Case study of soundscape assessment and design methods

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ABSTRACT

A case study for an urban design intervention in a medium-sized city was conducted as an investigation of acoustical assessment and design methods. A series of long term acoustical measurements of average sound levels in the community as well as more detailed measurements of specific acoustic events that comprised the ambient sounds were mapped for the community. Measurements included overall A-weighted and octave band sound levels and calibrated audio recordings. Sound walks were conducted at various times of day to understand the dynamics of the acoustical environment and to identify issues. Focus group discussions among stakeholders and team members developed the long term plans for the community and determined appropriate architectural and acoustical design criteria for the project. The acoustical data were used as the basis for determining design strategies for the urban interventions including reducing, buffering and mitigating undesirable existing sounds, preserving and enhancing desirable existing sounds and designing new soundscape elements to enhance the comprehensive plan for the community. The results of the study included an assessment of the acoustical analysis methods and soundscape design strategies for the project.

1 INTRODUCTION

A soundscape study was one conducted as one component of a comprehensive site analysis and initial design proposal for the Southwest 20th Avenue proposed urban village in Gainesville, Florida, USA. The city and surrounding area has approximately 200,000 inhabitants. Southwest 20th Avenue is a major east-west connector road that links rapidly growing western suburbs with the University of Florida campus and central Gainesville. It is one of only four east-west connector roads that cross I-75, a major north-south interstate limited access highway in a stretch of approximately 32 km (20 miles). The main study was partially funded by the Metropolitan Transportation Planning Office (MTPO) to investigate integrated solutions to transportation, infrastructure and urban development issues through the Florida Community Design Center. The design concepts explored by the team of architects, planners, urban designers and transportation specialists included developing a sustainable urban village in the area that could serve the university; multi-modal transportation systems including various forms of transit, pedestrian and bicycles in addition to automobiles; and ecologically-based infrastructure systems for water, storm drainage sewage and electric power.

The historic center of Gainesville and the university, which is the major employer in the area, lie to the east of I-75. The developing rural and suburban lands lie to the west of the interstate highway. The easternmost end of Southwest 20th Avenue terminates just south of the university. Southwest 20th Avenue is a heavily congested, two lane connector road during rush hours and most of the middle of the day. At the present time the frequent buses must stop in the main thoroughfare backing up traffic. There are currently a large number of low density apartment and condominium complexes that line the road, several small commercial establishments, a fire station, a park and developing open land.

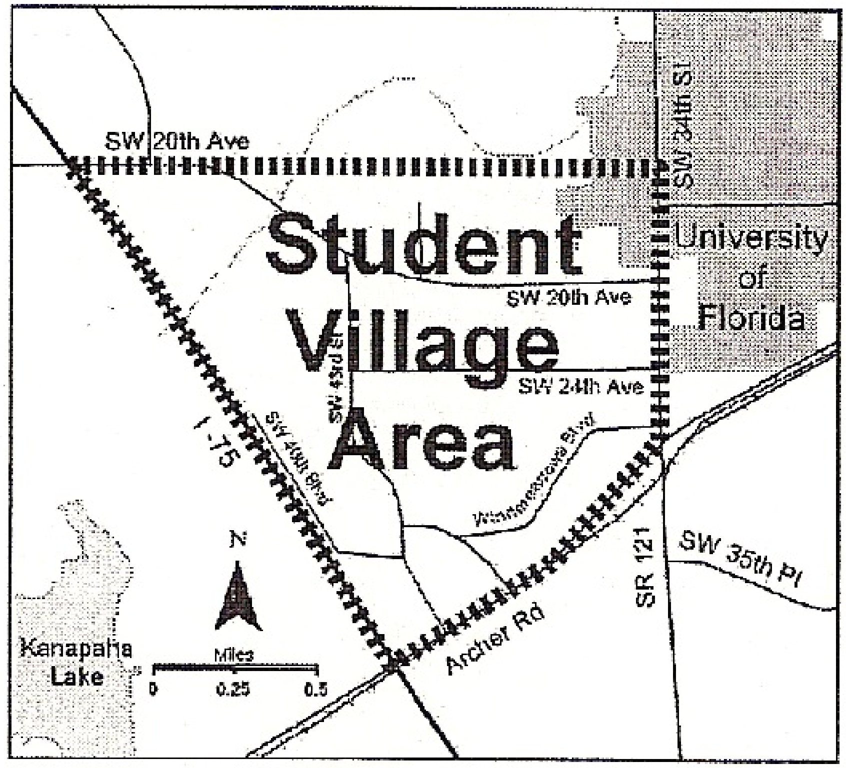

Figure 1. Site plan of the SW 20th Avenue soundscape project area.

2 METHOD

The soundscape study or an exploration of the acoustic landscape was included as part of the overall study. The soundscape study consisted of seven elements.

1. A series of sound walks through the site were taken at representative times of day to gain an understanding of how the types and character of activities and sounds varied over the course of typical days. Walks occurred in the early morning, mid-day, afternoon, evening and night. Qualitative observations of the type, level, frequency content, time duration and sources of sound were recorded during the sound walks. Primary and secondary acoustical zones on the site were identified.
2. Long term average A-weighted acoustical measurements and a number of statistical measures of typical ambient sound levels were made to document the general acoustical conditions within each zone. Average day-night sound levels (LDN's) were calculated from these data.

3. Short term measurements of specific acoustic events that were identified in each acoustic zone and which contributed to the ambient sound levels were recorded as both overall, A-weighted sound levels and in octave bands. These measurements were intended to isolate each of the specific sounds that comprised the ambient at each location as well as to identify specific combinations of sounds that occurred simultaneously. These measurements were made during each of the sound walks at representative times of day so an acoustical profile of the specific acoustic events that comprised the ambient at different locations and different times of day could be developed.
4. Focus group discussions with the design team, residents and other stake holders were conducted to identify categories of sounds found in the soundscape studies and to develop potential acoustical intervention strategies that could be considered in the project.
5. Calibrated recordings were made of the specific acoustic events in each zone to document the aural complexities of the soundscapes as well as the source sounds that contributed to the overall sound levels at each location.
6. Acoustical mapping of the soundscapes graphically depicted the findings over the project area.
7. Acoustical modeling of various types was conducted to evaluate the elements included in the acoustical design to understand how and where each element should be used.

3 RESULTS

3.1 Focus Group Discussions

Focus group discussions with design team members, city planning staff, residents, prospective developers, real estate agents, students, city officials and MTPO staff indicated that the physical, social and sonic qualities of the existing environment should be transformed through a series of ecological, transportation, architectural and sonic interventions to create a master plan for a new and revitalized district. Sustainable transportation alternatives such as bicycles, walking, transit and quiet buses; ecologically-based infrastructure for storm water and other utilities; recreation opportunities, outdoor gathering spaces, increased retail, commercial and office occupancies; and increased dining, shopping and gathering spaces were among the items to be included at higher densities than the existing situation.

Sounds of high density automobile traffic masks or covers-up many of the social and natural sounds in the area at the present time. It also interferes with communication among people at normal conversational levels near the main roads. Three categories of acoustical interventions were proposed in parallel with the transportation, infrastructure and architectural interventions to achieve the goals.

1. Reduce, buffer or mitigate existing sounds identified as too loud or undesirable
2. Preserve and enhance existing sounds identified as being desirable
3. Add new acoustical elements to the soundscape that are not found in the existing context, but that may encourage the architectural and urban design goals for the project.

3.2 Acoustical Zones

Five primary acoustical zones were identified within the existing project area. Transition zones were identified between the primary zones where combinations of the characteristics of each were found.

Figure 2. Five primary acoustical zones.

Zone 1 extended along SW 20th Avenue, the main transportation artery, running from the university in the east to the suburbs in the west. It was characterized by traffic noise on the street with an LDN of 65 dBA. The typical sound levels of automobiles on the road were 58-64 dBA during the day. The levels decreased to 48-56 dBA at night as the number of cars decreased. The loud sounds of city buses starting and stopping numerous times directly on the roadway were a characteristic sound heard at regular intervals. Traffic sounds from I-75 in the distance, some natural sounds such as the wind blowing in the trees and insects could be heard between cars especially at night.

Zone 2 was found within the residential complexes behind the first row of buildings facing the main street. This zone was dominated by the sounds of medium density residential living including people driving to parking lots, residential air-conditioning units running, people talking, television sets and recorded music playing in homes and cars in the distance. The LDN was 55 dBA. Sounds of cars on the road were 48-53 dBA during the day. Ambient levels of 40-45 dBA at night consisted of intermittent traffic on SW 20th Avenue, distant sounds of traffic on I-75, wind blowing in the trees and air-conditioning units operating.

Zone 3 was located where the residences adjoin a large natural area about four blocks north of SW 20th Avenue with an LDN of 49 dBA. This zone was dominated by the sounds of nature such as wind blowing in the trees, insects, birds flying into the area and singing. Traffic sounds were heard only in the remote distance. Ambient sound levels of 38-47 dBA were recorded.

Zone 4 was identified in the suburban shopping area along SW 34th Street, a four lane divided road running north and south at the eastern edge of the project site with an LDN of 75 dBA near the road. The soundscape was dominated by pulses of traffic starting and stopping on the busy road at traffic lights every few blocks and major commercial activities along the road. Traffic noise varied from 69 to 73 dBA during the day and decreased to 59 to 64 dBA at night. Other sounds I this zones included large commercial air-conditioning units, service trucks, cars entering and leaving parking lots, opening and closing of car doors and buses starting and stopping.

Zone 5 ran parallel to I-75, a major interstate highway running north and south along the western edge of the project site with an LDN of 67 dBA approximately 60 m from the road. The soundscape was dominated by cars and heavy trucks traveling t highway speeds. The sound levels varied from 58 to 63 dBA during both the day and night hours. During the day there were more cars and less trucks with less low frequency noise. During the night there were more trucks and less cars with higher levels of lower frequency noise.

3.3 Acoustical Interventions

The three categories of architectural design interventions identified in the focus group discussions were developed as an acoustical palette for the architects and urban designers to use in the schemes for the site. The three primary categories or acoustical design interventions of 1. reduce, buffer or mitigate; 2. preserve and enhance; and 3. add new acoustical elements are described below.

3.3.1 Reduce buffer or mitigate

Three basic methods to reduce, buffer or mitigate existing sounds identified as too loud or undesirable in the redevelopment plan were developed.

1. **Reduce or mask noise sources.** This strategy included reducing automobile and bus noise sources through the use of electric buses, reducing car trips by increasing bicycle and pedestrian trips and alternate transportation modalities. A second method was to separate through transportation routes fro local traffic to reduce mixed traffic flows and associated noise levels fro stopping and starting of buses and cars. A necessary correlate of these strategies was to develop the infrastructure for alternate transportation modalities such as bicycles. Masking of noise sources at selected locations included the use of background music t indoor/outdoor gathering spaces and cafes and sounds from flowing water in fountains, streams, water falls and other water features in transitional areas between noise sources and gathering spaces.
2. **Buffer areas** where people may gather, rest and/or walk from primary noise sources. This strategy included separating bike paths, sidewalks, places of repose and gathering spaces from transportation thoroughfares by distance; topography (vertical offsets); integrated acoustical and landscaped buffers or filters; and providing landscape and constructed elements such as berms, screens, planters and walls to define space and reduce noise entering the space.
3. **Mitigate primary sources** of noise in areas where strategies 1 and 2 can not be implemented for a variety of practical reasons using full or partial noise enclosures at the source or near the receivers.

3.3.2 Preserve and enhance

Four basic methods to preserve, include and enhance sounds in the existing context identified as desirable were identified.

1. **Provide distance and/or barriers** between sounds found as desirable to preserve and

enhance and new or existing sources of noise.

2. **Zone activities on the site** to locate those program elements that can use or enhance soundscapes near them. For example, locate bicycle and pedestrian paths, dog parks, and soccer fields near natural areas and not near transportation through routes.
3. **Arrange program activities** on site so they can buffer or mitigate intruding noise. for example, organize buildings and walls to shield gathering areas and parks from primary noise sources.
4. **Provide acoustical or soundscape design concepts** for each program activity and each "zone" of the site.

3.3.3 Add new acoustical elements

Potential new acoustical elements that can be added to the soundscape that are not present in the existing community to encourage or fulfill architectural and urban design goals for the project are described below.

1. **Import neutral or natural sounds** into the area as a masking noise such as fountains, flowing water, textured surfaces for walking, sculptural elements or trees to catch breezes, flags or banners to flutter in the breeze, wind chimes and other soothing sounds the community may desire.
2. **Allow sounds from gathering spaces to flow** from the space of origin through a series of acoustically designed spaces to provide aural foreshadowing of the event and encourage participation.
3. **Design areas of quiet** and repose where people can retreat fro urban life when desired.
4. **Import specific sounds** with qualities to support or stimulate activities such as background and foreground music, clock towers, carillons, and other sounds of social or cultural significance.

4 CONCLUSIONS

A comprehensive soundscape assessment with seven elements is proposed for analysis of existing communities and design interventions in new communities. The method includes broad participation of all stakeholders in the process through focus group discussions and a limited, focused data acquisition process. Acoustical mapping and modeling techniques are selected as appropriate for the complexity of each individual project.

The specific acoustic event is defined as the basis for the soundscape analysis. That is, the ambient is defined as a combination of specific sounds that must be identified and measured individually when possible and in combinations, as they exist in time and location on the project site.

A simplified three part acoustical palette for architectural and urban soundscape interventions was developed that allows integrated acoustical, architectural and urban design strategies that complement each other in support of the overall project goals to be developed. The soundscape analysis method allows design schemes to evolve in a participatory, accurate and scientific process.

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