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Why Positive Olfactory Perception Is An Issue For Evaluation Of Buildings

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SUMMARY

The real estate market is changing rapidly and with it the evaluation of buildings. Requirements are being changed in order to meet market demand. Besides the location, infrastructure and the actual condition of a building's technical equipment a further parameter called the "Soft Factor" is required in the evaluation of a building's quality. High end equipped spaces, according to statistics, are more easily let and are therefore the key assets in higher cash flow portfolios. A factor that can significantly decrease the value of a building is low air quality. The quality of air, however, is not determined by standards, it is determined by perception. Although thermal comfort plays an important role, olfactory comfort is critical to this perception of air quality. This paper will show why the real estate market is adapting to this new paradigm. It will demonstrate why olfaction and the perception of "natural fresh" air play such an important role and why it is has become a key issue for the HVAC community.

INTRODUCTION

The ability to assess the Fair Market Value of a building or a portfolio of real estate assets has become particularly important since private equity and real estate funds have become major players in the European real estate market. They have introduced to Germany the internationally accepted standards for the evaluation of buildings. Other continental European countries have seen similar changes in evaluation parameters. For many years, the physical value of a building has played a major role in the evaluation process of a real estate asset. Today, the evaluation of an investment decision is focused above all on the evaluation of the discounted cash flow which is distinct from the physical or land value of the asset. The discounted net annual rent is the basis for the evaluation. The investor will typically choose an investment time horizon with the result that even the "life expectancy of the building" has little relevance to the calculation of value.

In this context the outfitting of a building can be of importance since the discounted cash flow calculation not only includes the actual rent but also an assessment of the sustainable market rent. The value of buildings with current or future vacancies therefore benefits from outfitting that create an additional value for potential users and make them easier to let. Outfitting features that are of little benefit to potential tenants (such as golden bathroom fixtures in an office building) no longer play any role in the valuation of a property. In other words, the substance of a building or the outfitting are incorporated in the cash flow calculation only if they increase the lease yield.

Employees are the largest expense of most companies and therefore these human resource issues are very important when analyzing companies. Nowadays, banks go as far as to look at these aspects in order to reveal the so called "hidden costs". These can have a significant impact on the banks' assessment of the creditworthiness or the interest rates they charge. Similarly, Chen [1] found that there is a strong awareness and growing concern over the "silent crises" of IAQ and its potential to cause large industry losses. These losses included both direct costs to insurers from paying health insurance and professional liability claims as well as the cost of litigation.

ENVIRONMENT

Increasingly, the business world is beginning to address the "soft factors" that have not traditionally been included in business economics or management science. More and more attention is being given to these soft factors - satisfaction vs. profitability, quality vs. productivity, qualitative advantages vs. financial ones, ethics vs. efficiency. Hidden costs with significant potential financial impact arise when these factors are not adequately measured or addressed. The impact of the environment is one of those soft factors.[2].

The impact of environment, air and its olfactory content has been known to science for at least 20 years. Frequently, the market fails to act on scientific evidence, sometimes as in the case of climate change perhaps "shutting the stable doors once the horse has already bolted". The recognition and acceptance of human resource issues and the associated costs has also lagged science. The HVAC community has clearly missed the opportunity to define air quality and its hedonic value [3] with respect to well-being in response to neurophysiological and psychological science. This shows quite clearly the impact of olfaction on humans since air quality encompassing olfaction plays a major role in well-being. Improving the well-being of room occupants will result in companies enhancing their performance. There are several studies that demonstrate the link between a qualitative working environment and the productivity of a company. [4]

STRESS

According to a European survey nearly one in three European workers is affected by work-related stress. In the European Union, over the last decade, work related stress has been consistently identified as one of the major workplace concerns – a challenge not only to the health of working people but also the healthiness of their organization. Studies suggest that between 50% and 60 % of all lost working days are related to stress. People are experiencing stress when they feel an imbalance between the demands on them and the personal and environmental resources that they have to cope with those demands. [5] One of the main factors of managing stress is promoting health. The perceived environment is one of the main factors which can enhance stress or reduce it. An improvement in workplace health can be a key ingredient of business efficiency and competitiveness.

OLFACTORY COMFORT

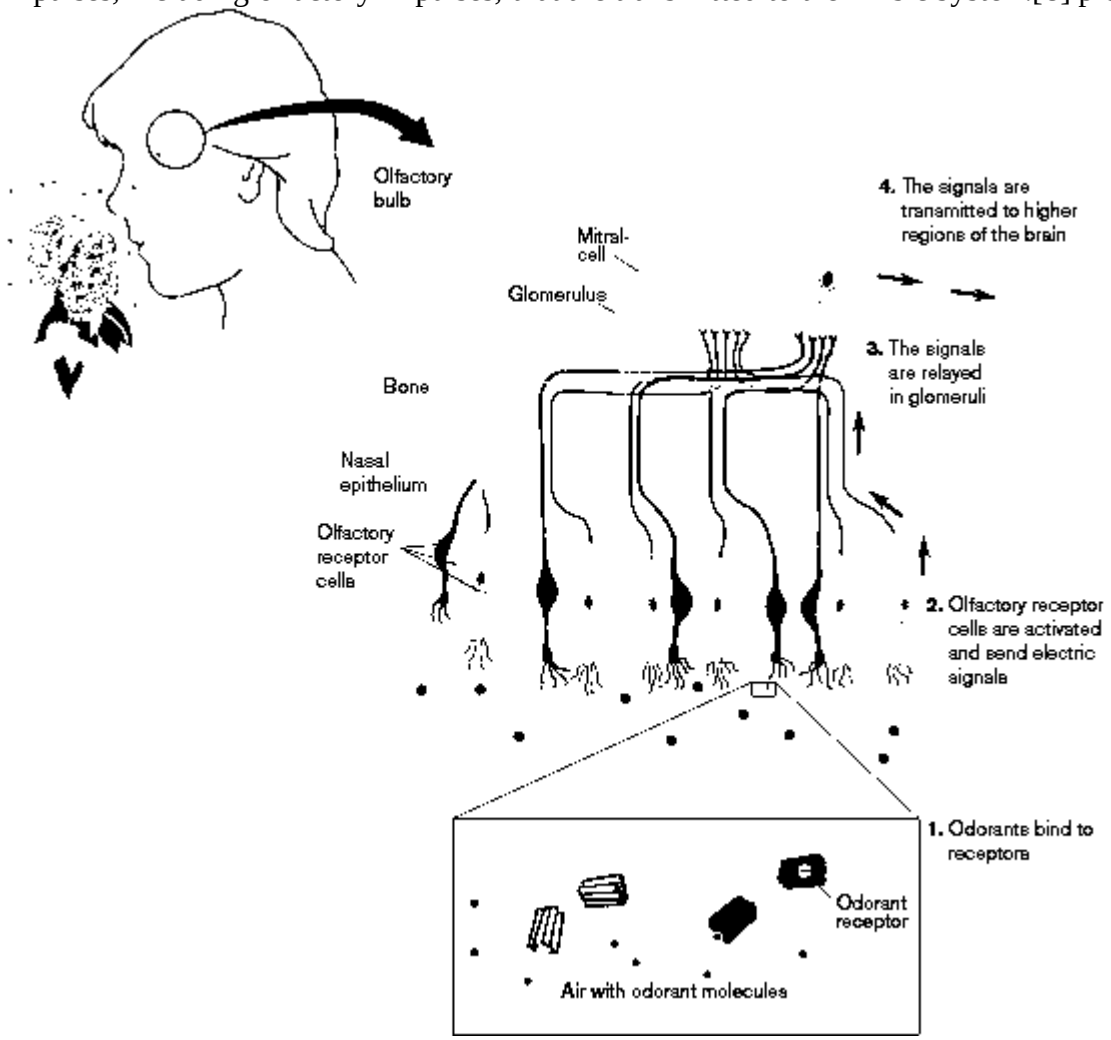
Neurophysiological and psychological research in the field of chemical senses has shown that our well-being is controlled to a significant extent by the olfactory substances found in the indoor air. [6] Olfactory comfort is not only defined by the absence of negative olfactory substances but also as a condition of mind that expresses satisfaction with the olfactory environment created by positive stimulating substances in the indoor air. Buildings situated in

metropolitan areas typically lack these positive olfactory substances. The substances are generally not found in sufficient quantities in the outside air and filters and cleaning mechanisms within HVAC systems remove them along with any negative substances. Therefore positive olfactory substances have to be restored in the indoor air. [7]

OLFACTORY SYSTEM

With every sniff, olfactory molecules pass through the nostrils to the olfactory epithelium. The millions of sensory (receptor) cells in the epithelium are connected via the sensory nerves and the olfactory bulb to the hypothalamus, other limbic system structures, the cortex and other sites which receive this information to coordinate and manage our abilities to learn, think, remember, respond and contemplate.

The limbic system is responsible for a person's range of feelings, his emotions, memories and the so-called effective tone of their entire behavior. A person cannot, therefore, block out any impulses, including olfactory impulses, that are transmitted to the limbic system.[8] picture 1



To date, findings from cerebral imaging have shown that olfactory function involves a complex and extensive neural network. Odor processing appears to be based on two main modes of processing. One is a serial processing with successive involvement of the primary and secondary olfaction areas, and the second is parallel processing which processes odor in the right and left hemisphere separately depending on the nature of the cognitive task. While areas located in the right hemisphere such as the orbital frontal cortex (OFC) and piriform

cortex (PC) are more involved in memory and familiarity, those located in the left hemisphere, such as the OFC, insula, PC, amygdala, temporal lobe, and superior frontal cortex, participate more in the emotional response to odors. The piriform-amygdala region appears to be associated with the evaluation of emotional intensity and it is therefore activated more by unpleasant odors than by more mild odors. The role of the superior frontal cortex is to process the odors and their effect on emotional state and use this information to make personally relevant decisions. [9]

A number of major investigations in recent years have dealt with the effect of odor on electrical brain activity, as well the physiological effects of odors. Torii [10], Lorig [11] and Saito [12] carried out various studies to examine the effect of odors on the brain. They measured the contingent negative variation. Contingent negative variation (CNV) is an increasing negative shift of cortical electrical potentials associated with an anticipated response to an expected stimulus. Lorig [13] established that even low concentrations of odor that remain undetected bring about significant changes in EEG activity and behavior. Subsequently, Kobal [14] at the University of Erlangen demonstrated using electrical brain activity that cognitive processes can be influenced in a controlled manner by the administration of various odors to the right or left nostril. Kikuchi [15] explored the effect of five odorous substances on both heart rate and contingent negative variation. They found that pleasant odors activated the central nervous system increasing the heart rate variations, and calming odors decreased the heart rate.

In addition to the neurophysiological effects of odor substances, psychological effects can also play an important role. Clinical studies over the past 18 years have shown that certain odors promote relaxation and alleviate stress. Warm, Dember and Parasuraman[16] found that people who monitor routine tasks on video displays demonstrated improved performance when they received occasional whiffs of certain odors. These results show that pleasant olfactory substances can enhance task performance. Another study by Danuser suggests that performance deteriorations can be caused by environmental chemical odors and that unpleasant odors are distracters, capable of inducing sensory deprivation.

A number of techniques and scales have evolved to measure the different aspects of odor.. Zevon and Tellegen [17] and Watson [18] proposed that the structure of mood can be represented by two factors, which are called Positive Affect (PA) and Negative Affect (NA). These two factors can be monitored using the PANAS (Positive and Negative Affect Schedule). Another related scale is the OCA scale[19]. Electro-olfactograms (EOG) have also been used to provide evidence for the dominant role of the nervous system in olfactory desensitization, for the functional characterization of the olfactory epithelium, the specific topographical distribution of olfactory neurons, the expression of olfactory receptor neurons in response to exposure to odorants, or characterization of certain odorants as olfactory receptor antagonists.[20] Together with the recording of olfactory event-related potentials[21], magnetic source imaging [22], functional magnetic resonance imaging fMRI [23] [24], and appropriate psychophysical techniques[25], the human sense of smell can be described in its many facets at many different levels.

APPLICATIONS

The Kajima Building in Tokyo was one of the first big buildings to implement the addition of olfactory substances to their new premises in order to enhance the indoor environment. A comfort ratio increase of 24% (simple mean value) was achieved by implementing the

olfactory environment.[26] The results in 1999 [27] of a building in Berlin where a new tenant conducted productivity research to satisfy themselves of the payback of higher rent that had been demanded based on the outfitting of the office building. The analysis that was based on their experience over the course of one year after moving to the premises is shown in Figure 1-3. This building was equipped to achieve the full potential of a "multisensual" building.

Real Estate Investor's Perspective

Building data			
Letting area		3,000	m^2
Basic Costs - **Low technology building**			
Property and building		€ 14,730,000	
Technical Equipment (without HVAC & R)		€ 2,450,000	
	Subtotal	**€ 17,180,000**	
Extra Costs - **High technology building**			
Property and building		€ 14,730,000	
HVAC & R		€ 400	per m^2
HVAC & R costs		€ 1,200,000	
Other technical equipment		€ 2,450,000	
	Subtotal	**€ 18,380,000**	
Additional cost for high technology building		**€ 1,200,000**	
Rent Income for low technology building		€ 22	per m^2 per month
Rent Income for high technology building		€ 26	per m^2 per month
Additional rent income for high technology building		**€ 144,000**	
PAYBACK PERIOD - IN CURRENT TERMS		**9.5**	**years**
D.C.F.YIELD - IN CURRENT TERMS		**6.7%**	
D.C.F.YIELD - IN CONSTANT TERMS		**4.1%**	

Assuming tax deductability and depreciation over 15 years.
Inflation set at 2.5%, tax rate at 43%, 15 year life of equipment

Tenant's Perspective

Low technology building

Building costs

Rent	€ 22.00	per m^2 per month
Ancillary Costs (building)	€ 3.50	per m^2 per month
Subtotal Building costs	€ 918,000	p.a.

Employee Costs

Employee productivity	100	Index
Sickness/Absenteeism	6%	days p.a.
Workforce (Full time equivalents)	120	FTE
Salaries	€ 3,100	per FTE per month
Other employees costs/benefits	38%	of salary
Office equipment & supplies	€ 200	per FTE per month
Subtotal Employee costs	€ 6,448,320	p.a.

Total building & employee costs **€ 7,366,320**

Tenant's Perspective

High technology building

Building costs

Rent	€ 26.00	per m^2 per month
Ancillary Costs (building)	€ 4.75	per m^2 per month
Subtotal Building costs	€ 1,107,000	p.a.

Employee Costs

Employee productivity	106	Index
Sickness/Absenteeism	4.2%	days p.a.
Workforce (Full time equivalents)	120	FTE
FTE reduction (productivity improvement)	(6.8)	FTE
FTE reduction (sickness reduced)	(2.0)	FTE
Salaries	€ 3,100	per FTE per month
Other employees costs/benefits	38%	of salary
Office equipment & supplies	€ 200	per FTE per month
Subtotal Employee costs	€ 5,973,800	p.a.

Total building & employee costs **€ 7,080,800**

Overall savings **(€ 286,000) p.a.**
equivalent to **(3.9%) of operating costs**

CONCLUSION

Changes in the real estate market have created new demands that have to be met in order to create more added value for buildings in particular for vacant buildings.. The competitive advantage of a high quality building can do much to increase return on investment. Buildings with lower standards are less likely to find tenants and will contribute to loss of productivity and absenteeism. Therefore an evaluation of buildings that includes the perception of indoor air and the environment of the occupants is necessary.

In order to fine tune the measurement of the indoor air quality, it is necessary to take into account the influence of the hedonic value of the environment on room occupants. Essentially, the hedonic value affects the well-being of the room occupants.

In order to understand olfactory comfort, we have to look into different psychological, neurological, physiological aspects. Our sense of smell lets us explore our chemical environment. Therefore the perception of an odor will determine our reaction - approach or avoidance, positive or negative - depending on the type and concentration of the odor.

DISCUSSION

An interdisciplinary scientific approach is necessary in order to create an environment which enhances well-being. Perception must play a major role in evaluating a building. Measurements should be based on neurophysiologic and psychological data such as the PANAS and OCA scales and whenever possible supported by research using electro-olfactograms.

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