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# PSYCHO-ACOUSTICS AND TRADITIONAL ACOUSTICS. DO THEY LIVE WELL TOGETHER DURING PRODUCT DEVELOPMENT?

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**ABSTRACT**
Philips DAP B.V. develops and produces many different appliances. When these appliances are used, their sound is important to the user. Several years ago we have started to introduce elements from psycho-acoustics into our development and production effort. Since this introduction, problems for developers have increased seriously. Designing and talking about results have become much more difficult. The deceptively simple ideas in psycho-acoustics result in a competition between the classical approach and the psycho-acoustic ideas.

## 1 - INTRODUCTION

During design development and production, appliance noise is a very important aspect which deserves and gets considerable attention. In our case the appliances are normal life consumer products, and can be described as small household appliances and personal care products. A common aspect of these products is the fact that they are electrically driven. This type of products have typically very stringent constraints for price, performance and visual appearance.
These products are very diverse, both in principle and in use. Furthermore, personal care products can be gender- specific: for example an electric razor versus a depilation device.
For all these products sound is considered to be important for realising complete customer satisfaction.

## 2 - HISTORY

The acoustics of our products has been studied by our laboratory for over 30 years. The analysis and measurement methods available to us can be considered state of the art, and has been continuously upgraded. From the beginning the main focus of our work has been to control and to lower the sound power level of the various products. This has begun by looking at the total soundpower level, but as soon as more sophisticated analysis methods were reliable and available these methods were introduced into the working environment of our laboratory. The analysis types had mainly to do with temporal and frequency analysis, made possible and affordable with the advent of FFT and digital filtering techniques. These techniques allowed to look into more detail what contributes most to the noise, which dominant components are visible in the spectrum and to correlate this information with the construction of the device. This in itself is only possible with a thorough understanding of the device at hand.
From the beginning also listening panels were used. These panels listened to actual devices or to actual prototypes and were asked to formulate opinions about the devices behaviour, including noise. Questions concerned the allowable levels of sound and vibration, and investigations concerning the audibility of deviations of the sound during actual production. It can not be overestimated how important the control of between products variation of sound is for industry. The real tough question is how to achieve this robustness and stability over years and millions of products, instead of a few prototypes.
Let us call the above described cluster of methods the classical acoustical engineering approach.
In more recent years we see the advent of psycho-acoustic based analysis [1]. Furthermore, with the increased computing power, coupled with wide-spread digital recording and reproduction technology, a total new capability has arisen: sound creation without hardware. These techniques are typically used

to record and reproduce sounds, or to modify recorded sounds, or to synthesise sounds. The technology has made it far more easy to manipulate sounds, without having to rely on hardware modifications of actual products. These possibilities open up questions like: what is the better sound of the product, how should the product sound like etc.
Let us call this cluster of methods the psycho-acoustic approach.
The development process of new products is strongly influenced by these new possibilities. In order to have a good understanding how this development process goes we will describe this process.

## 3 - PROCESS DESCRIPTION

Normally a product creation process (or PCP) can be divided into several parts. Early in the PCP visual aspects of the appliances are decided, together with its working principle. In the middle part of the PCP the detailing of the interior and the working parts are done. In the later parts of the PCP things like production equipment and larger scale testing are done.
It is obvious that many choices done in the early stages of the PCP have a dominant effect later on [2]. All too often it is in the later stages of this process that noise related problems surface. To prevent the possibility that these problems occur, or can not be solved, it is common to introduce a sufficient level of "acoustical expertise" in all phases of the PCP.
Generally speaking it is the task of the development team to fullfill the criteria laid down in the concept phase of the project. However, for noise these criteria are in many cases not sufficient nor complete. Partly this is because of the complex nature of noise, but also the use of new constructions or new working principles can give rise to new sound effects.
These ill defined criteria about noise surface only when true devices are at hand. The way that these types of problems are tackled is the use of panels: let the panels form opinions of the noise the appliance produces. What the panel tells you, will guide you to improve the product in acoustical sense. These problems can arise several times during the development, and have a significant work-load.

## 4 - USING PSYCHO-ACOUSTICS

What we notice is that the use of the so called psycho-acoustic technology, is a very attractive way to communicate with non-acousticians. It demistifies strongly the acoustic jibberish of decibels, reference values etc. It is for everybody quite easy to understand and discuss things like: how do people like the sound, is it not too loud or what irritation level do you reach? Putting it this way strongly underestimates the real problems of properly designing interview questions which are helpful for a development department [3].
Listening tests can be done on real, modified or on fancy sounds. Real sounds can be listened to from actual devices, and from recordings. Recordings can be listened to using headsets or using speakers. Modified sounds are dangerous because these sounds can prove to be unreachable in the actual product. Fancy sounds can be extremely dangerous, because it can be completely incompatible with the mechanics of the machine. This means that the ability to create artificial sounds immediately poses the question what to create.
Having said this, it proves to be very usefull to conduct these panel tests, especially during the preliminary phases of the development. The real issue is then to translate these findings into the classical descriptors like spectral content and temporal behaviour, which can be correlated with the construction. An important descriptor remains the sound power level, and knowing the values that are allowable is one of the important issues. Furthermore, soundpower level [4,5] is important because it is one of the product specifications that can be used in communications to the customer, and it is very usefull during production.
Panel testing however should be restricted to the early stages of the development. The reason for this is that during these stages sufficient time and opportunity is available to make drastic modifications. Later on during the development it becomes less and less usefull to do panel based tests, or to make use of typical psycho-acoustic descriptors. Additionally, the time-pressure tends to increase, and less and less time is available to make a translation from the findings of the experiment into the controllable features of the device like geometry and tolerances. The only real use is for go or no-go like decisions. It is obvious that acoustics plays only a part in these decisions.
Very dangerous is the fact that it is so deceptively easy to talk about the things you would like to know: how do people experience the noise. This simplicity invites many people to raise all sorts of questions about sound during the complete development process. It is this improper timing that poses the biggest threat for a succesfull development. In fact it means that the availability of these wonderfull techniques must be used with great care in respect of the timing of the project. It is the engineers job to help to pose the right questions at the right time.

## 5 - CONCLUSION

The use of artificially created or modified sounds in panel testing and psycho acoustic descriptors create exciting opportunities. However, during the development and production cycle of new products, less and less usefulness can be found in the use of this type of testing and analysis. Panel testing in itself has the big disadvantage that it does not tell what to do in order to reach what is preferred. When the time of a development project goes by, less opportunity exists to make a translation between what is found by panel testing and the construction of the device.

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