

COMDEMTM 2010

**Advances in Maintenance and
Condition Diagnosis Technologies
towards Sustainable Society**

**Proceedings of the 23rd International Congress on
Condition Monitoring and Diagnostic Engineering Management
June 28–July 2, 2010, Nara, Japan**

Edited by
Susumu Okumura
Tadao Kawai
Peng Chen
Raj B. K. N. Rao

Organized by
The Society of Plant Engineers Japan

CONTENTS

A trailing asterisk in the title field of a paper denotes that it is a short paper.

Preface

Key Note

Design of Self Maintenance and Engineering Immune Systems for Smarter Machines and Manufacturing Systems	1
<i>J. Lee</i>	
Analysis of Damage Behavior of Rolling Bearing with New Measurement Technique by New Signal Processing	15
<i>K. Miya and K. Takase</i>	
Structure Adaptation Based Bionic Fault Self-Recovery System of Machine	27
<i>J. Gao and W. Wang</i>	

Workshop

Workshop 1: Safety Integrated Systems and Applications for Condition Monitoring and Diagnosis

Organisers:	
Prof. Dr.-Ing. habil. Josef Börcsök (University of Kassel, Germany)	
Dr. Michael H. Schwarz (University of Kassel, Germany)	
Influences of Attacks on Safety Related Systems	39
<i>J. Börcsök and E. Ugljesa</i>	
Calculation of Safety Parameters	49
<i>J. Börcsök</i>	
The Probability Distribution of Failure Rates and Diagnostic Coverage Factors	57
<i>H. D. Wacker, P. Holub and J. Börcsök</i>	
Different Aspects to be Considered for Safety Related Development	65
<i>M. H. Schwarz and J. Börcsök</i>	
Functional Safety IEC 61508 and Sector Standards for Machinery and Process Industry	73
The Impact to Certification and Users Including IEC 61508 2nd Edition	
<i>H. Gall and J. Iden</i>	

Workshop 2: Continual Improvement through Asset Condition Monitoring

Organisers:	
Prof. Gopi Chattopadhyay (CQUniversity, Australia)	
Dr. Aditya Parida (Luleå University of Technology, Sweden)	
Gap Analysis for Asset Condition Monitoring	83
<i>R. Egelstaff and G. Chattopadhyay</i>	
Performance Measures for Achieving Asset Productivity Improvement	89
<i>A. Parida, G. Chattopadhyay and U. Kumar</i>	
Work Integrated Blended Learning for Improvement by Asset Managers	95
<i>G. Chattopadhyay and A. Parida</i>	

Workshop 3: Artificial Intelligence in Designing Modern Decision Support Systems

Organisers:

Prof. Peter Funk (Malardalen University, Sweden)

Prof. Raj B. K. N. Rao (COMADEM International, UK)

Artificial Intelligence in Designing Modern Decision Support Systems	103
<i>B. K. N. Rao</i>	
Why We Need to Move to Intelligent and Experience Based Monitoring and Diagnostic Systems	111
<i>P. Funk and N. Xiong</i>	
Experiences from Designing Early Warning System to Detect Abnormal Behaviour in Medium-Sized Gas Turbines	117
<i>C. Karlsson, B. Larsson and A. Dahlquist</i>	

Workshop 4: Ocean Engineering Equipments for Condition Monitoring and Diagnosis

Organiser:

Prof. Shiming Wang (Shanghai Ocean University, China)

Condition Monitoring and Diagnostic Engineering Management on Ocean Engineering Vehicles	121
<i>S. Wang and A. Wu</i>	
On-Line Seawater Quality Monitoring System and Testing Analysis Method	131
<i>Z. Wu and Y. Zhang</i>	
Shift-Invariant Sparse Coding for Vibration Analysis with Application to Gearbox Diagnosis	135
<i>H. Liu, C. Liu, Y. Li, Z. Miao and H. Chen</i>	
Research on Fault Diagnosis Symptom Parameters of Rolling Bearing	145
<i>H. Chen, S. Wang, X. Liu and Y. Yin</i>	

Workshop 5: Condition Based Maintenance Technology for Nuclear Plants

Organisers:

Prof. Mitsuru Uesaka (the University of Tokyo, Japan)

Prof. Hiroshi Miyano (Hosei University, Japan)

Examination about the Advancement of Diagnose Technique by the Composition of Condition Monitoring Parameter (Part 1)	153
<i>M. Kawabata and Y. Sasaki</i>	
Application of 950 keV Portable X-Band Linac X-Ray Source to Condition Based Maintenance	159
<i>T. Yamamoto, A. Kahata, M. Kawabata, Y. Sasaki and M. Uesaka</i>	
Noncontact and Accurate Measurement of Pipe Wall Thinning by a Circumferential Lamb Wave Using a Pair of Air-Coupled Transducers	163
<i>H. Nishino, T. Asano, K. Yoshida, H. Ogawa, M. Takahashi and Y. Ogura</i>	
Defect Detection by Using Fiber-Optic Distributed Sensors in Welded Joints	169
<i>H. Murayama, D. Wada, N. Kanata, H. Igawa, K. Omichi and M. Azemoto</i>	
Evaluation of the Lifetime of Ball Bearings with an Outer Race Defect Using RMS	175
<i>S. Mawatari, K. Takase, M. Tsunokai, R. Kayata, S. Perrin and K. Miya</i>	

Sizing of Defects on the Outer Race of Ball Bearings	179
<i>S. Mawatari, K. Takase, M. Tsunokai, R. Kayata, S. Perrin and K. Miya</i>	
Condition Monitoring for Rotating Machine*	183
<i>T. Usani and F. Kojima</i>	
Prediction of Time-Series Data by Singular Spectral Analysis (SSA)*	187
<i>K. Demachi and A. Mizuguchi</i>	
Workshop 6: Research and Application on Monitoring and Diagnosis Technique for Manufacturing Equipments	
<hr/>	
Organisers:	
Dr. Bangxi Hu (Wuhan Iron & Steel Stock Co. Ltd., China)	
Prof. Lixin Gao (Beijing University of Technology, China)	
Prof. Huaqing Wang (Beijing University of Chemical Technology, China)	
Study and Application of Monitoring and Diagnosis Technique on Low-Speed and Heavy-Duty Equipments	191
<i>L. Gao, F. Zhai, Z. Yang and S. Su</i>	
Application of Support Vector Machine in Condition Diagnosis of Centrifugal Blower	199
<i>H. Wang, Y. Guo, H. Yuan, F. Wang, P. Chen and Z. Ren</i>	
Dynamic Analysis for Condition Diagnosis of Misalignment States of Gear Equipment	205
<i>I. Yamataka, P. Chen, M. Yamashita and T. Mitoma</i>	
Intelligent Diagnosis Method Based on Relative Ratio Symptom Parameters and Support Vector Machines for Rotating Machinery	211
<i>H. Xue, K. Li, J. Zhu and P. Chen</i>	
Condition Diagnosis Method of Rotating Machine Using Support Vector Machine and Symptom Parameters in Frequency Domain*	219
<i>T. Teraoka, H. Xue, K. Li and P. Chen</i>	
Tendency Prediction of Rotating Machinery Using Genetic Algorithm*	223
<i>Y. Koide, K. Kanamori, N. Satonaga and P. Chen</i>	
Extraction Method of Failure Signal for Condition Diagnosis of Rotating Machinery Using Genetic Algorithm*	227
<i>R. Ichiyonagi, H. Wang, T. Mitoma and P. Chen</i>	
Volume of the System Process Running at High Speed Wire Rod Mill Monitoring*	231
<i>D. Zhou, L. Sun, B. Hu, Y. Wang and L. Gao</i>	
Promote “Thousands of Points Being Controlled” Management Engineering The Pursuit of Equipment Maintenance Management Excellence*	235
<i>B. Hu, J. Zou, J. Chen, Y. Xiao and H. Ye</i>	
To Promote Integrated Management of Equipment to Break Through Practicing the Scientific Development Concept*	239
<i>S. Du and L. Gao</i>	
Research and Application of Equipment Monitoring and Diagnosing Technology on Bar & Wire Rolling Mill*	243
<i>G. Chi, G. Yu, J. Tong, L. Gao and H. Ye</i>	

Oral Session

Session 1: Damage Detection and Monitoring Technologies

Imaging of Defects in a Concrete Structure by Inverse Analysis of Nonstationary Thermal Images	249
<i>A. Masuda, S. Nishimura, T. Fuminoto and K. Suzuki</i>	
In-Service Diagnosis of Contact-Type Damages by Nonlinear Piezoelectric Impedance Modulation	257
<i>A. Masuda, J. Aoki, J. Sasahara, D. Iba and A. Sone</i>	
System for Condition Monitoring of Reciprocating Machines	265
<i>A. P. Naumenko and V. N. Kostyukov</i>	
Automotive Diagnostic and Monitoring Using Magnetism	273
<i>A. Le Goff, J. L. Lacoume, R. Blanpain, S. Dauvé and C. Servière</i>	
Detection of Inner Abnormality by the Frequency Modulation of Ultrasonic Wave	281
<i>T. Nakano, T. Inoue, T. Sugiyama and S. Yamanaka</i>	
A New Feature for Monitoring of Planetary Gear Sets Based on Physical Model	289
<i>Z. Cheng, N. Hu and G. Qin</i>	
Detection of Diesel Engine Injector Faults Using Acoustic Emissions	297
<i>F. Elamin, Y. Fan, F. Gu and A. Ball</i>	
A Basic Study on the Method for Detecting Step-Shaped Wear on Contact Strips	305
<i>Y. Yamashita, T. Usuda, M. Ikeda and K. Nakamura</i>	
The Development of the Condition Monitoring System for the Mine Hoist	313
<i>S. Fu and Y. Hu</i>	
Experimental Study on Rubbing Position Locating for Rotor-Bearing System Based on Rubbing Acoustic Emission	317
<i>Y. He and X. Yin</i>	
Cost-Effective Solution for Detection of Leaky Food Packaging Seals Using Innovative Non-Contact Testing	325
<i>G. R. Gibson, G. Chattopadhyay and D. Hargreaves</i>	
Extraction Method of Failure Component on Vibration and Acoustic Signals Generated by a Reciprocal Engine Based on Cross Correlation of Close Two Point Signals and Characteristic of Paralleled Auto Regressive Model with Extra Input	333
<i>H. Ohta and T. Aikawa</i>	
The Development of In-Situ Diagnostic Analysis for Motor Operated Valves	341
<i>S. Suzuki, S. Nakamura, S. Saishu, K. Okiguchi and O. Okada</i>	
Gear Fault Detection Using Transmission Error Measurements	347
<i>M. Taylor, M. Timusk and C. K. Mechefske</i>	
Acoustic Emissions Observed from a Naturally Degrading Slow Speed Bearing and Shaft	355
<i>M. Elforjani and D. Mba</i>	
Benefits and Capabilities of AE Technology: Defect Detection, On-Line and Condition Monitoring, Diagnostic and Prognostic Tools for the Process and Management of Maintenance in Industries	365
<i>S. Husin and R. I. R. Hamzah</i>	

An Integrated Flexible Platform for Development of Fault Detection Systems and Duty Cycle Simulation*	373
<i>M. Timusk, D. Crymble and J. McBain</i>	
Non Destructive Evaluation Method about the Texture of Puffers Meat on Its Response*	377
<i>H. Ohta, K. Sasada and M. Nakamura</i>	
Early Failure Detection and Diagnosis of High Speed Self Aligning Journal Bearing*	381
<i>P. Raharjo, F. Al Thobiani, F. Gu and A. Ball</i>	
A Novel Intelligent Health Monitoring System for Gear Fatigue Failure Prediction*	387
<i>A. Onsy, R. Bicker and B. A. Shaw</i>	
Session 2: Modeling, Analysis and Optimization	
<hr/>	
Identifying a Crack in a Cantilever Beam Based on the Determinant Transformation Method	393
<i>B. Li, X. Chen and Z. He</i>	
Nonlinear Dynamic Characteristic Analysis of a Vertical Mass Unbalanced Rotor	401
<i>X. An, D. Jiang, C. Liu and M. Zhao</i>	
Fault Diagnosis of Rotating Machinery Using Adaptive Ensemble Empirical Mode Decomposition Method	409
<i>Y. Zi, L. Chen, Z. He, Y. Lei and J. Yuan</i>	
Horizontal Vibration of a Structure Excited by Oscillators	417
<i>T. Nagamine, H. Mori, T. Motegi and Y. Sato</i>	
Optimization Design of Vibrating Centrifuge Equipment Based on Test FEM Simulation and Sensitivity Analysis	425
<i>T. Wang, M. Hu, J. Yue, Y. Jiang, L. Liu and Z. Qiao</i>	
Fatigue Life Numerical Simulation and Optimization Design of Brush Seal in Rotary Air Preheater	433
<i>M. Zhang, L. He, W. Wu and Y. Jiang</i>	
Study on Stress and Strain for Fatigue Cumulation Evaluation in Turbine Generator Shafts Due to Torsional Vibration	441
<i>D. Jiang, C. Liu, X. An and J. Chen</i>	
Nonlinear Vibration Analysis of a Frame Structure with Breathing Cracks	449
<i>K. Kamiya and H. Kawai</i>	
Analysis of the Causes of Register Errors in a Rotogravure Printing Press	457
<i>R. Basso, G. Fanti and P. Gottardelli</i>	
Tripod Vibration Effects on Photographic Image Quality	465
<i>G. Fanti and R. Basso</i>	
Experimental and Numerical Investigation on the Effect of Blade Number on Vibrations of Industrial Fans	473
<i>M. Behzad, A. Ebrahimi, S. N. Oskouie and H. Massoumi</i>	
Session 3: Diagnosis and Prognosis	
<hr/>	
A New Method to Predict Incipient Fault of Rotating Machinery	481
<i>Z. Jiang, Z. Wei and B. Ma</i>	

Research on Data-Based Nonlinear Fault Prediction Theory and Methods in Multi-Transform Domains for Electromechanical Equipment	489
<i>S. Wang, T. Chen and X. Xu</i>	
Fault Diagnosis of Rolling Element Bearings Based on Incremental Nonlinear Dimensionality Reduction	497
<i>Y. Zhang, G. Xu, L. Liang and J. Wang</i>	
Fault Diagnosis of Rolling Element Bearings Based on Cyclic Bispectrum	505
<i>Y. Zhou, J. Chen, G. Dong, W. Xiao and Z. Wang</i>	
Real-Time Multivariate Performance Degradation Assessment Based on a Cerebellar Model Articulation Controller	513
<i>C. Hua, G. Xu, Q. Zhang, J. Xie, Y. Zhang and M. Fu</i>	
Prediction of Tool Failure in Ceramic Grinding	521
<i>T. Inoue, T. Emura, K. Shimizu and S. Kunitomi</i>	
Rolling Bearing Fault Diagnosis Based on Spectral Kurtosis in Condition Monitoring	529
<i>F. Cong, J. Chen and G. Dong</i>	
Diagnostic Evaluation of Rolling and Lubricating Behavior in Ball Bearings by Ultrasonic Technique	537
<i>T. Wakabayashi, Z. Kawanoue and T. Ohi</i>	
Model-Based Diagnosis Approach of Vibratory Systems Considering Uncertainty of Mathematical Model	543
<i>S. Kawamura, J. Yamamoto and H. Minamoto</i>	
Development of a Multi-Function Fault Diagnosis Instrument Based on USBI and ZigBee	551
<i>Q. Liu, G. Yang, J. Deng and J. Gao</i>	
Reduction Gear Broken Teeth Diagnosis by the Induction Motor Instantaneous Power Analysis	559
<i>A. Q. Flores, A. J. M. Cardoso and J. B. Carvalho</i>	
Remaining Useful Life of Heat Exchanger Inlet Filters	567
<i>B. H. Nystad</i>	
Diagnosis of Air-Conditioner by SVM	575
<i>T. Kawai and S. Kushizaki</i>	
Recent Developed Techniques for Machine Health Prognostics	583
<i>B.-S. Yang and A. Widodo</i>	
Failure Diagnosis by Improved Mahalanobis-Taguchi System	591
<i>S. Okumura and N. Take</i>	
A Modeling Method of Complex Multi-Medium Interacted Process System Based on Polychromatic Sets for Fault Diagnosis and Safety Analysis	599
<i>X. Huang, J. Gao, F. Chen, Y. Lv and H. Jiang</i>	
Condition Diagnosis of Process Industry System with Topology Analysis Based on Complex Network	607
<i>H. Jiang, J. Gao, Z. Gao, Y. Lv and X. Huang</i>	
Designing Empirical Diagnostic Rules for Plant Start-Up Monitoring Using Synchronization of Data Trajectories*	615
<i>M. Tamura</i>	

Diagnosis without Sensors — Integration of External Data for Condition Monitoring of Railway Switches*	619
---	-----

Th. Böhm and C. Doegen

Strategies for Intelligent Tool Wear Prediction in a Machining Process*	623
--	-----

K. Patra, S. K. Pal and K. Bhattacharyya

Session 4: Sensor Technologies

Investigation of Wireless Sensor Deployed on a Rotating Shaft and Its Potential for Machinery Condition Monitoring	627
---	-----

L. Arebi, Y. Fan, F. Gu and A. Ball

Development of Method to Measure Vibrational Stress of Small-Bore Piping with Multiple Contactless Displacement Sensors	637
--	-----

A. Maekawa and M. Noda

On-Line Monitoring of Freight Train Bearing Using Wireless Sensor Networks	645
---	-----

C. Huang, Q. Ma, Q. Meng and H. Wang

Structural Optimization of Micro-Power Piezoelectric Generator	653
---	-----

H. Wang, Q. Meng, Q. Ma and C. Huang

Research on Method of Fault Diagnosis Based on Acoustic Image Pattern Recognizing Technology	661
---	-----

W. Jiang and J. Hou

Photonic Sensors for Autonomous Wireless Sensing Nodes	669
---	-----

C. Riziotis, D. Dimas, S. Katsikas and A.C. Boucouvalas

Thick Film, Acoustic Emission Sensors for Embedded Structural Health Monitoring Systems	677
--	-----

A. J. Pickwell, R. A. Dorey and D. Mba

Position Monitoring Sensor by Using Rotating Magnetic Field*	685
---	-----

Md. T. I. Khan, K. Teramoto and H. Ohta

Session 5: Tribology

Model Testing of the Particle Contamination in Hydraulic Systems	687
---	-----

Y. Kamizuru, R. von Dombrowski, T. Verkoyen, K. Warlick and H. Murrenhoff

The Influence of Manganese Contents on Microstructure and Abrasive Wear Characteristic in Fe-5.1Cr-0.6C-0.5Si Hard-Facing Alloys	695
---	-----

C. Lin, C. Chang, J. Chen and W. Wu

Primary Study of Tool Effective Speed Those Affected to Formability of SS400 Steel in Incremental Forming Process*	703
---	-----

K. Rattanachan and C. Chungchoo

Centrifiltergram: A New Approach for Wear Debris Separation*	707
---	-----

S. Raadni

Tribotronics: An Active Approach to the Condition Monitoring of Tribological Components in Wind Turbines*	711
--	-----

S. Glavatskih and I. Sherrington

Used Grease Monitoring of Large Slewing Bearing in Port Machinery*	715
---	-----

X. Bai, H. Xiao, X. Yan and X. Zhou

A New Approach to Evaluate Wear on Automotive Leaf Spring Suspension Bushes*	719
<i>Raghvendra G and S. Dasari</i>	
A Method for Rapidly Quantifying Filter Patch Wear Debris*	723
<i>A. Becker</i>	
Session 6: Advanced Signal Processing and Data Fusion	
<hr/>	
Bistable Signal Recovery and Parameter Tuning	727
<i>W. Ding, Y. Leng, S. Fan and L. Huang</i>	
Data, Information, Knowledge and Decision-Making in Condition Monitoring	735
<i>M. Singh, T. Fosselie and F. Wiggen</i>	
Application of Multi-Sensor Data Acquisition and Fourier Transform in Separation of Vibration Sources	743
<i>A. Mahwash and A. A. Lakis</i>	
The Mathematic Principle of Inner Product Transform for Mechanical Fault Diagnosis	751
<i>Z. He, Y. Zi and J. Yuan</i>	
Regression Rules Extraction from Neural Network Based on Piecewise Linear Function Intelligent Insertion	759
<i>J. Wang, W. Zhang, W. Shi and B. Qin</i>	
Feature Selection, Detection, Extraction and Classification Technology in COMADEM: A Tutorial	767
<i>B. K. N. Rao</i>	
An Approach for Exploratory Analysis of Repetitive Waveforms in Sensory Time-Series Data	777
<i>H. Mizuyama</i>	
Application Research of Fractal Information Fusion on Condition Recognition in Process Industry Complex Systems	785
<i>Y. Lui, J. Gao, Z. Gao, X. Huang and H. Jiang</i>	
A Visualization System for Failure Information Using Learning Semantic Network*	793
<i>H. Yachiku, H. Konishi, T. Ohnishi and A. Nakajima</i>	
A Fault Diagnosis Approach for Rolling Bearing Based on Ensemble Empirical Mode Decomposition*	797
<i>P. Tse and W. Guo</i>	
Extraction of Transient Signals of Bearing Based on Blind Deconvolution by Acoustical Analysis*	801
<i>Y. Wang, X. Wu, Y. Chi, C. Liu and X. Liu</i>	
Session 7: Maintenance Engineering, Technologies and Integrated Systems	
<hr/>	
IT Procurement within Maintenance: Survey Results	805
<i>M. Kans</i>	
E-Maintenance & Integrated Maintenance Solution	813
<i>A. Malik and M. Kidd</i>	
Integrating Quality and Maintenance Development — Opportunities and Implications	821
<i>M. Bengtsson, A. Fundin, M. Deleryd, A. Salonen, E. Olsson, P. Funk, C. Andersson and H. Qureshi</i>	

Condition Monitoring in the Management of USW	829
<i>A. Abreu, A. Jorge, F. Didelet, L. Esteves, A. Magrinho, M. Marques and L. Varela</i>	
Cost-Effectiveness and Optimization in Condition Based Maintenance Strategies	835
<i>E. Conde, S. Fernandez and A. Arnaiz</i>	
Computerised Maintenance Decision Support System (MDSS) for Simulating and Selecting the Most Cost-Effective Production and Maintenance Solution: Case Study in FIAT/CRF, Italy	843
<i>B. Al-Najjar</i>	
RAMS Parameters as KPI Rotating Machinery Maintenance	851
<i>D. Galar, L. Berges and J. Royo</i>	
Development of Laser Peening Technology for Nuclear Power Reactors*	859
<i>I. Chida, T. Uehara, M. Yoda, H. Miyasaka and H. Kato</i>	
Session 8: Risk, Safety Assessment and Plant Design	
<hr/>	
Monte Carlo Risk Assessment for Journal Bearing	863
<i>Z. Zhang, Y. Zhang, Y. Zhu and X. Wang</i>	
Safety of Workers during Maintenance of Machines, Equipment and Processes: A Canadian Perspective	871
<i>Y. Chinniah</i>	
Determination of Risks to Manufacturer and Buyers for Lifetime Warranty Policies by Considering Uncertainties of Lifetime	879
<i>A. Rahman and G. Chatopadhyay</i>	
Design for Performance: Review of Current Research in Norway	887
<i>T. Murkeset</i>	
Design of Mixed-Product Line Production System by Multi-Objective Genetic Algorithm	897
<i>R. Hwang and H. Katayama</i>	
Technological Classification of Visual Management for Its Enhancement: An Application in Chemical Plant	905
<i>K. Murata, F. Suzuki, Y. Honda and H. Katayama</i>	
Reinforcement of Performance Competitiveness by Concurrent Strategy	913
<i>K. Yamauchi, K. Murata and H. Katayama</i>	