Faculty Engineering Technology

Chair: Applied Mechanics

Research: Structural Dynamics & Acoustics

by

André de Boer

Structural Dynamics & Acoustics Staff

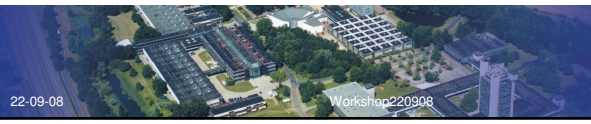
- Peter van der Hoogt (dynamics)
- Ysbrand Wijnant (acoustics)
- Marcel Ellenbroek (0.4) (applied mathematics)
- Richard Loendersloot (0.5) (material & dynamics)
- Bert Wolbert (0.8) (technical support)
- Axel Lok (0.6) (technical support, ict)
- Debbie Zimmerman (0.8) (secretary)
- Vacancies: 2 PhD (Intel, EU), 1 Post doc (IMPACT)
- 7 PhD's, 1 Post doc

Structural Dynamics & Acoustics
Staff

- Peter Sloetjes (STW, MicroNed)
- Didem Akcay Perdahcioglu (EU)
- Emre Dikmen (MicroNed) (AM/MA)

- Martin Nijhof (Intel)
- Jelmer Wind (STW)
- Ronald Kampinga (Pulse)
- Arjan Schutte (CCAR, Vredestein, TNO)

- Vikas Arora (Post-doc, NIVR)



Structural Dynamics & Acoustics
Research areas

- Analysis of dynamic behaviour of structures

- Interaction of vibrating structures with vibrating medium (air, water) → acoustics

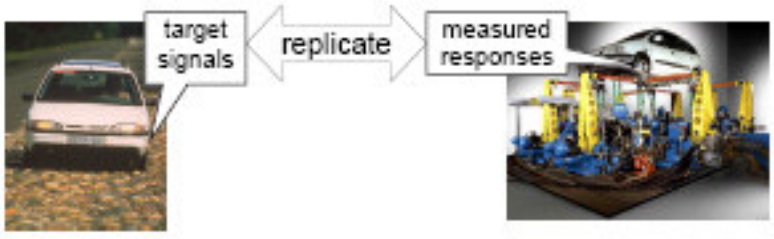
- Crash behaviour of composite structures
- Structural health monitoring

Structural Dynamics & Acoustics Research areas

- Analysis of dynamic behaviour of structures
- Interaction of vibrating structures with vibrating medium (air, water) → acoustics
- Crash behaviour of composite structures
- Structural health monitoring

Structural dynamics

- Inverse dynamics



- Rotor dynamics

Structural dynamics

- **Damping of Structural Vibrations**
  - **Passive damping**
    - **Air film damping**
    - **Constraint layer damping**
    - **Vibration isolation (together with ETE)**

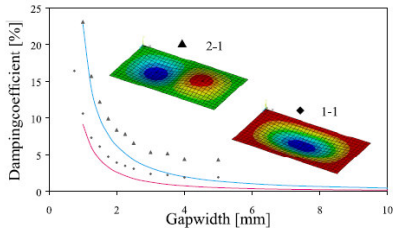
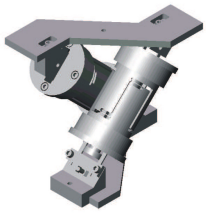
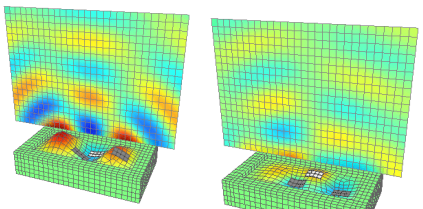


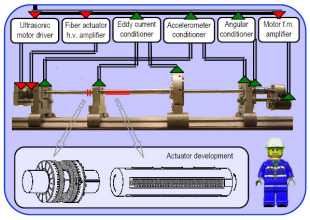
Figure 4 : Damping as a function of gapwidth

Structural dynamics

- **Damping of Structural Vibrations**
  - **Active damping (together with MA, ETE)**
    - **Hybrid vibration isolation**
    - **Vibration damping**
    - **Active balancing**







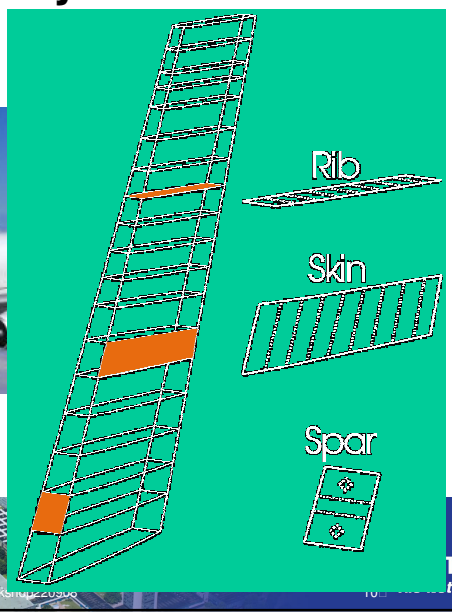
No control With control

Structural dynamics

- **Optimization**
  - SD&A developed an Optimization tool for Airbus Hamburg
  - Focussed on A380 Vertical Tail Plane
  - Optimization on component level taking the global load distribution into account
  - For static load situation

Structural dynamics

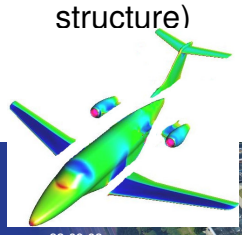
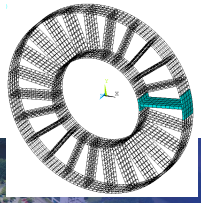
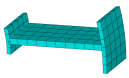
- Optimization



Together with SKF and EU

Structural dynamics

- Optimization
  - Based on dynamic model reduction, ANN, GA+SQP
  - Focus on optimization of complex large structures
  - Method is especially efficient for optimizing one part of a structure while the rest of the structure remains unchanged
  - Method is also efficient for structures with a lot of components with the same geometry (repetitive structure)

Structural Dynamics & Acoustics Research areas

- Analysis of dynamic behaviour of structures
- Interaction of vibrating structures with vibrating medium (air, water) → acoustics
- Crash behaviour of composite structures
- Structural health monitoring

Acoustics

- Acoustics
  - Interaction of vibrating structures with vibrating medium (air, water)= **Vibro-acoustics**
  - **Flame/combustion-acoustics** (Thermal Engineering)
  - **Aero-acoustics** (Engineering Fluid Dynamics)
  - **Electro-acoustics** (Signal & Systems, EWI)

Acoustics of tubes and thin air layers

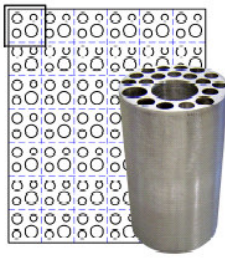


Figure 1 : Aircraft cabin with trim panels (left) and sample for experimental validation (right)

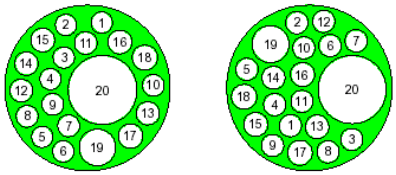


Figure 3 : Sample 1 (left) and sample 2 (right)

Applications:

- Sound Absorption
- Transmission loss

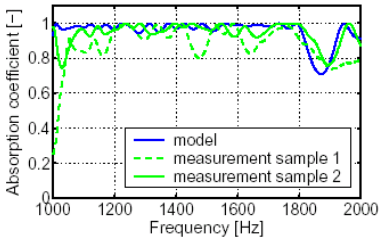
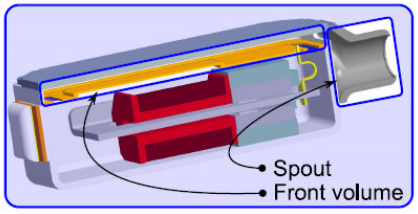


Figure 4 : Measurement results

Acoustics of computer fans & hearing aids



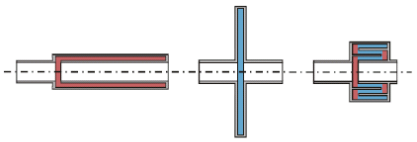


Fig. 1) Cylindrical, circular and folded resonator geometry

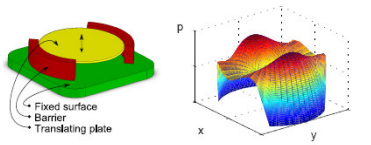
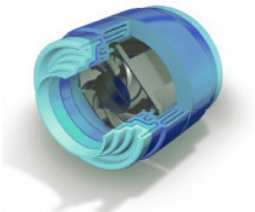


Figure 2 : layer geometry and calculated pressure profile



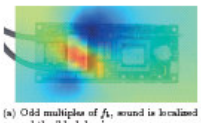
Together with Pulse

Together with INTEL

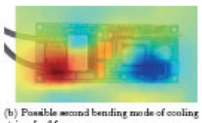
Source localization

(a) Picture of the EPC.

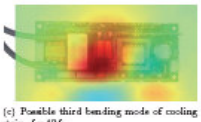
(b) Simplified BEM model.



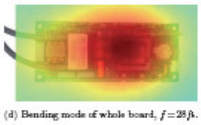
(a) Odd multiples of f_1, sound is localised around the 'black-box'.



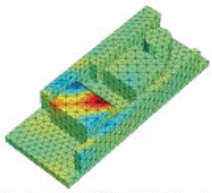
(b) Possible second bending mode of cooling strip, $f = 6f_1$.



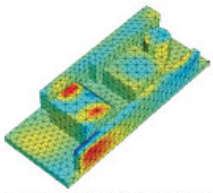
(c) Possible third bending mode of cooling strip, $f = 12f_1$.



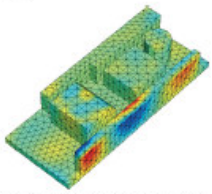
(d) Bending mode of whole board, $f = 28f_1$.



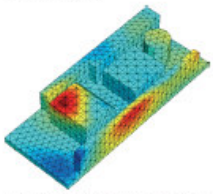
(a) 'Black-box' vibration at odd multiples of f_1.



(b) Excitation of second bending mode of cooling strip, $f = 6f_1$.



(c) Excitation of third bending mode of cooling strip, $f = 12f_1$.

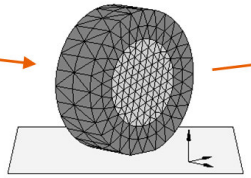


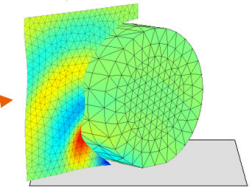
(d) At higher frequencies, $f = 28f_1$, more complex vibration shapes are found.

Tire Noise

Het contactgebied tussen
de band en de weg
is een bron van trillingen.

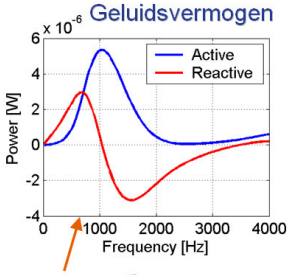
Randelementen model

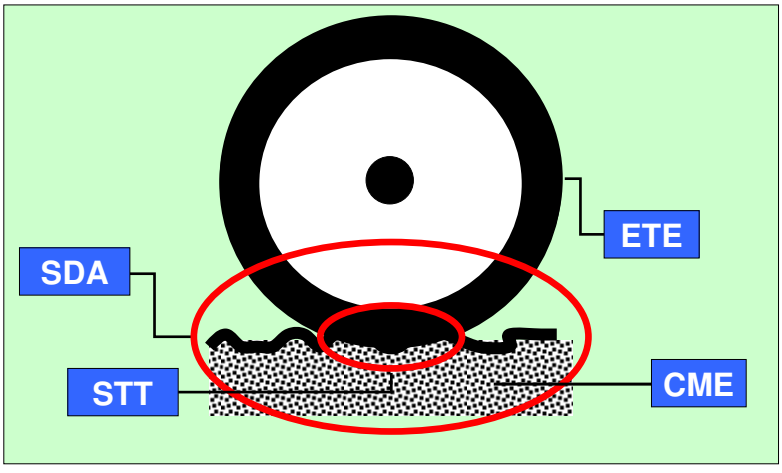




Berekende geluidsveld

Geluidsvermogen





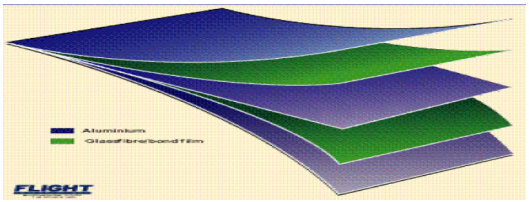
- UT Tire-Road Interaction Consortium
  - Elastomer Technology and Engineering (ETE)
  - Construction Management and Engineering (CME)
  - Surface Technology and Tribology (STT)
  - Structural Dynamics and Acoustics (SDA)

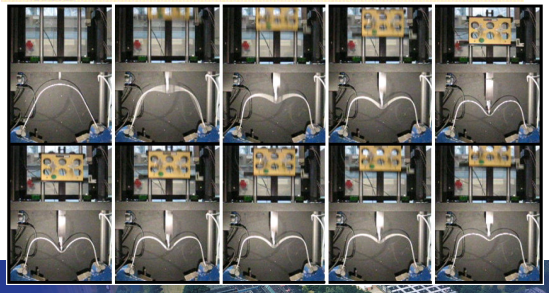
Structural Dynamics & Acoustics Research areas

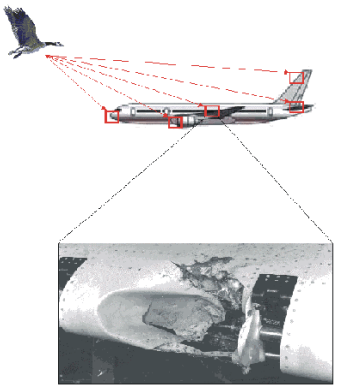
- Analysis of dynamic behaviour of structures
- Interaction of vibrating structures with vibrating medium (air, water) → acoustics
- Crash behaviour of composite structures
- Structural health monitoring

Crash behaviour of structures

- Bird Strike on Glare structures (together with PT)







Structural Health Monitoring

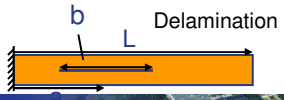
- **Condition monitoring gas pipes (PT)**
- **Monitoring of degradation in polymeric composite pipe (PT)**
- **Condition monitoring water pipes (together with PT)**
- **Delamination detection with fibre bragg gratings based on dynamic behaviour (together with PT)**

Structural Health Monitoring

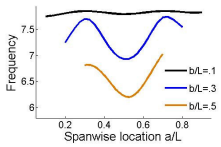
- **Delamination detection with fibre bragg gratings based on dynamic behaviour**

Damage ⟺ Alteration in geometry or material properties ⟺ Change in dynamic behaviour

Damage results in an alteration in geometry or material properties. The effect of damage on structural integrity is evaluated.

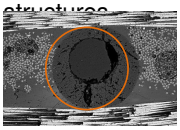


A mathematical model couples the structural alterations to changes in



Embedded fibre Bragg gratings are applied to measure the dynamic behaviour of composite structures

FB G



Structural Dynamics & Acoustics Research areas

- Analysis of dynamic behaviour of structures
- Interaction of vibrating structures with vibrating medium (air, water) → acoustics
- Crash behaviour of composite structures
- Structural health monitoring