



Spectrum

Winter 2023 | Issue 108

Moment arm balancing of
Bladed Rotors

The 3 main challenges

maintaining electrical machines



Photos from Conference '23

Full montage inside...

Left: Conference keynote speaker Mike Davis.

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Issue 108

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Conference paper submissions
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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.

Contributions to Spectrum are welcome. Email material to:
> spectrumeditor@vanz.org.nz

Address all VANZ correspondence to:
VANZ
PO Box 2122,
Shortland Street,
Auckland

Editor: Angie Delfino
> spectrumeditor@vanz.org.nz

President: Tim Murdoch
> Timothy.Murdoch@ballance.co.nz

Treasurer: Graeme Finch
> g.finchnz@gmail.com

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

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PRESIDENTS' REPORT

By Tim Murdoch, VANZ President



The VANZ Conference for 2023 in Tauranga's Trinity Wharf was a great success! The committee did an amazing job bringing it all together. A big thank you to GVS as our Platinum sponsor and to all our exhibitors, awesome presenters, the companies that sent their employees to attend and of course to those of you that attended.

We changed things up a little this year, Mike Davis ran a motors masterclass which was a good mixture of hands on and theory. Mike had a great turn out from a variety of backgrounds. If you missed out on attending the course we hope to run it again next year, there will be limited numbers again so get in quick.

We had a couple of first time presenters who had some really great papers, we would love to have more first time presenters so keep any interesting case studies over this next year in mind for the 2024 conference. A theme that seems to be getting stronger now is the use of AI (Artificial Intelligence), and there were some interesting papers and discussions about this area.

Congratulations to both Rodney Bell and Tony Hardcastle on achieving VANZ Life membership. Both have contributed so much to VANZ over the years. Thank you for your commitment, your passion and support to our amazing organisation.

The AGM was held at the conference on May 18th and the committee was voted in as follows:

President: Tim Murdoch
Vice president: Nicky Lord
Treasurer: Graeme Finch
Secretary: Angie Delfino
Members: Rodney Bell, Glen Pepper, Simon Hurricks, Larry Wiechern, Cameron Blackbourn, Bill Sinclair, Alex Lawrence, Alan Wang and Stephen Read.

Welcome Stephen Read (GVS) to the VANZ committee, its great having you onboard.

Work is underway for the VANZ 2024 conference, which will be held in New Plymouth. If you are interested in being a presenter or exhibitor please express your interest with us now, email secretary@vanz.org.nz for more info and let your companies know you are interested in attending.

New Plymouth is known for its mountain, good surf, the oil and gas industry and the dairy industry, among many other things. This is also the location of the very first VANZ conference.

If you want to keep up to date with VANZ or have a discussion with VANZ members on a problem you may have, check out our social media platforms on Facebook (Vibrations Association of New Zealand - VANZ), LinkedIn (Vibrations Association of New Zealand) and our website (www.vanz.org.nz).

Winter is upon us and the ski fields are opening. Keep warm, dry and safe. ■

“
Work is well underway for the VANZ 2024 conference, which will be held in New Plymouth.
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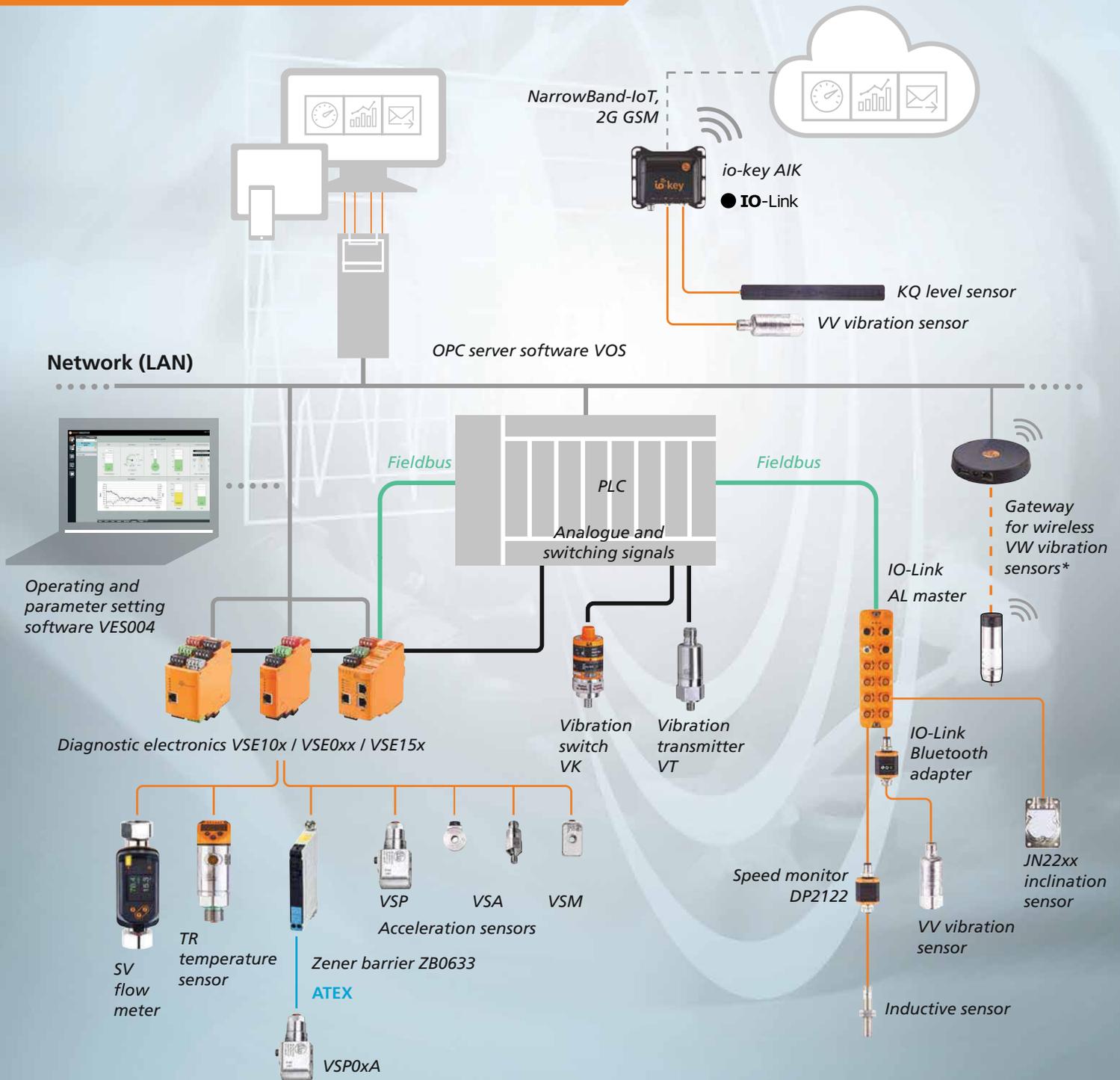
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And the award goes to...

In recognition of their continued service and support, VANZ would like to extend our congratulations to new life members **Tony Hardcastle** and **Rodney Bell**, who were presented their awards at the recent conference in Tauranga.

Rodney has served on the committee as a member and as President. Tony has also served on the committee and was a founding member.

Both were very humbled by receiving their awards, delivered gracious words which resonated around the full room.

Congratulations gentlemen! ■



Photo: Larry Wiechern.

EDITORS' CORNER

As we recover from the hustle and bustle of the conference, we take stock of how everything has come together this year, the new ideas that worked well, the things we can improve on and the good old standard ideas that come through each year.

We'd like to thank our major sponsors GVS for the continued support, it is much appreciated and we hope all the attendees enjoyed their time with VANZ over the conference week, it was so good to have some new faces and also catch up with our regular supporters.

Many thanks go to the organising team that helped push everything into place and to the various sponsors, many of which had a trade stand at the conference and have also placed an ad with us for this issue. Be sure to check out our Presidents Report from Tim Murdoch, squeeze a bit of the old grey matter with Carl's quiz and see what sort of deals our post-conference advertisers have to offer.

As we continue on with the year our elected committee members are already ploughing into organising the conference for next year so we can continue to make it better and better for all involved. Be sure to expect further information to come in due

course surrounding the 2024 conference in New Plymouth. Be sure to lock this into your diaries when the dates come through.

Stay warm during these winter months and happy reading! ■





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OUT AND ABOUT

Conference '23

Tauranga | May 9th–11th

PHOTO MONTAGE

VANZ would like to take this opportunity to thank our platinum sponsor GVS, as well as all advertisers, exhibitors, speakers and attendees at this year's conference contributing to the overall success that it was. We hope to see you all back next year!

'PEOPLE AND THEIR SKILLS DRIVING INDUSTRY'





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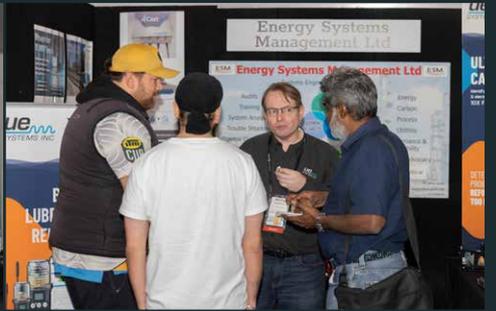
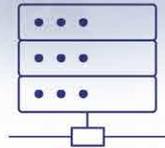


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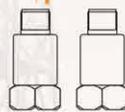
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Cleanliness of Electrical Connections

Connections are the weakest link in an electrical system. To operate correctly, connections must have the right mechanical load (e.g. bolt tension or spring pressure), but they must also be clean! Dirty connections cause high resistance joints that result in energy losses, electrical system malfunctions, and fires. This is of particular importance on high current devices such as 415V circuit breakers.

The upper limit for the resistance of connections between circuit breakers and switchboards is a VERY LOW - 10 micro ohms. If the resistance is allowed to reach even one hundredth of an ohm on a single phase, then on an 800 amp load we have a 6.5 kW heater (6 bar radiator) inside the switchboard. And heat is the switchboard's worst enemy.

So clean connections are essential

In order to help maintain a low resistance connection, the circuit breaker / switchboard connections are silver plated. Silver is used because it is the only material that has an oxide that is electrically conductive. The silver plating is very thin, so care must be taken not to damage it. It must be cleaned using a non abrasive material and a solvent that leaves no residue. Where the silver plating has been damaged, as shown below, the components MUST be replaced as the exposed copper will oxidise and create a high resistance joint. There are many other electrical connections where the same principles must be applied.

This photo (*fig. 1*) is of a connection in a combined fuse switch unit. The "lubricant" that was applied

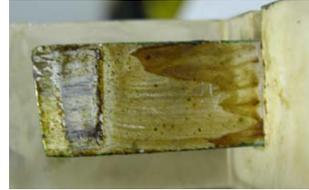


Fig. 1

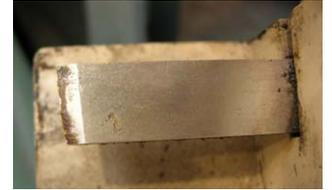
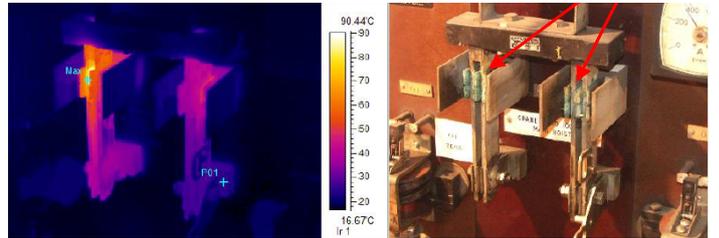


Fig. 2

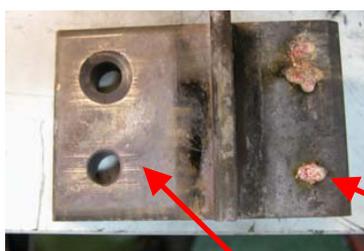
Fig. 3. Corrosion is indicated by the presence of a non-conductive green compound.



in the past has dried out and left a non conductive residue which causes a high resistance connection.

This is what (*fig.2*) these connections should look like after being cleaned before being put back into service – spotless! Knife switches must also be kept clean. The first picture (*fig.3*) shown below is an infra red image that shows severe heating of a knife switch on a crane. The second image shows that the root cause of the over heating is corrosion of the copper components. Corrosion is indicated by the presence of a non conductive green compound.

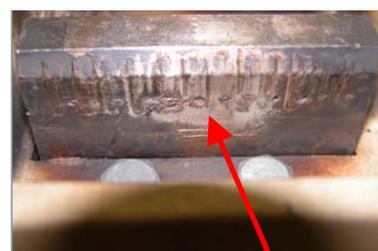
Whether you are dealing with electrical or mechanical things, cleanliness is next to reliability! ■



Appearance of clean surface.



Arcing damage due to high resistance.



Scoring damage.



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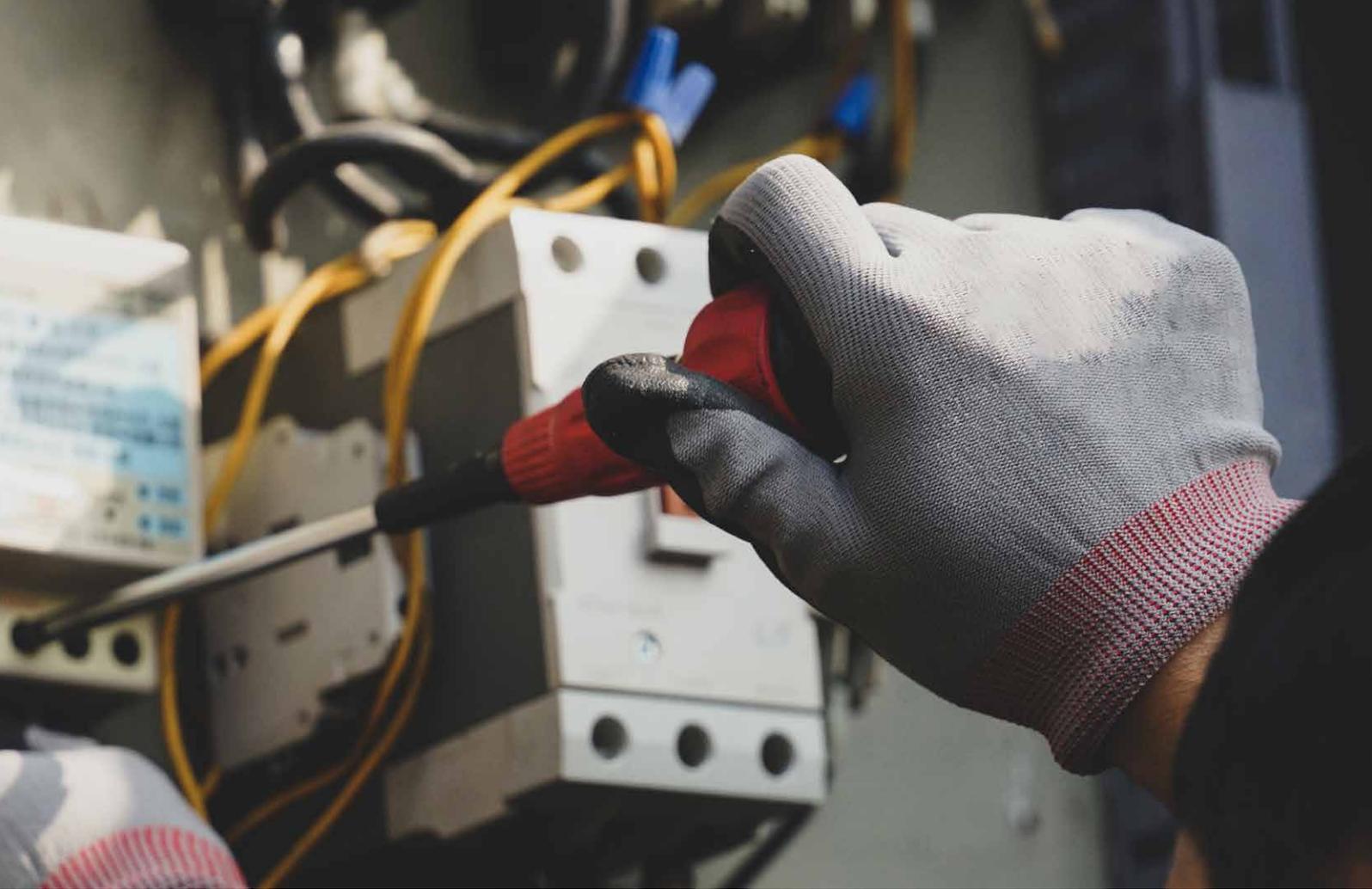
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The three main challenges of maintaining **Electrical Machines**

If you're an asset manager, principal electrical engineer, maintenance manager, supervisor or similar... chances are you're seeing costly failures in your plant.

In this article, I explore the 3 main challenges asset managers face while maintaining electrical machines then discuss how industry-leading factories and plants are addressing the issues.

Challenge 1 – Staff Competence

Do you feel like you have a skills shortage in your staff or contractors? Or that they have a bad attitude, varying skills, not enough knowledge or experience in the field?

“
Chances are your staff just don't have enough knowledge, and they also need more in-field experience.
”

If this rings true, it really gives you no peace of mind. And you're not alone, either. We hear this commonly from the supervisors and managers in the industry. Chances are your staff just don't have enough knowledge, and they also need more in-field experience. As a result, you can FEEL the incompetence and lack of morale.

This then adds to the pressure that management are putting you under every day. You've got budgets to meet, and they need you to reduce these costly failures.

Continued over page >

Article by Mike Davis from EMKE. Learn more about Mike and the EMKE coaching program for your maintenance staff, contact: <https://emkecoach.com/contact/>

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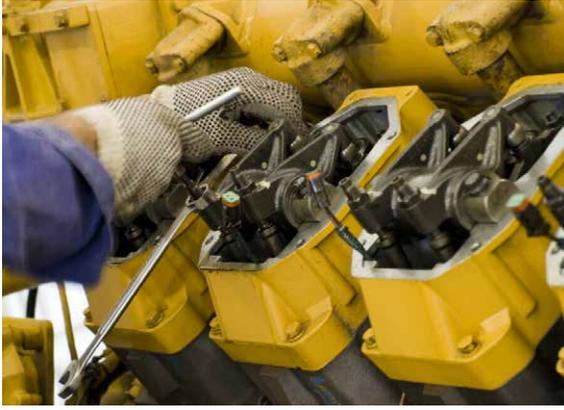
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Challenge 2 – Repeated Failures

If you experience costly electrical machine reliability issues on a repeating basis or if you find yourself constantly fighting fires when things unexpectedly go wrong, it becomes very difficult to stick to your plans. Or budgets. Ultimately, this results in a stack of money being poured into repairs, over and over.

Regardless of whether you believe the issues are caused by the brand of motor, poor staff attitudes or bad contractors ... you're still the one that has to report the bad news to management every time. That's not pleasant.

Plus, if you have to get the plant re-instated by external contractors, your own staff never really get to learn from the experience or build plant knowledge. So, later down the track, the same failure occurs and the cycle repeats.

Challenge 3 – Safe Work

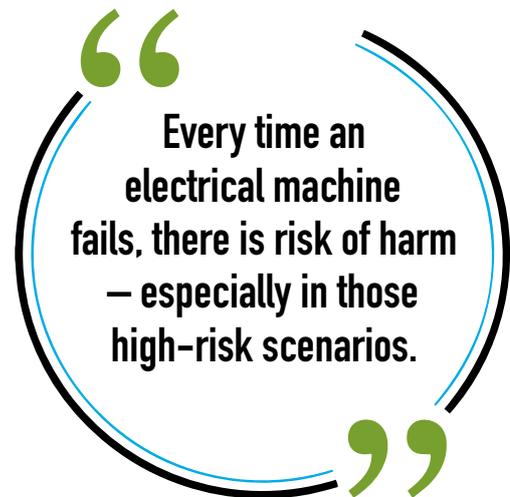
Most asset managers have regulators watching their team for any safety issues. Not to mention shareholders talking about safety. Add to that – you're genuinely worried about the team that you are responsible for.

Every time an electrical machine fails, there is risk of harm – especially in those high-risk scenarios.

How Asset Managers Are Addressing The Challenges Through Coaching

These challenges are real and common in our industry. The best way to address them is by coaching your staff. Ongoing coaching of your staff will significantly reduce these changes. Here are some of the impacts the industry's leading coaches will create:

- Coaching your staff to be proactive.
- Coaching your staff to consider all possible failure modes.



- Coaching your staff to think like an engineer.
- Coaching your team to identify potential issues before they happen.
- Coaching your team to identify the root cause of failures.

The Benefits of Electrical Maintenance Coaching

As long as you are providing your staff with the right electrical machine coaching framework, and giving them both knowledge and experiential learning... electrical maintenance coaching can help you to:

- Significantly reduce the frequency and severity of machinery failures, thereby reducing downtime costs.
- Improve the long-term reliability of your machines.
- Improve safety in your workplace by reducing risk factors associated with electrical equipment failure, such as fire and explosion.
- Enhance the effectiveness of corrective actions by increasing employee skillset in electrical maintenance activities. This can lead to improved performance in all areas related to machinery maintenance (e.g., mechanical).

But better still, here are some of the second-



“
**The more skilled
your team is, the higher
your productivity, with
less breakdowns, reduced
costs and happier
clients.**
”

order benefits of coaching that you may not have considered:

- Now that they are trained, your staff will have a new enthusiasm and confidence around the machines – which then has them more proactive in maintaining them. Your team see you as a good leader who is always ready to help.
- You don't have to rely on expensive external contractors, firmware, CAD, computerised

controls or software solutions. As a result, you're able to exceed your budgets every month.

- Every week you're actively building your plant knowledge. So new hires are able to quickly learn about your machines and how to maintain them.

With the right coach, you can confidently tell management that your team is being mentored by a leading expert in the industry. Much more effective than sending them to trade conferences. And regulators and shareholders stop asking so many questions too!

The Bottom Line (and improving it)

Investing time and effort in electrical maintenance coaching will pay off for your plant. The more skilled your team is, the higher your productivity, with less breakdowns, reduced costs, happier management and clients.

If you're experiencing the 3 main challenges of electrical machine maintenance in your team... Coaching is a no-brainer. ■



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Moment arm balancing of **Bladed Rotors**

Large, bladed rotors, such as the low pressure turbine rotor above, typically only have a limited amount of balance weight which can be added when the rotor is in the machine. During the life of the rotor, it is likely that one or more rows of blades will need to be replaced, in the case of the low pressure rotor the most likely row to require replacing is the last row on each flow due to erosion of the blades from moisture in the steam.

This paper explains the manufacturing procedure to facilitate balancing during the life of the rotor.

What is a moment arm?

The moment arm is the product of the weight times the distance of the centre of gravity (CoG, the location on the object through which the weight acts) from the pivot point or centre of rotation.

Consider two identical turbine blades (*fig. 1*). They have the same length, shape, weight etc. These are all visibly measurable parameters. What is not so easily measured is the position of the centre of gravity (CoG). If we have two 5 Kg blades where the CoG of one blade is 1mm different compared to the other then the moment arm difference is 5000 gram mm.

If we were to place these two blades opposite each other on a rotor, then the rotor would have a static imbalance (*fig 2*). To ascertain the moment arm, a moment arm weighing machine is used. (*See fig. 3*).

Each blade has a number and the moment arm for each blade is noted against the blade number.

Manufacturing process

Once all machining has been completed, the rotor is put into a balancing machine and the balance correction required at the two middle rows (row 1 left hand and right hand) is calculated. This correction is then made using the moment arm data for this set of blades.

Continued over page >

■ Simon Hurricks is Genesis Energy's Predictive Maintenance Engineer, and has been based at Huntly Power Station for 43 years and is responsible for the condition monitoring vibration analysis and balancing of the Huntly plant since it was commissioned in the early 1980s.

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Fig. 1

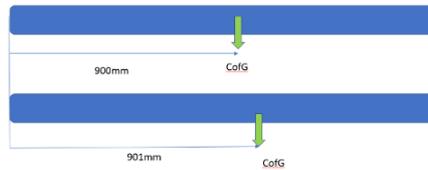


Fig. 2



Fig. 3

With these blades in position the rotor is again put into a balancing machine and the correction at the 2nd row of blades is calculated and corrected using the 2nd row of blades. This process is repeated for the 3rd and 4th rows.

Once the 4th row is fitted the balance correction is carried out by grinding off sections of the balance ring on the inboard side of the 5th row disc as shown in fig.3.

The 5th row is then added as a zero-balance correction based on the moment arms weights. On completion any residual imbalance is corrected using the dovetail balance slot on the outboard of the disc as shown in fig. 4.

What could possibly go wrong?

During commissioning, the unit heat rate (efficiency testing) showed that the Huntly machines were several % below the contractual minimum. Rather than pay liquidated damages, Parsons elected to re-blade the last row on the LP turbine with a new “high twist” design in return for the penalty clause in the contract being voided.

As a result, the last row of LP blades, on each unit, were changed out over a 4-year period. There are 92 left hand and 92 right hand blades. These arrived on site from the manufacturer and the old blades removed and the new blades fitted as per the blading diagram to give a zero-balance correction.

Note. There was no available portable balancing machine in NZ with this weight capacity and any trim balancing was to be done in-situ.

Unit 3 LP was re-bladed as per the blading diagram.

1st indications of a problem

- At the completion of the re-blade the LP rotor is lifted into the machine and left uncoupled.
- The rotor is then turned by hand on jacking oil so that the blade radial clearances can be set and ground.
- When Unit 3s rotor was put on jacking oil the 36-tonne rotor rotated by itself and then oscillated back and forth until it came to rest.
- Nothing was said by maintenance and the machine was coupled up and made ready to run.
- The first run only got to 750RPM when the eccentricity was off scale and the whole foundation was bouncing in time with the rotor.

Where to from here?

We had to get the machine to full speed (3000 RPM) to determine the extent of the imbalance.

Using trial weights in the dovetail slots a full two plane balance was undertaken. Initially at 750 RPM and then at higher speeds as the balance improved. We were not able to get enough weight on the rotor using standard weights so some special weights, 3 times the normal size were made up.

By adding 52 “special” weights at one end and 12 weights at the other, 3000 RPM was finally attained. Balance calculations indicated 10Kgs of weight was required at the dovetail radius. Special weight on the left, standard weight on the right.

The final solution

Parsons had three possible solutions.

1. Re-blade the rotor. These are pin bladed, and each blade custom fitted so this was not a viable option.
2. Acid etch a number of blades on one side to reduce the weight. Not really a viable option.
3. Drill holes in the trip blocks.

Fig. 3



Fig. 4



Fig. 5

4. Option 3 was the only realistic option. This required 4 X 5/8" holes in 26 blades on one end and 12 blades on the other end.

This was done and the final trim balance done on the dove tail slots.

What had gone wrong?

After a lot of enquiries, it was determined that part way through the moment arm weighing of our blades the blading company had an emergency order. On the completion of the emergency order the weighing machine was not reset for our blades which resulted in several heavy blades being placed on one side of the rotor.

Learnings

Huntly designed and constructed a soft bearing transportable balancing machine with a 36 ton capacity. After re-blading LP rotors were balanced to G1 grade prior to refitting in machine.

So where is this balance rig now? When NZED was split the rig was at New Plymouth. They consequently owned it on the understanding that we could use it if we paid for the transport.

We again re-bladed unit 1 and 4 LP rotors and used the rig. New Plymouth shut down and in 2018 Huntly was going to be shut down. The rig was sold to Gouk and Sullivan at Kauwerau. They never used it and it was scrapped.

Getting it right

- A few years ago Mitsubishi advised us that there was a potential flaw on one of the rotor disks on the gas turbine which, depending on a number of factors, could crack and fail.
- Their fix was to send the rotor back to Japan and we would get it back in 6 months time.
- Loss of generation for this period was not acceptable.
- Genesis elected to purchase a new spare rotor and blade it with our spare set of blades and send the old rotor to Japan so we would end up with a rotatable spare rotor.
- The new rotor arrived (no blades) along with a blading diagram to position each blade for each of the 14 rows of compressor blades and 4 rows of combustion blades.
- The bare rotor weighs 79 tonnes.
- 10 Tonnes of blades were fitted.
- The rotor ran very smoothly, and no additional balancing was required. ■



Fig. 6. Special weight on the left, standard weight on the right.

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The future of machine reliability isn't a single quick-fix product, new sensor or particular technology. It's about connecting to a holistic ecosystem that allows you to identify which machinery is critical to your business so you can plan maintenance, control inventory and prioritise actions to operate more efficiently.

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Nesti4.0 WebPortal

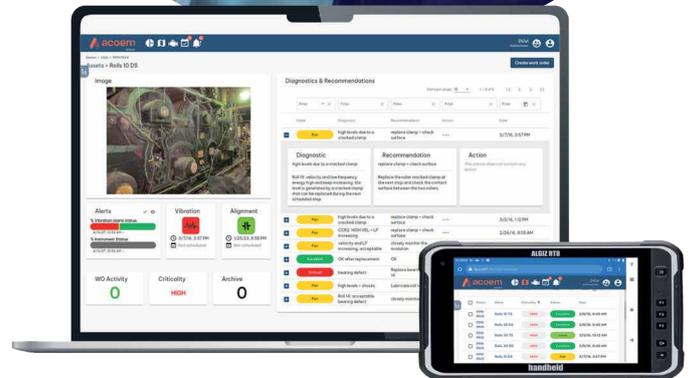
Next level predictive maintenance

Introducing the next generation Nesti4.0, your all-powerful predictive maintenance & diagnostic tool and gateway to total machine maintenance management. Harnessing the full power of Accurex™ Artificial Intelligence (AI), Nesti4.0 works seamlessly with Acoem's signature vibration measurement solutions — the FALCON portable analyser, Machine Defender app, EAGLE wireless sensor and the MV-x real-time monitoring system.

View the health of an individual piece of machinery or your entire multi-plant network on one centralised web interface, accessible from any mobile device. Instant access to actionable data empowers you to make informed decisions and take action on maintenance priorities based on criticality. With its highly flexible architecture (cloud or on-premises), Nesti4.0 lets you share your data in real time with full connectivity and easy integration with existing data servers.

The Acoem WebPortal multi-technology approach gives you complete control of your plant predictability

- Intuitive & quick setup with Machine Builder module
- Enhanced analysis productivity via Health Matrix module
- Improved reporting productivity via Accurex™ AI-powered diagnostics
- Open data platform (OPC UA, CSV export).



Discover Acoem's range of proactive and predictive maintenance solutions:



MV-x

AI-powered system with real-time edge computing that pinpoints the source, direction and intensity of vibration



FALCON

The fastest and smartest tool for vibration measurement and analysis



EAGLE

The first wireless monitoring solution with automatic AI diagnostics



RT-300

Customisable app-based augmented mechanics ecosystem that combines vibration, laser lineage and thermography



NXA Pro

Digital laser-based shaft alignment system with advanced functionality and easy operation

TEST YOUR KNOWLEDGE - PART 72 OF A SERIES

- 1 If a gearbox has a star gear in it, what might that tell us about the gearbox?**
- a It is a high-efficiency gearbox
 - b The gearbox has helical gears in it
 - c The overall ratio of the gearbox will be an integer to 1, e.g. 5:1, 6:1 etc
 - d None of the above are necessarily true
- 2 For the above-mentioned gearbox with a star gear in it, which of the following is correct?**
- a The carrier is fixed
 - b The ring is fixed
 - c The sun is fixed
 - d Any of the above
- 3 Vibration levels on industrial fans can often be improved with just single-plane balancing. When might 2-plane balancing be necessary?**
- a When the width to diameter ratio is high
 - b When the fan runs at high speed
 - c When the impeller has a strong couple unbalance
 - d Any or all of the above could be relevant
- 4 What steps might be taken if base-strain sensitivity of an accelerometer is problematic?**
- a Consider gluing the accelerometer rather than stud-mounting
 - b Choose an accelerometer with a shear sensing design rather than compression
 - c Neither a nor b
 - d Both a and b could be good options
- 5 The circuit-breakers have been tripping intermittently on an air compressor driven by a 3-phase induction motor. The cause of the trips is unknown. You suspect high motor current events might be occurring, and you decide to collect data using an analyser and a clip-on ammeter. You select armed level-triggered collection of the time-waveform. After setting an appropriate level setting, which of the following pre-trigger percentages would be your best choice?**
- a 10%
 - b 20%
 - c 50%
 - d 90%
- 6 In 1978 the P-F curve was introduced to maintenance discussion. The curve was later (in 2006?) revised. What was that curve known as?**
- a D-I-P-F
 - b P-F-D-I
 - c P-F-V2
 - d V2-P-F
- 7 Which of the following analyser specifications will give you the best chance of seeing low-amplitude vibrations in the presence of high-amplitude vibrations?**
- a 8-bit data collection
 - b 12-bit data collection
 - c 16-bit data collection
 - d 24-bit data collection
- 8 The most-commonly known singing bowl which produces vibration / sounds often used in healing is associated with which geographical region?**
- a China
 - b India
 - c Tibet
 - d Sri Lanka
- 9 Statistical alarms can be valuable in vibration analysis. Which of the following is true?**
- a They cannot be applied to overall level data
 - b They cannot be applied to spectral band data
 - c They cannot be applied to time-waveform data
 - d None of the above
- 10 The 2024 VANZ Conference will be held in which NZ location?**
- a New Plymouth
 - b Auckland
 - c Christchurch
 - d Timaru

Answers on page 32



Brüel & Kjær Vibro

A member of the NSK Group

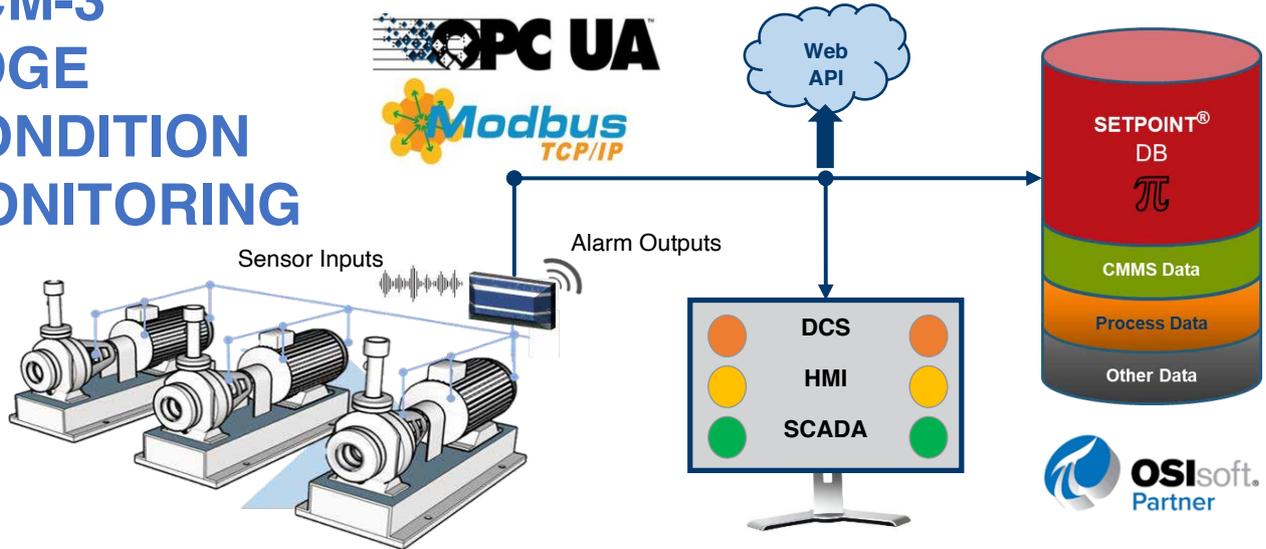
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VCM-3 EDGE CONDITION MONITORING



For more information, please refer to BKVibro Website:

<https://www.bkvibro.com/product/vcm-3/>

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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.

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



There is 4 possible 5 letter words above. Can you find them?

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...



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. Why not time yourself? We've started it off for you...

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

Missed an issue of Spectrum?

No worries. Head on-line to www.vanz.org.nz to find back issues of the magazine to catch up on.

Or, simply scan the QR code here to link your device directly to the VANZ website. There you will find back issues of Spectrum available to view*.

* A QR code reading app will need to be installed on your device first.



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 to the same way to performance needs or customer failures? How have we got to where we are today? How can we use discerned failure patterns to redefine where we need to be? In every bit of the present advances in technology and machinery have us to begin to identify the right order for all of the required pieces within our maintenance organizations?

The VanZ Quality Award!
Over the last three decades the vibration and condition monitoring industry has witnessed many changes. While these changes have been technically positive, some have required a deeper analysis of performance today than in earlier times. Many non-traditional programs, approaches and tools have been developed to address the challenges of today's manufacturing environment. The VanZ Quality Award program today will not change to accommodate the future right now. The award "house of reliability" has been defined as best of its kind in the industry.

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

A Beginning Discussion on Maintenance Management
Clearly there is a need to understand how to effectively manage plant maintenance programs, integrate real-time monitoring and maintenance and ensure the reliability of plant and other critical systems. This is a complex task that requires a multi-disciplinary approach.

The Emerging Role of the Operator / Maintainer
During the early days of manufacturing, the operator was the maintainer. As technology advanced, the operator's role evolved into a more specialized function. The operator is now responsible for the day-to-day operation of the plant, while the maintainer is responsible for the long-term health of the plant. This division of labor has led to a more efficient and effective maintenance program.

Keep your machines running longer with clean, dry oil.



Traditionally, machinery lubrication has been seen as a function of low importance, being messy work, requiring limited skills & lacking organization & structure.

THIS IS CHANGING

The risks of misapplication are high with many oils being supplied in the same basic drums with only complex codes indicating the different oil characteristics. The consequences of the incorrect oil being used can be catastrophic to machinery.

Lubrication Engineer's best practice lubrication reliability solutions contribute to 5S and also assist with addressing workplace safety & environmental compliance

- SUSTAIN – Best Practice, Less Downtime = MORE PROFIT
- SORT – Lubrication Site Audit, Lubrication Application Chart
- STRAIGHTEN – Label Safe, Colour Coding, Storage & Handling
- SHINE – Oilsafe Transfer containers, Clear Grease Guns, Contamination Control
- STANDARDISE – Consolidate Lubricants, Multipurpose Lubricants

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Transfer



Asset



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The small print...

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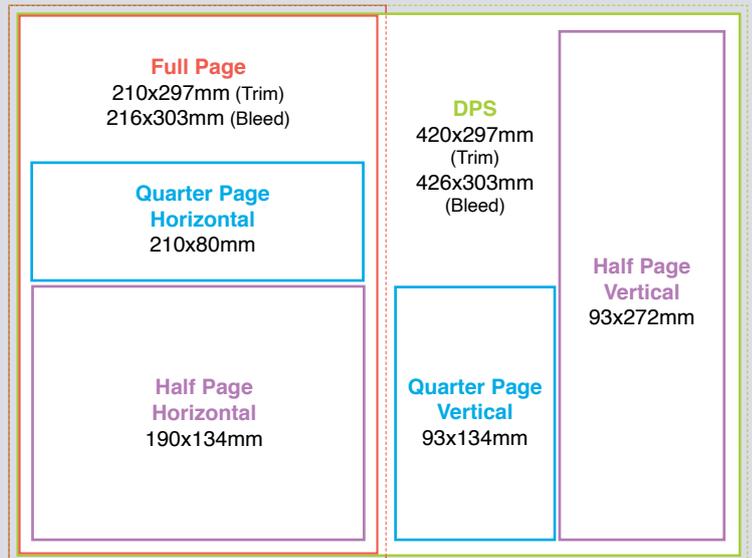
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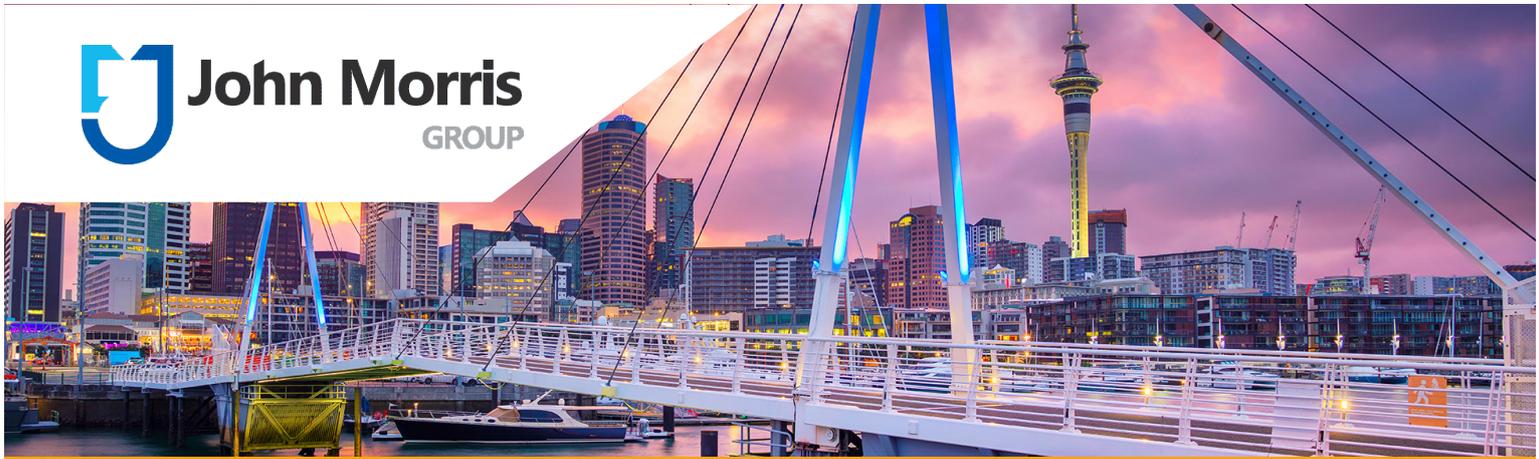
Each SPECTRUM will be distributed as an epub document and available for download and printing by VANZ members. Previous issues will become available on the public domain.

Article submissions:

Articles for upcoming issues of Spectrum are welcomed by the editor. Copy to be supplied preferably in Microsoft Word, but PDF file format is also acceptable. Please email spectrumeditor@vanz.org.nz with your submission or should you require further information.



Word Ladder: 1. washer 2. cashew 3. search 4. chairs 5. choirs 6. riches
Word Builder: pride, priced, redip, ripped
Carlton Technology Quiz 72: 1D, 2A, 3D, 4D, 5D, 6A, 7A, 8C, 9D, 10A

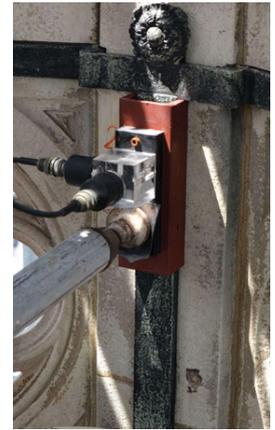


Seismic Testing and Infrastructure Monitoring

PCB® and Endevco® offer a diverse portfolio of sensors used for smart infrastructure worldwide, designed to measure earth tremors, foot, automobile and bridge traffic, trains and other seismic events that impart low frequency vibration. These vibratory loads accumulate as stress and may degrade the structures built to support them. Smart infrastructure includes active measurement with real-time data logging that informs operators on structural integrity, critical during unforeseen loading scenarios.

Applications:

- Foundation, floor vibration, and security monitoring
- Earthquake detection
- Structural testing of bridges and foundations
- Process monitoring inside machinery that is susceptible to low level vibration



Machine Condition Monitoring

IMI Sensors is a global designer and manufacturer of industrial vibration monitoring instrumentation used to spot imbalance, bearing faults and misalignment by measuring machine vibration, providing early fault diagnosis and thus reducing downtime.



Crystal Instruments designs and manufacture handheld vibration analysers and compact industrial grade data acquisition and dynamic measurement systems, specifically for the machinery Predictive Maintenance (PdM) community.



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