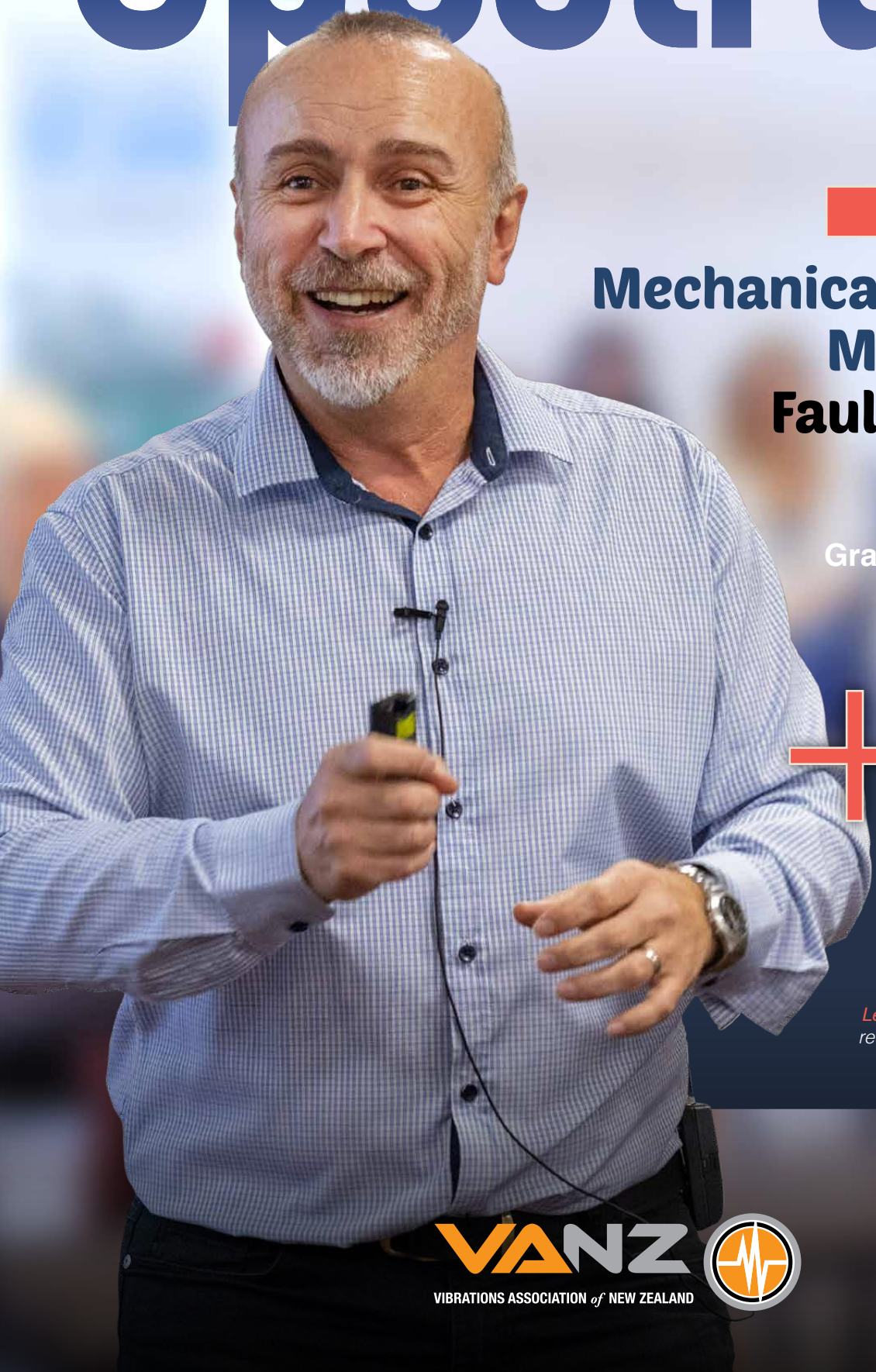
The official journal of the Vibrations Association of New Zealand

Spectrum

Spring 2022 | Issue 105



RECENT PROGRESS ON

Mechanical Condition Monitoring + Fault Diagnosis

Also...

Gravimetric Transducer Calibration

+

Full photo gallery from the VANZ Conference '22

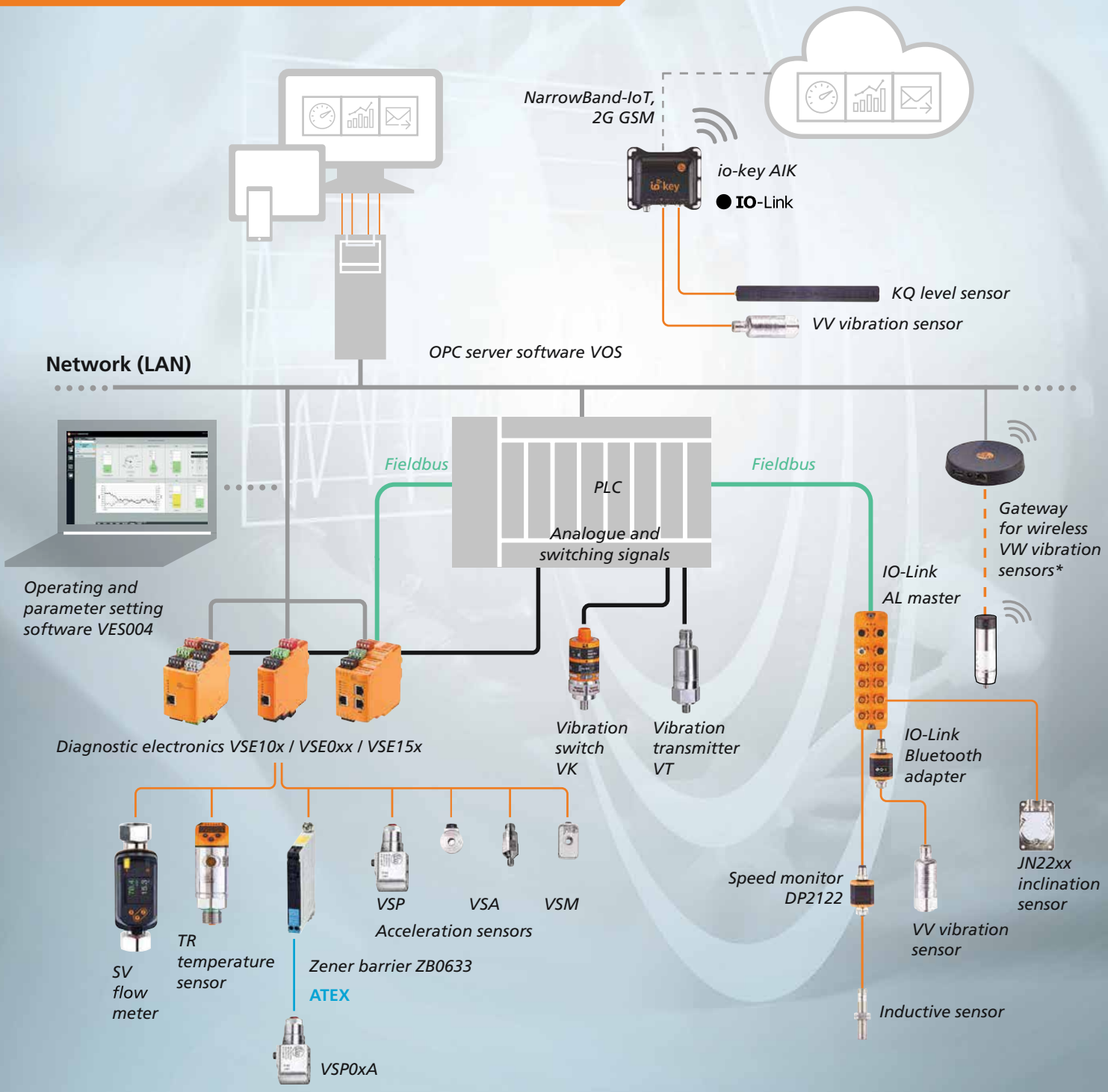
...and much more!

Left: Daré Petreski delivers a well-received keynote speech at VANZ Conference '22 in Taupo.

VANZ
VIBRATIONS ASSOCIATION *of* NEW ZEALAND

Plant Condition Monitoring Solutions

From Sensors to ERP



WARRANTY 5 years on ifm products

ifm offer a comprehensive range of industrial vibration and condition monitoring systems - ex-stock NZ! German quality - supported by local engineers, call us for advice on your machine requirements.

ifm – close to you!

www.ifm.com/nz ph: 0800 803 444

Spectrum

INSIDE THIS ISSUE >

Features

Skills and Practices
The real challenge is still ahead 6

Conference 2022 photo gallery 8

Mechanical Condition Monitoring and Fault Diagnosis 14

Gravimetric Transducer Calibration 22

Are you a VANZ Member? 26

Regulars

From the president 4
Editor's report 6
Puzzle corner 28
Test your knowledge 29

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*.

**QR code reading app need on your device first.*

Issue 105

Web Site: **www.vanz.org.nz**

Spectrum is published quarterly in a digital medium and printed twice yearly by the Vibration Association of New Zealand (VANZ). 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.

ISSN 1173-793X

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

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

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

President: Tim Murdoch
Email: tim.m@prelim.nz

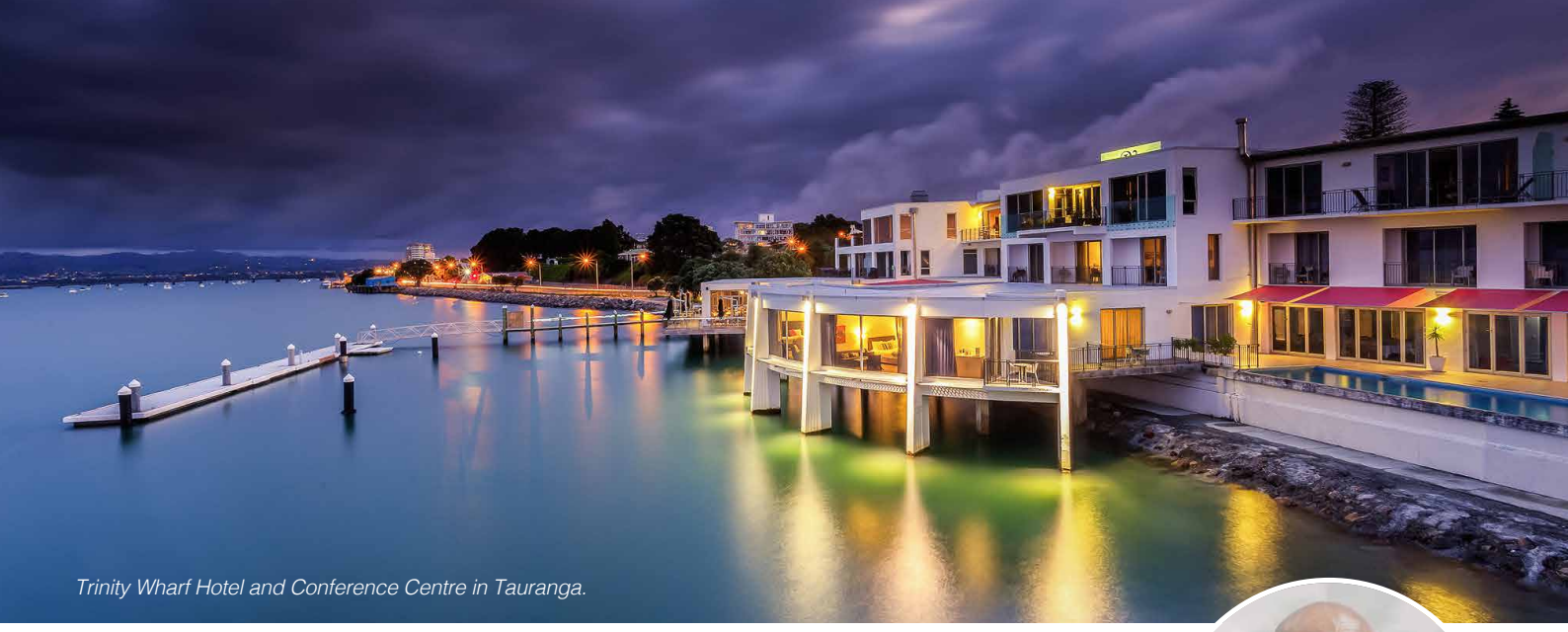
Treasurer: Graeme Finch
Email: G.Finch@auckland.ac.nz

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

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

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

VANZ
VIBRATIONS ASSOCIATION of NEW ZEALAND



Trinity Wharf Hotel and Conference Centre in Tauranga.

PRESIDENTS' REPORT

By Tim Murdoch, VANZ President

Hi, I'm Tim Murdoch. It is an honour and a privilege to be addressing you as the new President of VANZ. Thank you to Rodney Bell for his dedication and hard work as President these past few years and to the conference team for their tireless effort bringing everything together for the August 2022 conference.

A big thank you to our principal sponsor CSE W Arthur Fisher for your continued support especially during the Covid-19 pandemic and to our keynote speakers Dr Iain Epps, Mike Davis and Daré Petreski. Daré had to unexpectedly spend another week isolating in NZ, he is very grateful for the support and care he and his family received, telling us he will certainly be back. Also, for the support from all our fantastic presenters and exhibitors, who without their continued support, this conference would not have been possible.

> **VANZ conference 2022 was a great success at Wairakei Resort in Taupo, a big thank you to all those who attended.**

VANZ conference 2022 was a great success at Wairakei Resort in Taupo, a big thank you to all those who attended, I hope you really enjoyed yourselves and came away with some newfound knowledge from the inspiring papers that were presented on all three days.

I'd like to take this opportunity to introduce to you the current committee members of which there are seven new members: Bill Sinclair VANZ Secretary, Graeme Finch VANZ Treasurer, Rodney Bell, Glen Pepper, Simon Hurricks, Larry Wiechern, Alan Wang, Matthew Fallow, Nicky Lord, Joel Sowry, Dan Johnston, Chris Pullen, Bevan Rhodes, Alex Lawrence and Cameron Blackbourn.

After you finish reading this go to your calendars and block off **May 9 – 11 2023**, plans are underway to hold next years conference on these dates at Tauranga's **Trinity Wharf Hotel and Conference Centre.**

If you have any papers you would like to present, any case studies that you'd like to share please contact **papers@vanz.co.nz** as we would love to have you present them next year.

On our Facebook page we ran a competition to those who liked our page, congratulations to the winners Adam Bell and Deon Harrison. Take a look and follow our new Facebook page (@VibrationsNZ) for photos of the last conference and information on upcoming events.

As we move into these warmer months, I hope you make the most of this time to spend with loved ones and keep safe. ■

Congratulations

Congratulations to Chris Pullen from Westland Milk Products for winning the Peter Burgess Memorial Award for Best First Time Presenter.

MOBIUS INSTITUTE

Training & Accredited Certification

mobiusinstitute.com

Mobius Institute wants to help you

ACHIEVE YOUR GOALS™

Mobius Institute™ helps condition monitoring, maintenance, and asset reliability practitioners, business leaders, and strategic partners achieve the next level of success through leading-edge training, accredited certification, engaging conferences, and educational websites.

Professional Growth

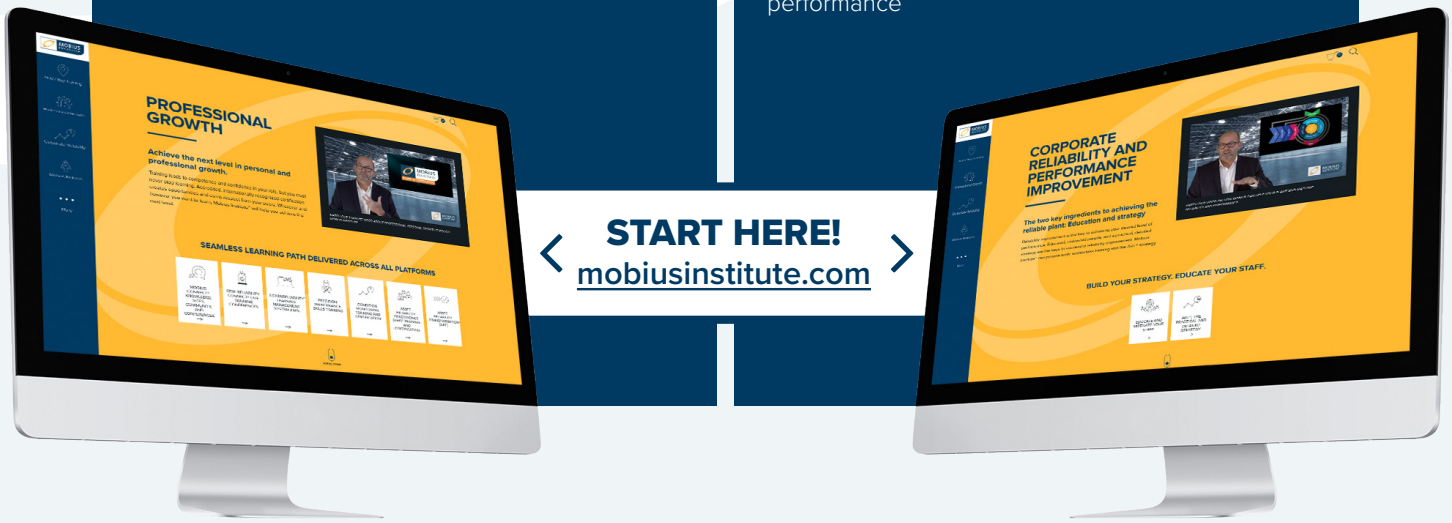
Move to the Next Level in Your Career

Gain the education and internationally recognized certification to take your career to the next level

Corporate Reliability

Improve Reliability and Performance

Educate your team or follow our Asset Reliability Transformation® [ART] process to improve your site's performance



START HERE!
mobiusinstitute.com

MOBIUS INSTITUTE BOARD of CERTIFICATION

Mobius Institute Board of Certification (MIBoC) is ISO/IEC 17024 and ISO 18436-1 accredited

Follow us on social:

FOR MORE INFORMATION:

learn@mobiusinstitute.com
Australia: (+61) (0)3-5977-4606

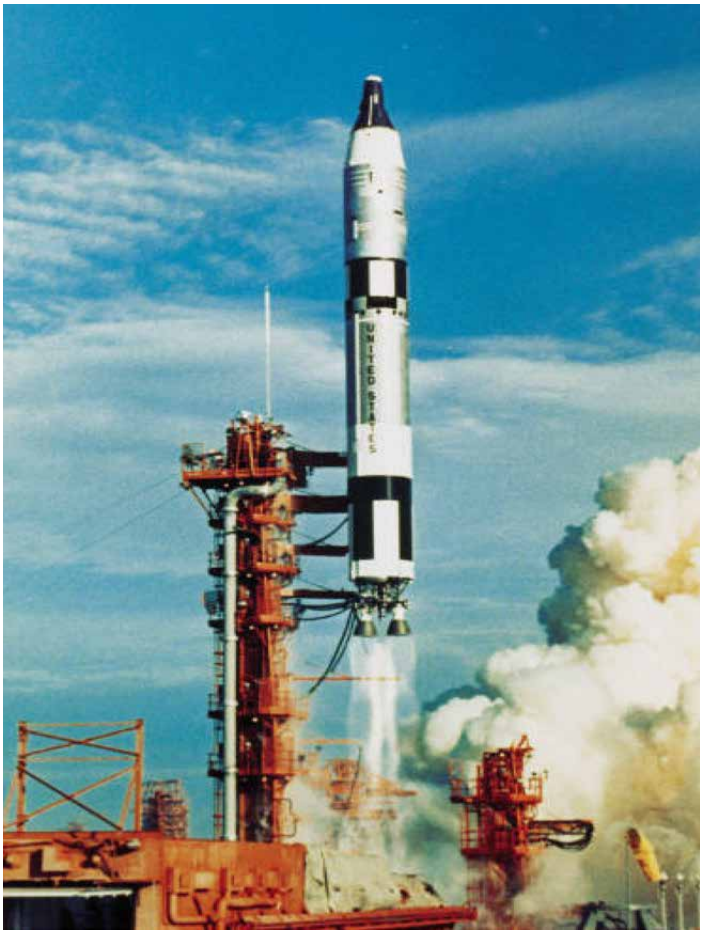
SKILLS AND PRACTICES

Your reliability improvement project is almost complete and things are looking good….

The real challenge is still ahead!

A summary of essential support requirements to enhance mission reliability

- Project file & records are updated and accessible. (Visible storage, Project Reporter history, PEA's, SAP work orders, change control, risk assessments, final report document etc).
- Drawings office records are updated. (Mechanical, Electrical, Instrumentation, P&ID's)
- Documentation and Manuals are readily available. (Maintenance, Operational, Systems).
- SOP's & Maintenance Procedures complete. (Including training thereof.)
- Software changes recorded, backed up, and accessible.
- Spares available and ongoing spare parts listed in SAP together with ordering information.
- Ongoing maintenance strategies established in SAP. ■



■ *Article prepared by Bluescope Steel.*

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 thru each year.

We'd like to thank our major sponsors CSE-W. Arthur Fisher and B&K Vibro 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 see 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.

As we continue on with the remainder of the year, our newly 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 check out our new Presidents report from Tim Murdoch, squeeze a bit of the old grey matter with Carls quiz and see what sort of deals our post-conference advertisers have to offer.

Happy reading! ■

The next step in your digital transformation just got easier!

Emerson's AMS Wireless Vibration Monitor is based on decades-proven technology that communicates using modern, cybersecure protocols. This is the wireless device that will extend your reliability program to an unprecedented number of plant assets – including those in hazardous or hard to reach areas – and deliver maximum visibility to asset health.

The unit features complete data acquisition – triax vibration with temperature and PeakVue measurements – to provide a sophisticated look at asset health on par with other online and portable monitoring options.

Ideal for deployment across your plant or enterprise, the AMS Wireless Vibration Monitor offers the following benefits:

- Automated machine monitoring with a lower total cost of ownership.
- Simple installation in about 5 minutes.
- Fleet management tools for fast configuration in the shop or in the field.
- Prescriptive analytics using patented PeakVue Plus to accelerate your diagnosis.
- Reduced time in the field – more time to recommend maintenance actions.
- Rapid ROI with lower installed cost and fast access to actionable information.
- Long 3-5 year life with an off-the-shelf battery collecting up to 4 waveforms per day.
- Battery replacement in the field – even in hazardous areas.
- Access asset health information on your mobile phone anytime, anywhere.

For More Information

The AMS Wireless Vibration Monitor is an integral part of the Emerson portfolio of portable and online machinery monitoring technology. Make it an integral part of your digital transformation journey today.

Visit our website at www.emerson.com/AMSVibrationMonitor, or contact your local Emerson representative.

AMS

Phone +64 9 441 0800 | emersonprocess.newzealand@emerson.com

EMERSON

CONFERENCE'22

Photos from the 33rd annual VANZ Conference in Taupo this year.


SDT Ultrasound
Have you been listening to your plant?
ASSET MONITORING AT THE PUSH OF A BUTTON
VANZ
PdM Laboratory in The Palm of Your Hand!
SIMPLE ASSET MONITORING - UPTIME!
GVS
RELIABILITY PRODUCTS
Machine Protection with Built-In "Flight Recorder"
experts and practitioners actively specialise in:
AUTOMATE
www.vanz.org.nz
www.bkvibro.com


TURNKEY SOLUTIONS TO FIT YOUR NEEDS
Mobil
Agen
Wireless Machine Condition Monitoring
The IIoT Smart Sens
for Industry 4.0
VANZ
SIMPLE ASSET MONITORING - JUST UPTIME!
Test & Measurement Solutions
Civil/Seismic Testing
Fatigue Testing
Condition Monitoring
Vibration Calibrators
Solutions
EMERSON
Applied Industrial Technologies Pty Ltd
APPLIED

CONDITION MONITORING WITHOUT SENSORS

The AMT Pro provides:

- Model based fault diagnosis technology
- Detects mechanical faults, electrical faults and process faults
- Portable or online

Visit our stand for a demonstration of the AMT Pro.

NVMS

+64 274 664 810
nvms.co.nz


VANZ
SIMPLE ASSET MONITORING - JUST UPTIME!
AUTOMATED ASSET FAULT DETECTION AND DIAGNOSTICS


VANZ
GE Acquires Commtest, Condition Monitoring P
VANZ is New Zealand's and Australia's premier association of industry experts and practitioners who actively specialise in:

VANZ
VANZ is New Zealand's and Australia's premier association of industry experts and practitioners who actively specialise in:

ALL THINGS INDUSTRIAL

Acquired in 2011 by Bently Nevada
GE Acquires Commtest, Enhances Bently Nevada Condition Monitoring Portfolio
Bently Nevada



CONFERENCE'22

SIMPLE ASSET MONITORING - JUST UPTIME!
VANZ








SERVICES

Waddington effect
In the WW2 1943, British scientist C.H. Waddington discovered that scheduled preventive replacement of the parts in the aircrafts was actually causing more harm than good.
VANZ

Brüel & Kjær Vibro
VANZ


Brüel & Kjær Vibro

A member of the NSK Group

ASSET HEALTH MONITORING FOR OPERATIONS AND MAINTENANCE

VCM-3 – Project Machine Health to Maximize Uptime

LOWER

Typically Rolling Element Bearings

Pumps, Motors, Gears, Fans, Blowers

CRITICALITY

Wind Turbines

HIGHER

Typically Fluid-Film Bearings

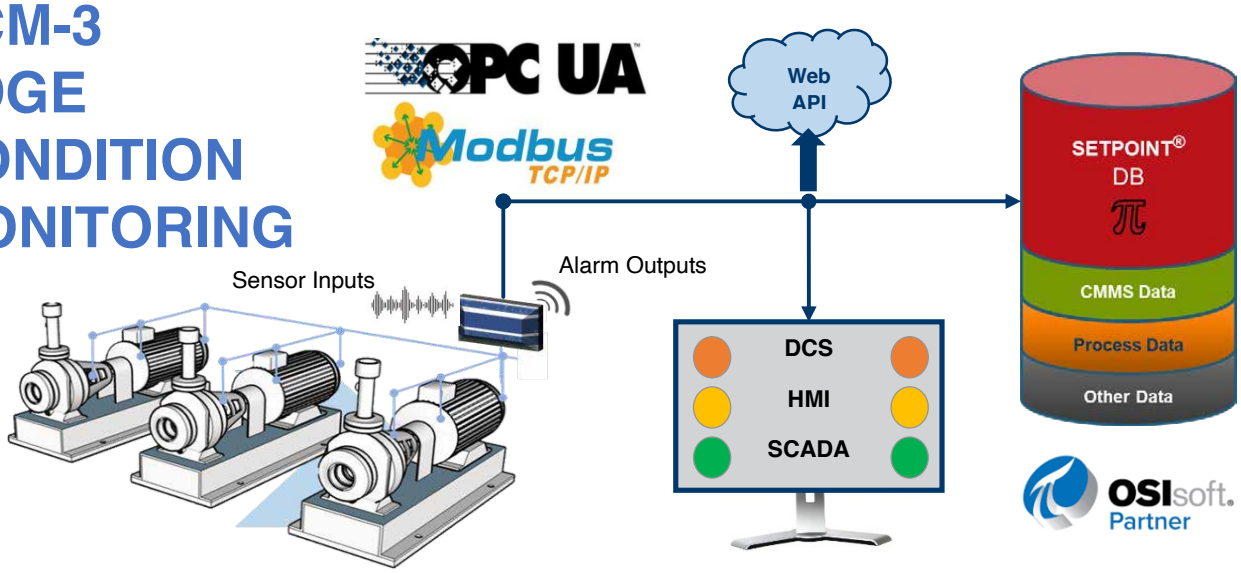
Generators, Steam, Hydro and Gas Turbines, Compressors

SOFTWARE & SERVICES		*CMS software for Fault detection & diagnosis Installation, Commissioning, CMS Service, Reporting*
CONDITION MONITORING		*Dedicated CM hardware for low-criticality Combined MPS+CMS hardware for high-criticality*
MACHINE PROTECTION		*From low-cost 1-4 channel devices up to API-670, SIL2-Capable systems with 4,000+ channels*
SENSORS	ACCELERATION, VELOCITY & DISPLACEMENT	*55,000+ sensors per annum, designed and produced in Germany*

Enabling a DIGITAL Strategy…

"Delivering insights in rotating machinery health by combining our domain expertise with advanced analytical software"

VCM-3 EDGE CONDITION MONITORING



For more information, please refer to BKVibro Website:

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

Enquire Now: sales@cse-waf.nz

CSE W Arthur Fisher

a division of CSE New Zealand

RECENT PROGRESS ON

Mechanical Condition Monitoring + Fault Diagnosis

Mechanical equipments are widely used in various industrial applications. Generally working in severe conditions, mechanical equipments are subjected to progressive deterioration of their state. The mechanical failures account for more than 60% of breakdowns of the system. Therefore, the identification of impending mechanical fault is crucial to prevent the system from malfunction. This paper discusses the most recent progress in the mechanical condition monitoring and fault diagnosis. Excellent work is introduced from the aspects of the fault mechanism research, signal processing and feature extraction, fault reasoning research and equipment development. An overview of some of the existing methods for signal processing and feature extraction is presented. The advantages and disadvantages of these techniques are discussed. The review result suggests that the intelligent information fusion based mechanical fault diagnosis expert system with self-learning and self-updating abilities is the future research trend for the condition monitoring fault diagnosis of mechanical equipments.

1. Introduction

With the development of modern science and technology, machinery and equipment functions are becoming more and more perfect, and the machinery structure becomes more large-scale, integrated,intelligent and complicated. As a result, the component number increases significantly and the precision requirement for the part mating is stricter. The possibility and category of the related component failures therefore increase greatly. Malignant accidents caused by component faults occur frequently all over the world, and even a small mechanical fault may lead to serious consequences. Hence, efficient incipient fault

Advanced in Control Engineeringand Information Science. Procedia Engineering 15 (2011) 142 – 146.
Article by Chenxing Sheng[a], Zhixiong Li[a], Li Qin[b], Zhiwei Guo[a], Yuelei Zhang[a]*
[a]Reliability Engineering Institute, School of Energy and Power Engineering, Wuhan University of Technology, Wuhan 430063, P. R. China. [a] Huangpi Campus, Air Force Radar Academy, Wuhan 430019, P. R. China

detection and diagnosis are critical to machinery normal running.
Although optimization techniques have been carried out in the machine design procedure and the manufacturing procedure to improve the quality of mechanical products, mechanical failures are still difficult to avoid due to the complexity of modern equipments. The condition monitoring and fault diagnosis based on advanced science and technology acts as an efficient mean to forecast potential faults and reduce the cost of machine malfunctions. This is the so-called mechanical equipment fault diagnosis technology emerged in the nearly three decades [1, 2].

> **Fault Mechanism research is a very difficult and important basic project of fault diagnosis, same as the pathology research of medical.**

Mechanical equipment fault diagnosis technology uses the measurements of the monitored machinery in operation and stationary to analyze and extract important characteristics to calibrate the states of the key components. By combining the history data, it can recognize the current conditions of the key components quantitatively, predicts the impending abnormalities and faults, and prognoses their future condition trends. By doing so, the optimized maintenance strategies can be settled, and thus the industrials can benefit from the condition maintenance significantly [3, 4].

The contents of mechanical fault diagnosis contain four aspects, including fault mechanism research, signal processing and feature extraction, fault reasoning research and equipment development for condition monitoring and fault diagnosis. In the past decades, there has been considerable work done in this general area by many researchers. A concise review of the research in this area has been presented by [5, 6]. Some landmarks are discussed in this paper. The novel signal processing techniques are presented.

The advantages and disadvantages of these new signal processing and feature extraction methods are discussed in this work. Then the fault reasoning research and the diagnostic equipments are briefly reviewed. Finally, the future research topics are described in the point of future generation intelligent fault diagnosis and prognosis system.

2. Fault Mechanism Research

Fault Mechanism research is a very difficult and important basic project of fault diagnosis, same as the pathology research of medical. American scholar John Sohre, published a paper on “Causes and treatment of high-speed turbo machinery operating problems (failure)”, in the United States Institute of Mechanical Engineering at the Petroleum Mechanical Engineering in 1968, and gave a clear and concise description of the typical symptoms and possible

Continued over page >

causes of mechanical failure. He suggested that typical failures could be classified into 9 types and 37 kinds [7]. Following, Shiraki [8] conduced considerable work on the fault mechanism research in Japan during 60s-70s last century, and concluded abundant on-site troubleshooting experience to support the fault mechanism theory. BENTLY NEVADA Corporation has also carried out a series experiments to study the fault mechanism of the rotor-bearing system [9].

A large amount of related work has been done in China as well. Gao et al. [10] researched the vibration fault mechanism of the high-speed turbo machinery, investigated the relationship between the vibration frequency and vibration generation, and drew up the table of the vibration fault reasons, mechanism and recognition features for subsynchronous, synchronous and super-synchronous vibrations.

Based on the table they proposed, they have classified the typical failures into 10 types and 58 kinds, and provided preventive treatments during the machine design and manufacture, Installation and maintenance, operation, and machine degradation. Xu et al. [11] concluded the common faults of the rotational machines. Chen et al. [12] used the nonlinear dynamics theory to analyze the key vibration problems of the generator shaft. They established a rotor nonlinear dynamic model for the generator to comprehensively investigate the rotor dynamic behavior under various influences, and proposed an effective solution to prevent rotor failures. Yang et al. [13] adopted vibration analysis to study the fault mechanism of a series of diesel engines. Other researchers have done a lot in the fault mechanism of mechanics since 1980s, and have published many valuable papers to provide theory and technology supports in the application of fault diagnosis systems [14-18]. However, most of the fault mechanism research is on the qualitative and numerical simulation stage, the engineering practice is difficult to implement. In addition, the fault information often presents strong nonlinear, non stationary and non Gaussian characteristics, the simulation tests can not reflect these characteristics very accurately.

The fault diagnosis results and the application possibility may be influenced significantly. As a result, the development of the fault diagnosis technique still faces great difficulties.

3. Advanced Signal Processing and Feature Extraction Methods

Advanced signal processing technology is used to extract the features which are sensitive to specific fault by using various signal analysis techniques to process the measured signals. Condition information of the plants is contained in a wide range of signals, such as vibration, noise, temperature, pressure, strain, current, voltage, etc. The feature information of a certain fault can be acquired through signal analysis method, and then fault diagnosis can be done correspondingly. To meet the specific needs of fault diagnosis, fault feature extraction and analysis technology is undergoing the process from time domain analysis to Fourier analysis-based frequency-domain analysis, from linear stationary signal analysis to nonlinear and nonstationary analysis, from frequency-domain analysis to time-frequency analysis.

Early research on vibration signal analysis is mainly focused on classical signal analysis which made a lot of research and application progress. Rotating mechanical vibration is usually of strong harmonic, its fault is also usually registered as changes in some harmonic components. Classical spectrum analysis based on Fourier transform (such as average time-domain techniques, spectrum analysis, cepstrum analysis and demodulation techniques) can extract the fault characteristic information effectively, thus it is widely used in motive power machine, especially in rotating machinery vibration monitoring and fault diagnosis. In a manner of speaking, classical signal analysis is still the main method for mechanical vibration signal analysis and fault feature extraction. However, classical spectrum analysis also has obvious disadvantages. Fourier transform reflects the overall statistical properties of a signal, and is suitable for stationary signal analysis. In reality, the signals measured from mechanical equipment are ever-changing, non-stationary, non-Gaussian distribution and nonlinear random. Especially when the equipment breaks down, this situation appears to be more prominent. For non-stationary signal, some time-frequency details can not be reflected in the spectrum and its frequency resolution is limited using Fourier transform. New methods need to be proposed for those nonlinearity and non-stationary signals.

The strong demand from the engineering practice also contributes to the rapid development of signal analysis. New analytical methods for non-stationary signal and nonlinear signal are emerging constantly, which are soon applied in the field of machinery fault diagnosis. New methods of signal analysis are main including time-frequency analysis, wavelet analysis, Hilbert-Huang transform, independent component analysis, advanced statistical analysis, nonlinear signal analysis and so on. The advantages and disadvantages of these approaches are discussed below.

Continued over page >

NEW PRODUCT ALERT:

Easy Bar®with Almasol ®(9210)

A solid lubricant that melts when placed on the hot surface of a kiln shell. It features a patented blend of mineral and metal lubricants – including Almasol, LE's proprietary solid wear-reducing additive suspended in a solid polymer binder that melts at approximately 49°C.

Typical Applications:

- Rotary Kilns, Dryers, Calciners,
- Cement, Lime, Pulp & Paper, Waste Processing
- Mining & Phosphate, Petroleum & Asphalt, Minerals
- Chemical, Food & beverage, Gypsum, Clay & Kaolin
- Iron ore & Aluminum

Lubricant Bar Effectiveness

Lubricant bars are solid dry lubricants encased within a carrier agent, which can be wax, polymer or other compound. This agent generally has a melting point of less than 93°C (200°F) and, when placed adjacent to the heated kiln shell, melts and releases the lubricant. Turning of the kiln causes these lubricants to flow over the wear pads and inside the tire bore, coating the mating surfaces.

Lubrication of the entire inside tire bore is crucial for effective lubrication. Solid bar lubrication between the filler bars or kiln shell and riding rings of a rotary kiln is proven to:

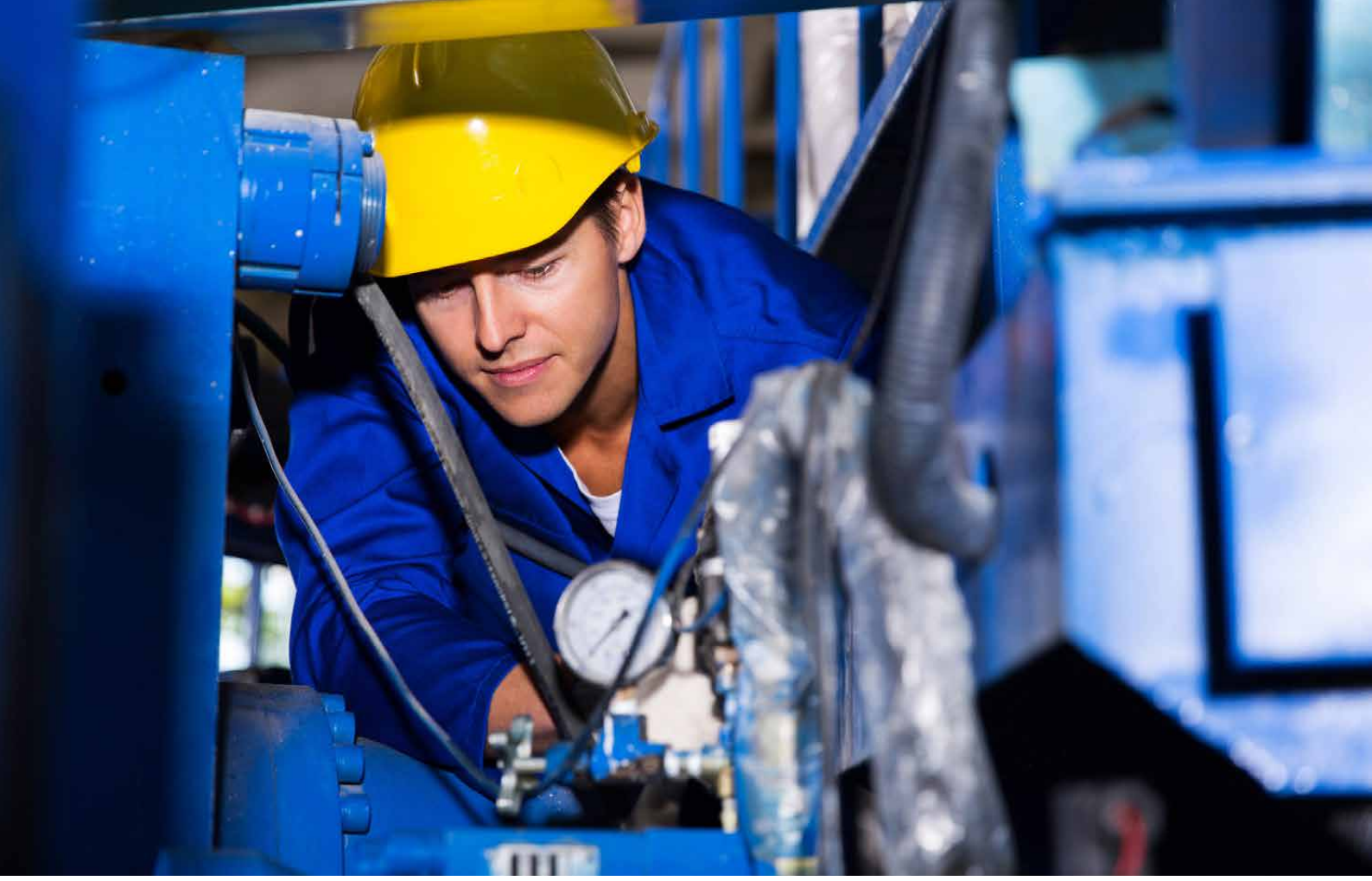
- Extend the life of wear filler bars
- Extend shell and refractory service life
- Reduce scoring of kiln tires, inside bore, riding rings, and stop blocks
- Reduce weld fractures at filler bar and kiln shell interface
- Reduce friction and wear
- Fill microscopic imperfections in contact surfaces

Lubricant Bar Application

Safe, Efficient Bar Insertion

While the kiln rotates, the operator simply inserts the recommended number of lube bars in the filler bar gaps between the tire and the shell. Insertion involves placing a whole bar between the filler bars or pads at the 5 or 7 o'clock positions. This should be done every quarter turn of the kiln as it travels through one full revolution.

For further information go to www.lubricationengineers.co.nz or Call Chris 021 385 487



4. Research on Fault Reasoning

At present, many methods are adopted in the process of diagnostic reasoning. According to the subject systems which they belong to, the fault diagnosis can be divided into three categories: (1) the fault diagnosis based on control model; (2) the fault diagnosis based on pattern recognition; (3) the fault diagnosis based on artificial intelligence. Among them, the fault diagnosis based on control model needs to establish model through theoretic or experimental methods. The changes of system parameters or system status could directly reflect the changes of equipments physical process, and hence it is able to provide basis for fault diagnosis.

> **The strong demand from the engineering practice also contributes to the rapid development of signal analysis.**

This technology refers to model establishment, parameters estimation, status estimation, application of observers, etc. Since it requires accurately system model, this method is not economically feasible for the complicated devices in the practice. Pattern recognition conducts cluster description for a series of process or events. It is mainly divided into statistical method and language structure method. The fault diagnosis of equipments could be recognized as the pattern recognition process, that is to say, it recognizes the fault based on the extraction of fault characteristics. There are many common recognition methods, including bayes category, distance function category, fuzzy diagnosis, fault tree analysis, grey theory diagnosis and so on. Recent years, some new technologies have been also applied in the field of the fault diagnosis of rotary machines, such as the combination of fuzzy set and neural network, the dynamic pattern recognition based on hidden markov model, etc.

5. Research and Development of Fault Diagnosis Devices

Fault diagnosis technology ultimately comes down to the actual devices, and at present research and development of fault diagnosis devices is in the following two directions: (1) Portable vibration monitoring and diagnosis (including data collector system), and (2) On-line condition monitoring and fault diagnosis system. Portable instrument is mainly adopted single-chip microcomputers to complete data acquisition, which has certain ability for signal analysis and fault diagnosis. On-line monitoring and diagnosis system is usually equipped with sensors, data acquisition,

Continued over page >

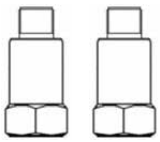
NZ Made Battery Powered Wireless Machine Condition Monitoring System

Your data hub

System integration via OPC-UA or MODBUS

Our system

- Install in minutes
- Run on standard Wi-Fi
- Up to 5 years of battery life
- Fully operated in a web browser
- Stand alone or integrated to your system
- Ex certified
- Designed and made in NZ



Your sensors (ICP® or 4-20mA Vibration Sensors or Proximity Probes)

Your assets

Agen Limited

8/2 Barry Hogan Place, Riccarton,
Christchurch 8041 New Zealand

www.agen.co.nz

contact@agen.co.nz

Ph: 03 930 0840

alarm and interlock protection, condition monitoring subsystem, etc. And it is also fitted with rich signal analysis and diagnosis software.

These software include America BENTLY Corporation 3300, 3500 and DM2000 systems, America Westinghouse Company PDS system, the 5911 system developed by ENTECK and IRD Company, Japan Mitsubishi MHM system, the Danish B&K Company B&K 3450 COMPASS system, etc. China has also successively developed large on-line monitoring and fault diagnosis system, which has been put into use on steam turbine and other important equipments.

Based on the realization of condition monitoring of equipments, network diagnostics center can monitor and diagnose the operation of equipments at any time through the network to achieve the long distance information transmission. The remote monitoring system can also achieve the collaborative diagnosis of production equipments, multiple diagnostic systems serve the same piece of equipment, and multiple devices share the same diagnostic system.

6. Conclusions

To achieve a dynamic system condition monitoring and fault diagnosis, primary task is the need to get enough reliable characteristic information from the system. Due to the fluctuation of the system itself and the environment disturbance, reliable signal collection is seriously affected. It is therefore very urgent for advanced signal processing technology to eliminate noise to get true signal. No matter classical or advance fault diagnosis techniques, they have achieved great progress in various applications. In the point of systematic view, every technology is a part of the whole diagnostic system, and the efficient fusion of these parts will provide best performance for the condition monitoring and fault diagnosis.

Thus, the fault mechanism research, signal processing and feature extraction, fault reasoning research and equipment development will connect even tighter to form an effective fault diagnostic expert system in the future. To realize the expert system, the core issue is to break through the bottleneck of knowledge acquisition, update the data model in a reliable manner and provide good generalization ability of the expert system.

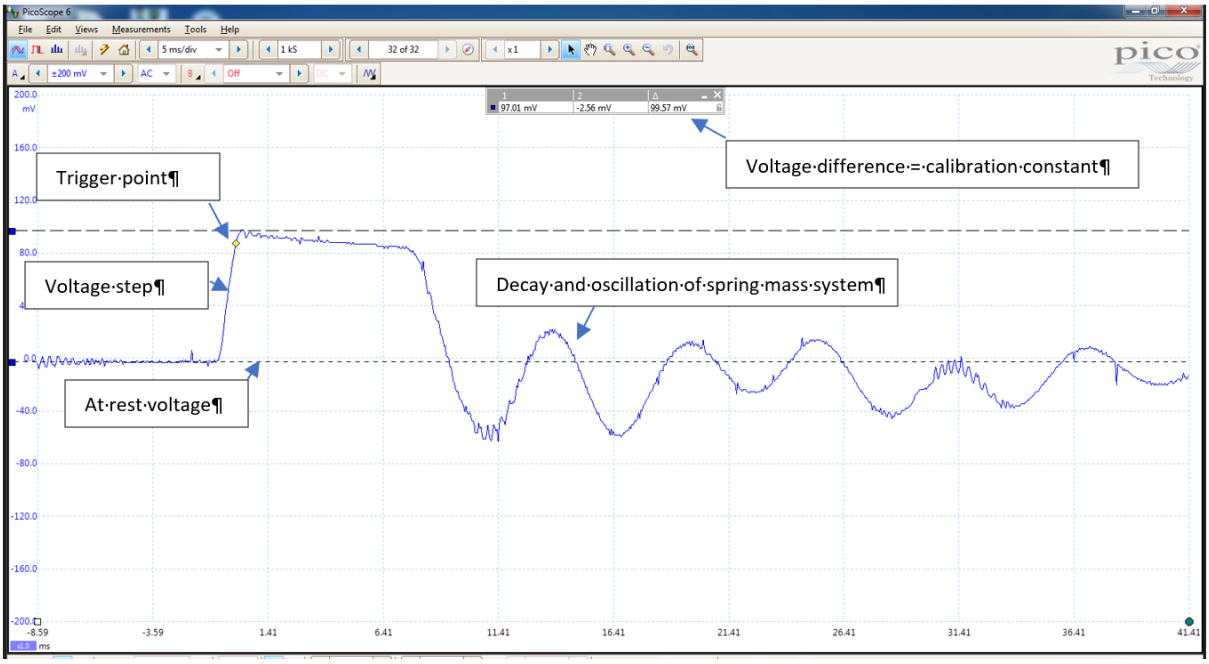
By doing so, the fault diagnostic expert system can offer accurate estimation of the potential abnormalities, and prevent them before breaking out to ensure the normal operation of the machines. Hence, the loss caused by the machine breakdowns can be minimized significantly. ■

Acknowledgements

This project is sponsored by the grants from the National Natural Sciences Foundation of China (NSFC) (No. 50975213).

References

[1] Wu XK. The fault diagnosis based on information fusion theory and its application in internal combustion engine. Ph.D. thesis, Wuhan University of Technology, 1998.
[2] Chen YR. Modern signal processing technology in the application of vibration diagnosis of internal combustion engine.Ph.D. thesis, Wuhan University of Technology, 1998.
[3] Qu LS, He ZJ. Mechanical fault diagnostics. Shanghai: Shanghai Science and Technology Press, 1986.
[4] Huang WH, Xia SB, Liu RY. Equipment fault diagnosis principle, technology and application. Beijing: Science Press, 1996.
[5] Jayaswalt P, Wadhwani AK. Application of artificial neural networks, fuzzy logic and wavelet transform in fault diagnosis via vibration signal analysis: A review. Australian Journal of Mechanical Engineering 2009; 7: 157-172.
[6] Daneshi-Far Z, Capolino GA, Henao H. Review of failures and condition monitoring in wind turbine generators. 19th International Conference on Electrical Machines. Rome, Italy; 2010.
[7] Sohre JS. Trouble-shooting to stop vibration of centrifugal. Petrop Chem. Engineer 1968; 11: 22-23.
[8] Shiraki T. Mechanical vibration lectures. Zhengzhou: Zhengzhou Mechanical Institute; 1984.
[9] Bently DW. Forced subrotative speed dynamic action of rotating machinery. USA: ASME Publication, 74-pet-16.
[10] Gao JJ. Research on high speed turbine machinery vibration fault mechanism and diagnostic method. Ph.D. thesis, Xi'an Jiaotong University, 1993.
[11] Xu M, Zhang RL. Equipment fault diagnosis manual. Xi'an: Xi'an Jiaotong University Press, 1998.
[12] Chen YS, Tian JY, Jin ZW, Ding Q. Theory of nonlinear dynamics and applied techniques of solving irregular operation of a large scale gas turbine in a comprehensive way. China Mechanical Engineering 1999; 10: 1063-68.
[13] Yang JG, Zhou YC. Internal combustion engine vibration monitoring and fault diagnosis. Dalian: Dalian Maritime University Press, 1994.
[14] Wang Y, Gao JJ, Xia SB. The study of causes and features of faults in supporting system for rotary machinery. Journal of Harbin Institute of Technology 1999; 31:104-6.
[15] Liu SY, Song XP, Wen BC. Catastrophe in fault developing process of rotor system. Journal of Northeastern University (Natural Science) 2004; 17:159-162.
[16] Han J, Zhang RL. Rotating machinery fault mechanism and diagnostic technique. Beijing: China Machine Press, 1997.
[17] Chen AH. Research on some nonlinear fault phenomenon of rotating machinery. Ph.D. thesis, Central South University of Technology, 1997.
[18] Zhang W, Zhang YX. Missile power system fault mechanism analysis and diagnosis technology. Xi'an: Northwest Industrial University press, 2006.



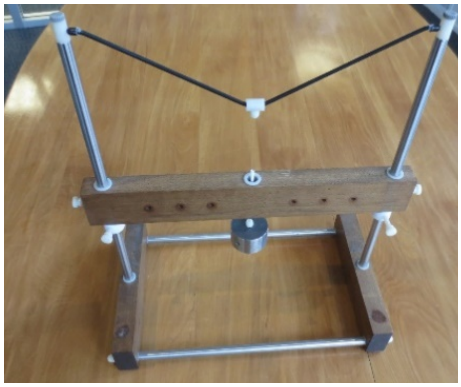
Above: A screen shot from a Pico Scope when the transducer had a short free fall as described below.

A SPOTLIGHT ON...

Gravimetric Transducer Calibration

1. Introduction

In 1901 the third General Conference on Weights and Measures defined a standard gravitational acceleration for the surface of the Earth: gn =9.80665 m/s2. It was based on measurements done at the Pavillon de Breteuil near Paris in 1888, with a theoretical correction applied in order to convert to a latitude of 45° at sea level.



Above: PCB Gravimetric Calibrator.

At the equator this value is decreased slightly (0.3%) due to the earth's rotation. Gravity also decreases with altitude and at a height of 9000 metres g is reduced by 0.29%.

2. Accelerometer output

ICP (Integrated Circuit Piezoelectric) accelerometers have their output stated in terms of mv/g. I.e. a 100 mv/g accelerometer will produce an AC voltage of 100mv (0 to Peak) when vibrated at 1 g as long as the frequency is within the frequency range of the transducer. The transducer specification will state the % reduction or dB drop outside of that range.

A typical industrial grade accelerometer range will have the output stated as 100mv/g +-10%, this means that a particular transducer could be 90mv/g up to 110 mv/g and will come with a calibration certificate with the actual output stated. For routine monitoring we would typically set our vibration instrument to 100mv/g and leave it at this setting even when we use numerous transducers.

If we are doing routine monitoring, we generally use the same transducer, and we are looking for changes in amplitude and / or frequency component changes. In this situation it does not matter if the calibration is not precisely set to that of the transducer. What is more important is the position and mounting of the transducer to ensure the readings are repeatable.

Continued over page >

Article by Simon Hurricks, Predictive Maintenance Engineer, Genesis Energy Ltd.

IT'S TIME FOR LESS DOWNTIME.

Facing the following machine issues?

- High oil consumption
- Malfunction due to deposits formation
- Pump failure and component wear

Breakthrough technology that keeps moving parts moving.

- **2X** Oil Life*
- **72%** Better Wear Protection**
- **89%** Better Deposit Control+

MOBIL DTE™ 20 ULTRA SERIES

Decreased downtime with extended:

- Component life
- Oil drain intervals
- Filter life

Disclaimer: *Mobil DTE 20 Ultra Series oils have demonstrated up to 2 times longer oil drain intervals versus similar competitive oils (ISO VG 46 with a viscosity index around 100 and a zinc-based anti-wear system – meeting at least ISO 11158 (L-HM) and/or DIN 51542-2 (HLP type) requirements) in demanding Mobil Hydraulic Fluid Durability (MHFD) testing. **72% lower wear than maximum limit for motor wear in BR RFT APU CL test (ISO VG 32). +89.2% lower sludge formation than maximum limit of ASTM D 6158 by using ASTM D 2070 method (ISO VG 68).

3. Calibration and traceability

There are several calibration systems available on the market, the simpler ones have a small shaker which vibrates at a known output at a fixed frequency. The more complex ones have a variable amplitude variable frequency shaker and use an internal accelerometer to measure output of the shaker, and this is compared to the output of the transducer being calibrated.

The output is generally measured with a data collector or similar vibration analyser. Both systems should be themselves calibrated to ensure they are reading correctly.

Many of these systems have a weight limit of 100 grams on the shaker, which is fine for the smaller transducers but not for the larger low frequency transducers.

To calibrate the calibrator, it is checked against a standard which is itself traceable back to a primary standard. These calibration systems are quite expensive, and the calibration would probably need to be done offshore.

4. AC coupling of vibration transducers

The ICP transducer is powered by an 18-volt DC, 4ma constant current from the vibration instrument or by an independent power source.

The ICP amplifier in the transducer modulates the DC such that the change in the DC voltage is the g value expressed in mv. i.e., a 1 g signal for a 100mv/g transducer will have a peak to peak modulation of 200 mv.

The transducer power supply or vibration analyser has 10 µF capacitor in the measuring circuit which blocks the DC so that the instrument only sees the modulation. i.e., the AC component.

When the instrument is first powered up there is a large value seen by the instrument while the capacitor is charging, and most instruments prevent measurements until the transducer has settled. This is best seen using an oscilloscope.

5. The drop calibration

If we applied a constant acceleration to the accelerometer the output from the accelerometer would be a step change in the DC voltage which would be detected by the oscilloscope. This voltage would quickly decay to 0 as the capacitor charged to its new level. If we measured the step change in the DC voltage we can determine the acceleration if we knew the calibration constant.

If we dropped the accelerometer, i.e. give it a 1 g acceleration we could measure the voltage step change and thus determine the accelerometer calibration constant in mv/g. Unfortunately, after dropping the transducer, it may be calibrated but no longer serviceable.

> **New Zealand is close to latitude 45 so even if you were calibrating at the top of Mt Cook you would still have a g value in free fall within 0.3%.**

6. Gravimetric calibration

If we were to suspend the transducer from an elastic cord via a thin string and then tap the cord, the accelerometer would experience a short 1 g drop before being arrested by the cord. Using an oscilloscope, we can accurately measure the step voltage and thus the calibration constant in mv/g.

7. Conclusions

New Zealand is close to latitude 45 so even if you were calibrating at the top of Mt Cook you would still have a g value in free fall within 0.3%.

We have experimented using a simple length of shock cord ($1.94 per metre) and two uprights to tie off the cord, suspended the transducer from a piece of thin nylon fishing line and achieved repeatable results within 0.5%. Having proven the concept, we purchased the PCB calibrator as it looks more professional and better in calibration reports. It was no more accurate than our trial system.

How accurate do you need to be, when just using the nominal calibration from the manufacturer could put you 5 to 10 % out, because for the most part it does not matter as the measurements are being used for detection of change not absolute vibration values. ■

Above: *Even at the top of Mt. Cook, a g value would fall within 0.3%.*

Monitor

*The **8 Pillars** of Ultrasound*

HEAR SDT MORE

Bearing Lubrication Monitoring:
Proper lubrication minimizes surface contact of machinery, and reduces undesired friction, excessive heat, metal-on-metal contact and wear and tear.

Hydraulic System Monitoring
Failure modes in hydraulics systems include external leakage, internal leakage, by-passing, and blockages.

Air & Gas leak Detection:
Undetected air & gas leaks are costly, inefficient, polluting, and sometimes unsafe.

Steam Trap Testing:
A fully-functional steam trap is energy-efficient and does not waste quality steam.

Mechanical Condition Monitoring:
Unexpected machine breakdowns threaten your bottom line, the environment, and worst of all, workers' safety.

Valve Condition Monitoring
Internal or external leaks, or issues with flow regulation in your valves threaten your factory.

Electrical Fault Detection:
Unreliable electric power system cost manufacturers millions in downtime and repairs and have the potential to maim and kill.

Underground Tank, Weather, & General Tightness Testing
When the tightness integrity of air tight compartments deteriorate, two things happen… Things leak out, and things get in.

Gain a better understanding of the health of your factory.

GVS

+61 (0) 2 49252701
sales@gvsensors.com.au

Are you a VANZ member?

You could be. Anyone with an interest in the area of mechanical and electrical machine condition monitoring, to facilitate predictive asset management is eligible to join VANZ. In-house technicians, consulting engineers, suppliers and distributors of specialised equipment, engineering students can all contribute and gain from membership.

Technology, materials and manufacturing processes are continually developing. And so too has the engineer skills and knowledge developed. Today the engineering role has evolved to where the analyst, by diligent use of multiple Condition Monitoring tools and principles, can empower Predictive Asset Management. But it is a challenging role! So much is at stake with the high cost of downtime, equipment replacement costs, and the potential safety risks. The future of the business can hinge on the Predictive Asset Management achieved by this special group of people. Yet detecting, diagnosing, and preventing these faults takes training, knowledge, skill and experience.That is why VANZ exists, and why VANZ constantly evolves!

> **Membership ranges from a business with a line of small water pumps to personnel from some of the largest plants running million dollar machines.**

VANZ recognises that the engineers who apply the technology are one half of the equation. Equally important are the industries and businesses served by it, with their varied experiences and evolving requirements. The size of the operation and the machinery it runs are not an issue either.

For Analysts and Predictive Asset Management specialists

VANZ is a volunteer-run, not-for-profit, membership group of like-minded people from New Zealand and Australia. VANZ as an organisation evolved from a Workshop Conference held in New Plymouth in 1989. From this Workshop Conference the Vibrations Association of New Zealand was registered as an Incorporated Society and the first annual technical conference held in Rotorua 1990. From this beginning VANZ has continually developed to provide a platform for people to discuss their challenges with their fellow analysts and learn from their peers and industry experts.

Annual conference for networking and learning

The core function of VANZ is the annual conference held every year in May. Like a family reunion, over 100 people gather in a friendly environment to participate in technical presentations, round-table discussions, and at times debate. Keynote speakers from Australia, Europe, America, and Turkey have, and continue to present technical papers at conference. And importantly New Zealand presenters add a New Zealand context.

VANZ is quite a unique society – it has withstood the 'test-of-time' – and has every year, for twenty-nine years run an Awareness Day training for apprentices and trainees. It is a reasonable 'track-record' which VANZ has consistently promoted for New Zealand and Australian industry.

GETTING IN TOUCH IS EASY...

For more information about membership, contact the VANZ secretary by emailing:

secretary@vanz.org.nz

EagleBurgmann®

Rely on excellence

Made to meet your need, but exceed your expectations

- Mechanical Seals ● Cartridge Seals
- Seal Supply Systems ● Gland Packing
- Static—Sheet Jointing / Formed Gaskets
- Expansion Joints—Fabric / Rubber / Metal
- Bearing Isolators ● Current Diverter Rings
- Couplings—Diaphragm / Magnetic
- Marine Seals ● MECO Seals
- Dry Powder Seals● Segmented Carbon Rings

EagleBurgmann Australasia Pty Ltd (NZ)
PO Box 300858, Albany, Auckland 0752, 47 William Pickering Drive, Rosedale, Auckland 0632
Ph: +64 (0)9 448 5001, Fax: +64 (0)9 415 0599, Email: sales@nz.eagleburgmann.com

PUZZLE CORNER

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

R	E	L	N	A

There is 2 possible 5 letter words above. Can you find them?

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

Solution on page 30.

T	R	E
I	X	P
E	S	E

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? We've started it off for you...

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

CarltonTechnology
• vibration • noise • reliability / engineering support

Carlton Technology Ltd
PO Box 18046, Merrilands, New Plymouth 4360
Ph: 64 6 759 1134 • Fax: 64 6 759 1184
Email: ctownsend@xtra.co.nz

TEST YOUR KNOWLEDGE - PART 68 OF A SERIES

1. Via a listening device attached to your analyser, you can hear what appears to be an intermittent rattle that you suspect might be sourced at cage frequency. The spectrum collected in route mode setup does not seem to be very definitive. Which of the following off-route options might result in a better understanding of this intermittent rattle?

a. Adopting time-synchronous averaging
b. Auto-correlating the waveform (if available)
c. Applying peak-hold averaging to the spectral collection
d. Both b and c could be options

2. A taper-roller bearing on the output shaft of a gearbox is in the later stages of failure. The shaft turns slowly at only 2 rpm. What might be a likely indicator of the bearing's poor condition?

a. Intermittent impact events witnessed in an acceleration waveform
b. High rms acceleration levels above 5 kHz
c. High rms velocity levels (e.g. above 10 mm/s rms)
d. All of the above

3. Which of the following communication options would serve you best if you are to upload large routes of data from your data-collector back to your computer

a. Serial communication
b. USB type 1
c. USB type 2
d. Ethernet

4. In a "made-for-television" Mythbusters experiment, a rock singer was able to shatter a wine-glass using his voice to excite the natural frequency of the glass. What frequency do you think was excited?

a. 5.66 Hz
b. 56.6 Hz
c. 566 Hz
d. 5660 Hz

5. A person suffering from noise-induced-hearing-loss might show a "notch" in his/her audiogram results. At what frequency is this most-likely to occur?

a. 2 kHz
b. 4 kHz
c. 6 kHz
d. 8 kHz

6. One of the gears in a gearbox has a chipped / broken tooth. How is this fault most-likely to present itself?

a. Singular side-band peaks of the gear speed either side of gear-meshing frequency
b. A number of sideband peaks of the gear speed either side of the gear-meshing frequency
c. Increased vibration at the gear-meshing frequency
d. Increased vibration at 2 x the gear-meshing frequency

7. What is true about anti-nodes?

a. They are the point of maximum amplitude on a wave
b. They occur mid-way between nodes
c. They are the point of minimum amplitude on a wave
d. Both a and b are true

8. If a rotor is running badly unbalanced, what shape is the vibration waveform most-likely to be?

a. Saw-tooth
b. "M" or "W" shape
c. Square-wave
d. Sinusoid

9. A deep-groove ball-bearing has 8 balls. If the cage frequency is 0.42 x rs, what frequency is the outer-race ball-passing frequency likely to be?

a. 3.36 x
b. 4.64 x
c. 8 x
d. 16 x

10. Which of the following windows provides the best amplitude accuracy?

a. Hanning
b. Hamming
c. Flat-top
d. Blackman

Answers on page 30

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

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..*

SAVE UP TO $200 ON ADVERTISING BOOK TODAY!

VANZ
VIBRATIONS ASSOCIATION *of* NEW ZEALAND

Advertising Rates

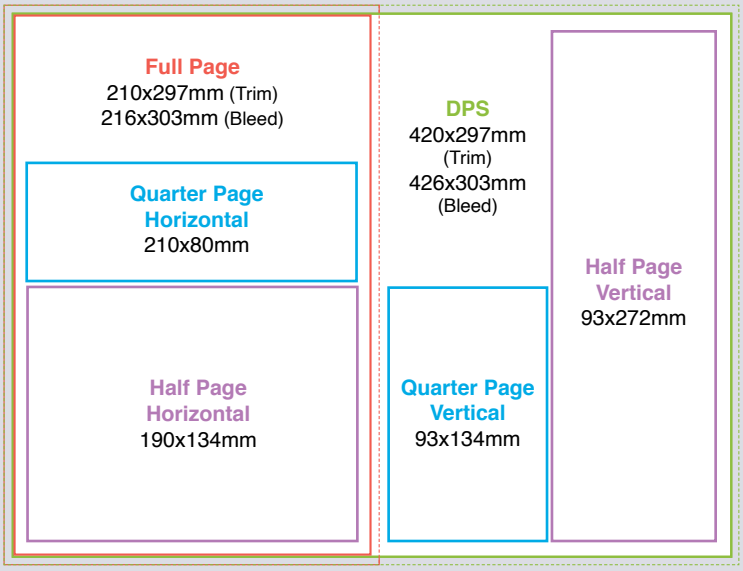
DPS	Full Page	Half Page	Quarter Page	Advertorial
Size (width x height): 420x297mm (Trim) 426x303mm (Bleed)	Size (width x height): 210x297mm (Trim) 216x303mm (Bleed)	Size (width x height): 190x134mm (Horz) 93x272mm (Vert)	Size (width x height): 190x80mm (Horz) 93x134mm (Vert)	$100 per page or 50% discount if bought in conjunction with a full page colour advert.
Single issue rate: **$550+GST**	Single issue rate: **$350+GST**	Single issue rate: **$300+GST**	Single issue rate: **$250+GST**	
4-issue (1 year) rate: **$500+GST**	4-issue (1 year) rate: **$315+GST**	4-issue (1 year) rate: **$270+GST**	4-issue (1 year) rate: **$225+GST**	

The small print...

How to supply an advert:
All advertising copy to be supplied in high-res PDF format at the correct size required. Files to be supplied press ready at 300dpi with 3mm bleed for full page and DPS advertisements. The special 4-issue rates are for advertising in 4 consecutive issues. i.e. Issue 91, 92, 93 and 94. ***Save up to $200 on your advertising in Spectrum!***
Email Angie at **spectrumeditor@vanz.org.nz** to confirm your advert(s) and method of payment as soon as possible.

Publishing:
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.



Answers to Carlton Technology Quiz 69:
1D, 2A, 3D, 4C, 5B, 6B, 7B, 8D, 9A, 10C

Word March: expertise | **Word Builder:** learn, renal

CALL FOR PAPERS

The VANZ conference is a place for learning and sharing

- Have you ever had an experience that you think others would benefit from?
- Something that went right or wrong?

We can all learn from our own experience, but we can avoid a lot of problems if we learn from other people too! That is what VANZ is all about. If you could talk for just 15 minutes (or longer if you like), please write to **papers@vanz.org.nz**

VANZ
VIBRATIONS ASSOCIATION of NEW ZEALAND

Your first choice for safe, combined detection of gas & refrigerant leaks: The new Testo 316 series

Be sure. testo

Whether it's for a small system or an industrial plant, Testo have the perfect solution for fast, reliable leak detection.

The new range of leak detectors covers all requirements and areas of application. The innovative **2-in-1 sensor in the Testo 316-2-EX** detects both gas and refrigerant, making your work even more efficient.

Connection to Testo Smart App

NEW!

The Testo 883 Thermal Imager for preventative & predictive maintenance.

A tool kit 'must-have' for maintenance staff, facility managers & building energy consultants who wish to rely on the best thermal image quality and features for their thermal measuring tasks.

SUPER RESOLUTION 4x MORE PIXELS
320 x 240
640 x 480

IR resolution and SuperResolution

Bluetooth to connect to other Testo smart devices

Manual focus & interchangeable telephoto lens

Become a qualified thermographer

Eurotec Category 1 Thermography Certification Courses.

- Auckland 7 - 11 November
- Christchurch 14 - 18 November

Secure your spot today!

EUROTEC 09 579 1990 sales@eurotec.co.nz www.eurotec.co.nz