University College of Dalarna
School of Humanities and Media Studies
Sound Production, Specialization 30 ETCS
Autumn Semester 2009

Bachelor Thesis

ACOUSTIC DESIGN IN URBAN DEVELOPMENT

- analysis of urban soundscapes and acoustic ecology research in New York City

Author: Emeli Pontén

Supervisor: Gunnar Ternhag

Examiner: Alf Björnberg

ABSTRACT

The world is urbanizing rapidly with more than half of the global population now living in cities. Improving urban environments for the well-being of the increasing number of urban citizens is becoming one of the most important challenges of the 21st century. Even though it is common that city planners have visions of a 'good urban milieu', those visions are concerning visual aesthetics or practical matters. The qualitative perspective of sound, such as *sonic diversity* and *acoustic ecology* are neglected aspects in architectural design. Urban planners and politicians are therefore largely unaware of the importance of sounds for the intrinsic quality of a place. Whenever environmental acoustics is on the agenda, the topic is *noise abatement* or *noise legislation* – a quantitative attenuation of sounds. Some architects may involve acoustical aspects in their work but *sound design* or *acoustic design* has yet to develop to a distinct discipline and be incorporated in urban planning.

My aim was to investigate to what extent the urban soundscape is likely to improve if modern architectural techniques merge with principles of acoustics. This is an important, yet unexplored, research area. My study explores and analyses the acoustical aspects in urban development and includes interviews with practitioners in the field of urban acoustics, situated in New York City. My conclusion is that to achieve a better understanding of the human living conditions in mega-cities, there is a need to include sonic components into the holistic sense of urban development.

TABLE OF CONTENTS

1. INTRODUCTION

It has been customary to treat sound classifications separately, i.e. 1) physical characteristics of sounds in the field of acoustics, 2) the perception of sounds in the field of psychoacoustics, 3) the cognitive and emotional variables of sounds in the field of semiotics, semantics and aesthetics. The attempt to merge these areas is today more than an interesting academic endeavor; it is a crucial scientific step in order to enhance human living conditions in sonically complex mega-cities.[1] My aim for this thesis is to investigate in what ways this process is employed theoretically and practically, with New York City as study site.

1.1. Soundscape Studies

There are many independent areas of sonic studies; acoustics, psychoacoustics, otology, international noise abatement practices and procedures, communications and sound recording engineering (electro-acoustics and electronic music), aural pattern perception and the structural analysis of language and music. In various parts of the world the study of sound is becoming an established type of research, with various method models and standardized ways of expressing the results.[2]

Soundscape studies represent a research field that unifies the independent areas related to sound and environment. Traditionally soundscape studies have been focused on noise pollution, which is a negative approach. Many scientists in the field now argue for the need to make environmental acoustics a positive study program. In soundscape research the field of science, society and arts meet. Therefore acoustic design needs to be introduced as an interdisciplinary subject of study for architects, musicians, acousticians, psychologists, sociologists etc. Involving various related professions is necessary in order to make the research as objective and insightful as possible.[3]

The study of soundscapes deals with historical documentation, recordings, interviews, graphical notation models and general analysis on a theoretic and practical level. Questions raised are; what are the sources for every specific soundscape, what is the human response to them and what are the proper methods and actions to modify or create a specific desired

---

[1] www.unhabitat.org/cdrom/docs/WUF4.pdf last seen 2010-01-23
[2] R M Schafer, *The Soundscape; Our Sonic Environment and the Tuning of the World*, Cambridge University Press, 2nd edn, 1977, p. 3
[3] Ibid. p. 4

soundscape? Cross-cultural aspects must be carefully assembled and interpreted in such studies.

Significant features of a soundscape are those that are important due to their *individuality,* their *numerousness* or their *domination.*[4]

In order to achieve consistent and scientifically relevant results from soundscape studies, Schafer emphasized already in 1977 that this field needs to be interdisciplinary. Today we can see that much progress has been made, but it appears that an authentic interdisciplinarity is yet to take form.

> The exploration of the acoustic environment – combined with the effort toward its improvement – is certainly one of the most stimulating intellectual, aesthetic and social adventures of our time. To be part of this adventure requires, I believe, a good deal of versatility. Thus, on the one hand, soundscape studies needs to continue in its search for systematic coherence in its undertakings, on the other hand it has to remain open for new (or rediscovered) inputs and ready to rethink its philosophy and methods.[5]

Soundscape studies are inevitably a case of phenomenological character.[6] Acoustics are physically measurable and considered objective (although data may differ and vary, depending on instruments etc.), but sounds are phenomena that must include cognitive, social and cultural aspects in the analysis. We most certainly are not conscious about all the sounds we are confronted with, but those sounds are non the less dealt with on an unconscious level. We cannot close our ears. Everything that fills our current surrounding with vibration is due to be processed by our perceptive system. This is why soundscape studies are immensely important for urban planning. If we believe in improvement of *human well-being*[7] as a foundation for urban development, we need to respect this approach.

> An important difference when comparing music and architecture and then the sonic environment, is that in music and architecture there is a conscious design. A sonic environment is very seldom planned or designed, but is for the most part an unplanned by-product. But even if the sonic environment lacks author, it

[4] R M Schafer, pp. 7-10
[5] A Mayr, 'Soundscape Studies, Experimental Music, and Time Geography' in H Järviluoma & G Wagstaff (eds), *Soundscape Studies and Methods,* The University of Turku, Vaasa, 2002, p. 36.
[6] B Hellström, *The Voice of Place: A Case-study of the Soundscape of the City Quarters of Klara, Stockholm,* Research Report: Royal Institute of Technology. Department of Architecture and Town Planning. Division of Complex Structures, Division of Design Methodology, Stockholm, 1998, p. 9
[7] http://www.ecosmagazine.com/?act=view_file&file_id=EC144p11.pdf last seen 2010-01-28

possesses a characteristic profile. A sound image continuously generated in a specific environment is not an occasional organization. All physical environments develop – no matter what we think about the sounds - characteristic sound images. [8]

Schafer makes a distinction between *low-fi soundscapes* and *hi-fi soundscapes*. Distortion, broad-band noise and annoyance contrasting a balanced, detailed and pleasing acoustic environment. This was the idea that turned out to be the most influential, as well as controversial, of all the theories presented by him.

The possession of a favorable signal-to-noise ratio is what we can define as a hi-fi system. Low ambient noise levels will aide delicate sound levels to be heard, which means that the soundscape in question is one of hi fidelity. When a surrounding is overdensed by numerous sounds, individual acoustic signals are dimmed and appear indefinite. This type of environment is what Schafer calls a low-fi soundscape; the pellucid sound is crowded and masked by broad-band noise.[9]

Perspective is lost. On a downtown street corner of the modern city there is no distance; there is only presence.[10]

The phenomenon in sound propagation whereby a sound wave moves around objects is called diffraction. Repeated reflections and diffractions of sound waves within an area will result in an even diffusion – a uniform distribution of sound energy. This is the theoretical explanation behind complex, low-fi spaces such as those of urban streets.[11]

Going from a hi-fi to a low-fi soundscape in urban environment is an inevitable transition due to the expansion of architectural construction, symptomatically caused by the enormous increase of city inhabitants. The challenge for city planners and architects of today is to optimize constructions so that they work as a medium for a sustainable environment, rather than obstacles. Buildings with green roofs and green walls to control internal temperature, is already a technique in use in many cities like Singapore, Shanghai etc.[12] What if we would also include acoustic design in this new innovative movement? Urban vegetation is a natural,

---

[8] B Hellström, p. 38
[9] B Traux, *Handbook for Acoustic Ecology*, A.R.C. Publications, 1978, p. 60
[10] R M Schafer, p. 43
[11] B Traux, p. 35
[12] Prof. T Elmqvist, personal communication, Dec 2009

effective, low-cost, low-maintenance absorbent of sound in general. If an additional acoustic analysis was to be implemented into urban architecture we could radically improve our city soundscapes with little effort.

Qualitative, as well as quantitative, aspects of city sounds must be acknowledged in modern city planning, if we want to achieve serious improvements of our urban sonic environment. There are many published case studies on acoustic annoyance and damage. What we need, is to implement these perspectives in architectural praxis and make the approach standardized in education.

Furthermore we can apply substance to urban soundscapes, such as pouring water and chirping birds, based on the notion that total silence is not the ideal soundscape. Rhythmically balanced ambience is shown to be more pleasing for the human ear than complete silence. First of all, because there is no such thing as complete silence[13], secondly because the ear will constantly search for sound. It is easy to forget that the ear is an organ for practical matters, other than the pure communicative and artistic. Our sensory system for the sense of hearing is also used to localize external objects, outline distances and keep ourselves in balance physically. Therefore we must see that the science of psychoacoustics is immediately related to the architectural conceptions of *room* and *place,* and that we can not speak of *space* and *dimension* in completion when excluding auditive perception. A low-fi soundscape will compress a room, while a hi-fi soundscape will expand the very same room, phenomenologically speaking.

> A modern city is a complicated set of relationships. In order to analyze this complex structure, Urban Studies should be approached from a plurality of perspectives, requiring various methodologies, on more than one scale. In this situation, Soundscape Study explores a new dimension in Urban Studies by introducing the sense of hearing. In other words, the basic significance of soundscape studies as a part of Urban Studies is that it introduces an aural dimension clearly into the field of Urban Studies.[14]

---

[13] R M Schafer, p. 256

[14] K Torigoe, 'A City Traced by Soundscape' in H Järviluoma & G Wagstaff (eds), *Soundscape Studies and Methods,* The University of Turku, Vaasa, 2002, p. 56

1.2. Acoustic Ecology

> Ecology is the study of the relationship between living organisms and their environment. Acoustic ecology is therefore the study of sounds in relationship to life and society.[15]

During the 1970's, the conception of acoustic ecology and its initial terminology took form as a new scientific field. At Simon Frasier University in British Columbia a cross-disciplinary mix of philosophy, sociology and art founded the World Soundscape Project.[16] Participants in the project, led by Schafer, collected recordings of 'soundmarks', documented soundscapes of various types and established models for research in the field.

The idea of hi-fi/low-fi soundscapes was widely spread and soon enough this idea had concrete impact in city planning. Previously, city sound ordinances were created to limit extreme amplitude levels and dim intrusive sounds such as highway noise. Now with a more detailed perspective on environmental sounds the value of sonic refuges, such as parks and open spaces, has become a more pronounced part of urban planning.[17] Parks were previously poorly designed, often a result of leftover pieces of real estate.[18]

So far environments have been built more for the eyes than for the ears. The sense of sight dominates environmental planning.

1.3. Acoustic Designers

Landscape architect Per Hedfors' interest in sonic environment started as "*a reaction to what I saw as a visual hegemony in landscape design and planning*".[19]

Together with system biologist Per Berg, who is doing research on inter-sensory perceptions in urban and rural environments, Hedfors has been studying the ways of developing tools to facilitate the inclusion of environmental sounds in landscape architecture and city planning. Another Swedish architect, with an interest in soundscape studies, is Björn Hellström.

---

[15] R M Schafer, p. 205
[16] http://www.sfu.ca/~truax/wsp.html last seen 2010-01-12
[17] J Cummings, 'Listen Up: Opening Our Ears to Acoustic Ecology', *Zoogoer* (magazine of the US National Zoo), July/August 2001
[18] R M Schafer, p.246
[19] H Järviluoma & G Wagstaff, *Soundscape Studies and Methods*, The University of Turku, Vaasa, 2002, p. 20

In the 1990's Hellström spent time at CRESSON[20], which can be described as the prominent center for developing methods in sonic analysis and acoustic design. He took part of Jean-Francoise Augoyard, Pierre Schafer and Pascal Amphoux's soundscape studies, whose concepts unfortunately have not made it into the wider soundscape research community, since the works are written in French. Björn Hellström has taken on the task to translate and subsequently spread the CRESSON approach for a general public.

> Augoyard and Amphoux emphasize that architecture is just as much a question of immateriality as well as acquired experience. Such approach implies dynamic understanding of architecture, i.e., as a reservoir that gives shape of the activities within it.[21]

The concepts developed by the CRESSON center are important, if not crucial, for the study of subjective and shared meanings of environmental sounds.

1.4. Noise

The primary topic to address in the field of acoustic design in cities is noise. The *Handbook for Acoustic Ecology* defines noise as "unwanted sounds".[22] Schafer proposed four different types of definitions that are subjective and objective: 1) unwanted sound, 2) unmusical sound (defined as non-periodic vibration), 3) any loud sound, and disturbance in any signaling system.[23] Three of them can be closely correlated to the psychological concept *frustration*. In the field of psychology, frustration is a key concept. It depicts the interruption of behavior at an individual level. The unwanted sound, loud sound and the disturbance of signal are independent factors, which all have the potential of interrupting an ongoing process of action. The emotional response to this interruption is frustration.[24]

> Auditory noise refers to a nonrepetitive signal in which amplitude varies randomly. In terms of the frequency spectrum, the amplitudes and the phases of the frequency components are randomly distributed. The power across the frequency components may be flat, creating white noise, or may vary, creating pink or brown noise.[25]

---

[20] http://www.cresson.archi.fr last seen 2010-01-24
[21] Järviluoma & Wagstaff, p.21
[22] Ibid. 79-85
[23] R M Schafer, p. 182
[24] D Ipsen, p. 186
[25] S Handel, *Perceptual Coherence*, Oxford University Press, 2006, p. 176

The modern regulations of unwanted sounds are called noise abatement and have been in practice since the 1960's. The first attempt to standardize noise measurements was the ISO 532, which was published only a few years after the dB(A)-proposal.[26] It is presented as one method, but is really a set of two - one simple method that can be implemented using relatively cheap equipment and one advanced standard that produces more accurate and appropriate values based on the human sensation of loudness.

Superior methods to measure and chart noise have been developed since then, although the qualitative aspects that initially were respected in these testings have gradually diminished in favor for more robust values.

> Early noise abatement legislation was selective and qualitative, contrasting with that of the modern era, which has begun to fix quantitative limits in decibels for all sounds [27]

The threshold of pain is 115-140 dB, the threshold of discomfort rising substantially with increasing habituation. Naive listeners reach a limit at approximately 125 dB SPL, while experienced listeners can expand the limit to 135 -140 dB SPL.[28] Audiologists agree however that no unprotected ear should ever be stressed with a 135 dB sound.[29] Constant exposure to moderate or intense noise levels will eventually lead to a temporary threshold shift, which is experienced as a loss of sensitivity when the stimulus is removed.[30]

Noise abatement laws do not address the matter of city sounds to a sufficient extent. Qualitative aspects such as envelope dynamics are ignored, and even if they protect human hearing from severe damage the restrictions are being modified to accept levels over our tolerable capacity due to excelling ambience sounds. For example, the sound output of the police siren has risen 40dB since the beginning of the last century as a result of more traffic, more street activity and an increased ambient sound level in general. Measurements of urban acoustics have shown that the average amplitude level has doubled since 1980, and there are

---

[26] H Fastl & E Zwicker, *Psychoacoustics; Facts and Models,* 11th edn, Springer-Verlag Berlin Heidelberg, New York, 2007, p. 315
[27] R M Schafer, p. 67
[28] E B Newman, 'Speech and Hearing' in *American Institute of Physics Handbook*, 3rd edn, 1972, pp 3-155
[29] B Traux, p. 143
[30] Ibid. p.71

no signs of a decrease in this trend.[31] The police siren needs to be heard through the highest levels of city sounds. This is a problem, and a rather complicated one. A siren in a noisy environment might be barely noticeable, while the same siren in a calm neighborhood might result in a temporal, or chronic, hearing loss if the attack is sudden. Another problem is the propagation of infrasonic frequencies, i.e. sound waves 20Hz or lower. These frequencies can, if intense enough, result in experiences of nausea, vertigo and even black-out. Such frequencies are only felt as vibrations and are difficult to extract since they diffract easily and have a tendency to transmit through earth and building materials. We still know little about the long-term physiological and psychological effects of constant exposure to these frequencies.[32]

With the 1969 UNESCO resolution, sonic overkill was introduced on the agenda as a contemporary problem.[33] Noise pollution, defined as an imbalance in an environment caused by intruding or disrupting sounds, was soon thereafter approached as a serious problem with The Noise Pollution and Abatement Act of 1972. Up untill then noise had been approached as "nuisance" by the US government, rather than an environmental problem.[34] However, investigations show that average sound intensity levels are insufficient indicators of hearing risk, since the impulsive character of the sound is overlooked.

> The simple decibel level used does not take into consideration the frequency bands in which the sound energy is concentrated (and certain of these, from 1 to 4kH, present greater hearing danger), infrasonic vibrations, amplitude modulation effects, time variation in sound levels, impact sounds, etc. All of these factors may cause annoyance and create a potential health hazard.[35]

In urban environment we come across a great deal of steady broad-band noise with much of its energy concentrated in the higher frequency region where the human ear is the most sensitive (1 – 4kHz). In decibel noise rating and noise criterion, this aspect is neglected.[36]

Loudness of noise often depends strongly on time. That is why we need to look upon a *cumulative loudness distribution*. Comparing loudness (sone) and level (dBA) will show the

---

[31] D Ipsen, 'The Urban Nightingale – or some theoretical considerations about sound and noise' in H Järviluoma & G Wagstaff (eds), *Soundscape Studies and Methods,* The University of Turku, Vaasa, 2002, p. 185
[32] B Traux, p. 61
[33] Schafer, p. 98
[34] http://www.law.cornell.edu/uscode/42/4901.html last seen 2010-01-24
[35] B Traux, p. 29
[36] Ibid. p. 16

reality of this theory. For example, from a level perspective, the trumpet is louder than the lawn mower but on a loudness account it is quite the opposite. Likewise, the violin and the electric drill are pretty equal when it comes to level, but the loudness of the drill is remarkably higher. You would suspect that the association factor would interfere with these results, but it is shown that cognitive effects like the identification of the sound source play a minor role in loudness evaluation of sounds.[37]

> Structure and noise are end points… perception is the abstraction of structure from ongoing change…[38]

To relate these psychoacoustical facts to urban environments; there are a number of sound events in our city surrounding that are very intense, although the level might be accepted by noise legislations. Noise abatement does not touch the complex nature of sounds. Aesthetic and/or cognitive aspects might not affect loudness evaluations, but they definitely play an essential roll in the sound quality evaluation (in addition to the obvious acoustic features).

Unfortunately laboratory tests cannot completely respect all the factors contributing to "annoyance" generated by sounds, as well as the "pleasantness" of sounds, due to the subjective nature of a qualitative evaluation. However, psychoacoustic annoyance may be approximately calculated through a combination of hearing sensation variables. There is an intimate relation between psychoacoustic annoyance (PA) and the basic quality aspect of sound as loudness (N), sharpness (S), fluctuation strength (F) and roughness (R), which can be shown as a mathematical formula (see Appendix II).

The matter of noise can therefore be referred to as a matter of psychoacoustic annoyance (PA), weighing in the loudness, the tone color and the temporal structure of sounds.[39]

> We know a good deal about the behavior and tolerances of the ear and the voice. When, as today, environmental sound reaches such proportions that human vocal sounds are masked or overwhelmed, we have produced an inhuman environment. When sounds are forced on the ear, which may endanger it physically or debilitate it psychologically, we have produced an inhuman environment.[40]

---

[37] H Fastl & E Zwicker, pp. 316-317
[38] S Handel, p. 374
[39] H Fastl & E Zwicker, p. 327
[40] R M Schafer, p. 207

2. METHOD

Methods are expected to contribute tools for research such as 1) a verbal terminology, 2) prototypes and models.[41] To adequately perform a soundscape study one must first study the expressions and sites used in earlier research, and take into consideration multiple types of documentations. This is crucial in order to make any new documentation relevant for future comparative studies, due to the mobility, plurality and coincidence of soundscape contents.[42] Also, environmental sounds have the character of posessing both denotations and connotations at the same time - carrying both personal and general meaning.[43]

> The sound profile of different places can be very different, even though they might be located within a very limited district with homogeneous urban character.[44]

2.1. Terminology

The basic acoustic parameters to recognize are the continuously variable (frequency, intensity, duration) and the non-continuous (timbre). Frequency is an acoustic variable, whereas pitch is a psychoacoustic one.[45] Loudnesss is measured in "sone" for narrow-band noise and sine tones, "PndB" for broad-band environmental sounds as a scale of subjective loudness.[46] "Phons" are used to describe sounds that are equally loud, a different type of scale devised to express the subjective impression of loudness (0 phons = 0dB at 1 kHz).[47]

Schafer presents in his pioneer work *The Soundscape* (1977) a terminology for the symbolic values of sound in human environments, words that now are used in most research models. These basic nodes in soundscape studies are 1) keynote sounds, 2) signals and 3) soundmarks - expressions borrowed from music theory and landscape architecture. He also relates to the psychological model *figure-ground* as a method to analyze complex sonic events.[48]

---

[41] P Hedfors & P G Berg, 'Site Interpretation by Skilled Listeners' in H Järviluoma & G Wagstaff (eds), *Soundscape Studies and Methods,* The University of Turku, Vaasa, 2002, p. 93
[42] A Mayr, p. 33
[43] H Uimonen, 'Cognitive Maps and Auditory Perception' in H Järviluoma & G Wagstaff (eds), *Soundscape Studies and Methods,* The University of Turku, Vaasa, 2002, p.173
[44] B Hellström, p. 37
[45] B Traux, p. 53
[46] Ibid. p. 71
[47] Ibid. p. 45
[48] R M Schafer, p. 9

To harmonize a sonic environment with place, an idea about the design/organization of sounds is presupposed.[49]

Keynote sounds represent the core of a soundscape; they are the main auditive characteristics of any acoustic environment. For example, keynote sounds are often produced by the materials of which a city or village is mainly built out of, and/or upon, - stone, wood, metal, glass, bamboo, water etc.[50]

Signals are sounds listened to consciously. They can be referred to as *figure* whereas keynote sounds are *ground*. These sounds are in urban environments primarily acoustic warning devices such as bells, whistles, horns and sirens.

Soundmark is derived from landmark, which is a landscape architectural concept. It concerns a unique sound, perceptively shared by the majority of people in a specific area. It is a persistent sound of historical importance that outlines the sonic identity of a city or village.[51] Preservation of soundmarks is scarcely involved in the architectural work of urban planning.

In addition to *acoustic ecology,* we can talk of *sonic diversity*. In a hi-fi soundscape, 'richness' is measured as sonic diversity where soundmarks are significantly important. Unique soundmarks deserve to be respected, as much as landmarks. We need to make sure that we are more sonically conscious when restorations and city reconstructions are planned. Some soundmarks are monolithic, appearing as a signature for an entire community. Preservation of soundmarks is one practical task for the acoustic designer.[52]

2.2 Models & Charts

What is obvious with soundscape studies is that the methods used often are extremely time consuming and, in the end, difficult to analyze due to the complex nature of sounds. As soon as a soundscape study is planned, there is an enormous structure of methodological options to deal with. A researcher needs to become conscious of the theoretical background to do so, and

---

[49] B Hellström, p. 38
[50] R M Schafer, pp. 58-59
[51] Ibid. p. 10
[52] R M Schafer, p. 239

every choice made at each stage in the research process must be made transparent and clear for critical scrutiny.

> Soundscape researchers do not merely report 'facts' about sounds. They interpret signs and actively produce new clues that can, in turn, be used to draw further conclusions. In this context, then, a method is constituted from (i) all of the practices and operations through which the researcher produces his or her observations, and (ii) from the rules according to which these observations are modeled and interpreted, in such ways that their meaning as clues can be understood.[53]

The soundscape is any acoustic field of study. *Aural space* is the graph created when we plot intensity against frequency, a notational convention. This should not be confused with *acoustic space*, which is an expression of the sound profile over a landscape.[54] The aerial projection applied to sound intensity – Isobel Contour Map – is derived from the contour map of geographers and meteorologists.[55] Data of the variations in sound pressure over a given area are collected with a sound level meter, whereafter bars of equal intensity can be drawn by connecting those points for where the measured levels are equal.[56] The technique is an empirical method to identify the quietest and the noisiest areas of a territory.

The founder of the World Soundscape Project, Schafer, suggests that we use a two-dimensional chart as a model for the acoustical study on soundscapes. On the horizontal plane *attack, body* and *decay* are issued, whereas on the vertical plane the relative *duration, frequency* and *dynamics* of the sounds are determined. To this additional observations are added such as momentary internal fluctuations (transients), and the features *mass/grain*.[57] For the cognitive perspective he suggests that we use "Sound Diaries" or "Listening Diaries" where the subjective response to particular or striking sounds, combination of sounds or sonic atmospheres is the focus of study.[58]

Amphoux[59] presents three approaches for sonic analysis in city environments;
1st approach – selection of representative examples – *sonic memory*

---

[53] Järviluoma & Wagstaff, pp. 12-13
[54] R M Schafer, p. 115
[55] Ibid. p. 131
[56] B Traux, p. 65
[57] R M Schafer, p. 134
[58] Järviluoma & Wagstaff, p. 29
[59] P Amphoux, 'The Sonic Identity of European Cities' in H Järviluoma & G Wagstaff (eds), *Soundscape Studies and Methods*, The University of Turku, Vaasa, 2002, pp. 59-82

2nd approach – constitution of an analytic framework – *sonic perception*

3rd approach – characterization of the sonic identity of the city – *sonic interpretation*

Hellström[60] presents a comparative soundscape study method for an architectural context. Six specific sites (in the quarters of Klara, Stockholm) were investigated sonically with sound recordings and a sound profile chart. Fixed categories on a conceptual scheme were used for this study. The case study investigated an outline survey of the chosen sonic environments, using the main categories *space* and *character* as well as the adjacent categories *present/past, figure/ground, order/chaos* followed by a *general summary*.[61]

The Soundwalk is a method used for both study and teaching. Nicolas Tixier, another CRESSON researcher, describes in his essay *Street Listening* a qualitative method for the dynamic characterization of the urban sound environment called 'Qualified listening in motion'. The method was first developed in collaboration with the head of laboratory CRESSON, philosopher Jean-Francois Augoyard. The method is described as an interdisciplinary process taking into account both the physical and the constructed dimensions of space, as well as the social and subjective dimensions given to it by the users. Jean-Paul Thibaud, a French sociologist, has recently modulated this soundwalk format to a "commented walk" - recording the interrelationship between researcher, interviewee and the sonic environment that is being perceived.

Other relative methods are sound preference tests, questionnaires and interviews. However, in general, these methods seem to lack the quality of certainty - the general public often finds it difficult to discuss everyday sounds. Environmental sounds are rarely consciously noticed and thus the public finds it hard to verbalize those experiences. It is a dimension of city architecture and urban research that unfortunately has been immensely neglected in our modern culture, dominated by an emphasis on visual aspects. Another problem in soundscape studies is the integration of new methods with the ones that have, thus far, proved useful.[62] They deal with many variables and produce both quantitative and qualitative data. Verbal terms are developed from interviewees' interpretations. Subjective sonic aspects of locations

---

[60] B Hellström, *The Voice of Place: A Case-study of the Soundscape of the City Quarters of Klara, Stockholm*, Research Report: Royal Institute of Technology. Department of Architecture and Town Planning. Division of Complex Structures, Division of Design Methodology, Stockholm, 1998

[61] Ibid. p. 28

[62] H. Uimonen, 'Cogntive Maps and Auditory Perception' in H Järviluoma & G Wagstaff (eds), *Soundscape Studies and Methods,* The University of Turku, Vaasa, 2002, pp. 171-184

with a subjectively created terminology make current soundscape studies a rather suspect scientific field, also since the same locations serve as prototypes and reference objects. The matter of studying environmental sounds is more complex than one would first think. A modern standardization of methods is crucial.

One fundamental problem in interview studies is the subject's unfamiliarity with the situation. For my thesis I have chosen to interview professionals in fields related to acoustic design, since they are familiar with the terms and issues related to analyses of urban acoustics. I selected three key informants, recommended by The New York Society for Acoustic Ecology – a membership organization dedicated to explore and promote public dialog concerning sound in NYC. The interviews were based on a questionnaire (see Appendix I), with an open-ended format.[63]

---

[63] T Hadjistavropoulos & W E Smythe, 'Elements of Risk in Qualitative Research' in *Ethics & Behavior*, Lawrence Erlbaum Associates Inc., 2001, pp. 163-174

3. RESULTS OF INTERVIEWS

3.1. Amanda Huron

Amanda Huron is a geographer who principally studies questions of urban land, housing, city planning and contested urban space. She is a PhD student at the City University of New York Graduate Center, and teaches classes in the Urban Studies Department at Hunter College. She has performed much of the cartographic work on the Mannahatta Project[64], which seeks to depict the ecological communities and plant/animal species of Manhattan in 1609. Amanda leads workshops on mapping and social justice, particularly interested in how young people make and use maps. She came to sound mapping through her strong interest in the geography of microradio, and her appreciation of musical noise.

In what way have you been involved in urban acoustic research?

The New York Society for Acoustic Ecology[65] asked me to present the sound work I've done at one day-long symposium they had. The thing that they asked me to present on was a mapping project, a sound-mapping project of a park that I've done. I did the project because I've been taking this GIS class, a computer mapping technology. It's a pretty complicated software in a way, but I was learning to use it and I wanted my own project where I could use the software for my own ends. So I ended up choosing to map the soundscape of this particular park. I was thinking about mapping two aspects of sounds, one was just the intensity of the sound – the decibel levels – and the other was the sources of the sounds. The thing that was so interesting about it was that it was so hard to do. I took a grid of points and went to each one, there were like 20 points in a little grid across the Fort Greene Park in Brooklyn. It's a square park so I could just do this evenly spaced grid. My idea was to go out with this decibel level meter and stay in each point and record the level of noise and then also note down what was making the noises that I heard. So I did it for three times a day - nine in the morning, noon and then three in the afternoon for multiple days. It was a huge time intensive data gathering process, which in the end I was like "wow this is a whole lot of work to do this" but I got a lot of data which was cool. So then what I did was I made these maps, a series of decibel maps that showed the levels of sound at each point. You can use the GIS

---

[64] http://themannahattaproject.org last seen 2010-01-12
[65] http://www.nyacousticecology.org last seen 2010-01-12

software to create these maps that use these algorithms to show where the sound is most intense. They kind of look like a weather map.

A whole other thing is the Manahatta project, that thing was amazing, and we actually wanted to do a sound component to that but we never ended up having the money or the time for it. There was a sound artist who was interested in making an audio mix of the sounds that those animals would've made and the sound of the trees, the wind in the trees, the water in the stream – all the sounds you would've heard at a particular point. Unfortunately that ended up not happening but that would've been very cool, like this historical soundscape.

Sound is so elusive you know and it just evaporates so quickly, so to try to map it is hard because a map is such a static object. To try to map something that is so ephemeral as sound is hard. That is kind of the main thing I learned of that project really, the difficulty of studying sound in place. There's a lot of challenges to it.

That's what I experienced through my research, that just finding an appropriate method for a soundscape study is maybe the hardest task…

Yeah, totally. It took me a while to find something. The method I used I borrowed from someone else that I'd seen, but it didn't seem like it was the best necessarily.

How would you define noise?

I had this problem [defining noise] when I was doing my sound mapping project - am I mapping sound or am I mapping noise and what's the difference? Sound to me is anything audio, and then noise - I guess it's usually considered to have a negative connotation to it and there's sort of a volume associated with noise. If something is noisy it means it's loud. It's considered to be something bothersome, but I think in that whole category of noise it's kind of problematic – what does that really mean? It's so subjective what someone considers to be noisy.

Do you think noise legislations of today are sufficient?

It's a really good question. I think it would be hard to say generally if they're sufficient or not, but I definitely think 'quiet' is really important. It seems like it's more realistic to create a refuge than to dim the whole thing, because that would be so hard. If you ever take the train here [in New York] there is usually a quiet car on the train, but it's hard to think about that outdoors. But I suppose it would be really cool to have some sort of park or space where you could designate a part of it a quiet zone. I mean, of course it would be impossible to keep all the noise out but it could still be pretty cool. One of the things I noticed in Fort Greene Park when I was mapping up there - the center of the park is up on a hill, there are streets along three sides and then there's a hospital on one side, so of course it's quieter in the middle because it's further away from the streets, but it's also up on top of a hill so it's even more removed from the traffic. It's quite peaceful up there and it's interesting, it has a more peaceful feel too. Maybe it's because the architecture is different up there from around the sides, but people just sit and it's quiet, not much running around. Even if there is no sign that says "this is a quiet zone", maybe there's something about the landscape architecture that makes people be more quiet.

How do you think we can involve sound design in urban development?

That's a really good question. One thing that I think works really well is the use of water to mask certain sounds, like traffic. There actually is a spot on 53rd street in Midtown here in New York that's really easy to miss. It's this little park that is just stuck between these two big buildings and you go in and it's wonderful because it's this total oasis. Part of the reason, I think, is because at the end of the park there is this wall and it's just got all this water, it's like a waterfall running down this wall, going down over this stone and there are trees. It's just a wonderful spot. I really think a big reason that it's so popular is because the water masks a lot of the city sounds. I'm really into plants, what they can do to increase the visual environment - but audio environment too maybe. I'm interested in this question about plants and how they absorb sounds, I wonder if succulent plants absorb more sound because their leaves are thicker.

3.2. Jeffrey Dugan

Jeffrey Dugan is an architect as well as a musician, sound artist and phonographer. He runs a recording label called GD Stereo[66]. However, he spends a majority of his time in architecture. He is a principal in the firm Dattner Architects[67] with an office in midtown Manhattan, New York City.

Tell me more about your occupation…

I'm a principal architect in the firm Dattner Architects. We are a New York City firm known for design excellence and civic engagement in a wide range of significant public and private projects. Since our founding in 1964 we have focused on realizing architecture that enables the everyday life of residents, workers, students, transit riders, and users of parks and recreation facilities. The firm's work aims at fulfilling their clients' highest aspirations while respecting shared social responsibility and maximizing the available resources. Our built projects promote sustainability in its largest sense – appropriateness, sensitivity for occupants, economy of means, respect for context, and design for the long term. I have been at Dattner Architects for 12 of the 20 years that I have lived in New York City. My work over the past decade has focused on transportation design for subways and airports as well as educational facilities and office buildings.

In what way does sound design, acoustic research etc. interest you?

The worlds of architecture and music rarely intersect in my life. Largely they remain separate entities. Over the years I have tried to find common ground for both. In 1997 I produced a compilation recording based on the exploration of a place through a psychogeograhical exercise as originated by the 1960's artist group the Situationist International. This seemed a perfect blend of site and sound that defined how I felt about both music and architecture. Beyond that point I began to make environmental recordings and create compositions with them that explored space and time.

---

[66] http://www.gdstereo.com last seen 2010-01-12
[67] http://www.dattner.com last seen 2010-01-12

Have you ever heard of the term "soundscape"? Do you think designing soundscapes in urban environment is realistic or even appropriate (just as landscape architects form landscapes)?

I prefer the found soundscape – that which is the result of an activity or purpose other than intended. The incidental soundscape is a place of discovery. It is also a place of noise and silence. Architecture is very involved with the visual. Landscape Architecture plays a little more with our senses but is weighted heavily in the visual experience. In comparing the visual to the aural we can easily close our eyes to shut out the visual. It takes more of an effort to close out the aural. Painting and sculptural installations in galleries can be selective viewed but sound installations are often inescapable unless they are confined to headphones.

Soundscape design can be part of an urban environment. The fountain at Columbus Circle in New York City is an aural oasis in the center of a traffic circle. The sound of the circular fountain drowns out the noise and cacophony of the city. This is likely an accidental product of the landscape design. Another similar but intentional sound design is Deam House by LaMonte Young and Marian Zazeela. This sound and light installation on the 3rd floor of a small tenement building in New York City is a sanctuary for the ears and eyes as well as a sensory depravation experience.[68]

What are your thoughts about noise?

Noise like music can be in the mind of the beholder. The cliché: one person's music is another person's noise. Environmental noise is rampant in New York City, specifically on the streets 24 hours a day. Lately I have noticed that street noise is mostly the byproduct of desire. More specifically, noise is the byproduct of our progress towards making money. The old saying "time is money" influences all persons directly connected to the production of noise. Trucks, buses and automobiles rumble across the streets on their way to deliver goods, to transport us to work and to carry us to pleasure. We reserve our time and effort for the visual narcissism and discard the aural, the resultant sound – noise.

---

[68] For a full explanation of the installation see http://www.melafoundation.org

How should we address noise in urban environments?

Awareness of sound is the first step. Most of us do not understand the value of our sense of hearing and it's impact on our psyche. In general there have been and continue to be artistic and civic efforts at recognizing the importance the sonic environment but this is not enough to address the issue. Governmental regulation may be our only hope.

What can we do to improve the general approach?

All of the obvious: education, regulation, interactive awareness and social dialog.

Can you give any examples of architectural work that have taken sounds and acoustics into consideration (other than concert halls)?

New school buildings for the city of New York consider acoustics and sound transmission in classrooms, gyms, auditoriums and music rooms. Green or sustainable design criteria are part of these building programs and regulate, through construction standards, the sound transmission of mechanical/air conditioning systems, window systems and architectural finishes.

Aside from architectural design and systems design there are sound masking systems that are used to cancel out or abate unwanted ambient noise. In general these systems are used for speech privacy/security between rooms but I have read that they have been applied to large enclosed spaces in Japan.

How would you suggest we implement sound aspects in architecture and make acoustic design a general concern in urban planning, just as visual aspects such as lighting design?

In buildings we can do this through mandated design criteria as part of sustainable design. In the open urban setting we can mandate this through zoning requirements for new structures and construction. However this does not address the existing conditions of roadways, vehicles, delivery systems, transportation systems, emergency vehicles, construction activities, manufacturing, music and speech amplification and extreme communications. Most generators of noise are generators of commerce and communication. Last, but not least,

war is a huge generator of noise that is the pinnacle of commerce and communication. It seems that peace (not a pun) would be the guiding principal for the implementation of acoustic design. Peace as defined by Wikipedia: " is a quality describing a society or a relationship that is operating harmoniously."

3.3. Andrea Williams

Andrea Williams is a sound artist who utilizes site-specific elements and perceptual cues in her work, that varies from radio pieces, installations and live performances to soundwalks.

In what way does sound design, acoustic research etc. interest you?

I am interested in exploring the act of listening and how sound can be used as a material in artmaking as well as in design. Also, as co-founder of the New York Society of Acoustic Ecology, I work on projects that focus on the sounds of the urban environment and host lectures and concerts that encourage public dialogue concerning sound in cities. Our society's NY Soundmap at Soundseeker.org allows the public to upload their own sounds that simultaneously get marked on an online map. We also have a monthly radio show called Giant Ear, that is based on a themed open call for recordings from international sound artists and from anyone with access to a recording device.

Have you ever heard the term "soundscape"?

The term 'soundscape' was introduced by Schafer in the late 1960's to define the aural layer of the environment. He used various terms to describe this environment that are similar to those used to describe a landscape including foreground and background with soundmarks instead of landmarks. I believe that sound is perceived more subjectively than what we perceive visually. Therefore we should not impose a general sound aesthetic when designing places. In interviews and observations with the general public from various cultures I have found that there is very little objectiveness. Some people love the sound of the subway, and some people cannot stand birdsong. Sound resonates differently with different people and cultures.

What are your thoughts about noise?

Noise is often defined as unwanted sound, but as an artist I also sometimes think of noise as sound that can be shaped into an interesting material. To me it is unrealized sound that has the possibility of being redesigned or put into a context that makes it more appreciated.

How should we address noise in an urban environment?

I think that it would be beneficial for our urban environment to educate people on how we perceive sound and noise. Everyone continually contributes sounds to the soundscape so it seems like a good idea to be aware of how our sense of hearing and listening works. It may inspire new acoustic designs.

What can we do to improve the general approach?

Having members of a community share their subjective views on sound with each other is a good start.

How would you suggest we implement sound aspects in architecture and make acoustic design a general concern in urban city planning, just as visual aspects (such as lighting design)?

I think that by dedicating more time on hearing and listening in education there will be more interest in utilizing it. I also think that it would be interesting to have architects and city planners go on soundwalks on a site where they intend to build. Such a walk based on listening to the environment and social atmosphere might inspire them to be creative with the design of the building and how it may interact with the soundscape around it.

4. DISCUSSION

> *Sonic phenomena have an effect on our everyday life whether we perceive them consciously or not. The point is to find suitable methods of charting these effects and especially how we react to them. Hearing or listening should not be considered as – or in the worst case reduced to – just another way of receiving information that works in collaboration with other senses, but as an independent sense as well.*[69]

Schafer argues that the passage from low-fi to hi-fi soundscapes can be characterized as the transition from rural to urban life. The loss of daily and seasonal rhythms, "synchronized beauty"[70], would be the reason for a regression in acoustic quality. This theory is clearly anti-modern and anti-urban. My claim is that there is much rhythm in urban cities, appreciated by many urban inhabitants. Aware of the crucial need for sonic dim and mask techniques in urban architecture, we should approach this creatively. The acoustic component of the urban environment has mainly been investigated in relation to noise pollution, which is a destructive approach.

My informants for this study have confirmed that although this is a complicated field, it is an important area for urban research and development. Many times the masking effect, as examplified by the fountain at Columbus Circle or the water wall on 53rd Street, is accidental and simply a byproduct of visually dictated design. What my informants suggest is a more conscious awareness for these types of architectural techniques to design and influence the sonic environment. Also suggested is that we mandate zoning requirements for new constructions, and reserve space for sonic refuges in sonically intense cities. Agreed is that we need more pronounced architectural tools to optimize the living conditions for urban inhabitants exposed to urban noise, which is causing psychoacoustic annoyance and even hearing loss. A sonically stressed populataion may also be productively impaired. This urges the need to offer zones and refuges in a sonically dense city as New York City – the opportunity for people to choose their sonic environment. We can't simply impose a general sound aesthetic in the way we have general visual aesthetics, since sounds are perceived more subjectively than visual objects.

---

[69] H Uimonen, p. 182
[70] R M Shafer, p. 6

My informants suggest three main solutions for the sonic improvement of urban environments: 1) education - creating an interest 2) organizations - creating a community 3) social dialog - creating awareness.

Acoustic quality can be related to The Theory of Complexity (see Appendix III), issued by Detlev Ipsen. The theory is quite different to that of Schafer, it is not the contrast between countryside and urban environment that is important but rather the level of acoustic complexity – sonic diversity. The motivational value of a situation may depend on the information which belongs to it. The graphic representation of the relation between motivational quality and the complexity of a situation is a non-linear regression. To explain it verbally; if the complexity of the information is rather low, we find a situation less attractive. Also if the complexity is very high and "unreadable" we tend to react with annoyance. Nevertheless there is a level of complexity, between these two extremes, which generates a high positive motivation and this applies to any form of information, including acoustic perception. It is still a matter of taste and individuality. The same level of complexity of a situation may be attractive or unattractive, depending on the individual. The more familiar an individual is with a situation, the less complex the information input gets. Also, the level of adaptability an individual possesses will influence the response to the acoustic information. Some people need more complexity than others to find a situation attractive. Even for one individual the level of adaptability is rather dynamic, depending on a multitude of factors.[71] The theory of complexity is obviously difficult to use in general sonic matters due to the subjective nature of the acoustic perception. But, we can learn from the theory that there is complexity that is appealing to us, no matter the context. Urban sounds can be enjoyable for people in need of high complexity information. At the same time urban planners need to respect those who do not find the high complexity of sounds as attractive. The solution for this would be the creation of zones and refuges, with varying acoustical complexity. Complete silence is impossible to achieve, but much city noise can be masked and dimmed. Using natural sound sources in urban planning, such as water and vegetation, has proved to be effective for this purpose and pleasing for the general public.

---

[71] D Ipsen, pp. 188-191

The common attitude among politicians, specialists and city planners who work in the field of urban sonic environment today can be denoted as defensive. It is described by Pascal Amphoux as "diagnostiquer le mal" – diagnosing the bad. The main concern is to protect citizens from sonic annoyance, e.g. to normalize/regulate/control. This is the general approach. However, there is a new attitude progressing and spreading in this field aiming at "diagnostiquer le bien" – diagnosing the good. It is based on promoting favorable conditions of an actual sonic quality in an urban space, preservation of characteristic soundmarks, sonic diversity etc.[72]

Humanity is more and more becoming an issue of urbanity. The designers of mega-cities such as New York City will be facing a multitude of challenges in the future, one of them being the acoustic ecology. For a better city, a better urban life, acoustic design should be more than an acknowledged interest amongst acousticians– it should be an established, respected part of urban planning.

Introducing the topics issued by the World Forum for Acoustic Ecology[73] and the New York Society for Acoustic Ecology, a chapter of American Society for Acoustic Ecology, has been my incentive for this study. Acoustic ecology is not just an interesting new aspect of urban studies, but also an argument when promoting a more sustainable design in cities - green walls for example absorbing sound waves and therefore attenuating the average sound intensity. Green walls can, if properly constructed, reduce up to 40dB of outdoor noise and vibration. I propose that acoustic design becomes an integrated subject in architecture, and a significant aspect in future urban development.

---

[72] B. Hellström, 'The Sonic Identity of European Cities' in H Järviluoma & G Wagstaff (eds), *Soundscape Studies and Methods,* The University of Turku, Vaasa, 2002, p. 61
[73] WFAE conference held in Koli, Eastern Finland, 2010.

5. REFERENCES

5.1. Litterature

Cummings J., 'Listen Up: Opening Our Ears to Acoustic Ecology', *Zoogoer* (magazine of the US National Zoo), July/August 2001

Fastl H. & Zwicker E., *Psychoacoustics; Facts and Models,* 11th edn, Springer-Verlag Berlin Heidelberg, New York, 2007

Hadjistavropoulos T. & Smythe W. E., 'Elements of Risk in Qualitative Research' in *Ethics & Behavior*, Lawrence Erlbaum Associates Inc., 2001

Handel S., *Perceptual Coherence*, Oxford University Press, 2006

Hellström B., *The Voice of Place: A Case-study of the Soundscape of the City Quarters of Klara, Stockholm*, Research Report: Royal Institute of Technology. Department of Architecture and Town Planning. Division of Complex Structures, Division of Design Methodology, Stockholm, 1998

Järviluoma H. & Wagstaff G., *Soundscape Studies and Methods,* The University of Turku, Vaasa, 2002

Newman E. B., 'Speech and Hearing' in *American Institute of Physics Handbook*, 3rd edn, 1972

Schafer R. M., *The Soundscape; Our Sonic Environment and the Tuning of the World*, Cambridge University Press, 2nd edn, 1977

Traux B., *Acoustic Communication,* 2nd edn, Greenwood Press, 2001

Truax B., *Handbook for Acoustic Ecology*, A.R.C. Publications, 1978

5.2. Electronic Sources

Anatomy of the Soundscape: Evolving Perspectives
http://www.wildsanctuary.com/popv2/jaes.pdf

Sensing the City
http://alcor.concordia.ca/~senses/sensing-the-city-lecture-RMurraySchafer.htm

The Acoustic Ecology Institute
http://www.acousticecology.org/writings/listenup.html

The New York Society for Acoustic Ecology
http://www.nyacousticecology.org

World Urban Forum III
http://www.unhabitat.org/cdrom/docs/WUF4.pdf

Ecos Magazine Aug./Sept. 2008

http://www.ecosmagazine.com/?act=view_file&file_id=EC144p11.pdf

Cornell University Law School

http://www.law.cornell.edu/uscode/42/4901.html

5.3. Informants

Thomas Elmqvist (Professor in System Ecology), Stockholm Dec 2009

Amanda Huron (geographer and teacher in Urban Studies), New York Dec 2009

Jeffrey Dugan (architect and sound artist), New York Jan 2010

Andrea Williams (sound artist), New York Jan 2010

APPENDIX I

Questions and topics of discussion:

In what way does sound design, acoustic research etc. interest you?

Are sounds important in human society?

Have you ever heard of the term "soundscape"? Do you think designing soundscapes in urban city environment is realistic or even appropriate (just as landscape architects form landscapes)?

How would you define noise?

What are your thoughts about noise?

How should we address noise in urban environments?

Do you think noise legislationsof today are sufficient?

What can we do to improve the general approach?

How do you think we can involve sound design in urban development?

Can you give any examples of architectural work that have taken sounds and acoustics into consideration (other than concert halls)?

How would you suggest we implement sound aspects in architecture and make acoustic design a general concern in urban city planning, just as visual aspects such as lighting design?

APPENDIX II

$$PA \sim N\left(1 + \sqrt{[g_1(S)]^2 + [g_2(F,R)]^2}\right)$$

PA – psychoacoustic annoyance

N - loudness

S - sharpness

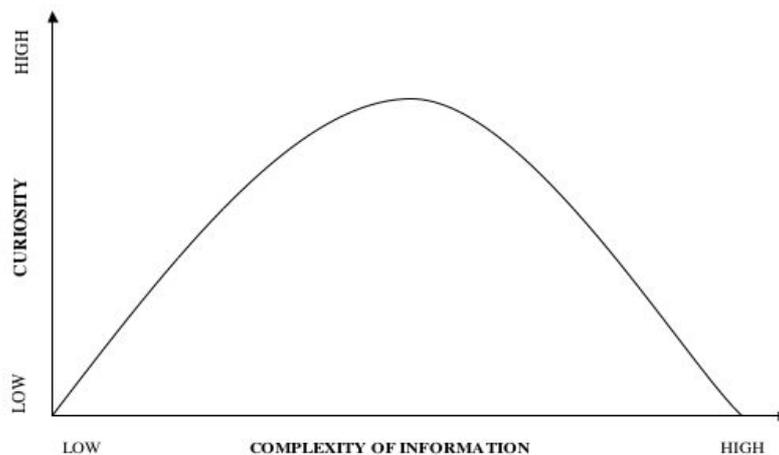F - fluctuation strength

R - roughness

APPENDIX III

Figure: Complexity of Information and Motivation (curiosity)

Source: The relation between the motivational quality of a situation and the complexity of its information is a non-linear regression. Let me explain: if the complexity of the information is rather low we find a situation less attractive. The same is the case if the complexity is very high and therefore not „readable". Between these two extremes, there is a level of complexity, which generates the highest possible motivation of an individual. This applies to any form of information including acoustic information. – D. Ipsen (2002)