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Characterisation of an existing building according to olfactory parameters

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Abstract

Olfactory interpretation is, most of the time, the combination of varied physical, chemical, physiological and sociocultural elements of odour. The paradigm of *olfactory effect* is one way to express some of these combinations which are among the most typical in building environment. The olfactory repertory presented here corresponds to the modes of appearance displacement and disappearance in space of the odour. When the concept is transferred to a field study, with the “commented city walk” method specifically adapted to olfactory sensation, some interactions between building environment, odours and the user interpretations can be highlighted. These “olfactory configurations” describe olfactory phenomena in their connections with technical or architectural devices. They can be, in the end, considered as models to integrate odour in building conception.

APPROACH FOR METHOD
ARCHITECTURE
ODOUR
PSYCHO-SOCIOLOGY OF ODOUR
SCIENCE FOR BUILDING ENVIRONMENT

Introduction

Many works [1] suggest that in most of human societies odour is a very important element, not only in inter-individuals relationship (especially in family), but also in the relationship between human beings with their life areas. A research made during a PhD work [2] shows that nowadays, odour is perceived as an intrinsic element of animate and inanimate things themselves. So it is supposed to be a palliative to vision limits. Now the *invisible* is very present in some aspects of our society, for example in global air quality or cleanliness evaluations. They are all the more estimated through odour, since their imagery seems so be very influenced by the 17's miasma theories [3] which used to ascribe sanitary danger to putrefaction odours.

Although indoor air control is currently an important preoccupation in buildings management and conception, it is relevant that its olfactory aspects are almost forgotten. In fact odour is still hard to interpret. So how can one observe its role as ambient factor in environment, and then take it into account in building conception?

The first studies about odour in environment are many centuries old [3], but it is still a topic to be ameliorated. The knowledge of all varied odorous molecules from a smelling miscellany is not sufficient to deduce the resulting odour because science doesn't master the knowledge of the mixing rules yet. So the methodological tools for olfactory environment evaluation are not full. The field studies have difficulties to make the connection between odour concentration and perception intensity account. This connection is different not only for each odour but also

for each component of the odour. The distance from the olfactory source, influencing components concentration, can thereby considerably change the olfactory perception quality . The only snag with the current field approaches of odour in environment is that is focus on the olfactory nuisances. But it is a contestable approach which limits the observation and then the intervention field on the smelling environment because it can only lead to “fight against” strategies. Considering building environment odours is going past the reductive notion of nuisance.

To do so, we prefer a phenomenological approach of in situ odour. Thanks to an analyse tool, the olfactory effects repertory, and with an odour adapted method, some olfactory phenomena in existing buildings can be understandable.

1. The olfactory effect, a repertory

The *olfactory effect* is a conceptual tool linking up different knowledge fields [2, 4]. On the theorisation model of ethology, some *transversals* have been stretched into diverse currently aspects of wisdom and the results of an enquiry about ordinary olfactory perception in building environment. These transversals enable to pay no heed the current gaps of knowledge on odour because they to lean on olfactory phenomena as they are described by users. The 32 olfactory effects already defined are organised¹ in 5 classes presenting commons schemes.

1.1. Elementary olfactory effects

Odour is a chemical signal arisen out of our environment, from animate and inanimate things around us. It's part of their escaping substance that we pick up and interpret. The olfactory phenomena links to the propagation of this signal in building environment can be expressed by the *elementary olfactory effects*.

The odour diffusion conditions in a volume of air depend widely on its volatility and especially on the distinct volatility of its diverse components. First, the most volatile molecules are principally emitted. Then, in a closed area, the air is slowly getting saturated by all the components of the odour. Theses phenomena can be described with the *static diffusion, invasion and concentration effects*. If there are some air movements, the olfactory homogenisation is faster (*dynamic diffusion effect*). Some environmental conditions such as heat improve components emission in the air. It can thereby induce changes in the odour aspect, modifying its components proportions (*warp effect*). Some materials with specific proprieties can also absorb a loss of these odorous volatile components, to release them later into another atmosphere (*permeation effect*). When the olfactory emission ceases, as fresh air comes, the odour components go out in their order of appearance (*disappearance effect*).

1.2. Composition effects

The smell sense has very important discrimination abilities, at low concentration. It is also organised in “stereo”, so the localisation of odour sources becomes easier. The composition olfactory effects can describe the space arrangement possibilities. They depend widely on the space-time devices of the odour diffusion, for example, during the moving of people in the surroundings of odour sources, in abrupt meetings with odour or in increasing or decreasing odour intensity gradients (*irruption, crescendo and decrescendo effects*). When the odour source is moving, it let a specific trace behind itself (*wake effect*). If many odour sources are (or had been) in the same volume, their odours can be perceived as separate clusters, because they are very localised in space or because their chemical nature and/or their perceptive

¹ This organization is based on the model of the sound effect repertory [4]

identification need that the “smeller” distinguishes them (*arrangement and superposition effect*). These odours can also be mixed, most of the time because they have similar volatility aspects ; then they are perceived as a whole (*chord effect*).

1.3. Mnemo-perceptive effects

The odour and its source can be sharply dissociated in space and time, so that the users have to make a double reconnaissance, both identification and space at a time (and also time) localisation of the (probable) odorous stimuli perceived. The *mnemo-perceptive olfactory effects* allow the description of this perceptive and mnemonic organisation in the reality.

The tiredness and recovery of the sense of smell plays a crucial role in the everyday olfactory sensation since the furtive, repeated or extended contacts with various odorous volumes conditions the place apprehension (*adaptation, recovering and repetition effects*). In the same way, the odour sources localisation possibilities in space depend, for a large part, on the “smellers” movements, because the olfactory dispersion often gives an odour “immersion” feeling (*ubiquity effect*). If the odour source is localised enough in space and time, then its position can be located (*localisation effect*). Air movements can also lead to spatial localisation mistakes (*miss-localisation effect*). On the contrary, air inertia can delay the olfactory detection (*time lag effect*).

The “smeller” can also be mistaken about the odour source identification (*confusion effect*). Odour can also generate a great reminiscence. This effect can be illustrated by the famous Proust’s “petite Madeleine” episode (*anamneses effect*). This strong link between odour and memory has two consequences. On the one hand it can make a previous liked odour become hated after a bad experience (*inversion effect*). On the other hand it can make an odour become a spatial or temporal mark for people who smell it in a repetitive way (*recurrence effect*).

1.4. Psycho-motions olfactory effects

Air movement, as people movement, play an essential role in olfactory sensation in building areas. But odour can also set people in action (giving a ghost of motion or real move). These situations, when olfactory sensation cooperates with people motion are described in four *psycho-motions effects*.

Since other people’s odours if too close can be felt as an aggression, the personal inter-individuals interactions “bubble” seems to have an odorous dimension (*imposition effect*). So the odours often make people act. It can be a run away, a polarisation or a systematic surveying of space (*repulsion, attraction and zigzag effects*).

1.5. Semantics olfactory effects

In the long philogenetic story where the sense of smell is included, the principal function of the olfactory signal is to be informative. The *semantics olfactory effects* allow describing situations when the game between odour emergent signification and real context is a part of the way people interpret the situation.

In spite of the current progression to the olfactory abstraction (perfume and its applications), the link between the objects smelling and their odours is still very strong. Some odours can therefore be exclusively or relatively attached to some specific beings, objects or places (*icon and qualia effects*). In the same way, when the odour source is not visible, odour identification can give information about an occurring or past event, except if there is a miss identification (*pretence effect*).

The current knowledge about odour insists on the chronobiological context in the hedonic olfactory interpretation (positive or negative judgement), but our work [1] brings out the

pound of the spatial-time context in this judgement. Users make a parallel between the semantic of odour (its signification) and a *reference olfactory idea* and estimate their coherences or incoherencies. When odour signification and the place and / or the moment it is smelled seem to be in contradiction, the situation judgement will be humorous at the best and negative at the worst. In this last case odour shall get a nuisance grade.

Theses olfactory effects definitions don't always lean on varied disciplinary fields in account owing to the many lacks in olfactory data. In spite of this heuristic part, these definitions make a synthesis about odour interpretation in context, its apparition, disappearance and transition modes in building areas.

The olfactory effect is a first step for the olfactory phenomena analysis in building environment, so important for spaces makers.

Therefore we used this repertory to analyse user's words in a fieldwork. Thanks to the city walk method [5] adapted for odour and to this repertory, we have been able to characterise some olfactory phenomena in an existing building (a shopping centre).

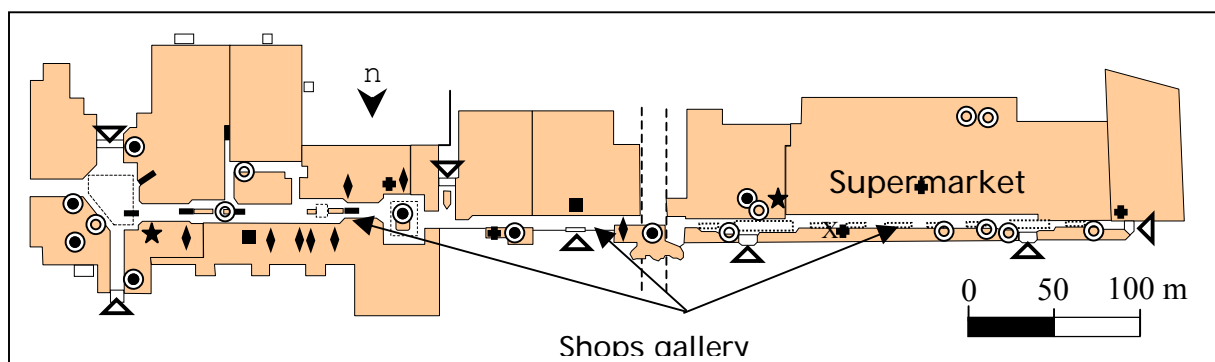
2. A fieldwork

2.1. Three corpus to collect and confront

Thibaud's city walk method consists in walkers taking a stroll. The description of what they perceive and feel during the walk is recorded. They were asked, in our case, to focus their words on their olfactory sensations. Theses descriptions were then analysed, using the olfactory effect to have a lecture of the olfactory phenomena described. This allows hypothesis on the specific olfactory phenomena of the studied site. Then, to put the walkers words in context, this hypothesis were confronted to the materialistic data of the building (measures, ethnographic observations...). It allowed to understand them in their physical (signal, architectural environment), temporal and social (uses) contexts and therefore to establish some of the olfactory configurations of the site.

The speech of users walking in the building as far as their olfactory sensations are concerned are most profitable. In order to understand the olfactory phenomena evoked in the best conditions, the materialistic and odour conditions analyse of these descriptions have been done.

The potential odour sources and their location, then the air conditioning device and especially air vent have been spotted. The qualitative and quantitative olfactory analyses of diverse zones have been done by a specialised jury using the field of odours [6]. It is mostly a



Legend : nature of the mains odors sources

- | | | |
|------------|-------------------------------|-------------------|
| Food: | ⊙ burning | ● frying |
| Materials: | ■ furniture | ♦ (fancy) leather |
| | ★ perfume cosmetic | ♣ pharmacy |
| | x outstanding shop (soaps...) | |

collection of 45 pure odour references and organised in a three dimensions space. This kind of odour characterisation is mainly used in food and materials industries. After the learning (facilitate by its organisation), any odour can be described using the odour references.

The studied building is a shopping centre in Grenoble (France). It is 2 parts composed, come through by a rectilinear gallery connected to another one facing a supermarket (fig. 1). The twelve recorded walkers had been chose with a familiarity degree with the building varied as possible. From people knowing it very well (as saleswoman...) to people coming in for the first time.

The olfactory characterisations made by the specialised jury allow to figure out walkers' talk's conditions. The common olfactory background of the building was very hard to be described, because olfactory sources objects were missing as references to the walkers. The jury's characterisations lit the general odours chord in this shopping centre as a pyrogenous, grass and sulphured assemblage (fig.2). In fact, the odour sources evoked by the users of the

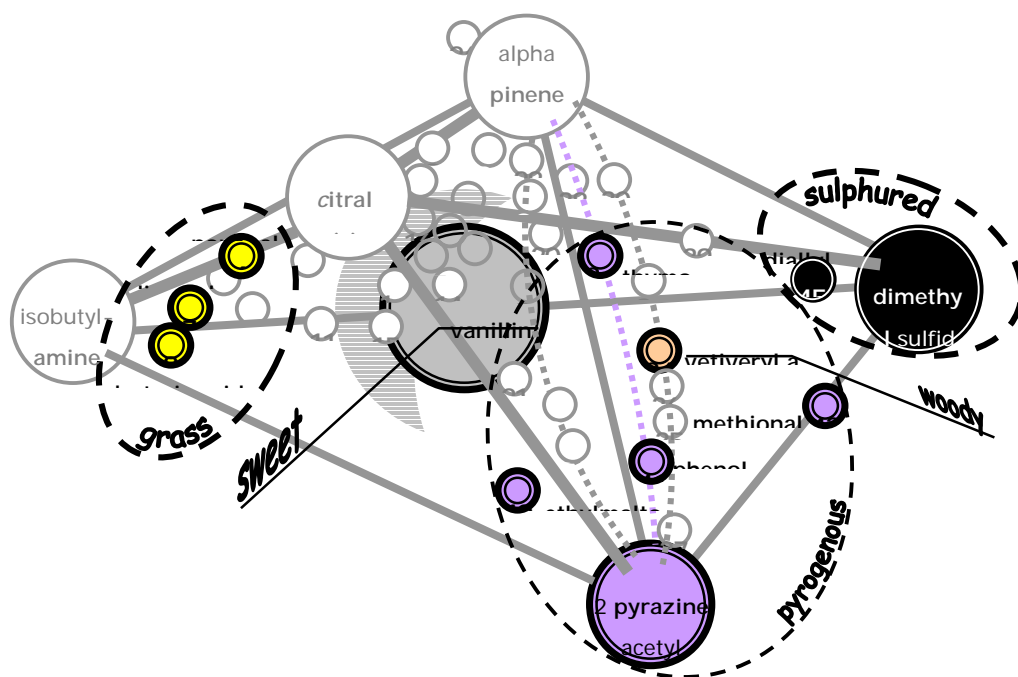


Figure 2: Three dimensions representation of the Field of Odors and of the common olfactory profile of the building.

(The numbers correspond to the smelling referents (pure substances))

The spotted referents broadly correspond to persistent odors (pyrogenous and sulphured). They largely tally with **food odors**. For example, the pyrazine (42) is the dominant referent of the characterizations, yet the pyrazines appear when there is burning (Maillard reaction). The dimethyl sulfide (44) and diallyl sulfide (45) are present in many vegetables and in some fruits. The human bioeffluents are also evoked in this profile, by the methional (43) and the diallyl (45) again (sweat), by the butyric acid (8) (excrements, vomit), and by the dimethyl again (excrements). The most spotted referents also evoke some materials. As plastics ((29), (11) and (5)), wood (34) and "dusty" earth (37) only in a part of the building.

building essentially tally with food production (cooking, burning, frying...) and this olfactory profiles fit well with this kind of sources. So it is probable² that the olfactory profile established through the *Field of Odours* be relating to the diverse cooking activities distributed in all the building.

The jury of expert made also some intensity evaluations with the *Odour Impact Meeting Scale* [6] (fig.3)

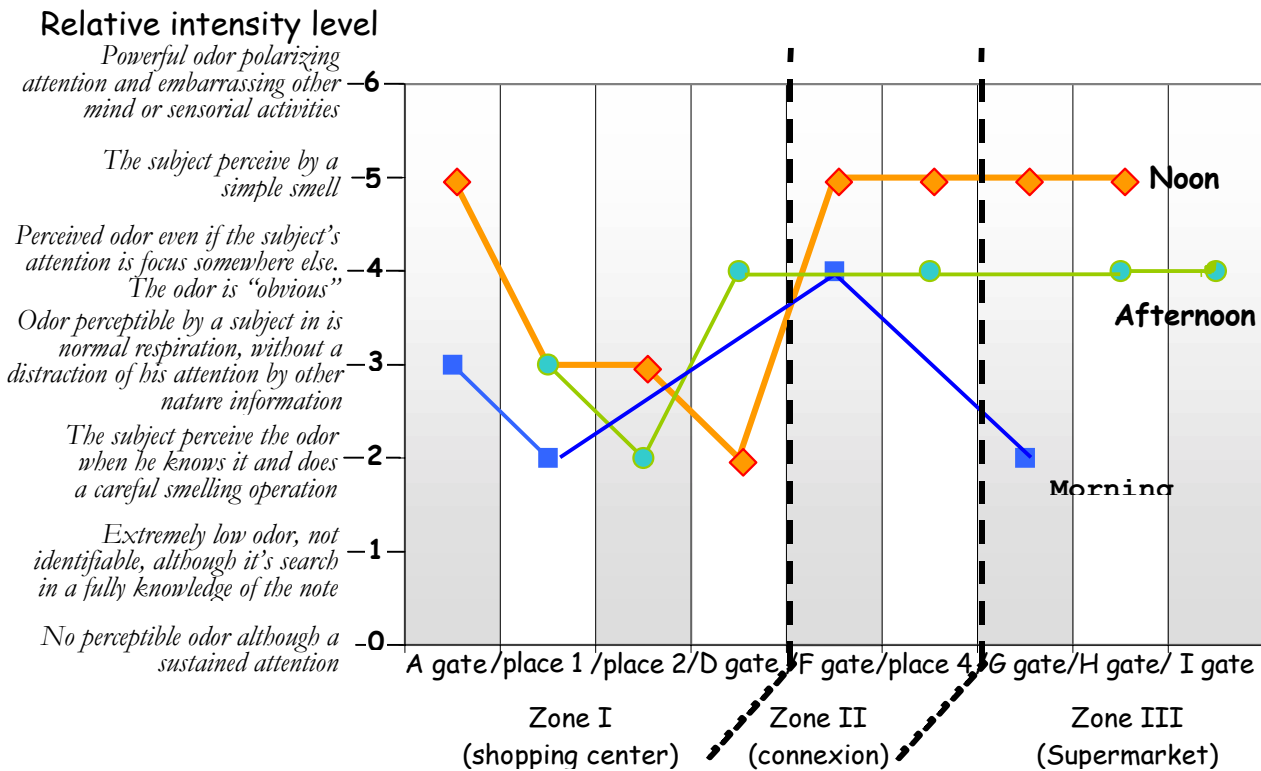


Figure 3: Example of relative odors intensities during a walk through the shopping center, in the morning, at noon and in the afternoon. The different levels [6] combine qualitative effects to the simple intensity. They don't take an eventual familiarization account. (The other levels are: 7 – « undeniable » odor polarizing subject's mind. 8- Very powerful odor making the smelling difficult. The odor disagrees with the subject and others nerve terminations can be solicited. 9- so strong odor that it constrains the subject to limit its inspirations (less deep inspirations or research to put a way of filter to the nose. 10- To powerful odor to be tolerate, the subject search a way to escape from the olfactory source.) The olfactory intensities of the first zone are for the most part lower than in the others parts of the shopping center. It's also at noon that the odors have the most important intensities. Weigh against the zone where it is, the A gate is an intense odors place.

In the walker's talks, the most odorous places are the food shops (at noon) and the shopping centre gates. The olfactory profile of the whole shopping centre at noon presents as a matter of fact important differences with the other profiles and above all its relative intensity is higher than in the morning or in the afternoon. Moreover, the gates haven't got an especially strongest intensity (comparing to other places in the building). The only exception is the A

² To establish a formal link between potential sources evoked by walkers and the shopping center's odors, some olfactory characterization should have been done potential source by potential source, yet we only characterize the building broads olfactory ambiances.

gate, where all the intensity evaluations are higher than in the same area at the over evaluation points. The walkers interpretations, often describing the gates (the way in) as strong odours places is therefore mainly induced by the big olfactory contrast between indoors and outdoors airs. The building gates are the place where *irruption effects* take place.

The olfactory areas establish through the Field of Odours and the Odour Impact Meeting Scale presents a qualitative contrast between the different parts of the studied shopping centre, with an intensity increasing from one end to the other. This contrast in quality and intensity should be explored deeper, for example by more systematic measuring of all olfactory sources in correlation with all air moves. But such evaluations would come up against the knowledge lacks about odour (additionability, differential volatility) and about slow air movement in huge volumes.

Although the type of shops repartition is thereabouts the same, the user's words analyse shows a difference between the odours organisation of the different parts of the building. In some places, the *chord effect* seems to be the rule, a mix of non-designable odours, and the walker's odour descriptions are not much redundant. Moreover, in some places like the gallery facing the supermarket, even if the odour background is still present, the odour areas seem much constant. Yet the air conditioning devices of theses parts of the building are roughly different. The first ones have strong draught power stations, pretty faraway from each other, and the other littler power stations make a narrow gird pattern. This raises questions

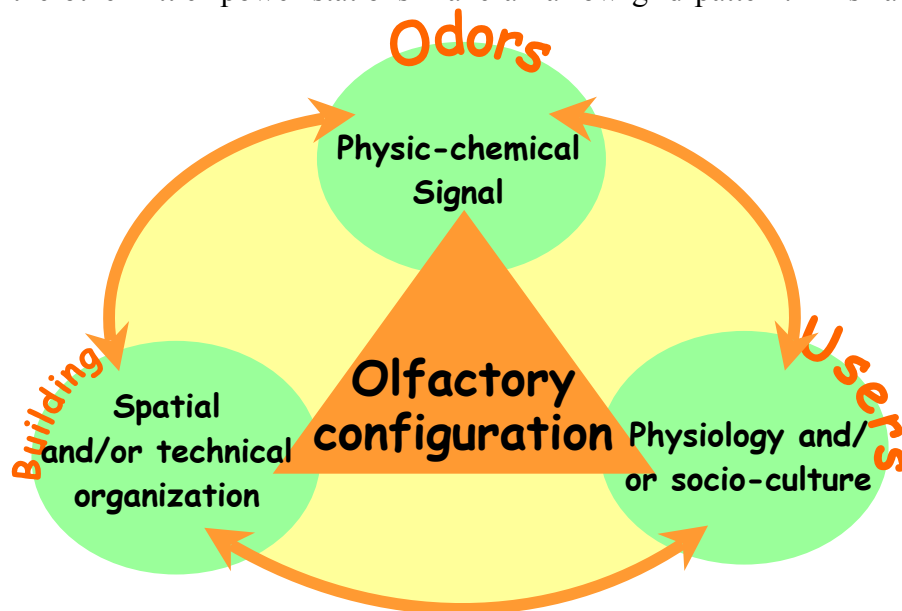


Figure 4: Principle of an Olfactory Configuration

about air movements, more or less located, that could induce an odour stirring and/or zoning more or less strong. But this question bumps into the lack of measure or modelling tools for odour dispersion and for slow air movement in big volumes.

2.2. A synthesis: olfactory configurations (how it gives a comprehension of in situ olfactory phenomena)

Olfactory effects spotted in walker's words confronted with the information from the materialistic data gives a first approach of the olfactory phenomena of the site. But if an olfactory effect emergence often points out a cause, it doesn't necessarily raise it. And in the architectural or urban project odours management perspective, the only description of olfactory phenomena is not enough. It doesn't allow to think of materialistic interventions on the happening of the effect conditions. As a result, an olfactory effect is the departure of a

field causal research. It drew our attention on the interactions between building, odour and user's sensation. The description of these interactions, for a given olfactory effect, forms an *olfactory configuration*. It is the expression of the interdependence relationships between the built object (through its architectural and/or technical devices), the user (its perceptive or using interpretations) and the odour (the nature of its sources, its physico-chemical proprieties) (fig. 4). The odour spreads in a building environment that may be odorous itself and which influences anyway its diffusion circumstances. The materialistic aspects of the built object also command, for a part, users' comportment and users are themselves management actors of this spatial and technical environment. Be that as it may, these users smell and/ or emit the odour. They interpret it and the odour may, in its turn, influence their comportment.

So, in the field study used as reference, some olfactory configurations have been brought to light, on the base of the olfactory effect spotted in user's words and with the olfactory and materialistic data collected. For example, there was an unintelligible mix of odours in the studied shopping centre. This "odour fog" as it was called by some walkers, can be described as a chord effect, probably caused by a specific olfactory configuration. There was, in this building, really varied nature odours sources (olfactory dimension). These sources are spread in the building area, and the indoor air is stirred up by many devices. This makes the mix homogenization (spatial/ technical dimension) easier. At last, the users have difficulty to distinguish the little sets of the general olfactory maelstrom, because they don't want to or because they don't know well enough these odours (perceptive dimension) (fig.5).

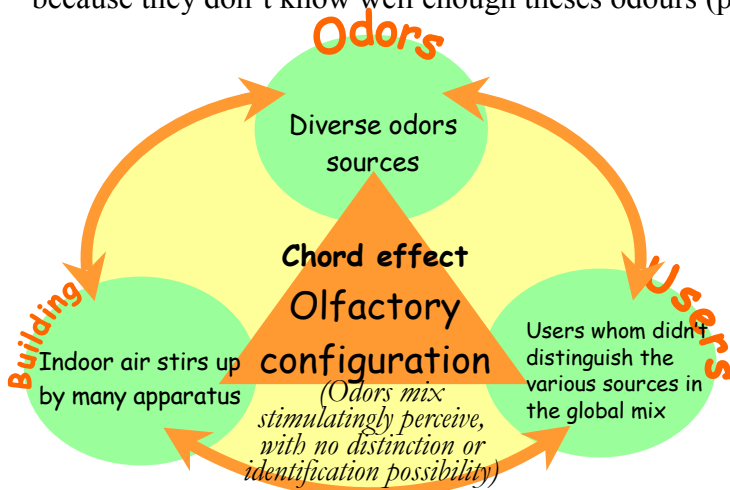


Figure 5: Olfactory configuration of a chord effect (the "odor fog" in the shopping center)

The visit of the site modes also plays a role in the anticipation and olfactory familiarity of some place and moments in the shopping centre. Some odours (and their sources) have been in effect revealed as real spatial and / or temporal landmarks. The olfactory configuration of this repetition effect is the interaction of many elements. These odours have specific aspects and are very limited in space. The regularity of users' visits induces also a memorisation and, consequently, a very good awareness of temporal and spatial particularities of the field.

The meeting with odour can also be progressive, as and when people move in the shopping centre. Especially when one goes up the shops gallery facing the supermarket, with a cooking/ burning odour getting crescendo. In this situation, the technical dimension of the configuration has still to be explored, but we can hypothesise that the crescendo is possible only if the air mix is not too strong compared to the power of diffusion and to the odour

source intensity. This source has to be sufficiently intense and confined. In fact many ovens are gathered together at one end of the gallery (this situation is different from the organisation of the other part of the shopping centre with its very scattering ovens). To perceive this odour intensity growing, the walker's adaptation has to be "lower" than the stimuli. The fact is that people has to move into increasing odour intensity, i.e. to move to the odour source (fig.6).

Sometimes, the spatial organisation is responsible of specifically odour meetings modes. For example when the circulation space is becoming narrower, the interpersonal distances shorten, in other words walkers cross each other closer. So this proximity allows them to smell one another, the spatial configuration encourages the waking effect (fig.7).

The first contact with odour is a crucial moment of smelling perception. So the entries of the site are particularly propitious places and moments for olfactory apprehension of the shopping centre. It is where and when people instantly discover the common chord (the olfactory identity of the site) and some specific smelling sources, close to the gates. The olfactory dimension of this superposition effect configuration is due to very different smelling distances. The olfactory background of the site is a mix of various sources, not necessarily easy to distinguish ; this sources removal involves that only some of their compounds are

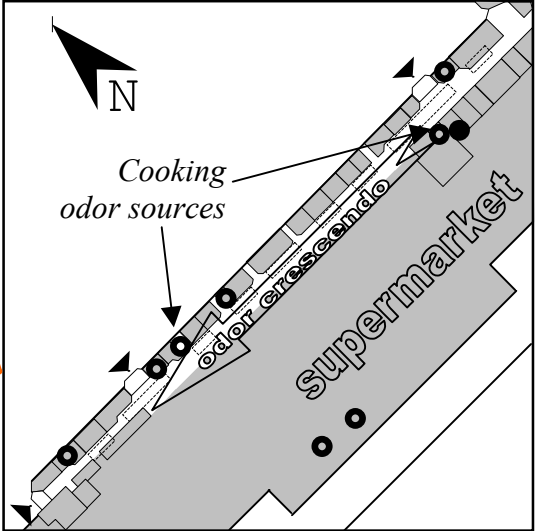
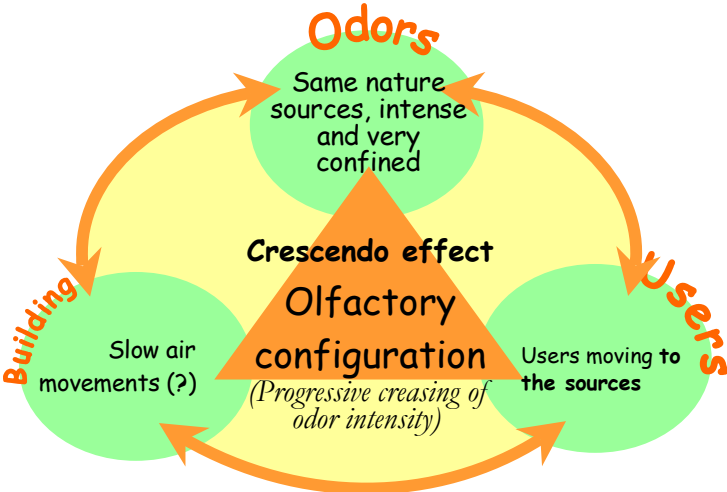


Figure 6: Olfactory configuration of a crescendo effect

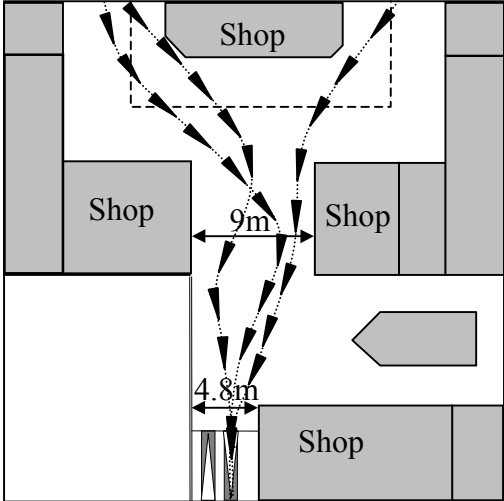
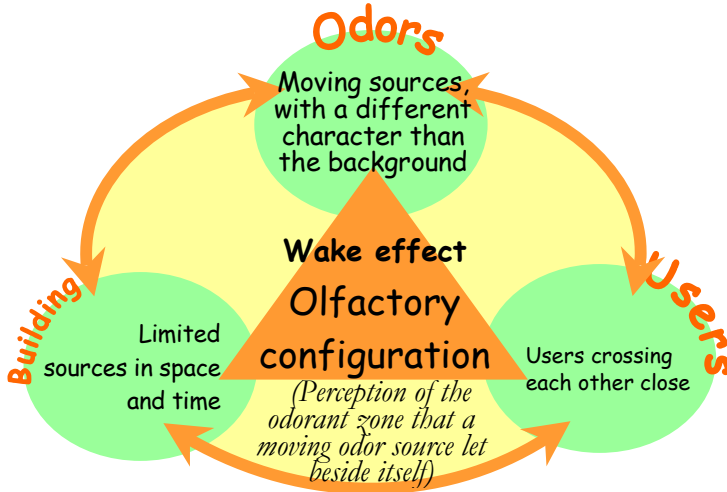


Figure 7: Olfactory configuration of a wake effect

perceptible (the other ones appear in too low concentration to be detectable). In other words, the odours of the most distant sources are not only mixed but also distorted. At the same time, there are often intense odours sources in the walker's proximity (the food shops, frequently very smelling, are concentrate at the gates proximity). Theses sources are, in addition, visible, which is probably helpful for the odours distinction and identification.

The gates of the building are also an irruption effect place, witch corresponds to the brutality of the meeting with the indoor odour. This configuration is the result of the lack between the outdoor air (roughly consider as the odourless reference) and the smelling air of the building. The acting (coming in) walkers are not adapted to the indoor air yet and they there smelling is "full". A revolving door is in fact a device conceived to separate indoor and outdoor airs as much as possible, in order to avoid thermal loss. As a consequence, these two very contrasted smelling atmospheres are in contact but don't mix.

3. Conclusion

The olfactory configurations presented here are only a few examples among the ones this field enquiry allowed to reveal. They are the characterisation of some olfactory phenomena of the studied shopping centre, but they also are the first step for olfactory interventions in this field. For example with the demonstration of the irruption effect mechanisms at the shopping centre gates, one can imagine ways to modify it, changing the materialistic, odours or uses dimensions of it. Transforming the air running of the building revolving door for example in pre-odorising it with indoor air, the actual irruption effect could be transformed in crescendo effect. The olfactory configurations of this site can be then regarded as interventions tools for the olfactory phenomena of the studied shopping centre, but they also have an ordinary dimension that can be transferred to this type of place and possibly to other type of areas. Some of theses configurations correspond to very specific dispositions of the site whereas some other are very general and could correspond to common phenomena in may spaces. So theses configurations present an exemplary character that could be taken into account in a project approach for this type of site. For example commercial identity is often an important preoccupation for the managers of this kind of places. One can imagine so that a specific odourisation, design from the different known configurations, could open the way to a control of olfactory identity of shopping places.

But the olfactory configuration notion is nevertheless limited, by its "sensory focus". The novelty of the subject towards architecture involves to be very focus on the smelling sense. But it is a very arbitrary choice that doesn't fit with the multi-sensoriality of the in situ real life.

Some of the checked configurations highlighted by the way show the importance of vision in the olfactory apprehension. The chosen limits must be called into questions for the odour definition³ because it seems to recover larger sensations in the current language (of the French people solicited). Anyway, theses configurations are typical of the interdependence relationships between odour, user and building. Because they take however the materialistic

³ We have chosen to only consider detection by the smelling sense. So we didn't take what we call *infra-odors* and *ultra-odors* account in this research. *Infra-odors* are chemicals emit by a living organism and unconsciously detected by another one. It doesn't correspond exactly to pheromone. Pheromone definition's is essentially given by its effects (influence fellows creatures in theirs physiology or in their comportment). A pheromone can be an odorant to. *Ultra-odors* are chemicals irritants perceive by the "pseudo-smell" perceptive systems like the trigeminal nerve.

realisation principles of the phenomena they tend to orient account, they can be hence considered as models for any smelling architectural conception.

The olfactory effect is therefore an analysis tool which, by the crossed knowledge it represents, allows to spot more than to characterise olfactory phenomena in building environment. After this first step, odour shall be, in the future, taken into account in architectural and urban conception.

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