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SOUNBE, A TOOLKIT FOR DESIGNERS DEALING WITH SOUND PROJECTS

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1. Introduction

Several characteristics define good design: safe functioning, long durability, simple use, quality of materials as well as resistance, lightness, elasticity, pliability, flexibility, transparency [Manzini and Cau 1989].
Our perceptual experience of the world is richly multimodal [Stein and Meredith 1993]. For this reason, every aspect has to be assumed as a very important quality of the product.
Designing sounds for products is a relatively new concept that still lacks a systematic procedure. Nowadays it is acknowledged that product sound design should be integrated in the main design process to enhance the user experience both on ergonomic and hedonic levels. However, an integration of the sound design into the design process requires specific tools and methods [Özcan and Van Egmond 2006]. The aim of this research project is to find the best response to all these needs.

1.1 The multisensory product experience

The experience of any product, physical object, service or space, comes from the sensorial reply of the subject being in contact with the product itself. For many years, the immediacy and spontaneity of the visual approach in perception has supported several theories [Berendt 1988] affirming living in a real “eye culture”. Nowadays, these theories are overtaken thanks to the proved collegiality of every sense in the perception process. In fact, in real life it is very difficult to delimit single perceptive experiences, uninterrupted and often unconscious, to one single sensorial channel [Bandini Buti et al. 2010]. Recently, some researchers proved that hearing represents our main perceptual alert system. The hearing system is indeed able to observe all the surrounding sounds, providing us the possibility to immediately react to a danger, or even pre-empting it, as well as inform us [Schiff and Oldak 1990]. This research aims to focus on one of the “invisible aspects of design” [Norman 2004], [Ferreri and Scarzella 2009] that, according to several scholars [Schafer 1969], [Truax 1978], [Bull and Back 2003], [Spence and Zampini 2006] and entire research groups (e.g. CLOSED project, literally Closing the Loop Of Sound and Evaluation Design) [Susini et al. 2006], proves to be promising: the sounding invisible aspect.

1.2 Phonosphere, soundscape and acoustic ecology

Sound surrounds and wraps us whatever activity we’re doing. Several evocative neologisms describing this phenomenon were found during the years. The term *phonosphere* is quite a recent neologism that effectively identifies the overall sounds that fill in the air [Bettini 2008]. The concept of phonosphere corresponds to the less recent English neologism of *soundscape*, coined in the seventies by the Canadian theoretician and composer Raymond Murray Schafer. Soundscape, as well as phonosphere, describes the acoustic landscape where we are plunged [Schafer 1969].

Today soundscape is considered with a maximum of attention for its consequences on human health. It is common to talk about *acoustic ecology*, to underline the concept of "living environment". As a demonstration of the growing interest for this subject, the WFAE (World Forum for Acoustic Ecology) was founded in 1993, an international association sharing the common concern of soundscape as an ecologically balanced entity. Interdisciplinarity and multidisciplinarity [Westerkamp 2000] represent a key driver of the analysis of the complex background that the soundscape is (Figure 1).

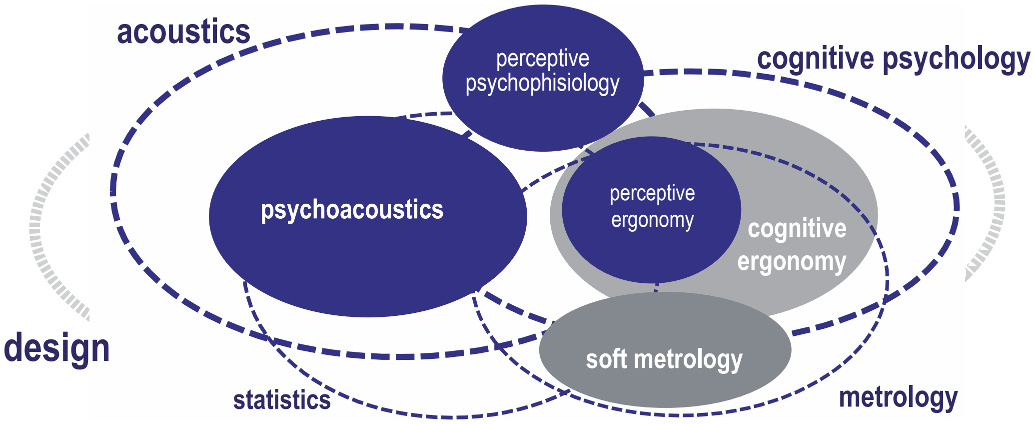

Figure 1. Interdisciplinary and multidisciplinary of the different sciences and matters involved in human sound perception and evaluation

1.3 Lack of tools for designing the product sound

The practice of product sound design is relatively new within the field of product development. Practice shows that various disciplines such as design engineering, acoustics, psychoacoustics, psychology and musicology contribute to the improvement of product sounds. Starting from this evidence [Özcan and Van Egmond 2009], product sound design should be an independent field that encompasses an inter-disciplinary approach.

In accordance with Schafer, to reduce the wasted energy that noise represents [Wrigtson 2000], we endorse the hypothesis to foster a new approach to design, providing designers with appropriate support tools in order to predict, adjust and plan the product sound, starting from the design phase.

The following modest overview highlights strengths and weaknesses of different tools currently supporting the design activity:

- **Spinotron**: developed by the Perception and Sound Design research team at IRCAM (Institut de Recherche et Coordination Acoustique/Musique, Paris, France), this tool investigates the continuous sonic feedback in tangible interfaces. A selected panel is challenged in performing a gesture associated to a listened sound (e.g. listening the sound of rice falling down on a surface, people will probably perform the gesture of pouring). These results hold promise toward creating a foundation for the design of continuous sounds that is intended to accompany control actions on the part of users [Lemaitre et al. 2009]. The device is clearly suitable for all those interfaces in which the sonic interaction represents an important element, even though it appears not to be suitable for designers managing the project of mechanical sounding objects, needing some indication in the materials hyper – choice;
- **Vocal imitations translator**: vocal imitations can effectively communicate a referent sound [Lemaitre et al. 2011]. This device records the vocal imitation and translates it to designers in meta-project answers (material, gesture, etc.). But the strong connection to the subjective ability to imitate and reproduce sounds vocally represents a weakness in relation with our purpose: a misrepresented imitation of the desired sound would produce meta-project answers misleading compared to the designer's demand;

- **Sound Design Toolkit (SDT)**: a software package including polyphonic features and connectivity to multiple external devices and sensors in order to facilitate the embedding of sonic attributes in interactive artefacts [Delle Monache et al. 2010]. The main criticality of the toolkit is being a complete virtual software that doesn't include the subjective attitude that must be at the base of each choice;
- **Audio-visual Virtual Reality-system**: a flexible audio-visual projection system that combines stereoscopic visualization in a CAVE (Cave Automatic Virtual Environment) with a new spatial acoustic reproduction method. This technology enables a realistic sound reproduction synchronously with the visualization of machinery, cars and other technical systems [Husung et al. 2010], [Husung et al. 2009]. Since this approach face the sound from the early phase of the project, it can be seen as a quite interesting possibility especially for complex systems. On the other hand, VR-system needs a virtual prototype of the product itself: this represents a quite costly step, especially if the final layout of the product is still not the ultimate one. Finally, we can hypothesize an earlier need of a more intuitive tool in order to orientate the meta-project phase, and a later step with VR-system in order to verify the real effectiveness and the final output of the design process.
- **Tuning forks**: in King's College (London) 16 tuning forks of identical shape but different compositions are adopted to compare different materials sounds. Sounding these forks, designers have a suggestion of the materials' sounds [Laughlin and Miodownik 2008]. Unifying the tool shape represents an interesting guideline, but the weakness stands in the human variability related to the intensity of the tester stressing the fork;
- **Xilofono**: developed by Materioteca, an Italian material library, this tool is a nearly ordinary xylophone composed by different equally shaped polymeric samples that allows to compare the acoustical behaviour of each material with something similar to a drumstick [Bano 2008]. Thinking to the analysed tools, this one appears to be the closest to real designers needs.

Starting from all these considerations, we can state that noisiness is an important experience in the product domain since everyday products may contribute to noise pollution [Fenko et al. 2011]. Therefore, the provision of an innovative support tool within the engineering design process is essential for the effective delivery of high quality products and systems [Klatzky et al. 2000] and, in particular, in order to orientate the designer choice between the hyper-choice of the possible materials.

Beyond the already cited acoustic tools, a good reference for designing a new support tool comes from the researches on tactile perception. Sensotact® is a tactile reference created in Technocentre, the Renault's sensory analysis laboratory; this empirical method facilitates panel members in the evaluation of the tactile. Recently, the instrument has been updated by the French company ExpertiSens and renamed TouchFeel. Specifically, TouchFeel splits the touch sense into 9 simple descriptors in order to promote a common language, and makes the panel associate these descriptors with 3 main movement patterns: orthogonal touch (measuring hardness, nervousness and memory effect), tangential touch (measuring slippery, braking, depth, relief and fibrousness) and static touch (measuring thermal features). By developing a common language, TouchFeel can be used in many different fields: cosmetics, automotive, aviation and even sports and the textile industry [Myth 2013].

Drawn on these considerations, in next paragraphs we will see how the innovative Category Based Affect methodology can be applied for the first time to the cognitive analysis of the product sound in order to deepen the qualitative set of characteristics of it. Furthermore, a wide focus will be on SounBe®, an innovative tool developed in aid to designers dealing with sounding objects, that represents the core part of this research.

2. Materials, methods and innovative tools

2.1 Cognitive analysis of product sounds

Our cognitive abilities guide us easily during each ordinary task also thanks to the surrounding soundscape. Several studies [Li et al. 1991], [Rosenblum et al. 2000] prove the human abilities to correctly recognize events and objects by sounds produced; furthermore, our ability seems to be reduced in presence of non-sounding and non recognizable-sounding objects.

Brain regions involved in the acoustic task gather the "sound sign" of the object, identifying its material, some details, its broad shape and dimensions. Nevertheless, if a sound appears to be incoherent in relation with an environment, we will perceive it incorrectly. Furthermore, every environment is characterized by its own sound sign, and the human brain exploit this element in order to understand if there is anything different in the current ambient, or if we are into a new one.

The environmental intelligibility arises then to be in coherence with the objects, events and materials' sounds to which the environment is constituted [Maier and Ghazanfar 2007], [Neuhoff 1998].

2.1.1 Analogies as key drivers in the qualitative analysis of sounds

In order to investigate the potentialities in acoustic communication, the first research goal was to highlight the meaning of the product sound, testing a new methodology.

Knowledge concerns the set of previously acquired concepts; usually, these concepts are neatly associated with key assumptions. This introduces the idea of cognitive organization, the structure in which the meanings that contribute to cognitive categorization are arranged.

Furthermore, every single information once acquired and memorized creates a specific mnestic trace, a cornerstone to whom connect the future information, establishing a true "net", more and more entwined and rich in signifiers. The imaginary lines connecting mnestic traces represent the *cognitive associations*, the links between knots. Changing some associations, the concept complexity will vary: the higher is the number of links, the higher will be the number of crossed references to other themes.

This cognitive technique is the starting point of the Category Based Affect investigation method, a qualitative technique of analysis of a concept, based on free connection of ideas. Asking for the activation of the most pertinent mnestic trace, a net of attributes and suggestions describing the qualitative features of the product sound will be created.

2.1.2 Conceptual maps

In order to represent the reciprocal relations between acoustic stimulus and the set of its suggestions, we can adopt the conceptual maps of analogies. A conceptual map is a diagram that graphically represents a set of information. Maps are particularly useful starting from the creation of the map itself, since this phase is a key stage of the entire process. The maps draft follows three different steps:

- Data collection, thanks to the Category Based Affect method;
- Re-examination of the collected data, in order to highlight the key points of the analysis;
- Conclusion of the map with the integration of important examples.

The ended map will visually show the set of concepts related with the sound in analysis. This approach represents a starting point regarding the product sound collective imagination. Following this methodology, the designer is able to catch some inspirations for the future product re-design.

2.2 Development of SounBe®, an innovative design support tool

2.2.1 The material-configuration form-exciting mode triangle

The first problem for the designer dealing with the project of sound is identifying the fundamental factors that contribute to the mechanical sound generation. Starting from an analysis of the soundscape and from different categorizations [Ferreri and Scarzella 2009], [Houix et al. 2012], the mechanical sound appears to be produced by 3 main variables that will be the starting point of every redesign project, synthetically outlined as a *material-configuration form-exciting mode triangle* (Figure 2). The following bullet point reveals the detail of each factor:

- **Material(s)**: the matter forming the product; it can belong to polymers, composites, ceramics, metals, woods, textiles, glasses, paper class;
- **Configuration form**: the geometrical shape of the material; the most common configuration forms are: foil and plates; section bars and pipes; sheets, films and ribbons; granules, flakes and powders, grids and nets, foams and expanded materials, gel and paste;

- **mode**: is the stress that makes the object sounding; the most common and interesting gestures are: knocking with the knuckle or other with a percussive stick, falling to the ground, flapping, sliding an object on the surface, crushing, breaking, rubbing.

In conclusion, what the *material-configuration form-exciting mode triangle* points out is the necessity to isolate the sounding variables of the sound source (the product or part of it) [Gaver 1993] in order to better redesign each of them.

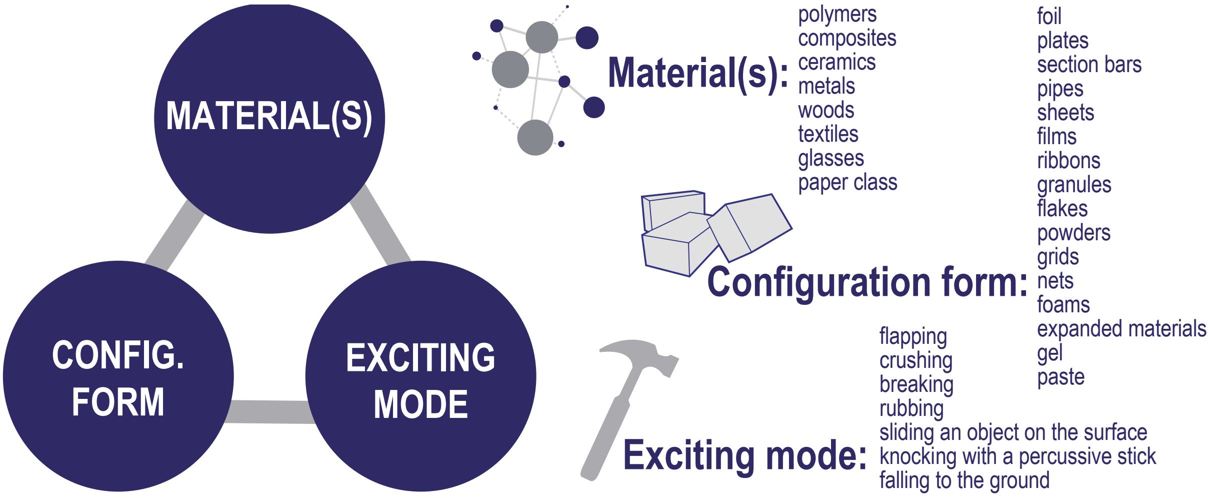

Figure 2. The material-configuration form-exciting mode triangle: three fundamental factors that generate each mechanical sound, and their specifics considered in SounBe® methodology

2.2.2 Development of the innovative design support tool

Starting from these analyses, it has been necessary to create a new device in aid to designers. The key point of this kind of devices is ensuring the reproducibility of the process, following the main principles of the scientific method [Pickering 1995]; this way, the tool allows several uses, both by different people, and in different contexts.

This innovative device and method for acoustic sensorial analysis of materials has been patented by Politecnico di Torino with the name of SounBe® [De Giorgi et al. 2011], (SounBe® European patent).

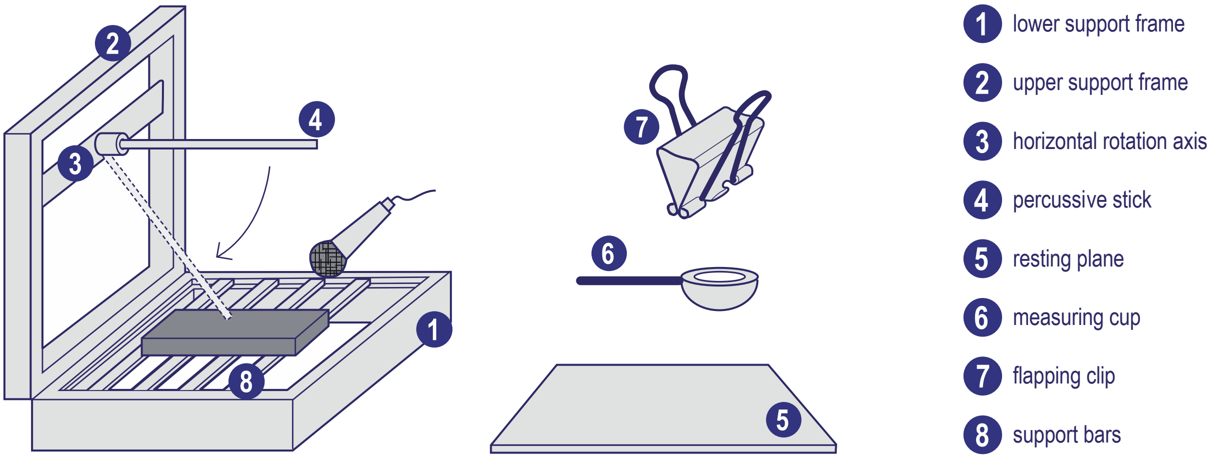

Figure 3. Deconstruction of the body frame and the main accessories of SounBe® toolkit, used by designers and other possible stakeholders (industrialists, manufacturers etc.) to make the material samples sound

The device (Figure 3) appears in the form of a kit housed in a briefcase, and essentially comprises a support frame, and a plurality of accessories to make the material samples sound. The frame comprises a lower and an upper surround hinged, and a horizontal rotational axis operative just for two tests. The set of accessories comprises percussive sticks of various materials (e.g. plastic material, wood, steel, glass) presented in a normalized shape and conveniently provided with an end eyelet to connect them to an horizontal axis of the frame, resting planes made of various materials (e.g. plastic material, wood, steel, glass), a measuring cup for granular substances, a flapping clip to repeatably hold sheet materials (thin plates, fabrics, etc.) and a plurality of support bars.

With the aid of this device, it's possible to stress differently various form of test samples (the materials that the designer needs to test for his project) with the possibility to compare every possible material-shape-gesture matching. Some solicitations permit to avoid the human variability in the test (knocking with a stick and falling to the ground), others include the presence of a tester starting from the assumption that the human interaction is necessary for several solicitations.

In detail, the possible gestures (Figure 4) provided by SounBe® are:

- **Knocking with a percussive stick**: for foil and plates, section bars and pipes (and, eventually, for finished products); once the sample is put on the frame support bars, this can be hit thanks to one of the percussive sticks. The stick falls down on the sample from a unified height. Changing the material of the excited sample but keeping constant the stick and the gesture, we could isolate the acoustical features typical of the tasted material;
- **Falling to the ground**: for granules, flakes or powder; the material is arranged in the measuring cup rotationally mounted about the horizontal axis; rotating the cup by 180° the granules/flakes/powder fall on the plane of a chosen material, mounted in the lower surround of the frame so as to rest with its peripheral edge the leaking particles; in this case too, we can valuate the sound generated by materials and/or shapes, keeping constant the applied gesture;
- **Flapping**: for sheets; the material is gripped by the flapping clip and manually flapped;
- **Sliding an object on the surface**: for grids and nets; the exciting mode consists in sliding percussive sticks on the surface of the sample;
- **Crushing**: for sheets and films; the material is held in the hands and manually crushed;
- **Breaking**: for foam and expanded materials, and for any deformable or easy breakable one; also in this case, it's not necessary a specific tool, we just need to keep the material in the hands and bend it up and down, until the break;
- **Rubbing**: for textiles, sheets and films; neither for this test is necessary a tool since it just consists in rubbing in the hands the material.

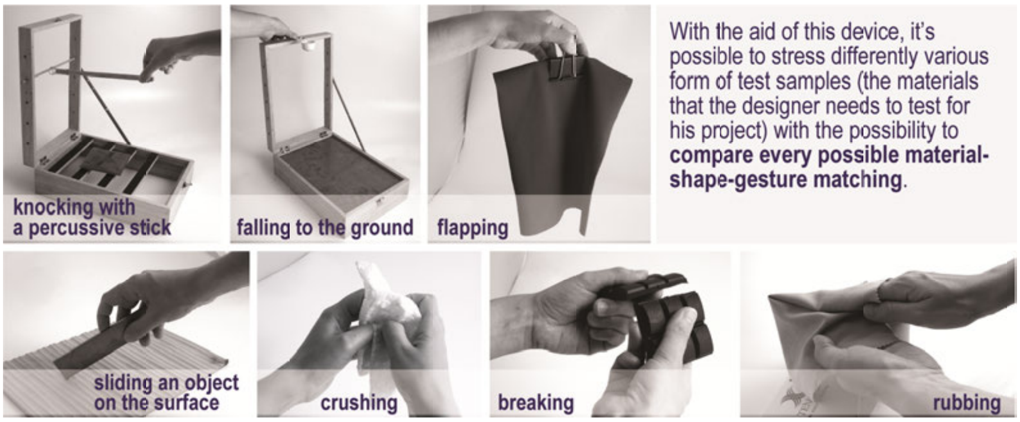

Figure 4. SounBe® exciting modes: the pictures show seven possible gestures to stress the material samples, giving the possibility to compare every possible material-shape-gesture matching

Finally, the sounds produced may be recorded using a microphone connected to a recording device, e.g. a computer provided with sound acquisition software.

2.2.3 Testing panel as a human assessment device

Qualitative and descriptive analyses are strongly connected with human perception [Berglund et al. 2011]. This assumption discloses the matter of *soft metrology* [Rossi 2013]. Soft metrology is defined as the set of measurement techniques and models, which enable the objective quantification of properties which are determined by human perception [Pointer 2003].

What characterizes the complexity in perception is the intrinsic multidimensional nature combined with a subjective attitude [Susini et al. 1999]. Recently, sensory evaluation techniques have been developed to reveal detailed information about perception of products [Pagliarini 2002], [Lokki 2013]. Both in soft metrology and in sensory evaluation, the human being is accounted as the measuring instrument, thanks to his involvement in focus groups and testing sessions. The testing panel (also called acoustic "tasters", e.g. a group of experts, appropriately guided in acoustic sensorial analyses) becomes in this research the real qualitative judge of the perceptive characteristics of the sound of the material at issue.

2.2.4 Corpus of semantic descriptors

In order to verbalize the characteristics of sounds, a specific and shared vocabulary is strongly necessary [Houix et al. 2012]. Once the sounds have been acquired, semantic descriptors defining the sensorial recall produced by the sounds themselves are attributed thereto.

The adopted descriptors are those known in literature as "Von Bismarck's adjectives" [Von Bismarck 1974], and are combined to the sounds by means of a reliable (reproducible in statistic terms when carried out in a suitable manner), pertinent and consistent procedure, with the use of a trained sensorial group, the "tasters".

2.2.5 Matching survey

To each sound, the nature of which is known by the tasters in order to avoid an excessive mental effort [Parizet and Nosulenko 1999], are attributed at least three descriptors by each taster (e.g. harsh, piercing, shrill or soft, deep, dull) thanks to a specific survey presenting in columns the semantic descriptors, and in rows a progressive number identifying each sound recorded with SounBe®.

The tasters' choices are analysed by means of the Borda method [Borda 1781] by assigning different scores to the first, second and third choice, which allows associating the most pertinent descriptor with each sound. It is worth noting that, although referred to sensorial, non-quantitative features, the method described is metrologically valid because it leads to statistically reliable sound-descriptor association.

2.2.6 Application to MATto library

Nowadays, designers are immersed in a surge of hyper-materialism, ultra-performance and environmental responsibility, material mutations, sensorial maximalism of luxury and effect: new materials have produced a vortex of "hyper-choice" [Kula and Ternaux 2009] and infinite material dialogues [Margolis 2010]. A benchmark for designers considering the materials hyper-choice are the material libraries, real physical and digital archives of material samples conveniently catalogued.

Today, several material libraries are available in Italy and Europe, and each of them has adjusted its own research path on a specific theme (single classes of materials, sustainability, innovation, building materials, etc.). A very up-to-date research path connected with the multisensory product experience is represented by the topic of sensoriality. But examining all the European libraries dealing with sensoriality only few, such as Materia (Naarden, The Netherlands), Matrec® (Rome, Italy), MaTech (Padua, Italy) and MATto (Turin, Italy), include the specific theme of acoustic behaviour [Lerma et al. 2011]. Precisely in MATto, SounBe® is adopted as research support tool in the definition of the acoustic behaviour of materials.

Therefore, on the basis of the processes described above, a database can be created in which a descriptor of the produced sound is associated with each material-configuration form-exciting mode combination. Such database may assist designers in determining the most suitable material for their project. According to the most advanced orientation of design culture, this choice should be dealt with in the meta-project phase, which is thus extended and charged with meaning [Lerma et al. 2011]. Furthermore, this choice plays a particular role since the experience of materials refers to the experiences that people have acquainted during their life [Karana et al. 2013].

3. Experimental phase and results

3.1 Pilot test: the first application of SounBe®

In order to test the real effectiveness of SounBe®, the research group decided to verify its functioning through a pilot test managed in MATto, the materials library at Politecnico di Torino, on ninety sounds obtained by various material-configuration form-exciting mode combinations. Several other tests on other materials will be part of SounBe® future validation, in collaboration with IRCAM in Paris. In the following paragraphs are presented the practical details and the final results of the pilot test.

3.1.1 Participants

The testing panel for this pilot test was a small group of 12 tasters (6 men and 6 women, mean age 24 years old) previously instructed on the finalities of the project and the testing procedures.

Since the purpose of this project is to create an instrument based on the real perception of general people, it's not necessary to select a panel with a specific acoustic sensibility (music players, singers, acoustic technicians, etc.). The suitable taster is a person interested in the field of human perception and sensorial analysis, suitably trained for this kind of sensory evaluation sessions.

3.1.2 Materials

During the pilot test, we considered just some configuration forms (plates, sheets and films, foam and expanded materials, textiles, grids and nets, granules and powders) in order to test each kind of exciting mode but, at the same time, bringing the number of recorded sounds down.

The selected materials have been chosen from the most common material classes: metals, ceramics, polymers and woods. Furthermore, the pilot test was the suitable opportunity to test SounBe® also on foods since these particular "materials" are nowadays gaining a huge importance in the design field, specifically relating with the perception of food sound [Zampini and Spence 2010], [Chauvin et al. 2008].

3.1.3 Stimuli recording

For the recording of the stimuli of 90 sounds in a silent room with acoustic sound absorbing treatment a cardioid microphone has been used. The microphone was set at 25 cm from the sound source (SounBe®). In this phase is very important to repeat the measurement with the same recording configuration, in order to keep constant the recording variables. Similarly, during the stimuli submission, the sound was kept constant.

3.1.4 Requested task

The sounds have been submitted to the tasters during several listening sessions, spaced out by 15 minutes pauses. The requested task was to rate the most suitable descriptor chosen from the list of Von Bismarck's adjectives (gentle, hard, beautiful, ugly, harsh, mild, thick, thin, sharp, dull, inharmonious, harmonious, loud, soft, strident, calm, weak, powerful, pleasing, unpleasing, smooth, rough, high, low, metallic, deep) in relation with each submitted sound.

Both recorded sounds and descriptors have been randomized, and the tasters have been asked to choose the three most suitable adjectives for describing each sound, also rating them on a 1 to 3 order.

3.1.5 Data analysis

The final scores obtained by each descriptor have been calculated with the Borda count method, in which each last place (in the 1 to 3 order) descriptor received 1 point, each next to last place descriptor received 2 points and each first place descriptor received 3 points.

Thanks to the sound evaluation sessions it has been possible to associate to each sound (obtained by the material-configuration form-exciting mode combinations) the most suitable descriptor between those proposed by Von Bismarck.

The association of different sounds with the same descriptor could be possible, or that more than one descriptor is rated to be suitable for one sound, but none of these cases invalidate the results of the test.

In the next paragraphs we will see how these results can support the design activity.

3.2 The acoustic database

Having recognized the importance of the perceptive characteristics of materials, the multi-sensory element has become a factor for cataloguing materials in material libraries. Each institute draws up its own individual system of cataloguing and evaluation but, unfortunately, there is no common language, vocabulary or method of sensory evaluation for materials based upon scientific, but also simple and comprehensible criteria, which would make the results of the actual analyses available to all: industrialists, manufacturers, designers and students [De Giorgi 2012].

The pilot test presented previously shows an easy procedure that allows researcher to catalogue materials starting from a shared semantic descriptor, a cognitive methodology to investigate the intrinsic recall generated by the product sound, and a standardized methodology to isolate the main sounding variables for further re-design processes.

The acoustic database has, therefore, a double possibility: users can search for the most suitable material for an application starting from the descriptor (the keyword) filtering just those samples associated with it or, on the other hand, they can compare the acoustical behaviour of different materials (e.g. different resins), examining the descriptors assigned by the tasters.

With this practical support, a huge amount of “sounding design errors” could be avoided in future redesign process.

4. Discussion and future development

4.1 A tool for designing soundscapes: application fields

These conclusive paragraphs will disclose the possibilities offered by this research in the field of the design project. As we introduced in the first part of this paper, all the objects surrounding us generate the soundscape. Clearly, if designers could act on the project of sounding products, the effect would be a modified soundscape.

The illustrated methodology can be applied in different fields and in the following paragraphs there are some meaningful examples.

4.1.1 Sound in workspace

For many people in the Western world, office is one of the most important environments of life as the major part of the day is spent there. Furthermore, several studies in single and open plan offices prove the negative effect of noise on performance, fatigue and stress [Jahncke et al. 2011], [Jahncke 2012].

Noise in office is in part due to chatting, plants and electronic devices; in part, background noise is due to accidental and temporary activity sounds produced by objects such as doors and cabinet doors, chairs, people walking, objects moving on the desk, keyboards and mouse, PC fan and countless other mechanical sources [Kjellberg and Landström 1994], [Roper and Juneja 2008].

The causes of poor acoustical performance are perhaps not adequately understood yet, but the return on office workers’ well being and productivity is an indisputable evidence [Banbury and Berry 2005], [Haka et al. 2009], [Kaarlela-Tuomaala et al. 2009]. Starting from this observations, the first suggestion for the future tests, validation and application of SounBe® are workspaces.

4.1.2 Sound in the domestic space

In addition to workspace, home environment represents another very important human habitat. Then, a positively perceived private acoustical environment can be regarded as an important aspect of life quality [Steffens et al. 2011]. Differently from the workspace, in this ambient people seldom have to complete high cognitive demanding tasks. For this reason, this environment could represent another interesting testing ground, but the real advantage arising from a redesign of domestic sounding objects would increase certainly the pleasantness of the domestic soundscape, but wouldn’t act on primary human needs such as well being. For this reason, this application field has been considered interesting but not as immediately necessary as the working field.

4.1.3 Sound branding

Another possible application of SounBe® is related to the huge and up-to-date field of sound branding. Several industries, such as those in the automotive field, household appliances, beauty care, multimedia but also food, deal with a great care the theme of sound in their products. In particular, over the years car and motorbike manufacturers generate unique artificial noises to brand their products, both in the interior and in the exterior of the vehicle. A well-known example is that of the researches on the cars door slamming sound [Parizet et al. 2008] started by a popular car manufacturing industry dealing with the luxurious and reassuring sound of a middle-class car.

In this field of sound branding, sound symbolism [Spence 2012] and researches on the acoustic identity of products, SounBe® could represent a possible creative tool in order to investigate and develop new sounds characterized by designed features and semantic contents.

4.2 Future development, SounBe® validation

In order to properly validate SounBe®, the workspace has been chosen as the first testing ground.

The validation procedure to carry out consists in an experiment that permits to find a relationship between the positive or negative attributes derived by SounBe®, and some aspects related to the subjective perception of the sounds in a real environment where materials will be placed. The main focus of the study merged on the accidental and temporary activity sounds produced by linings and furniture items that characterize every kind of workspace, and since they can potentially be re-designed (mobile phones buzzing, doors and cabinet doors slamming, people walking, objects putting and moving on the desks, office chairs squeaking and sliding, objects falling).

These noises are intrinsically non-stationary and several studies have shown that temporal variability generally increases the annoyance response when compared to continuous sounds. The reason might be that constant sounds are more predictable than unexpected sounds and when noise is predictable it should be less annoying than when it is unpredictable.

The analyses will be carried out in double cell-offices because in larger offices, as open-plan and shared offices, the high background noise level can mask the perception of this kind of sounds. During an experimental phase carried out in a simulated double cell-office, properly designed to test at least three different sets of linings and furniture, three main aspects connected with the subjective perception of these sounds will be investigated: the pleasantness (opposite of annoyance), the cognitive impairment and the physiological reaction.

5. Conclusion

In conclusion of this research we can state that the primary goals fixed in the introduction have been achieved. The main aim to create a new tool in support to designers has been carried out.

Designers dealing with sounding objects and sound projects have now available two different instruments in order to create new sounds or to evaluate the existing ones: thanks to the Category Based Affect method they will conduce a preliminary investigation on the sounds' collective imagination; thanks to SounBe®, they will be able to split the sound matter in main factors and gather some useful meta-project advices related to their needs.

Finally, a new conscious approach to sounding objects will generate new designed soundscapes, avoiding the increasing of noise pollution and poor sounding objects.

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