CAMM Newsletter #7
August 2017

Ongoing PhD projects

Ester Creixell Mediante, Industrial PhD at Oticon: **Computational reduction techniques for numerical vibro-acoustic analysis of hearing aids**
Supervisors: Jonas Brunskog, Martin Larsen (Oticon) and Jakob Søndergaard Jensen.
Project running: 2014–2018
Current research activities:

- Finishing up the work on model order reduction for vibroacoustic problems done in the external stay at KU Leuven the past fall.
- Investigating topology optimization techniques for vibroacoustic problems with application to the design of hearing aid parts.

Saeed Doagou Rad, PhD student: **Experimental and Numerical Characterization of Nano-filled Polymers for Thin-Walled Micro Components**
Supervisors: Aminul Islam and Jakob Søndergaard Jensen.
Project running: 2015–2018
Current research activities:

- Investigation of the interaction between the different nanofillers namely Carbon nanotubes and Graphene nanoplatelets within the polymeric system.
- Investigation of the influence of nanofiller augmentation on the thermal and electrical conductivity of the hybrid nanocomposites initially filled with the copper microfibers.
- Theoretical modeling of the three dimensional damping and damage mechanisms in the short fiber (carbon nanotube) reinforced composites.
- Molecular dynamics simulation of the carbon nanotubes and Graphene nanoplatelets using Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS).
- Finite element modeling of realistic carbon nanotube filled composites using ABAQUS

Peter Risby Andersen, PhD student: **Numerical and Experimental Study of the Acoustical-Mechanical Interaction at the Micro Scale including Losses**
Supervisors: Vicente Cutanda Henríquez and Niels Aage.
Project running: 2015–2018
Current research activities:

- Investigation of the performance and stability of a newly developed tangential derivative boundary element approach for modeling of acoustic viscous and thermal dissipation.
- Development of a framework for boundary element shape optimization including dissipation.

Sümer Bartug Dilgen, PhD student: **Topology Optimization of Acoustic-Mechanical Interaction**
Supervisors: Jakob Søndergaard Jensen and Niels Aage.
Project running: 2017–2020
Current research activities:

- Development towards a framework for level set based topology optimization of vibro-acoustic problems.
- Investigation of the different approaches in topology optimization of coupled acoustic-structure interaction problems including level sets and density based methods.

Cetin Batur Dilgen, PhD student: **Transient Optimization of Acoustic-Mechanical Interaction Problems**
Supervisors: Niels Aage and Jakob Søndergaard Jensen
Project running: 2017–2020
Current research activities:

- Development of topology optimization based on the level set method for vibro-acoustic problems.
- Investigation of the current state-of-the-art approaches in topology optimization of coupled acoustic-structure interaction problems including level sets and density based methods.

New published papers

Lian, H., Christiansen, A. N., Tortorelli, D. A., Sigmund, O., & **Aage, N**. (2017). Combined shape and topology optimization for minimization of maximal von Mises stress. *Structural and Multidisciplinary Optimization*, *55*(5), 1541–1557. https://doi.org/10.1007/s00158-017-1656-x

Aage, N., & Egede Johansen, V. (2017). Topology optimization of microwave waveguide filters. *International Journal for Numerical Methods in Engineering*. https://doi.org/10.1002/nme.5551

Wu, J., **Aage, N**., Westermann, U., & Sigmund, O. (2017). Infill Optimization for Additive Manufacturing –Approaching Bone-like Porous Structures. *IEEE Transactions on Visualization and Computer Graphics*, *2626*(c), 1–11. https://doi.org/10.1109/TVCG.2017.2655523

Direct electroplating of plastic for advanced electrical applications, in journal: C I R P Annals (ISSN: 0007-8506) (DOI: http://dx.doi.org/10.1016/j.cirp.2017.04.124), vol: 66, issue: 1, pages: 209–212, 2017. Link to the paper: https://authors.elsevier.com/a/1VLRw1oFTGMZz (free download until August 27, 2017), http://www.sciencedirect.com/science/article/pii/S0007850617301245.
Contact: Aminul Islam

Vicente Cutanda Henriquez, in collaboration with José Sánchez-Dehesa and Víctor M. García-Chocano from the Universitat Politècnica de València, has published a paper entitled "Viscothermal Losses in Double-Negative Acoustic Metamaterials" in the journal Physical Review Applied (8, 014029, 2017).
Contact: Vicente Cutanda Henríquez

Journal paper titled "Topology optimization of periodic microstructures for enhanced loss factor using acoustic-structure interaction", *International Journal of Solids and Structures,* Vol. 122, 59-68 (2017). Authors: Kook J and Jensen JS.
Contact: Jakob Søndergaard Jensen

Journal paper titled "**Modal interaction and higher harmonic generation in a weakly nonlinear, periodic mass-spring chain**", *Wave Motion,* Vol. 68, 149-161 (2017). Authors: Frandsen NMM and Jensen JS.
Contact: Jakob Søndergaard Jensen

Journal paper titled "**Tailoring the nonlinear response of MEMS resonators using shape optimization**", *Applied Physics Letters,* Vol. 110(8), n. 081902 (2017). Authors: Li LL, Polunin PM, Dou S, Shoshani O, Strachan BS, Jensen JS, Shaw SW and Turner KL.
Contact: Jakob Søndergaard Jensen

Conferences

Ester Creixell Mediante attended the conference "Acoustics'17" (the third joint meeting of the Acoustical Society of America and the European Acoustics Association) in Boston, Massachusetts, USA, in June. Ester gave a presentation entitled: "Reduced Order Modeling in Topology Optimization of Vibroacoustic Problems".

Vicente Cutanda Henriquez has attended the 3rd Joint Meeting of the Acoustical Society of America (ASA) and the European Acoustics Association (EAA), held in Boston (USA) on 25th-29th June and presented an invited abstract entitled "Effects of visco-thermal losses in metamaterials slabs based on rigid building units", together with José Sánchez-Dehesa and Víctor M. García-Chocano from the Universitat Politècnica de València.

Vicente Cutanda Henriquez participated in the 24th International Congress on Sound and Vibration, held in London on 23rd -27th July. Vicente was invited to the session on *acoustic metamaterials and phonic crystals* with the paper entitled "Numerical models of single- and double-negative metamaterials including viscous and thermal losses". His coauthor was José Sánchez-Dehesa.

Vicente Cutanda Henriquez and **Peter Risby Andersen** submitted and presented abstracts at the 13th International Conference on Theoretical and Computational Acoustics (ICTCA 2017), held in Vienna from 30th July to 3rd August. The titles were "Boundary Element Method with Viscous and Thermal Losses: A Calibration Microphone Test Case" and "A Hypersingular Boundary Element Formulation Including Viscous and Thermal Losses".

Peter Risby Andersen has attended DAGA 2017, the 43rd Annual Conference on Acoustics, held in Kiel (Germany) on the 6th - 9th March. Peter presented the paper entitled "Numerical Acoustic Models

Including Viscous and Thermal losses: Review of Existing and New Methods", co-authored by Vicente Cutanda Henríquez, Niels Aage and Steffen Marburg from the Technical University of Munich.

Niels Aage organized a tutorial at Eurographics in Lyon, France, April 2017 on topology optimization for shape generation and additive manufacturing. Authors: Wu, J., Lefebre, S., Wang, C.C.L & Aage, N.

Niels Aage attended WCSMO 12 in Braunschweig, Germany June 2017 and presented work on Electro-acoustic-mechanical topology optimization. Authors: Anders L. Møller, Jakob Søndergaard Jensen & Niels Aage

Niels Aage attended X-DMS in Umeå, Sweden June 2017 and presented work on Electro-acoustic-mechanical topology optimization. Authors: Anders L. Møller, Jakob Søndergaard Jensen & Niels Aage

Tolerances in micro manufacturing, part of: Proceedings of the 2017 World Congress on Micro and Nano Manufacturing, 2017, Presented at: 2017 World Congress on Micro and Nano Manufacturing (WCMNM 2017),, 2017, Kaohsiung
Contact: Aminul Islam

Influence of Processing Conditions on the Mechanical Behavior of MWCNT Reinforced Thermoplastic Nanocomposites, Procedia C I R P, Presented at: 1st CIRP Conference On Composite Materials Parts Manufacturing, 2017, Karlsruhe
Contact: Doagou Rad, Saeed ; Islam, Aminul ; Jensen, Jakob Søndergaard

3D Printing of Bio-inspired surfaces, 644 Wilhelm und Else Heraeus Semina, Bad Honnef, Germany, May 29-31, 2017.
Contact: Aminul Islam

MIDs- make plastic smart, World congress on smart materials, Bangkok, Thailand, March 16-18, 2017.
Contact: Aminul Islam

Jakob Søndergaard Jensen attended the ECCOMAS conference on Coupled Problems (June 11th – 15th) in Rhodes, Greece with a presentation on *"A new method for topology optimization of acoustic-structure interaction"*.

Saeed Doagou Rad presented his paper titled "Influence of processing conditions on the mechanical behavior of MWCNT reinforced thermoplastic nanocomposites" on the "advanced manufacturing processing" session at the CIRP Conference on Composite Materials Parts Manufacturing 2017 (CIRP CCPM) on 8th – 9th June in Karlsruhe, Germany.

Cetin Batur Dilgen and **Sumer Bartug Dilgen** presented papers at WCSMO12 in Braunschweig, Germany June 2017. The presentations were titled "Topology optimization of turbulent flows with the RANS k-omega model" and "Density based topology optimization of turbulent flow heat transfer systems". Authors: Cetin Batur Dilgen, Sumer Bartug Dilgen, David R. Fuhrman, Ole Sigmund, Boyan S.

Lazarov

Upcoming conferences

Vicente Cutanda Henriquez has co-authored the paper entitled "Environmental coefficients of the free-field sensitivity of measurement microphones", submitted to the Internoise 2017 conference to be held in Hong Kong on 27th– 30th August. The paper will be presented at the conference by Salvador Barrera Figueroa, from Danish Fundamental Metrology (DFM).

Saeed Doagou Rad will give a talk at 6th ECCOMAS Thematic Conference on the Mechanical Response of Composites on 20th- 22th September in Eindhoven, Netherland. The title of his paper is "Multiscale modeling of the structural and vibrational behavior of carbon nanotube reinforced polymeric nanocomposite plates".

Aminul Islam will attain 33rd Annual Meeting of the Polymer Processing Society held during December 10-14, 2017 in the City of Cancun, Q.R., Mexico.

Aminul Islam is an invited speaker for 4th Congress of Smart Materials-2018, to be held in March, 2017, Osaka, Japan. He will also organize and chair the session of Shape memory Polymers.

Upcoming courses

Numerical Acoustics 31265 - The third edition of the course will start in September. The course responsible is Vicente Cutanda Henriquez.
Contact: Vicente Cutanda Henriquez

The 3-week course 41743: Next run of DTU course 41743 (3 week course on Micro Product Design, Development and Production) is planned for Jan 2018 in collaboration with Widex A/S. The intake capacity of the course has been increased by 25% due to high interest for the course among DTU students.
Contact: Aminul Islam

Fagprojekt 41801: From 2018 (Feb-June), Aminul Islam will run DTU course 41801 together with Knud Erik Meyer. This is a compulsory course on the Bachelor in Mechanical Engineering. In this course the students try to solve a both practical and theoretical exercise in a team and get acquainted with project work in larger groups (typically five members). The students obtain experience in solving a practical construction exercise followed by a presentation of the solution and an associated written documentation (a report) over both the solution but also on the solution process itself. The problems dealt in the course usually come from various industrial sectors. If you are interested to be part of this course by providing industrial problem or by providing supervision, you are welcome to contact.

Contact: Aminul Islam

Completed courses

41813: **FEMVIB** - "Finite element based vibration analysis and acoustic interaction" ran for the third time in the spring semester of 2017. This time 34 students participated in the course.
Contact: Jakob Søndergaard Jensen or Niels Aage

41591: The PhD-course on Topology Optimization took place from June 21st-27th 2017. The record number of 60 participants included Rene Christensen from GN Resound.

Master and Bachelor projects – completed and ongoing

Sarunas Alijosius (MSc): Modelling, evaluation and optimization of contacts in hearing aids (carried out in collaboration with Oticon) under the supervision of Ester Creixell Mediante and Niels Aage.
Contact: Ester Creixell Mediante and Niels Aage

Christian Rye Thomsen (MSc): Buckling Optimization of Extremal Materials (30 ECTS). Completed
Contact: Niels Aage

Erik Träff (BSc): Interactiv finite element methods. Completed
Contact: Niels Aage

Hansotto Kristiansen (MSc): Density based topology optimization for frictional contact problems. Completed
Contact: Niels Aage

Daniel G Nielsen & Søren D. Pedersen (MSc): Topology optimization and experimental validation of microwave waveguide filters. Completed
Contact: Niels Aage

Mati Malik (BSc): Optimization, coating and experimental verification of high-end sports components. Completed
Contact: Niels Aage

Morten Rasmussen (MSc): Shape optimization of flow problems using panel methods. Ongoing.
Contact: Niels Aage

Lukas Blume (MSc): Efficient transient topology optimization through dynamic substructuring. Ongoing.
Contact: Niels Aage

Martin Ohrt Elingaard (MSc): Structural optimization using CutFEM. Ongoing.
Contact: Niels Aage

Timea Denisa Merca, "Design and evaluation of tunable vent for RIE earmould", Department of Mechanical Engineering, Technical University of Denmark, August 2017. **Partner: GN Resound A/S.**
Contact: Aminul Islam

Rosa Camilleri Lledo, "Fabrication of a Gecko adhesive tape and its application to wall-climbing robots", Department of Mechanical Engineering, Technical University of Denmark, July 2017. **Partner: University of Southampton, UK.**
Contact: Aminul Islam

Christian V. Jensen, "Battery Replacement System for Hearing Aids", Department of Mechanical Engineering, Technical University of Denmark, June 2017. **Partner: Widex A/S.**
Contact: Aminul Islam

Jens Mørup, "Comfortable hearing aid remote fitting device developed with co-creation", Department of Mechanical Engineering, Technical University of Denmark, April 2017. **Partner: Widex A/S.**
Contact: Aminul Islam

Lisa Rabenow, "Development of Materials and Manufacturing Processes for the Production of Artificial Human Teeth", Department of Mechanical Engineering, Technical University of Denmark, February 2017. **Partner: Dentawi ApS.**
Contact: Aminul Islam

Jonathan Alexander successfully defended his Master thesis entitled "Approaches to modelling pressure gradient microphones" on 7th July. This project was run in collaboration with the Danish company DPA microphones.
Contact: Vicente Cutanda Henríquez

Alexander Hvid Jessen completed and successfully defended his master project in June 2017 in collaboration with Widex A/S (Lars Friis) on "Topology optimization of sound pressure generated vibrations".
Contact: Jakob Søndergaard Jensen

New master projects - fall 2017

Macarena Mendez Ribo, "3D Printing of Bio-inspired Surfaces", Department of Mechanical Engineering, Technical University of Denmark, Expected to be finished by September 2017.
Contact: Aminul Islam

Ammar Alnasser, "Development of thermally / electrically conductive hybrid composites", Department of Mechanical Engineering, Technical University of Denmark, Expected to be finished by November 2017.
Contact: Aminul Islam, Saeed Doagou Rad

Vittorio Albertazzi, "Encapsulation of thermal sensor for microwave heating application", Department of Mechanical Engineering, Technical University of Denmark, Expected to be finished by November 2017. **Partner: Senserna ApS.**
Contact: Aminul Islam

Anna Halina Danielak, "Injection moulding of Shape Memory Polymer (SMP)", Department of Mechanical Engineering, Technical University of Denmark, Start: September 2018.
Contact: Aminul Islam

Wahib Joseph Abboud, "Micro Moulding (Tentative)". Start: September 2018.
Contact: Aminul Islam

Nicolai Domingo Nielsen, "LDS MID for hearing aid antenna application". Start: September 2018.
Partner: GN Resound, (Tentative).
Contact: Aminul Islam

Grant applications

Villum Young Investigator: Funding application on "Topology optimization for electro-acoustic-mechanical systems" was send to the Villum Foundation for a total of 9.9 million DKK. The project was rejected and a smaller version of the same project will be submitted to DFF-FP1 September 2017.
Contact: Niels Aage

Marie Curie ITN project- SIMEC: The SIMEC project submitted under ITN call 2016-2017 (Aminul Islam as project coordinator) has been received a favorable evaluation (score 93.8%), but still have not received the funding (given the budgetary limits). It has however been put on the reserve list of proposals that might be invited to grant preparation, if proposals with a higher ranking drop out or additional funding becomes available. So at this stage we are waiting for the final decision from European Commission. The project has been planned to re-submit for the next call and all partners are highly interested to retain the partnership.
Contact: Aminul Islam

Marie Curie IF project- MNN-ECP: We are currently working on Marie Curie Individual Fellowship (IF) grant. The potential candidate is **Dr. Ibrahim Khan** from USA. The fellow will be supervised by Aminul Islam and the project will deal with the fabrication of Metal Nanowire Networks for Enhancing the Conductivity of Plastics.
Contact: Aminul Islam

Saeed Doagou Rad has been awarded a scholarship from Karlsruhe Nano Micro Facility (KNMF) in Germany to conduct in collaboration with them on a project titled "Compounding, simulation, processing, and investigation of nanofiller and metal fiber filled thermoplastic-based composites". In this regard, a separate application has also been submitted to Otto Mønsteds Foundation.

Miscellaneous

Jungwhan Kook has left CAMM as of June 2017 and been employed at GN Jabra.

Saeed Doagou Rad will have an external research stay at Institute for Applied Materials - Materials Science (IAM-WK) in Karlsruhe Institute of Technology (KIT) with the main focus on the micro-manufacturing and processing simulation of the hybrid and nano composites from 1st Oct. – 1st March 2018.

MTS Acumen Electrodynamic Test System installed in the DTU mechanical department has been upgraded for the Dynamic Mechanical Analysis (DMA) tests with the joint financial support received from Fabriksejer, Civilingeniør Louis Dreyer Myhrwold og hustru Janne Myhrwolds Fond and CAMM. The instrument is currently located at DTU Building 414, and will be used in the CAMM projects.
Contact: Aminul Islam, Jakob Søndergaard Jensen, Saeed Doagou Rad

CAMM people:

Nadia Larsen – Group coordinator: njl@elektro.dtu.dk – 45253931
Jakob Søndergaard Jensen – Head of CAMM: json@elektro.dtu.dk - 45253936
Aminul Islam – Associate professor: mais@mek.dtu.dk - 45254896
Niels Aage – Associate professor: naa@mek.dtu.dk – 45254253
Vicente Cutanda Henriquez – Associate professor: vcuhe@elektro.dtu.dk – 45253938
Ester Creixell Mediante- Industrial PhD – DTU Elektro/Oticon - ecrme@elektro.dtu.dk
Peter Risby Andersen – Phd student – DTU Elektro - prand@elektro.dtu.dk
Saeed Dougou Rad – Phd student – DTU MEK - sadora@mek.dtu.dk
Cetin Batur Dilgen – Phd student – DTU MEK - cedil@mek.dtu.dk
Sümer Bartug Dilgen – Phd student – DTU Elektro - sydil@elektro.dtu.dk