its severity, location on the machine and confidence level. Full remote access significantly reduces the time and cost of on-site intervention. Wireless three-axis sensor and real-time processing capabilities cut measurement times to as little as 8 seconds per bearing.

Falcon seamlessly integrates with the entire Acoem ecosystem through the Nest i4.0 software platform. An ideal vibration measurement and analysis tool, it puts condition-based maintenance within everyone's grasp.



The industry's fastest data logger & sensor system offers:

- Embedded Accurex™ AI for automatic fault diagnosis
- Quick & easy tri-axial wireless measurements
- Built-in pyrometer, strobe light & camera
- Enhanced measurement productivity
- Analyser & balancer
- Automatic detection of measurement points via QR Codes

Falcon Features	Essential	Smart	Expert	Ultimate
Hardware kit, data collection & off route module	✓	✓	✓	✓
Smart Wireless Triaxial sensor - 8 Seconds Data Acquisition		✓	✓	✓
Accurex™ Automatic Diagnosis		✓	✓	✓
Camera, Stroboscope & Laser Pyrometer		✓	✓	✓
Expert Measurements - 102.4k Spectra, LTWF (4M Samples)			✓	✓
Balancing, RU/CD, FRF & ODS				✓

TEST YOUR KNOWLEDGE - PART 65 OF A SERIES

- 1 **A 4-pole 3-phase electric motor is one of the machines at a factory that is surveyed annually for occupational noise purposes. The A-weighted sound level was noticed to have increased by 12 dB in the most-recent survey. If the overall vibration levels of this motor were also surveyed annually, which of the following parameters is most-likely to also show a strong increase in signal?**
 - a Overall displacement
 - b Overall velocity
 - c Overall acceleration
 - d Could be either a or b

- 2 **A headset might be used in conjunction with a data-collector to listen to the signals from the transducer. A wireless option is most-likely to utilise which of the following?**
 - a Wi-fi
 - b Bluetooth
 - c Ethernet
 - d intranet

- 3 **A 24-metre long tug of a new design was manufactured and was found during sea trials to oscillate left and right with a rhythmic pattern when it should have travelled forward in a straight line. Modifications were made to the hull to correct this. The shimmying behaviour was caused by...**
 - a cavitation
 - b Vortex shedding
 - c Planinga
 - d Laminar flow

- 4 **At the final stage of the overhaul of a centrifugal pump, the mechanical fitters were seen to be hammering the coupling onto the shaft. The bearings became damaged as a result. What type of bearing damage is most-likely to have occurred?**
 - a brinelling
 - b false-brinelling
 - c EDM damage
 - d Pitting

- 5 **Random high-pitched squealing could be heard from the bearings of a lightly-loaded electric motor. The manufactured clearance of the bearings is unknown, but which of the following is most-likely to facilitate the high-pitched squealing?**
 - a C1
 - b C2
 - c C3
 - d C4

- 6 **DC gap is a term you will most-likely encounter with which of the following?**
 - a Dust-collect fans
 - b 3-phase electric motors
 - c Rolling element bearings
 - d Journal bearings

- 7 **If one of the gears in a gearbox has a broken tooth, in what manner is this fault most-likely to show itself in your vibration analysis?**
 - a Increased vibration at tooth-meshing frequency
 - b Increased vibration at harmonics of tooth-meshing frequency
 - c Side-bands around tooth-meshing frequency
 - d Vibration at half tooth meshing frequency

- 8 **100 % speed for a particular electric motor is achieved when the electrical line frequency is 50 Hz. The switching frequency for the VSD control is 4 kHz. If the motor is slowed down to 80% speed, what is the switching frequency likely to be?**
 - a 1.2 kHz
 - b 2.4 kHz
 - c 3.2 kHz
 - d 4 kHz

- 9 **What indication might you get if you mount an ICP accelerometer on a bearing that has acceleration levels in excess of what the transducer is capable of measuring?**
 - a There might be ski-slope in the spectral data, particularly if the signals are integrated
 - b There might be a spurious vibration showing at 50 Hz
 - c Vibration at 1 and 2 x the shaft speed might read twice their real values
 - d There might be a spurious vibration showing at 100 Hz

- 10 **If acceleration signals are doubly integrated, the resulting signals will be...**
 - a displacement
 - b velocity
 - c acceleration
 - d None of the above

Answers on page 23

WORD BUILDER

How many words of three or more letters can you make, using each letter only once? Plurals are allowed, but no foreign words or words beginning with a capital. There is at least one 5 letter word.

6 - Good | 10 - Very Good | 15+ - Excellent

W	O	K	N	S
---	---	---	---	---

WORD MARCH

Draw a path from one square to another to find the secret nine letter word. You may move in any direction. Each square can only be used once.

There are approx. **96** words (four letters or more) that can be made from the combination of letters below. How many can you make?

Solution on page 23.

W	O	D
N	L	K
S	C	O

Nine letter word is... _____

SODUKU

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. Why not time yourself? See how well you go.

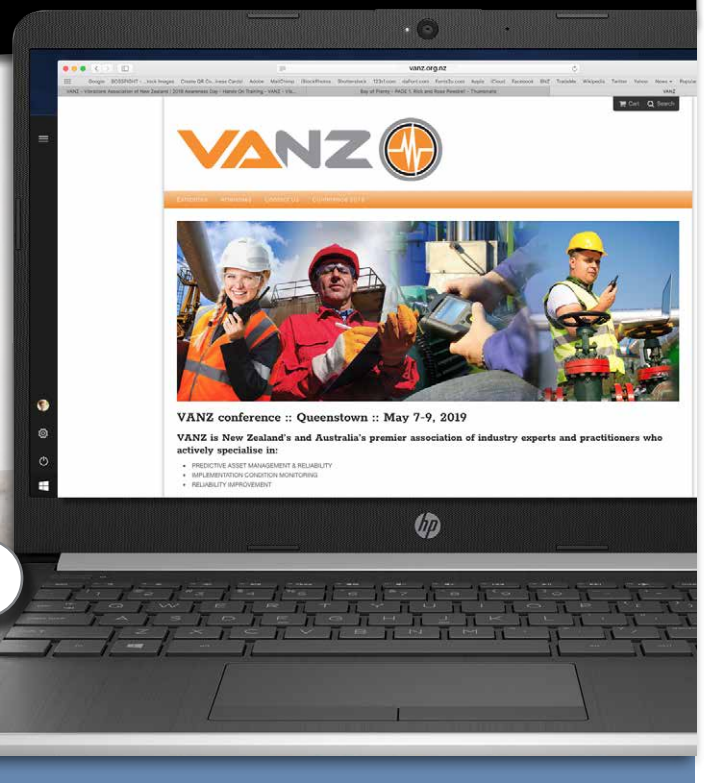
	1	3		6		7	2	
		2				1		
9								6
		6				8		
8			9		4			5
5			1		9			8
	6			8			7	
		4		2		9		

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Spectrum

The official journal of the Vibrations Association of New Zealand (VANZ)



Our quarterly magazine includes:

- Papers from conference reprinted
- Conference information
- Articles and reports from industry leaders
- Presidents report
- Notices
- Committee reports
- Interactive activities *and much more...*



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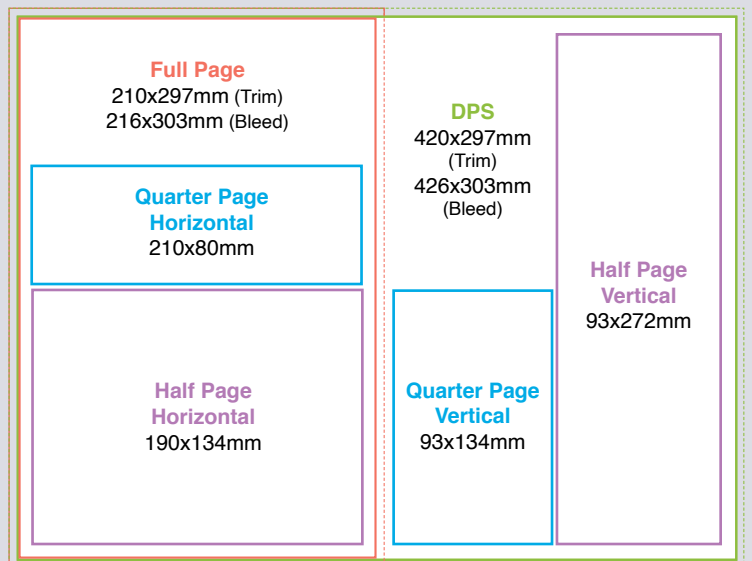
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Answers to Word March #101: LOCKDOWNS
1C, 2B, 3B, 4A, 5D, 6D, 7C, 8D, 9A, 10A
Answers to Carlton Technology Quiz 65:



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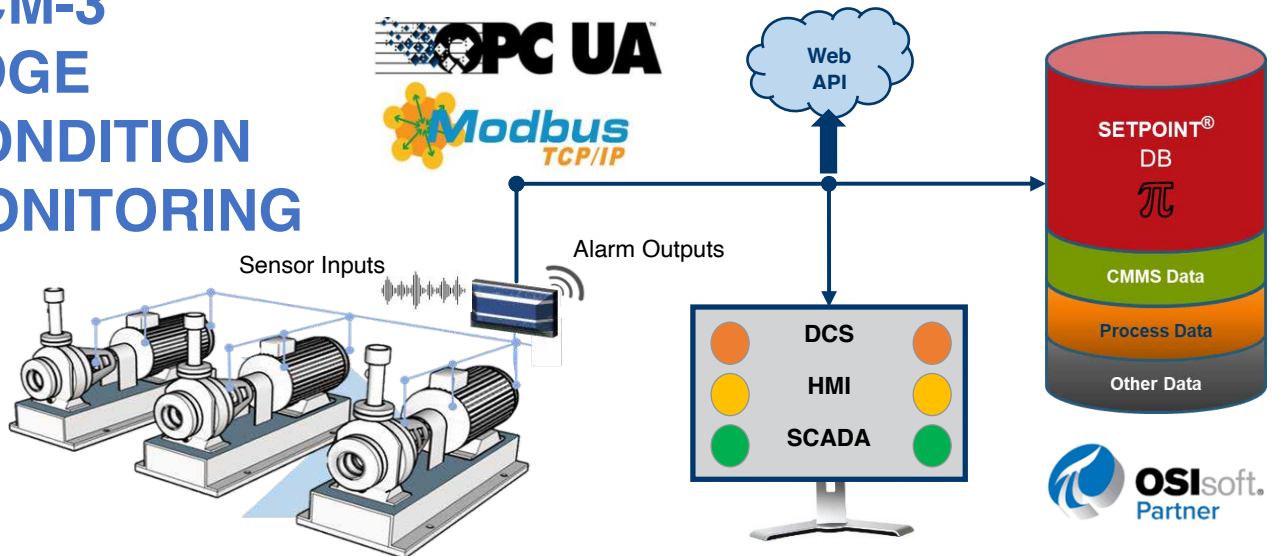
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