



## ROTOR DYNAMICS & BEARINGS

Seminar mainly for participants from EUROPE, AFRICA, and the MIDDLE EAST

**Seminar Program**  
Subject to changes!

### ROTOR DYNAMICS & BEARINGS TECHNOLOGIES

Lateral & Torsional Vibration Analysis / Fluid-Film Bearings

Basics & Theory / Practical Applications & Case Studies

**This online seminar is more than a short course** – It is a **TECHNOLOGY TRANSFER SEMINAR** performed by acknowledged experts tailored to engineers and technical managers involved in **ROTATING MACHINERY** design, operation, maintenance, diagnosis, and troubleshooting, with emphasis on machinery **rotor dynamics**, drive train **torsional vibrations**, and **fluid-film bearing systems** that support, guide, and locate the rotating assembly. Detailed coverage of all these topics 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.*

**1<sup>st</sup> Day:** Online Seminar "FLUID-FILM BEARINGS" (Technology & Applications)

**2<sup>nd</sup> Day:** Online Seminar "ROTOR DYNAMICS 1" (Basics & Technology)

**3<sup>rd</sup> Day:** Online Seminar "ROTOR DYNAMICS 2" (Applications & Case Studies)

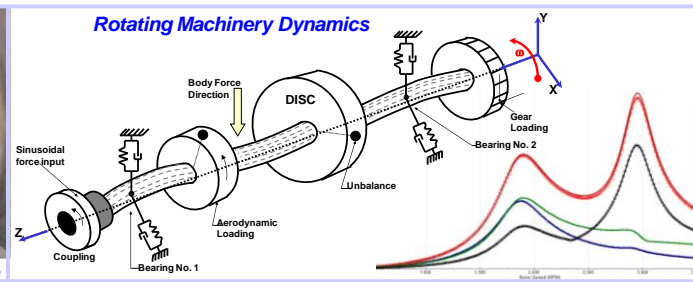
**4<sup>th</sup> Day:** Online Seminar "TORSIONAL VIBRATIONS" (Basics & Applications)

**DATES:**

Announcement → <https://www.laschet.com/en/seminars/>

**VENUE + DURATION:**

**ONLINE SEMINAR** over 4 days via Cisco Webex / 4 hours per day



Sponsored by:

**Laschet Consulting GmbH**

Friedrich-Ebert-Str. 75, 51429 Bergisch Gladbach, GERMANY

Ph: +49 2204 84-2630

E-mail: [info@laschet.com](mailto:info@laschet.com)

Fax: +49 2204 84-2639

Internet: [www.laschet.com](http://www.laschet.com)

Info & Online Registration:

<https://www.laschet.com/en/seminars/>



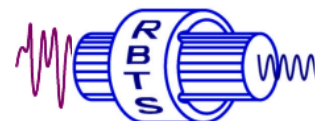
Presented by:

**RBTS, Inc.**

**Rotor Bearing Technology & Software, Inc.**

1041 West Bridge Street, Phoenixville, PA 19460, U.S.A.

Internet: [www.rbts.com](http://www.rbts.com)



### About the Online Course

The main subjects of this course (4 seminar days in 3 SECTIONS) are related to dynamic effects (vibrations) that occur in all rotating machinery (like turbomachinery, compressors, pumps, etc.):

- **FLUID-FILM BEARINGS (SLIDING SURFACE BEARINGS)**
- **ROTOR DYNAMICS** (lateral vibrations)
- **TORSIONAL VIBRATIONS**



The course prepared and conducted by professional experts and is designed for engineers and technical managers who are involved in **rotating machinery design, operation, maintenance, diagnosis, condition monitoring, and troubleshooting**, with emphasis on vibration analysis including the influence of bearings that support, guide, and locate the rotating assembly. The main objective of the course is to present details and methods to **properly understand the dynamic effects and vibration behavior of overall systems**. Participants are encouraged to present problems to be discussed. Since seminar time is limited, please send us your individual examples at least 1 week before the course starts and we will see how we can incorporate “your” topics (at least partially) into the course program.

To cover all the specific topics of this seminar, the course has been divided into 3 coordinated sections (see below), which can be booked completely – what we recommend – but also individually.

#### Section #1 (Day 1) – presented by **Victor Obeid (RBTS, Inc. / USA)**

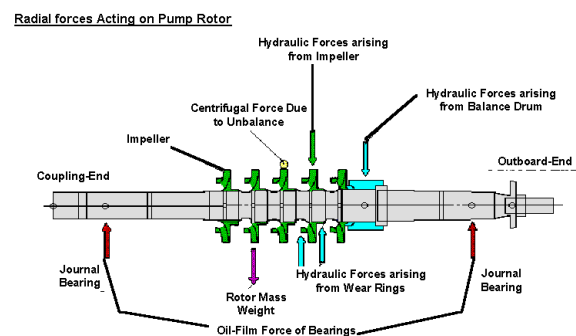
The first part of the course will focus on **FLUID-FILM BEARINGS**, the vital tribological element of rotating machinery, beginning with their fundamental principles of operation through computer implemented evaluations of their operational performance characteristics and limitations. Design considerations and applications of fluid-film bearings will be discussed along with the presentation of numerous real life case histories to illustrate the technology and its application to rotating machinery failure analysis and troubleshooting of common, as well as, unique vibration problems.

Please note: An **introduction to rolling element bearings** will be presented in **Part #2** (see below).

#### Section #2 (Day 2+3) – presented by **Victor Obeid (RBTS, Inc. / USA)**

The second part of the course is divided into 2 subsequent days as many crucial topics are addressed. We start with an introduction in theory and practice of **ROTOR DYNAMICS**, i.e. **lateral vibration analysis** in rotating machinery from fundamental principles through present state-of-the-art analytical methodology to solve typical problems. The discussion of special and advanced topics is planned as well.

Furthermore there will be an introduction to rolling element bearings illustrating their various applications and their effects on system rotor dynamics. The interacting influence of bearings (either fluid-film or rolling element types) on the dynamic behavior of machinery will be reviewed and illustrated by the construction of analytical models, and evaluated by computerized solutions.



#### Section #3 (Day 4) – presented by **Dr. Andreas Laschet (Laschet Consulting GmbH / Germany)**

The third part of the course deals specifically with **TORSIONAL VIBRATIONS** as they occur in complete drivelines. Apart from model generation strategies, we present the basics of the analysis of excitability including the interpretation of vibration modes of the drive system. Examples show the steady-state or time-transient response signals generated by the calculations – also in comparison with measurement signals.

### Section #1 (Day 1): FLUID-FILM BEARINGS

This seminar 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. The session is a full coverage of **FLUID-FILM 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 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

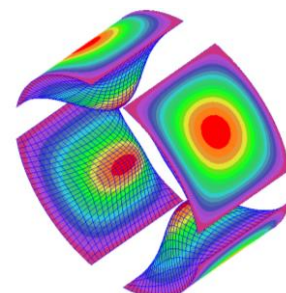
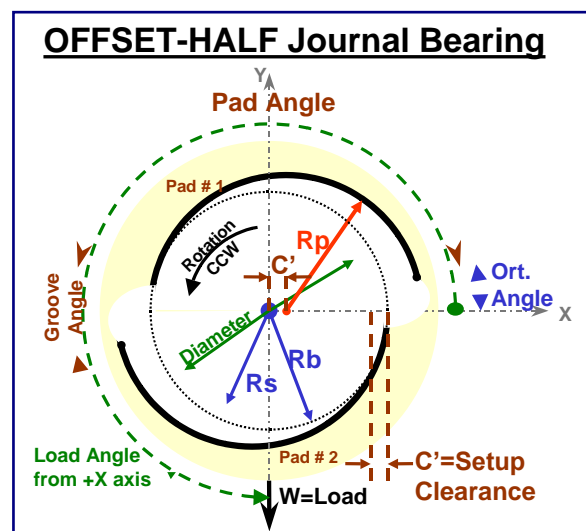
- Fundamentals
- Types and Definitions
- Load Support Mechanisms
- Modes of Lubrication
- Frictional Response Characteristics
- Terms and Concepts of Hydrodynamic Lubrication and its Requirements
- Terms and Concepts of Hydrostatic-Hybrid Lubrication and its Requirements
- Lubricant Temperature/Viscosity 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

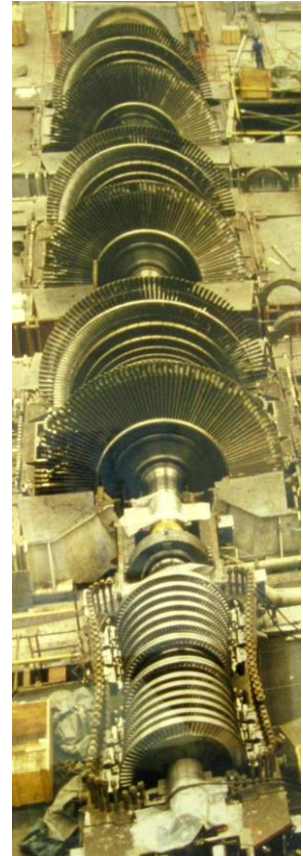
#### BEARINGS STATE-OF-THE-ART TECHNOLOGY

- Advanced Technology Presentation & Demonstration
- Summary of Course Content and Application of Bearings Technologies
- Group Discussion



### Section #2 (Day 2 + 3): ROTOR DYNAMICS

This seminar 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.

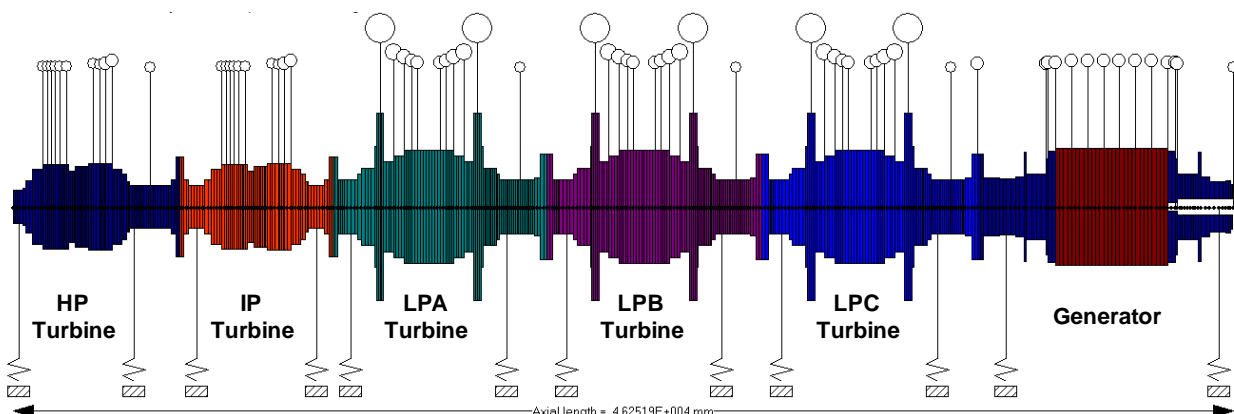


#### INTRODUCTION & OVERVIEW

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

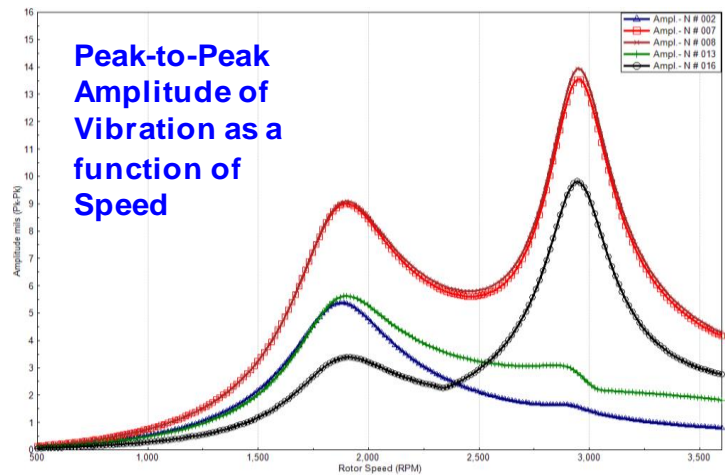


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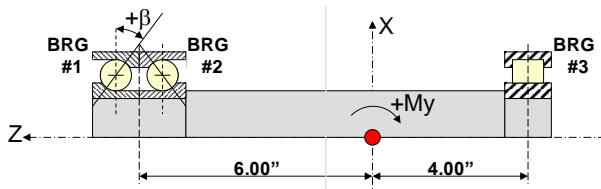
### ROTOR DYNAMICS – ADVANCED

- **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

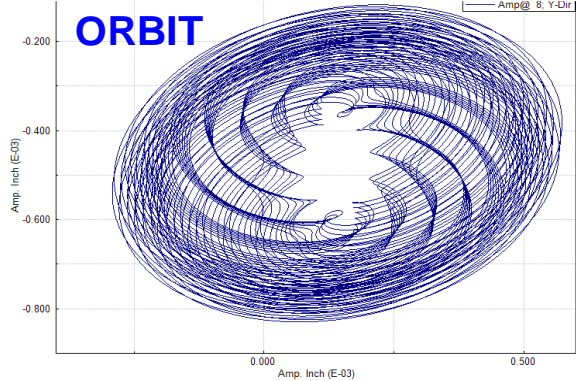


### ROTOR DYNAMICS DETAILED CASE HISTORY

- **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

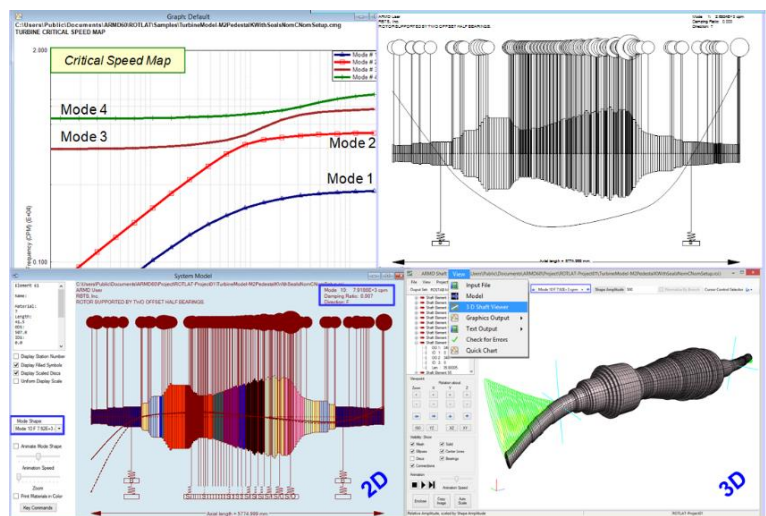


Coupling-End Bearing at Instability Threshold



### STATE-OF-THE-ART TECHNOLOGY PRESENTATION & DEMONSTRATION

- Advanced Technology Presentation, Demonstration
- Summary of Course Content and Application of Rotating Machinery, Dynamics Technologies



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.

**Please note:** Attendees who are interested in details concerning the specific analysis of **TORSIONAL VIBRATIONS** in complete drivelines should also book the **special seminar** on the **4<sup>th</sup> day (Thursday)**.

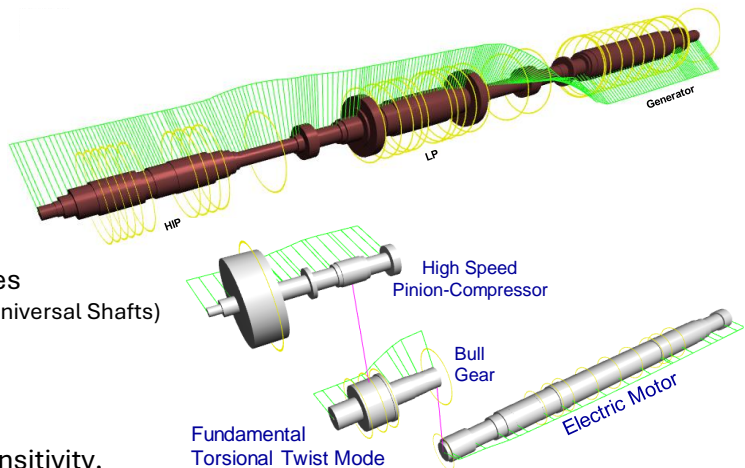
### Section #3 (Day 4): TORSIONAL VIBRATIONS

This seminar will give interested participants more depth into the basics on **TORSIONAL VIBRATIONS** including case studies and applications in rotating machinery supported by computer simulation methods. This course is recommended as additional session of the previous days. Complete drivelines are analyzed and evaluated concerning excitability and response capability at specific stations (inertias) and elements (stiffnesses).

The following subjects are covered:

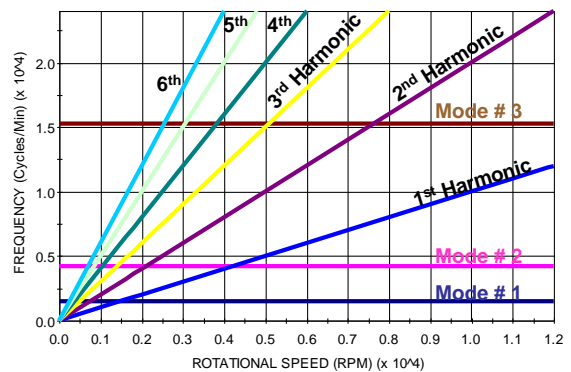
#### MODEL GENERATION

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



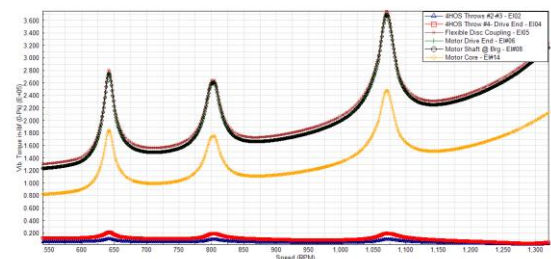
#### ANALYSIS OF EXCITABILITY

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



#### SIMULATION METHODS

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

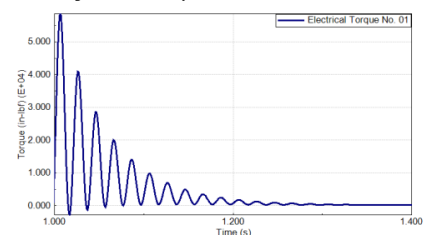


#### SYSTEM EVALUATION

- 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 Motors, Engines & Reciprocating Compressors
- Electrical Effects (Motor Start-Up, Short Circuits, Synchronous Motor Dynamics)
- Nonlinear System Behavior, Influence of Nonlinear Effects (like Gear Dynamics, Backlash & Impacts, etc.)
- Presentation of Computer Results, Demonstration of Specific Applications (presented by **Victor Obeid**)

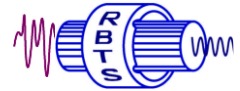




### About RBTS & LASCHET and the Speakers

#### 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 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.

More information: [www.rbts.com](http://www.rbts.com)

#### About the Speaker:

**VICTOR K. OBEID** has over 35 years of experience in the fields of rotor dynamics, fluid-film and rolling-element bearings, machinery vibration, failure analysis and troubleshooting.

He is a pioneer in the development and application of PC based state-of-the-art computer aided design software for predicting the dynamics of complex rotor-bearing systems. A former Staff Engineer at the Franklin Institute Research Laboratories and a technical leader at *RBTS*, he directs government and industry sponsored projects involving design, analysis and troubleshooting of rotating machinery systems and their components.



He has been instrumental teaching and training in the fields of bearings and rotor dynamics, and their application to common as well as unique equipment design, operation, and failure analysis. He taught seminars and training sessions worldwide at rotating equipment OEM, end users, packagers, government agencies, and open seminars to machinery engineers.



Mr. Obeid holds a Bachelor degree from Drexel University and Master of Science degree from Penn State University, both in Mechanical Engineering. He holds numerous US & Canadian patents on bearing designs & machinery elements.



### LASCHET CONSULTING: From Tradition to Further Progress in Engineering Services

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.



This tradition was continued with the company *Laschet Consulting GmbH*, officially started in 2016 as consulting and engineering service ... with decades of experience.

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 25 years to offer the rotor dynamics software **ARMD™** and the accompanying engineering services in Europe, in the Middle East, and also worldwide. **ARMD™** is used to calculate the dynamic behavior (torsional & lateral vibrations including the bearing behavior) in drive systems. Typical applications are found in all rotating machinery, and many other applications related to power transmission engineering.

Since we offer both software support and engineering services, there is always a reference to practical use and customer-oriented 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 (mostly supported as online service) complete the range of services.

The cooperation between *LASCHET* and *RBTS* started already 25 years ago. Therefore we provide an international professional engineering and software service as part of an acknowledged expert team with many years of experience ... with excellent references and feedback from customers around the world.

More information: [www.laschet.com](http://www.laschet.com)

#### About the Speaker:

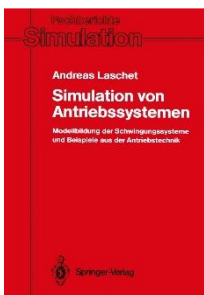
The head of the company, **Dr. ANDREAS LASCHET**, studied „Mechanical Engineering“ at the University of Technology in Aachen (Germany) and carried out research work in the field of machine dynamics as a scientific assistant at the Institute of Machine Elements. His thesis "Development of a method for 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 is one of the pioneers who carefully investigated CAE methods and simulation algorithms for creating torsional vibration models of complete drivelines (not only single drive elements) and performed detailed studies to verify computer results with measurements. This was usually done as part of his engineering services.

Furthermore, he published more than 60 technical papers and gave numerous lectures at international conferences (like VDI, HDT, EFRC, ASME, SAE). He conducted many custom workshops and – as part of the collaboration with *RBTS* – since 2004 an extended seminar on torsional vibrations during the annual rotor dynamic lectures.

His expertise is based on more than 40 years of professional experience.







## ROTOR DYNAMICS & BEARINGS

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### Seminar Organization & Costs & Registration

All courses are **ONLINE SEMINARS in REALTIME**, realized as courses in a digital classroom (i.e. online meetings via Cisco Webex) for a limited number of participants. The language is **ENGLISH** only. A couple of days before we start, you will receive the **seminar documents as PDF files** matching the booked seminars – provided you have completed all registration steps. In addition, you will receive updated **INTRODUCTION INFORMATION** where you will learn more about the organization so that we don't waste time on longer introductions when the event officially starts.

The **4 seminar sections** will be on **4 subsequent days** with **4 hours per day** according to a **schedule** with the time specifications “**CET = Central European Time**”. We normally plan the seminar **once a year** in **October** or **November**. **The exact dates will be announced on our web site.**

See the following table with the **allowed booking combinations** including the corresponding **seminar fees (in EUR currency)**. Depending on the tax regulations in your country **you have to add the local tax**. *Important:* EU companies must enter the VAT identification number (**VAT IdNo**) in the registration form.

*Please note:* The prices may change. You should take the official prices as mentioned on our web site. The prices below can be taken as BUDGET PRICES.

PRICE LIST & BOOKING MATRIX (bookable combinations)								
Seminar (Day) No.	1 (Mon)	2 (Tue)	3 (Wed)	4 (Thu)	Booking Code	Price [€] - net -		
Seminar Date and Exact Time / Day	<a href="https://www.laschet.com/en/seminars">https://www.laschet.com/en/seminars</a>							
Duration / Day	4 hours - usually in the afternoon (CET)							
Seminar Content	FB	RD		TV				
Booking of 1 Day	X				FB1	595,00		
				X	TV1			
Booking of 2 Days		X	X		RD12	995,00		
	X			X	FB1-TV1			
Booking of 3 Days	X	X	X		FB1-RD12	1.395,00		
		X	X	X	RD12-TV1			
Booking of 4 Days	X	X	X	X	FB1-RD12-TV1	1.695,00		

Abbreviations: FB = Fluid-Film Bearings; RD = Rotor Dynamics; TV = Torsional Vibrations

Although you can also book the seminar days individually (see table above), we recommend booking the **COMPLETE seminar package (4 days)**, as all topics of the seminars are perfectly coordinated.

To **REGISTER**, please go to our website <https://www.laschet.com/en/seminars/> and follow the respective **ONLINE BOOKING link** that refers to the corresponding seminar days you wish to book.

In case of any questions, please contact: *Dr. Andreas Laschet* @ Laschet Consulting GmbH (Germany). Write an E-mail ([info@laschet.com](mailto:info@laschet.com)) or follow the link <https://www.laschet.com/en/contact/>.