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Dear Stakeholder in Noise and Smart Structure Technology,

Over the last six months, InMAR was quite active in finishing its successful second year. Following the baseline analysis of considered applications, solutions are currently designed showing the feasibility of an active noise reduction in all transport related applications.

Besides, more and more enabling technologies are provided allowing the commercial implementation of active systems. Many InMAR partners were also quite active in presenting their results at European and international conferences. This second issue of InMAR's Newsletter gives an update on the progress and informs you on the latest news regarding InMAR.

Research Training Network on a Computer Aided Engineering Approach to Smart Structures Design

Out of the InMAR consortium, a research training network (RTN) on smart structures has been proposed under MarieCurie and finally approved earlier this year. This RTN network is complementing the RTD activities performed in InMAR and aims at further extending, integrating and consolidating the knowledge in the different research fields of InMAR by a structured research training program, with a main focus on integrating the research results in system-level solutions. The overall objective of the RTN network is to develop an educational and research framework for developing macro-scale noise control applications based on intelligent material systems. The scientific and technological objective of the network is to advance the state-of-the-art in smart materials research to the level of system integration and industrial applicability, with a specific focus on solutions for noise and vibration reduction and for vibration-based damage

detection. This requires that the involved research teams not only focus on the development and use of novel materials and control algorithms, but that they explicitly address the integration into sensor/actuator material systems and even further into application-level solutions. The study will include not only the target performance of the solutions, but also their constraints with respect to system reliability and cost. In this process, particular attention is paid to modelling aspects on the different scales: models for the intelligent materials and material systems, for the sensors and actuators, for the integrated control systems and the system-level applications.

The RTN will start in January 2007 but is already open for applications of Early Stage Researcher. Young researchers interested in a position within the RTN may contact the RTN coordinator Wim Desmet (wim.desmet@mech.kuleuven.be) or the InMAR secretariat for further information.

The InMAR Female Network

The Female Network initiated within InMAR as one of the key gender related activities has now been established with its first meeting held May 3rd in Berlin. The Female Network is aimed at being a platform to discuss gender aspects in professional life and to promote female researchers. At the meeting, an action plan was discussed and agreed upon. Among others, the focus will be on recruiting more women for engineering-related topics starting already at elementary and high-school level, to provide monitoring and coaching programs and to raise the awareness of existing differences in professional life of women and men. It is of great importance for the network that it does not end with InMAR. So everyone in the European Research Area interested in this network is very welcome to take part. Detail information can be obtained from the IP secretariat.

Any Questions?

Please contact us!

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Participants of the 1st InMAR Female Network workshop



Commissioner Potocnik, Minister Frankenberg (Baden-Württemberg), Prof. Bullinger (FhG Board member) and Dr. Bein discussing active noise reduction at the Fraunhofer Day in Brussels

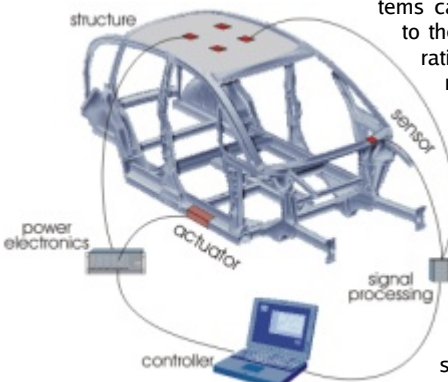
InMAR Present at Conferences

Many InMAR partners were participating at various conferences world-wide presenting their results obtained within InMAR. Over the last two years about 70 publications were made of which some can be found on InMAR's homepage. Highlights were the Forum Acousticum 2005 in Budapest and the Euronoise 2006 in Tampere, both coordinated by InMAR partners with sessions dedicated to InMAR. In addition, general overviews on InMAR were and will be presented at major conferences on noise and transport issues. This year, InMAR will be presented e.g. at the Transport Research Arena 2006 in Göteborg and the TRANS-FAC 2006 in San Sebastian. Another highlight was the Fraunhofer Day in Brussels where InMAR was presented to Commissioner Potocnik.

What are Intelligent Material Systems and Adaptive Systems?

The constantly growing demands on modern structure systems today increasingly cause conventional passive as well as active mechatronic approaches to reach their technical and economic feasibility limits. Adaptive structure technology (smart structures) based on intelligent material systems is an innovative, new cross sectional technology for the optimization of structure systems. It is based on the integration of additional functionality by combining conventional structures with intelligent material systems, which extend the classic function of load-bearing and form-defining structure to sensing and acting capabilities. In connection with suitable adaptive controller systems, adaptive structure systems can optimally adapt to their respective operational environment. Intelligent material systems themselves are built up from of passive, conventional light weight materials and so-called transducer materials with acting and sensing properties.

By using this approach, modern structures can be implemented easily and compactly as well as with low-vibration and low-noise and/or as dimensionally stable as well as with the potential for

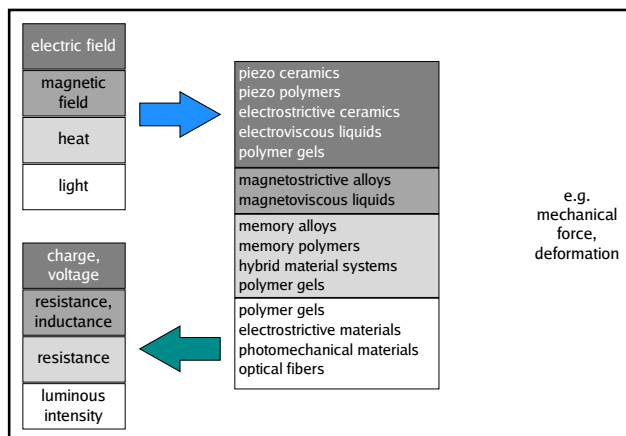


structure integrated monitoring. This leads to the protection of raw materials, lower environmental stress resulting from noise and emissions, lower system and operating costs and higher functionality and efficiency of systems.

While mechatronics extends the functionality of the existing structure system pertaining to a design point mainly by adding components, the core goals of adaptive structure technology consist

- in the continuous interference into the structure-mechanical, mostly structure dynamic, characteristic of the overall system and
- in the optimization of the structure system by replacing structure components with intelligent material systems (effective in the sensor-actuator sense) to save mass and designed space

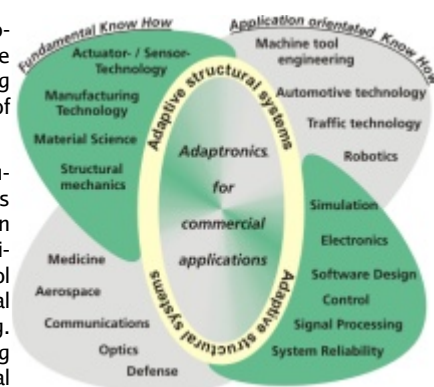
Adaptive or intelligent solutions are thus characterized by a function integration and a certain measure of function consolidation, i.e. a structure conformed integration of the sensor characteristics and actuator components, and an active system intervention while assuming mechanically load-bearing characteristics in the overall structure. They fundamentally expand the structure characteristics and permit the fight against structure disturbances at their source, in the transmission paths and/or in sensitive areas of the system. Adaptive structure technology can be understood as a logical consequence of mechatronics, which does not lose their importance, however.



The goal of adaptive structure technology is to influence structures. By so doing, a new technology is made available to the user to optimize his/her products. The main focus is in particular the vibration reduction, noise reduction and the structure integrated damage monitoring. Likewise of importance are shape control and the fine positioning. At the same time, further applications can be derived from the partial competences.

The need for innovative adaptive measures is rising for many fields of application.

A need for solutions usually exists in the vibration and noise reduction, shape control and the Structural Health Monitoring. By implementing adaptive structural

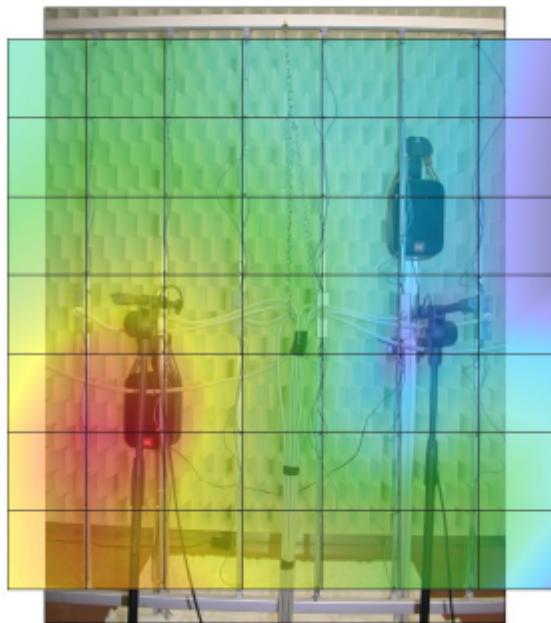




measures, functionality, life span, comfort, security, production efficiency and quality are to be increased and stresses, weight and costs reduced.

Adaptive Noise Control

Contrary to passive structural measures of noise reduction that concentrate on the strong increase of structure mechanical impedance and structure damping by adding material, adaptive noise reduction is based on the principle of replacing passive structure components with active, multi-functional components, to control these adequately and thus counteract the spreading structure-borne sound and the propagation of interference energy and not only the consequences of the interference.



This means that ideally the sound energy's interfering radiation is not only reduced by active countermeasures, but rather prevent such noise disturbance. This approach of active structure influence is summarized under the term of the Active Structural Acoustic Control (ASAC).

In contrast, the manipulation of active noise according to the well-known principle of Active Noise Control (ANC) pursues the goal of weakening primary acoustic sources and their emitted sound by superimposing artificially produced sound fields and destructive interference. To accomplish this, secondary sources (loudspeakers) are electronically controlled.

Selected Results

Noise Reduction by Tunnels and Bridges

The work area aims at developing active solutions for noise reduction of steel bridges and reduction of squeal noise in tunnels. The effort spent so far has been focused on different activities such as investigation on bridge noise and squeal noise, conceptual design of noise reduction solutions, selection of actuator concepts and extensive numerical and experimental study. Based on these outcomes and requirements, the design of the active systems will be reviewed and optimized with special attention to noise reduction performance, actuator design and integration, control strategy, and feasibility considerations.

Regarding bridges it was shown that the bottom plates of the railway bridge, due to their large radiating areas, are the main contributors to the far field pass-by noise levels. It was further concluded that using Active Damping Devices (ADD) to reduce

structural resonances of the lateral steel plates of the bridge would not be effective in reducing the far field noise. According to these results, it has been necessary to envisage the wide-band control of the bottom plates of the steel bridges. This can be done with the ADD providing that actuator is stiffened to allow for vertical operation and that the analog control board is replaced by a digital one. The latter would allow implementing either (i) wide-band feedback controllers, (ii) noise-cancellation feed forward controllers or (iii) local active damping controllers, as the analog version, but with a higher degree of flexibility.

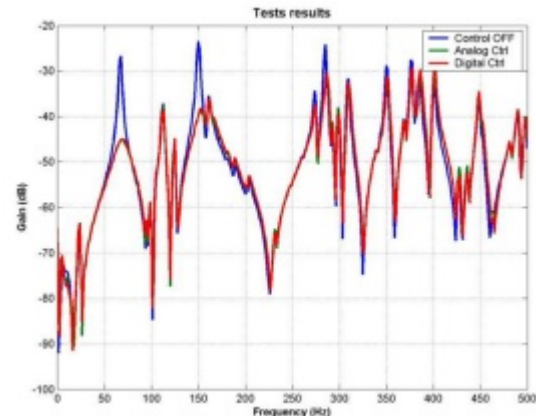


Fig. 3 Performance of the active damping device (Source D2S)

Noise Reduction by Power Trains and Bogies

The work area "Power Train and Bogies" considers the propulsion system, i.e. powertrain (diesel engine and gearbox) and the bogie as the main issue, especially in the case of diesel propelled vehicles. Background is a Diesel Multiple Unit vehicle by Bombardier, developed to the state of the art with passive Noise Vibration and Harshness (NVH) technologies. Three major operating areas were pre-selected so far, decoupling, shell noise and encapsulation. Whereas in total four ANR applications are actually under investigation:

- Diesel engine encapsulation by active shielding
- Active in-duct valve system in exhaust system
- Active vertical damper in secondary bogie suspension
- Active vibration control in second suspension stage of Diesel engine

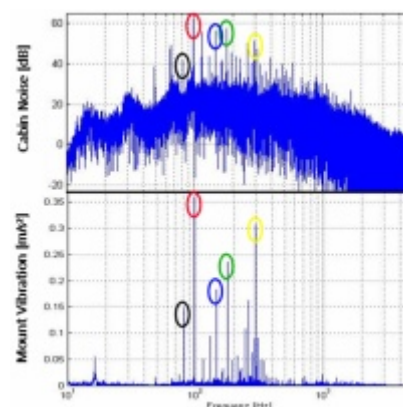


Fig. 2 Correlation Mount Vibration / Cabin Noise (Source FEV)

Two major noise and vibration test campaigns were carried out to provide baseline data for the AGC train. In parallel, a vibro-acoustic model of the train engine in view of active control design was established including an experimental study of the noise components and building an experimental and a numerical boundary element model to derive surface-level source descriptions. Based on these models, a coupled vibro-acoustic model of an encapsulated engine was derived and validated



with experimental data. This model was then used as the basis for building models including active noise control which can be used in optimization algorithms for position and strength of active monopole sources. With respect to structure-borne noise and vibration from diesel engines, an FEM model of the DMU (Diesel Multiple Unit: engine and generator) was set-up and first simulations with regard to power train vibration excitation and the related power train vibration natural vibration modes were performed (Fig 2). The environment for a smart interface to reduce the power train vibration transmission via the sub frame mountings into the train chassis (car body) and the active device mechanical characteristics required were assessed based upon experimental data. A piezoceramic-technology based interface seems to represent the technical solution able to cover the desired frequency range and to provide the necessary displacement / force profile.

Any Questions?

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