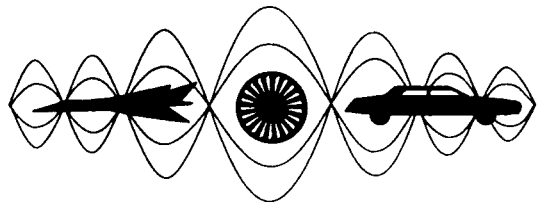

FIFTH INTERNATIONAL CONGRESS ON SOUND AND VIBRATION
DECEMBER 15-18, 1997
ADELAIDE, SOUTH AUSTRALIA

INDUSTRIAL APPLICATIONS OF ACTIVE SEAT ANCAS™

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ABSTRACT

In 1995, we presented the first results about the Active seat ANCAS®, jointly developed by Dassault Electronique and TechnoFirst. Strongly concerned by progressing to an improved product, TechnoFirst has carried on research in order to enlarge the universality of this technology, either in aeronautic or automotive applications. This paper contains the work recently performed on the ANCAS® including experimental results and several industrial applications.

INTRODUCTION

All research about active noise control in propeller aircrafts have been made with a global treatment in the cabin. After valuation, TechnoFirst chose in 1990 an alternative solution. As a matter of fact, the global processing needs heavy installation (modification of the cabin to fix speakers and sensors, important wiring and so forth). The seat is a solution which is in place of standard seat without any modification of the aircraft cabin. This paper describes rapidly the attenuation performances obtained with the active seat. It shows that N seats used together may be equivalent to a global treatment.

THE BACKGROUND

Today, more and more efforts are realized in order to reduce disturbances caused by noise. A specific case is common transport where the comfort of passenger remains one of the most important criteron for privated companies. Aeronautic industrials are sensible to this fact and are leading today new action in order to reduce noise in aircraft. In particular, with the development of Digital Signal Processor, active noise technology may be applied for acoustic reduction. Most researches were done primarily using non-localized (global) Active Noise Control (ANC) methods to achieve full-cabin interior noise reduction [1], [2]. Two main problems appear with the global system. First, the difficulties for aeronautic companies are important to retrofit active solution in existing aircraft and to fit it in new cabin design.

In the beginning of the 90's, TechnoFirst shows the feasibility of an original configuration : a specific acoustic module is integrated in the seat and is piloted with NOVACS controller (Noise and Vibration Active Control System) developed by TechnoFirst and the CNRS (Centre National de la Recherche Scientifique). Dassault Electronique is interested in this project and decided to become TechnoFirst partner in ANCAS (Active Noise Control for Aircraft Seat) development.
Second, global process is very sensible to acoustic configuration of the cabin ; that means a specific design for each aircarft model and high sensivity to modification of the environment.

INDIVIDUAL MEASUREMENTS

Today, some researches are trying to carry out the design of active control devices based on the seat concept [3]. Particularly, virtual microphone technology is applied to enlarge silence area size [4]. However we have tried already this solution in an original ANC headset [5]. But in fact the risks to increase the noise between loudspeakers and control microphones is very important whatever the solution used for an headset or an headrest. That is why it does not seem to give enough robust results to be integrated in an industrial product.

TechnoFirst works have led to significative in flight cabin and prototype simulation measurements [6].
They show the efficiency of the system to reduce ATR 72 spectrum noise (fig.1&2) and to obtain an « area of silence » well-defined three-dimensional bubble well outside the passenger's ear.

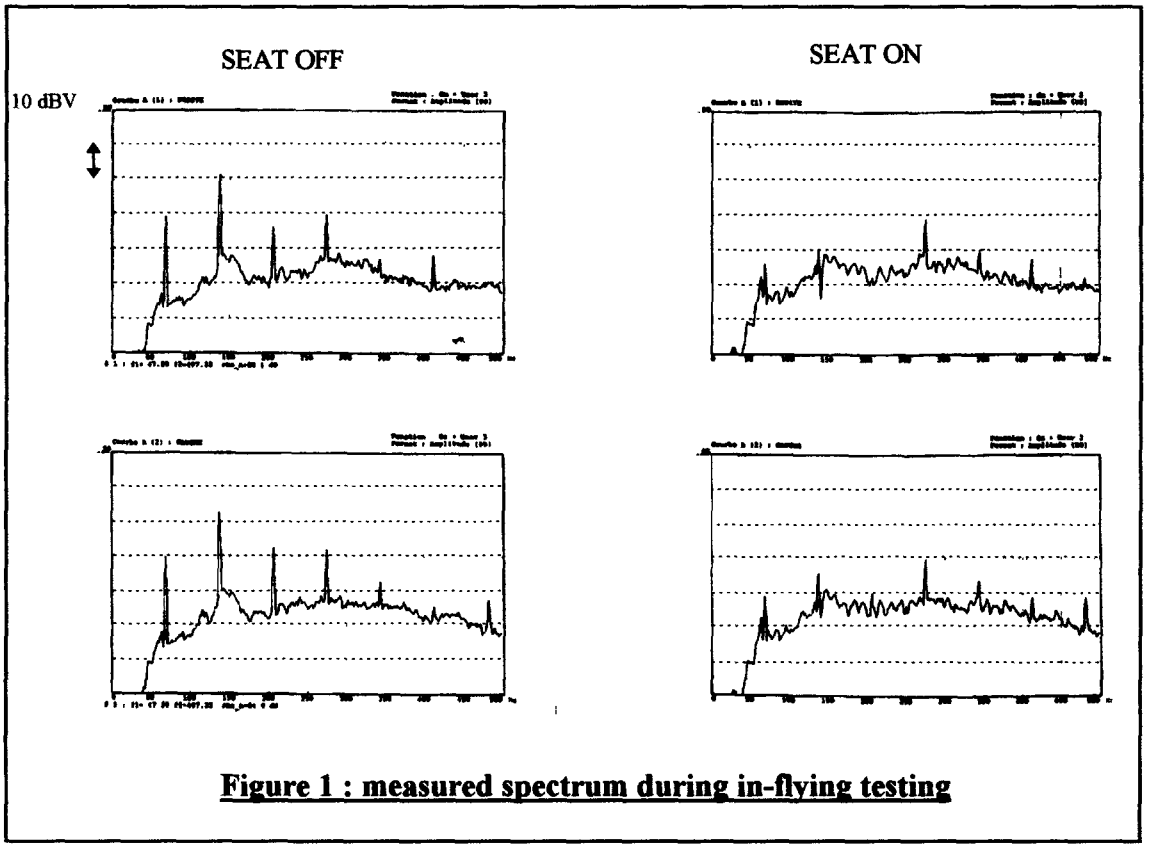


Figure 1 : measured spectrum during in-flying testing

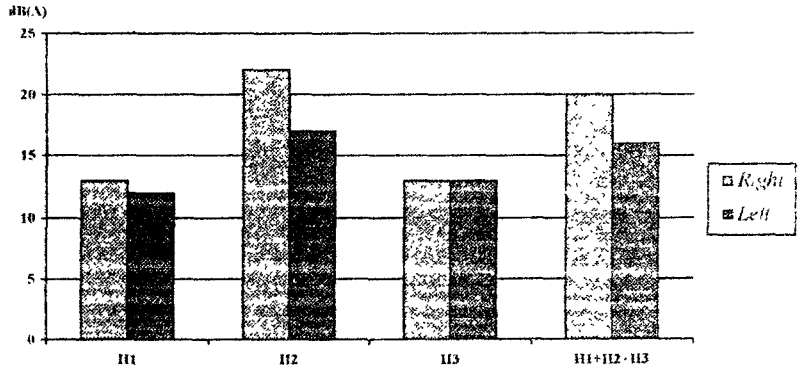


Figure 2 : Attenuation obtained during in-flying testing

The in-flight tests have been realized with the collaboration of Aerospatiale company. During these tests 5 to 7 dB(A) global attenuations have been measured. The impressions and sensations brought by the system were very positive. Particularly, the global noise level has been reduced significatively for human perception with less roughness sensation which traduces a quiet effect very impressive.

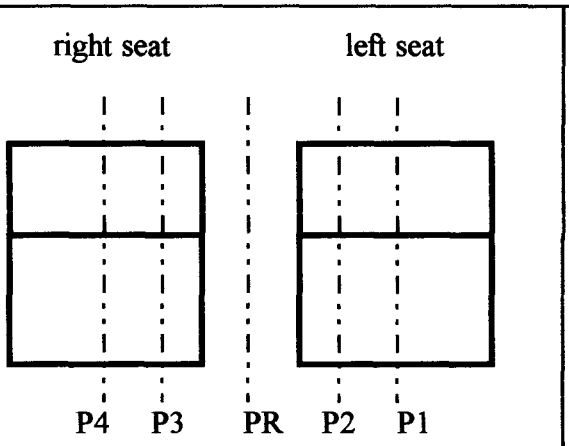
GLOBAL TREATMENT

ANCAS design has been studied to have the most efficient acoustic performances for individual protection but also to be combined with other ANCAS systems in order to obtain a global treatment in the cabin. Experimentation and prototype measures have been processed to show the gain brought by the combination of two ANCAS systems fitted in two seats side by side.

The lab setup consists in a mock-up of the fuselage of the actual aircraft in which in-flight testing was done. This experimental bench allows a high degree of accuracy in reproducing acoustic cabin environment.

Figure 3 defines how are installed the two seats equiped with ANCAS system. The measurement scheme consists in using parallel measurement matrix all perpendicular to the back of the seats in order to determine the size of the silence area surrounding the passenger. Five planes are selected : P1 and P2 for the left seat, P3 and P4 for the right seat and PR charaterizing the space between the seats. The acoustic energy is measured at the four main harmonics of the aircraft noise H1, H2, H3 and H4.

Each perpendicular matrix consists in a grid of 36 equal-volume quadrants. This measurement scheme allows an accurate characterization of the active device performances.



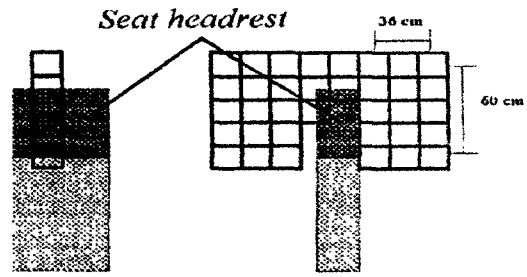


Figure 3 : Definition of seat perpendicular measurement matrixes

The measures are made on P1 on the left seat.
Figures 4 and 5 allow to make the comparison of acoustic attenuation performances between one stand-alone seat and two seats functionning together. The results show that no conflict appears when two ANCAS systems are working side-by-side ; the right seat has no influence on the left one. On the contrary, better performances may be measured, particularly on H1 harmonic.
Similar results are obtained with P3 on the right seat.

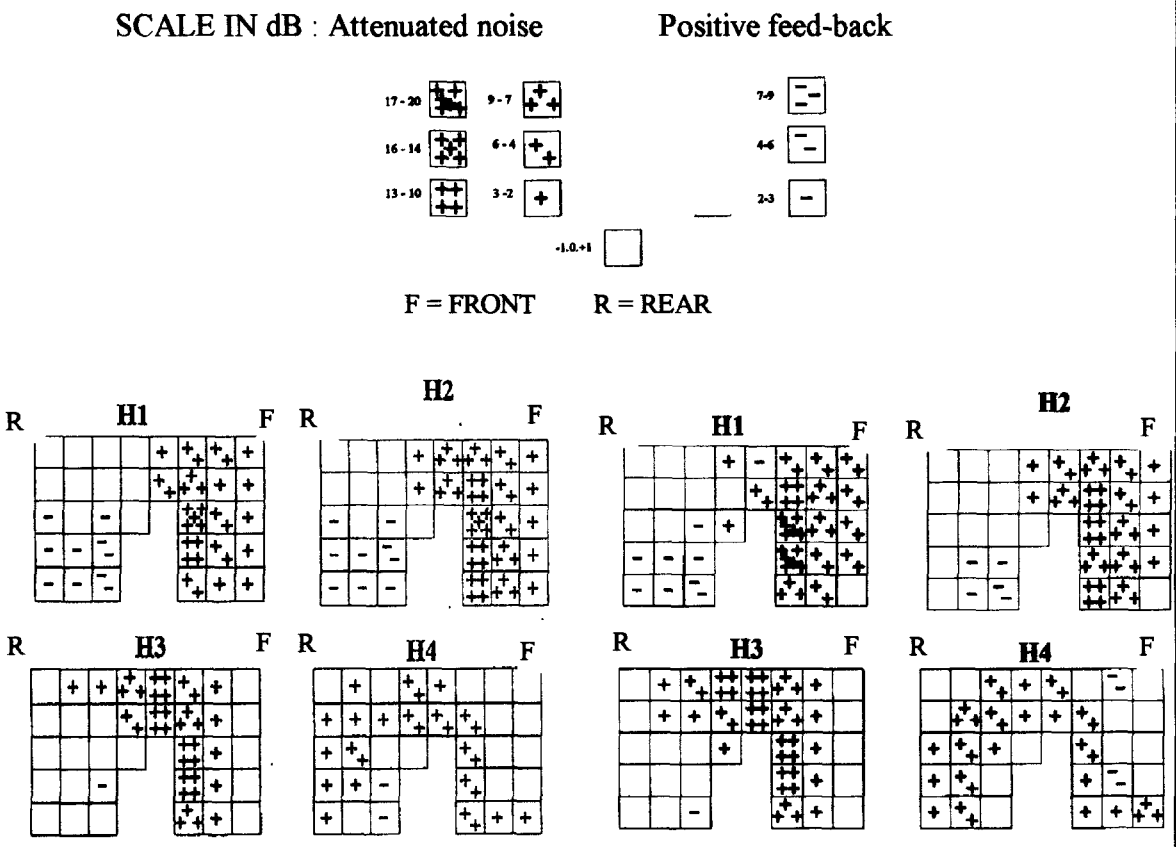


Figure 4 : Stand-alone seat

Figure 5 : Coupling seats

Concerning P2 and P4, the measures (fig. 6) have shown that the size of the silence area is larger when the two seats are functionning at the same time, particularly for H1 and H3 harmonics.

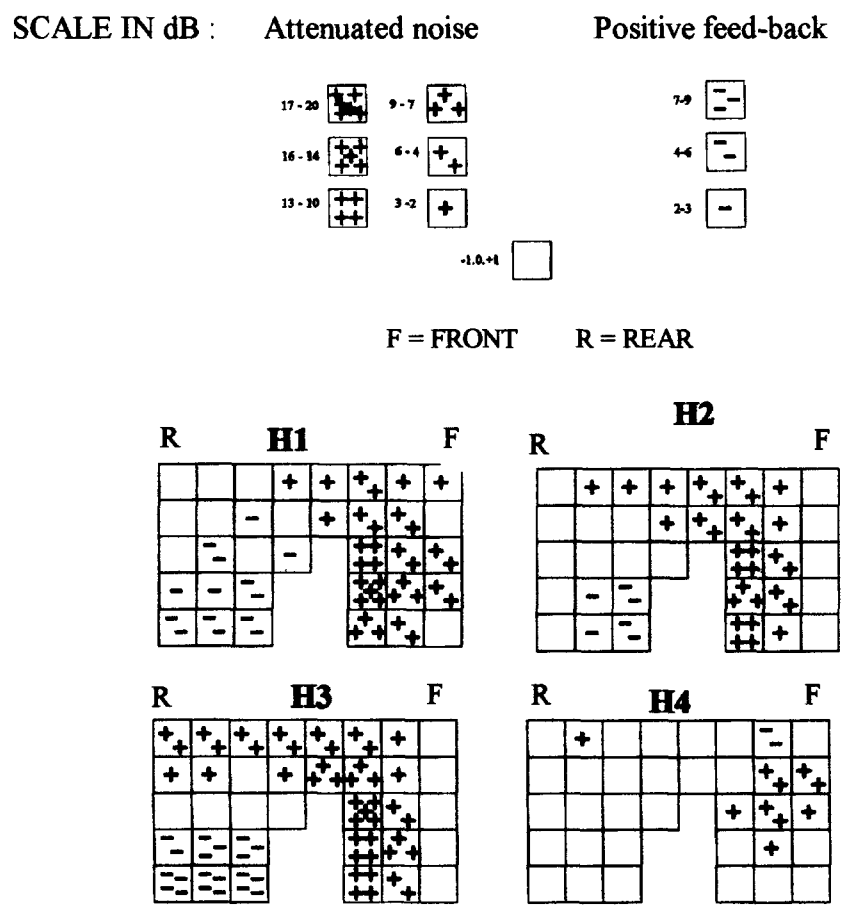


Figure 6 : Seat attenuation levels measured in P2 plane

The most interesting results are obtained on PR plane. Figure 7 corresponds to attenuation measures when only one seat is functionning. Figure 8 corresponds to attenuation results with the two seats available. For the first three harmonics, we have the performances reported on table 1.

attenuation (dB)	One seat	Two seats
H1	6	13
H2	9	18
H3	9	16

Table 1

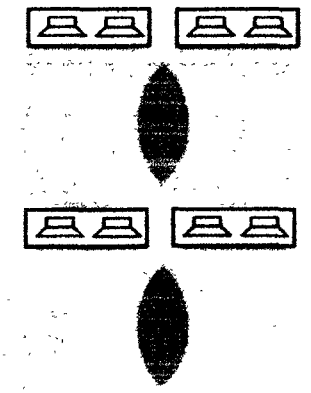


Figure 9 : Silence area created by four ANCAS systems

INDUSTRIAL INTEGRATION

Today, ANCAS prototypes give excellent results. The main problem remains the industrialization of the system. ANCAS must be adapted to the majority of existing seats to make retrofit. So, acoustic module composed with speakers and microphones has to be integrated whatever the seat without changing its aspect and its functionnality. The small size of microphones makes them easy to integrate.

A difficult compromise must be done between performances in low frequencies and size of the speaker. 170 mm diameter speaker have been selected because they are very efficient in low frequencies. Nevertheless, the deep of such speaker is around 80 mm and the space available in the seat limited to 40 mm.
This technological problem has been solved by developing a specific speaker with 160mm diameter, 35mm deep and 300g weight. This speaker using new technologies combines small size with good efficiency and low distortion even at low frequencies around 70 Hz. It has been developed specially for this application by AUDAX company.

Figure 10 presents the profile of a standard propeller aircraft seat in which is integrated ANCAS speaker.The ANCAS speaker is shown on figure 11.

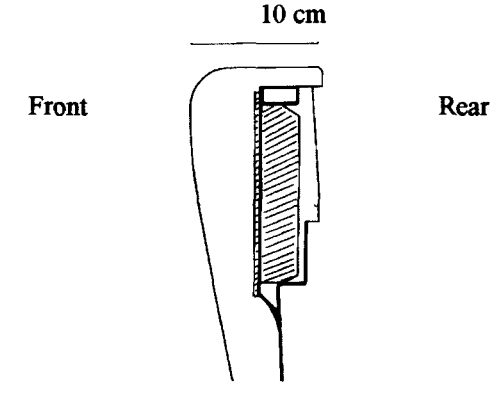


Figure 10 : ANCAS speaker integration in standard propeller aircraft seat

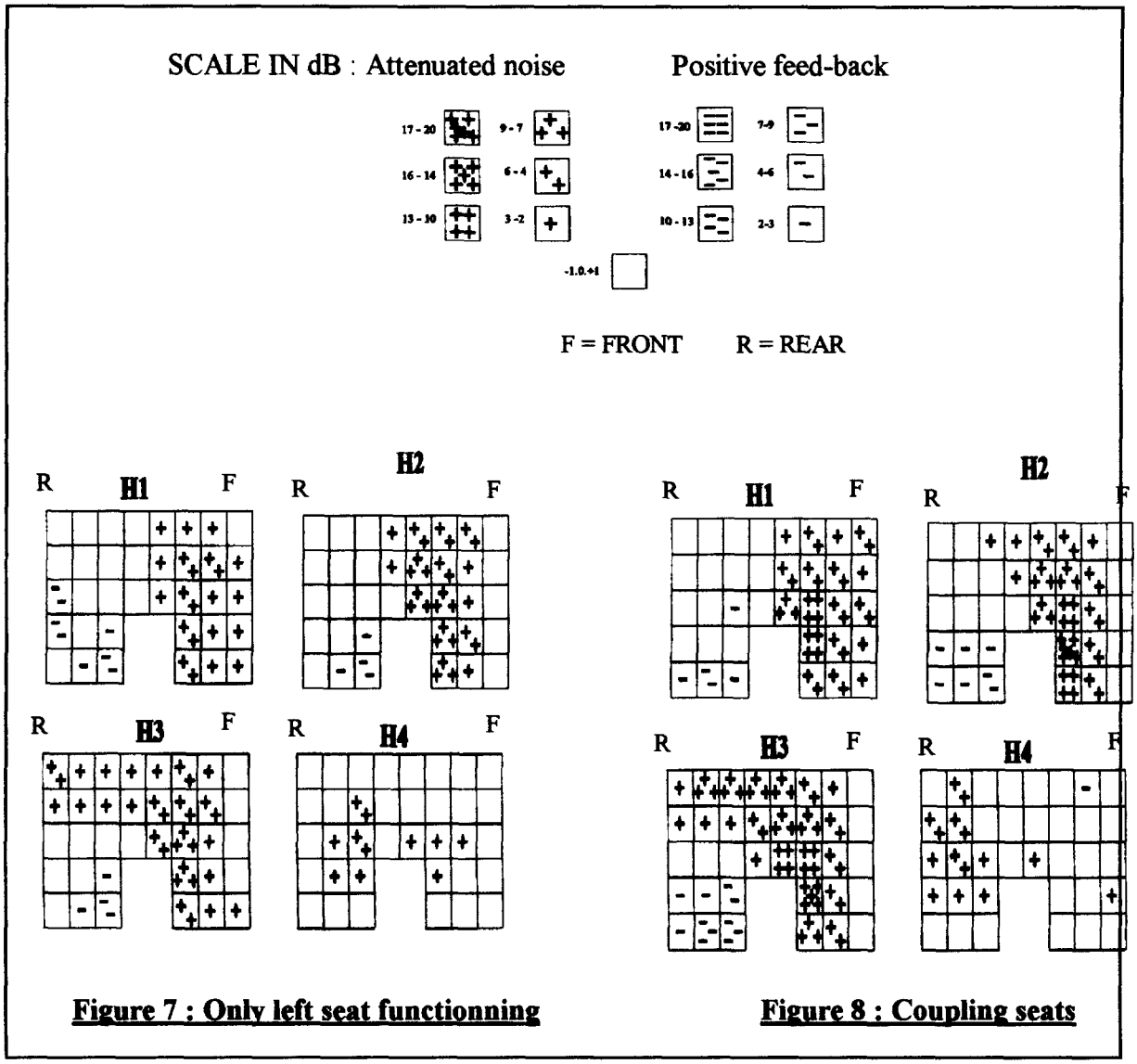


Figure 7 : Only left seat functionning

Figure 8 : Coupling seats

These results show us the increase of the performances obtained with two seats placed side by side in comparison with only one seat. It is easy to check that several ANCAS local treatments may be equivalent to a global system by reducing noise around all passengers seats, processing the volume between each seat in the cabin. Using N seats allow to uniformize the attenuation and to better the performances of each ANCAS system. Figure 9 describes schematically the silence area created by the effect of four ANCAS systems used together. In an aircraft aisle, the distance between two seats is small enough to provide by the silence areas created by each seat an homogeneous area of noise reduction. It means that significant attenuation may be measured even in the aisle. If all the seats of the aircraft are equipped with ANCAS system, the addition of attenuation effect of all the seats is equivalent to a global system designed specifically for the aircraft.

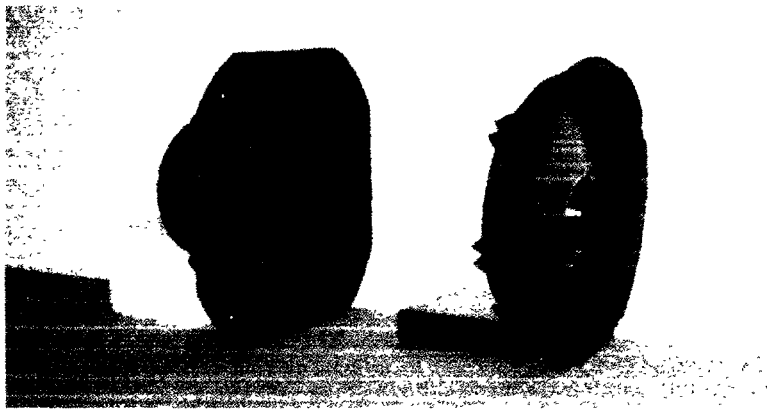


Figure 11 : Comparison between ANCAS speaker and a standard boomer

CONCLUSION

The preceding results show that TechnoFirst/Dassault Electronique passenger seat-mounted active noise control system (ANCAS) gives results equivalent to global system by installing it in seats placed side by side. The performances of each individual system are increased and a global silence area is obtained by combining the effect of all the seats.

Industrial integration is about to be achieved by the development of a specific speaker which is enough efficient to process in low frequencies range and has dimensions adapted to the space available in standard seat.

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