Vibration Analysis …

… Extended Engineering Services for Rotating Machinery

Computer Simulation of Drive Systems (Drivelines) in <u>*Rotating Machinery Applications*</u>

… dedicated to *Industry, Marine, Oil & Gas, Power Generation, etc.* *– with the main focus on:*

DEVELOPMENT & DESIGN, SYSTEM RELIABILITY, CONDITION MONITORING, TROUBLESHOOTING, FAILURE ANALYSIS

Dr.-Ing. Andreas Laschet is specialist in computer simulation technology. Due to longterm experiences in the simulation of complete drive systems, he offers a professional customer **CAE Service for Engineers** worldwide including consultation, analysis, troubleshooting supported by computer simulation of <u>**TORSIONAL & LATERAL VIBRATIONS IN ROTATING MACHINERY**</u>:

ENGINEERING

Services

Customer-Dedicated Support

SOFTWARE

Simulation + Analysis Tools

- **Turbomachinery**

- **Compressors**
  (reciprocating, screw, turbo compressors)

- **Pumps, Fans/Blowers/Ventilators, Generator Drives**

- **Vehicle and Ship Drivelines** (with E-drives or all types of engines)

- **Drive Systems in Aviation & Aerospace Applications**

- **Drives with Couplings, Clutches, Gear Stages, Universal Shafts, E-Motors, Reciprocating Engines**

- **Test Rig Optimization** considering dynamic effects

- **Driveline Matching** crucial for design & troubleshooting
  (considering measurements, field testings, and machine diagnosis)
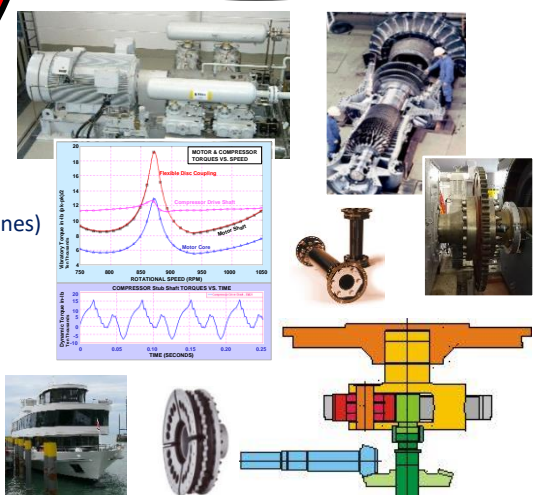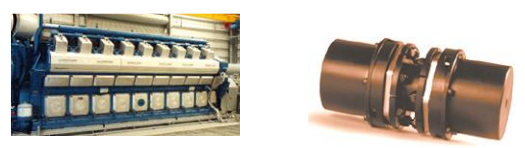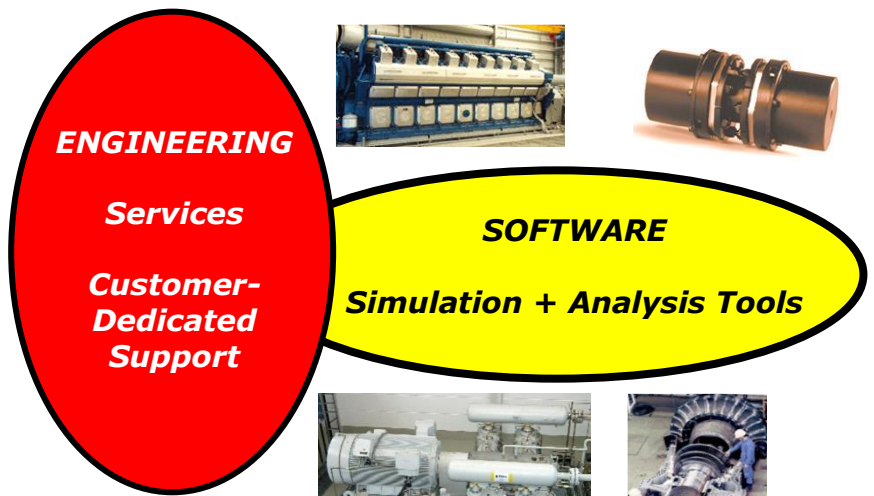
The **CAE Service** provides the customer with a project-oriented analysis and interpretation of vibrations caused by external or internal excitation or parametrically excited disturbances. Nonlinear characteristics like backlash or torque-angle-hystereses can be taken into account, too. In order to meet all customers' requirements, **Dr.-Ing. Andreas Laschet** uses and distributes high-sophisticated simulation software in close cooperation with software & engineering companies like *Concepts NREC, USA* with the rotordynamic software **ARMD** (www.rbts.com).

I present "**Service for Engineers**" regularly at international conferences and exhibitions: ASME, POWER-GEN, SAE, IMechE, VDI, EFRC, TVS. Please also visit the annual **International Rotordynamic Seminar** in close cooperation with *Concepts NREC, USA*. Furthermore I offer online trainings, short courses, and brief FREE webinars.

Measurements and field testings are done via cooperative partners worldwide. In all these cases, we combine the design results and offer the customer a **complete design solution including CAE and test results** – carried out by a professional team of experts.

Concepts NREC

International Seminar: ROTOR DYNAMICS & BEARINGS

In-Person & Online Seminars Customer Trainings

The Professional Engineering Service ...

... supported by *Concepts NREC's* simulation software **ARMD 6.2** – *software & training service*

Advanced Rotating Machinery Dynamics

Dynamic Analysis
- Rotor Dynamics
- Torsional Vibration

Bearing Analysis
- Journal
- Thrust
- Conical
- Tilt-Pad
- Rolling

Tools
- Lubricant Properties
- Wear-Ring
- Aerodynamic Cross Coupling
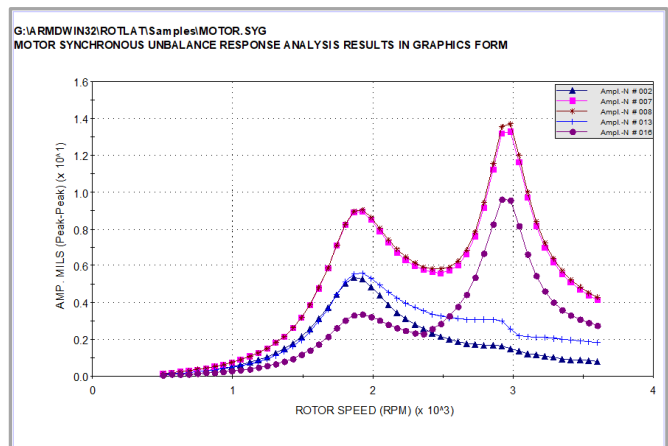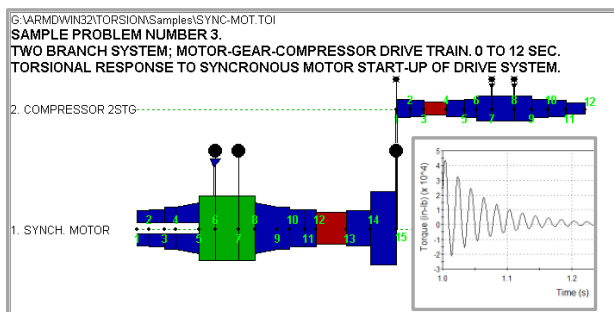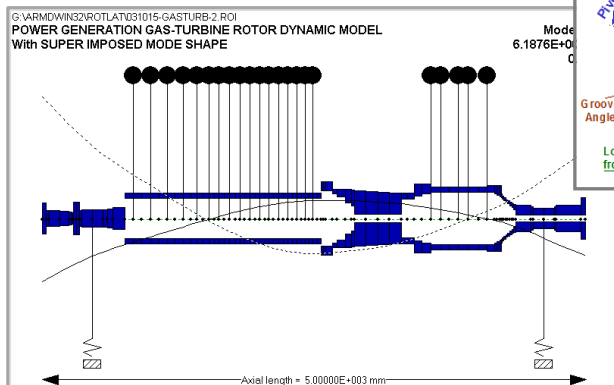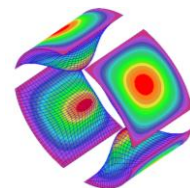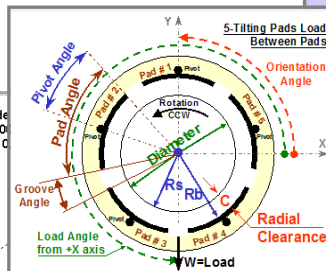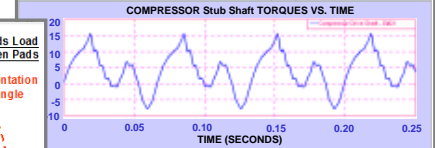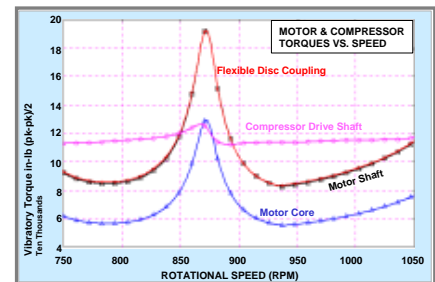- Squeeze Film Damper

Viewers
- 2D Plots
- 3D Bearing
- 3D Shaft

ARMD consists of 4 main modules:

- **Rotor Dynamics**
- **Torsional Vibration**
- **Bearing Analysis**
- **Lubricant Performance**

… with a variety of features, including:

- user-friendly interface
- project and file management system
- 2D/3D graphics capabilities
- intermodule communication and data exchange
- powerful help tools & model templates

Concepts NREC

Generator

LP

HIP

R B T S

MOTOR & COMPRESSOR TORQUES VS. SPEED

Flexible Disc Coupling
Compressor Drive Shaft
Motor Shaft
Motor Core

COMPRESSOR Stub Shaft TORQUES VS. TIME

G:\ARMDWIN32\ROTLAT\031015-GASTURB-2.ROI
POWER GENERATION GAS-TURBINE ROTOR DYNAMIC MODEL
With SUPER IMPOSED MODE SHAPE

Axial length = 5.00000E+003 mm

G:\ARMDWIN32\TORSION\Samples\SYNC-MOT.TOI
SAMPLE PROBLEM NUMBER 3.
TWO BRANCH SYSTEM; MOTOR-GEAR-COMPRESSOR DRIVE TRAIN. 0 TO 12 SEC.
TORSIONAL RESPONSE TO SYNCRONOUS MOTOR START-UP OF DRIVE SYSTEM.

2. COMPRESSOR 2STG

1. SYNCH. MOTOR

G:\ARMDWIN32\ROTLAT\Samples\MOTOR.SYG
MOTOR SYNCHRONOUS UNBALANCE RESPONSE ANALYSIS RESULTS IN GRAPHICS FORM

Dr.-Ing. Andreas Laschet • Apolloniaweg 6 • 51515 Kürten • GERMANY

The Strategy to Minimize Vibrations in Drivelines ...

… Supported by Powerful CAE Tools & Laschet's Engineering Services

Chronology
Increase of Data Uncertainty

PAST	PRESENCE	FUTURE

Real Systems
(Machines, Plants,
Vehicles, Ships)

System 1
- Experiences
- Measured Data
- Monitoring

System 2
- Acceptance
- Real Time Testing
- Monitoring

System 3
- Estimated Data
- Models
- Sensitivity Analysis

VIRTUAL ENGINEERING
Link between Past, Presence, and Future

Tools:

Software

Measurement
(Equipment)

CAx Tools: CAD / CAE (Simulations) / Evaluations

Measuring the System, Test Rigs

- **Support of the R & D Process**
  - early detection of possible **critical speeds** and **resonance problems**
  - evaluation of **different powertrain configurations** to determine the **"best"** set-up
  - significant **quality improvement** with simultaneous **reduction of development time**

- **Support of Commissioning, Predictive Maintenance, Machine Diagnosis**
  - understanding **field testing** during **commissioning** using **vibration simulation tools**
 - fine tuning of the CAE model, improved **machine diagnosis & conditioning monitoring**

- **Support of Troubleshooting, Failure Analysis, Root Cause Analysis**
  - improved **troubleshooting & root cause analysis** considering existing measurements
  - **measurement and computer simulation "in dialogue"** for **fast problem solving**

Typical Structure of my Engineering Services ...

… CAE Supported Vibration Analysis Based on Laschet's Extensive Know-How

- **TORSIONAL VIBRATION ANALYSIS (TVA) – Basic Analysis**
  Natural Behavior, Resonance Analysis (Analysis of Excitability)

- **TORSIONAL VIBRATION ANALYSIS (TVA) – Extended Analysis**
  Nonlinear Effects (Load Dependent Coupling Behavior, Gear Backlash, etc.), Sensitivity Studies

- **LATERAL VIBRATION ANALYSIS (LVA) – Basic Analysis**
  Natural Behavior, Resonance Analysis (Analysis of Excitability), Sensitivity Studies

- **Complete ROTORDYNAMIC ANALYSIS (RDA) – Extended Analysis**
  Optionally with a Detailed Fluid-Film Bearing Analysis incl. Configuration & Sensitivity Studies

- **Simulation Methods: STEADY-STATE or TIME-TRANSIENT Simulations**

- **Special Evaluation Approach Concerning NVH Effects in Vehicle Drivelines**
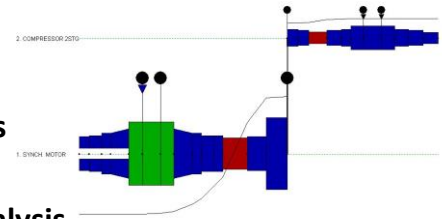
We usually provide you with a quotation splitted into the following parts:

1. **BASIC ANALYSIS (TVA / LVA)**
   analysis of the natural behavior including analysis of excitability

2. (optional) **EXTENDED ANALYSIS & DETAILED STUDIES (TVA / LVA / RDA)**
   steady-state simulations and/or time-transient simulations for various load cases or time-dependent load scenarios – also in correlation with existing measurements if required; special RDA service in case of the analysis & configuration of fluid-film bearings

3. (optional) **PARAMETER STUDIES (TVA / LVA / RDA)**
   if the results concerning 1. or 2. do not meet customer expectations often combined with iterative analysis steps referring to a revised analysis of 1. + 2.

All the services can be offered as a **fixed price package** provided that the job description is really clearly defined, or alternatively as a **customized consulting service** based on hourly or daily rates.

PLEASE SEND US YOUR INQUIRY AND CONTACT US TO DISCUSS FURTHER QUESTIONS IN A FIRST, NON-BINDING ONLINE MEETING.