ANALYSIS OF COMPLEX DRIVETRAIN USING SIMPACK
- A WIDE RANGE OF APPLICATIONS -

SIMPACK User Meeting 2011

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Introduction

Technische Universität Dresden - Chair of Machine Elements

- Field of research: drive technology, especially gear technology and components

- Calculation procedures and development of standards, guidelines
- Load-carrying capacity of gearings
- Software for simulation of drive systems and calculation of machine elements
- Dynamic analysis of electromechanical drive systems
- Machine diagnostics and operational measurements
Introduction

Dynamic analysis of electro-mechanical drive systems

- Improvement and verification of simulation techniques
- Investigations in the time and frequency domain using the MBS and FEM
- Analyses of drive train systems and drive train concepts
- Verification of simulation models by measurement results
Modeling of wind turbines – components and loads

- Rotor
- Shafts / gearings
- Gear box housing / structure
- Wind
- Bearings
- Generator / grid
Modeling of wind turbines – drive train
Modeling of wind turbines – structure

Influences of the gear box support concept: three or four point support

Influences of the main frame design on the dynamic behavior of the drive train
Modeling of wind turbines – results

Campbell-diagram

- 1p - rotor
- 3p - rotor
- 6p - rotor
- St3
- St2
- St1
- 3.0 Hz
- 23.0 Hz
- 40.5 Hz
- 127.0 Hz
Modeling of wind turbines – results

- Emergency stop of a wind turbine
  - Disconnecting the generator,
  - Pitching of the blades, braking
Modeling of pitch and azimuth drives
Further areas of application

- Rolling mills
- Bogie
- Ladle crane
- Thruster
- Compressor
- Longwall shearer
- Aircraft engine
- Mechanical watch
- Bucket wheel excavator
Simulation of a mechanical watch

- Analysis of the *running behavior* - due to the small dimensions no comprehensive measurements are possible
- Clockwork: not constant *ratio*, permanent *acceleration* of all components
- Determination of the *dynamic* behavior of the system and the influences on the *running accuracy*
- Comparison of results with *torque measurements*, *theoretical approaches*, optimization of the *gearing*
Simulation of a mechanical watch

- Nonlinear input torque of the main spring
- Stepwise output torque caused by the anchor wheel
- Detailed modeling of the nonlinear gearing characteristic (pressure angle, ratio not constant during one meshing)

main spring – minute wheel

second wheel – anchor wheel
Simulation of a mechanical watch

- Analysis of the influence of each gear stage on the resulting output torque
Simulation of a bucket wheel excavator

- Analysis of the drive train and the supporting structure of a bucket wheel excavator
- Changing operating conditions (hard layers of overburden) – prevention of damages (drive train, structure)
- Increase of life time by load reducing operation and control strategy
Simulation of a bucket wheel excavator

- Detailed simulation model of the drive train
- Modeling the motor and the controller
- Development of a theoretical digging force model
- Additionally using measurement results to determine realistic forces acting at the bucket wheel
- Consideration of the structure of the excavator (boom) by beam approaches/finite element models
Simulation of a bucket wheel excavator

- Modeling the **digging forces**
  - Theoretical approach considers the properties of the **overburden** and **displacements** of the boom
  - Comparison with a **measurement based model** for the digging forces
Simulation of a bucket wheel excavator

- Intended results
  - Determination of critical operating conditions (resonances)
  - Analysis of the acting forces/torques for each drive train component
  - Simulation of different load cases to determine design loads, development of a load reducing control strategy

![Circumferential force at cutting edge graph](image)
Thank You for Your Attention

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