NAFEMS UK Regional Conference 2018 - Abstract Submission

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| **Name** | Mrs. Leonie U |
| **Job Title** | Marketing Manager |
| **Company** | Siemens |
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| **Will you be the presenting author?** | No |
| **Presenting Author** | Mr. Kaushik Illa |
| **Presenting Author Company** | Siemens |
| **Presenting Author Job Title** | Manager |
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| **Presenting Author City, State/Province** | Bellevue<br>United States |
| **Presentation Title** | Vibro-Acoustic Analysis of a Permanent Magnet Machine for Electrical Vehicles |
| **Relevant Themes / Keywords** | Vibro-acousitc, hybrid vehicle, CAD elextric vehicle, |

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| **Abstract (plain text)** | With the emergence of hybrid vehicles and the significant reductions of combustion engine noise achieved in the past few years, new challenges arise. In particular, electric machines have become a significant contributor to noise in cars. The noise produced by a machine in operation can be assessed early on in the design process using simulation methods (virtual prototyping). In this paper, we present a series of tools chained seamlessly from the electromagnetics inputs to the noise outputs.<br>This paper presents currently available methods for assessment of the noise induced by the magnetic field in a brushless permanent magnet machine. The method combines an original method based on Finite Volumes to get the electromagnetic forces together with Finite Elements to compute the structural response, and a Boundary Element Method to compute the induced noise. Special care is taken on the interfaces between the methods used, both in terms of accuracy and ease of use. This machine was selected, as they tend to generate noise in vehicles, which makes the problem more interesting to solve. The process begins with the geometry creation; this is done in the software SPEED, using either templates or an embedded CAD modeler. This is where the control parameters are defined for example, the current, the voltage, the circuit regulation topology, phase advance angles and other parameters which are essential in defining the electromagnetic characteristics of the machine. The current profile from SPEED is imported into STAR-CCM+ where the objective is to calculate the electro-magnetic surface force distribution, and record their time history in a file that will be read in the vibro-acoustic analysis. In this paper we present a novel approach using a finite volume discretization technique to a 2D section of an electric machine and obtain the magnetic field distribution and electromagnetic force acting on the stator surface of an electric machine.<br>In a second part of the paper a vibro-acoustic analysis is presented where we use Virtual Lab (VL). A coupled structural-acoustic model is created in VL where the geometry and loads are imported to define spatially distributed loads. The procedure is different from those published by other authors who have illustrated the use of numerical methods for similar purposes; however they have some practical limitations. The vibro-acoustic coupling was usually handled using a weak formulation, whereas a strong formulation is better suited to a vaster category of problems (the electric motor may be placed in a thin plastic enclosure, possibly with foams around, for example). In addition from the prior references, the quality of the mapping between the tools required a specific interface, external to the tools used for each sub-task (electromagnetic or vibro-acoustics); this usually meant great care on the user side. In this work we propose an embedded mapping method, more comfortable for industrial usage. The surface loading on the stator uses electromagnetic forces as a source in a fully strong-coupled vibro-acoustic analysis of the stator and housing compounds; the problem is solved using a state of the art FEM-BEM solver. Results include sound pressure level spectra, and informative visualization of the dominant structural modes at the peaks, which opens perspectives for design improvements.<br><br>A chain of tools will be illustrated using the state-of-the-art methods all part of Siemens Simcenter portfolio. Special care was taken to have a good mapping procedure to ensure a good quality of the final results. The automation of the vibro-acoustics steps enables the use of the tool chain by non-vibroacousticians |
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