PROCEEDINGS of the
23rd International Congress on Acoustics

9 to 13 September 2019 in Aachen, Germany

# Characterization of the indoor kitchen soundscape

Pieter THOMAS[a], Luc DEKONINCK[a], Stephanie VAN HOVE[b], Anissa ALL[b], Peter CONRADIE[b], Lieven DE MAREZ[b], Henk HUISSEUNE[c], David PLETS[a] and Dick BOTTELDOOREN[a]

[a] WAVES, Ghent University, Belgium

[b] imec-mict, Ghent University, Belgium

[c] NOVY nv, Belgium

## ABSTRACT

With a growing tendency for compact living, the kitchen space is typically at the center of the daily activity, combining different functionalities. In the context of the ”IoT chef” project, the cooking experience is optimized, with focus on the cooker hood noise. In a first part of the study, a large-scale online survey (N = 754) is conducted among Flemish home cooks in order to (1) map personal assessments of the sound environment during a typical cooking experience and (2) evaluate the indoor (kitchen) soundscape based on the ISO 12913-1/2 standard. The impact of the role of the observant (chef or bystander) on the subjective evaluation is investigated. In a second part of the study, typical kitchen sound levels are monitored during a one-week period at 16 households, selected from survey participants. Additionally, cooker hood levels are measured at the cook’s ears to define the contribution of hood noises in the overall kitchen sound environment. Results from the measurement campaign are presented and discussed.

Keywords: Indoor Soundscape, Kitchen, Cooker Hood

## 1. INTRODUCTION

Today, the product sound quality of many different types of products including vehicles and household appliances is carefully designed [1]. Their sound often contributes to the branding of the product [2]. Some products however do not produce a dominant sound while in use. On the contrary, their sound is expected to blend into the overall sonic environment without attracting much auditory attention [3]. Yet they could still contribute to the overall soundscape; the sonic environment as perceived and understood by people within context [4] even in a subliminal way. Some of these products are always found in a similar context or at least this is commonly assumed. The kitchen hood is an example of such an appliance. Low noise level is an important discriminating factor between hoods, yet the characteristics of the sound leading to energetic or perceptual masking have not been investigated. To understand the interaction of this device with its environment and to be able to design its sound, the typical surrounding soundscape and the variety of soundscapes corresponding to various types of kitchens and household types must be understood. Kitchen sound environment is not the only reason to address the issue of kitchen hood sound. Reduced use of the kitchen hood due to its negative impact on the sound environment may lead to higher pollution levels with potential health impact.

Thus, several research questions were formulated: (1) are people generally satisfied with the sound environment in their kitchen; (2) to what extend does the kitchen hood contribute to this appreciation; (3) what is the effect of personal sensitivity? To answer these questions, in the IoTChef project, a broad questionnaire survey was conducted that amongst others enquired about the soundscape using a standardized approach [cite ISO12913 part 2]. In addition, a focused survey was conducted with a subgroup of 27 households. In this focus group, questionnaires were complemented with physical observations and measurements.

## 2. METHODOLOGY

### 2.1 Broad survey

A survey on cooking experience was conducted online with a panel of volunteers that were

previously recruited by imec-mict for consumer research. As part of the survey, four questions related to sound were included:

(1) a standard noise annoyance question [**Error! Reference source not found.**] slightly modified to reflect the context of the kitchen (freely translated from Dutch) “Think about an ordinary evening in the kitchen. Describe how you experience the kitchen as sound environment. To what extend are you annoyed or not annoyed by the sound of [vocal sounds of people, non-vocal sounds of people, sound of pet animals, installation sounds, operational sounds, electronic sounds, environmental sounds]?” For each category a few examples are given and a five-point standard answering scale is provided.

(2) An overall appreciation of the sound environment according to the circumflex model [7] which after the same leading context sketch as above reads “The sound environments is [pleasant, comfortable; chaotic, complex; fascinating, stimulating; immobile, passive; calm, tranquil; irritating, annoying; active, lively; monotonous, uninteresting]” Again a five-point answering scale is provided.

(3) A general appreciation on the sound environment with five answering categories from very good to very bad.

(4) A noise sensitivity question, the 10-item Weinstein scale [8].

In total 754 participants answered the survey, 330 female, 424 male and with and age range 18 to 70 years.

### 2.2 Focus group

Volunteers (16) were selected from the survey that were willing to participate in an in-depth study of their kitchen habits. For this reason, an in-depth interview was conducted with these volunteers. In addition, activities in the kitchen were video-recorded and noise and air quality were monitored over a period of one week. This study was approved by the ethical committee of UGent and participants were duly informed about the purpose of these recordings.

For soundscape observation, the microphone was placed at ear height in a corner of the kitchen. A black carbon aethalometer is used to evaluate the air quality in the kitchen.

## 3. RESULTS

The soundscape evaluation from the broad study (question (3)) is treated as a continuous scale and responses are averaged. This gives an average score on each of the eight dimensions that is shown in Fig. 1. Standard deviations over the population of respondents are similar for each dimension and amount to slightly under one unit. On average the kitchen soundscape at home is evaluated as pleasant and comfortable, quite calm and tranquil, but also active and lively.


Figure 1 – Spider graph of kitchen soundscape evaluation.

Although most participants indicate a positive valence of the soundscape, it is worth analyzing the contribution of various possible sounds that could be heard in the kitchen to the negative valence (annoyance). Therefore, the first sound related question is analyzed (1). Figure 2 shows reported annoyance by different categories of sounds. In general, the percentage of the respondents that report moderate to high noise annoyance is low and there is not much distinction between sources. Although the relatively high percentage of annoyance by sounds of pets is worth mentioning, we further focus on installation sounds and operational sounds. 11.9% of the respondents is at least moderately annoyed by the sounds of installations (e.g. ventilation, kitchen hood) while 13.7% is at least moderately annoyed by operational sounds (e.g. microwave, oven, blender).

On the other hand, 55% of respondents mention in another part of the survey that the noise level is a very important criterium when buying a new kitchen hood. This makes it the criterion that is selected by the highest number of respondents as very important, more so than suction power and energy efficiency.

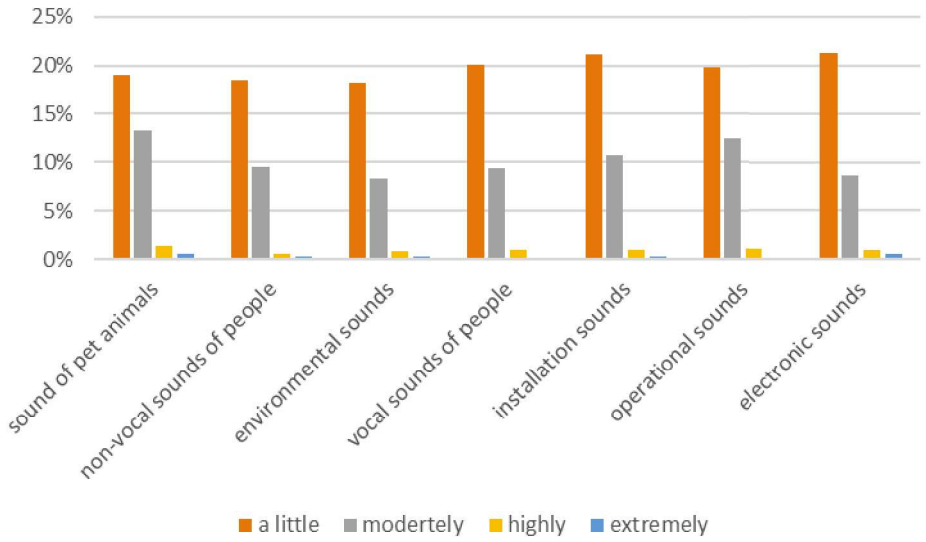


Figure 2 – Percentage of the respondents that indicate that they are annoyed by the different categories of sounds for several degrees of annoyance.

As it is well known that personal factors (and in particular noise sensitivity) influence noise annoyance it is worth investigating the correlation between the responses on the noise annoyance questions and the personal noise sensitivity as evaluated using the Weinstein questionnaire; sound question (3). The sum of responses on the sub-questions (including a sign switch where needed) is a significant predictor for all noise annoyance questions. However, it should be mentioned that also the answer on the questions on annoyance by sound produced by people is a good predictor for the answer on the question on annoyance by installation or operational sounds. The latter even produces a slightly better linear regression model.

## 4. DISCUSSION

For putting kitchen hood sound in a context where it is usually perceived, kitchen soundscapes were investigated. This showed that people perceive the sound environment in their kitchen generally as pleasant and calm and tranquil or lively and active. All of these factors have positive valence. This may be explained by a strong feeling of control on the sound environment perceived in this context [cite reference on control]. In addition, the relatively strong contribution of own sounds during cooking may reduce the probability of noticing potentially disturbing sounds [9]. The observation that environmental sounds from outside the kitchen (cars, trains, planes) cause high annoyance only for 1% of the respondents – while government surveys show values of up to 10% - may confirm this observation.

Moreover, it could be observed that installation sounds and operational sounds, both mechanical sounds produced by e.g. the kitchen hood, blenders, ovens, contribute to noise annoyance. However, these sounds affect a similar percentage of the respondents as other sounds that could be heard in the kitchen context such as pets and humans or sound from outside. It is known since long that noise

sensitivity is a stable personality treat that may influence the effect of noise on people [10]. It is partly inherited and may influence the way the human brain analysis the auditory scene [11]. Hence, it is not unexpected that a significant percentage of the reported noise annoyance is explained by noise sensitivity and therefore does not depend strongly on the noise source: a small percentage of very sensitive people will experience any additional sound as annoying.

## 5. CONCLUSIONS

The kitchen soundscape was analysed with a focus on the contribution of installation sound and operational sound. This puts the design of kitchen appliances in a clearer context where sound quality may be less important than their contribution to noise annoyance. Nevertheless, some further analysis of the focus group study should reveal whether particular components of the sound contribute more to this annoyance.

## ACKNOWLEDGEMENTS

This work was performed within IoT Chef, a project co-financed by imec and receiving project support from Flanders Innovation & Entrepreneurship.

## REFERENCES

1. Blauert, J., & Jekosch, U. (1997). Sound-quality evaluation–a multi-layered problem. Acta acustica united with acustica, 83(5), 747-753.
2. Jackson, D. M., & Fulberg, P. (2003). Sonic branding: an introduction. Basingstoke: Palgrave Macmillan.
3. Özcan, E., & van Egmond, R. (2012). Basic semantics of product sounds. International Journal of Design, 6(2).
4. ISO 12913-1: “Acoustics-Soundscape-Part 1: Definition and conceptual framework”
5. ISO/TS 12913-2 “Acoustics-Soundscape-Part 2: Data collection and reporting requirements”
6. ISO/TS 15666 "AcousticsAssessment of noise annoyance by means of social and socio-acoustic surveys".
7. Axelsson, Ö., Nilsson, M. E., & Berglund, B. (2010). A principal components model of soundscape perception. The Journal of the Acoustical Society of America, 128(5), 2836-2846.
8. Weinstein, N. D. (1978). Individual differences in reactions to noise: a longitudinal study in a college dormitory. Journal of Applied Psychology, 63(4), 458.
9. De Coensel, B., Botteldooren, D., De Muer, T., Berglund, B., Nilsson, M. E., & Lercher, P. (2009). A model for the perception of environmental sound based on notice-events. The Journal of the Acoustical Society of America, 126(2), 656-665.
10. Stansfeld, S. A. (1992). Noise, noise sensitivity and psychiatric disorder: epidemiological and psychophysiological studies. Psychological medicine monograph supplement, 22, 1-44.
11. Kliuchko, M., Heinonen-Guzejev, M., Vuust, P., Tervaniemi, M., & Brattico, E. (2016). A window into the brain mechanisms associated with noise sensitivity. Scientific reports, 6, 39236.

Proceedings of the

# ICA 2019 AND EAA EUROREGIO

## 23rd International Congress on Acoustics, integrating 4th EAA Euroregio 2019

9 - 13 September 2019, Aachen, Germany


ISSN 2226-7808 and 2415-1599
ISBN 978-3-939296-15-7