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ARCHITECTURE AS SOUNDSCAPE INTERVENTION: DESIGN PROCESS AND STRATEGIES

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ABSTRACT

Students, faculty, and acoustic consultants collaborated to measure, evaluate, and propose soundscape interventions in urban and suburban morphologies in Fort Lauderdale, Florida. Soundscape interventions sought to preserve, enhance or expand existing soundscape elements associated with new program activities, urban development, and ongoing activities. Strategies for architectural design that buffer, mitigate, preserve and enhance soundscapes were derived through an elastic, context driven design process that included participation by students, consultants, city personnel, business owners, citizens, and community stakeholders. Architectural interventions were developed as integrated proposals deploying soundscape strategies at conceptual and schematic levels of design. Soundscape interventions provided evaluation tools to support community vetting toward consensus building and future planning strategies. Integrated architectural proposals mediated between existing, present, and future contexts with a focus on soundscape impacts toward the overall improvement of the urban soundscape. Groups of students, working in a design studio modality, studied a range of strategies leading to alternative interventions for specific sites. These alternatives allowed best practices to be drawn from the diversity of context specific design proposals. The results of this design process supported consensus prioritization, further evaluation through computer modeling, conceptual cost analysis, iterative community reviews, stakeholder forums, and civic policy initiatives that could be implemented through, incentives, land development regulations, or building codes.

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1. INTRODUCTION

The International Organization for Standardization (ISO) is in the process of developing the standard *ISO/AWI TS 12913-4 Acoustics — Soundscape Part 4: Design and intervention* as this paper is being authored. Presented herewith, is a summary of the collaborative work between professional acoustical consultants, academics, students from the University of Florida School of Architecture, and community stakeholders toward a process of soundscape design. This work is draws on ISO 12913 soundscape standards Parts 1 through 3 as guidelines for assessing soundscapes.

Existing soundscapes were evaluated at multiple locations in Fort Lauderdale Florida representing the range of urban circumstances and soundscape elements of concern to the larger community. These assessments included: policy, geographical and demographic data collection; acoustic measurements and qualifying descriptors; meetings with stakeholders and city staff; soundwalks, and observations. The data-based assessments were then used to formulate and characterize design and intervention strategies toward improving the soundscape in the areas studied.

Design strategies could be generally grouped into two categories: (1) policy interventions that could be implemented through land use, planning, or building code changes such as changing the methodology for measuring sound within the current noise ordinance; and (2) physical interventions that rely on the design of future urban infrastructure and architecture that is specific to improving the soundscape. Physical interventions will rely on policy,

land use regulations, building code changes, or perhaps municipal incentives for implementation and will require substantial investments by the city, developers, condominium associations, and businesses. The process of soundscape interventions will need to offer a clear value that is perceivable by the community to motivate investment in improving the soundscape. This work suggests that integrated schematic design proposals can develop consensus toward that investment.

Fort Lauderdale, has noted history of combining retirement living and nightlife entertainment as substantial contributors to the economic success and robust development of the community. The balmy climate supports nearly year-round outside social activities. Similar to many other US cities. Fort Lauderdale has undergone an urban renaissance of rapid redevelopment, residential densification, and the expansion of entertainment venues offering extended hours of outside entertainment activity initiated in 2009. In 2022, the City of Fort Lauderdale empaneled the *Noise Control Advisory Committee* (NCAC) comprised of citizens effected by chronic sound disturbances along with business owners who have substantial financial stakes in the entertainment venues they own or manage. The NCAC was tasked with addressing conflicts between a vibrant urban entertainment culture, longtime residents, and a rapidly growing population of new residents relocating to medium and high-rise luxury condominiums and recently renovated luxury single family homes near entertainment venues.

The Noise Control Advisory Committee commissioned Siebien Acoustic consultants and the UF School of Architecture to study a range of urban and suburban districts including designated activity centers toward a comprehensive assessment of the City and to develop strategies for improvement. Measurements, observations, citizen interviews, stakeholder meetings, soundwalks (with citizens and municipal staff separately), and reviews of complaint logs were conducted in the variety of soundscape contexts comprising the larger urban context. The work was conducted over eighteen months in order to evaluate the seasonal dynamics with the different contexts.

Students and faculty from the University of Florida drew from the research noted above to developed conceptual and early schematic design proposals that illustrate the potential impacts of urban design changes as strategies for improving the soundscape in these contexts. To fit this format, the overall design process and recommendations draw primarily from one seminal high-density mixed-use urban site representative of eight locations.

One design intervention proposal is presented that is representative of the spatial impacts of urban form, program zoning, and materials selections at the building scale. The proposal presented illustrates an iterative design process for testing strategies and techniques that consider multiple aspects of urban contexts through the architecture of the city that seeks to improve the soundscape among other important emerging issues. This design process methodology and example proposal is submitted to the Forum Acusticum Euronoise 2025 toward supporting the ongoing effort to establish a viable standard SO/AWI TS 12913-4 Acoustics — Soundscape Part 4: Design and Intervention.

2. SUNDSCAPE CONTEXT

The soundscape team initiated the context assessment by researching the history and demographic changes occurring over time that established the initial community and led to the present urban culture. This effort included studies of climate, geology, sea level rise, economy, transportation, and population demographics. It was established that Fort Lauderdale has a noted history of relying on an entertainment-based economy and that this element has ebbed and flowed in response to extreme partying. A substantial economic downturn in 2008 prompted a return to entertainment as a consensus strategy to revitalize the urban economy.

2.1 Acoustical Assessment.

Ambient sound levels were measured ranging from 60 dBa to 70 dBa which were nominally 5dB to 10dB above the sound level limits set in the present municipal code. This would render enforcement of noise violations that were within the ambient, but over the limit quite difficult to enforce if legally challenged. Ambient noise sources included traffic, insects, wind in trees and shrubs, and mechanical equipment noise. Ambient measurements were taken when no distinguishable single sound source was occurring.

In the activity centers of focus, amplified music, with a strong and rhythmic low-frequency (bass) component was the primary sound source noted as being disturbing in the high-rise residences near the activity centers. Sound levels were measured at elevated positions with a line of site to the sound source similar to residential condominium balconies in the urban core.

Figure 1. Outdoor urban entertainment venue playing music 12:30 am (00:30 hrs.).

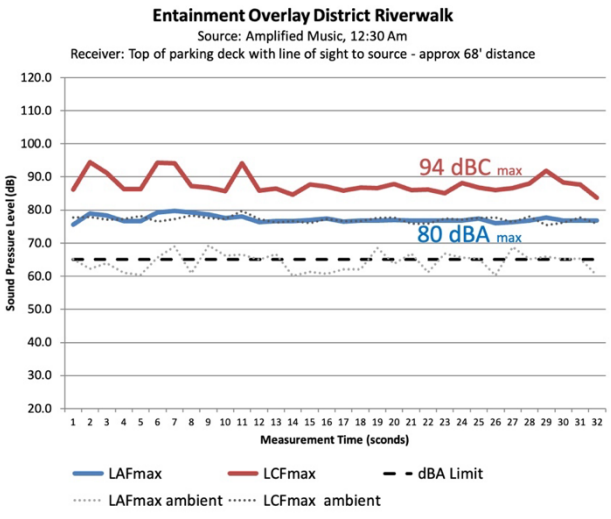

Figure 2. Sound levels measured from the entertainment venue from a location typical of residential condominiums (68-foot distance [21 meters] from edge of property). The venue was in compliance with the current ordinance.

2.2 Psycho-physiological Assessment.

Residents near the venue complain that even when the venue is complying with the ordinance, the low-frequency sound is clearly audible inside their residential units, and that it is disturbing on an on-going basis. It should be noted that Fort Lauderdale has a requirement for impact rated glass (hurricane code) and the windows of the condominiums are required to be laminated layers of glass.

A group of venues occupying two city blocks operates, just 1.5 blocks away from the venue in Figure 1 and produces sound levels at the street of over 111 dB-C at the street. The proximity, and number of venues with sounds bouncing and diffracting through the urban infrastructure make it difficult to identify any individual source of disturbance in the urban reverberant field [1].

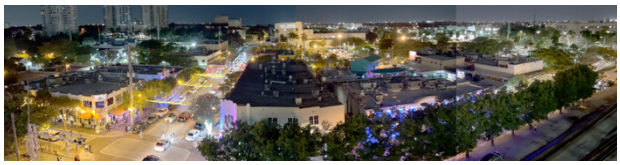

Figure 3. Outdoor urban entertainment venue playing music 12:00 am (00:00 hrs.).

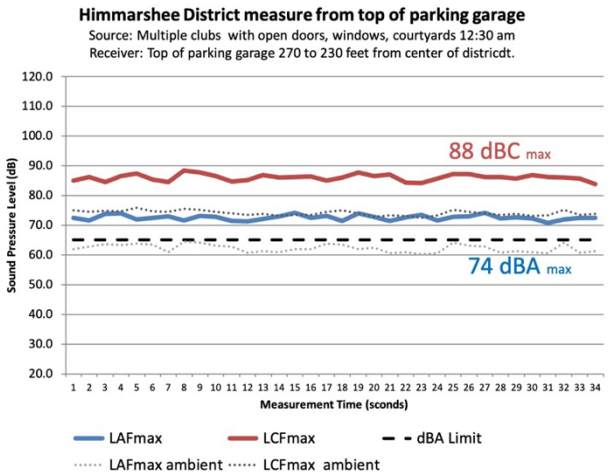

Figure 4. Sound levels measured from outdoor urban entertainment venues playing music 12:00 am (00:00 hrs.) in the urban core. Measured at approximately 300 ft. (91 m) from the collection of venues.

The daytime soundscape is generally relaxing – wind in trees, birds, ambient marina sounds (sails and ropes lashing). However, at night, the background sounds reduce with less breeze and outdoor entertainment venues activate with amplified music as many residents seek to sleep.

2.3 Context Assessment.

There are multiple music venues within the urban core with only two noted specifically in figures 1-4. Some of the venues follow the specified noise limits ascribed to their businesses however some do not. In the complex urban environment, sounds can be focused, reflected and the frequency content altered as the sound moves through the city. With the propensity of low-frequency sounds to excite planar surfaces such as walls and large windows, sounds can be re-radiated inside residences becoming more disturbing than is suggested by measurement outside the residence [2].

Due to the number of venues operating simultaneously, and the context of multiple reflections from high-rise buildings, it is difficult for noise enforcement personnel who operate at the ground level to identify a source of disturbance at a particular resident living on an upper floor of a high-rise condominium two or three blocks from the potential source.

2.4 Design and Remedial Action.

Recommendations sought to balance the interests of the residents and businesses who have invested in the economic development. People who move to the urban core, in general should be accepting of an 18-hour vibrant culture. Near-term strategies were identified to: set standards that specifically limit low-frequency sounds; improve measurement equipment (to Type I) so more refined measurements can be taken; and to potentially limit the hours of operation for outdoor venues—currently operating through the night until 3:00am (03:00) on weekends and 1:00am (01:00) on weekdays.

Soundscape design strategies were developed and recommended for renovating existing buildings, and for new construction systems that meet a 'to be determined' standard for Outdoor-indoor Transmission Class (OITC) rating. Conducting noise studies is needed to set that standard (such as is done for transportation projects), and to offer guidelines or regulations for vertical zoning of buildings. Buildings acting as sound absorbing and sound diffusing surfaces [3] are recommended to improve the urban soundscape.

3. DESIGN PROCESS AND STRATEGIES

Architectural design is a process of iterative cycles of research, scheming, evaluating, research, scheming and repeating. The starting point should be based on a set of ideals, goals, or desires that will be further defined and refined in the process. Bringing many potentially conflicting elements into harmony, must be a poetic act [4] that is subjective, relying on expertise and balance considering—at the most fundamental level—'firmness, commodity, and delight' [5]—generally meaning integrity/durability, value/cost, and enjoyment/inspiration.

Soundscape interventions are presented as schematic design proposals that incorporate soundscape strategies integral to building form, program distribution, and architectural materials. The proposals accept the ongoing intention of the City of Fort Lauderdale to promote and expand while perhaps serving as a model for high residential density activity centers.

Students were tasked with selecting a site, working with a representative urban redevelopment program, and to research the elements enumerated in Section 2 Soundscape Context in advance of developing proposals. One example project is presented in Section 4 Integrated Design Process Applied.

3.1 Project Scope and Assignment

3.1.1 Conceptual Visioning – the big ideas

Before endeavoring to resolve the 1000's of detail questions that a piece of architecture will demand be answered, clarity of intention must be established to guide spatial connectivity, contextual response, human activities, and places that are inspiring for designers and for those who might dwell within the architecture. Clarity of intention comes from research into the context, precedents, visiting the context and sites, and considering linkages between conceptual ideas and the physicality of the place.

3.1.2 Schematic Design

Here ideas are translated into visioning concepts and subsequently into architecturally specific proposals that integrate linkages to context; develop structural, spatial, and circulation systems; and resolve these systems through plan, section, and 3D models. How does the

focus on 'soundscape' influence and prioritize these systems? How does soundscape design suggest possibilities for materials, enclosure systems, and refinement of program elements that advance the conceptual visioning phase?

3.1.3 The site

Students chose to work on one of two sites: Fort Lauderdale Beach, or Fort Lauderdale Downtown. Each of the sites is approximately 1.2 to 1.5 acres. Requirements for setbacks and height limits should were governed by the local building code. The Downtown Fort Lauderdale site response is presented in Section 4.

3.1.4 The Program

Program elements noted below are the minimum required. Other program elements, especially those that explore ideas of the soundscape could be added as part of the design process.

- Night Club 10,000 sf with 5,000 sf of that area at least 24' tall (main dance area)
- Retail area 30,000 sf
- Municipal offices 35,000 sf
- Lease offices 35,000 sf • Parking for 300 automobiles.
- Residences (2,000 sf average size): 300
- Required vertical circulation – elevators and fire stairs

4. INEGRATED DESIGN PROCESS APPLIED

4.1 The Ecological Revive, Maite Bruno [6]

The Ecological Revive exemplifies a design process that seeks to understand a broad range contextual influences and then respond with site specific strategies that include soundscape design among other important issues of sustainability, resilience, and livability. Ms. Bruno's proposal suggests a vertical ecology that generates energy, harvests water, and offers a soundscape that limits urban noise and promotes natural sounds. Her work is representative of multiple students working in parallel to integrate similar strategies and as an applied example of an integrative design process.

Figure 5. Schematic design proposal illustrating integrated soundscape design for new construction in Fort Lauderdale, Florida.

4.2 Context Analysis: Ecological Revive

The context includes the history, ecology, economy and those influences on the urban area of focus. The illustrations below show how those elements are identified and considered as both independent elements and as part of the larger urban fabric.

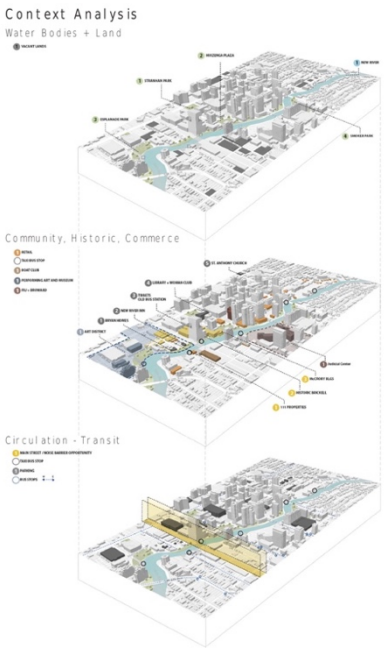

Figure 6. Water, land, historic community, commerce and transportation elements.

4.2 Site analysis: Ecological Revive

Conceptual design scheming with site influences were identified as facilities to be embraced or nurtured (nature and ecology) or difficulties (amplified music source and commuter rail line). Rather than a tabulated inventory, using spatially scaled diagrammatic analysis tools maintains geospatial information with descriptors and potential indicators [7].

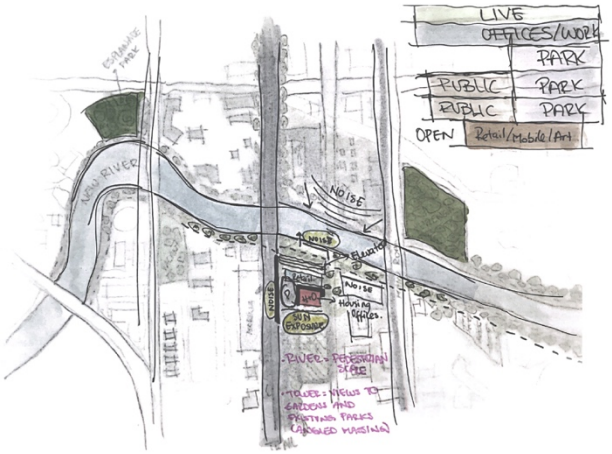

Figure 7. Spatial diagramming of the soundscape, urban elements, and natural ecology at a selected study site in Fort Lauderdale, Florida.

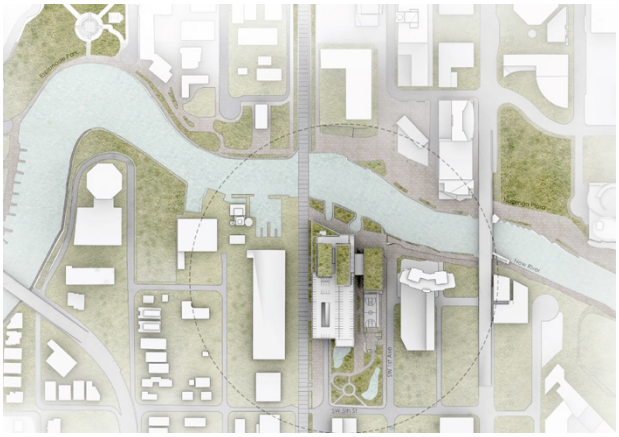

Figure 8. Schematic development of responses to adjacent context considering the soundscape, ecology, and development priorities for residential density.

4.3 Building form and massing considerations.

Program and building form are considered as complimentary elements (form follows function while considering opportunity and re-shaping form) as an iterative design process.

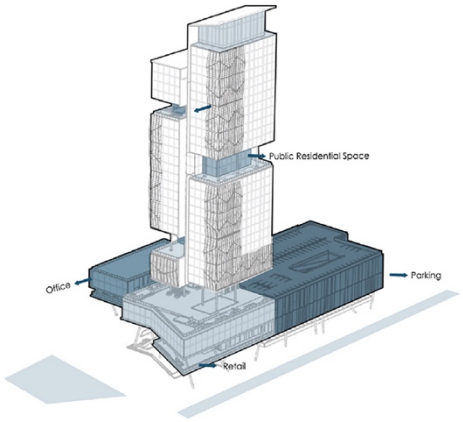

Figure 9. Elevating the occupied ground plane for distance from noise sources.

Spatial distance from noise sources (ground level) is enhanced through program distribution with acoustically less sensitive spaces (parking garage and retail) at the street or as buffers to the light rail and amplified outdoor music venue. *Vertical zoning* can be an effective land use policy strategy for maintaining distance between noisy commercial and transportation activities at the ground level and residential outdoor terraces, or shared spaces.

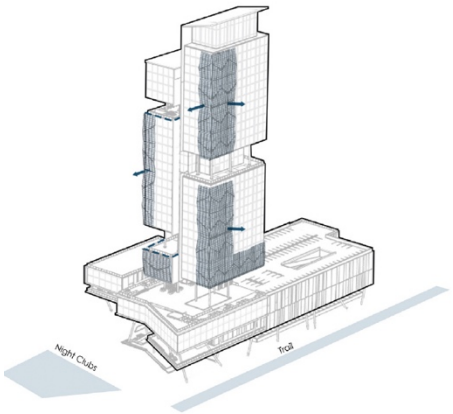

Figure 10. Initial studies of double skin acoustic buffer and diffusing element at residential units.

4.4 Building material considerations.

Residential program elements are typically the most acoustically sensitive spaces in mixed-use buildings common in urban activity centers. Layered building facades (or skins) can provide sound reduction via panel absorption, perforated surface interactions, diffusion and noise reduction through material density. These building materials can be relatively transparent and still control sound considering balance between necessary, view, sun shading, the potential for vegetated skins (air quality and shade), and improve Outdoor-indoor Transmission Class (OITC).

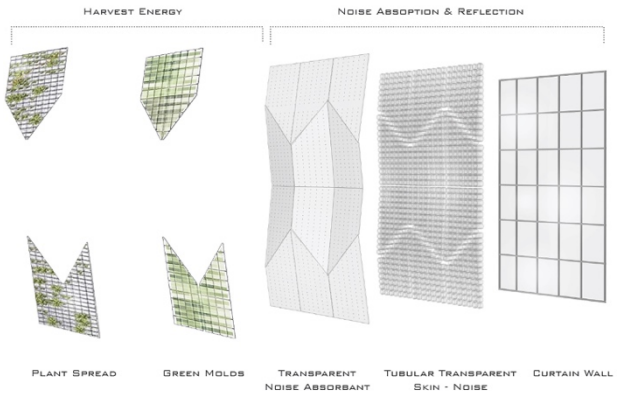

Figure 11. Potential building skin layers as elements responsive to soundscape, shading, hurricane resistance, and ecological sustainability.

Figure 12. Sound diffusing ceiling surfaces, landscape elements, and porous paving.

Building form and materials can be designed to offer sound diffusion and absorption [8]. These strategies are well understood when applied to room acoustics and concert halls. Sound diffusion is emerging as a recognized noise control strategy in urban contexts [9]. For example, glass curtain walls can be designed to be sound diffusing by manipulating their form while as a basic material, glass is not considered sound absorbing. In populated urban centers, buildings are typically large enough to have surfaces that diffuse sound through the range of human audibility.

Figure 13. Sound diffusing building form with angular articulation, façade articulation at multiple scales, and layered panelized surfaces with moderate to good sound absorbing properties.

Sound absorption typically requires lightweight porous materials that might be difficult to maintain in harsh exterior environments. However, even the asphalt streets can be engineered to be 2 to 4 times more sound absorbing than typical asphalt [10] as permeable paving. Permeable paving can also reduce the load on stormwater abatement infrastructure perhaps offsetting any additional material costs.

5. CONCLUSTIONS AND RECOMMENDATIONS

5.1 Vertical distance

Vertical distance can be an effective sound abatement strategy to reduce street noise including traffic, sidewalk cafes, and unamplified events in the streets. This strategy could be implemented through requiring residential high-rise construction to limit residences in the lower floors creating a vertical zoning matrix specific to the soundscape context under consideration.

5.2 At window sound level limits.

Sound level limits at the windows or balconies of residential units could be established and monitored remotely (via the internet) as a more nuanced implementation of property line noise level standards.

5.3 Building envelope systems.

Building codes could require that, as a system, the building enclosure must limit the amount of sound that is transmitted through them. OITC standards that are context specific could be established and achieved with material layers, heavier construction, or buffer spaces between the outside and inside spaces.

5.4 Buildings that absorb and diffuse sounds.

The urban fabric could utilize the buildings to absorb and diffuse sound to reduce the ambient urban noise. Material selections and surface articulation strategies can be adopted to guide architects and developers in activity centers or dense mixed-use environments.

5.5 Strategic zoning.

Incentivizing development along arterial corridors that span entire sites that are multi-story and utilize sound absorbent and diffusing building materials can provide acoustic barriers between noisy districts or transportation corridors and residential neighborhoods near them.

5.6 Rooftop and elevated terraces.

Providing healthful respites for residents such as elevated or rooftop terraces, away from the busy streets, could allow residents to find peaceful natural outdoor spaces within their larger buildings offering relief from urban noise.

5.7 Ground as heat sink.

Often overlooked in urban areas, are the numerous mechanical systems (cooling towers & condensers) required, even in heating dominated climates, as comfort expectations and rising global temperatures coincide. Mechanical systems that use the earth or nearby waterbodies as the heat sink for their cooling needs can avoid noisy cooling towers and condensing units from contributing noise to the urban soundscape. This also avoids adding heat and moisture to the local air that may increase the ambient temperatures during warm periods.

6. ACKNOWLEDGMENTS

The authors would like to recognize the City of Fort Lauderdale and the Noise Control Advisory Committee for collaborating on the larger body of work that led to this publication. Also, to the students at the University of Florida who contributed to the research and soundscape design proposals with a special acknowledgement to Ms. Maite Bruno, whose outstanding work, included here, exemplifies the broader body of student proposals.

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