4-DAY SEMINAR: October 10-13, 2022 in Cologne, Germany

ROTOR DYNAMICS & BEARINGS TECHNOLOGIES
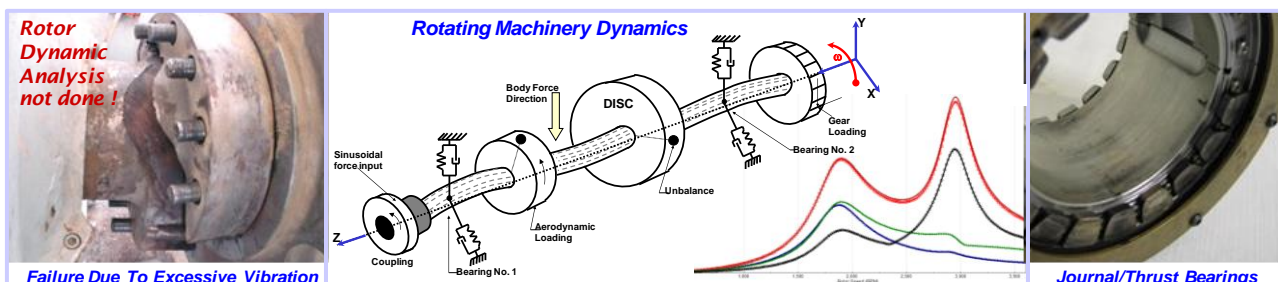## Lateral & Torsional Vibration Analysis / Fluid-Film Bearings
Basics & Theory / Practical Applications & Case Studies

A 4-day seminar and workshop for engineers and technical managers involved in **ROTATING MACHINERY** design, operation, maintenance, diagnosis, and troubleshooting. The seminar focus is on machinery **rotor dynamics**, drive train **torsional vibrations**, as well as the **bearing systems** (*fluid-film*) that support, guide, and locate the rotating assembly. Detailed coverage of the field of fluid-film bearings, rotor dynamics and torsional vibration includes the presentation of case histories and the application of advanced software for modeling, analyses, and troubleshooting real life bearing systems and vibration problems encountered in rotating equipment. No previous experience is required.

1st Day:	**Oct 10, 2022**	*Seminar* **"FLUID-FILM BEARINGS"** (Technology & Applications)
2nd Day:	**Oct 11, 2022**	*Seminar* **"ROTOR DYNAMICS"** (<u>Part 1</u>: Basics & Technology)
3rd Day:	**Oct 12, 2022**	*Seminar* **"ROTOR DYNAMICS"** (<u>Part 2</u>: Applications & Case Studies)
4th Day:	**Oct 13, 2022**	<u>*Parallel Sessions:*</u> *Seminar* **"TORSIONAL VIBRATIONS"** (Basics & Applications) *Workshop* **"ARMD SOFTWARE APPLICATIONS"**

<u>*VENUE:*</u>	**LEONARDO HOTEL KÖLN, Cologne, Germany**

Failure Due To Excessive Vibration — *Rotating Machinery Dynamics* — *Journal/Thrust Bearings*

Sponsored by:

Laschet Consulting GmbH
Friedrich-Ebert-Str. 75, 51429 Bergisch Gladbach, GERMANY

Ph:	+49 2204 84-2630	E-mail:	info@laschet.com
Fax:	+49 2204 84-2639	Internet:	www.laschet.com

Online Registration:
www.laschet.com

Presented by:

RBTS, Inc.
Rotor Bearing Technology & Software, Inc.
1041 West Bridge Street, Phoenixville, PA 19460, U.S.A.
Internet: www.rbts.com

About the Course

The complete course is presented in ENGLISH language by **Victor Obeid** (*RBTS, Inc.* / USA) and designed for engineers and technical managers who are involved in rotating machinery design, operation, maintenance, diagnosis, and trouble shooting, with emphasis on machinery rotor dynamics (analysis of lateral vibrations), drive train torsional vibrations and bearing systems that support, guide, and locate the rotating assembly.

The course is designed to introduce the theory and practice of vibration analysis in rotating machinery ("**Rotor Dynamics**") from fundamental principles through present state-of-the-art analytical methodology for the solution of common, as well as, unique machinery vibration problems (for example in couplings, gears, or cracks in rotors). The discussion of special and advanced topics is planned as well.

Design consideration and application of fluid-film bearings will be discussed along with a presentation of practical examples and case histories.

The interacting influence of bearings on the dynamic behavior (rotor dynamics) of machinery will be reviewed and illustrated by the construction of analytical models, and evaluated by PC-implemented computerized solutions. Participants are encouraged to present problems to be discussed. Extended engineering studies can be offered separately by a special quote. Informal technical sessions and workshops are intended to provide participants with adequate time to describe problems they have encountered in **BEARING SYSTEMS**, **ROTOR DYNAMICS**, and **TORSIONAL VIBRATIONS.**

Computers and computer software will be available at the course for problem-solving, and for the application of state-of-the-art computer-aided engineering of bearings and rotor dynamics. Participants will have access to the latest release of the "*Advanced Rotating Machinery Dynamics*" software package **ARMD™** - *RBTS'* popular engineering software. At the end of every day an optional software presentation approx. between 17:00 and 17:30 is planned upon request. This seminar is NOT an ARMD user training but a **TECHNOLOGY TRANSFER** and is therefore dedicated to **all engineers interested in the dynamics of rotating machinery** – independent of the software use.

The course can be booked as a whole, but also separately for every section. You may use **LASCHET's ONLINE REGISTRATION** form that is available at *LASCHET's* special web site www.laschet.com/en/seminars/ in *English (and German) language*. Having registered you will receive a confirmation and also the invoice from *LASCHET* as soon as possible. It is up to you to register your accommodation at the *Leonardo Hotel (Please mention "LASCHET" to receive the special conditions!)*.

If there are any questions, please do not hesitate to contact **Dr. Andreas Laschet** directly (Ph: +49 2204 84-2630, E-mail: info@laschet.com).

Note: The program (subjects / schedule) may change according to customer's wishes. Visit *LASCHET's* web site for any updates: www.laschet.com/en/seminars/.

Radial forces Acting on Pump Rotor
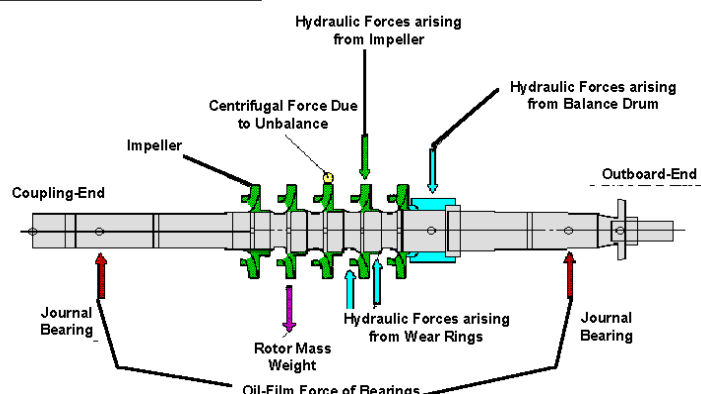
Day 1 - FLUID-FILM BEARINGS

1st Day: October 10, 2022   **MONDAY**   **09:00 – 17:00**
(~ 17:00-17:30 ARMD demonstration – as an option)

◆ This session is presented in a simple way to understand the technology of **sliding surface bearings** so that participants with or without previous knowledge benefit from the presentation and can apply it immediately in their profession. It is an introduction to BEARINGS, the vital tribological elements of rotating machinery that support, guide, and locate the rotating assembly beginning with their fundamental principles of operation through computer-implemented evaluations of their operational performance characteristics and limitations. Design considerations and applications of sliding surface and rolling element bearings with emphasis on HYDRODYNAMICALLY lubricated fluid-film bearings will be discussed along with presentations of practical examples and case histories.

INTRODUCTION TO BEARINGS
➢ Functional Roll
➢ The Two Primary Classes
➢ Noteworthy Differences between
  the Two Classes of Bearings

SLIDING SURFACE BEARINGS
➢ Fundamentals
➢ Types and Definitions
➢ Load Support Mechanisms
➢ Modes of Lubrication
➢ Frictional Response Characteristics
➢ Terms and Concepts of Hydrodynamic
  Lubrication and its Requirements
➢ Terms and Concepts of Hydrostatic-Hybrid
  Lubrication and its Requirements
➢ Lubricant Temperature/Viscosity Dependent Properties and Heat Balance Effects
➢ Turbomachinery Hydrodynamic Bearing Types, Performance, and Dynamic Characteristics
➢ Oil Whirl / Whip
➢ Advantages / Disadvantages
➢ Costs

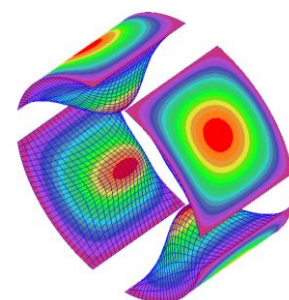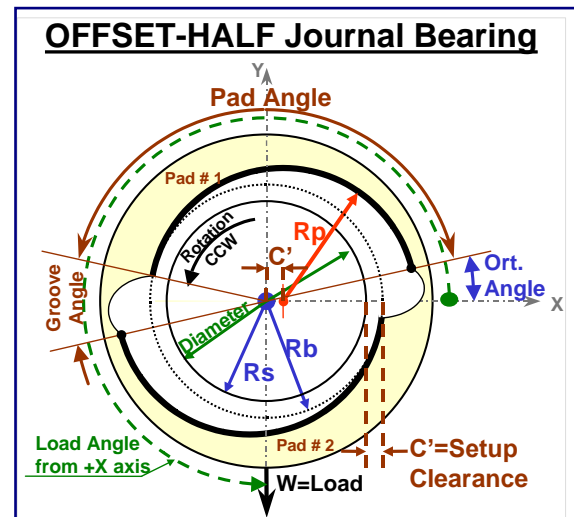## FLUID-FILM BEARING TYPES AND APPLICATIONS
➢ Fixed & Tilting Pad Geometries
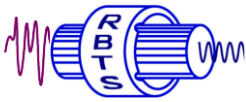➢ Journal, Thrust & Conical

BEARINGS STATE-OF-THE-ART TECHNOLOGY
➢ Advanced Technology Presentation & Demonstration
➢ Summary of Course Content
  and Application of Bearings Technologies

WORKSHOP & TRAINING
➢ Participants' Systems
➢ Group Discussion

OFFSET-HALF Journal Bearing

Day 2 & 3 - ROTOR DYNAMICS

2nd Day: October 11, 2022   **TUESDAY**   09:00 – 17:00   **Part 1: Basics**

3rd Day: October 12, 2022   **WEDNESDAY** 09:00 – 17:00   **Part 2: Applications**
*(~ 17:00-17:30 ARMD demonstration – as an option)*

◆ This session is presented in a simple way to understand the "**ROTOR DYNAMICS**" technology so that participants with or without previous knowledge benefit from the presentation and can apply it immediately in their profession. Commonly used terminology in the industry such as critical speed, mode shapes (rigid body and bending), stability, bearing whirl/whip, phase angle, critical damping, gyroscopic effects, unbalance, API-amplification factors & required separation margins, etc. will be discussed and illustrated throughout the course by the presentation of practical examples and case histories. The course handout includes sufficient details to be used as a reference including a tutorial section on rotor dynamic fundamentals and terminology. The next day covers subjects on advanced applications in rotor dynamics and lateral vibrations.

INTRODUCTION & OVERVIEW
includes the presentation of real life vibration problems and cost/time effective corrective actions taken as a solution

ROTOR DYNAMICS INTRODUCTION & APPLICATION

➢ **Basics** of Machinery Vibrations

➢ **Response & Shaft Dynamics** – Displacement, Velocity, Acceleration, Amplitude & Phase

➢ **Forces in Rotating Machinery**, Bearings, Cavitation, Imbalance, Hydraulic, Aerodynamic

➢ **Basics & Application** of Rotor Dynamics

➢ **Shaft Dynamics & Response** Controlling Mechanisms and Balancing

➢ **Modeling**: Shafting, Disks (Impellers, Couplings, Thrust Collars, Blades, Balanced Pistons, etc.), Bearings (Fluid-Film & Rolling Element), Seals (Wear-Rings, Labyrinth), Housing/Pedestal, Aerodynamic, Steam Whirl, Hydraulic Effects, External Excitations, Gyroscopic Effects

➢ **Analysis**: Damped & Undamped Rotor Stability, Natural Frequencies, Mode Shapes, Stability & Critical Speed Maps, and Responses
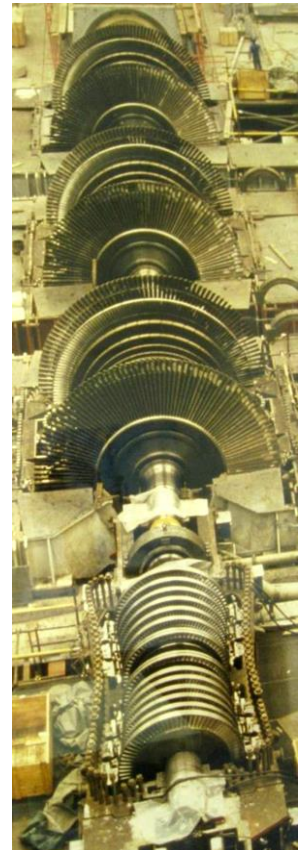
ROTOR DYNAMICS – ADVANCED

➢ **Synchronous** Steady-State Response.

➢ **Non-Synchronous** Time-Transient Response.

➢ **Balancing** Grades & Guidelines.

➢ **API Standards & Guidelines** – Amplification Factor, Critical Response Envelope. Required Separation Margins for Operation Below & Above Critical Speed, Shaft Vibration Orbit Properties.
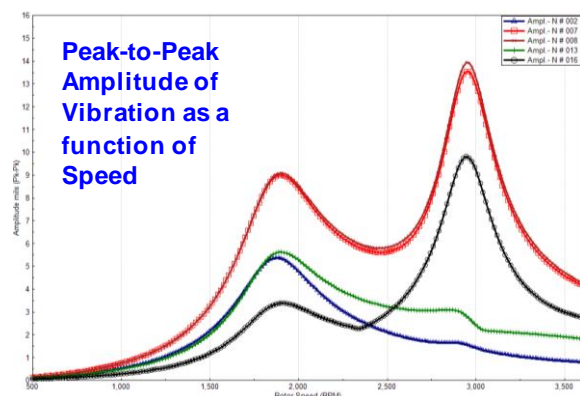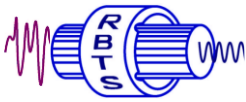
Peak-to-Peak Amplitude of Vibration as a function of Speed

ROTOR DYNAMICS DETAILED CASE HISTORY

➢ **Step-by-Step Rotor-Bearing System Modeling**, Analysis, and Problem Solution by the Introduction of Rotor Dynamics Software and its Application to a Rotor-Bearing System

➢ **Bearing Interaction** with the Rotating Assembly, Oil-Whirl/Whip Phenomena, Rotor-Bearing Response, and Stability Illustrations

➢ *Brief Section on* **Torsional Modeling and Analysis** of Drive Trains illustrated by Presentation and Solution of Problems associated with Synchronous/Induction Motor Startup Transients and Reciprocating Equipment Steady-State Operation
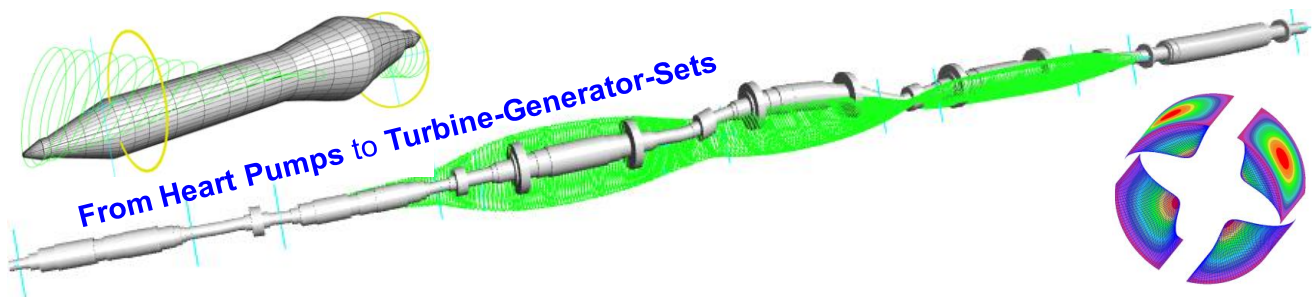
Coupling-End Bearing at Instability Threshold

STATE-OF-THE-ART TECHNOLOGY PRESENTATION & DEMONSTRATION

➢ Advanced Technology Presentation, Demonstration

➢ Summary of Course Content and Application of Rotating Machinery Dynamics Technologies
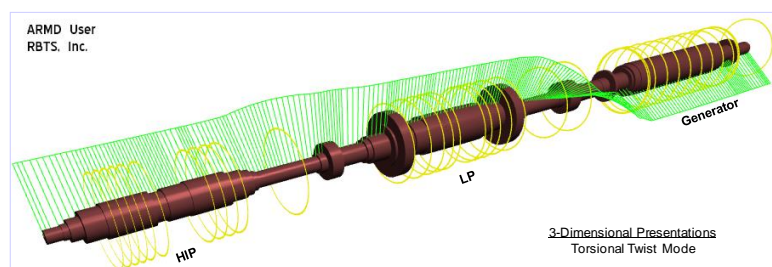

WORKSHOP & TRAINING

➢ Participants' Systems & Discussing Problems in the Group

Application of Rotor Dynamic Technology to Wide Spectrum of Rotating Machinery.

From Heart Pumps to Turbine-Generator-Sets

◆ During the session, numerous real life case histories will be presented to illustrate the technology and its application to rotating machinery failure analysis and troubleshooting of common, as well as, unique vibration problems.
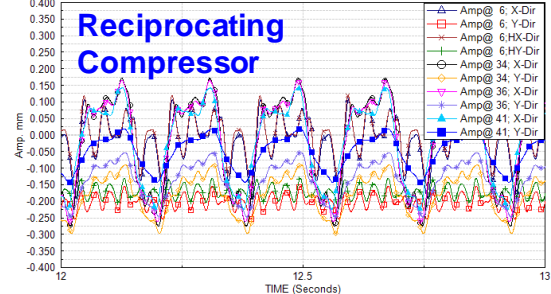
◆ Attendees who are interested in more details concerning the extensive and elaborate analysis of **TORSIONAL VIBRATIONS** in complete drivelines should also book the extra special seminar on the **4th day (Thursday)**.

Day 4 – Special Seminar
TORSIONAL VIBRATIONS

**4th Day: October 13, 2022   THURSDAY   09:00 – 16:00**
(~ 16:00-16:30 ARMD demonstration – as an option)

◆ This is a special seminar and will give interested participants more depth into the basics on **TORSIONAL VIBRATIONS** including case studies and applications in rotating machinery (on request: also on vehicle drivelines) supported by computer simulation methods. This session will be presented by *Dr. Andreas Laschet* (*Laschet Consulting GmbH*, Germany). This course is recommended as additional session of the previous days. The following subjects are covered:

MODEL GENERATION

➢ Introduction & Problem Description
➢ Getting the "Right" Parameters
➢ Model Structures of Complete Drivelines (including Motors, Engines, Couplings, Gears, Universal Shafts)
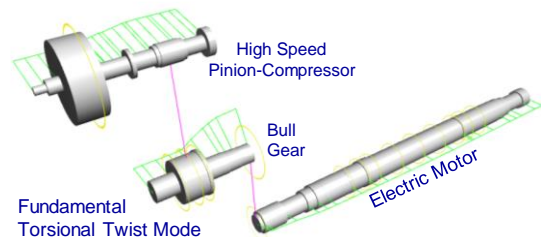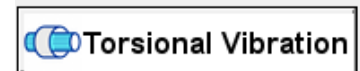
ANALYSIS OF EXCITABILITY

➢ Natural Frequencies
➢ Modes and Interpretation of System Sensitivity, Model Refinement
➢ CAMPBELL Diagram & Discussing the Relevant Excitations

SIMULATION METHODS

➢ Simulation in the Time Domain
➢ Simulation in the Frequency Domain (Steady-State)
➢ Analysis of the System Response & Discussing Case Studies
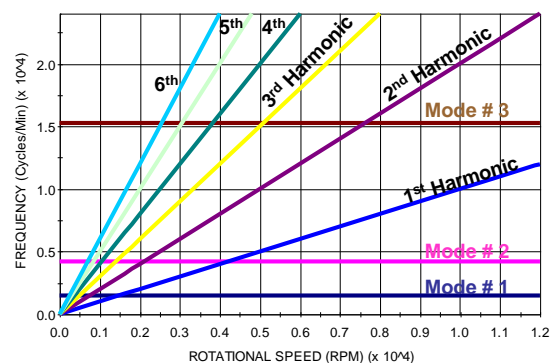
SYSTEM EVALUATION

➢ Evaluation Methods & Sensitivity Analysis Methods
➢ Correlation with Measurements
➢ Identification of Dynamic Effects & Machine Diagnosis
➢ Planning Further Steps towards System Optimization

APPLICATIONS

➢ TVA (Torsional Vibration Analysis) of a Total Drive System
➢ Drivelines with Reciprocating Engines & Reciprocating Compressors
➢ Electrical Effects (due to Motor Start-Up, Short Circuits, Synchronous Motor Dynamics, etc.)
➢ Non-linear System Behavior, Influence of Non-linear Effects (like Gear Dynamics, Friction Hystereses, Rubber Influence in Flexible Couplings, Backlash & Impacts, etc.)
➢ Presentation of Computer Results
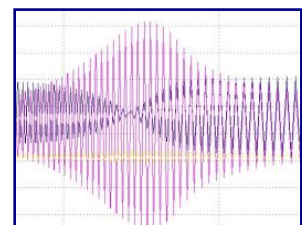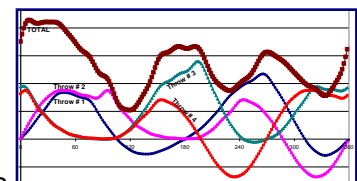
Note: It is planned that in the afternoon the participants of the rotordynamic workshop (see the description of this parallel session on *Page 7*) will/could join this course in order to discuss some typical examples presented by *Victor Obeid*. This is just an option and will be done on agreement with the participants.
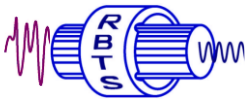
Day 4 – Workshop
Rotordynamic Software Applications

4th Day: October 13, 2022   THURSDAY   09:00 – 16:00

◆ This workshop is planned for participants who are interested in the detailed modeling and analysis of rotor bearing systems and their interactions utilizing the **ARMD Software**. Participants can bring their own rotating machinery problems to be presented and discussed in an open session, watch a problem developed and solved (as far as possible), or use the software and create their own models and perform the analysis of their interest. Time will be allocated to discuss FAQs and some details of the ARMD soft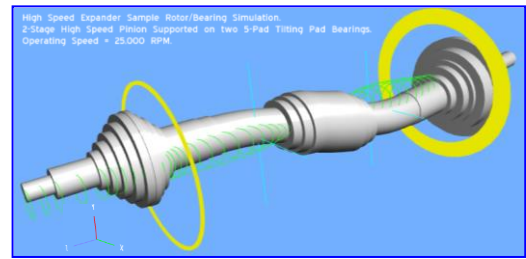ware, which has been used to solve the seminar sample problems. This workshop will be presented by *Victor Obeid* (*RBTS*, USA). Possible subjects:

MODEL GENERATION
➢ Introduction & Problem Description
➢ Getting the "Right" Parameters
➢ Dividing the Rotating Machine into Components for Modeling and Integration
➢ Verification of Constructed Models

ROTOR/BEARING SIMULATION
➢ Deflection & Load Calculations
➢ Bearing Performance and the Generation of Dynamic Coefficients (Stiffness and Damping)
➢ System Natural Frequency, Mode Shapes and Stability Calculations
➢ Critical Speed Map Generation
➢ Stability Map (CAMPBELL Diagram)
➢ Synchronous Unbalance Response
➢ Non-Synchronous Time Transient Response
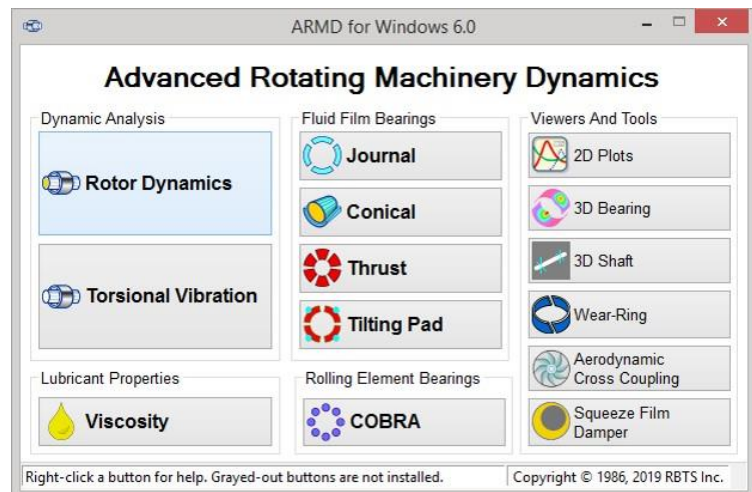
INTERPRETATION OF RESULTS
➢ Acceptable Bearing Performance
➢ Rotating Machinery Dynamic Performance and Cost Effective Corrective Action
➢ Comparison/Correlation of Calculated & Measured Machinery Dynamic Performance

APPLICATIONS
➢ Participants' Problems
  (if available early before the seminar starts)
➢ Group/Instructor Sample Problem

DISCUSSING SPECIAL "TVA" STUDIES
(as an option, upon request)
➢ Presenting Special TVA Applications
  (planned in the afternoon during the parallel TORSIONAL VIBRATION course, see Page 6)
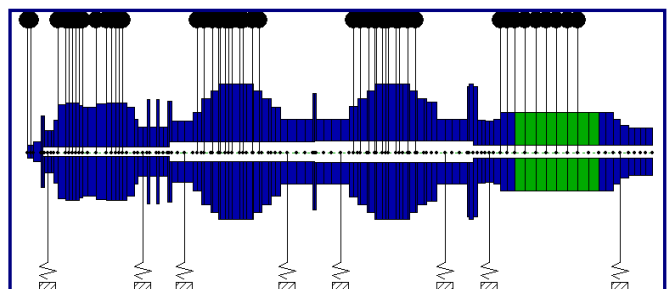
About RBTS & LASCHET

RBTS: A Tradition in Engineering Excellence

Established in 1986, *RBTS, Inc.* (USA) offers professional engineering services in rotating machinery dynamics, bearing systems, and structural engineering. *RBTS'* principals bring a versatile, yet highly specialized perspective to the solution of commonplace as well as unique engineering problems.

As an international leader in the design and development of software for rotating machinery dynamics, bearings, and seals, *RBTS* offers expertise in advanced rotor dynamic technologies. The engineering software, *Advanced Rotating Machinery Dynamics* (**ARMD**™) is currently in use by major corporations worldwide. Through its state-of-the-art software and service programs, *RBTS* provides computer-assisted technologies to companies to help them "test" the performance of rotating machinery during development and analyze machine failure in operation. Consulting services are available to supplement computer programs and for highly complex or unique machinery.

Through its principals, *RBTS* offers more than 60 years of combined experience. Senior consultants from these and other engineering fields also work with *RBTS*. Together, the *RBTS* network provides the most comprehensive engineering expertise available.

RBTS takes an integrated approach to problem solving, analyzing the entire project to determine the impact of each component. Again, the collective expertise of *RBTS'* professionals means that the clients receive both generalized as well as specialized consultation.

Further information: **www.rbts.com**

LASCHET CONSULTING: From Tradition to Further Progress

In 1918 *Arnold Laschet (senior)* set up a company in Essen (Germany), specialized in mechanical and electrical engineering, design of tools, fixtures, jigs, gears, devices, special machine tools, and made-to-order production. This is the start of the family-owned company. Since 1984 an independent company was established which covered – besides of modular machine tool machines – also powerful engineering services, and the development and sale of technical software products.

To be able to meet the increasing demands made on the simulation of vibrations, we started a close cooperation with *RBTS, Inc.* (USA) for more than 20 years to offer the rotordynamics software **ARMD™** and the accompanying engineering services in Europe and worldwide. **ARMD™** is used to calculate the dynamic behavior (torsional & lateral vibrations) in drive systems. Typical applications are found in all rotating machinery, turbomachinery, and further applications referring to power transmission engineering.

Since we offer both software support and engineering services, there is always a reference to practical use and customer-near verification of this kind of computer simulation. Worldwide, a lot of customers in R&D and testing departments use the software with great success. Customer training courses and consultancies (also supported by video-audio conferences like WebE*x*) complete the range of services.

Laschet Consulting GmbH originated from the parental business in 2016 as a separate engineering and consulting company dedicated to engineering services worldwide.

The head of the company, *Dr. Andreas Laschet*, studied „Mechanical Engineering" at the University of Technology in Aachen (Germany). His thesis "*Development of a method for the computer supported simulation of torsional vibrations in drive systems*" was published 1988 as a Springer book „*Simulation of the Dynamic Behaviour of Drive Systems*" (in German language). He was one of the pioneers who carefully studied CAE methods and simulation algorithms to generate torsional vibration models of complete drivelines and published more than 60 technical papers. His expertise is based on more than 40 years of professional experience.

Further information: **www.laschet.com**.
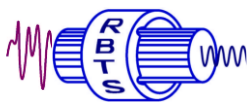
R e g i s t r a t i o n

Please fill in this form per person and fax it to: **+49 2204 84-2639** or submit a scan to info@laschet.com. It is better to **REGISTER ONLINE** via **www.laschet.com/en/seminars/registration/**. The **INVOICE** is issued by *LASCHET* in **EUR**.

Last (Family) Name
+ Academic Title: _____

First Name(s): _____

Job Title: _____ *Dept.* _____

Company Name: _____

Company Address: _____

Zip (Postal) Code & City: _____

State / Country: _____

VAT IdNo. _____ *(only for companies from EU)*

Phone + Email Address: _____

*Personal and company name (including city, country) will appear on the name badge and the attendee list. The course and literature are in **ENGLISH language only**. **Please provide us with your INVOICE address**, if it is not the same as above. Changes or modifications of the program may be possible according to the requests from the participants. Our "Seminar Terms" are valid.*

Please tick the boxes for registration.
You may book single days/sections separately. All sessions are in ENGLISH language.

*) Tick only a single box for the 4th day, as on this day we have **two parallel sessions**.

☐	**Day 1**	**FB**	1-Day **Seminar FLUID-FILM BEARINGS**	*10 Oct 2022*	*Monday*	*09:00-17:00*
☐	**Day 2+3**	**RD**	2-Day **Seminar ROTOR DYNAMICS, Part 1+2**	*11 Oct 2022*	*Tuesday*	*09:00-17:00*
				12 Oct 2022	*Wednesday*	*09:00-17:00*
☐	**Day 4-A** *)	**TV**	1-Day **Seminar TORSIONAL VIBRATIONS**	*13 Oct 2022*	*Thursday*	*09:00-16:00*
☐	**Day 4-B** *)	**AA**	1-Day **Workshop ROTORDYNAMIC SOFTWARE**	*13 Oct 2022*	*Thursday*	*09:00-16:00*

*The prices as mentioned below include the participation of **1 attendee, 1 set of literature, beverages** during the breaks, and **lunch**. German companies and all private participants (worldwide) have to notice: **19 % German VAT (value added tax) is extra and must be added to the yellow marked prices.** Hotel accommodation is paid by yourself. Download the following documents:*
a) *official "LASCHET-RBTS Seminar Brochure":* **https://www.laschet.com/en/seminars/**
b) *effective "LASCHET Seminar Terms & Conditions":* **https://www.laschet.com/en/download/**

Seminar Price List *Please notice: Participants from Germany or private persons have to **add 19 % VAT**.*

1 Day = EUR 790,00

2 Days = EUR 1.390,00

3 Days = EUR 1.890,00

4 Days = EUR 2.290,00 (complete seminar)

*In order to plan this seminar, we appreciate your registration as soon as possible. Within 1-2 weeks LASCHET usually sends you the official confirmation and the invoice; a first confirmation will be sent via Email in advance. **Please check once again that your a.m. Email address is correct and written legibly.** Seminar details: subject to modifications; please notice our web site www.laschet.com. Please notice: If you like to stay at the Leonardo Hotel Köln in Cologne (seminar venue), please book your room as soon as possible; the room contingent is limited. The course rate will be about **EUR 89,00 for a single room per night (including breakfast)**; see the details of the venue on Page 10. The accomodation price is not guaranteed and may change.*
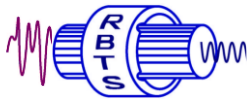
Location & Accommodation

The seminar will take place at the following hotel (Please notice the **exact hotel name/address** mentioned below, as there are also other "Leonardo Hotels" in Cologne!):

Leonardo Hotel Köln
Waldecker Str. 11-15
51065 Köln (Cologne) - GERMANY
Phone (Reservation): **+49 221 7771977**
Phone (Reception):   +49 221 6709-0
Telefax: +49 221 6709-321
Email: reservations.koeln@leonardo-hotels.com
Internet: https://www.leonardo-hotels.com/cologne/leonardo-hotel-koln

The hotel is in the city of **Cologne** (Köln) in the west part of Germany and very close to the urban motorway (extension of the A4), exit "*Köln-Buchforst*" (see the road map on the following page). Due to other events which take place during the same period of time (like conventions, trade fairs, shows), we recommend to book your hotel room **as soon as possible**. Please book your room **directly via the a.m. Email address** to get your special room rates. The reservation is guaranteed if you communicate your credit card details to the hotel reservation manager. The conditions can only be granted by mentioning the reservation code "*LASCHET*".

The **seminar room rate** incl. breakfast, service, WLAN, and tax (VAT) (city tax extra for private persons) is:

EUR 89,00 for a single "comfort room" per night *(room rate 2022)*
earliest check-in at the arrival day: 15:00 (03:00 p.m.)
latest check-out at the departure day: 12:00 (12:00 noon)

PLEASE NOTICE: The hotel offers rooms in **various categories**. Some-times there are even **REDUCED RATES** as a special offer within a limited time. Therefore you should always ask the hotel first which room rates are really valid, and which categories are available. Guaranteed reservations can be done against your credit card. The a.m. price is not guaranteed at the moment and may change. Please notice updates on our web site.

All **152 comfort rooms**, **11 superior rooms**, and **2 junior suites** are equipped with bath, shower, WC, hairdryer, radio, TV with national and in-ternational programs, telephone, WLAN, and an individually adjustable full air-conditioning system. The hotel is a non-smoking hotel. Laundry services are from Monday to Friday. 4 hotel rooms are suitable for handicaped per-sons. The rooms are equipped with a connecting door to a neighbor room and can be easily accessed with a wheelchair. A free safe deposit box is available at the reception. If you arrive by car, use one of the 90 parking spaces of the hotel (EUR 13,00 / 24h). More information are available at the hotel web site **https://www.leonardo-hotels.de/cologne/leonardo-hotel-koln**. Please note possible price updates.

It is up to you to book another hotel in the Cologne area if you don't like to stay at the seminar location. However, consider the traffic in the morning. *Examples: HYATT Regency*, *MARRIOTT*, *HILTON*, *DORINT*, *Best Western*, *NOVOTEL*.

How to get there?

BY CAR

From the NORTH direction: *from North-East:* **A1** to Leverkusen intersection or *from North:* **A3** from Oberhausen, from there via the **A3** in the direction of Frankfurt to Cologne-East (*Köln-Ost*) intersection, then via the urban motorway in the direction of Cologne city centre / downtown (*Köln-Zentrum*), take **Köln-Buchforst** exit.

From the SOUTH direction: **A3** to Cologne-East (*Köln-Ost*) intersection, then via the urban motorway in the direction of Cologne city centre (*Köln-Zentrum*), take **Köln-Buchforst** exit.

From the WEST direction: **A4** to Dreieck Heumar (junction), then take the urban motorway in the direction of Cologne city centre (*Köln-Zentrum*), take **Köln-Buchforst** exit.

From the EAST direction: **A4** in the direction of Cologne city centre (*Köln-Zentrum*) - do not leave the motorway because it automatically runs in the urban motorway, take **Köln-Buchforst** exit.

BY TRAIN

There is a **S train station** about 400 m away (**Köln-Buchforst**). The **international central (main) station** is 4 km away. There is a very fast connection (~ 50 minutes) from Cologne city to Frankfurt airport (terminal).

FROM GERMAN AIRPORTS TO THE LEONARDO HOTEL KÖLN (COLOGNE)

Cologne/Bonn Airport: *By taxi* approx. 15-20 minutes. There is also a *direct railway connection* **S13** which goes every 20 minutes from Cologne/Bonn Airport railway station to the Deutz/Messe and Cologne Central Station, from there you take a taxi to the hotel.

Düsseldorf Airport: *By taxi* approx. 20-30 minutes, or you better take the *railway* to Cologne Central Station, and from there a taxi to the hotel.

Frankfurt/Main Airport: Arrival at Deutz/Messe Station or Cologne Central Station approx. 50 minutes by **ICE** (*"Intercity Express Train"*), from there you take a taxi to the hotel.

*Come to **Germany**, come to **Cologne** (Köln) and attend the*

14th International Seminar (October 10-13, 2022)
"ROTOR DYNAMICS & BEARINGS"

... in close cooperation between RBTS and LASCHET