Site Soundscapes

Landscape architecture in the light of sound

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Abstract

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This research was based on the assumption that landscape architects work on projects in which the acoustic aspects can be taken into consideration. In such projects activities are located within the landscape and specific sounds belong to specific activities. This research raised the orchestration of the soundscape as a new area of concern in the field of landscape architecture; a new method of approaching the problem was suggested. Professionals can learn to recognise the auditory phenomena which are characteristic of a certain type of land use. Acoustic sources are obvious planning elements which can be used as a starting point in the development process. The effects on the soundscape can subsequently be evaluated according to various planning options.

The landscape is viewed as a space for sound sources and listeners where the sounds are transferred and coloured, such that each site has a specific soundscape – a *sonotope*. This raised questions about the landscape's acoustic characteristics with respect to the physical layout, space, material and furnishing. Questions related to the planning process, land use and conflicts of interest were also raised, in addition to design issues such as space requirements and aesthetic considerations.

A prototype of a computer tool for use in landscape architecture was developed. This was intended to promote listening as well as stimulate an appreciation of the soundscape approach in the processes of planning and design. The purpose was to illustrate auditory problems and raise the aural awareness of the practitioners, for example, while carrying out visits on site. The tool provided a means through which researchers, practitioners and members of the public could meet to facilitate a mutual exchange of ideas. The tool was based on the results of qualitative interviews on two urban settings. These were referred to as *reference objects*, the design, building material, plant material, functions, traffic conditions and location of which have characteristics which practitioners can compare with their ongoing projects. One of the locations was a pasture on the outskirts of a city, while the other was a public garden which was located towards the centre of the same city. The pasture's sonotope was characterised by clear, distinct sounds which were neither drowned out by sounds which were emitted a short distance away nor by those emitted at much greater distances. In contrast, the sonotope of the city garden was characterised by the sounds of its surroundings.

Key words: landscape planning, landscape design, urban planning, acoustic design, acoustics, noise, intersensory, sustainable development, landscape perception, sense of place.

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Sammandrag

Denna forskning utgick från att landskapsarkitekter arbetar med projekt där ljudhänsyn kan tas. I sådana projekt lokaliseras verksamheter i landskapet och till respektive verksamhet hör specifika ljud. I denna forskning lyftes orkestreringen av ljudlandskapet fram som ett nytt problemområde för landskapsarkitektur som profession och ett nytt angreppssätt föreslogs. De yrkesverksamma kan lära sig känna igen de auditiva fenomen som är karaktäristiska för en viss typ av markanvändning. Ljudkällor är påtagliga planeringsobjekt som då kan tas som utgångspunkt och konsekvenser på ljudmiljön kan därefter bedömas för olika planeringsalternativ.

Landskapet betraktades som ett rum för ljudkällor och lyssnare där ljuden överförs och färgas, så att varje plats blir en specifik ljudmiljö – en *sonotop*. Detta gav frågor om landskapets akustiska egenskaper kopplade till landskapets fysiska form, rum, material och möblering. Dessutom genererades planeringsfrågor om markanvändning och intressemotsättningar samt designfrågor rörande utrymmesbehov och estetiska överväganden.

I projektet utvecklades en prototyp till ett datorverktyg för professionen. Det var avsett för att utveckla lyssnande och ljudens formspråk i såväl planering som projektering. Syftet var att visa på auditiva problem och att höja praktikernas auditiva uppmärksamhet, exempelvis inför platsbesök. Verktyget var även ett medel för forskare, praktiker och allmänhet att mötas för en ömsesidig kunskapsgenerering. Verktyget baserades på resultat från kvalitativa intervjuer på två urbana platser. De var avsedda som *referensobjekt*, vars form, byggmaterial, växtmaterial, funktioner, trafiksituation, byggnadsplaceringar *etc.* har egenskaper som praktiker kan jämföra egna aktuella projekt med. Den ena platsen är ett beteslandskap strax utanför en stad och den andra platsen är en centralt belägen stadsträdgård i samma stad. Beteslandskapets sonotop kännetecknades av en klarhet med tydliga ljud på nära håll som varken överröstades av ljud på halvdistans eller av ljud på stort avstånd. Stadsträdgårdens sonotop karaktäriserades istället av omgivningens ljud.

Contents

Appendix

Papers I-IV and Appendix V (CD-ROM)

This thesis comprises the following papers which will be referred to by their Roman numerals in the forthcoming chapters.

I. Hedfors, Per & Grahn, Patrik. 1998. Soundscapes in Urban and Rural Planning and Design – a brief communication of a research project. In: R. Murray Schafer & Helmi Järviluoma (eds.), Northern Soundscapes – Yearbook of Soundscape Studies, vol. 1. *Univ. of Tampere, Dept. of Folk Tradition, Publ.* NO. 27, 67-82. ISSN 0357-0010.

II. Hedfors, Per & Berg, Per G. 2002. Site Interpretation by Skilled Listeners – methods for communicating soundscapes in landscape architecture and planning. In: Helmi Järviluoma & Gregg Wagstaff (eds.), Soundscape Studies and Methods. *The Finnish Society for Ethnomusicology Publ. 9; Univ. of Turku, Dept. of Art, Literature and Music Series* A51, 91-114.
ISBN 951-96171-5-9.

III. Hedfors, Per & Berg, Per G. 2003. The Sounds of Two Landscape Settings – auditory concepts for physical planning and design. Landscape Research, vol. 28, NO. 3, 243-261. *In press.*

IV. Hedfors, Per. An Audio-Visual Tool for Landscape Planning and Design – preliminary evaluation of an interactive CD prototype. *Manuscript.*

Additional output results from the research are available on CD-ROM in the form of a prototype of a practical tool. This CD-ROM is used in paper IV and will also be referred to by its Roman numeral:

V. Jämförelser av ljudbilder från två landskap (Comparisons of Acoustic Images from Two Landscapes, in Swedish or English).

Preface

Landscape architecture, with all its applications, is a fascinating subject. It is personally considered to be of great importance in both urban planning and rural development. Students and supervisors in the undergraduate Landscape Architecture programme seemed to consider aesthetic criticism to be a purely visual matter. The undergraduate thesis work therefore focused on the auditory aspects of this subject in order to broaden this limited perspective.

Any other sense could have got in the way, but sounds were considered to be manifest and significant, yet overlooked in terms of landscape experiences. It was therefore natural that the viewpoint of hearing be investigated. Lavish parks in which no-one wanted to stay were noticed; this was chiefly because the acoustic environment had been neglected. It was observed in many cases that these areas could be noticeably improved by even minor adjustments to the acoustic environment. Even successful solutions were encountered, with respect to sounds which deserved to be repeated in new forms in other locations. The basis of the work was landscape architecture and the risk of sounds being neglected as an experience factor in the design of outdoor environments. This starting point was a guiding star which steered the investigations to issues concerning practical uses of sound – a guiding star by which to navigate the seven investigative seas.

Although this study is aimed at landscape architects, it may also be put to good use by other groups. These include those in the building industry such as traffic planners and building architects, whose professions overlap and affect landscape architecture from time to time.

The outline of Appendix I-V

The introduction of this research was a project description which was formulated for international publication, Paper I. This provided an important basis of communication with other researchers in the fields of music, radio and film, among others. A research plan which was intended to contribute to the field of landscape architecture was subsequently formulated. A preliminary version of the plan was presented at an international conference on acoustics. Paper II presents a further developed plan which comprises six steps. The interview stages prescribed by the research plan were completed; results from interviews related to two selected locations are discussed in Paper III. The application of the remaining steps were later presented in a semi-annual report (Hedfors, 2001). The research resulted in a preliminary prototype of a practical tool (Appendix V), based on the results presented in Paper III. Paper IV presents the development and evaluation of the tool. Further information on the origins and progress of the work can be found in *Selection of research path.*

Introduction

People continuously mould their environment, much the same as environments mould people. This is true for all species. The creative force of humans appears to them to be stronger than that of other species. Humans, in any case, are thought to place more value on human intentions than on those of other creatures. There may well be justification for this position. Nevertheless, the landscape is moulded by all species together, conditioned by the shapes of soil, bedrock and water flows.

One of the starting points of this project was people's actual thoughts on landscapes and garden design. There are sophisticated methods to design the surroundings, but what about the sounds? Is the bluntness in the design of acoustic environments really justified? The sound at a location certainly does not occur by chance; when people listen and notice the sounds that they create, they respond to their surroundings. The design, material and contents of the location invite activities and sounds which are associated with life and movement. The sounds say something about the landscape, the gardens and the spaces. The sounds are messengers. Humans' conscious moulding of their surroundings needs to include acoustic environments, because acoustic environments mould people.

Landscape portrays in which sounds are messengers

Sounds are used as distinct messengers in fictional works. The following examples illustrate the significance of sounds in the outdoor environment: the three quotations show the different styles used by the writers to describe sounds and auditory sensations. The first example is a rather exhaustive rendering of an urban landscape from over a century ago. The second quotation is a verse from the same era and constitutes a description of one of the landscaping customs of ancient times – herding. The last example is set in a garden; it demonstrates the sensation of being blind and thus having to rely a great deal on the sense of hearing.

In the beginning of *The Red Room*, August Strindberg describes the acoustic environment as he experienced it in Södermalm, Stockholm at the end of the 19th century. His descriptions bring the scene to life. Each individual observation tells something about the situation and the place from which the sounds are emitted. Strindberg uses the sounds to transmit information, as well as to set the theme for the scene. The town is bustling with activity:

> "Far below him rose the clamour of the newly awakened town; down in the harbour the steam cranes whirred, the bars rattled in the iron weighing-machine, the lock-keepers' whistles shrilled, the steamers at the quayside steamed; the Kungsback omnibuses rattled over the cobblestones; hue and cry in the fishmarket, sails and flags fluttering on the water, screams of seagulls, bugle-calls from Skeppsholm, military commands from Södermalmstorg. Workmen in wooden shoes clattered down Glasbruksgatan, and all this gave an impression of life and movement…

Now the bells of Santa Katrina chimed seven and were echoed by Santa Maria's reedy treble, the Abbey and the German Church joined in with their basses, and soon the whole air vibrated with the city's seven bells. And as, one after the other, they fell silent, the last one could still be heard in the distance, singing its peaceful evensong. This had a higher note, a purer ring and a swifter tempo than the others – yes, indeed it had. He listened, trying to make out where the sound came from, for it seemed to wake some memory…

The Klara bell stopped and he was jerked from his thoughts by the sound of a footstep on the gravel path."

August Strindberg, *The Red Room*, 1879 (transl. by Elizabeth Sprigge, 1967)

Gustaf Fröding depicts an old tradition in "Song of the Herdsmaiden". Not only is the poem an ode to herding, it also describes how sounds are coloured by the landscape. The shepherdess calls to her guide cow and the song echoes in the mountains of the surrounding landscape. The echo's reply is shorter; three syllables – "my Lily" – disappear between the mountains. In so doing Fröding captures one of the landscape's vital characteristics:

"Can't you hear cowbells ring, hear now the singing,
watching and wandering astray in the dale?
Cows moo and bellow, their full udders swinging,
trotting to follow the milkmaid's trail.

Ringing round mire and heath, listen how:
Lily – my Lily – my Lily – my cow!
Echo awakes in rocky lairs now,
issuing forth the cry,
in mountains north, the cry:
Lily – my Lily – my cow!

Bell-ringing echoes, both rising and falling,
sighing is still and it rests in repose,
woods, evening-heavy, sleep-silent, enthralling.
Only the singing there
leading the ringing there,
forth through the marshes and heath it goes.

…

Sleeps pine and spruce now, 'midst darkness clinging,
hollow the mountain stream trills on the brae.
Far, far away a high treble is singing,
wandering, watching, alone in the lay."

Gustaf Fröding, *Guitar and Concertina*, 1891 (transl. by Mike McArthur, 1997)

John Hull (1990: 22-23) describes what he, as a blind person, experiences during a light shower in a garden. The entire garden suddenly opens. Everything which is invisible and previously inaudible to him is transformed into sounds of the light rain drumming, splashing and sprinkling against the various materials in the garden:

"… I opened the front door, and the rain was falling. I stood for a few minutes, lost in the beauty of it. Rain has a way of bringing out the contours in

everything; it throws a coloured blanket over previously invisible things; instead of an intermittent and thus fragmented world, the steadily falling rain creates continuity of acoustic experience.

I hear the rain pattering on the roof above me, dripping down the walls to my left and right, splashing from the drainpipe at ground level on my left, while further over to the left there is a lighter patch as the rain falls almost inaudibly upon a large leafy shrub. On the right, it is drumming, with a deeper, steadier sound upon the lawn. I can even make out the contours of the lawn, which rises to the right in a little hill. The sound of the rain is different and shapes out the curvature for me. Still further to the right, I hear the rain sounding upon the fence which divides our property from that next door. In front, the contours of the path and the steps are marked out, right down to the garden gate. Here the rain is striking the concrete, here it is splashing into the shallow pools which have already formed. Here and there is a light cascade as it drips from step to step. The sound on the path is quite different from the sound of the rain drumming into the lawn on the right, and this is different again from the blanketed, heavy, sodden feel of large bush on the left. Further out, the sounds are less detailed. I can hear the rain falling on the road, and the swish of the cars that pass up and down. I can hear the rush of the water in the flooded gutter on the edge of the road. The whole scene is much more differentiated than I have been able to describe, because everywhere are little breaks in the patterns, obstructions, projections, where some slight interruption or difference of texture or of echo gives an additional detail or dimension to the scene. Over the whole thing, like light falling upon a landscape is the gentle background pattern gathered up into one continuous murmur of rain.

I think that this experience of opening the door on a rainy garden must be similar to that which a sighted person feels when opening the curtains and seeing the world outside…"

The three quotations illustrate how sounds transmit information about the surroundings. The descriptions are defined in such a manner that the landscape's character is brought forth by the sounds which are heard. The description by the blind man indicates a multitude of sounds amongst which most people can distinguish. He has been forced to develop his sense of hearing over a long period of time; nevertheless, his hearing does not differ biologically from that of other people. The distance between walls, the height of the walls, the texture of the pavements, the location of different use of land, the location of functional surfaces, the amount of vegetation, the height of the trees, water flows, *etc.* – these are all a part of landscape architecture and planning – they all affect the acoustic environment of any location. The sounds which accompany the design influence humans and other creatures who have the sense of hearing. These may be experienced as comfortable or uncomfortable, but they are always able to relate some amount of information.

Sound as a part of landscape architecture

This research considered the issues of sound and landscape architecture. How does the city park or a housing area sound, for example? Does the acoustic environment correspond with the intentions behind the designed places, in general? Does a general landscape plan give enough considera-

tion to the existing conditions and future requirements of the individual acoustic environments? Does the planning allow space for the design to take shape?

The aim of the research was to view sounds as potential resources in the planning and design of outdoor environments. This approach is poorly developed in physical planning, where issues concerning sound are mainly regarded as noise problems and are thus treated from technical perspectives (*i.a.* SOU 1993:65).

Site specificity as a basis for design

The purpose of landscape architecture is to create space-related solutions (*i.a.* Swaffield, 2002: 207ff). The design problem is therefore one of both practical functionality and aesthetics. The aim is not just to remove the sections which are undesirable, but to weigh many factors in the formulation of solutions which are suited to the purpose (*e.g.* McHarg, 1969). The "right sound at the right place" enhances the character of the locations and highlights any adjustments which are made:

> "… each site has its own special qualities of stone and earth and water, of leaf and blossom, of architectural context, of sun and shade, and of sounds and scents and breezes. Seek these out, and you will discover promises of formal order or of artful naturalism – the beginnings of your garden."
>
> (Moore, Mitchell & Turnbull, 1988: 1)

Sources of sound studies

Sound is studied in several traditional disciplines such as acoustics, music and oral communication. These disciplines, however, possess no significant connection to landscape architecture. *Environmental psychology*, on the other hand, has such a connection; it deals with the treatment of humans' sensory experiences in landscapes and outdoor environments (*i.a.* Kaplan & Kaplan, 1989; Bell *et al.*, 2001). However, this has not resulted in any significant interest in acoustic experiences in which sounds are considered to be resources. A textbook on the subject (Bell *et al.*, 2001) can be used as an example. The chapter which is dedicated to the auditory sense is entitled *Noise* and it treats sound only as a disturbance. The same aspect of sound, *i.e.*, as noise, is investigated as the cause of stress, for example (Moser, 1988).

Environmental psychology has rather become visually oriented (*i.a.* Appleton, 1996 [1975]; Kaplan & Kaplan, 1989; Axelsson-Lindgren, 1990; Hägerhäll, 1999) much the same as the professions of landscape architecture, building architecture and urban planning. This relationship is further discussed under the heading *A visual profession*. Building architecture displays exceptions with respect to architectural acoustics and the design of concert halls or theatres, among others (*e.g.* Rasmussen, 1959; Hesselgren, 1967; Barron, 1993; Crunelle, 1993; Ando, 1998; Sällström, 2002).

Several topics in geography border on the area of environmental psychology and investigate the effect of the surroundings on sensory stimuli. The landscape's acoustics were highlighted in the investigations as a vital contribution to "pure and sensuous geography" (*e.g.* Granö, 1997 [1929]; Ohlson, 1975, 1976; Porteous & Mastin, 1985; Carles, Bernáldez & de Lucio, 1992; Pocock, 1993; Smith, 1993; Rodaway, 1994; Smith, 1994; Hogdal, 1995; Carles, López Barrio & de Lucio, 1999).

The research problems which are investigated within prescribed disciplines are, in some ways, insufficient to be applied to landscape architecture. The questions which are asked do not focus on the problems which practitioners face out in the field; the research results therefore lack precision. Classical noise research considers the risks of damages and disturbances, but lacks developed terminology for the creation of desirable acoustic environments. Musical research comprises a wealth of terminology, but is centred around the delivery and enjoyment of individual musical compositions. An exception to this is the study of ethnomusicology, for example background music – muzak – intended for public places (*i.a.* Herrington & Capella, 1996). Otherwise, musical research places very little focus on the daily acoustic environments which are affected by landscape architecture (Karlsson, 2000).

Building architecture and architectural acoustics serve to foster knowledge about sounds for indoor environments. Skills training with respect to the construction of concert halls or theatres certainly has much to do with desirable acoustic environments, but the intention is more to create conditions for the enjoyment of exclusive musical compositions or theatrical performances. A concert hall is designed in such a manner that the circumstances are controllable: the conditions are therefore essentially different from those involved in the design of an outdoor environment. Those environments which are studied in geography are often uncontrolled, but the skills which are developed are seldom connected to the processes of planning and design since the geography is so descriptive. The concepts of geography are intended solely for descriptive purposes; the planning and construction processes within landscape architecture, on the other hand, require tools which cater to future developments while managing the changes which arise (Fig. 1).

There is no obvious acoustic terminology for landscape architecture among the assorted collection of traditional disciplines of sound. Each discipline has a specific focus in research; this separates each discipline from the other, by definition. A great deal of work was involved in this project with respect to extracting the nugget of information which was sought from the traditional areas of specialisation. The selection process required the formulation of the specific issues concerning landscape architecture which developed from empirical studies. Only then would it be worth searching within other disciplines for correspondence between the results of previous investigations. This project does not, however, complete the language development process.

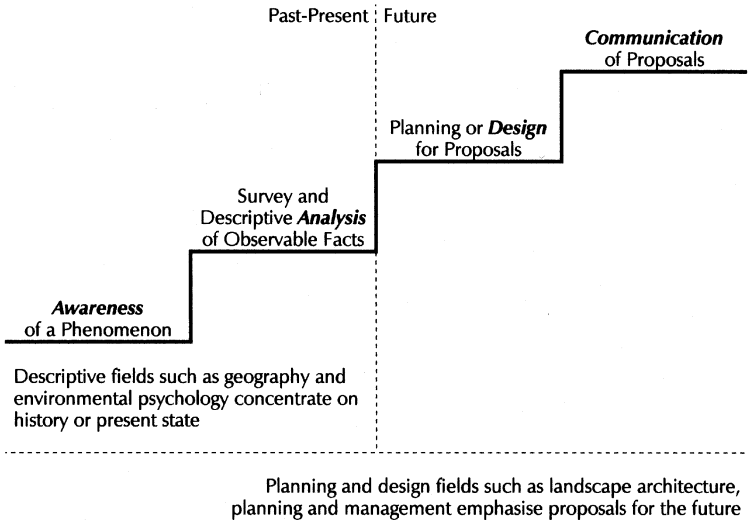

Fig. 1. Cognitive levels in the planning and design processes, in part according to Geddes' (1971) SAD-methodology. All four levels are to be included in landscape architecture (cf. Paper I: 77-78). Each of the higher levels can only be reached from the level immediately below it; in reality, there is continuous interaction between the levels that have been reached.

Soundscape studies

The empirical studies phase of this research project coincided with the growth of interdisciplinary research on *soundscapes* (Augoyard, Karlsson & Winkler, 1999; Hiramatsu, 1999; Truax, 2002). Such research was considered to be creative, but dense. It was there that researchers with descriptive concepts and other particular aims than to develop relevant concepts for planning and design could be found (*i.a.* Schafer, 1977; Lorenz, 2000; Minoura & Hiramatsu, 2000). There were even researchers with projections for design theory, but which focused on product development, *i.e.*, on the quality of the sounds from individual sources (*i.a.* Bernsen, 1999; Engelen, 1999). The acoustic skills requirement for landscape architecture appeared to be essentially different from those of many areas within this interdisciplinary field of soundscapes.

The significant differences in approach between research in other disciplines and the issues surrounding landscape architecture were not surprising. None of the specified disciplines have reason to consider the issues faced in practical situations concerning landscape architecture, where the task is to plan and create living environments where people dwell and where plants and animals are viewed as a natural part.

Against this backdrop, the project was almost completely isolated in the research world. This remained the case in the project's immediate proximity with respect to research problems; however, there were several interesting studies within the specific subject areas. Musicology and communi-

cation provide vital contributions (*e.g.* Schafer, 1977; Truax, 1984), as well as the work within the field of architecture (*e.g.* Southworth, 1969; Lynch, 1976; Augoyard & Torgue, 1995; Daumal i Domènech, 1998a, b; Augoyard, 1999), geography (*e.g.* Granö, 1997 [1929]; Rodaway, 1994), psychology (*i.a.* Anderson *et al.*, 1983; Kageyama, 1993), ethology (*i.a.* Oba, 1995) and acoustics (*i.a.* Vinokur, 1979; Blauert & Jekosch, 1997). Studies from these areas, as well as from the interdisciplinary research on soundscapes are referred to below. Several of the above-named studies can be counted in the interdisciplinary group.

The theoretical argument below begins from the viewpoint of practical landscape architecture. Some conditions related to landscape architecture were used as the basis of the research: these then generated the range of issues and research problems which were to be investigated. The choice of landscape architecture as a profession implies taking a clear position in relation to other forms of research on sound. This position is further clarified in the section entitled *Acoustic images in landscape architecture*.

Landscape architecture as a basis of research

This research was based on the view that landscape architects had practical insight into projects where sounds can be taken into consideration. The projects comprise tasks involving planning and design scenarios where certain types of acoustic problems occur. These require a prescribed method of approach if they are to be discovered, defined and solved. The scale of the project indicates a fixed period for the continuous preparation of proposals for treating the problems (Lundequist, 1995: 47). Methods which could be used in such contexts were developed during this project. The following investigation outlines the required conditions for such projects. It indicates *when* questions concerning sound arise, as well as the types of questions which are concerned with description, planning and design.

Landscape architecture is the science and art of making spaces which are biologically wholesome, socially just and spiritually rewarding (Turner, 1998). Benson & Roe (2000a: 3) put it another way: "Landscape architecture is about making fit places which fit". Consequently, it alludes to a *good outdoor environment*, with new objects and activities being attractively placed in locations which have been carefully selected within the existing landscape. Sounds are a part of the biological, social and spiritual fibre which need to be considered if good outdoor environments are to be provided.

Conan (1999) stated that gardens ought to be investigated in their context. The social currents as well as the surrounding landscape should be studied. The scope of landscape gardening was broadened to include the entire landscape. In addition, Turner (1990, 29) pointed at the amount of practical projects outside the realm of gardens. Landscape architecture therefore affects all possible outdoor environments and consequently, the corresponding soundscape. Even towns are included in the landscape:

Frederick Law Olmsted introduced *greenways* as an element of urban planning during the second half of the 19th century. "He interlaced cities with parks," as Turner described it (1996: 179).

As industrialism grows, so too emerges a new breed of buyers and users in the society; this implies a wider portfolio of problems within landscape architecture (*i.a.* Bucht, 1997; Andersson, Jonstoij & Lundquist, 2000). Common gardens and green areas could be an example, since they signify the daily environments of many people, as opposed to the classical and exclusive landscaped gardens. Other examples are the huge infrastructural projects which will affect a much larger portion of the landscape than had previously been done (Nilsson, 1988). Furthermore, landscape architecture addresses questions on the relations and transitions between outdoor and indoor environments (*i.a.* Booth, 1983: 161ff).

As a result, landscape architecture characterises many different types of projects and exerts great influence on the manner in which the surroundings are shaped. Sound-generating processes and activities are assigned to locations by the method in which the landscape is designed. A landscape plan or design which focuses on acoustic experiences enables significant areas and people's close surroundings to acquire acoustic qualities which support everyday living and thus contribute to ecological sustainability. The definitions of good outdoor environment and good acoustic environment are naturally dependent on the circumstances. Landscape architects' formulation of the practical problems and the corresponding methods of approach will generate alternative solutions which will vary from place to place (*i.a.* Booth, 1983; Swaffield, 2002: 207ff).

Characteristics of landscape architecture

Those who are employed as landscape architects are described below as practitioners. Their primary task is to formulate professional plans and projects; this requires a trustworthy relationship with buyers, openness to users, association with a professional ethics body, respect for skills training and efficiency of performance, among other qualities (*i.a.* Thompson, 2000: 21). Practitioners with academic qualifications are obliged to conquer all these skills. Consequently, they are faced with almost impossible demands that they participate in skills training, keep abreast of current trends and determine when the results of investigative research are applicable. Researchers and practitioners within the field of landscape architecture and planning therefore need to develop methods and establish meeting places for the communication of results and the mutual exchange of information (Persson, 1997). This research project presented a CD-ROM as a means of such mutual information exchanges.

Landscape architecture is described from two professional perspectives in order to obtain an image of the profession itself, as well as the problems which arise related to sound. The first can be described as a *project worker's role*, in which landscape architects share the responsibility for parts of a

construction project with other consultants. This role arises from the older profession of landscape gardener (*i.a.* Turner, 1990; Bucht, 1997; Andersson, Jonstoij & Lundquist, 2000). The second role fits into the area of physical planning. *The planning role* takes the form of a civil service position and is supervised by politicians. The role came about due to the society's demand for household with natural resources and other related services (*e.g.* McHarg, 1969; Nilsson, 1988). The landscape architect's systemic comprehension skills and knowledge of ecological facts, as well as the management skills of the planning process are the foundations of this second professional role. Nonetheless, the two roles cannot be separated; the project worker's tasks include instances of planning, while the planner often works as a consultant or under similar conditions. Both roles require an insight into the problems and circumstances on each side.

Sketches for the communication between operators

What are the problems faced by practitioners in the different professional roles? And which auditory aspects can these problems be associated with? Landscape architects produce creative suggestions – sketches – to establish different alternative solutions or possible paths to take. The comprehension and subsequent formulation of the problems involved in actual situations determine the final layout of the acoustic environment, but the acoustic aspects are often overlooked. The result is then that the use of an active *acoustic design* in the project fails to materialise. When formulating a design, practitioners place emphasis on shaping functions into a complete working unit within the framework of the project – a sort of economical and system definition, with respect to time. Buyers are able to prioritise by selecting between alternative suggestions. They may consult with representatives of those who use the location in question. Buyers and users thus become participants in the project workers' design – a significant factor for the result of any project. Carefully-formulated supporting documents – sketches – must be presented at the buyer's consultation meeting in order to encourage a good communication process. Supporting documents are rarely formulated for acoustic environments; however, these need to be placed on the project workers' agenda during the design stage if sounds are to be considered and included as a natural part of the projects' results.

The landscape architects' classical method of running a project with the help of sketches, including perspective drawings, was documented in the early 19th century by Humphry Repton (1982 [1816]). Perspectives and plans show both the existing and proposed appearance of a place (the 'before and after' technique). New techniques which allow the consideration of auditory aspects need to be adapted to this classical sketching technique. Design theory describes the art of sketching (*e.g.* Schön, 1983; Lundequist, 1995) as being similar to that used in artistic processes, but it should rather be seen as an engineering skill and an exercise in craftmanship. Collingwood (1938) distinguishes between 'design' and 'proper art' in several ways. A designed product has prescribed *functions* to fulfil in

addition to being the result of one artist's individual expression. It was subjected to *criticism* from both buyers and users during its formation. Corresponding conditions should be applied to an auditory sketching technique. Sketching is described by Linn (1998: 76) as the project's process of managing problems such that mental models are brought out explicitly in visual images. The process of mental modelling makes it possible to study a future design and scrutinise inherent problems more deeply without having to construct a full-scale model of the object. A corresponding method of managing problems posed by sound would be based on mental models brought out explicitly in acoustic sequences.

Planning sets the framework of the soundscape

Patrick Geddes (1971 [1915]) used a planning method in the beginning of the 20th century which became a classic. The method is based on three systematic steps: survey-analysis-design (SAD), (Turner, 1996: 145) (Fig. 1). A similar technique is used by the Swede Knut Forsberg in the 1860s (Suneson, 2000: 121). The steps of the method give an idea of the differences between investigations – survey-analysis (SA-) – and planning (SAD). It is progressive planning which sets frameworks for the soundscape of the future. Ian McHarg (1969) documented a method in which transparent maps could be placed over each other to show different aspects of the same landscape. This overlay technique is intended for use in large-scaled investigations and the compilation of these different aspects forms the supporting documents for the planning process. It is appropriate to make use of this method if the soundscape is to be considered in the planning stages. An attempt is presented later in this thesis. McHarg's method can be easily adapted to computer techniques, as well as digital inventories and analyses of recent times. Furthermore, the advent of the Internet implies that more aspects of the process can easily be allotted more space in addition to being made available to the public. Each interest group can thus publish its own suggestions on urban planning, focusing on its own special interests (Turner, 1996: 62-63). For example, ornithologists, just as the joggers or *critical listeners* can express their views on the town.

The landscape architect executes various assignments at the request of politicians or businessmen in the capacity of public planner. Large-scale functional studies and legal development planning at the local government level are normal. The planner participates in defining the conditions and restrictions by which the project workers will abide in the design stage. The planning process is thus a critical stage with regards to the quality of the acoustic environment, since the development planning is not concerned with acoustic sources outside the indicated territory. The planning process' large-scale design of settlements creates fixed structures which have some significance for future acoustic experiences.

Landscape architecture in the form of knowledge and skills

Landscape planning as phenomenon is expressed in investigations and proposals on the spatial utilisation of the landscape's assets. *Landscape architecture* focuses on design and comprises the combined knowledge and skills which are necessary for the creation or management of a garden or landscape, *i.e.*, people's normal everyday environment, which also includes acoustic environments. It has a much higher level of detail and greater precision than landscape planning. The systematic operating mode of the controlled planning allows important knowledge and skills, just as other more liberal, heuristic modes of operation, with a higher degree of individual creativity. A development procedure with respect to sound therefore needs to be applied to both systematic and search procedures.

Practitioners in both the project worker and planner roles have to deal with complex, incompletely formulated problems in projects which are constrained by time, space and finances. Practitioners are expected to both evaluate the available information and determine whether the acquired skills are adequate under these conditions. New aspects which arise in the profession demand additional involvement on the part of the practitioners; the auditory aspects can be seen as extravagant, since they had not previously been the norm. It is therefore vital that practitioners have access to tools to assist them in ascertaining the relevant aspects of each individual case as early as possible in the project.

The profession creates a discipline

The profession of landscape architecture and planning create the need for a discipline which attends to the development of relevant factual knowledge and comprehension skills. The measurements of the width of the pathways in a park, plant depths and tree heights can serve as examples of fact, while the purpose behind the layout of the park demands an understanding of the requirements and abilities of the location. The profession has not developed any corresponding combined or established 'knowledge' about sound as a resource or element of design. Its skills requirement constituted the foundation for a research project such as this one. In the first place the problem was highlighted and methods formulated to allow practitioners to proceed unsupervised. The field of landscape architecture is profession-driven; the *landscape architectural theory of town planning* is one example of an expression for concise theorising within the discipline, where specific questions on urban planning are formulated (Wallin, 2002). The present research on sound contributes to this theory.

Long-term planning as a foundation

The view of time and long-term planning differs between landscape architecture and professions which traditionally work with sound, such as musicians or architectural acousticians. The sounds are experienced as transient, in comparison to built-up environments which give fixed

frameworks for a long time. The planning process focuses on the future, by definition, while settlements and landscapes are designed to last. Landscape architecture involves planning, design and cultivation of vegetation, for example (*i.a.* Florgård, 1981; Gustavsson, 1986). Most mature after one generation, while many species and biotopes live for several hundred years.

The Swedish Environment Protection Agency defined a number of long-term environmental goals, one of which was designated a *"good built environment"* (SEPA, 2003). The term 'built-up environment' as used in this research included both urban and rural settlements. The general aim of obtaining a good environment for sustainable development corresponds with one of the cornerstones of landscape architecture (McHarg, 1969). A 'landscape architectural theory of town planning' is here proposed to be based on the layout of the town and its functions as ingredients in the landscape where for instance landscape ecology and recreation are emphasised as knowledge bases and starting points in the long-term planning of urban structures. Landscape architecture includes more than the built-up environment. Long-term access to recreational areas, for example, is a commodity which is in demand both inside and outside of built-up areas. A long-term strategy was, correspondingly, one condition which was specified during the formulation of planning methods for managing sound.

Design and planning with emphasis on experiences

The experience factor and a host of other issues are affected by the planning and design processes in several phases. The writing of programmes, sketching, consultations and negotiations are examples of phases which are difficult to oversee as well as manage. The processes provide a structure for the physical environment in which human activities take place and aesthetic experiences occur. Aesthetic experience refers to that which affects the senses, *i.e.*, the impressions which are generated by the senses and interpreted by the individual. The presented design proposals are increasingly tested and gradually rejected in the sketching phase. Experience factors are connected to the purpose of the functional areas as well as the sizes and dimensions of the spaces. The conditions for including acoustic experiences therefore take shape gradually.

The aim of the consultations in the design and planning processes should be to ascertain the ability of the concerned individuals to be comfortable in the proposed environment. The sketching phase is often passed during the consultations. For this to happen then sufficient information in the form of well-formulated supporting documents must be made available so that all concerned might understand the thought process. In practice, only serious faults are attended to after the consultations.

Experiences are seldom a point of discussion during the negotiations. These are more likely to concern property claims and accessibility to physical establishments with various social functions. These negotiations often occur between local government representatives and a developer. The planning monopoly held by the Swedish local government imposes certain conditions upon the negotiations. Experience factors can be considered as compensation for beautification purposes. The sketching and design phases of the work begin only after negotiations have been completed. The sketches are then preparatory for the formulation of legal building documents.

To establish a relevant development procedure in this research on sound it was necessary to proceed from the point of view of the businessmen or the project workers during these stages. Interviews with practitioners and personal practical experience were used as a basis for the development procedure. The sketches and plans which are formulated during the phases appeal to visual experiences since they can be presented on paper or on a computer screen, with few exceptions. Physical models can be used in larger projects; even these contribute to the visual experience. The concerned individuals are rarely allowed to change the physical models, but an active influence could result in haptic and tactile experiences, *i.e.*, an additional form of comfort. The gravitation towards the visual stimulates thoughts about the limitations of one culture and a mindset which is visually dominated (Ong, 1982; Levin, 1993; Pallasmaa, 1996). A reasonable assumption is that a visual mindset is hardly capable of forcing the 'visible' away; design suggestions are thus limited to what the visual sense is able to transmit. There is a risk that the proposals do not consider the multi-dimensional reality which is absorbed and created by merging all the senses. How else could an idea based on the impressions of one of the senses – sight – be used to formulate an idea based on the impressions from another sense, or even complex impressions, *i.e.*, a combination of senses?

A visual profession

The methods which are traditionally used in the architectural professions, concentrate on visual aspects of the society. The related subjects are dominated by visual images and therefore prioritise one sense above the others. Gordon Cullen's *Townscape*, a recognised reference within the field of urban planning, can be used as an example of this visual viewpoint. Cullen (1971: 8) writes

> "We turn to the faculty of sight, for it is almost entirely through vision that the environment is apprehended. If someone knocks at your door and you open it to let him in, it sometimes happens that a gust of wind comes too, sweeping round the room, blowing the curtains and making a great fuss. Vision is somewhat the same; we often get more than we bargained for."

Why not use Cullen's metaphor to show that if the environment is almost entirely apprehended through vision then the person knocking at the door

would remain standing in the gust – the knocking in the door would not be realised since it is not seen – neither would the wind be felt. Important information on the environment is thus gathered in more ways than Cullen claims.

The methods within landscape architecture and planning appeal to the visual senses out of necessity. Conversations about changes and preservation for the future can be held by creating visual representations such as those illustrated by Repton (1982 [1816]) and McHarg (1969). Wikforss (1977) investigates the pedagogy involved in the use of such visual media in architecture in general. Eckerberg (1999) illustrates the visual use of pictures within landscape architecture from a historical perspective.

The visual reproduction according to Repton's (1982) 'before and after' technique are naturally supplemented by descriptive text, but even the letters against a background appeal only sight. A broader repertoire of projection techniques can offer reproductions beyond the framework of the visual senses. The target should be to present and discuss the current situation, changes and maintenance, starting with the combined experience of a physical environment as encountered by all available senses (*i.a.* Thiel, 1996). Böhme (2000: 16) writes

> "… a city's or a countryside's atmosphere, is fundamentally determined in each instance by the acoustic space. This means that one's conception of what a landscape is can today no longer be restricted to what one sees and that city planning can no longer be content with noise control and abatement, but must pay attention to the character of the acoustic atmospheres of squares, pedestrian zones, of whole cities."

The fact that a range of senses is crucial for the complete appreciation of the outdoor environment can be illustrated in a more correct and credible light if the presented proposals are not necessarily reduced to a visually accessible form. This research tests both the auditory and visual representation with the aid of computer technology (Appendix v), but the focus is exclusively on the auditory case.

Visual sketches as the only method of representing an outdoor environment can be likened to a musical score to a certain extent. An individual with little knowledge of the musical equipment will hardly hear the music by looking at the sheet. The visual sketch poses a greater challenge to the reader than a score. The reader is expected to visualise *one* of the other senses through the score – the auditory sense – while the drawing of an outdoor environment affects *all* senses. The perspective sketch is nothing more than a visual representation of visual qualities of an environment. The score is thus a visual representation of the auditory qualities. It is also possible to conceive of the opposite: auditory representations of the visible. The conclusion ought to be that the visual representation of visual qualities is closer to each person's (visible) reality; their interpretation is therefore not considered to be demanding.

The visual information about the visual qualities already poses problems for many individuals with respect to the interpretation of mental visual

representations (Wikforss, 1977). Other mental experiences which result from a proposal require more advanced interpretation, since visual information must be seen as representations of other essential dimensions such as sound, smell and movement, among others. The merging of the concepts of complete experiences, *i.e.*, ideas on the interaction of the impressions over time and space, implies additional degrees of complexity.

Acoustic images in landscape architecture

The description above of landscape architecture and planning according to this research project led to an investigation of the methods by which sound can practically be used in the field. The purpose of the description was first to take a position in relation to other research on sound; the second reason was to provide sufficient background to the introduction of questions on sound. The research problems, the expected result of the research, the choice of research procedures and the relations which were treated in the conclusions should first be viewed against this background.

One motive for this research was the acceptance of sounds as being important for the experiences in the outdoor environment. Knowledge of visual experiences could be supplemented and a foundation laid for a relevant understanding of the consideration of multiple senses in the design process. The focus on a co-ordinated sense, traditionally speaking, with regards to landscape architecture, steered the profession into new avenues. Comprehension of the creative process for both visual and multi-sensual experiences was clarified by the study of sounds. Questions were raised about the consequences of the planning process on the continuous interaction between the sensory experiences which arise when an individual encounters the landscape.

Another reason for this research was the fact that sounds are treated from technical viewpoints in the physical planning process, rather than the aesthetic. One example is the *Time-Saver Standards for Landscape Architecture* where sounds are the only sensory domain in addition to the visual sense which is being treated (Harris & Dines, 1998). The sounds are treated according to the traditional technical method and thus the section on sound is entitled *sound control*. The most common point between landscape architecture and acoustics is that sound is treated as disturbance; visual qualities are in this case considered with respect to the design of noise limitation measures such as sound barriers (*e.g.* Mulligan *et al.*, 1987; Kotzen & English, 1999).

An idea of a more active management of sounds in the outdoor environment was conceived at the start of this project; it was imagined that even the *advantages* of sounds would be considered – an *acoustic design*. The main question was the manner in which the sounds could be introduced. The Swedish report *Auditory City Space – sounds and acoustic design in the cityscape* (Hedfors, 1993) gives examples of active management. It highlights the cities' sounds as a continuous musical performance which

can be consciously managed within the areas of both planning and design. The planning perspective is based on the acoustic identity of the cities and districts, while the design perspective is based on the spatiality and sound quality of the sound-generating object.

Exploratory interviews were conducted with professionals from the relevant fields at the start of the research. One question concerned the relevance of discussing the introduction of sounds in landscape architecture under the prevailing situation. All interviewees had some form of experience related to executed projects. However, the experience-based skills did not appear to be easily accessible to other practitioners, due to the strong ties of these experiences to specific projects. One of the interviewees had experiences of rustling leaves from designed vegetation at rest-stops along motorways, for example, while another described the layout of wilderness trails along streams with attention-grabbing babbles. The project-based experiences did not allude to any existing theory or systematic knowledge on the management of sounds in the landscape. The exploratory interviews demonstrated the need to compile the project-related skills in the form of project descriptions. This was partially conducted by Hedfors in 1993.

Biogeographic keynotes in the landscape

Kerry J. Dawson (1988) attempts to view landscape architecture from the sound of the surroundings. He highlights the garden and what he describes as "natural" sounds. These are primarily sounds from birds, insects, the wind and water. The sounds they create are contained in a few branch-dependent guidelines on water systems and plant material, among others (Booth, 1983: 260; Melby, 1989; Brigham, 2000; Hedfors, 2002). One of Dawson's points concerns that habitats can be created for sound-making fauna in the practical landscape architecture. "Each biogeographic area has its own vernacular keynote," he writes (1988: 171). This statement constitutes a basis for the acoustic development of landscape architecture. He considers his acoustic perspective to be a commentary on traditional landscape architecture with its visual focus and wishes instead to display the multi-sensual characteristics.

Anne Whiston Spirn (1998) also touches on sound and landscapes within landscape architecture. She passed an acoustic installation during a visit to Parc de La Villette in Paris and describes the experience thus:

> "I continued to hear the music or just perceiving ambient sounds in a new way. I was tuned into the sounds of the city and heard an order… Since that day, I am more aware how sound shapes context, and sounds became less ephemeral, more easily recalled" (Spirn, 1998: 221).

Dawson and Spirn are two landscape architects who write about sound. Others (Brown, 2003) recently suggested a similar approach to fitting acoustic design into urban and landscape planning and design. He referred to the statements on "Sonic Urban and Landscape Architecture" by the World Forum for Acoustic Ecology (WFAE, 1998). Sowa (1999)

carried out related descriptive studies of garden sounds. Three undergraduate theses in Sweden dealt with auditory characteristics as assets to the landscape planning process. Karlsson (1991) gives examples of authors, composers and others who are inspired by sound in the landscape, while Hedfors (1993) presents examples of installations and practical solutions in which sounds play a vital role. The acoustic environments in housing areas are investigated in the third study (Larsson, 2003). An undergraduate project was conducted in Canada, where the expression "Acoustic Landscape Ecology" was coined (Somers, 2002).

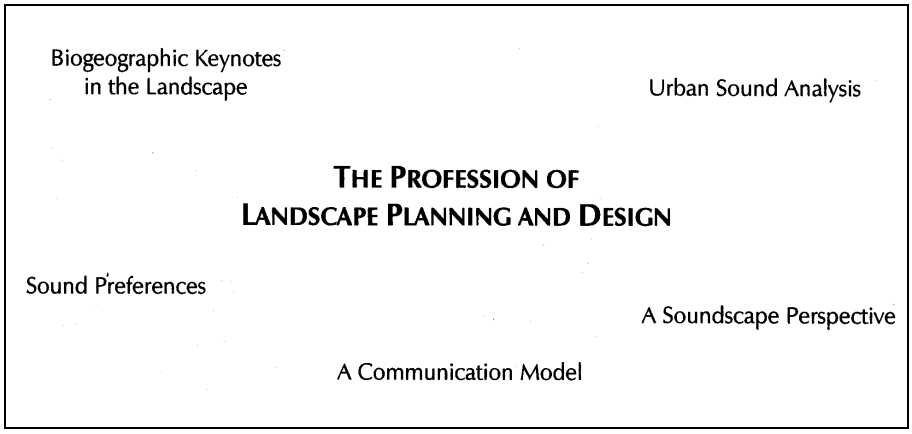

Fig. 2. Theoretical framework – The basic theoretical prerequisites of the profession are supported by five components.

A soundscape standpoint

Dawson (1988) introduces Schafer's (1977) musical perspective into landscape architecture and Schafer's *soundscape*; a collective designation for the auditory experience of acoustic environments. Augoyard, Karlsson & Winkler (1999: 131) write that

> "Soundscape shall be defined tentatively as the totality of sound phenomena that lead to a perceptual, esthetic and representational comprehension of the sonic world."

The concept is widely applied today in the fields of radio, music, film and acoustics, to name a few (*i.a.* Schafer & Järviluoma, 1998; Kihlman *et al.*, 2001). Schafer (1977) presents the first historiography on acoustic environments, going even so far as to describe acoustic design, where he prescribes a method of listening. Because of his background as a composer, he relies more on the ear's abilities, rather than on measuring instruments.

Long before Schafer's pronouncements, Granö (1997 [1929]) studies landscapes, focusing on various sensory experiences. Granö considers that acoustic experiences constitute an important component and chooses to analyse landscape experiences with respect to the *distance* from that which is experienced. He further describes situations in which different senses

either contribute to or dominate the landscape experiences. Granös investigations are descriptive and are conducted in rural landscapes. He does not focus on developing concepts useful in the planning or design processes.

This presentation has been entitled *Site Soundscapes* in order to focus on the connection between sounds and specific outdoor environments. The *design* of outdoor environments are only occasionally mentioned in Schafer's monographs (1977; 1993) and other soundscape research. Schafer does not consider the practitioners' position as described above. The task of the landscape architect should be to determine whether special consideration should be given to acoustic characteristics in the early stages of projects; the project group should then take steps to manage the acoustic environment if they are considered to be adequately qualified for such an undertaking. If the level of competence is insufficient then additional competent staff should be recruited to the project. Schafer never goes practical problems such as those concerning the composition of the project group. However, the Royal Swedish Academy of Music covers this in *Manifesto* (1996: 9):

> "Appropriate governmental agencies and business enterprises ought to be urged to recruit regularly personnel with competence in acoustic ecology in all areas of urban and landscape planning."

Urban sound analysis

Amphoux (1991, 1993) developed a method of describing the characteristic sounds and acoustic environments of cities. The method is intended to be used in urban analyses and thus in the preparation of supporting documents for the planning process. Unfortunately the document is written only in French and is therefore inaccessible to those who do not speak French. It is thus difficult to judge the extent to which the document is effective as a tool in planning and design. Anyone who uses the method faces three new concepts at each stage of decision. Such a structure suggests that the method was developed with strong pedagogical characteristics; consequently, it is not based entirely on empirical results. Amphoux's method coincides with this research to the extent of the descriptions and analyses of acoustic environments. Abdulkarim and Abu-Obied (2001) tested it in Amman, Jordan and the essential sections are translated to English by Hellström (2002).

Torigoe (2002) presents a method for the acoustic analysis of cities, with respect to the citizens. Amphoux's and Torigoe's methods reveal limitations under analysis. The investigation in question aimed to both develop analytical methods – from which the supporting documents are formulated – and most of all to develop methods which support a creative design and planning process. Amphoux limits his work to urban environments; this project did not follow that trend, since landscape architecture affects outdoor environments in general.

Amphoux's method was developed in connection with a comprehensive conceptual application for acoustic aspects of planning and architecture

(Augoyard & Torgue, 1995). This conceptual application is unfortunately also only available in French, but Hellström (2003) plans to have it translated. Over eighty concepts are defined to describe acoustic phenomena in urban environments. It is difficult to understand why these two French treatises are only intended for urban situations. A third document which outlines an acoustic perspective for urban planning is written in Catalan (Daumal i Domènech, 1998b).

A few timeless urban planning solutions for acoustic environments such as *Quiet backs, Garden wall* and *Garden seat* are presented in *Pattern Language* (Alexander *et al.*, 1977). Alexander *et al.* go on the premise that an individual at work should be able to "pause and refresh himself with quiet in a more natural situation" (p. 302). They give the following advice (Quiet backs)

> "If the back is to be quiet, a place where you can hear only natural sounds – winds, birds, water – it is critical that it be protected. At the same time, it must be some way from the buildings which it serves. This suggests a walk, some distances behind the buildings, perhaps separated from them by their private small gardens, completely protected by substantial walls and dense planting along its length (p. 302)."

Alexander *et al.* further write

> "Since the sound of water plays such a powerful role in establishing the kind of quiet that is required, these paths should always connect up with the local pools and streams,"

…another of their more than 200 patterns of design. Finally, they present a plan of action (p. 303)

> "If possible, place the backs where there is water… and where there are still great trees unharmed by traffic… connect them to accessible greens… and protect them from noise with walls or buildings…"

Alexander *et al.* stress the need for *enclosure* to protect the interior of a quiet garden (Garden wall). The smaller the garden, the more important this is, they state. This advice should be further developed, since activities in larger parks are disturbed and the background sounds are often the same in the entire park. The discussion which takes place further on in this document considers *walls and buildings* as opposed to *respectful distances*. Walls and buildings are viewed as hard sound barriers which produce effects such as echoes and long reverberation time, while respectful distances are viewed as soft acoustic transitions between different forms of urban activities.

One of the garden's most important components is, according to Alexander *et al.* "…a quiet garden seat, in which a person – or two people – can reach into themselves and be in touch with nothing else but nature (p. 816)." Their directions are: "…Pick the place for the seat carefully; pick the place that will give you the most intense kind of solitude (p. 817)."

Alexander *et al.* focus on a type of acoustic environment which offers calm; this is one type which may prove difficult to maintain in the context

of urban planning. Consequently, Alexander *et al.*, as opposed to Amphoux (1993), do not develop a general method of analysis for urban sounds. Their patterns can instead be considered as measures for the prevention or reduction of noise, but which are elevated to the status of urban planning concerns.

A communication model

One of the bases of this research is most easily described with the aid of Truax's communication model (1984, 1998). Truax presents an ecological perspective of sound by viewing them as part of a complex system. There is a continuous exchange of sound between listener and surroundings. Truax's perspective can be found in the traditional ecology, where the term ecology defines a concentration on the *pattern of relations* within an environment (Odum, 1983).

Three components are isolated in the traditional acoustics model for the study of sound: source, transmitter and receiver. This model is considered to be linear and unidirectional from sender to receiver. Instead, Truax (1984) presents a network of interactions which comprise an acoustic environment, including several senders and receivers which can change roles and have both functions at the same time. This research followed Truax's model as a guidance to an *acoustic ecology*. The landscape becomes that which is designated by transmitters in the acoustics branch, *i.e.*, the space (or matter) in which the sounds are transferred (Morfey, 2001) and generates questions on the landscape's acoustic characteristics in connection with its *shape, space, material* and *furnishing*. Moreover, the landscape contains both senders and listeners; the landscape's function as an outlet for these, results partly in classical planning problems on land use and conflicts of interest and partly in classical design problems on future requirements and aesthetic experiences.

Sound preferences

The project was first intended to be a development procedure which was free from restrictions, but it included instructions on its use. Practical landscape architecture takes care of recurring problems which are related to people's preferences. One of the uses of the method is therefore illustrated through the following investigations. The results that show that "natural sound" is desirable.

Anderson *et al.* (1983) demonstrate that "natural sources" such as insects and birds are rated positively, mechanical and engine sounds are rated negatively and human and domestic animal sounds are considered neutral or intermediate to others in a range of investigations of different outdoor environments. Sounds which might be regarded as enhancing improve wooded, natural and heavily vegetated urban settings, but not downtown or other mostly built-up sites.

Anderson *et al.* (1983) further demonstrate that the interaction between sound and setting is of the greatest interest, as it concern the aesthetic impacts of the sounds as a function of the site in which they are heard. The interaction of sound and site is best described as the increased sensitivity of a wooded site to acoustic stimuli. Desirable sounds strongly enhance the setting, while undesirable sounds greatly detract from it. A botanical garden site and a memorial garden site are almost as sensitive to most sounds. An urban hard-surface site is relatively insensitive to the sounds, being neither greatly enhanced nor greatly marred by them. The sensitivity to sounds of the human-influenced but heavily vegetated areas in the Anderson *et al.* study indicate that the public standards for certain outdoor sounds are just as stringent for residential settings and urban parks as they are for natural areas; the exception is that children and pets seem to be better tolerated in residential and urban park settings.

The most enhancing sound in an urban setting is traffic (Anderson *et al.*, 1983). Southworth (1969) makes the same observation, where some traffic sounds are appreciated in an urban environment. Andersson *et al.* find this result interesting because traffic noise is one of the common targets of noise pollution regulations. One explanation could be that noise control efforts are directed at disturbances which are experienced in the indoor environment, while the investigations of Southworth and Anderson *et al.* are based on the outdoor environment.

Anderson *et al.* (1983) conclude that a setting may induce expectations about the sound to be heard in it. These expectations may affect the tolerance of noise and appreciation of sounds, but particular qualities of the sound – whether expected or not – will also influence the overall evaluations of a setting: "Sounds would have a constant effect, regardless of the site ('singing birds will enhance any location where they are heard')" (Anderson *et al.*, 1983: 560).

Kariel (1980) investigates sound preferences in recreational areas. Although mountaineers consider nature-related sounds more pleasant and both man- and technology-related sounds more annoying compared to other visitors, the rankings according to the degree of pleasure or annoyance are extremely close. Nature-related sounds are those of running water or waves on the shore, wind, birds, insects, and native animals. Person-related sounds are those of ordinary daily human activities such as persons talking or chopping wood and sounds made by pets. Technology-related sounds are those made by machines and equipment, such as radios, stereos, or television sets, motorboats, cars, motor or trail bikes, snowmobiles or chain saws. Kariel concludes that those sounds which enhance the visitors' activity are considered to be pleasant. Kariel formulates implications for policy decisions in the management of natural areas: planners should design campgrounds to be as quiet as possible and certain areas should be retained as "super quiet", so that those persons who wish to escape as much as possible from the technology-related noise of their everyday urban environment will have a place to do so. Kariel

(1980: 166) emphasises that "the fault often lies not with the actual sound level – say of a jet overflight – but rather with its intrusiveness into and incompatibility with the natural environment."

Kageyama (1993) conducted an opinion poll with nearly 1000 Japanese university students. Kageyama concludes that natural sounds and music are appreciated the most, while sound from building sites and industries are most disliked. Natural sounds are appreciated by students from urban environments, while sounds from loudspeakers and motor vehicles are valued by students from rural areas. Kageyama interprets this to mean that sounds which are not familiar in the home environment are considered to be interesting.

Conclusions of the preference studies

The results of the outlined investigations of general preferences show that some acoustic characteristics are highly valued. Such qualities are desirable and should be made accessible close to people through the processes of planning and design. The method formulation in this research should therefore be viewed against the backdrop of such basic preferences.

Dawson (1988, 1998) raises the possibility of creating space for natural sound through landscape architecture; he consequently agrees with the preference studies' unequivocal results. These correspond Schafer's (1977) perspective as well. In a main article where a number of modern theories on architecture are related to soundscape research, Dyrssen (1998: 20) writes: "Hopefully, we can let go of picturesque attitudes that have relished only the so called natural sounds, hating the manmade ones". The above-described preference studies illustrate what groups of people appreciate. Making it possible for people to experience natural sound should instead be seen as the planning process' answer to their basic needs and clearly expressed desires.

Other planning and design perspectives are also important; however, solutions in urban environments could very well arise from other avenues (*e.g.* Dyrssen, 1998; Hellström, 2001, 2003) and therefore be exciting, interesting, mystifying, peaceful or edifying to those who stay there. One perspective concerns the protection and development of different acoustic identities between districts (Truax, 1984). Another concerns the acoustic refining of junctions in cities so that information appears instead of tiring or irrelevant sounds (*i.a.* Dandrel, 1993: 2; Remy, 2001). This is particularly important for people with a diminished capacity to see and hear, but even for others in general (Stokols, 1978).

Problem and research approach

The formulation of practical planning and design techniques was one point of focus for this research. The aim was to supply the profession with methods and techniques with respect to its specific challenges. Other professions contribute substantially to these methods which highlight new phenomena and particularly convert sounds to a manageable quality. The methods therefore offer practitioners new ways by which to train their skills.

Introducing auditory aspects

The purpose of the physical planning and design is to create improved structure in the physical environment. This research identified the auditory sense as a contributor to the comprehension of the intersensory experiences in the physical environment. The investigation concentrated on the theory that landscape architecture and planning could be developed and give way to conscious acoustic design and active sound management in order to produce the "right sound at the right place". It was further intended to stimulate questions concerning the *quality* of the acoustic environment; this is a matter which has not previously held a prominent position. The case studies were used to lay the groundwork for the practitioners to obtain a personal acoustic reference bank. It was envisaged that such an acquisition could serve to stimulate their aural awareness during the planning process, *e.g.* , site visits. The investigation aimed to illustrate the inventory, analysis, design and representation of the auditory aspects of landscape architecture and planning. The inventories and analyses should be adapted to project-based situations if they are to constitute a sufficient basis for the further stages of the planning and design processes. The adaptation of the formulated method is intended to provide a basis for a discussion of such auditory aspects as the *degree of information* contained in the sounds, *expectations* of acoustic environments, *desirable* and *surprising* sounds, *location-based* sounds, activities and acoustic sources, as well as proposals for the *modification* of acoustic effects.

Introducing practical methods

The methods comprise mental tools in the form of concepts, models and reference objects which support the professionals in specifying the site properties and aid them in the design and planning processes. The formulation of the design technique required the systematic choice of useful concepts which could support landscape architects and planners with respect to the management of sound. Concepts, models and reference objects also stimulate the practitioner to search for a deeper understanding of the acoustic aspects of landscape architecture.

The methods were defined through the development of tools whose efficiency should be increased with regards to time, economy and quality. As

the tools are used a new model world is introduced within which professionals could operate and thus further develop on their own. The decisions which they make and the experiments which they conduct will increase their experience and refine their ability to *hear* and *listen*. Hearing implies a passive reception of the surrounding sounds, while listening reflects an active search for the sound. This ability is based on the *observation* of an actual problem *as* inherent in other known problems, one example being the reference objects upon which this method of approach was based. Such problems are unique in many ways. However, practitioners are able to compare related problems which have similar patterns and detect similarities and differences between them with the aid of related tools (Alexander *et al.*, 1977; Schön, 1983).

Highlighting a new professional area

The project's overall aim was to investigate sounds as a resource in the design and planning of outdoor environments. Several relevant perspectives of sound were formulated for the purpose of conducting a practical investigation into the processes of landscape architecture and planning. The questions on the methods by which practitioners could acquaint themselves with concerns related to sound were uniquely suited to the profession. The task was to relate these concerns in a manageable format as well as to focus on those matters which were considered useful.

An investigative method was subsequently formulated by way of an exploratory approach. There was no tangible alternative to such a plan, since scarcely any of the work within the field of landscape architecture had been based on sound. Landscape architect Dawson (1998: 43) states

> "…that acoustic analysis in the garden is in an infant stage. As opposed to visual analysis sophisticated techniques have yet to be developed for systematically inventorying environmental sounds."

In addition to methods for inventory, it was also necessary to formulate methods of planning and design in order to incorporate sounds into ordinary projects. There are no methods to represent acoustic landscapes in such a manner as to enable individuals to experience the effects that physical measures and modified land use can have on the resulting environment.

The problems resulted in a search for relevant concepts related to acoustic problems in the areas of planning and design. Questions on investigative methods for the expression of these concepts were subsequently raised. It was thought that such expressions could take the form of mental tools for the practitioners. The concepts were partly represented by single words and partly by entire frameworks which were embedded in reference objects as physical examples. The use of such reference objects as the basis of knowledge generation has been well tested within the architectural disciplines (*i.a.* Steenbergen & Reh, 1996: 11; Birksted, 1999: 229ff).

The overall problem could also be expressed as the formulation of a technique for the design of outdoor environments, taking sounds into consideration. The basis in this case was the users' *hearing* as the focal point; this was thus satisfied and used in a practical manner. Sounds can aid users to regain their bearings, identify activities and experience various atmospheres in parks and gardens. Investigations of this problem could make a significant impression on landscape architecture in addition to contributing to existing theories on urban development and other matters of importance in the field of landscape architecture.

Proposing a new practical approach

The application of a new and partially unknown problem in the field of landscape architecture required the implementation of certain measures to increase the awareness of the central issues. The significance of the problem with respect to the discipline was highlighted through the use of case studies and project descriptions. It follows that the practitioners in their on-going projects are responsible for determining the urgency and usefulness of the problem. In this way they would be better able to evaluate the extent of the acoustic problems and thus decide which action should be taken, if any.

It was assumed that the practitioners needed some indication of *how* to attack the problem – not because practitioners lack ideas – but rather in order to provide them with a path to follow, thus increasing the efficiency of their work. Several general approaches which could be adapted to various situations were then required. A similar technique to that selected by Alexander *et al.* (1977) was used in the development of the general method of approach.

It was proposed that certain *concepts* be outlined. These were intended to constitute a basis for the field, provided that the practitioners were familiar with them. Several *approaches* was further proposed to demonstrate the use of the concepts. The practitioners were then expected to evaluate the relevance of these concepts and its usefulness in the profession.

The research assignment was summarised as the formulation of a design method for application in the field using specific tools; the aim was thus that the problem be introduced and treated as a case for further development. The problem was presented in a manner which raise the awareness of practitioners and enable them to determine when the method can best be applied. The problem which was the focus of this research was divided into three steps:

1. It has implications for the process of physical planning and was therefore presented in a manner designed to enable landscape planners to view sounds as a *planning resource*.

2. It is of significance to the layout of outdoor environments and was therefore presented in a manner designed to enable landscape architects to view sounds as a *design component*.
3. It was presented together with *practical methods of approach*; these are flexible in order to enable practitioners to more efficiently transform them for each unique situation. Sounds are therefore managed in the processes which affect either the creation of the physical environment or the changes therein.

Problem presentation

Several specific concerns with respect to this project were identified on the basis of the problems described above. Should landscape architecture be expanded to permanently include the consideration of auditory aspects? What do the practitioners need to know in addition to the knowledge that they already possess?

The problem was such that its effect was visible right throughout the society. An extraordinary effort was therefore required to introduce the problem. It was not enough to raise the question in a manner which would result in attracting only a few curious practitioners. The concern was thus to discover something which could persuade practitioners to spend time and energy on their own for the purpose of stimulating knowledge. What sort of *argument* do they need in order to determine whether special measures should be implemented to take auditory aspects into consideration? What do they need to make an inventory of, when they formulate arguments for a preliminary evaluation? The next step was to investigate the methods by which *alternative* proposals for modification of the soundscape could be designed and communicated (cf. the steps in Fig. 1.).

This project was concerned with the introduction of the problem and the possible encouragement of practitioners to actively participate in the generation of knowledge. The research problems were based on the qualities displayed by the reference objects and a few recurring areas of concern to the profession. This indicated a programme based on introduction of tools, the formulation of conceptual models and the practitioners' own generation of knowledge.

Discussion of the results

The introductory sections outlining the theoretical foundations and the existing conditions of the profession led to the general problem definitions and the specific formulation of this research project. The results of the research are presented in Appendices I-V and are briefly mentioned when needed. The discussion aims to the future and presents a tentative treatment of the problem based on the results of this work and those of others. This reasoning is then applied in the section entitled *Discussion of methods*, which discusses the manner in which the problems were investigated.

The Model of Prominence

One important result of the interviews (Paper III) was the description of acoustic images on the basis of the expression *figure-background* (Table 1). The sounds which the listener distinguished from a background of sounds were described in the interviews. The prominent sounds were identified as specific auditory objects which told something about the location. The objects which were not immediately recognisable resulted in a search for supplementary or confirming sensory impressions. The sense of hearing was useful in detecting many activities and operators in the landscape; these craved a subsequent confirmation by sight.

The term *figure-background* is applied to soundscape studies by Schafer (1977: 151ff) and Truax (1978: 68), who use the expressions *signal-keynote sound*. Winkler (1993) describes keynote as a *reference tone*. The model comes from the visual Gestalt psychology (*e.g.* Arnheim, 1974 [1954]), but it is difficult to make comparisons between a visual and an auditory model since the sensory impressions are based on different phenomena (light photons *vs.* sound waves). The interviews showed that the expression was effective in preliminary discussions on acoustic experiences in outdoor environments: this formed a framework through which the interviewees developed their understanding.

A more complex conceptual model was formulated from this line of reasoning, illustrated in the *Model of Prominence* (Fig. 3). This should be tested for all sensory impressions in future research projects. The model was generally designed to illustrate the ability of living creatures to distinguish between significant and insignificant matters simply from sensory impressions. The expression *figure-background* was combined with two other dimensions in the model. These were denoted by the expressions *experienced intensity* and *experienced clarity* respectively. Several of these expressions are used in the field of acoustics (*i.a.* Morfey, 2001) and soundscape studies (*e.g.* Truax, 1978); the difference is that they were combined in a transparent model in this case, so that each one explained the other. If prominent sounds were strongly experienced against a weak background then the soundscape can be said to be *clear*. The opposite relationship is

known as a *crowded* soundscape. If both prominent and background sounds are strongly experienced then the soundscape is said to be *powerful*. The opposite relation would then denote a *mild* soundscape.

One characteristic of the prominent sounds was that they occurred rarely (Table 1). In contrast, the background sounds occurred in very long sequences. These were experienced as an unbroken presence during short visits to a location (long duration), while prominent sounds were transient. The range between *never* and *always* being present was therefore explained by the relationship *figure-background*. According to Schaeffer (1966), prominent sounds have a progression consisting of a preliminary *attack*, a *body* of sound and a region of *decay* (Fig. 4). The background sounds do not possess a corresponding progression since they are experienced as continuous and lack both attack and decay segments.

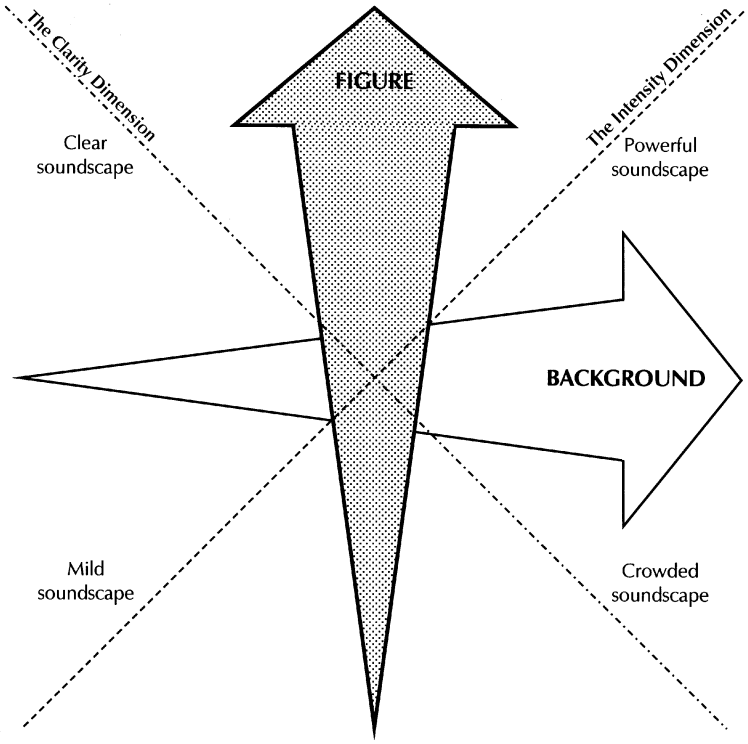

Fig. 3. *The Model of Prominence* shows different proportions between prominent sounds and background sounds. The expression *clarity* was defined as something which is essentially different from intensity. Four distinct characteristics of soundscapes were defined: mild/powerful, clear/crowded.

Table 1. *Characteristics of auditory figure and background according to the expressions which were used in the interviews (Paper* III*)*

Figure	Background
Short	Long
Transient	Continuous
Many	One or occasional
Intentional signals	Contributes to the atmosphere
Events	Steady state
Progression	Constance
Attracts attention	Does not demand attention
Necessary for consciousness	Secondary to consciousness
Individual	Complex
Limited	Limitless

The characteristic *clear* soundscape implies that a substantial portion of the prominent sounds' progression possessed attack and decay segments which could easily be identified. In a *crowded* soundscape the sounds are mixed and drown each other out. The background sounds hid the attack and decay segments of the prominent sounds. The individual prominent sounds therefore become less susceptible to identification. The characteristics *mild* and *powerful* followed each other in much the same way as the two extremes of a sound volume regulator. The proportions between the outgoing sounds is maintained regardless of the setting of the regulator. The situation is the opposite in the case of the expression *clarity*.

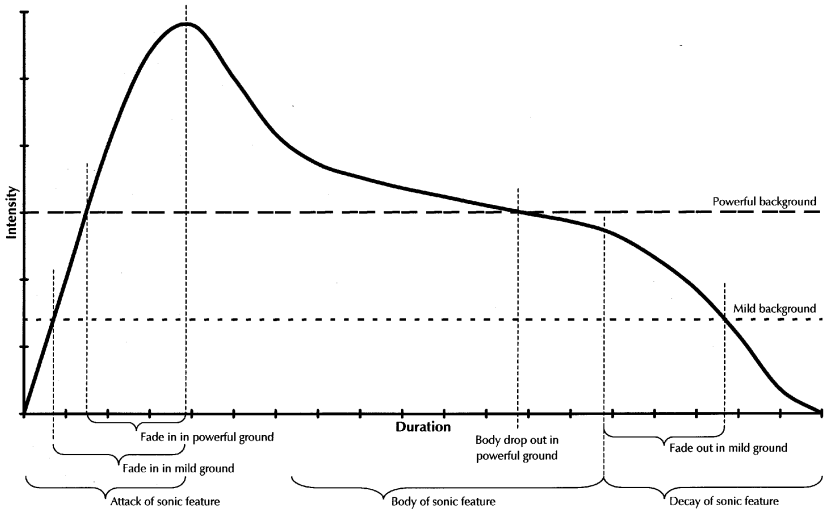

Fig. 4. A prominent sound is thought to have a beginning (attack) and an end (decay) with a background (keynote) which lacks both beginning and end. Prominent sounds are at times drowned out to various degrees, depending on such keynote qualities as the degree of strength. This defines the depth of the acoustic image. (cf. Schafer, 1977: 129)

Table 2. *Properties that exemplify the character of prominent sounds which influence an individual's awareness – dimensions taken from Dvoretsky (1982)*

Intensity	Experienced strength in sounds
Size	The acoustic space which is perceived to be occupied by an individual sound
Movement	Transference of sounds in the auditory space
Conversion	Experienced progression in sounds
Deviation	Differences between characteristics of individual sounds, as well as that between an individual sound and a complete auditory space
Repetition	Individual sounds in sequence which are perceived to form a rhythm

Pratt, Henson & Cargill (1998: 31-32) use the expression *articulation* within the field of music. This can be described as the clarity with which tones, phrases and melodies are expressed. Articulation corresponded with *clarity* (Paper III) since the characteristic clear was experienced as being well-articulated, while the *(over)crowded* soundscape was not considered to be articulated.

The perception psychologist Dvoretsky (1982) describes several characteristics in the surroundings which attract attention. According to him people react to the intensity, size, movement, conversion, deviation or repetition, among other such qualities (Table 2). These general characteristics were recognised in the prominent sounds in the field survey.

Creation of auditory space

Mammals possess a primitive ability to identify sonic or other sensory figures: acoustic impressions are compared to a storage of auditory memories which have been built up from experience. The combined relations between acoustic characters and ambience create *auditory experiences of space*. These are more complex and demanding than the identification of individual sound features. Spatial auditory experiences arise due to the identification of the sound features (Bregman, 1990: 401).

Ohlson (1976) studied the acoustic environment in the Finnish archipelago. He labelled the experience of auditory space *soundscape*, in accordance with Schafer. Ohlson makes a clear distinction between soundscapes and distribution of sound by the acoustic sources: he refers to the latter as *sound fields*. This distinction was useful and recurs in the discussions on the procedures involved in planning and design (refer to *Acoustic planning according to McHarg's method* below). Truax (1984) denotes sound fields as *acoustic profiles*. 'Soundscape' is thus an expression which focuses on the listener's experience of space, while 'sound field' places the focus on the

distribution of sound by the acoustic source. Each listener in the vicinity of an acoustic source experiences different soundscapes.

Gärling & Toomingas (1975: 54ff) investigated the auditory space experience, but have a different interpretation of the concept. The focus of their investigation can be entitled *auditory experiences of visual spaces*. An absolute auditory space experience must mean something else that is disengaged from other sensory impressions. The boundaries of the auditory space seldom coincide with those of the visual space, particularly not in the outdoor environment. There are no completely separate sensory spaces, since all impressions are probably under the influence of the others. The expression *auditory space* was used in this research to denote the *concentrated* experience of a single individual in a surrounding acoustic environment. *The model of prominence* offered a conceptual structure which could be employed by practitioners to test such acoustic environments, as well as to freely interpret their qualities in relation to the social or cultural context.

Sounds in the landscape were shown to be intimately associated with movement. A sound most often revealed some form of movement, except in the case of electronically generated sounds. The movement and sound were both sequential since they took place over time. In contrast to the visual world which lends itself to photography, the auditory space cannot be documented in an instant. The variable auditory space comprises time, *i.e.*, it is based on sequences of time. Even a soundless film sequence would be a better comparison to the acoustic image than a single photographic image.

Among the things which are investigated by Granö (1997) are auditory aspects of the landscape. These are discussed in the monograph *Pure Geography* from 1929. He distinguishes between sensory experiences in the *landscape* and *proximity*, where landscapes are primarily experienced from a distance through vision, while proximity is experienced through several senses. Nemeth (1984) and Ohlson (1976) both discuss Granö's concepts; Ohlson investigated acoustic sources and refine the landscape concept by defining a number of auditory zones. Gehl (1996) defines proximity against the backdrop of the level of articulation in the human voice in the outdoor environment.

The interviewees in Paper III referred to the *foreground* of an acoustic image as a complement to *figure* and *background*. The proportions between the constituent sections of the image were thus further refined; this increased the comprehension of the space construction process. Granö's proximity is similar to the foreground while the *depth of the foreground* (image depth) implies a gradient from the nearest surroundings to the wider landscape.

Paper III discussed Bregman's (1990) *auditory scene*. There is an obvious visual parallel in the use of *landscape scenery*, but as with Granö the landscape experiences were perceived from a distance. The experience of

sound was better described as an *auditory space* or *arena*, since they comprise both the landscape at a distance and the nearest surroundings. The auditory space is further described in the section on *Acoustic planning according to McHarg's method* below.

Sense of direction from the perception of an auditory space

Landscape orientation is necessary for guidance, direction and a feeling of control. Elfström (1991) studied analyses of visual appearance of landscape, based on previous findings by Lynch (1960). Southworth (1969) conducted a study in which he compared visual and auditory orientation. It was demonstrated that it is useful to speak about auditory orientation since this perspective is of high significance to people who are visually impaired. Schafer (1977) and Truax (1984) used the expression *soundmark* – an analogy to Lynch's (1960) *landmark*. Both terms lie at the centre of concept of orientation.

A blind interviewee used *echolocation* to describe orientation in Paper III. A "vision" of the outer room's construction was obtained through the acoustic effects created by the sound of the interviewee's shoes as they came in contact with the ground and the guidance of the cane. The interviewee confirmed that even thin objects such as lampposts were identified with the same method. Echolocation can thus be viewed as the ubiquitous and intimate pattern of reflection surrounding living creatures which are used for the purposes of orientation and navigation. Truax (1984) defines soundmark as those acoustic objects which are considered to be common to a specific region or city district, thereby building an *acoustic community*. Echolocation corresponds with proximity, while soundmark corresponds with the wider landscape: this comes back to the theory outlined by Granö (1997).

Place identity constructed by the auditory space

The identities of the Håga Mound and the Linnéträdgården garden were reflected in both visual and auditory respects (see Paper III). The sounds at the locations contributed to the atmosphere. One interviewee spontaneously compared these to sounds on film, where music is used to create a certain atmosphere, with environmental sounds being one of the forms used. Chion (1994: xxvi) treats sounds in films in an interesting manner to illustrate the reality of audio-visual combination: it is shown that one perception influences the other and transforms it.

The nearest surroundings, *e.g.*, of birdcalls, insects *etc.* were distinctly perceived in the pasture landscape on the outskirts of the town (proximity). The city, with its access roads, could be heard in the distance during most of the interviews; the sounds were heard from several fixed locations. The atmosphere of the pasture landscape was clearly defined by its sonic proximity, as well as by the distant sounds which could be heard from a limited number of directions. One interviewee (Paper III) analysed the pasture landscape in three stages. Proximity was determined by the

rustle of leaves and songs from grasshoppers. The landscape was divided into two characteristics, one of which was the sounds of the city as detected from a distance along one of the compass points. The other consisted of a forest located at a certain distance along another compass point and gave the impression of *relative silence*. The distant forest became a form of "auditory antipole" to the city and could thus be regarded as both a visual and auditory phenomenon *without being heard*. The significance which the interviewee ascribed to "the large forest" which safeguarded the silence was a striking indication of the sense of place.

The surroundings of the public city garden provided it with an identity which consisted of modern city sounds; the proximity showed few signs of life in this case. The sounds of visitors' steps and the gardeners' raking in the gravel were nevertheless viewed as careful sounds. The location was perceived as a small oasis due to the songs of the birds, but the surroundings dominated the auditory identity.

All locations can be expected to have a unique auditory identity. One of the most ambitious investigations was carried out by Keiko Torigoe (Environmental Agency of Japan, 1996). The results of this investigation, which distinguished between 100 Japanese soundscapes, were published in the form of a guidebook for the entire country of Japan. Torigoe (1999) describes how these landscapes are preserved in order to protect individual acoustic qualities. An acoustic reservation has existed in Sweden since 1992. The existing authority at the time (Domän, 1992) established a forest reservation of nearly 2.5 hectares of woodland in Uttersberg on account of its acoustic characteristics.

Relations to other sensory impressions

The interpretations of the locations (Paper III) affected the acoustic impressions with respect to other sensory impressions. Most of the comments which were related to other sensory impressions were concerned with visual aspects. The knowledge of the inherent relations between the sensory impressions can appear to be of great significance in the field of landscape architecture. Places are thus planned for a number of functions; additionally, a limited number of mental states are expected to weigh in when these sites being used (Berggren-Bärring & Grahn, 1995). The combined sensory impressions, together with the expected mental states constitute supporting documents for planning decisions and bases for the planning process.

The view from the top of the Håga Mound attracted several of the interviewees. This visual attraction influenced everything which could be perceived with the other senses. Several reported experiencing a livelier course of events than they expected. This assertion was due to the concentrated mental states in which the interviewees placed themselves while listening. The interviewees were urged to pay attention to auditory impressions; they therefore discovered more than they had expected. The site interpretations were therefore more varied than would be the case in

an ordinary situation without artificial questions which affect the sensory modes. It would have been paradoxical to interview individuals on various aspects of sound without asking them to listen for anything; a *concentrated* form of listening could therefore not be avoided in the site interpretations. This would have been problematic if the research was concerned with the sound preferences of humans. However, the study was a search for the various expressions for auditory experiences in the outdoor environment. A particular interview setting which included listening was required in order to make the participants more focused.

Several of the participants were struck by the contrast between the visual and auditory impressions in the Linnéträdgården public garden. The visual space of the park was well defined, while the auditory space extended beyond the visual boundaries. The auditory space created due to construction work near the garden, was experienced as exciting. The sound of the construction cranes and other machinery described the activities on the neighbouring property. Otherwise, several of the interviewees expressed a longing for the characteristic sounds from inside the garden. The visual impression of the garden's baroque layout was not considered to possess any auditory equivalent. Several interviewees therefore requested that an *auditory focus* be created in the park's main pond. This could be in the shape of a tasteful fountain to correspond with the garden's visual layout.

Creation of inter-sensory space

It is worth applying the *model of prominence* to the other senses. Each individual sense can be studied from an *intra-sensorial* perspective, since this project was mainly focused on sound. The aim of a research on experiences in the field of landscape architecture is to understand the impression of the landscape as perceived by all the senses combined, *i.e.*, an inter-sensory creation of space. The profession is dependent on the ordinary inter-sensorial aspects, but the knowledge base and significance of the synesthesia must be clarified and developed through a combination of practical experience and research.

The creation of inter-sensory spaces in landscapes is the combination of all the sensory-based contributions to create an overall experience. Furthermore, these contributions are imagined to transform each other. In this way, the expression "landscape" gets a much more significant meaning than the one used by Schafer (1977: 7). He draws a parallel between soundscape, *i.e.*, that which is perceived by the ear and landscape, or that which is perceived by the eye. He thus limits the landscape to the category of landscape painting or photography. A visual parallel to a soundscape can instead be called a *lightscape* (Paper I), since the term "landscape" should be reserved for experiences which include all senses (the contribution of the five basic senses to the experience of the space can be denoted lightscape, soundscape, scentscape, touchscape and tastescape, while the overall inter-sensorial impression can be denoted feelscape).

This research touched upon the subject of inter-sensorial problems. Some relations to the sense of hearing are discussed below as a means of developing the *model of prominence* and generating hypotheses for application to inter-sensorial aspects. The corresponding expressions to the four characteristics of the soundscape with respect to the model can be denoted *mild, powerful, clear* and *crowded* for each of the sensory spaces (Dvoretsky, 1982: 57). Lightly seasoned food and weak odours should characterise mild tastescape and mild scentscape respectively. The opposite characteristics should then maintain their relative proportions, but nevertheless be experienced as strong. A clear scentscape should contain scents which are clearly distinguishable, depending on their divergent characteristics or on the direction and position in the space. The impressions obtained in a mature scent-filled garden should combine to produce a crowded scentscape. New, unfamiliar sensations should arise from the combination of scents. A touchscape is based on a perception of space with respect to contact with the foundation, wind, temperature *etc.* The individual's *movement* and *balance* are aspects of choreography which also should be included for consideration.

The following investigations and results play an important part in promoting a deeper understanding of the significance of combining sensory impressions in the design of a garden or the planning of a landscape. Don (2001) shows examples of the ways in which different senses can be treated in a garden. Granö (1997), Rodaway (1994) and Carles, López Barrio and de Lucio (1999) focus their acoustic investigations on combining additional sensory impressions from a geographical perspective. Southworth (1969), Couic and Delétré (1999) and Viollon and Lavandier (2000) study sounds in a similar manner in association with other impressions; however, these studies are conducted from the perspective of urban planning. Cazeaux (2001) uses a phenomenological basis, asserting that the experience of sound, in particular, is what opens the door to research in synesthetical problems. Iwamiya, Hosono and Fukuda (1992) studied audio-visual interaction and highlighted five common aspects of the senses: calmness, activity, naturalness, uniqueness and magnitude. The research in question on sonotopes focused on an individual sense; however, the future challenge is to investigate the inter-sensorial *feelscape* as a basis of an inter-sensory conception in landscape planning and design. This implies a need for developed design tools to manage information related to the inter-sensorial aspects.

Two reference objects

Two carefully selected outdoor environments are presented in Paper III and Appendix V. These were selected based on the sounds experienced at these locations. Practitioners within the field of landscape architecture and planning kept these two environments as reference objects, comparing them to their current projects. This presentation together with its Appendi-

ces involve that practitioners can be encouraged to test, compare and maintain representations of the reference objects in the future as well. The outdoor environments were described in general terms such as *pasture landscape (on the outskirts of a city)* and *(public) city garden*, in order to facilitate such comparisons. The pasture landscape thus came to represent places located just outside a Nordic city, while city garden represented smaller, centrally-located parks. The two areas in the landscape reflected many ordinary, practical projects, since new constructions often occur on the outskirts of cities and central parks and greenways are exclusive elements of urban planning. The two objects possessed opposite qualities, according to Berggren-Bärring and Grahn (1995; Paper II). The selection of the reference objects is described in more detail in Papers I and II.

The acoustic environment around the *Håga Mound* contained sounds which originated from near and distant locations respectively. A zone from which sounds rarely originated existed between these two positions. The silence experienced of this middle area provided clarity to the acoustic image. This clarity was due to the fact that nearby sounds were not drowned out by sounds within the middle area, while distant sounds rarely became so strong that they had any significant effect on the nearby sounds. The sounds from aeroplanes and to a certain extent, helicopters, were the exceptions to this pattern. The sounds from one of the approach routes to the Arlanda airport were heard over the Håga Mound every 5 – 8 minutes during the daytime hours on weekdays.

The *Linnéträdgården public garden* was characterised by the sounds of the surroundings. At times, sounds originated from the park itself. There were the chirping of birds, the sighing of the wind in the high treetops, the light rippling from a filling pipe to the central Sjödammen pond, the crunching steps of visitors in the gravel or the sounds of the gardener's raking. Among recurring suggestions for modifications to the acoustic image was a moderately sized fountain which rippled into the central pond and the diversion of the surrounding traffic.

The interviewees' choice of observation spot reflected their manner of listening, to a certain extent. The choice also meant that certain phenomena were highlighted at the expense of others. A striking example was the difference in the various experiences of wind sounds. Most found their way to the top of the Håga Mound and looked out over the landscape. At this point there was often some gust of wind which blew in their ears. Another category of interviewees searched for the wind in order to capture its effect with their entire bodies. The powerful gusts confirmed their overall experiences; the wind was a solace to those who had tinnitus. The wind was not only expected, but was also a contributing factor to the experience of the location.

Other reference objects than those two which were selected are necessary, if a more comprehensive picture of the auditory problems faced by practitioners is to be obtained. What is most important, however, is that the practitioners develop their own portfolio of solutions which can be

adapted to recurring planning and configuration problems. Future research should nevertheless be devoted to the formulation of a broader definition of reference objects; such a definition should focus on auditory experiences and be formulated in relation to the landscape settings. The reference objects do not need to be representative, but the problems that they illustrate should possess similarities to recurring planning and design problems.

Two perspectives were based on the sounds in the landscape. The first concerned the arrangement of the various materials in the landscape and the shapes which cause reflection patterns in sounds. This concept of acoustic space in the landscape, as in the case of a passive reverberation of sounds, signifies *a resonating landscape*. The other concept concerned the arrangement of the activities and operations in the landscape which involve sounds. This signifies *a generating landscape* and is related to classical problems within the field of landscape architecture, with respect to the use of land and the placement of functional surfaces, conflicts of interest, *etc.*

The resonating landscape

A landscape colours the sounds which travel within it; each location is thus unique. The landscape can be viewed as a gigantic reflector in the form of a resonance box or *resonator* in which sound is reflected. An open landscape does not have the lock possessed by the resonance box and the early reflections are weakened as they progress towards the sky. One of the interviewees (Paper III) remembered exactly how sounds evaporated and disappeared in open landscapes. The contrast, according to this participant, was the wooded landscape with dense crone closures where the early reflections of the spring birds' songs produced reverberation. This resonator function now assigns a *transmitter* function to the landscape, according to the traditional linear model for the transmission of sound: source – transmitter – receiver.

The sounds were coloured by the topography

There were considerable differences between the physical conditions of the two reference objects. The pasture landscape is a wide, open expanse of land with sections of woodlands around it. Smaller groves are close at hand. The wind often increases in speed in the open landscape and symbolises the openness of the location. The composition of the location's vegetation is revealed by the specific noise frequency of the wind as it passes through each species of tree. The shrubs and trees also constitute locations for songbirds. The mound in the centre of the investigation area screens the sounds and gives rise to *sound shadows* (cf. Truax, 1978: 127).

The city park's topography is depicted by buildings which both reflect certain sounds and screens others. The wooden fences on those sides where the park faces the trafficked streets serve the same function as the

buildings; however, they are less effective. High trees extend over the surrounding roofs and catch the wind on some occasions. In autumn and winter the rustling of the plants which keep dry leaves and catkins is different from the deciduous whose leaves fall. The shrubs and layer of trees also provide protection and lookout posts for birds, but the bird fauna is different. The cries of the birds are important contributions to the two site soundscapes.

The generating landscape

A landscape houses places for several forms of land use. It thus functions as an arena for temporary activities and permanent operations which cannot be separated from the landscape itself. The appearance of the landscape and its soundscape both reflect the use of the land. The sound generating landscape encompasses not only acoustic sources but also the listeners in the landscape, while maintaining the function of a transmitter. The entire model source-transmitter-receiver is included, but Truax's communication model (1998: 12) describes the situation in an even better manner. The uniqueness of the locations are accentuated by the sounds which are generated and received there. The reflection of sounds (the resonating landscape) is therefore supplemented by the generation of sounds.

Sound characteristics can be divided into passive reflections (resonator) and active production (generation) upon analysis of the landscape. The aspects require different methods of approach with regards to planning measures, design and detailed construction. Passive reflections of sound are determined by choice of material, localisation and layout. A road construction adjoining a stream results in that the water, as a material, reflects and transports the sounds from the road to the wider surroundings. Active generation implies other conditions for the processes of planning and design. A road which is designed in the landscape signifies that the sounds come from the road and not from a forest right next to it, for example. Consequently, the active generation of sound occurs in the locations where the activities take place and is determined by the arrangement of the landscape.

The sounds were part of the activities

The activities in the pasture landscape were of the outdoor variety. Occasional visitors wandered by or had picnics in the fields. Other passed by with their dog. There was a gate to the area which banged when it was let go. The sound of the listeners' clothes, footsteps, *etc.* were very distinct. Individual motor vehicles could be often distinguished over the distance as they slowly droned in and then disappeared behind a hill. The approach route to the international airport Arlanda is localised over the area and approaching aeroplanes are heard every few minutes, as mentioned above. The activities of the birds were considered to be a function of the vegetation's composition (cf. Oba, 1995). Even horses were located in the area:

these were normally very quiet, but snorted on occasion. The air was dominated by the sound of grasshoppers in the late summer.

The city garden was only opened during the summer season. There was a café just inside the entrance. The bus traffic outside one of the walls of the garden was apparent to the customers in the café. The sounds in the café were characterised by chatter and the quiet rattle of porcelain. Several interviewees (Paper III) observed that the surface of the steps in the public garden was different from that of the surrounding pavement. There were concrete slabs and asphalt outside the park, but the garden paths were covered with fine-grained crushed gravel. A building was erected which generated a multitude of sounds near the park during one period. This included squeaking sounds from a construction crane. Sounds sometimes came from open windows in the row of houses. Indistinguishable ventilation sounds were perceived in the garden. Enormous flocks of jackdaws gathered in the city in the evenings, especially in the autumn. These sometimes flew over the park and settled in the high trees on its outskirts. Most of the sounds in the park came from the surroundings; one interviewee therefore stated that one of the park's functions was precisely to keep the other sounds from the city at a distance.

A tool to generate a repertoire of references

It became apparent at an early stage in this research that sound-related problems should be treated with the aid of sound itself, *e.g.*, as representations in sound, and not only as visual representations in graphs or words. Sound representations are scarcely encountered in the field of landscape architecture and planning. As previously mentioned, other forms of visual representations such as plans and perspective sketches are more common. This research tested *audio-visual* techniques with both sound representations and other traditional illustration methods which are practised in the field. Sound recordings were conducted in the pasture landscape and the city park; a tool was developed in the form of a prototype, based on the two reference objects (Appendix V). The sound recordings were arranged so that a practitioner could select examples and compare various settings from the same location at different times of the year. It was also possible to compare examples from one place to those from the other.

Visual representation was attempted alongside the content in Appendix V. Plans or drawings with icons representing the geographic propagation of the sound were used in the last stage of the interview process (Paper II: 106; cf. Appendix A, B). These representations gradually developed during the field survey and illustrated the participants' site interpretations. The interviewees added their interpretations to an existing drawing upon their site visits. The drawings were adjusted from interview to interview in order to reflect the combined interpretations up to that point.

The places were visually presented in Appendix V with the aid of photographic images taken from the ground and from the air. Drawings and

plans were used to supplement the visual presentation; text descriptions were added to provide a combined impression of the cases. The aim was to promote the understanding of the sound representations in a relevant context, against the backdrop of these facts. Neither the visual nor the written representations in Appendix v described the *sounds* at the locations. The CD-ROM was instead developed as a pedagogical tool for the use of practitioners. Open questions were posed to the user in order to encourage reflection and stimulate the formulation of independently written answers. The user received guidelines on three categories of expressions that they could relate to at the end of the exercises. This was to enable them to streamline their notes as they wished. The three categories were denoted *technical, onomatopoetic* and *appraising*. The categories were denoted by specially selected expressions for sounds in the outdoor environment; these expressions had been indicated as useful for such purposes in pilot studies. Some 70 words were selected from a total of 400 during the pilot studies (see Table 3). These 70 words were then transferred to one of the three categories.

Table 3. *The most useful words for the description of individual sounds or soundscapes in outdoor environments according to preliminary tests. The words are translated from Swedish and are divided into three categories*

TECHNICAL	ONOMATOPOETIC	APPRAISING
COHERENT	BLEATING	BORING
COMPLEX	BUBBLING	CALM
DIFFUSE	CLATTERING	CALMING
DULL	CLINKING	CHAOTIC
HOMOGENOUS	COOING	COMFORTABLE
MONOTONOUS	CRASHING	DEVOTIONAL
NUANCED	CREAKING	DISTURBING
RHYTHMIC	CRUNCHING	EVOCATIVE
RICH	DRIPPING	EXQUISITE
SUBDUED	ECHOING	FAMILIAR
UNIFORM	EFFERVESCING	HAPPY
VARIED	GONGING	IMPRESSIVE
	GURGLING	INSISTENT
	HOWLING	LACKING
	HUMMING	LIVELY
	KNOCKING	MELANCHOLIC
	LAPPING	MIGHTY
	MURMURING	MILD
	POUNDING	PEACEFUL
	RINGING	PLEASANT
	ROARING	POMPOUS
	RUMBLING	REPULSIVE
	RUSTLING	SAFE
	SQUEAKING	SERENE
	THUMPING	SPOOKY
	THUNDERING	THREATENING
	TRILLING	TIRING
		UNCOMFORTABLE
		URBAN
		WONDERFUL

The first group of auditory examples in Appendix v was entitled *site-specific sequences*. The second group dealt with *comparisons* between locations, while the third and last group dealt with *experiments* with the acoustic images from the different locations.

The tool encourages listening

The pedagogy behind the audio-visual tool led to the question of developing expressions based on other aspects than visual. The formulation of an auditory expression differs from that of a visual expression, since the latter is based on the fact that the expressions are always in possession of a visual reality. The development of the practitioners' aural awareness and "pitch training" could be the basis of increased auditory understanding of a landscape which is based on expressions for audible aspects (Paper iv). The manner in which practitioners represent the world, *i.e.*, their auditory philosophy, is made topical in this research.

The idea of an aural awareness is well developed in the world of music (*i.a.* Pratt, Henson & Cargill, 1998). This must differ somewhat from that of music in the field of landscape architecture and results in the development of auditory expressions for *everyday sounds* in the outdoor environment. Schafer (1977) investigated the concentrated listening of the everyday sounds; this can also be traced to John Cage (1976). *Sound walks* is one method by which practitioners could raise their aural awareness (*i.a.* Winkler, 1996; Tixier, 2001). Additional examples constitute the methods described in Paper ii. These are tentative and are suitable for the exploratory investigations in this study. However, the practitioners can modify the approach such that they are able to ask critical questions about the acoustic environment in conjunction with their own site visit.

Expression formulation through aural training

Walter Ong (1982) demonstrates how the human consciousness was originally based on oral communication and listening. Ong asserted that the human consciousness was changed in conjunction with the introduction of the written language. All humans undergo a similar process of development as children when they learn to read. Humans train themselves to use concepts as written words in the world of the written language, but expressions for sounds are created via the auditory sense.

Methods of facilitating *aural training* for practitioners were developed in this work. That is, methods to train the ability to use the sense of hearing to interpret and evaluate acoustic phenomena. This type of hearing has less precision and lower specifications than those which are applicable in the field of music: the pitch is one such example. Practitioners were able to listen to, sort and label sounds with the aid of a tool such as that which was described in Appendix v. Words and phrases thus represented relationships as the practitioners perceived them. Concepts which were transformed from auditory-oral to visual-figurative or visual-written were

present between reality and words. A CD-ROM provided the opportunity to create auditory examples and communicate expressions for acoustic images and landscape architecture in the intrinsic medium of *sound*. The formulation of expressions and the aural training were therefore provided with an authentic and original foundation. The purpose was not to encourage practitioners to replace site visits with the tool. Rather, it was to highlight auditory problems and stimulate curiosity for auditory aspects before a site visit.

The tool as the basis of investigation in a studio setting

The audio-visual tool can be used in the development of a laboratory setting for the study of experiences (cf. Söderholm, 1998). The preliminary evaluations (Paper IV) should be understood as such a setting. The sound files on the tool can be further analysed through traditional acoustic measurements and can therefore in future investigations operate as controlled inputs, according to Blauert (1997: 6ff). Adjectives and opposite word pairs can be tested within the framework of a semantic method (Paper II: Appendix p. 114). Several of the expressions were related to each other in this investigation: these were used to construct the *model of prominence*. The model can be compared with the supplementary word pairs; a broad portfolio of expressions which describe dimensions and properties can thus be tested.

Naturally, it is the practitioners who are responsible for the use of the expressions and who must explain how these are applied from case to case. The audio-visual tool provides a simple method of testing in a studio setting where the practitioners can listen critically. The following methods of approach were obtained from the music branch (taken from Pratt, Henson & Cargill, 1998: 87). Modifications are marked in italics.

1. to analyse the elements of which a given [time] span of *soundscape* is made;
2. to explore the ways in which these elements act alone, and interact with each other;
3. to synthesise these actions and interactions into *sonic* effects – at their simplest, describable as 'tension' and 'release' (see below);
4. to establish whether these effects are desirable or not, [if they are] measured against historical facts and *the users' expectations of the use of place or land*;
5. to recognise and compensate for factors which may make the judgement unreliable.

The *model of prominence* was used in steps 1 and 2. *Tension-release* is introduced by Pratt, Henson and Cargill in stage 3. The word pair *calming-rushing* corresponds closest to this expression (Paper II: Appendix p. 114, no. 38). The term *desirable*, to which the word pair no. 1 *pleasant-unpleasant* corresponded, was introduced in stage 4 (see a combination in Fig. 5). The above layout implied that questions related to *desirability* were not dis-

cussed before the end; this was supported by the results of this research. The evaluations risked being oversimplified or unreflecting when the sounds were immediately judged as beautiful or ugly. The method of approach was applicable to situations involving listening to recorded acoustic sequences and those involving on-site inventory. The aspects which were used by Pratt, Henson and Cargill were further developed by Västfjäll (2001), who describes extremes and intermediary forms of emotion in an explanatory diagram called "circumplex".

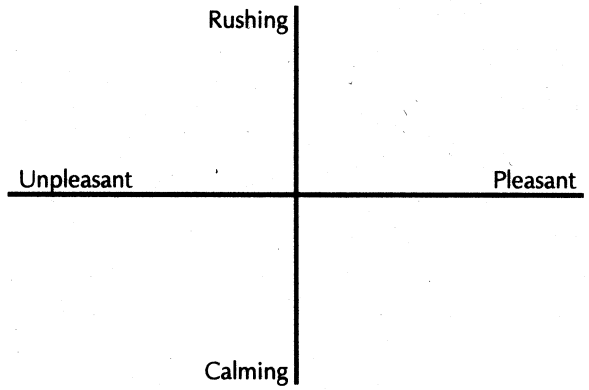

Fig. 5. *Tempo* (calming-rushing) and degree of *pleasantness*, dimensions used by Pratt, Henson and Cargill (1998) have been further developed into the *affect circumplex* in Västfjäll (2001: 24).

The inputs which are necessary to determine the relevant auditory aspects of the outdoor environment are now to be decided – if ever possible. *Mild soundscapes* (see Fig. 3) are expected to be exceedingly problematic to evaluate in a laboratory environment. The process of listening to weak sounds from representations of the mildest of soundscapes can be easily disturbed in such an environment. These require that the listeners be placed in a frame of mind which is essentially different from that which is offered by the laboratory and its surroundings. If the laboratory were located in a correspondingly mild outdoor environment then the reliability of the results would increase.

An audio-visual aid can guide practitioners in compiling their personal reference banks. The prototype (Appendix v) was developed to demonstrate the methods by which reference objects could be presented. The two reference objects were carefully selected and studied; however, these should be supplemented by additional methods and the adaptations outlined in Paper iv applied. The prototype was furthermore designed to encourage practitioners to develop their personal reference banks by simpler means.

According to the evaluation of the prototype (Paper iv) a couple of the interviewees were thought to be inspired by the material. A couple of others were sceptical and an additional person did not succeed in getting the prototype to work. One of the sceptical participants became considera-

bly more involved in the problem by way of a subsequent conversation on sounds in the outdoor environment. One conclusion was that the prototype as a self-study material was not suitable for all users. A mutual generation of knowledge for practitioners and researchers thus required several methods of meeting, rather than just through the use of the computer medium. The participants who were inspired by the material gave suggestions for additional exercises. The conclusion was that the prototype helped to highlight the problem. It was also concluded that the contents could be varied in many ways. The prototype cannot be used to reach all landscape architects, but it is believed that it will generate much interest if it is combined with traditional study material and a course consisting of lectures and exercises.

Critical evaluation of an audio-visual prototype

The audio-visual prototype (Appendix v) can be discussed in a critical manner. There were several critical stages from the point at which the interviewees perceived sounds to that which the practitioners perceived and interpreted with the aid of the audio-visual representations. What is it about a reference object that practitioners need to reflect current projects against in order to consider the auditory aspects and refine suggested plans and designs? What can the tool represent and to what extent did the prototype succeed in representing that which the interviewees (Paper iii) originally interpreted?

The purpose of a reference object is simply to be an example of accomplished solutions. The city garden, as a reference object, had a weak internal auditory identity which was dominated by the external sounds from the surrounding environment. The location's auditory identity was thus based on the sounds of the surroundings. This situation has similarities to other locations which practitioners may recognise. The design, building material, plant material, functions, traffic settings, building locations, *etc.*, of a reference object has characteristics which practitioners can compare with their own projects.

The function of a tool is to simplify the creation process, either through precision or flexibility. Was this what was offered by the representations? Yes, to a certain extent. One encountered difficulty concerned the application of the selected time sequence, for example, how well they represented the auditory aspects of the reference objects. For example, were the surrounding sounds sufficiently representative, with respect to what many visitors experience on site?

Such questions about the tool's ability led to other questions which could be addressed in a future investigation. Is it at all possible to talk in terms of general auditory settings of a place? Or does the acoustic environment of a place consist only of a series of unique sound events? Schafer (1977: 272) discusses *keynote sound* which changes slowly during the day and is experienced as constant during a short visit. A keynote can therefore be

viewed as a general component of a place. Furthermore, certain sound events recur in a place according to a spatial pattern with regards to time. The sounds thus repeat themselves at prescribed time intervals at a limited possible number of positions in the landscape in question. For example, a species of bird returns each year and chooses the same type of vegetation for its specific daybreak song. Consequently, the *keynote* and *pattern of sound events* constitute something general or permanent in an auditory setting.

Selective hearing compared to microphone recording

It is likely that visitors to a reference object reject many surrounding sounds with their selective hearing. The proportions between surrounding sounds and internal nearby sounds in the event of an actual site visit therefore hardly correspond with audio-visual representations, since a recording microphone filters sound in a different manner than the auditory system in humans. Each living creature has a constantly variable focus for its attention – something that the microphone lacks.

The interviewees observed a number of phenomena and described them on location (Paper III). The echo of carpet-beating from a neighbouring house in the city garden can serve as an example. The sound recordings were designed to capture these corresponding phenomena (Paper IV). The rhythm in the echo of the carpet beating can initially stand out clearly to the visitors in the garden, only to later sink back into consciousness. The visitors should pay attention to the echo in order to facilitate a preliminary identification; the first aim should be to determine whether the sound is indicating danger. The microphone simply registers the echo since it does not possess this auditory warning function which humans and many other animals have. The practitioners listening process during their use of the tool and its different representations are therefore compelled to place extraneous concentration on the acoustic images while they obviously were not recorded with a human filter or focus. If the users had been at the location instead then they would have followed certain acoustic trains, *i.e.*, sonic figures which appear to the listener, while other sounds would settle into the subconscious to constitute a background. The users of the tool can therefore experience a distorted and disordered acoustic image in which certain phenomena are not recognised in relation to what was actually experienced on site.

Photographic representations can be compared to the previously outlined *model of aural prominence*. The camera reproduces an optic image and the microphone produces an acoustic record. The degree of correspondence between the photographs and the actual experiences at the location is, in fact, no greater than that of the recorded acoustic images. Visual images are not often treated critically within the field of landscape architecture; this can be compared to the manner in which acoustic representations are addressed.

The problem encountered by the users in listening to the technically filtered acoustic images was countered by the fact that the tool nevertheless presented opportunities for concentrated listening. This provided an effective method of conducting controlled comparisons over time and space. The efficiency of the method lay in the fact that practitioners could not only listen to similar situations but also discover and select those acoustic patterns which could be of interest to an ongoing project. It could also aid practitioners to streamline the problems in their projects through the subsequent selection of a particular supplementary visit to an ideal and similar acoustic environment.

Equipment problems

In addition to the microphones' inability to detect sound with the same capacity as an ear, the equipment is also incapable of switching mental states as a human. One could therefore be fooled into thinking that the microphone produces "objective" acoustic images to which the listener could relate. The users are certainly able to listen to the same acoustic images over and over again, detached from the original constraints of time and place in relation to the acoustic events. But the users must be aware that the sound recordings were not experienced in the manner in which the headphones present them to the human ear.

Sound recordings were conducted with binaural microphones in a bid to produce realistic acoustic images. This technique relayed the spatial information of the sounds to the auditory images. The images were recorded as if they were to be listened to through normally applied headphones. The acoustic spaces are then reproduced with respect to the directions and movements of the sounds in the landscape. The concentrated listening which is brought about by the audio-visual tool requires a critical approach such as that outlined above; this is so even if the aim was to prepare for problems which have not yet become sufficiently prominent in the areas of landscape architecture and planning.

Determining the right occasions for sound recordings

Sites and their design lie at the centre of landscape architecture. The occasion on which an acoustic sequence is recorded is significant, since it determines how much of such a site is captured in that sequence. The occasion also plays a vital role in the choice of sequences which will be combined to reflect a place. There is an important relation between a *visual* image and the time at which it is taken. The photographer's consideration of these times plays a pivotal role in the outcome of the images. The times need to be related to patterns which are typical of the location. Additionally, they should reproduce enough to the same pattern in order to do the place justice. The *recordings* in this research were mainly conducted during normal working hours, *i.e.*, between the morning and evening rush hours. The flow of traffic varied during one week, being highest on Friday afternoon and lowest in the early hours of Sunday morning.

One starting point for both the interviews and the sound recordings was that they were conducted at times when people were expected to be either using or visiting the landscape. The recording occasions were consequently related to when people were expected to be present. However, the city garden was only opened during certain seasons and thus there were no other visitors during some of the interviews.

Formulating expressions with written words

Expressions can be viewed as planning tools in the work of either the planner or the designer. The models of physical settings take the form in the sketch. A conceptualisation process takes place during the sketching phase; practitioners make use of their portfolio of expressions to aid them in the formulation of the sketches. Written words can be employed in the formulation of expressions based on hearing. Such a combination is not without concerns, since the listening must be reinterpreted in visual language. The research was based on the absence of expressions for auditory experiences in the fields of planning and design. Tentative tests were therefore conducted using words which were deemed to be useful for the purpose of describing sounds in the outdoor environment (Table 3).

Küller (1972), Viberg (1984), Maeda and Iwamiya (1993) and Suzuki *et al.* (2000) had previously conducted investigations into the use of language and sensory impressions. Expressions help to make visual aspects understandable and manageable in the visual world. Words or phrases can be used to express something about colours and visual shapes, for example. The aesthetics of architecture has, to a great extent, been developed around such expressions, while expressions for auditory experiences have traditionally been formulated in the fields of music and psychoacoustics. Gaver (1993) attempted to derive onomatopoetic words for specific sounds from various types of material. This project illustrated several specific expressions from the traditional disciplines by way of introducing them into the field of planning and design. Several of the introduced expressions are included in the *model of prominence*.

Forty-five (45) word pairs were extracted from related disciplines and problem areas in order to simplify the evaluation of sounds in outdoor environments. These were presented in Paper II (Appendix p. 114). This presentation of words encouraged interviewees (Paper III) to describe aspects of the auditory experience that they would otherwise not have been able to. The risk that the word pairs affected the interviews was minimised by distributing the word pairs towards the end of the interview.

Acoustic planning according to McHarg's method

Landscape architects are familiar with the objects which generate sounds in the landscape, although they may not regard the objects as acoustic

sources. Such sources are tangible planning objects which can be used as the foundation of various aspects of sound and auditory experience. Professionals can learn to recognise the phenomena which are characteristic of a particular type of land use. The consequences on the acoustic environment can subsequently be estimated for various planning options. Using the acoustic sources as the only starting point for the management of acoustic images can, however, result in the actual auditory experiences being overlooked. The categorisation of acoustic sources should thus be supplemented by studies and descriptions of sounds in their own right.

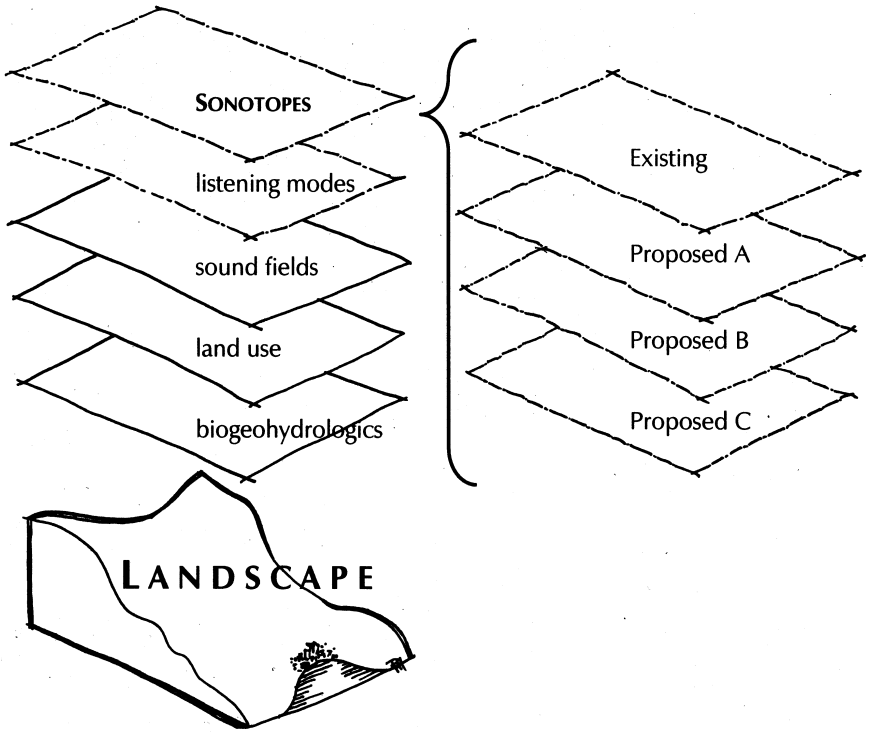

Fig. 6. The sonotope layer proposed as one of the layers of information in landscape planning. Conventional landscape data are based on geology, hydrology, biology *etc.*, as well as information on the use of land. Studies of acoustics or noise in the landscape generate maps of sonic propagation from sources of noise – sound fields. To define existing and proposed sonotopes, the users' expected listening modes on respective sites should be considered. Knowledge of their on-site expected activities with respect to the land use is vital in the planning or design of appropriate acoustic conditions. The proposed options (A,B,C) were illustrated in the CD-ROM by the situations in the road and fountain experiments (Appendix V). The proportions between sonic figures and keynotes should vary between proposed alternatives; this would facilitate communication between groups who represent the interests of those parties who are concerned with a planned landscape change.

The natural (passive) acoustics of the locations – which includes reflections of sound (the resonating landscape) – should be considered in the process of landscape planning, since it is then that the conditions concerning preservation and development are determined. The passive acoustics should also be considered in the practical choice and shaping of material. Recurring sound-producing activities (the generating landscape) should be treated in association with questions concerning land use. The contents of the soundscape are thus determined through the assignment of places for various activities. Landscape architecture signifies the assignment of such places, independent of scale. The shaping of the landscape during the processes of planning and design thus regulates the contents of future soundscapes.

The *current situation* of site soundscapes or sonotopes can be illustrated and planned with the aid of Ian McHarg's (1969) over-lay technique (Fig. 6). The landscape which is the object of the planning or design process is placed at the bottom. Several aspects of the same landscape are then represented through various maps or plans. One of the overlays is a *land use plan* which assigns areas to different operations.

An inventory of existing acoustic sources can be drawn up on the basis of the land use plan. Planned sources can be assigned to new locations in the landscape. *Sound fields* (Ohlson, 1976) from all contributing acoustic sources can thus be identified. Different methods and time considerations are required in order to represent the fixed and the mobile sources in the landscape. The normal procedure today is to describe sound fields for one or a few acoustic sources which are designed or perceived to be disturbing. The description of sound fields is thus often limited to degrees of strength (decibels).

The next overlay places the listeners at the centre of the events. The land use plan can therefore be reinterpreted in terms of *expected mental state*. This reinterpretation is based on the assumption that different uses of land generate a limited number of mental states in visitors to particular locations. Activities which require *directed attention* (Kaplan & Kaplan, 1989, 1990) imply that the users focus their attention on that specific activity and do not attach much importance to the surroundings. A football training session is an example of such a situation in which attention is expected to be focused on the ball, the players and the exercises. Activities which are easily disturbed by the surroundings involve other mental states; these are a state of *soft fascination*. The condition is described as a state of alert restfulness which requires little exertion in a restorative environment. The mental states all involve different ways of relating to sounds and thus different *listening modes*; these are studied in the fields of music and psychoacoustics (*e.g.* Adorno, 1976; Truax, 1984; Chion, 1994; Schaeffer in Hellström, 2003).

Sonotope plans for communication

A landscape analysis which is based on expected mental states and listening modes is necessary for the planning and design of sonotopes. The word pairs in Paper II (Appendix p. 114) and the previously described method of critical listening outlined by Pratt, Henson and Cargill (1998) are recommended for such an analysis. Starting from the users' perspective, assumptions can be made about the aspects which capture their attention in different locations – *i.e.*, the characteristics which are outstanding to them. A *sonotope plan* can then become a basis of the dialogue concerning the listeners' location-based experiences of the combined sound fields. The sonotope plan is supported by the land use plan where the listeners' current and future patterns of movement, dwelling places and pathways in the landscape are gathered. A limitation of the plan is proposed to concentrate on a few critical landscape positions and paths where essential experiences of the acoustic environment arise. Without such a limitation the plan may become too complex. Each perspective of the soundscape – for example, each listener's capacity for comfort and empathy – cannot be considered at the planning level. A more general attitude is therefore required, much the same as in other forms of planning and design. It is necessary to be able to formulate a language using words, sounds and images which allow descriptions, plans and correspondence between the parties who have interests in the landscape.

McHarg's overlay technique is based on a geographic distribution in the landscape space. The sounds are, however, distributed both in space and time. In order to produce sufficient bases for dialogue then the descriptions and plans need to be supplemented by a form of *landscape score* which illustrates changes over time (Thiel, 1996: 305ff; Strömberg & Johnsson, 1995: 98ff).

Soundscape EIA improve noise abatement

One element of landscape planning consists of the description and evaluation of various planning options on the environment. McHarg's method can be used to consider sonotopes as an object of analysis within environmental impact assessment (EIA). Assessments of sonotope qualities can thus be applied as a supplement to current noise analyses. The method highlights the need for *descriptions* of acoustic environments. Paper I illustrated different methods of investigating acoustic environments: *acoustic documentation* (recording), *physical measurement techniques* and *field surveys* (interview techniques). These methods resulted in various types of descriptions which can be formulated to suit the EIA.

The planning processes for the protection of health and the environment has traditionally been based on noise level measurements of everything which is perceived to be unwanted noise. The primary task in this case is to protect citizens from noise which is directly harmful or disturbs the night's sleep. Other descriptive methods are required to offer *correct* information to the process of planning and design within the field of

landscape architecture. Proposals which arise from such a process are created from the ability of everyone involved to combine skills and experiences which are difficult to evaluate.

Changing soundscapes

Which procedures should support landscape architecture and planning where the task is not only descriptive? Planning and design constitute resources for *change*, such that all interested parties are able to feel a sense of participation. A new road construction is an example which implies changes in land use, vegetation and the surrounding acoustic environments. The motive for such a project is typically based in a political decision. The methods should therefore focus on the future and support the drive to create or propose solutions for problems in acoustic environments which do not yet exist. Alternative routings of new roads can be proposed according to the effect that they will have on the existing soundscape. Those involved in road planning will perhaps state that this is precisely what is being suggested. However, the road is considered to be an isolated linear element in today's road planning processes; furthermore, the noise levels are calculated from estimations of traffic volume (Canter, 1996: 304ff; Morris & Therivel, 2001: 65ff). Consequently, the sounds generated by road traffic are calculated, but no inventory is made of the *existing* soundscape against which the future sounds should be compared. Thus no complete evaluation of potential consequences can be conducted.

Even existing landscapes, with or without built-up environments, can be treated with these methods so that suggestions for improvements can be obtained. The methods can therefore be adapted to both new projects with great significance to the landscape and proposals for smaller changes which are based on an existing landscape with existing sounds. The methods can generate representations of acoustic environments which create conditions for the affected parties' capacity for comfort in the proposed environment. This is outlined in three examples below: *auditory refuges, traffic regulation* and *water sounds*.

Example I. Creating auditory refuges

Varieties, contrasts and contradictions need to be promoted in the process of planning and design. The identity in different places can therefore be displayed. At the same time, the local environment can be enriched with expressions which create the pleasures of discovery, tension, mystery, peace, safety, familiarity, belonging and other such qualities. Since auditory design has not been a conscious part of the planning and design process then preliminary measures can be directed towards avoiding *uniformity*. Research in the field of environmental psychology highlights the significance of a varying complexity (*i.a.* Kaplan & Kaplan, 1989: 53ff; Thiel, 1996: 216ff; Ipsen, 2002: 189ff). Professionals could obviously point out that there is really no uniformity. However, a special principle should be formulated to treat the differences or irregularities between acoustic

environments. The expressions in both the urban and rural landscapes converge through various forms of rationalisation today. Similar types of acoustic sources tend to indicate an increasingly globalised arena which smoothes out local identities.

The aspiration towards irregularity can be supported by *auditory refuges*. Refuge often means a place which offers protection. A suitable definition of a refuge in this case can be a place where listeners perceive themselves to be in control of their acoustic environment. The expression "refuge" in this research is used as a place which offers another acoustic environment than that of the surroundings. The characteristic of the refuge is thus that it exists in contrast and sometimes in contradiction to the surroundings. The surroundings can be regarded as an *acoustic matrix*, while the refuges are like *acoustic patches*, in similarity to the terminology of landscape ecology (Forman & Godron, 1986). The patches can be tied together with *acoustic corridors/paths* or *stepping stones* so that they do not become isolated phenomena in the landscape or city. Such corridors can be used in the urban planning process to make auditory refuges accessible at a small distance from residents and workers in the region. The compilation of recommended distances to parks and green areas constitute a reasonable starting point. There is a suggested guideline of no more than 300 m to the nearest recreation area (Ericson & Ingmar, 1989). The same distance was mentioned by Alexander *et al.* (1977: 307). The distances need to be short enough to enable residents, workers, old and young to be able to partake of the qualities which are offered by parks and green areas. A similar argument regarding distances should be applicable to auditory refuges. The contrasting qualities which are offered by the refuges will make use of land, just as parks and green areas require space. The discourse on the contents and density of the cities (*i.a.* European Commission, 1990) therefore gets additional arguments against the exploitation of open spaces. Such discourse should, in actual fact, focus on the *quality* and *accessibility* of the open spaces (*e.g.* Grahn, 1991) and in particular, on the improvement of their *sound quality* in this context.

The expression *auditory refuges* is meant to refer to the development and protection of squares, walkways, parks and landscapes with various acoustic qualities. A reasonable interpretation of the expression is that such a location provides sufficient distance from the surrounding noisy activities. This does not mean that all refuges will always be mild soundscapes. Nevertheless it is important to contemplate the degree of clarity (Fig. 3). An auditory refuge requires a spatial distribution area; moreover, it can be limited in time. A time-zoned refuge could be the churchyard on Sundays, if tranquillity is desired. It is thus unsuitable to run garden machinery; surrounding operations can eventually come to a standstill or traffic temporarily diverted. Similar time zoning could be implemented for a walkway such that deliveries to businesses occur during a limited period on weekdays.

Quiet environments have been promoted as desirable during recent years in the Swedish planning process; preliminary inventories have been conducted. These inventories must, however, be viewed as bases for traditional noise planning, albeit on a larger scale. The idea behind the expression 'quiet environments' arises from a need to use decibel measurements to define and reserve the land area. Decibel inventories are nevertheless limited to specifying a single quality for sound – the degree of strength. The problem with this type of measurement is that both desirable and undesirable sounds are expressed in the same value (Brown, 2003). *Mild soundscapes* were described in Fig. 3, which is proposed as a better and more realistic designation than quiet environments. The environments which are documented always contain sounds and are naturally never *quiet*. On the other hand, they can be weak or mild. Silence works better as a relative expression (Day, 1990: 138ff; Stockfelt, 1997). An environment or experience can never be quiet; nevertheless it can be *quieter* compared to something else. The absolute expression 'quiet' is applicable to acoustic sources, since it can be said that the church bell has been silenced (is quiet), but that the environment in which the bell pealed has certainly not been silenced. In the most strict silent environment the listeners at least can hear their own blood circulation and other sounds related to the body. The quiet environment is, in principle an abstraction which should not be aimed at in practical planning and design. Instead, the sounds which arise can be managed in a modulated manner. The challenge lies in the representation of the phenomena and the assignment of words to the characteristics; this will make them communicable and pliable. *Auditory refuges* should consequently not be confused with quiet environments.

The shifting of the focus between distinct sounds and those which constitute the background in both urban and rural landscapes can be considered with respect to the *model of prominence*. Auditory refuges should thus offer other proportions than the surroundings. A successful combination of refuges in an area should provide both auditory legibility and auditory mystery. Kaplan and Kaplan (1989: 53ff) discuss corresponding characteristics based on visual studies. They present comprehensible, appealing outdoor environments which can be oriented. Appleton (1996) discusses not only refuges, but also *prospects*. One of the qualities of the auditory refuges could be the provision of an auditory equivalent to the visual prospect – an auditory panorama with a huge image depth which implies that sounds at a great distance are experienced distinctly.

Example II. Traffic control – framework for a varying soundscape

Traffic regulation is an essential concern in urban environments. Motor traffic must be increasingly *concentrated* along well-defined routes to ensure that the enclosed areas will have room for other purposes. If this does not occur then the soundscapes in the cities may converge, *i.e.*, that they will eventually all sound the same. Concentration therefore serves to avoid that extreme which is known as *monotony* (an appropriate des-

ignation in auditory contexts), even if cities will always possess more than one 'tone'.

The sounds emitted by motor traffic will not decrease appreciably in the foreseeable future (SOU 1993:65); however, the urban sounds can be more clearly categorised. Traffic should not be directed along water or parks, for example, (Rasmusson, 1985: 28) if the purpose is to enable other sounds to be noticed. Water is an effective sound distributor: it causes traffic murmurs to be heard from much greater distances. Furthermore, buildings should be located in-between strong flows of traffic and water or parks. A traffic route is an unsuitable demarcation for a recreational area, but well-designed buildings along a path can prevent sounds from spreading to such an adjacent area. The noise-damping function of a building should be integrated at its architectural execution, while maintaining its visual aesthetics. Hiramatsu (2003) illustrates how central Kyoto manages to maintain districts with tranquil cores and lanes despite being surrounded by lively streets – especially during festivals and other events.

These principles of traffic regulation are apparently not applicable to all forms of traffic sounds. The transient sounds are easy to accept and are informative. The sound of occasional passing vehicles or trains, the sounds of the pedestrians' steps and the sound of cyclists are examples of *informative* traffic noise (*i.a.* Southworth, 1969). The traffic activities which generate a continuous keynote are less informative, since the variation is either minimal or much too complex and disjointed. If such activities were geographically limited then even powerful traffic sounds could be perceived as *spatially informative*. A city street which is exposed to extremely heavy traffic gives clear indications of the types of activities which take place in its vicinity. Certain conditions are therefore implemented around it to inspire the required level of awareness in the street users – in particular pedestrians and children. If limits are not imposed on the amount of traffic in the cities then the acoustic environments will converge: the urban districts become diffuse and psychologically more demanding since the individuals do not receive directions on where to focus their attention (*e.g.* Stokols, 1978; Moser, 1988).

Additional auditory aspects can be refined through the use of traffic regulation. Interviewees in the pasture landscape (Case 1) testified that the constant sounds of the city reminded them of civilisation. Visually impaired interviewees explained that they sometimes used the murmurs from road traffic to help them with orientation. Roads and railways therefore assigned auditory directions in the landscape.

These apparently normative proposals for basic measures are probably necessary for the creation of varying acoustic environments in places where many people dwell, *i.e.*, in the cities. Traffic planning was used an example because it treats loud activities. These proposals do not extend very far, but are necessary if the work with a greater level of detail in acoustic design is to be meaningful.

Example III. Water – a source of multisensory landscape experiences

Water was investigated as an acoustic source by way of several experiments which are outlined in Appendix V. Water can offer an abundance of sound. The formulation of a regional landscape plan affects square kilometres of drainage areas. Situations which affect the flow of water through the landscape and the accompanying sounds are planned at this general level. Ecological rainwater management (Lönngren, 2001) can be implemented to recreate open brooks; this would create water sounds in both the urban and rural environments. The movements and sounds of the water reflect the landscape's topography, seasonal variations and weather. Artificial fountains can be used to accentuate the landscape. The fountains which relate to the shape of the landscape makes both the flow of the water and the landscape itself more legible. Rushing water can be used as an *acoustic camouflage* of traffic sounds, for example (*i.a.* Booth, 1983: 260; Brown, 2003). Paley Park in Manhattan is one such example (Watanabe, 1988: 78). Delage (1999: 72), however, warns against such masking techniques which create the impression of a pure environment. He points out that the acoustic energy is doubled by such measures, *i.e.*, it increases by ca. 3 dB (the experienced doubling of the sound pressure corresponds to an increase of about 10 dB). This danger may be somewhat exaggerated, since the slightly increased acoustic strength is hardly as significant to the experience as the desired improvement of the overall acoustic quality.

The open waters in the cities constitute a suitable framework to which auditory refuges can be related, as discussed in Example I above. A very large share of the world's cities lie beside streams; many of them were originally created around flowing water which produced hydropower. Ideal settings for harbours were found downstream, while fords which enabled passages were found upstream. Such sites in the landscape were attractive to settlers. The original waterfalls still exist in many places and create seasonal water sounds. These water movements and related sounds are the most original phenomena among all categories to be exhibited by the cities in certain cases. Because of this the soundscape around these *acoustic nodes* can be regarded as a cultural heritage and thus important to preserve. An example of isolated interactions between traffic sounds and waterfalls was demonstrated in Gävle, Sweden (Strömberg & Johnsson, 1995: 94ff). Soundscapes in Japan are viewed as a part of the country's cultural heritage. As was previously mentioned, a guide to 100 Japanese soundscapes was developed, several of which consisted of the sound of water (Environmental Agency of Japan, 1996; Torigoe, 1999: 103; Torigoe, 2003).

Planning and design are supported by a descriptive terminology

The need to change sounds in the outdoor environment has so far resulted in measurements and damping strategies for the most part. What is missing are alternative methods of describing and representing soundscapes so as to enable affected parties to imagine the effects of

various physical measures and modified land use on the acoustic environment.

An active sound management strategy can be formulated with the aid of the proposed methods. Descriptions of sonotopes were vital elements of these methods, which can generate basic data for planning and design. Syntax for acoustic space was discussed in Paper IV. Such descriptions can start out from the *use of land* and the users' continuously shifting *attention* at various locations. The expected *activities* at a site generally imply both specific behaviours and specific modes of hearing. Such behaviour should be described in the planning process in terms of the expected *listening modes* (Truax, 1984) since they determine which signals or messages individuals extract from a certain setting. Apart from individual messages, the entire soundscape may be of significance to listeners. That significance is related to the *acoustic atmosphere* (Böhme, 2000) and the degree of *clarity* at a site, as was previously discussed. Some basic elements such as the *sources* of sound and associated qualities related to *intensity, pitch, duration* and *space etc.* can be useful in the description of clarity. The sources may be denoted as either stationary or moving. The auditory space may be described in terms of *propagation, direction* and distance or *depth* of image. Propagation may be studied as sounds moving towards the listeners. The size of a sonic feature in the listeners' auditory space is an additional object of analysis.

The role of sounds within landscape architecture

Landscape architecture is expressed in and comments on the present era by shaping or maintaining historical parks, roads, city parks, pathways, squares and pedestrian facilities, housing areas, churchyards, national parks and catchment areas, among others. Some examples of how sounds can be viewed in various contexts will now be presented.

Questions concerning changes in the soundscape over time can be raised in conjunction with work carried out at *historical parks*. Special energy can be devoted to investigating the acoustic sources and sound generating activities of a certain epoch in those cases where the task is to recreate an ancient environment; this can contribute to the understanding of the structure (Torigoe, 1993). The authenticity of historical structures is sometimes mentioned. A city garden of historical significance and its problems with regards to auditory authenticity was described in Paper III. Devereux & Jahn (1996) point out archaeological acoustic aspects in historical landscapes. They studied the acoustics of caves and curved rock surfaces which acted much the same as parabolic reflectors.

Road planning processes were discussed to a certain extent, in association with traffic regulations and auditory refuges. Motor traffic can be concentrated to a few streets and roads where significant combined efforts can be expended on sound-reduction measures (Hedfors, 1993). The effect of the sound barriers which are erected in the landscape in the shape of banks is,

however, often doubtful. These types of sound barriers should be viewed as emergency solutions since the banks constitute unrelated formations in most landscapes. Large expanses of land and enormous amounts of landfill are required in order to connect such systems to existing terrains.

City parks are suitable to provide space for many different auditory refuges. Sowa (1999) documented sounds in parks and defined such zones. *Sonotope* was introduced in Paper III as an expression for location-based acoustic environments. Several sonotopes can be refuges, however not all acoustic environments in city parks are calm places of refuge; several are, in fact, lively environments. Water constructions give classical acoustic features to city parks. Wakao (1993) presents a variation called Suikinkutsu – a dug-out cistern in the park in which water slowly drips. The system requires very mild surroundings to be detected. Ipsen (2001) presented artificial fountains producing sounds vital to visually impaired. Several smaller fountains were presented in Appendix V. These signified the differences in the sounds between various water movements. Other acoustic installations can also be tested in the city parks (*i.a.* Brush, 1993).

A *housing area* often provides space for the children's play. Buchen and Buchen (1998; Sonic Architecture, 2003) developed acoustic playgrounds and Augustenborg, a district of Malmö in Sweden houses a similar playground (Svenska Landskap AB, 1999). Gardens can be refined with very simple resources to make it easier for people to hear each other in conversation – through the installation of a bench, for example. It is important to analyse critical locations for various auditory functions, particularly in housing environments. Unfortunately ventilation equipment is often insensitively placed in garden environments. Conflicts can be avoided in most cases with minimal resources through the careful placement and formation of the equipment's exhaust system. The sounds of the fan can be directed so that they are released in a demarcated area. In this way the system could even become a contribution to the environment.

The acoustic environment in *churchyards* is completely centred on expressions such as peace and tranquillity. Water constructions are suitable in the sections of the churchyard which are experienced as disturbed. Portals were built in the entrances of the walled churchyards in many areas during the Catholic middle ages (Johansson, 1993; Paper III). The portals are called lich gates and symbolise the transition between the profane and the consecrated grounds. Several lich gates were built of stone and produced the outdoor environment with a different architectural acoustics. This acoustic function of entrance portals is worth considering with respect to the effect on both churchyards and other gardens. In a multiethnic society with ecumenical churches there are various expectations of the acoustic environment. The implementation of time and space zones in the churchyards could create conditions for the mutual respect of the different ceremonies. The choice of bells is an important task affecting the soundscape in both churchyards and other contexts (Hasell & McLachlan, 2003).

School yards can be viewed as miniatures of the society's outdoor environments where young citizens from all social groups meet. During the renovation of school yards (*i.a.* Olsson, 2002) it is appropriate to look at the physical conditions for varying auditory experiences. A functional school can be equipped with such sonic aspects as to encourage outdoor education.

The nodes or *intersections* of the landscape, such as its squares and walkways, as well as its terminuses and travel centres (Remy, 2001) require additional acoustic care since these locations are considered to be the centres of intensive activity. Environments with dense infrastructure are easily perceived to be overloaded and difficult to grasp. A person who passes a particular node on a daily basis learns to process the necessary information in order to proceed further. The classification process requires energy and the passage can therefore be tiring. It takes a while for a tourist to process the impressions at a node. This experience may well be the aim of the journey, but the impressions can be overwhelming for the inexperienced and insecure traveller. Since nodes are intended for individuals with different backgrounds then a coherent design concept should be targeted. An acoustic concept for terminuses is the co-ordination of signals and messages; different types of signals could also be assigned to different transmission frequencies. Nodes can be advantageously connected to auditory refuges so that the contrasting effect between the intensive and the extensive aspects becomes especially distinct. The classical railway park is an excellent example of an auditory refuge in connection with a node. The railway park provides prospective travellers with an open-air waiting room.

Consideration is given to the surrounding sounds in the construction of *national parks* and other outdoor environments. Such areas are designated for biotopes and species of animals which produce peculiar sounds and acoustic environments. A national park can be planned so that a core area receives a projected acoustic environment, while a buffer zone with lower acoustic quality surrounds the core and allows a marginal space. It could be important to inform visitors of this plan, since they may otherwise not think to seek out the core area and thus fail to experience the full quality of the park.

The construction of *catchment areas* raises good prospects for a design which considers water sounds in a drainage area. Many qualities can be created and movements shaped by letting water flow in open streams. Flowing water and waterfalls can be consciously placed in locations where people pass; otherwise pathways and bridges can be constructed at those places where the water rushes noisily. Florgård *et al.* (2000: 89) highlighted the quality of water sounds with respect to the risk of a lowering of the water table after the construction of a tunnel. The quality of water sounds was treated on a similar great scale in earlier projects, this time with regards to the expansion of hydropower facilities. Since the water is led through turbines the old streams would dry up and become silent. A smaller quantity of water was instead maintained, but both the waterfall

and the bed were treated so that the water sounds resembled those of previous times (Nilsson, 2000).

These concluding glimpses into the ways in which sounds can be treated in some typical projects should be seen as reflections which are based on the results of the research work. The list can be extended: it is hoped that those who work in the field of landscape architecture will take the time to complete it.

An aesthetic approach to sustainability

A sustainability perspective on community development is unavoidable in landscape architecture and the associated planning processes (Conan, 2000; Benson & Roe, 2000b). At the same time, these processes are necessary for the creation of sustainable solutions (*e.g.* McHarg, 1969; Benson & Roe, 2000b). The concept of aesthetics was introduced in the project as a sensory aspect of sustainability. The Greek word *aisthetikós* originally referred to the perception or feeling brought about by sensory impressions (Barnhart, 1988: 17). The term aesthetics was later applied to the beauty of the arts, among other things. Ecology was the basic foundation of a discussion about sustainability in community development in the 1970s. This discussion was later expanded to include questions related to the economy and social welfare (WCED 1987). Aesthetics is therefore an additional dimension which should be taken into consideration (Berg, 2003).

This research can be looked at in a wider context, where beauty and health constitute the ingredients for sustainable urban and rural development. It is presumed that *sustainable development* needs to consider all human senses (Pallasmaa, 1996; Couic and Delétré, 1999) in order to create supportive environments in everyday life (Berg, 1993; Paper II). Sustainable development should improve the quality of life while living within the carrying capacity of supportive ecosystems (IUCP/UNEP/WWF 1991). The European Commission (1996) concludes that

> "sustainable development is thus a much broader concept than environmental protection. It implies a concern for future generations and for the long-term health and integrity of the environment. It embraces concerns for the quality of life (not just income growth), for equity between people in the present… for inter-generational equity… and for the social and ethical dimensions of human welfare" (p. 21).

Furthermore, the European Commission

> "explores the core meanings of sustainability by thinking of the city in ecosystems terms… Within the city itself it is possible to speak of ecology in the literal sense: the habitat cities provide and the plants and animals that live in them. We may also conceive of human ecology of cities – the way cities provide for human needs and wants, the qualities and options of human life they make possible, and the relationships between planning, design and service provision and human behaviour and welfare" (p. 21).

In this sense, the concept of sustainability relates to the design of sonic environments as a question of providing habitats for both animals and humans, and a question of welfare inside as well as outside of urban environments. Our starting point is the aesthetics; that is, the senses are important factors in the provision of sustainable habitats and welfare.

The European Commission (1996) finally presented a policy option called *Improvement of the quality of urban space*:

> "Urban physical problems such as decay, deterioration and pollution in cities contribute to severe human and social problems, including alienation and violence. Both the physical problems and social symptoms should be addressed. Streets and buildings influence the relationship between the citizen and their city and constitute a framework, an architectural and urban space where urban society and culture can develop. 'Urbanity' is also based upon the citizen's capacity to symbolically recognize themselves in their own city and the greater the sophistication of urban shapes, the more rich and sensitive the effects that they will induce" (p. 177).

It can be claimed that informed design of outdoor soundscapes can contribute to such sophistication. This research introduced some concepts related to the use of auditory impressions in the planning and design of landscapes; these concepts were also thought to improve habitats and increase social welfare within the carrying capacity of supportive ecosystems.

Experiences in an acoustic environment can be "sustainable" only when aesthetic aspects of said environment are taken into consideration. The soundscape cannot only be viewed as a physical resource because it has physical components. Neither should it be viewed only as a biological or social resource simply because it is experienced by biological or social beings. In addition to physical, biological and social elements, the soundscape also has psychological and musical features. It should consequently be regarded as an aesthetic asset or resource and thus assigned an aesthetic value. Truax (1984) discusses acoustic communities where great value is attached to bell-ringing as a soundmark (Schafer, 1977). A soundmark unites people, whether in a town or village. The level of aesthetic experience is therefore a significant resource in social settings. The sounds are additionally a democratic issue, *i.e.*, a matter of choice, for the visually and hearing impaired. If the visually impaired are unable to perceive the informative sounds on their own, through their canes, or from the surroundings then they will hardly have access to the society, with the result that they feel excluded. The same feeling can hearing impaired but not deaf have if they are unable to sort the relevant sonic information out of the context. This is perhaps one of the most alarming auditory aspects of the outdoor environment with regards to social sustainability.

Discussion of the research methods

Exploratory research as the unavoidable beginning

It was mentioned in the introduction to this thesis that there were scarcely any research programmes in the field of landscape architecture which had an acoustic focus. There was therefore no methodological foundation from which to start: a methodological investigation thus became the subject of the preliminary stages of this research work. This consisted largely of exploratory studies and tentative approaches. The main theory was that the selection of investigative method is determined by the definition of the research problem. Methods derived from various sources were explored in order to extract that combination which was required for the investigations. The need for further skills in the field of landscape architecture was highlighted with the aid of the formulated methodology. This particular deficiency of skills arises in the practical problems which landscape architects encounter in the roles of project worker and planner respectively. Donald Schön (1983) depicts the plight of the practitioners and the available paths of operation in the profession. The choice of investigative method used in this research was based on his pragmatic perspective. This perspective was presented in Papers II-IV.

The viewpoints and objectives of the research on landscape architecture and planning differed from those of the traditional disciplines of music and acoustics. It was therefore difficult to transfer the relevant information between these areas. The selected investigative method was used to formulate concepts to facilitate both the exchange of information and its adaptation to the relevant application. This implied that the musical and acoustic disciplines could be further applied within the scope of community development.

Design of research methods for profession-based results

The method was designed in order to produce reference objects, concepts, models and tools for the profession. Such results will only be verified after being adopted by practitioners who then apply them to their regular working routines. The research methods were developed along several *thought processes* which are used by professionals and with respect to several *practical elements* of planning and design.

The practitioners' encounters with profession-based problems can be likened to the construction of a model, where various concepts have to be established if operating models are to be developed. This realm of models can take the form of sketches, plans, drawings and physical models. The research methods were formulated to produce results which would support both the practitioners' design work, including the initiation of internal thought processes and the communication aspects, including the external dialogue with other operators in the field.

The applied methods are discussed in the following comparison between the research method used in the case studies (Paper II) and experiments conducted in the field of psychophysics. The comparison could signify a distinction between a phenomenological and a positivistic method of approach. This distinction could therefore result in the dismissal of either of the two approaches. A pragmatic approach is therefore taken with the comparisons; this explains methodological differences in several practical situations. The case studies in this research constituted the foundation for the development of both a profession-based investigative process and a similarly related tool (Paper IV). This foundation was subsequently evaluated, *i.e.*, the case studies were discussed as a *meta-methodology*.

Case studies versus laboratory experiments

Blauert (1997: 6) distinguishes between three elements in psycho-acoustic experiments: inputs (sound events), output 1 (auditory events) and output 2 (descriptions). Test subjects were subjected to controlled sounds (inputs) which were experienced as auditory events. Blauert labels these experiences output 1; he notes that these are not possible unless the test subject and the researcher are one and the same. Output 2 consists of the test subjects' interpretations in the form of statements or data; these are accessible to the researcher and others.

Blauert subsequently constructs an experimental model, but this lacks several vital elements for the description of the scenarios in the case studies of this research. The purpose of psychoacoustics is to explain human hearing (the auditory system). The case studies, on the other hand, were intended for finding concepts and determine reference objects for the processes of planning and design. The research was thus a recording of auditory experiences at various locations. The cases' sounds caused a sense of place which were described by interviewees who possess various qualifications related to sounds.

A significant element which is missing in Blauert's model (compared to the case studies) is the *location*, *i.e.*, the landscape in which the investigations take place. An additional difference is the researcher's influence on the input. The interviewees in the case studies interpreted sound events since they were unknown. Blauert's model also does not include the *state of mind* of the various interviewees. It is possible that test persons may maintain the same level of concentration in controlled laboratory settings. During this research the test subjects were distracted by all the sensory impressions which are usually produced during the day. This distraction guaranteed reality-based descriptions (output 2) based on assessments of the acoustic environments under the influence of other sensory impressions. The distraction naturally occurs in laboratory experiments, but the researcher in Blauert's model ignores the effect of the environment on the test subjects' other senses. This means that the effect of the other senses on the sense under investigation was also left out of the experimental situation.

Blauert stresses the importance of maintaining quantitative descriptions, or at least descriptions which allow quantification. Psychoacoustics results in the measurement of controlled inputs, while the case studies in this research implied an empirical description of previously unknown acoustic phenomena which had different meanings to different individuals. The case studies were based on an exploratory and qualitative investigation of sonic events, as opposed to a risky enterprise in uncontrolled situations based on irrelevant quantification which has been legitimised by established measuring techniques. The investigations were conducted with respect to the connections to the respective locations and the mutual differences between the sounds at these locations. These elements are missing in Blauert's model. The case studies thus differed from the experimental situation in several respects.

Development of tools for the profession

The case studies were not solely intended to describe the individual cases. They also resulted in general terminology and models for use in landscape architecture and planning. This research (Appendix v) supplemented the pattern language of Alexander *et al.* (1977) with cases and experiments in planning and design which clarified various acoustic settings. An array of reference objects can be compared to a typology to which practitioners can relate actual projects. The patterns of Alexander *et al.* are based on a planning problem and propose general solutions which can then be adapted to each unique location. There was no specific focus on such planning problems in this project. The planning and design experiments were instead aimed at illustrating the variety of possible pathways down which the practitioners could proceed. The tool was therefore expected to be professionally managed. Consequently, some training is required if the tones indicated by the tool are to be noticed.

The two reference objects which were presented by the method can be regarded as test cases for two ordinary scenarios: *recreation in the transition area between city and countryside* and *recreation in the city garden*. Supplementary reference objects are required in order to obtain a broader portfolio of problems, together with accompanying solutions. The selection of supplementary reference objects should therefore result from additional design problems with regards to sound.

It can be seen as difficult to make generalisations based on a single case, since each location is considered to be unique, just as the occurrences at each site. One form of generalisation occurred at the instant in which the interviewees expressed themselves in words. They were able to form generalisations of their experiences using certain expressions (cf. Blauert's Output 1 and 2 above). The informants' expressions and the interviewer's subsequent interpretation comprised the method of generalisation which was used in this investigation. These were thus not widely applicable generalisations based on statistically guaranteed basic data.

One form of generalisation which was tested involved representing the names of places in universal terms. Instead of using the names *Hågahögen* (The Håga mound) and *Linnéträdgården* (The Linnéträdgården garden), the designations *beteslandskapet* (the pasture) and *stadsträdgården* (the public city garden) were used as short descriptions of the two settings. These designations were intended to encourage practitioners to use naturalistic generalisations (Stake, 1995: 85ff). Practitioners would in that way draw their own conclusions and find similarities and differences between their own projects and several different reference objects or patterns. This would then cause the discerning practitioners to reflect on their own conclusions. The research task was thus to apply solid techniques to the selection of objects, to discuss the aim and selection process, to document relevant aspects of the research object and to adapt the presentation of results to the target group. At the same time, the target group was to evaluate the research and benefit from the results.

Selection of research path

This section refers to Appendices I-V

The discussion of the research method now proceeds according to Fig. 1 of Paper I. This paper presents four areas for the collection of empirical data, namely *physical acoustic measurements, acoustic documentation* (sound recordings), *interviews* and *landscape analysis* (where the sounds occur). Paper II outlines the methods applied in the interview in six steps and is entitled *Site Interpretation by Skilled Listeners*. It was natural to formulate a qualitative interview method (Kvale, 1996) in order to initiate the discussion of the problem area; the individuals in this case were experienced listeners by virtue of their professions or other reasons. One of the above steps involved investigations of the location with the aid of landscape architecture terminology with which places are typically described. Another step contained visualisations or geographical representations which were intended to communicate the experiences of the interviewees and reflect the locations (cf. Appendix A, B). The six steps corresponded with two of the methods in Fig. 1 of Paper I, namely *interviews* and *landscape analysis*. Paper II also contained a semantic step with opposite words (Appendix: 114). The subsequent quantitative results were not presented, since the number of interviewees was too small. The list of words was instead considered to be suitable for introduction towards the end of an interview, as an additional basis for discussion. The results of the interviews were quoted in Paper III. The most important categories were discussed against the backdrop of an analysis of the transcriptions. An in-depth investigation of the locations was presented and a discussion on auditory experiences was carried out for each location.

Appendix V focused on a third method according to Fig. 1 of Paper I. The *acoustic documentation* which was conducted was based on the results of the interviews and the landscape analysis. The purpose of the research was to develop a tool by preparing and presenting documents on acoustic phe-

nomena in a prescribed manner. Practitioners were thus encouraged to listen and benefit from these presentations. The research objectives did not specify the need for a highly precise formulation of the various situations: instead, the need to develop practical methods to assist professionals in understanding a comparatively overlooked problem was stipulated. The methods were not primarily systematic, but were instead rather *heuristic* in order to stimulate discoveries. Pedagogical considerations are required if the sonotopes are to be communicated in an interactive environment as afforded by the format of a CD-ROM. An evaluation of the prototype (Appendix V) by landscape architects pointed at the usefulness of the results (Paper IV).

Related methods

The method of approach in this investigation can be compared to that of Alexander *et al.* (1977) with respect to the development of practical models for use in planning and design. While the models and the problem scenarios were not expressed as precisely as those of Alexander *et al.*, they were based on examples which were taken from precise locations. Several site-specific characteristics of the reference objects were nevertheless described in a similar manner to that presented by Alexander's *et al.* (Paper III). The models require that an investigative direction be taken by the practitioners, as was previously mentioned (Appendix V).

The descriptive accounts of the location experiences (Paper III) bring the results of geographical methods of approach to mind (*e.g.* Granö, 1997; Ohlson, 1975; Porteous & Mastin, 1985; Smith, 1993; Carles, López Barrio & de Lucio, 1999; Winkler, 2002). There is a similar descriptive technique in the field of musicology (*e.g.* Schafer, 1977; Uimonen, 2002; Minoura & Hiramatsu, 2000). The purpose of these methods is to investigate the *characteristics* of the acoustic landscapes. The investigative method formulated by Alexander *et al.* (1977) and which is used in this research to a certain extent should instead be regarded as *design research*. Kaplan, Kaplan and Ryan (1998) formulated corresponding methods, but in the context of environmental psychology.

Base in scientific theory

Landscape architecture, other forms of architecture and planning research all have a common base in scientific theory (Næss & Saglie, 1999). A wide array of problems controls the choice of investigative method. Generally, these methods are intimately associated with various scientific theories. The research problem faced by the field of landscape architecture is often *situation- or location-based* and *solution-driven* (*e.g.* Thompson, 1999: 3). The landscape architect's scientific theory is therefore characterised by *pragmatism* and *contextual focus* (Swaffield, 2002). It is further characterised by a concerted aspiration to suitability and adjustment before each individual research problem. The openness of landscape architecture to scientific

theory arises from the multitude of problems to which the researcher can be exposed. Within the discipline there is both a consensus and a curiosity with respect to the freedom to choose the method and corresponding theory, depending on the research problem to be investigated (Swaffield, 2002).

The term *relativism* plays a part in the explanation of the base in scientific theory. Relativism in this case is associated with the contextual focus or relation and is based on the theory that a specific knowledge is only applicable in a limited context. This is obvious to the landscape architect, since each location has unique characteristics, of which only a few can be treated with general methods. Relativism does not imply that all knowledge is applicable, but that the knowledge must be related to each unique location – it needs to be *associated*. The focus of pragmatism on *useful* knowledge, as opposed to *true* knowledge, is associated with the theory of relativism. It is the useful knowledge which is applicable in the unique locations, while the general true knowledge is viewed as being provisional and thus needs to be selected and carefully managed in order to become *useful*.

This project did not seek to establish the state of the object's condition. The results from the conducted interviews cannot be interpreted as the *only* true descriptions of the soundscapes by any means. The interviews constituted the foundation for an analysis of the knowledge requirement within the field of landscape architecture. The descriptions of the reference objects illustrated how several individuals who were qualified in various sectors dealing with sound expressed themselves with vocabulary which is unusual in landscape architecture. The aim was thus to select a number of expressions such as background, depth of image, sound shadow and echo-localisation, which could be *useful* in the processes of planning and design.

This project was also grounded in *phenomenology*, where one group of direct sensory experiences, the auditory experiences, were the main focus. The exploratory character of the problem area required an investigative method of approach; as a result there were several untested methods from which to choose. The work did not proceed according to a traditional natural science perspective. However, such a perspective is at times assumed in order to determine certain facts by experimental methods. The project also had a *qualitative* base. It was attempted to determine the qualities of the acoustic environments, rather than quantifying one or several parameters. It is vital that a qualitative investigation precedes the comprehension of individual parameters, as well as that of the values which such parameters can assume.

It may be necessary to reflect on the visual sense again and the manner in which it is treated in research. Which parameters that produce quantities of light are directly harmful (*e.g.* from a blow torch)? Such research questions seek to avoid the risks involved. But risks are not the focus of the investigation into acoustic images in landscape architecture; the focus is rather on such questions which concern the *identities* and *design* of places. A sense of *well-being* is not only determined by risk management

and basic needs, but is also based on other, more sophisticated considerations.

A contrast between a qualitative research which is, to all intents and purposes, difficult and the precise needs of the profession can be revealed. Rational methods are required in the application of landscape architecture and planning in order to achieve a high degree of efficiency. It may therefore be considered natural to comply with the requests of the profession, from a pragmatic perspective. It is, however, too early to determine the manner in which the qualities of the acoustic environment will be managed with regards to faster and simpler methods.

An exploratory projection is often associated with a theory which is based on empirical investigations, *i.e.*, a grounded theory. Deduction and induction are sometimes compared in order to emphasise the difference between research investigations (*i.a.* Lundequist, 1995: 32-33). The deductive strategy is said to be based on an existing theory which is tested, while the inductive strategy is based on empirical data, *i.e.*, a collection of some form of data from which a theory is formulated or grounded. A third term is abduction, where consideration is given to the researchers' pre-comprehension of a research problem. Abduction is therefore a better term to be applied to this research. There is no official theory on the objects' condition; neither does a practical investigative procedure exist. Similarly, a description which is based entirely on grounded theory does not do the research justice. The pre-comprehension taken together with an exploratory collection of data, *i.e.*, *data creation* (Kvale, 1996: 12), better describes this research. The aim was to construct a conceptual model, or a theory, based on the preliminary understanding and the data creation. It is hoped that the conceptual model, together with the related tools will contribute towards the formulation of a *practical theory* (Cronen, 2001). The professionals' application of relevant sections of such a propagating theory constitutes the actual practical theory.

Conclusions and future prospects

This research can be regarded as a reorganisation of well-known principles from other disciplines. The information contained in this thesis was intended to be adapted to a particular target group – landscape architects. The thesis was therefore an attempt to apply principles from various disciplines to one specific profession. This was supplemented by empirical data which was gathered using specially designed methods.

The *model of prominence* was suggested both as a starting point for practitioners and an introduction to the processes involved in landscape architecture and planning. This hypothetical model was produced from the research. The model was formulated based on the result of interviews and found useful while describing auditory experiences in outdoor environments. This implied the adoption of separate acoustic and musical terminology which was arranged into a clear picture. The model was intended as a support for changes in outdoor environments with respect to their acoustic characteristics, but it might equally be applied to all sensory impressions.

The model contains a dimension which is denoted *clarity*. The extremity of clarity was clear-crowded. A soundscape can maintain clarity and still be crowded to a certain extent. It is up to each individual to determine whether such a concentrated acoustic environment can be deemed clear, depending on that individual's actions and state of mind. Those cases where the crowded state becomes over-crowded give rise to situations in which the acoustic environment becomes over-informative; the result is that the individual is unable to trace the relevant sonic information. The location has therefore lost its auditory legibility and is thus no longer clear to the individual.

Sonotopes and *site soundscapes* were introduced in order to support an auditory approach to the design of outdoor environments. Both terms serve to create a connection between places in general and the sounds at these sites. The listeners' perception of sounds is focused rather than the sounds produced from acoustic sources. *Auditory refuge* as a form of sonotope was introduced as a planning tool for the purpose of highlighting, extracting and contrasting auditory experiences in landscapes or cities. Auditory refuges were formulated in case studies where two locations were studied; both permitted investigative listening. Auditory refuges were suggested to be more realistic than quiet environments. The case studies demonstrated that auditory refuges required *distance* from surrounding loud activities. If effective auditory refuges are to be created in inhabited areas such as cities then much space is needed. The increasing exploitation of open spaces in already densely populated cities was therefore questioned, based on the results of this research. The arguments were presented in Paper III.

Great significance is placed on the visual impressions in contemporary landscape architecture and planning. These characteristics provide the foundations of the view of overall aesthetic experiences in the profession. A non-visual example is one in which the auditory impression not only warns the individual of activities and operators in the landscape, but also controls the visual awareness. The example accentuates the co-operation between the senses. A greater awareness of sounds and other sensory impressions creates a more harmonious understanding of the individuals' aesthetic encounter with the surrounding landscape. Such an understanding should be taken into consideration during the processes of planning and design.

Torbjörn Stockfelt (1997) gathers all aspects related to the field of sound under the term *sonology*. This expression with the suffix -logy denotes the theoretical knowledge. This research focused instead on several *practical applications* and sought to promote the management of sound. The term *sononomy* is a complement to this focus on the theoretical aspects and refers to the continuous maintenance of supportive sound environments for living creatures. The prefix, -nomy, denotes the management skills and thereby comprises everything to do with the administration, care and operation of ongoing processes and physical facilities, in addition to the production of items such as motor vehicles, leaf bowers, ventilation equipment and speakers on terminals, with respect to sound.

Future prospects

The purpose of this research was to contribute to the development of the field of landscape architecture. One subject for future investigation is to establish a closer link between this research and the urban development theory of landscape architecture. The terms sonotope (site soundscape) and auditory refuge contributed to the theory which stressed the problems of landscape architecture in the context of urban planning. The aesthetic problems, *i.e.*, the questions related to the sensory impressions in the outdoor environment, are at the centre of this theory; one of the senses was highlighted through the introduction of expressions such as sonotope and auditory refuge. The development of a design which takes *intersensory* aspects into consideration is, however, a long-term goal. Other matters of concern with respect to the urban development theory are for instance landscape ecology and local energy production. The provision of recreational facilities and the implementation of preventive healthcare measures are additional areas which both fall under the theory and are related to intersensory aspects. The expressions for auditory experience are applicable to both recreational and preventive healthcare measures.

The urban development theory constitutes a section of a programme which was discussed at the Department of Landscape Planning in Uppsala in relation to research in the field of landscape architecture. The aim of this programme, entitled *Managing Landscape Values*, was to investigate the processes of planning and design in the management of the physical

resources in the landscape, as well as of those values which are typically placed on the landscape by interested parties. One aim of these processes is to facilitate the comfort of those affected in the proposed environment. The connection between land use or functional surfaces and the expected state of mind is important if sounds and other sensory experiences are to be understood. Land use patterns are often used to aid the understanding of the landscape during the processes; however, the expectations of the concerned individuals and their state of mind at respective locations need to be investigated in greater detail.

The development of an interactive tool was viewed as a method of transmitting knowledge. The method involved the use of acoustic image sequences to demonstrate the ability to increase the comfort of concerned individuals in the proposed environment. This was presented in the context of a planning and construction project. Audio-visual representations can be developed with computer support. Other sensory impressions are more difficult to recreate using ordinary computer equipment. The gradual construction of a *studio* for multi-sensory experiences is therefore one vision. Such an environment would facilitate the simulation of outdoor environments, where certain parameters could be kept constant. Furthermore, students would be able to practice in the studio and design solutions tested.

The co-operation to manage acoustic problems in the Swedish society has been inadequate, especially with respect to the outdoor environment (Karlsson, 2000: 23). The problem was to co-ordinate a host of regulations which were designed to limit specific noise emissions. This can now be more effectively executed on the basis of the viewpoints highlighted in this research. Desirable acoustic qualities which promote different forms of land use can thus be defined. As a result, properties with various qualitative criteria can be regarded as planning objects. The sound emissions which reduce the quality of these properties can consequently be geographically defined. The authoritative body under whose portfolio such matters fall should define the soundscape qualities which are desirable in various regions. A useful framework of criteria can be developed on the basis of this research. In a similar manner, alternative methods of inventory, planning and design can also be formulated.

Soundscape research in the field of landscape architecture is uncommon. Its application, as presented in this thesis, was intended broaden the scope of the discipline. It may be considered that a more conventional problem could contribute more to the definition of the core principles of the subject. It is hoped that the investigation of this acoustic problem will cast the discipline in a new light.

References

Abdulkarim, Dina & Abu-Obied, Natheer. 2001. The sonic image of the environment – characterising and evaluating soundscapes. *Conf. proceedings "Sound Practice", Dartington Collage of Arts, Devon*, UK, *16-20 Feb.*, 1-10.

Adorno,Theodor W. 1976. *Inledning till musiksociologin – tolv teoretiska föreläsningar* (Introduction to the sociology of music). Cavefors. Lund, Sweden.

Alexander, Christopher, Ishikawa, Sara, Silverstein, Murray, Jacobson, Max, Fiksdahl-King, Ingrid & Angel, Shlomo. 1977. *A Pattern Language – towns, buildings, construction.* Oxford Univ. Press. New York, USA.

Amphoux, Pascal (ed.). 1991. The acoustic quality of urban space. *Architecture & comportement–Architecture & behaviour, vol. 7,* NO. *1.*

Amphoux, Pascal. 1993. L'Identité sonore des villes européennes – guide méthodologique. (The acoustic identity of European cities, in French). *Centre de recherche sur l'espace sonore et l'environnement urbain, Grenoble/Institut de recherche sur l'environnement construit, Lausanne, Rapport,* NO. *117.*

Anderson, L.M., Goodman, L.S., Mulligan, B. Edward & Regen, H.Z. 1983. Effects of sounds on preferances for outdoor settings. *Environment and behavior, vol. 15,* NO. *5,* 539-566.

Andersson, Thorbjörn, Jonstoij, Tove & Lundquist, Kjell (eds.). 2000. *Svensk trädgårdskonst under 400 år* (Swedish garden design during 400 years, in Swedish). Byggförl. Stockholm, Sweden.

Ando, Yoichi. 1998. *Architectural Acoustics – blending sound sources, sound fields, and listeners.* AIP Press/Springer. New York, USA.

Appleton, Jay. 1996 (1975). *The Experience of Landscape.* Wiley. Chichester, UK.

Arnheim, Rudolf. 1974 (1954). *Art and Visual Perception – a psychology of the creative eye.* Univ. California Press. London, UK.

Augoyard, Jean-François. 1999. The cricket effect. In: Henrik Karlsson (ed.), *From Awareness to Action, Conf. proceedings "Stockholm, Hey Listen!", Royal Swedish Academy of Music/World Forum for Acoustic Ecology, Stockholm, Sweden, 9-13 June 1998,* 116-125.

Augoyard, Jean-François, Karlsson, Henrik & Winkler, Justin. 1999. Report and resolution of the Soundscape Research Study Group. In: Henrik Karlsson (ed.), *From Awareness to Action, Conf. proceedings "Stockholm, Hey Listen!", Royal Swedish Academy of Music/World Forum for Acoustic Ecology, Stockholm, Sweden, 9-13 June 1998,* 130-135.

Augoyard, Jean-François & Torgue, Henri (eds). 1995. *À l'écoute de l'environnement – répertoire des effets sonores* (Listening for the environment, in French). Editions Parenthèses. Marseilles, France.

Axelsson Lindgren, Christina. 1990. Upplevda skillnader mellan skogsbestånd – rekreations- och planeringsaspekter (Perceived differences between forest stands, in Swedish with English summary). *Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning/Movium, Stad & land,* NO. *87.* ISSN 0280-4549.

Barnhart, Robert K. (ed.). 1988. *Chambers Dictionary of Etymology – the origins and development of over 25,000 English words.* Chambers. Edinburgh, UK.

Barron, Michael. 1993. *Auditorium Acoustics and Architectural Design.* Spon. London.

Bell, Paul A., Greene, Thomas C., Fisher, Jeffery D. & Baum, Andrew. 2001. *Environmental Psychology.* Harcourt. Fort Worth, TX, USA.

Benson, John F. & Roe, Maggie H. 2000a. The scale and scope of landscape and sustainability. In: John F. Benson & Maggie H. Roe (eds.), *Landscape and Sustainability,* 1-11. Spon. London, UK.

Benson, John F. & Roe, Maggie H. (eds.). 2000b. *Landscape and Sustainability.* Spon. London, UK.

Berg, Per G. (ed.) 1993. *Biologi och bosättning – naturanpassning i samhällsbyggandet* (Biology and settlement, in Swedish). Natur och kultur/Institutet för framtidsstudier. Stockholm, Sweden.
Berg, Per G. 2003 (in press). Sustainability resources in three townscape neighbourhoods – results from model project Hågaby and comparisons with three common residential aeras. Landscape and Urban Planning.
Berggren-Bärring, Ann-Margreth & Grahn, Patrik. 1995. Grönstrukturens betydelse för användningen – en jämförande studie av hur människor i barnstugor, skolor, föreningar, vårdinstitutioner m.fl. organisationer utnyttjar tre städers parkutbud (Green structure's importance in utility, in Swedish with English summary). *Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning Alnarp, Rapport,* NO. *3.*
Bernsen, Jens. 1999. *Lyd i Design–Sound in Design.* Danish Design Centre/Delta Acoustics and Vibration. Copenhagen. Denmark.
Birksted, Jan (ed.). 1999. *Relating Architecture to Landscape.* Spon. London, UK.
Blauert, Jens. 1997. *Spatial Hearing – the psychophysics of human sound localization.* Massachusetts Inst. of Technology. Cambridge, MA, USA.
Blauert, Jens & Jekosch, Ute. 1997. Sound-quality evaluation – a muli-layered problem. *Acustica/Acta acustica, vol. 83,* 747-753.
Booth, Norman K. 1983. *Basic Elements of Landscape Architectural Design.* Elsevier. New York. USA.
Bregman, Albert S. 1990. *Auditory Scene Analysis – the perceptual organization of sound.* Massachusetts Inst. of Technology. Cambridge, MA, USA.
Brigham, Don Jr. 2000. Plants of a musical nature – plant selection can reflect musical themes. *Landscape architecture, Dec.,* 22.
Brown, A. Lex. 2003 (unpubl.). Acoustic objectives for designed or managed soundscapes. Conf. paper presented at "Acoustic Ecology", Australian Forum for Acoustic Ecology/World Forum for Acoustic Ecology, Melbourne, Australia, 19-23 March.
Brush, Leif. 1993. Aspects of the terrain instruments. *Conf. proceedings "The Tuning of the World", Banff, Canada, 8-14 Aug., vol. 2.*
Buchen, Bill & Buchen, Mary. 1998. *Sonic Architecture.* Sonic Architecture. New York, USA.
Bucht, Eivor. 1997. Public parks in Sweden 1860-1960 – the planning and design discourse. *Swedish Univ. of Agricultural Sciences, Acta Universitatis Agriculturae Sueciae, Agraria,* NO. *56.* ISSN 1401-6249.
Böhme, Gernot. 2000. Acoustic atmospheres – a contribution to the study of ecological aesthetics. *Soundscape–Journal of acoustic ecology, vol. 1,* NO. *1,* 14-18.
Cage, John. 1976. *Silence – lectures and writings by John Cage.* Wesleyan Univ. Press. Middletown, CT, USA.
Canter, Larry W. 1996. *Environmental Impact Assessment.* McGraw-Hill. Boston, MA, USA.
Carles, José, Bernáldez, Fernando & de Lucio, José. 1992. Audio-visual interactions and soundscape preferances. *Landscape Research, vol. 17,* NO. 2, 52-56.
Carles, José Luis, López Barrio, Isabel & de Lucio, José Vicente. 1999. Sound influence on landscape values. *Landscape and urban planning, vol. 43,* 191-200.
Cazeaux, Clive. 2001. Sound and synaesthesia in Nietzsche and Merleau-Ponty. *Conf. proceedings "Sound Practice", Dartington Collage of Arts, Devon,* UK, *16-20 Feb.,* 35-40.
Chion, Michel. 1994. *Audio-Vision – sound on screen.* Columbia. New York, USA.
Collingwood, Robin George. 1938. *The Principles of Art.* Oxford Univ. London, UK.
Conan, Michel (ed.). 1999. *Perspectives on Garden Histories.* Dumbarton Oaks. Washington D.C., USA.
Conan, Michel (ed.). 2000. *Environmentalism in Landscape Architecture.* Dumbarton Oaks. Washington D.C., USA.

Couic, M. Christine & Delétré, J. Jacques. 1999. An intersensory approach to urban analysis and design. *Conf. proceedings, Acoustical Society of America/European Acoustics Association–Forum Acusticum, Berlin, Germany, 14-19 March.*

Cronen, Vernon E. 2001. Practical theory, practical art, and the pragmatic-systemic account of inquiry. *Communication theory, vol. 11,* NO. *1,* 14-35.

Crunelle, Marc. 1993. Is there an acoustical tradition in western architecture? *Conf. proceedings "The Tuning of the World", Banff, Canada, 8-14 Aug., vol. 2.*

Cullen, Gordon 1971. *The Concise Townscape.* Butterworth-Heinemann. Boston, MA, USA.

Dandrel, Louis. 1993. Sound town planning. *Conf. proceedings "The Tuning of the World", Banff, Canada, 8-14 Aug., vol. 1.*

Daumal i Domènech, Francesc. 1998a. Basic sonor elements in architecture – urban and landscape. In: Henrik Karlsson (ed.), *Conf. papers "Hör upp! Stockholm Hey Listen!", Royal Swedish Academy of Music, Stockholm, Sweden, 9-13 June,* 36-41.

Daumal i Domènech, Francesc. 1998b. Arquitectura acústica – 1 poètica (Architectural acoustics, in Catalan). *Universitat politècnica de Catalunya, Quaderns d'arquitectes,* NO. *17.*

Dawson, Kerry J. 1988. Flight, fancy and the garden's song. *Landscape Journal, vol. 7,* NO. *2,* 170-175.

Dawson, Kerry J. 1998. Natural sound in the garden. In: Henrik Karlsson (ed.), *Conf. papers "Hör upp! Stockholm Hey Listen!", Royal Swedish Academy of Music, Stockholm, Sweden, 9-13 June,* 42-47.

Day, Christopher. 1990. *Places of the Soul – architecture and environmental design as a healing art.* Aquarian. London, UK.

Delage, Bernard. 1999. On sound design. In: Henrik Karlsson (ed.), *From Awareness to Action, Conf. proceedings "Stockholm, Hey Listen!", Royal Swedish Academy of Music/World Forum for Acoustic Ecology, Stockholm, Sweden, 9-13 June 1998,* 67-73.

Devereux, Paul & Jahn, Robert G. 1996. Preliminary investigations and cognitive considerations of the acoustical resonances of selected archeological sites. *Antiquity, vol. 70,* 665-666.

Domän. 1992. Akustikreservatet i Uttersberg (The acoustic reserve in Uttersberg, in Swedish). Hedemora skogsförvaltning, Beslut 1992-06-29. Ks 98/92 Nv 20.10.

Don, Montagu. 2001. *Sensuous Garden.* Conran Octopus. London, UK.

Dvoretsky, Sigurd. 1982. *Perception och perceptionsstörningar* (Perception and perceptual disorder, in Swedish). Gothia. Göteborg, Sweden.

Dyrssen, Catharina. 1998. Eyes letting go. In: R. Murray Schafer & Helmi Järviluoma (eds.), *Northern Soundscapes – yearbook of soundscape studies, vol. 1. Univ. of Tampere, Dept. of Folk Tradition, Publ.* NO. *27,* 7-23. ISSN 0357-0010.

Eckerberg, Klas. 1999. Information technology in landscape architecture – development of tools, methods, and professional role. *Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning Ultuna, Samhälls- och landskapsplanering,* NO. *6.* ISSN 1403-1361.

Elfström, Johan. 1991. Landskapsbildsanalys – landskapets visuella identitet med exempel från Nyköpings kommun (Analysis of the visual appearance of landscape, in Swedish with English summary). *Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning/Movium, Stad & land,* NO. *97.* ISSN 0280-4549.

Engelen, Heleen. 1999. Sounds in consumer products. In: Henrik Karlsson (ed.), *From Awareness to Action, Conf. proceedings "Stockholm, Hey Listen!", Royal Swedish Academy of Music/World Forum for Acoustic Ecology, Stockholm, Sweden, 9-13 June 1998,* 65-66.

The Environmental Agency of Japan. 1996. *100 Soundscapes of Japan – preserving our heritage.*

Ericson, Gunnar & Ingmar, Tord 1989. Nära till naturen – en diskussion om riktlinjer för grundtillgång på friluftsmarker nära tätorter (Close to nature). *National Swedish Building Research, Rapport, Byggforskningen,* NO. R102. ISSN 0349-3296.

The European Commission. 1990. *Green Paper on the Urban Environment – communication from the Commission to the Council and Parliament.* COM(90)218. Brussels, European Commission.
The European Commission. 1996. *European Sustainable Cities.* Brussels, European Commission.
Florgård, Clas. 1981. Naturmark i bebyggelse (Natural vegetation and development, in Swedish with English summary). *Swedish Univ. of Agricultural Sciences, Konsulentavd. rapporter, Landskap,* NO. *64.* ISSN 0347-9676.
Florgård, Clas, Linnér, Harry, Olsson, Mats, Olsson, Susanna, Persson, Gunn & Wiklander, Gunnar. 2000. Grundvattensänkning på Hallandsås – effekter på natur, jordbruk och skogsbruk (Drop in the groundwater level on Hallandsås, in Swedish). *Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning Ultuna, Samhälls- och landskapsplanering,* NO. *11.* ISSN 1403-1361.
Forman, Richard T.T. & Godron, Michel. 1986. *Landscape Ecology.* Wiley. New York, USA.
Fröding, Gustaf. 1997 (1891). Gitarr och dragharmonika *(Guitar and Concertina)*. Oak Tree Press. Wintringham, UK.
Gaver, William W. 1993. How do we hear in the world? – explorations in ecological acoustics. *Ecological Psychology, vol. 5,* NO. *4,* 285-313.
Geddes, Patrick. 1971 (1915). *Cities in Evolution – an introduction to the town planning movement and to the study of civics.* Harper Torchbooks. New York, USA.
Gehl, Jan. 1996. *Life Between Buildings – using public space.* Arkitektens forl. Copenhagen, Denmark.
Grahn, Patrik. 1991. Om parkers betydelse – parkers möjligheter att underlätta och berika föreningsverksamhet och arbete på daghem, skolor, servicehus och sjukhus (On the importance of parks, partly in Swedish and English with English summary). *Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning/ Movium, Stad & land,* NO. *93.* ISSN 0280-4549.
Granö, Johannes Gabriel. 1997 (1929). *Pure Geography.* Johns Hopkins Univ. Press. Baltimore, MD, USA.
Gustavsson, Roland. 1986. Struktur i lövskogslandskap – former och samspel mellan lövträd och buskar i Sjöarps lövskogsområde – strukturella typer, egenskaper och förändringar i innerbestånd, bryn, buskage och halvöppen mark (Structure in the broadleaved landscape, in Swedish with English summary). *Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning/Movium, Stad & land,* NO. *48.* ISSN 0280-4549.
Gärling, Tommy & Toomingas, Allan. 1975. Experimentalpsykologiska undersökningar av auditiv rumsupplevelse (Experimental psychology investigations of feeling of auditory space). In: Hesselgren, Sven, Brodin, Carina, Gärling, Tommy, Toomingas, Allan & Sivik, Lars. Arkitekturpsykologi – en översikt samt något om stadsmiljöupplevelse, rumsupplevelse och färgupplevelse. *National Swedish Building Research, Rapport, Byggforskningen,* NO. R24, 54-63. ISSN 0346-5616.
McHarg, Ian L. 1969. *Design with Nature.* Wiley. New York, USA.
Harris, Charles W. & Dines, Nicholas T. (eds.). 1998. *Time-Saver Standards for Landscape Architecture – design and construction data.* McGraw-Hill. London, UK.
Hasell, Anton & McLachlan, Neil. 2003. The secular bell. *Conf. proceedings "Acoustic Ecology", Australian Forum for Acoustic Ecology/World Forum for Acoustic Ecology, Melbourne, Australia, 19-23 March.*
Hedfors, Per. 1993. Auditiva stadsrum – ljud och akustisk utformning i stadslandskapet. (Auditory city space, in Swedish with English abstract). *Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning, Stencil,* NO. *4.* ISSN 0282-5023.
Hedfors, Per. 2001 (unpubl.). Att tyda och samtala om ljudbilder i landskapsarkitekturen (To interpret and talk about acoustic images in landscape architecture). Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning Ultuna, Uppsala, Rapport, 13 June.

Hedfors, Per. 2002. Med öppna öron för trädgård (With open ears for the garden, in Swedish). *Swedish Univ. of Agricultural Sciences, Fakta Trädgård-Fritid,* NO. *87.* ISSN 1102-1969.
Hellström, Björn. 2001. Modelling of sound in public spaces. *Conf. proceedings "Sound Practice", Dartington Collage of Arts, Devon,* UK, *16-20 Feb.*, 41-48.
Hellström, Björn. 2002. The sonic identity of European cities – a presentation of the work conducted by the Swiss-French researcher Pascal Amphoux. In: Helmi Järviluoma & Gregg Wagstaff (eds.), Soundscape Studies and Methods. *The Finnish Society for Ethnomusicology Publ.,* NO. *9/Univ. of Turku, Dept. of Art, Literature and Music Series,* NO. A*51*, 59-82.
Hellström, Björn. 2003 (in press). Noise Design – architectural modelling and the aesthetics of urban acoustic space. Royal Institute of Technology, Dept. of Architecture. Stockholm, Sweden.
Herrington, J. Duncan & Capella, Louis M. 1996. Effects of music in service environments – a field study. *The Journal of Services Marketing, vol. 10,* NO. 2, 26-41.
Hesselgren, Sven. 1967. *The Language of Architecture.* Studentlitteratur. Lund, Sweden.
Hiramatsu, Kozo. 1999. Activities and impacts of soundscape association of Japan. *Conf. proceedings "Internoise", Fort Lauderdale,* FL, USA, *6-8 Dec.*, 1357-1362.
Hiramatsu, Kozo. 2003. The idea of soundscapegraphy and its description of old town of Kyoto with Gion Festival. *Conf. proceedings "Acoustic Ecology", Australian Forum for Acoustic Ecology/World Forum for Acoustic Ecology, Melbourne, Australia, 19-23 March.*
Hogdal, Jon. 1995 (unpubl.). Ljuden i landskapet–ljudskapet (The sounds in the landscape–soundscape). Conf. paper, Uppsala Univ., Dept. of Social and Economic Geography, Leufsta bruk, Sweden, 6-7 June.
Hull, John. 1990. *Touching the Rock – an experience of blindness.* SPCK Publ. London, UK.
Hägerhäll, Caroline. 1999. The experience of pastoral landscapes. *Swedish Univ. of Agricultural Sciences, Acta Universitatis Agriculturae Sueciae, Agraria,* NO. *182.* ISSN 1401-6249.
Ipsen, Detlev, 2001. Towards a new water culture. In: Herbert Dreiseitl, Dieter Grau & Karl H.C. Ludwig (eds.), *Waterscapes – planning, building and design with water,* 124-143. Birkhäuser. Basel, Switzerland.
Ipsen, Detlev. 2002. The urban nightingale – or some theoretical considerations about sounds and noise. In: Helmi Järviluoma & Gregg Wagstaff (eds.), Soundscape Studies and Methods. *The Finnish Society for Ethnomusicology Publ.,* NO. *9; Univ. of Turku, Dept. of Art, Literature and Music Series,* NO. A*51*, 185-197.
IUCP/UNEP/WWF. 1991. *Caring for the Earth.* World Conservation Union/UN Environment Programme/World Wide Fund for Nature. Gland. UN.
Iwamiya, Shin-ichiro, Hosono, Haruo & Fukuda, Kazuaki. 1992. Interaction between acoustic environment and landscape – the effect of acoustic environment on perceived landscape and the effect of landscape on percieved acoustic environment. *Annals of Physiological Anthropology, vol. 11,* NO. *1,* 51-59.
Johansson, Jan. 1993. Kyrkogårdens hägn i det medeltida Sverige – om bogård, balk och stiglucka (The enclosure of the churchyard in medieval Sweden, in Swedish with English summary). *Kungl. Vitterhets Historie och Antikvitets Akademien, Antikvariskt arkiv,* NO. *76.* ISSN 0083-6737.
Kageyama, Takayuki. 1993. Individual differences in preference for environmental sounds. *Perceptual and Motor Skills, vol. 76,* NO. *1,* 279-284.
Kaplan, Rachel & Kaplan, Stephen. 1989. *The Experience of Nature – a psychological perspective.* Cambridge Univ. Press. Cambridge, MA, USA.
Kaplan, Rachel & Kaplan, Stephen. 1990. Restorative experience – the healing power of nearby nature. In: Mark Francis & Randolph T. Hester, Jr. (eds.), *The Meaning of Gardens – idea, place, and action,* 238-243. Massachusetts Inst. of Technology. Cambridge, MA, USA.

Kaplan, Rachel, Kaplan, Stephen & Ryan, Robert L. 1998. *With People in Mind – design and management of everyday nature.* Island press. Washington D.C., USA.
Kariel, Herbert G. 1980. Mountaineers and the general public – a comparison of their evaluation of sounds in a recreational environment. *Leisure Sciences, vol. 3,* NO. 2., 155-167.
Karlsson, Henrik. 2000. Ljudvärldar – nya fält för musikforskare (Sound worlds, in Swedish with English summary). *Svensk tidskrift för musikforskning, vol. 82,* 21-40.
Karlsson, Kristina. 1991. Auditiva aspekter på landskapsplanering (Auditory aspects on landscape planning, in Swedish). *Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning, Stencil,* NO. 9. ISSN 0282-5023.
Kihlman, Tor, Kropp, Wolfgang, Öhrström, Evy, Berglund, Birgitta. 2001. Soundscape support to health – a cross-disciplinary research program. *Conf. proceedings "Internoise", The Hague, Netherlands, vol. 3,* 1237-1242.
Kotzen, Benz & English, Colin 1999. *Environmental Noise Barriers – a guide to their acoustic and visual design.* Spon. London, UK.
Kvale, Steinar. 1996. *Interviews – an introduction to qualitative research interviewing.* Sage. Thousand Oaks, CA, USA.
Küller, Rikard. 1972. A semantic model for describing perceived environment. *National Swedish Building Research, Document,* NO. 12. ISSN 0586-6766.
Larsson, Ulla. 2003 (unpubl.). Bostadsgårdens ljud – ljud och utformning på bostadsgårdar i stadsmiljö (The sounds in the common garden). Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning Ultuna. Uppsala, Sweden.
Levin, David Michael (ed.) 1993. *Modernity and the Hegemony of Vision.* Univ. of California Press. Berkeley, CA, USA.
Linn, Björn. 1998. Arkitektur som kunskap (Architecture as knowledge, in Swedish). *Swedish Council for Building Research,* NO. T10/*Arkitekturhistoria och bebyggelsevård,* NO. 1. ISSN 1104-8433; ISSN 1103-5838.
Lorenz, Alexander M. 2000. *Klangalltag–Alltagsklang – Evaluation der Schweizer Klanglandschaft anhand einer Repräsentativbefragung bei der Bevölkerung* (Everyday sounds–sounds of everyday life, in German). Univ. Zürich, Der Philosophischen Fakultät. Zürich, Switzerland.
Lundequist, Jerker. 1995. *Design och produktutveckling – metoder och begrepp* (Design and product development, in Swedish). Studentlitteratur. Lund, Sweden.
Lynch, Kevin. 1960. *The Image of the City.* Massachusetts Inst. of Technology. Cambridge, MA, USA.
Lynch, Kevin. 1976. Managing the Sense of a Region. Massachusetts Inst. of Technology. Cambridge, MA, USA.
Lönngren, Gabriella. 2001. Vatten i dagen – exempel på ekologisk dagvattenhantering (Water brought to light, in Swedish). *Svensk byggtjänst, Stockholm/Movium, Stad & land,* NO. *165.* ISSN 0280-4549.
Maeda, Koozoo & Iwamiya, Shin-ichiro. 1993. The Japanese soundscape represented in the world of Haiku. *Conf. proceedings "The Tuning of the World", Banff, Canada, 8-14 Aug., vol. 2.*
Melby, Pete. 1989. Sound of water. *Grounds Maintenance, June,* 38-44, 60.
Minoura, Kazuya & Hiramatsu, Kozo. 2000. Comparing soundscapes based on free response questionnaire surveys. *Conf. proceedings "Internoise", Nice, France, 27-30 Aug.,* 2829-2832.
Moore, Charles W., Mitchell, William J. & Turnbull, William Jr. 1988. *The Poetics of Gardens.* Massachusetts Inst. of Technology. Cambridge, MA, USA.
Morfey, Christopher L. 2001. *Dictionary of Acoustics.* Academic Press. London, UK.
Morris, Peter & Therivel, Riki (eds.). 2001. *Methods of Environmental Impact Assessment.* Spon. London, UK.
Moser, Gabriel. 1988. Urban stress and helping behavior – effects of environmental overload and noise on behavior. *Journal of Environmental Psychology,* NO. *8,* 287-298.

Mulligan, B. Edward, Lewis, S.A., Flaupel, M.L., Goodman, L.S. & Anderson, L.M. 1987. Enhancement and masking of loudness by environmental factors – vegetation and noise. *Environment and Behavior, vol. 19,* NO. *4,* 411-443.
Nemeth, David. 1984. Prolegomenon to a geographic study on the subjective quality of inner-city space. *Cheju National Univ. Academic Journal, Korea, vol. 19,* 151-162.
Nilsson, Kjell. 1988. Industri möter landskap – visuella aspekter på utformning och inplacering av industriella ingrepp i landskapet (Meetings of industry and landscape, in Swedish with English summary). *Swedish Univ. of Agricultural Sciences, Dept. of Landscape Planning/ Movium, Stad & land,* NO. *69.* ISSN 0280-4549.
Nilsson, Kjell. 2000. Henning E. Segerros – 1916-1965 (in Swedish). In: Thorbjörn Andersson, Tove Jonstoij & Kjell Lundquist (eds.), *Svensk trädgårdskonst under 400 år,* 250-257. Byggförl. Stockholm, Sweden.
Næss, Petter & Saglie, Inger-Lise. 1999. Planforskning og vitenskapsteori (Planning research and theory of science, in Norwegian). In: Terje Kleven (ed.), En dagsorden for norsk planlegging – åtte artikler og et program. *Norwegian Institute for Urban and Regional Research,* NIBR*:s Pluss-serie,* NO. *1,* 213-245. ISSN 1500-9939.
Oba, Teruyo. 1995. What is the natural sound diversity? – a consideration for the local natural amenity. *Natural History Research, vol. 3,* NO. 2, 173-185.
Odum, Eugene Pleasants. 1983. *Basic Ecology.* Saunders College Publ. New York, USA.
Ohlson, Birger. 1975. Landsbygdens och stadens ljudlandskap (Sonic levels in rural and urban environments, in Swedish with English summary). *Åbo Academy, Academy of Economic Studies, Dept. of Economic Geography, Meddelanden,* NO. *7,* 36-50/ *Nordenskiöld-samfundet Journal, Reprint,* NO. *35.* ISSN 0496-5825.
Ohlson, Birger. 1976. Sound fields and sonic landscapes in rural environments. *Fennia, 148,* 33-45.
Olsson, Titti (ed.) 2002. *Skolgården som klassrum – året runt på Coombes School* (The school yard as a classroom). Runa. Stockolm, Sweden.
Ong, Walter J. 1982. *Orality and Literacy – the technologizing of the word.* Methuen/ Routledge. London, UK.
Pallasmaa, Juhani. 1996. *The Eyes of the Skin – architecture and the senses.* Academy Ed. London, UK.
Persson, Bengt 1997. Kunskapsöverföring till yrkesverksamma inom landskapsarkitektens arbetsfält (Knowledge dissemination to practice within the field of landscape architects, in Swedish with English abstract). *Swedish Univ. of Agricultural Sciences, Acta Universitatis Agriculturae Sueciae, Agraria,* NO. *33.* ISSN 1401-6249.
Pocock, Douglas C.D. 1993. The senses in focus. *Area, vol. 25,* NO. *1,* 11-16.
Porteous, John Douglas & Mastin, Jane F. 1985. Soundscape. *Journal of Architectural and Planning Research, vol. 2,* NO. *3,* 169-186.
Pratt, George, Henson, Michael & Cargill, Simon. 1998. *Aural Awareness – principles and practice.* Oxford Univ. Press. New York, USA.
Rasmussen, Steen Eiler. 1959. *Experiencing Architecture.* Chapman and Hall. London, UK.
Rasmusson, Ludvig. 1985. *Städernas musik i framtiden* (Future music of the cities, in Swedish). Sekretariatet för framtidsstudier/FRN/Forskningsrådens förlagstjänst. Stockholm, Sweden.
Remy, Nicolas. 2001. Sound qualities in railway stations. *Conf. proceedings "Sound Practice", Dartington Collage of Arts, Devon,* UK, *16-20 Feb.,* 82-86.
Repton, Humphry. 1982 (1816). *Fragments on the Theory and Practice of Landscape Gardening.* Garland. New York, USA.
Rodaway, Paul. 1994. *Sensuous Geographies – body, sense and place.* Routledge. London, UK.
The Royal Swedish Academy of Music. 1996. *Manifesto for a better environment of sound – 8 Feb. 1995.* Stockholm, Sweden.

Schaeffer, Pierre. 1966. *Traité des objets musicaux – essai interdisciplines.* Seuil. Paris, France.
Schafer, R. Murray. 1977. *The Tuning of the World.* Alfred A. Knopf. New York, USA.
Schafer, R. Murray. 1993. *Voices of Tyranny–Temples of Silence – studies and reflections on the contemporary soundscape.* Arcana. Indian River, Canada.
Schafer, R. Murray & Järviluoma, Helmi (eds.). 1998. Northern Soundscapes – yearbook of soundscape studies, vol. 1. *Univ. of Tampere, Dept. of Folk Tradition, Publ.* NO. 27. ISSN 0357-0010.
Schön, Donald A. 1983. *The Reflective Practitioner – how professionals think in action.* Arena. Aldershot, UK.
SEPA 2003. Sweden's environmental objectives. Swedish Environmental Protection Agency. *http://miljomal.nu* (accessed 16 May).
Smith, Christopher J. 1993. The acoustic experience of place. *Conf. proceedings "The Tuning of the World", Banff, Canada, 8-14 Aug., vol. 2.*
Smith, Susan J. 1994. Soundscape. *Area, vol. 26,* NO. *3,* 232-240.
Somers, Bob G. 2002. *Acoustic Landscape Ecology and the Urban Environment.* Univ. of Manitoba, Dept. of Landscape Architecture. Winnipeg, Canada.
Sonic Architecture. 2003. New York, USA. *http://www.sonicarchitecture.com* (accessed 16 May).
SOU 1993:65. *Handlingsplan mot buller* (Strategy against noise, in Swedish). Allmänna förl. Stockholm, Sweden.
Southworth, Michael. 1969. The sonic environment of cities. *Environment and Behavior, vol. 6,* 49-69.
Sowa, Haruyoshi. 1999. The sound of water and environment in "Tairyu-Sanso Garden" (in Japanese with English abstract). *J. Jila, vol. 62,* NO. *5,* 661-664.
Spirn, Anne Whiston. 1998. *The Language of Landscape.* Yale Univ. Press. New Haven, CT, USA.
Stake, Robert E. 1995. *The Art of Case Study Research.* Sage. Thousand Oaks, CA, USA.
Steenbergen, Clemens & Reh, Wouter. 1996. *Architecture and Landscape – the design experiment of the great European gardens and landscapes.* Prestel. Munich, Germany.
Stockfelt, Torbjörn. 1997. *Ljud och tystnader i dimensioner – tillvaropsykologiska reflexioner om hörandets och lyssnandets konst* (Sounds and silences in dimensions, in Swedish). The Royal Swedish Academy of Music. Stockholm, Sweden.
Stokols, Daniel. 1978. A typology of crowding experiences. In: Andrew Baum & Yakov M. Epstein (eds.), *Human Response to Crowding.* Erlbaum. Hillsdale, MI, USA.
Strindberg, August. 1967 (1879). Röda rummet *(The Red Room)*. Dent. London, UK.
Strömberg, Mikael & Johnsson, Håkan. 1995. Stadens ljud (Sounds of the city, in Swedish). In: Henrik Karlsson (ed.), *Svenska ljudlandskap – om hörseln, bullret och tystnaden,* 94-105. Bo Ejeby. Göteborg, Sweden.
Suneson, Torbjörn. 2000. Knut Forsberg – 1829-1895 (in Swedish). In: Thorbjörn Andersson, Tove Jonstoij & Kjell Lundquist (eds.), *Svensk trädgårdskonst under 400 år,* 118-127. Byggförl. Stockholm, Sweden.
Suzuki, Yôiti, Abe, K., Ozawa, K. & Sone, T. 2000. Comparison between the effects of additional verbal and visual information on the perception of environmental sounds. *Conf. proceedings "Internoise", Nice, France, 27-30 Aug., vol. 4,* 2285-2291.
Svenska Landskap AB. 1999 (unpubl.). Musiklekplats och trädgård i Augustenborgsparken, Malmö (Musical playground and garden in Augustenborgsparken garden, Malmö; account and drawings, 3 Dec.). Malmö, Sweden.
Swaffield, Simon (ed.) 2002. *Theory in Landscape Architecture – a reader.* Penn. Philadelphia, PA, USA.
Sällström, Pehr Mikael. 2002. Om arkitekturens akustiska form – en fallstudie av interaktioner mellan ljud, rum och arkitektur i Lunds domkyrka – utformning och upplevelse (On acoustic form of architecture, in Swedish). *Royal Institute of Technology, Dept. of Architecture, Trita-*ARK, NO. *1.* ISSN 1402-7453.

Söderholm, Monica. 1998. Listening test as a tool in sound quality work – applied on vacuum cleaners. *Royal Institute of Technology, Dept. of Vehicle Engineering, Trita-*FKT, NO. *13.* ISSN 1103-470X.
Thiel, Philip. 1996. *People, Paths and Purposes – notations for a participatory envirotecture.* Seattle Univ. Press. Seattle, WA, USA.
Thompson, Ian H. 1999. *Ecology, Community, and Delight – sources of values in landscape architecture.* Spon. London, UK.
Thompson, Ian H. 2000. The ethics of sustainability. In: John F. Benson & Maggie H. Roe (eds.), *Landscape and Sustainability,* 12-32. Spon. London, UK.
Tixier, Nicolas. 2001. Street Listening – a characterisation of the sound environment – the 'Qualified listening in motion'-method. *Conf. proceedings "Sound Practice", Dartington Collage of Arts, Devon,* UK, *16-20 Feb.,* 109-113.
Torigoe, Keiko. 1993. A soniferous garden of Rentaroh Taki. *Conf. proceedings "The Tuning of the World", Banff, Canada, 8-14 Aug., vol. 2.*
Torigoe, Keiko. 1999. A strategy for environmental conservation. In: Henrik Karlsson (ed.), *From Awareness to Action, Conf. proceedings "Stockholm, Hey Listen!", Royal Swedish Academy of Music/World Forum for Acoustic Ecology, Stockholm, Sweden, 9-13 June 1998,* 103-109.
Torigoe, Keiko. 2002. A city traced by soundscape. In: Helmi Järviluoma & Gregg Wagstaff (eds.), Soundscape Studies and Methods. *The Finnish Society for Ethnomusicology Publ.,* NO. *9/Univ. of Turku, Dept. of Art, Literature and Music Series,* NO. *A51,* 39-57.
Torigoe, Keiko. 2003. Insights taken from three visited soundscapes in Japan. *Conf. proceedings "Acoustic Ecology", Australian Forum for Acoustic Ecology/World Forum for Acoustic Ecology, Melbourne, Australia, 19-23 March.*
Truax, Barry (ed.). 1978. Handbook for acoustic ecology. *World Soundscape Project, The Music of the Environment Series,* NO. *5.* A.R.C. Publ. Vancouver, Canada.
Truax, Barry. 1984. *Acoustic Communication.* Ablex. New Jersey, NJ, USA.
Truax, Barry. 1998. Models and strategies for acoustic design. In: Henrik Karlsson (ed.), *Conf. papers "Hör upp! Stockholm Hey Listen!", Royal Swedish Academy of Music, Stockholm, Sweden, 9-13 June,* 8-16.
Truax, Barry. 2002. Sound in context – acoustic communication and soundscape research at Simon Fraser University. World Forum for Acoustic Ecology. *http://interact.uoregon.edu/MediaLit/*WFAE*/ readings/Truaxcontext.html* (accessed 16 May 2003).
Turner, Tom. 1990. Was 'Landscape Architecture' a good idea? *Landscape Design,* NO. *191,* 28-29.
Turner, Tom. 1996. *City as Landscape – a post-postmodern view of design and planning.* Spon. London, UK.
Turner, Tom. 1998. Twelve alternatives. *Landscape Design,* NO. *267,* 42-45.
Uimonen, Heikki. 2002. You don't hear anything 'round here! – cognitive maps and auditory perception. In: Helmi Järviluoma & Gregg Wagstaff (eds.), Soundscape Studies and Methods. *The Finnish Society for Ethnomusicology Publ.,* NO. *9/Univ. of Turku, Dept. of Art, Literature and Music Series,* NO. *A51,* 171-184.
Viberg, Åke. 1984. The verbs of perception – a typological study. In: Brian Butterworth, Bernard Comrie & Östen Dahl (eds.), *Explanations for Language Universals,* 121-162. Mouton. Berlin, Germany.
Vinokur, R. Yu. 1979. Propagation of sound generated by a point source in certain built-up urban environments. *Soviet Physics Acoustics, vol. 25,* NO. *5,* 377-379.
Viollon, Stephanie & Lavandier C. 2000. Multidimensional assessment of the acoustic quality of urban environments. *Conf. proceedings "Internoise", Nice, France, 27-30 Aug., vol. 4,* 2279-2284.
Västfjäll, Daniel. 2001. Affective reactions to interior aircraft sound quality. *Chalmers Univ. of Technology, Dept. of Applied Acoustics, Report,* NO. *F1.* ISSN 0283-832X.
Wakao, Yu. 1993. On the Suikinkutsu – a traditional japanese sound installation. *Conf. proceedings "The Tuning of the World", Banff, Canada, 8-14 Aug., vol. 2.*

Wallin, Fredrik. 2002. Ekologisk potential och upplevd miljökvalitet – egenskaper i ett urval svenska bostadskvarter med inriktning på solenergipotential, dagvattenhantering, vardagslivets resmönster samt upplevd kvalitet i den lokala boendemiljön (Ecological potential and human perception of urban quality, in Swedish with English summary). *Swedish Univ. of Agricultural Sciences, Acta Universitatis Agriculturae Sueciae, Agraria,* NO. *344.* ISSN 1401-6249.

Watanabe, Tomio. 1988. Urban scene and pocket park – New York. *Process Architecture "Pocket Park",* NO. *78,* 78-87.

WCED 1987. *Our common future.* United Nations Environment Programme, World Commission on Environment and Development. Nairobi, Kenya.

WFAE 1998. Sonic urban and landscape architecture. World Forum for Acoustic Ecology. *http://interact.uoregon.edu/MediaLit/*WFAE*/noise/landscape.html* (accessed 16 May 2003).

Wikforss, Örjan. 1977. Åskådlig planredovisning – om bildberättande i fysisk planering (Clear plan presentation, in Swedish with English summary). *National Swedish Building Research,* NO. T*8.* ISSN 99-0136496-5.

Winkler, Justin. 1993. Paesaggi sonori – Valenze estetiche e sociali dell'ambiente acustico (Sonic landscapes, in English). *Conf. proceedings. "Container", Centro cultura contemporanea, Firenze, Italy, 7 June.*

Winkler, Justin. 1996 (unpubl.). Hörspatziergänge – eine kleine Dokumentation (Sound walks, in German).

Winkler, Justin. 2002. Rhytmicity. In: Helmi Järviluoma & Gregg Wagstaff (eds.), Soundscape Studies and Methods. *The Finnish Society for Ethnomusicology Publ.,* NO. *9/Univ. of Turku, Dept. of Art, Literature and Music Series,* NO. A51, 133-142.

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