

Towards a new Dummy Head?

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Abstract [61] In addition to conventional measurement microphones, dummy heads are more and more used for physical as well as subjective noise evaluation. Within the DIN, a study group (A2 AK8) was formed, analyzing features of commercially available dummy heads. It was found that mainly because of geometrically different shells, different dummy heads produce different sound images. In practical applications, the resulting differences in perceived sound quality can lead to serious problems: If for example the power train department of a car manufacturer uses dummy head A, but quality control dummy head B, different evaluations of the sound quality may occur. An obvious solution to the compatibility problem of different dummy heads could be that all manufacturers of dummy heads use the same (new) standardized shell which provides for identical geometric features. Before engaging in such an enormous project, colleagues using dummy heads in the context of sound quality design or sound engineering were asked about their opinion. They had to answer two questions: (1) Whether they would welcome a standardized new shell for dummy heads, and (2) How much they would pay for a possible retrofit. Answers were collected in the USA by Patricia Davies, in Japan by Masao Ishihama, and in Europe by Hugo Fastl. The results show that the majority of the dummy head users who responded would welcome a new standardized shell for dummy heads, and they would be prepared to pay for a retrofit on the average 25 % of the original price or 5 000 US-Dollars.

1 INTRODUCTION

Within the last 30 years, the use of dummy heads for measurement and evaluation of acoustic signals has been increasing. In 1975, Burkhard and Sachs [1] published their classic paper on a dummy head, which was primarily designed for the evaluation of hearing aids. While this classic dummy head had replicas of real ears, Genuit [2] proposed in 1986 to use a simplified geometry for dummy heads. For measurement and reproduction of dummy head signals, the proper equalization plays a crucial role (cf. e.g. Theile 1984 [3], Fastl et al. 1985 [4], Zollner 1998 [5], Daniel 2004 [6]). Comparisons of different dummy heads performed by Hammershøi and Møller [7] in 1992 showed that in relation to human heads, there is quite some room for improvement. For special applications like measurements with children, dedicated dummy heads have to be realized (cf. Fels and Vorländer 2004 [8]). Also it turned out that some dummy heads are primarily used in a specific field, like the Neumann head for broadcast applications (cf. Peus 1983 [9]). Interestingly, recently a manufacturer of dummy heads proposed a revival of an old Sennheiser idea to use the experimenter's own head and two miniature microphones (Ladegaard et al. 2004 [10]).

Within the German standardizing committee DIN A2 AK8, extended comparisons of dummy heads commercially available have been performed, and data were compiled by Fedtke [11]. After quite

some deliberations it was found that – because of geometric differences of the products of different manufacturers – it is more or less impossible to get identical results when the same sounds are recorded by different dummy heads. An electronic equalization is easily done for one direction, say frontal incidence, but next to impossible for all spatial directions.

This finding has some rather important practical implications, since the resulting differences in perceived sound quality can lead to serious problems: If for example the power train department of a car manufacturer uses dummy head A, but quality control dummy head B, different evaluations of the sound quality may occur.

In this situation, this author came up with the idea that one and the same (new) standardized shell should be used for all dummy heads, avoiding differences due to geometrical differences. First, the reaction of some major manufactures of commercially available dummy heads like Brüel & Kjær, Cortex, HEAD acoustics, or Neumann was gathered on a more personal basis, because this author would have expected a blunt rejection of such a futuristic idea. However, the response of the manufactures was by and large rather positive, and therefore a more formal inquiry was envisaged.

2 QUESTIONNAIRE

To get some feedback of users of dummy heads in the context of sound quality design and sound engineering, a questionnaire was designed with the help of Patricia Davies and sent out to dummy head users in the USA by Patricia Davies, in Japan by Masao Ishihama, and in Europe by Hugo Fastl. Essentially the questionnaire contained two questions. (1) Whether the users would welcome a common new standardized shell of dummy heads and (2) What amount they would be prepared to pay for a retrofit. The details of the questionnaire can be seen below.

<p>Dear colleague,</p> <p>we are working on a DIN committee to standardize binaural heads and would like some feedback, particularly from users in industry.</p> <p>It is clear from experiments that it is impossible to translate measurements made with one binaural head into measurements from a binaural head made by a different manufacturer. This is due to differences in head and torso geometry. Manufacturers of binaural heads on the DIN committee are seriously considering a standard on head and torso geometry. Electronics may change from head to head but the fundamental geometry would be the same making it easier to translate measurements from one system into measurements from another. However, people on the committee are reluctant to move forward unless there is some consensus from binaural head users that they would welcome this standardization.</p> <p>So here are the questions.</p> <p>(1) Would you like to see a binaural head geometry standard put in place?</p> <p>Yes <input type="radio"/> No <input type="radio"/></p> <p>Comments:</p> <p>(2) If manufacturers had a retrofit policy (send in the old head, get one back with standardized geometry, but electronics may differ from different manufacturers), how much would you be willing to pay?</p> <p> % of cost of a new had % of cost you paid US\$</p> <p>Fill in what you can!</p>
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3 RESULTS

Nine colleagues from the United States, five colleagues from Japan, and 17 colleagues from Europe, all engaged in sound quality design or sound engineering, sent back the questionnaire to the respective coordinator. Therefore, a total of 31 responses could be analyzed. Figure 1 gives an overview of the responses to the first question, namely whether the colleagues active in sound quality engineering would welcome a new standardized shell for dummy heads.

In figure 1 the number n of responses to the question whether a new standardized shell for dummy heads would be preferred is plotted. Responses from Japan are hatched horizontally, from USA diagonally, and from Europe vertically.

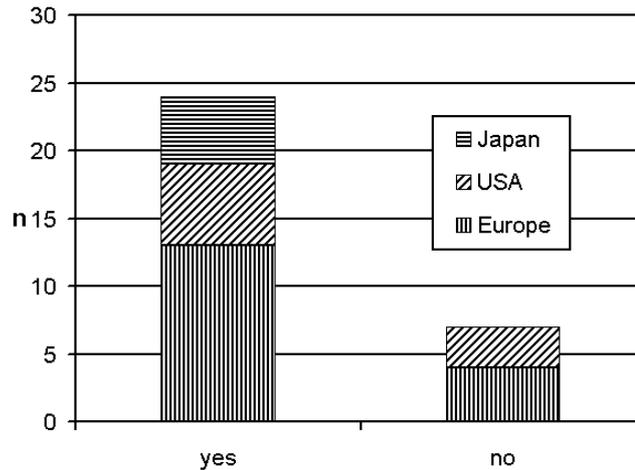


Figure 1. *Distribution of responses to question 1, whether a new standardized shell for dummy heads would be preferred.*

The data displayed in figure 1 clearly show that on the average a new standardized shell of dummy heads would be welcomed by the participating users. From 31 answers, 24 (i.e. 77 %) are positive and 7 (23 %) are negative. This means that the clear majority of responding dummy head users would welcome a new standardized shell common to all manufactures of dummy heads. From Japan, only positive answers were obtained, and from USA and in particular from Europe substantially more positive than negative answers.

Concerning the question of a possible retrofit, results are plotted in figure 2.

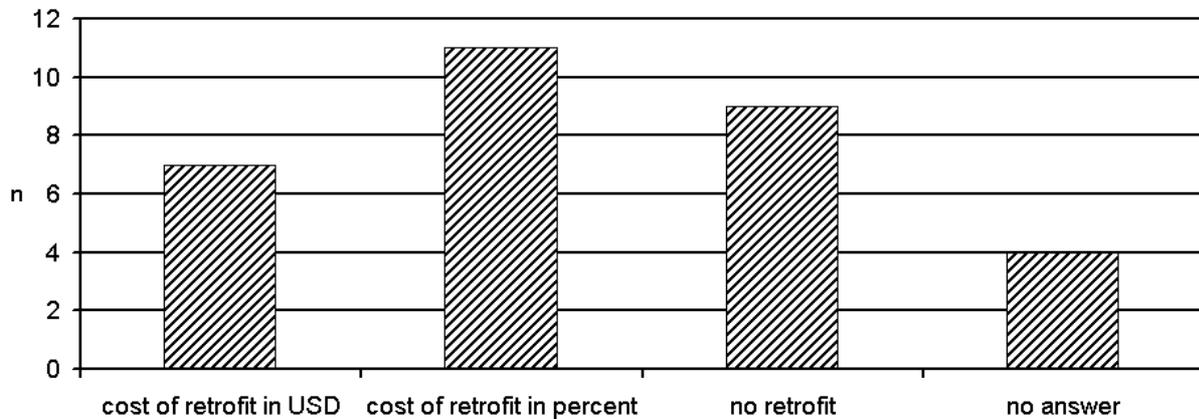


Figure 2. *Distribution of responses to question 2, concerning a possible retrofit.*

The data displayed in figure 2 show, that from 31 colleagues 4 (13 %) gave no answer for the question concerning the retrofit. From the remaining 27 colleagues 9 (33 %) are not in favour of a retrofit. From the remaining 18 users who are in favour of a retrofit, 11 (61 %) gave an estimate of the cost of the retrofit in percent, and 7 (39 %) gave the estimate of the cost in US-Dollars.

Even if we count the cases in which no answer was given as negative responses, nevertheless 18 from 31, i.e. 58 % of the users would welcome a retrofit. Although because of the small number of responding colleagues all numbers given in this paper are not statistically significant, the generally positive results may give a hint to the manufacturers of dummy heads to consider to offer a retrofit, if a standardized new shell of dummy heads would be set in place.

Figure 3 shows the distribution of the cost accepted for the retrofit in percent compared to the cost of a new head.

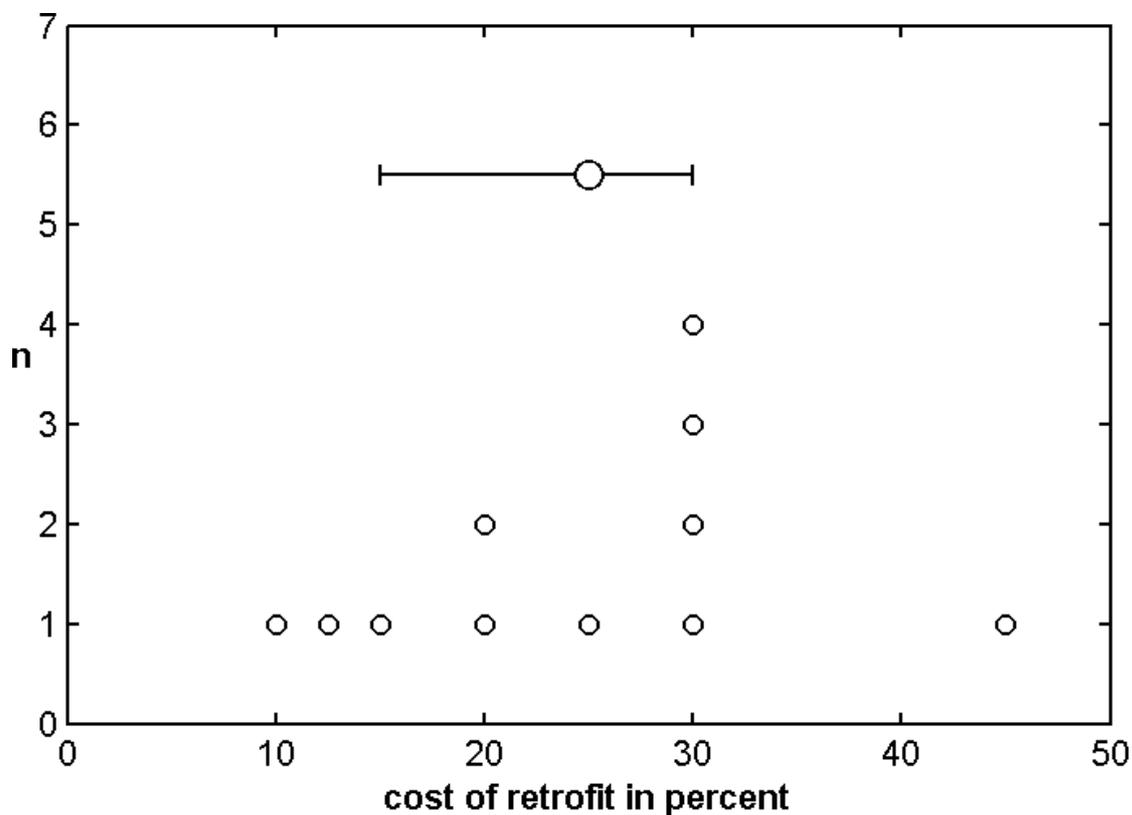


Figure 3. Number *n* of users prepared to pay for a retrofit a percentage of the cost of a new dummy head as displayed on the abscissa.

The small circles in figure 3 indicate that users are willing to pay between 10 % and 45 % of the cost of a new dummy head for a retrofit. On the average (median, large circle) the cost accepted for a retrofit amounts to 25 % of the price of a new dummy head; the interquartiles encompass values from 15 % up to 30 %.

Figure 4 shows the distribution of the cost accepted for the retrofit in terms of US-Dollars.

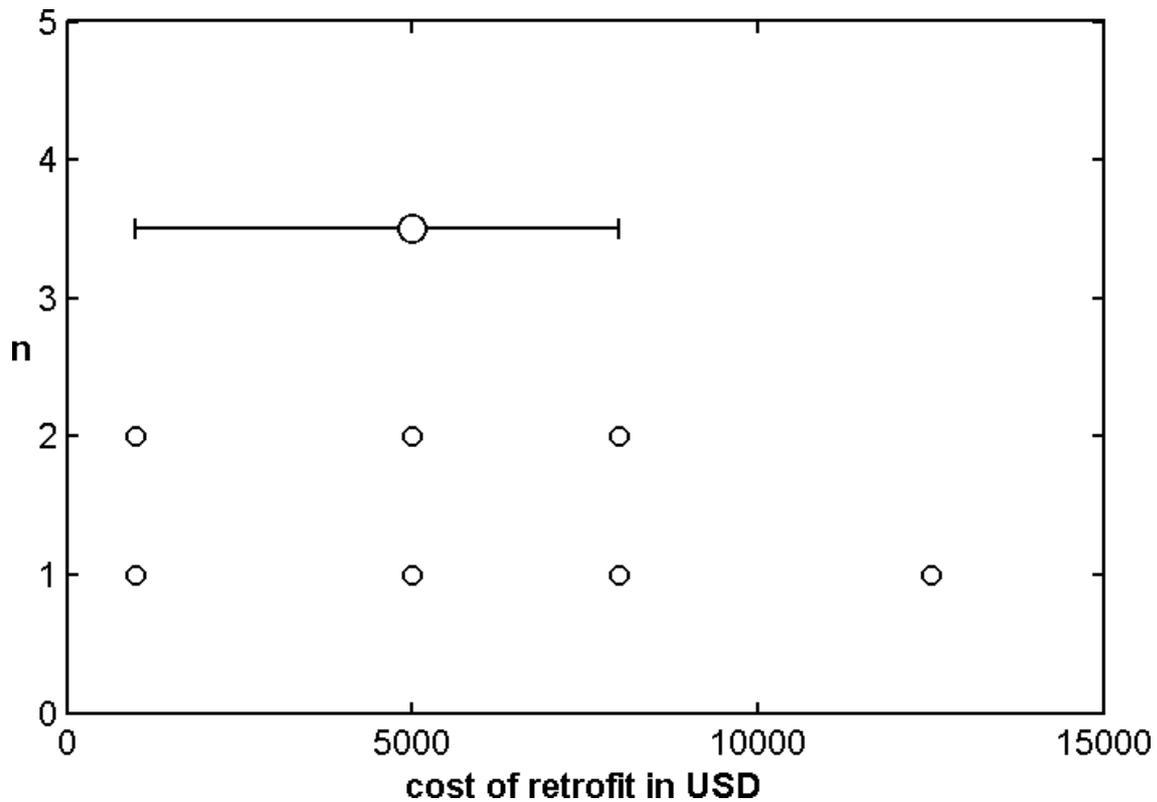


Figure 4. Number n of users prepared to pay for a retrofit an amount in US-Dollars as indicated on the abscissa.

The small circles in figure 4 indicate that users are prepared to pay for a retrofit between 1 000 and 12 500 USD. On the average, from the colleagues responding to our questionnaire, the price for a retrofit of 5 000 USD (median, large circle) would be accepted with interquartiles between 1 000 USD and 8 000 USD.

4 CONCLUSIONS

My at first sight very adventurous idea to evaluate, whether there would be room for a new standardized shell for dummy heads, on the average got a rather favourite response. Of course, the data shown in this paper are by no means statistically significant. However, after this talk we will gather at internoise 2004 more opinions, and if they are positive, we will start first steps for the realization of a corresponding project. Definitely we will have the support of DIN, and will continue our work in DIN A2 AK8. However, we feel that such a task should be dealt within an international consortium. Another very early step would be to look for funds from agencies like European Union or interested parties like SAE to set up such an enormous project.

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