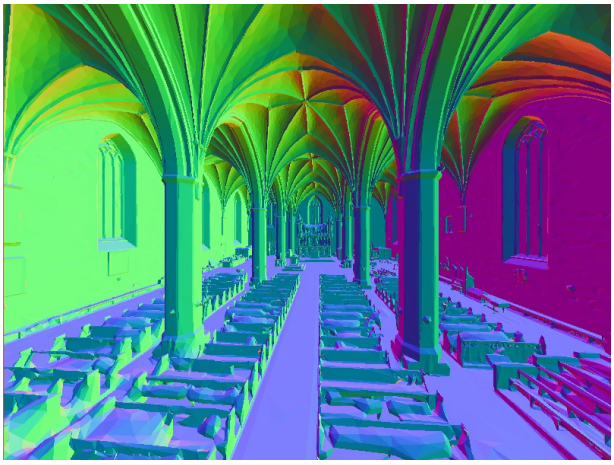
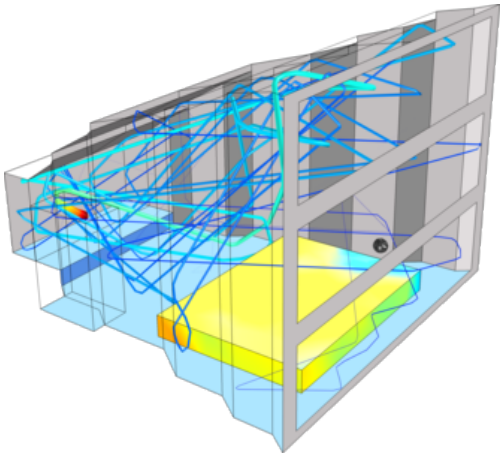
LUND UNIVERSITY
ENGINEERING ACOUSTICS, LTH

# Master thesis topics in Acoustics

2020-2021

## Room acoustics modelling in a medieval church using COMSOL





### Objectives

The church of Vadstena is under investigation by researchers who try to virtually restore the monument. A "restoration" of the old sound field of the church during operation is developed at the same time by LTH-Acoustics. The geometry of the church will be used for a set of acoustic simulations which model the sound propagation in the space and calculate the impulse response on certain positions. Room acoustic parameters such as RT, EDT, Clarity, etc will be investigated as well.

- ### Main challenge

  To develop a good acoustic model, based on simplicity of geometry, optimization of the ray tracing method and settings, as well as good comparison with measured data in certain key positions of the church.

- ### Research questions

  Which parameters affect significantly the room acoustics model? And how do we interpret the calculated acoustic metrics? E.g. is the acquired RT60 and C80 appropriate for such a space? How do those values compare with similar spaces or music spaces for choirs?

- ### Expected outcome

  The target is to create a working acoustic model, which will provide valuable information of the church's acoustics and sound propagation.

### Student profile (1-2 persons)

This is a project for students interested in acoustics, both theory and application. You like to explore further room acoustics but also gain hands-on experience with acoustic measurements and computer modelling.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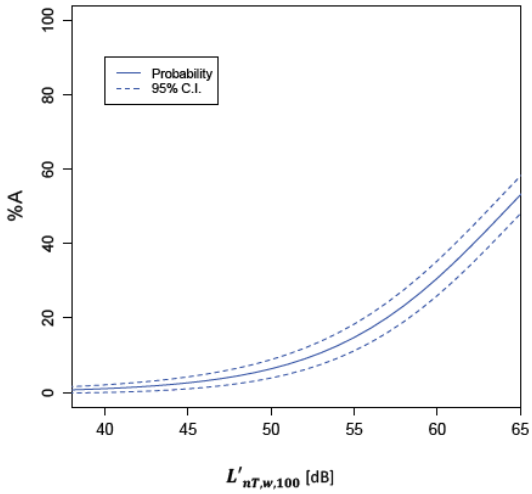
# Soundscapes data analysis: perception in Swedish apartments




## Objectives

Flat owners or renters still complain about various factors related to the sound environment at home. Better prediction of residents' perception in apartment buildings is demanded, especially after the entry of wooden buildings in the construction industry of Sweden. During this project, measured data from airborne and impact sound in flats is gathered. Then it is compared to subjective annoyance data of building's occupants (questionnaire survey).

- ## Main challenge

  To develop an acoustic comfort model, derived from statistical associations between building acoustic data and noise annoyance data.

- ## Research questions

  Which types of noise dominate the soundscape and mostly affect subjective annoyance in flats? What other factors play a big role in perception of sound environment at home? How do those factors relate to the building acoustic descriptors $\boldsymbol{D_{nT,w,50}}$ and $\boldsymbol{L'_{nT,w,50}}$? What about other acoustic metrics?

- ## Expected outcome

  The target is to build statistical models which describe the relation between measured acoustic data and subjective perception of residents.

## Student profile (1-2 persons)

This is a project for students interested in acoustics and data analysis. You like to explore further building acoustics, gain hands-on experience with ISO measurements and data analysis.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# Building acoustics investigation of wooden components

## Objectives

Concrete and wooden building components differ regarding their acoustic behavior. This project concerns investigation of modern CLT (or other wooden) floors, walls and junctions in order to study which configurations offer the best sound insulation conditions. Measured data from airborne and impact sound in CLT flats or in a lab setup will be gathered and analyzed accordingly.

- ### Main challenge

  To explore how the parameters of different building component configurations affect their acoustic behavior and sound insulation efficiency.

- ### Research questions

  Which parameters play a big role for sound insulation in wooden elements and what acoustic environment do they offer? Relation to building acoustic descriptors $\boldsymbol{D_{nT,w,50}}$ and $\boldsymbol{L'_{nT,w,50}}$? Which design principles and configurations work better?

- ### Expected outcome

  The target is to build a comparable dataset of various acoustic measurements from wooden elements and analyze their characteristics.

## Student profile (1-2 persons)

This is a project for students interested in acoustics and data analysis. You like to explore further building acoustics, gain hands-on experience with ISO measurements and data analysis.



| **Contact:** | Nikolas Vardaxis | nikolas.vardaxis@construction.lth.se |
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Acosense develops and sells non-invasive instruments for monitoring and analysis of processes and process fluids using vibrations as the main information carrier. We are now looking for master thesis students and below are one of two proposed master thesis projects.

Figure 1: Acosense instrument consists of piezo electric actuators, force transducers and accelerometers installed on the outside of pipes and tanks.

## Vibroacoustic methods for estimating density of a flow in industrial pipe systems

In a pipe with a fluid flowing through it the density of the fluid affects the resonance frequencies of the pipe. We often estimate parameters that are closely related to fluid density and would like to explore different methods for doing so.

One interesting way would be to estimate the fluid density as well as the other model parameters from measurements by using a model for a pipe-fluid coupled system at larger wavelengths and fitting it to the measurements. The difficulty here is that practice does not always match with theory. Boundary conditions are not as straight forward, and there may be other impedance changes in the pipes that a simplified model does not consider.

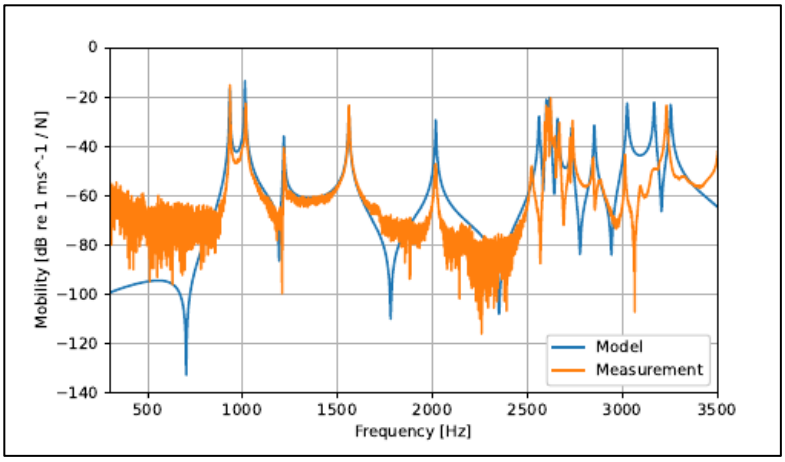


***Figure 2:*** *Model vs. measurement*

A robust optimization method is needed to fit the measurements to the model predictions automatically. Measurements in our lab will provide the initial dataset to fit a model to. Depending on those results additional measurements can be done in an external lab where the fluid density can be controlled with more precision.

During the thesis, you will be working with vibroacoustics, mathematical models, and optimization. The work is preferably done in Python. Performing measurements is a small part of the work.

Frederik Rietdijk

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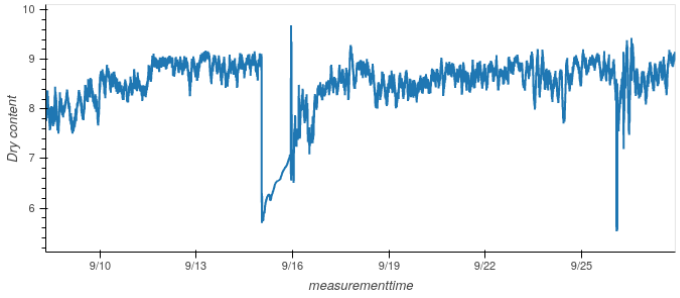
Figure 1: Acosense instrument consists of piezo electric actuators, force transducers and accelerometers installed on the outside of pipes and tanks.

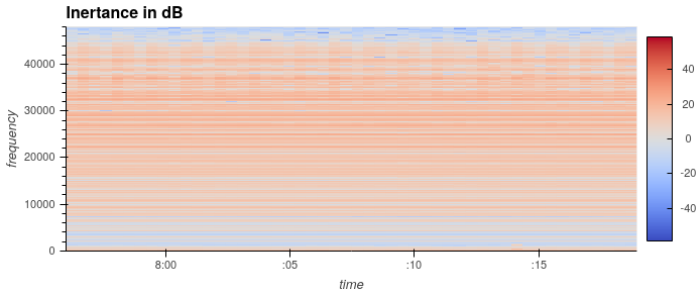
## Industrial process forecasting with machine learning

The goal of this master thesis is to forecast the quality and yield using the outputs from the Acosense sensors of a pulp mill. Additionally, the output may be tuned based on what the other sensors measure and data from several plants will be available. A pulp mill is a system with large time constants and large quantities of material involved with makes it challenging to control.

Pulp mills often use in the kraft process. The kraft process is a process for converting wood into wood pulp. Two steps in this process are the digestor and the recovery boiler. We would like to improve the performance of these systems using machine learning.

In the digestor wood chips are cooked to obtain pulp. Depending on what the pulp will be used for a certain quality is needed and given the required quality one wants to achieve the highest yield. Before cooking the chips are saturated with chemicals known as black and white liquor. The purpose of the recovery process is to recover as much as possible of these chemicals.




The whole process can take many hours, and the travel time of a piece of wood chip and pulp may fluctuate over time. Various sensors are setup in these processes. These sensors measure properties such as vibrations, pressure, temperature and dry contents.

This thesis requires a background in machine learning and specifically an interest in time series forecasting. The work is preferably done in Python.

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