InMAR Newsletter 2005

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Dear Stakeholder in Noise and Smart Structure Technology,

It has now been about one year since the Integrated Project "Intelligent Materials for Active Noise Reduction – InMAR" has had its official project start. After a successful start, first dissemination and training activities come in play of which this newsletter is just one tool. The aim of the Newsletter is to get you as stakeholder in touch with InMAR and to inform you on a regular basis on the newest results of InMAR or activities planned by InMAR.

Short Introduction to InMAR

Last year the European Commission launched a 27 million € Integrated Project (IP) that seeks to reduce noise levels associated with transport systems and infrastructures. Noise is a serious form of environmental pollution believed to affect the lives of some 100 million European citizens. The cost of the associated damage is estimated at more than ten billion euro per year. Now, under the nanotechnologies and nanosciences, knowledge based multifunctional materials and new production processes and devices (NMP) section of the Sixth Framework Programme (FP6), a consortium of some 41 partners from 13 European countries is preparing to address the problem. 'Intelligent materials for active noise reduction' (InMAR) aims to reduce noise levels associated with road and rail transport, both interior and exterior, as well as associated infrastructure such as bridges. The IP InMAR is aiming at introducing new technologies into mass production, which have proven effective in the laboratory.

During the last decade, fundamental research on smart structures using intelligent materials has raised industrial interest in applying these results to many problems found in commercial and civil life. The main objective of smart structure technology is noise and vibration reduction in civil engineering, machine tools, automobiles, trains, and aerospace engineering. Both strongly coupled phenomena limit the design of highly advanced and efficient lightweight structures, whereby nowadays noise is considered one of the worst forms of environmental pollution worldwide. In addition to simply being annoying, day-to-day noise exposure may cause serious health problems such as sleep disturbance, stress, disturbance of mental activities, hardness of hearing, and even deafness as well as an increased risk of heart attacks. Consequently, the political target of the EC must be the substantial reduction of the number of people regularly affected by long-term, average levels of noise. The EC is defining new standards for the year 2010 to compensate for these noise emissions, targeting a reduction of 19 dB(A) for road traffic and an even higher required reduction of 21 – 26 dB(A) for freight rail traffic. It is obvious that the EC goals cannot be achieved with advanced traffic management or political methods (e.g. traffic restriction) alone. An approach based on lightweight design and smart structure technology combined with traffic management concepts has to be pursued.

Beyond their impact on noise, smart structure technology will for the first time allow for a concurrent lightweight design that enables the efficient use of natural resources in the product itself (less fuel consumption, less exhaust emission,…). With the upcoming demand of highly efficient, emission-less lightweight structures and increased standards for any type of emission, new intelligent materials systems are needed that allow for both highly damped and controllable as well as light but durable structures for any type of high-tech application.

In order to gap the bridge between fundamental research and applied technology the consortium of the IP InMAR consists of all leading research institutions in Europe (8 research organizations, 11 universities) in the field of smart structures and intelligent material systems as well as most of the major industries of the intended applications (23 companies), 8 of which are considered SMEs. The consortium combines researchers from various, complementary specialties and enables the cross-frontier cooperation of partners beyond their traditional target markets by providing S&T excellence and by ensuring the quality of the consortium. The scientific and technological objectives are reflected in the structure of the IP as shown in Figure 1 below. According to these objectives, the IP InMAR is structured in three complementary technology

Any Questions?

Please Contact Us!

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areas (sub-projects) dealing with intelligent material systems and their integration, simulation, and life-cycle aspects. These technology areas strictly concentrate on providing the enabling technology required for the application scenarios but at the same time strongly rely on the system definitions and requirements provided by them. The application scenarios again are divided into three sub-projects for application, integration, and verification in automotives, trains, and infrastructure.

Cluster 1: Technology Area	Enabling Technology / System Requirements	Cluster 2: Application Scenarios	
Sub-Project	Work Areas	Sub-Project	Work Areas
TA 1 Intelligent Material Systems	Material Systems	AS 1 Noise Reduction in Automotives	Tires & Brakes
	Actuator & Sensor Systems		Power Train
	Manufacturing		Sheet Metal Parts
	Control		Car & Truck Bodies
	Electronics		Sound Quality of Interior Noise
TA 2 System Integration	Simulation & Optimization		Noise Transmission of Windows
	Electronic & Control Systems	AS 2 Noise Reduction in Trains	Wheels & Brakes
	System integration		Power Train & Bogie
	Characterization & Validation		Ventilation
TA 3 Life-Cycle	Reliability	AS 3 Noise Reduction in Infrastructure	Windows & Facades
	Condition Monitoring		Bridges & Tunnels
			Elevators

Figure 1: InMAR Project Structure

The InMAR Homepage

The InMAR homepage can be found at www.inmar.info. This homepage will constantly be updated according to the project progress. It is structured in such a way that it can be used as an interactive tool to provide recent information for the targeted audience as well as useful information for the sectors concerned. The homepage leads to pages with general description of the project and its objectives, participating partners and information on the research performed and results obtained as far as they are for public use. Links are given to organisations, public bodies and projects connected to InMAR. It is also used to distribute public deliverables, project brochures and to announce conferences, workshops and calls performed by the consortium.

One key feature of the homepage is a discussion forum (newsgroup) for all stakeholders in smart materials, vibro-acoustics and noise & vibration control. The purpose of this forum is to get in touch with you as stakeholder discussing or exchanging information on InMAR related topics. You can join the newsgroup either as guest or as registered user. All guests can enter the newsgroup on a read-only basis. If you are interested in obtaining further information on InMAR-related topics or in providing comments and/or suggestions to the InMAR consortium or would like to discuss specific problems, a registration is required. As registered member access to the InMAR public section of the BSCW-server is granted where selected scientific and technical information as well as non-confidential project results are placed. Please visit our homepage and register as member. We want to hear from you.

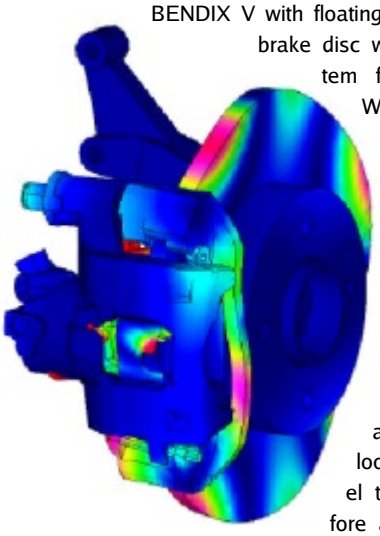
Local Dissemination Points

Within the InMAR project, special focus is given on the dissemination of results to the local SME industry by introducing regional dissemination nodes. Local SME's are not necessarily involved in international research programs. With a dedicated technology transfer by partners of the InMAR consortium, local seminars will be set up to enhance their knowledge on the topics of the project. Furthermore, premium access will be granted to selected project training activities and assistance will be provided in using the technology considered in InMAR. These dissemination nodes are currently implemented. Please visit our homepage to obtain further information.

First Selected Results

Noise Reduction in Brakes

The WA "Tires and Brakes" deals with tire/road interaction as the main source of noise of automobiles at higher speed. With respect to the work tasks on brakes, the brake system BOSCH BENDIX V with floating caliper and not-ventilated brake disc was chosen as target system for in-depth investigation. With this system four major work tasks have been carried out dealing with the simulation of the active system, the actuator concepts, modelling of the passive brake system and first experimental investigations.



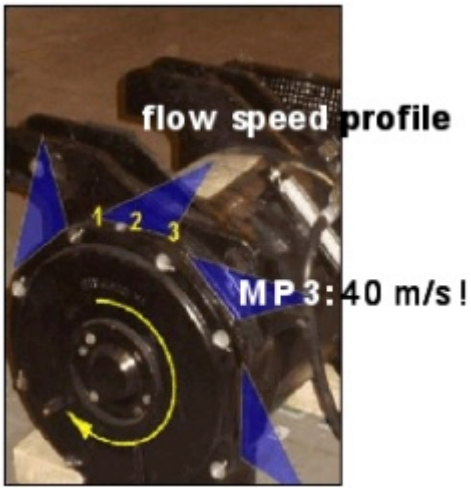
Bosch Bendix V – most critical eigenmode at 3.3 kHz (Source: C.R.F.)

In order to model the active system in closed loop it was necessary to model the Brake System. Therefore an NVH FE model of the Bosch Bendix V brake system has been created. This baseline model has been meshed and assembled appropriately in order to simulate the real mechanism of the brake. It consists of about 25000 grids in order to be of sufficient complexity to enable frequencies of up to 15 kHz to be detected and analyzed. The model will be the base for the numerical – experimental comparison as well as the baseline for the simulation of self–excitation mechanism. This model has already been tested and validated with respect to the functional specification of the brake. Based on this model, the underlying brake squealing problem including the self excitation mechanism has been assessed. In future work, the NVH-Model has to be reduced in its complexity in order to perform simulation in the MATLAB/SIMU-LINK environment of the active system to be

developed.

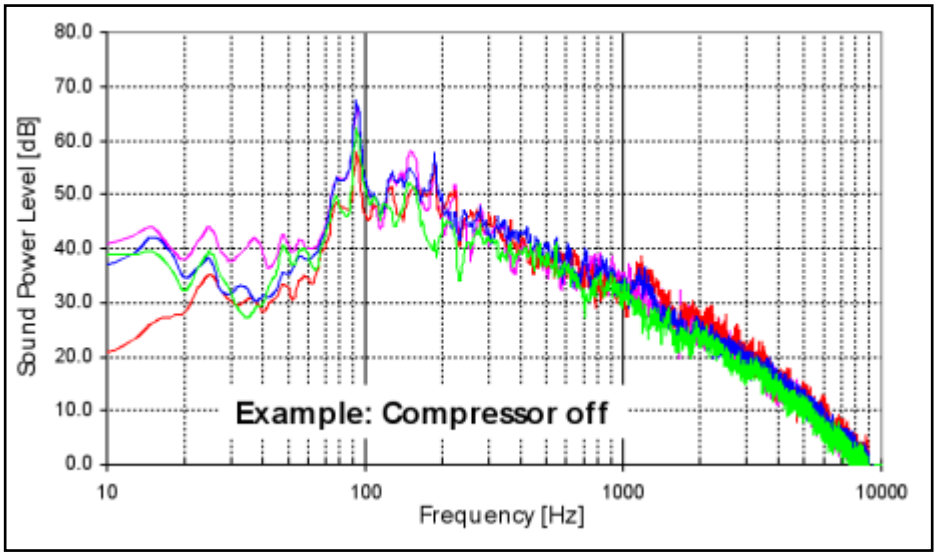
Noise Reduction in Ventilation Systems

The aim of the work area "Ventilation" is to overcome the lack of alternatives and is initiated and supported by novel, suitable materials which are robust, reliable, durable, and intelligent. Their configuration within active control strategies for several application scenarios on railway vehicles, e.g. thermal, load-controlled fans of self-ventilated traction motors and activated, acoustic resonance structures, will complete the radical innovation. Due to the common features and noise problems of HVAC systems of trains and cars, special efforts will focus on the generalized and multi-sectoral applicability of the developed materials and noise-control solutions.



Considered traction motor (Source:

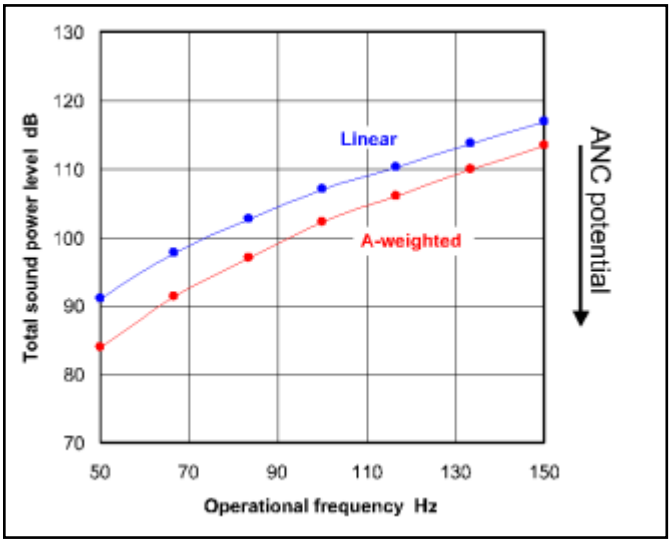
HVAC unit (Source: Bombardier)



Tonal noise radiation of HVAC unit (Source: CRF, IBP)

At first, typical noisy ventilation components have been selected comprising a self-ventilated traction motor and a driver cab HVAC unit. These components are installed in suitable acoustic laboratories, such as the semi-anechoic chamber and aerodynamic/aeroacoustic wind tunnel and baseline measurements performed. The diagnosis of noise sources and propagation paths, of operating conditions and restrictions is required for the aero- and vibroacoustic modeling and for additional acquisition of special experimental data.

The acoustic treatment of the self-ventilated traction motor strongly depends on thermal (load characteristics), aerodynamic (performance) and mechanical (torque transmission) aspects. As the air outlet is the dominating noise source an improved aero-acoustic design of fan and flow paths (active, passive, hybrid methods) as well as a temperature controlled viscoelastic (de)coupling of the fan with a smart clutch will be required. Furthermore, modifications of the aerodynamic and acoustic fan performance need to include active blade shaping and/or positioning system and adaptive control systems for separate tailored fans. The HVAC unit for driver's cab includes three different (independent) sound sources (condenser fan, ventilation fan, and compressor) with different characteristics and propagation paths. Additionally, interior and exterior immission points are involved. Since there is significant (and annoying) tonality of the flow noise, e.g. ventilation fan noise, specific tailored active material systems are considered. In order to reduce noise level and tonality actively absorptive silencers or activated acoustic resonators have to be developed or adapted to the scenarios which were found during the base line analysis.



Potential of ANC measures (Source: IBP)