

Vibration Analysis Excellence

Establish Expert Systems for Automated Machinery Condition Assessment to Increase Cost Savings and Enhance Equipment Performance

Crowne Plaza Mutiara Kuala Lumpur, Malaysia • 27th – 29th July 2009



Course Facilitators:

Dr. Robert Badgley
Owner
Emcon Systems

Hear What Other People Said About Dr. Badgley

- ◆ *'Very good, balanced course for petrochem engineers'*
– Texaco Inc.
- ◆ *'Case studies related well to my machinery problems'*
– M.W. Kellogg
- ◆ *'Analysis methods and techniques were helpful in understanding my motor and pump problems'*
– Dow Chemical

Capitalize On The Expert Knowledge To Gain Maximum Value On These Vital Issues

- ❖ **OBTAIN** practical and stronger knowledge about vibration analysis and control
- ❖ **ESTABLISH** effective expert systems for automated machinery condition assessments
- ❖ **IDENTIFY** various symptoms of vibration and RECTIFY machinery fault
- ❖ **LEARN** how to deal with relatively large amount of vibration data from different kinds of machinery
- ❖ **UTILIZE** symptom-fault matrix to identify detailed monitoring routes
- ❖ **GARNER** knowledge about vibration alert and alarm limit
- ❖ **APPLY** expert systems on plant environment for vibration data reduction and analysis
- ❖ **BUILD** systematic thinking and operating process to identify root cause of vibration problems and minimize it

UNI training courses are thoroughly researched and carefully structured to provide practical and exclusive training applicable to your organization.

Benefits include:

- Thorough and customized programmes to address current market concerns
- Illustrations of real life case studies
- Comprehensive course documentation
- Strictly limited numbers

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Workshop Overview

For industry like power generation, petrochemical and other processing industries, vibration analysis has been the technique of choice for monitoring the condition of large, critical pieces of rotating equipment and has proven economic benefits. Great savings are realized by improving the performance of the machines so that they can last longer, require less downtime, consume less power and improve plant productivity.

In this three-day masterclass, you will learn practical methods to assess machinery condition, identify and correct root causes of problems and manage large amount of vibration information. Dr. Robert Badgley, one of the leading expert in vibration analysis, will present to you specific tools and methods to measure, interpret and model machinery vibration. Dr. Badgley will also provide recommendation for expert system application in plant environments. All vibration concepts are presented with a practical approach in mind. The learning will be accentuated through discussion of case studies and industry best practices.

Facilitated discussion and hands-on exercises will allow you to share your challenges and opinion. Delegates can immediately apply the knowledge gained from the workshop to improve and analyze the mechanical condition of rotating equipments. After this course, you will depart with a set of more advanced tools to improve your machinery performance and bring last changes to your organization.

DAY 1 / 27th July 2009

PART 1 – INTRODUCTION

- ❖ Course objectives
- ❖ Description of course content by part
- ❖ Basic terminology

PART 2 – ROTOR BEARING SYSTEM DYNAMICS

- ❖ Spring and damping coefficients
- ❖ Rotor response analysis
- ❖ Rotor dynamics for a typical machin

PART 3 – ROTOR RESPONSE TO VARIOUS FORCES

- ❖ Types of forces
- ❖ Response to unbalance
- ❖ Response to other forces

PART 4 – ROTOR BEARING SYSTEM INSTABILITY

- ❖ Dynamic instability in rigid-body systems
- ❖ Complicating factors
- ❖ Control of rotor instability

PART 5 – ROTOR AND SHAFT BALANCING

- ❖ Balancing of rotors and shafts
- ❖ Single plane balancing
- ❖ Balancing in a commercial balancing machine
- ❖ In-place rotor and shaft balancing

DAY 2 / 28th July 2009

PART 6 – TORSIONAL VIBRATION

- ❖ Modeling
- ❖ Sources of torsional excitation
- ❖ Transient response
- ❖ Damping
- ❖ Interpretation of analysis

PART 7 – VIBRATION ANALYSIS

- ❖ Analytical methods for calculating vibration amplitudes
- ❖ Troubleshooting analysis
- ❖ Diagnostic procedures
- ❖ Machinery faults and vibration frequencies
- ❖ Vibration at running speed
- ❖ Shaft surface defects and proximity probe readings
- ❖ Vibration analysis
- ❖ Vibration amplitude jump phenomenon
- ❖ Beating of two adjacent frequencies
- ❖ Harmonics
- ❖ Subsynchronous vibration
- ❖ Modulation
- ❖ Vibration of ball and roller bearings

PART 8 – VIBRATION DATA INTERPRETATION AND PROBLEM SOLVING

- ❖ Acquiring data to define the problem
- ❖ Long-term history of machine
- ❖ Field measurement data acquisition
- ❖ Field measurement data assessment
- ❖ Field measurement data interpretation

DAY 3 / 29th July 2009

PART 9 – SYSTEM APPROACH FOR LARGE SCALE MONITORING

- ❖ Tabulated list of vibration frequencies which may be present in operating machinery
- ❖ Tabulated list of machinery faults which may be present in operating machinery
- ❖ Relationships between vibration frequencies and machinery faults

PART 10 – SETTING UP THE KNOWLEDGE BASE FOR EACH MACHINE TO BE MONITORED

- ❖ Preparation of Symptom-Fault Matrix
- ❖ Selection of vibration frequency types for monitoring
- ❖ Specification of fault identification annunciations

PART 11 – SETTING VIBRATION ALERT AND ALARM LIMITS FOR EACH INDIVIDUAL FREQUENCY TO BE MONITORED

- ❖ Assessment of machine ruggedness
- ❖ Limit setting by convention for new machines
- ❖ Limit setting by measurement data for known machines

PART 12 – APPLICATION OF EXPERT SYSTEMS WITH MEASURED SPEED INPUTS

- ❖ Selection of measurement sensor mount points on each machine
- ❖ Installation of sensor mount blocks on each machine
- ❖ Speed measurement
- ❖ Grouping of machines by convenient groups or routes (manual data)
- ❖ Acquisition and evaluation of data

SIMULATION, EXERCISES AND CASE STUDIES

There will be simulation of setting up and preparing to operate a vibration expert system during Part 9 - 12. Dr. Badgley will also present to delegates several case studies and exercises, e.g. identifying vibration sources and faults in different sizes of machines, preparing detailed symptom-fault matrices and planning to set up and operate vibration expert systems in typical plant environments.

ABOUT YOUR COURSE FACILITATOR

Dr. Robert Badgley is owner of **Emcon Systems**, which offers a range of professional technical consulting services (motor vibration analysis, vibration failure analysis, vibration control, vibration monitoring, root cause failure analysis, vibration damping, vibration testing and predictive maintenance) for machinery of many types and sizes (compressors, turbines, bearings, generators, marine equipment etc.)

At Emcon Systems, Dr. Badgley currently provides expert technical consulting services and training to a range of firms at US and international locations. The focal point of Dr. Badgley's services is forensic engineering, directed at understanding and resolving machinery failure problems, sometimes catastrophic, in various types of plant machinery, including fans, blowers, motors, generators, compressors and turbines

When Dr. Badgley was at Mechanical Technology Inc., over a 15-year period, he has presented Advanced Vibration Analysis course to over 1,500 engineers on a worldwide basis. All major US companies, including **Mobil, Shell, Exxon, Texaco**, etc. Others come from Canada, Venezuela and Japan. Before he formed Emcon Systems, he also served as Executive Vice President of Dynamic Science Inc. and Director of Engineering at TECO-Westinghouse Motor Company.

With over 40 years of experience, Dr. Badgley has built up a wealth of practical experience with organizations throughout the world. He has undertaken successful projects in Canada, Europe, the Middle East, and Asia, as well as extensively in the US. His partial client list includes:

- ✓ **ExxonMobil**
- ✓ **ChevronTexaco**
- ✓ **BP**
- ✓ **Syncrude**
- ✓ **Suncor**
- ✓ **Global Sunta Fe**
- ✓ **Pemex**
- ✓ **ARCO Dubai**
- ✓ **PetroCanada**
- ✓ **ADMA-OPCO**
- ✓ **General Electrics**
- ✓ **Rolls Royce Inc.**
- ✓ **Seagate Technology**
- ✓ **Singapore Air Force**
- ✓ **US Army**

Dr. Badgley is registered as a Professional Engineer in the State of New York, and is a Life member of the American Society of Mechanical Engineers. He has authored or co-authored 43 technical publications. He received the Master of Science degree in Nuclear Engineering from Massachusetts Institute of Technology and Ph.D. in Mechanical Engineering from Cornell University.

WHO SHOULD ATTEND

This training program is uniquely designed to provide valuable insight for:

- ✓ Head of Maintenance or Operations
- ✓ Rotating Equipment Engineers
- ✓ Reliability Engineers
- ✓ Instrumentation and Control Engineers
- ✓ Vibration Monitoring Engineers
- ✓ Mechanical Engineers
- ✓ Equipment Specialists
- ✓ Technical Managers/Engineers
- ✓ Process Engineers
- ✓ Production Engineers
- ✓ Project Engineers
- ✓ Plant Engineers
- ✓ Lubrication Managers
- ✓ Facilities Managers

WHY YOU SHOULD ATTEND

This is a highly impactful workshop to provide you with a solid and comprehensive understanding of vibration analysis as a tool for quickly identifying and correcting the root causes of machinery problems, achieving precise tolerance and improving machinery performance beyond what is expected for a new machine. Dr. Badgley will share with you some advanced knowledge and solutions for problems resulting from unbalance, misalignment and many other machinery defects. He will also share with you how to utilize symptom-fault matrix to determine detailed monitoring routes or arrange complete non-wired monitoring area systems. This is a course developed based on proven methodology and Dr. Badgley's over 40 years of experience in vibration. Through a series of practical illustrations and real life case studies, you will return with a whole new set of perspective and practical tools.

PRE-COURSE QUESTIONNAIRE

To ensure that you gain maximum value from this course, a detailed questionnaire will be forwarded to you upon registration to establish your exact training needs and issues of concern. Your completed questionnaire will be analysed by the course trainer prior to the event and addressed during the event. You will receive a comprehensive set of course documentation to enable you to digest the subject matter in your own time.

Program Schedule

(Day 1 - Day 3)

08:30	Registration
09:00	Morning Session Begins
10:40 - 11:00	Refreshments & Networking Break
12:45	Luncheon
14:00	Afternoon Session begins
15:30 - 15:50	Refreshments & Networking Break
17:00	Course Ends