

# **An Architectural approach to analyzing design strategies for acoustic comfort in modern public libraries.**

## **A Review of the University of Birmingham Library**

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### **Abstract**

The incorporation of acoustic comfort and strategies into public library design is discussed in this paper. For decades, one of the main goals of acoustic theory and experiments has been to solve architectural acoustic issues. Recent contributions by the soundscape approach have highlighted wider beneficial goals that acoustic designers can follow, such as encouraging ecological reasoning about the acoustic system and its understanding as a whole. Using references from the literature, this paper illustrates the application of architectural acoustics and soundscape methods into the field of architectural architecture education, stressing the importance of unique design circumstances and aural teaching strategies in learning contexts.

According to the findings of this study, the incorporation of Acoustic comfort can be accomplished by architectural design rather than active means, and the literature review discusses all methods of achieving Acoustic comfort or Architectural Acoustics. This research would look at potential noise sources as well as steps or technology that can be incorporated into the architectural design of a public library to improve acoustic comfort. HVAC, atmospheric noise from outside the lecture room, low sound insulation construction materials, and so on are examples of noise sources.

### **Keywords**

Acoustic design, soundscape, architectural acoustics, education, acoustic comfort.

## **1. Introduction**

Libraries have long been affiliated with peaceful and silent environments. Previously, this was due to the fact that they housed a comparatively small range of functions (e.g., book storage, reading, and studying) that did not have any unique sound source, and the architecture itself was built to encourage silence and self control. However, the philosophy and architecture of new public libraries seem to strive for more vibrant spaces (e.g., audio-visual resources and video formats), which go beyond the conventional libraries' basic reading-related roles. Users of contemporary public libraries, for example, infants, elderly people, or university students, are thought to have particular desires and perceptions of the auditory world (ibid). There has been a steady change from individual participation to collective and even social events (e.g., cafes, gathering areas), which correlates to numerous room arrangements and furniture components, as well as acoustic treatments.

The explosion of modern practices in libraries has eventually culminated in the introduction of multiple types of sounds and sound sources, necessitating architects and interior designers to rethink how to enhance the user atmosphere in such spaces by handling the acoustic environment in a constructive rather than reactive manner. Multi functions and contemporary spatial styles with large open plan areas, in particular, find it difficult to control the sounds of different human actions and speech. In certain cases, acoustic experts have recommended solid separations between various roles to reduce these aural influences, but this often clashes with the design goal of constructing open-plan spaces. People's reasons for attending libraries have extended from only reading to visiting for shows, children's events, making friends, and eating lunch. Users today have diverse standards and views of library spaces and their acoustic conditions, which conventional acoustic architecture approaches based on quantitative acoustic features cannot meet.

Present acoustic architecture methods aim to focus on reaching precise sound intensity thresholds and reverberation periods for target events, using acoustic materials to capture, diffuse, and echo noises in environments, but they do not account for user interactions. Such typical methods of planning for acoustic comfort can be incapable of dealing with behavioral sounds, such as those generated by walking, laughing, turning pages, shifting seats, and so on and, at the same time, satisfy evolving user needs and the open-plan design of new public libraries. A soundscape approach, on the other hand, reflects on the human perceived acoustic atmosphere of a location within its context, and examines acoustic comfort both through empirical acoustic features and through human experiences. Meanwhile, this paper believes that reading and learning are still valuable uses for libraries, even though they must involve all these other apparently contradictory practices in order to survive. It is important to have 'appropriate' soundscapes in areas of the Library where reading and learning occur. As a consequence, this research studies the consistency of the acoustic University of Birmingham Library from a soundscape viewpoint and explores architecture techniques for ensuring acoustic relaxation for reading and learning in multi-function, open-plan urban public libraries.

## **2. The importance of good library acoustics**

Libraries are more than just collections of books and academic periodicals; they play an important role in cities and villages, colleges and universities, elementary schools, and major businesses. Libraries are as popular as they have always been, with an increasing need for low-cost, public access to the Internet and multimedia resources. With too many diverse resources offered in the modern library, acoustic comfort is important, even when libraries become populated not just with humans but also with loud machines (printers, copiers, and beeping bar-code scanners to name a few). Wide open spaces for users to stretch out, read, learn, or simply relax have long been recognised by library planners and architects. These open spaces are often mixed into the library's book shelves, at other times they are distinct. Libraries also have locked spaces for private research or community sessions, as well as classes with multimedia display capabilities. Each of these spaces has its own set of standards for acoustic comfort.

In addition to the library user spaces mentioned above, libraries generally have administrative and user service areas (e.g. reference desks, circulation desks, copy rooms, computer clusters, and other similar areas). These areas are easily identifiable as noise-producing sections of the library, and can have a detrimental effect on general acoustic comfort, particularly when located in or near open study areas in

libraries. Acoustic comfort is necessary for a library to succeed. What makes a library acoustically comfortable? How can a subjective impression such as “acoustic comfort” be properly quantified? What features are necessary in library building design to promote acoustic comfort?

### 3. Methods

#### 3.1 Case Study

A case study approach was used to investigate the dynamics of real-life circumstances leading to soundscapes in a contemporary public library. The Birmingham Public Library is located in the city center and was built as a landmark, reflecting Birmingham's industrial heritage (see Figure 1). The striking presence and diversity of events at Birmingham's Library draw a diverse number of people, indicating that the structure is likely to have a dynamic acoustic atmosphere. A brief was developed focusing on the user, rather than the collection, with intuitive, natural circulation.



*Figure 1 (image source: Tim Cornbill)*

The plan is bisected by a central street running north-south. This generates the internal planning, creating quiet study spaces around the building's perimeter. 17,000sq.m of floor space is arranged over six levels with a series of light wells running through the building. The angled west side is aligned to the new ring road, with railway and canal beyond. This arrangement exploits views and maximises the scheme's presence seen from the railway.

Acoustics are one of the most crucial factors to consider when designing a library. Two large atria and perimeter study spaces required treatment to ensure the acoustic criteria were met. The feature gold staircase in the centre of the building acts as a large acoustic baffle, with insulated metal perforated panels wrapped around its structure, alongside insulated panels that line the perimeter of the slab edges in the atria. Suspended metal acoustic baffles are located above the perimeter study spaces to ensure sound doesn't break out into the atria. Other study spaces vary in function from individual study, group workspaces and silent study spaces, so these are treated locally with a combination suspended baffles and acoustic ceilings, to help provide comfortable spaces for students to work.

Overall, this case study indicates that it is worthwhile to investigate the acoustic atmosphere of public libraries from a soundscape viewpoint to determine which architecture techniques could be applied to improve users' acoustic satisfaction in those spaces.

Participants in this research measured the general consistency of the acoustic environment based on their definitions of space rather than the appropriateness of contexts. Participants seem to have higher acoustic criteria for spaces for 'reading and dreaming' than for 'interacting and communicating.' Meeting points, the reception room, the foyer, the led research area, and the café are certainly spaces for 'interacting and communicating,' while the silent study area and reading space are definitely spaces for 'reading and thinking.'

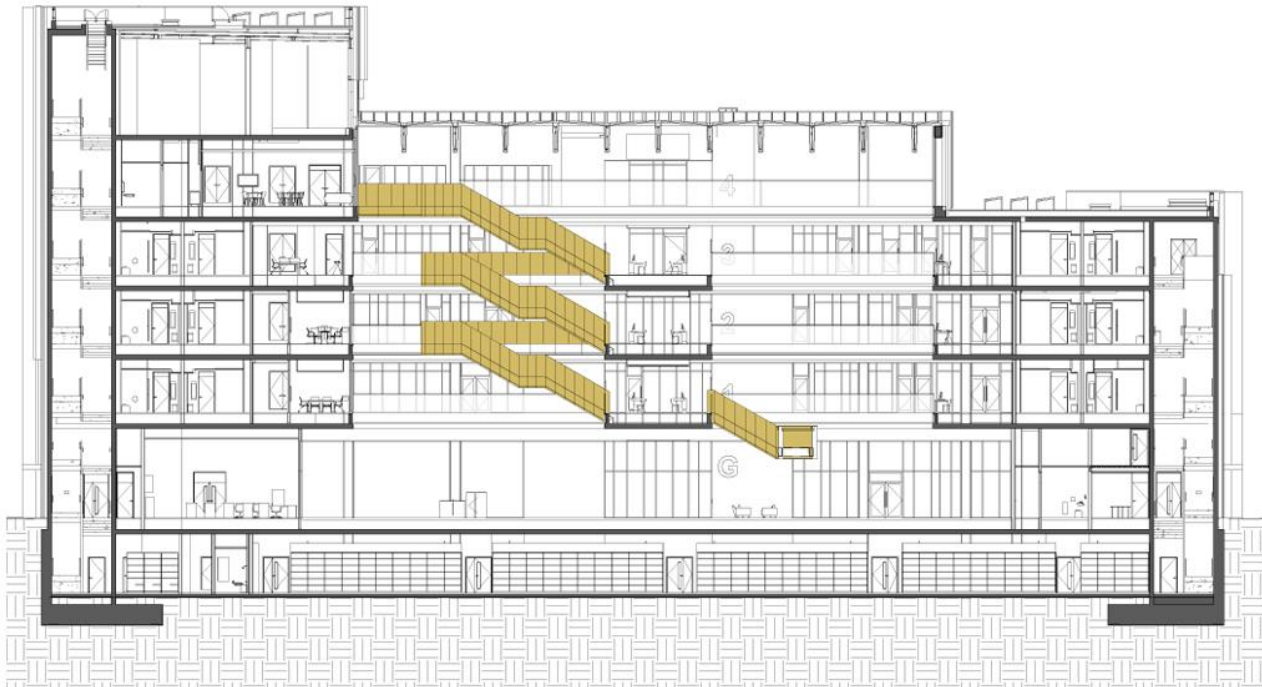


Figure 2: Technical section of University of Birmingham library (image source: Archdaily)

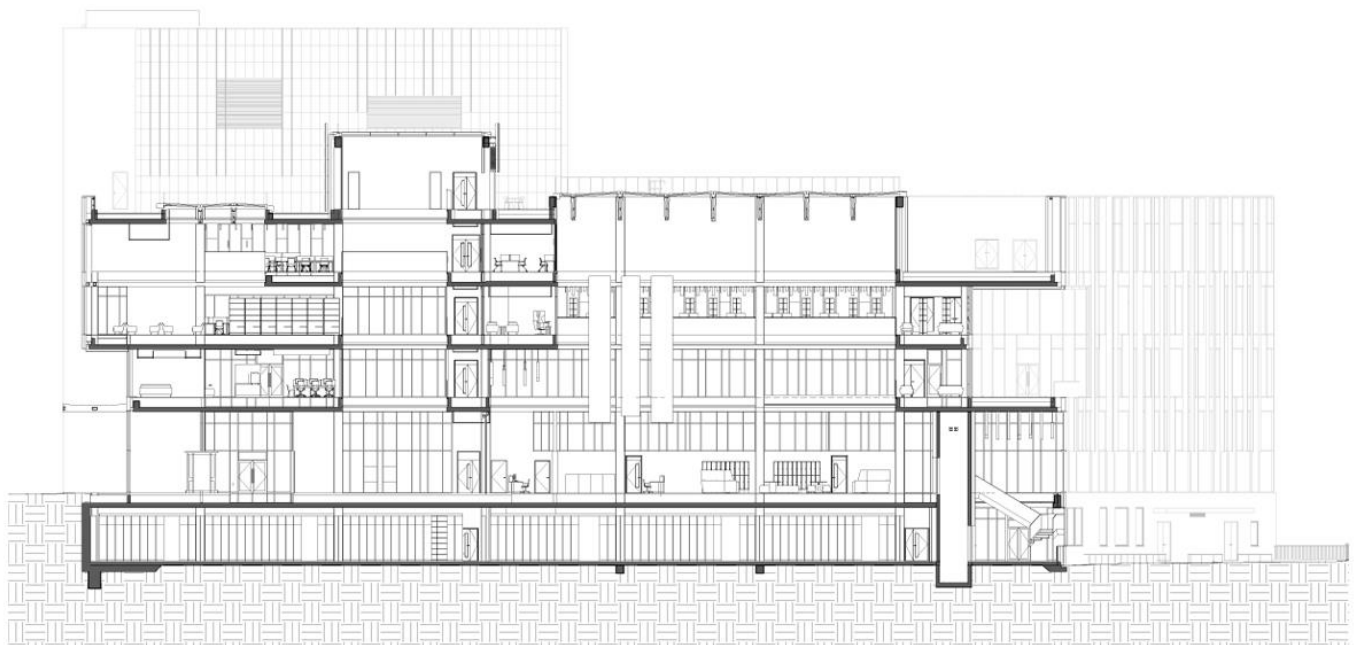


Figure 3: Technical section of University of Birmingham library (image source: Archdaily)



Figure 4: Ground floor plan of Birmingham library (image source: Archdaily)





Figure 5: First floor plan of Birmingham library (image source: Archdaily)

### 3.2 The Library’s sonic structure

The detection and recognition of sound sources is crucial in the soundscape approach to comprehending the acoustic environment. A library's sonic structure involves the kinds of sounds heard and how dominant they are in vacuum. Figure 4 depicts the composition of sound sources perceived at each stops on all explored floors were identical, with verbal and nonverbal sounds being detected more commonly, suggesting a hearing world dominated by human sounds. Figure 6 summarizes the sound source profiles on each floor by averaging the sound source domination scores from the various stopping points

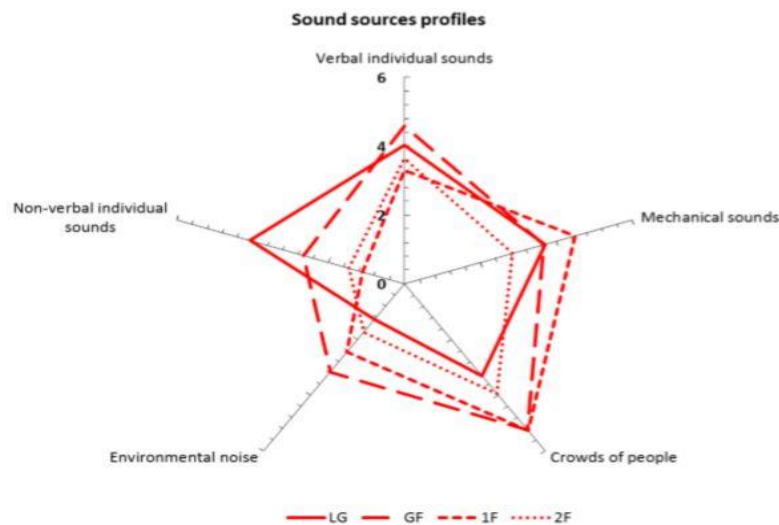


Figure 6: Aggregated Soundsource profiles for each floor.

#### **4. Discussion: Design strategies ensuring acoustic comfort in public libraries.**

The layout of space is critical for influencing people's behaviors and separating different user groups to improve acoustic comfort, especially in large open-plan library spaces with minimal solid separations. Arranging sonic spaces in a Hierarchy is a method of organizing spaces in libraries in order to achieve a healthy listening environment.

A library must have:

- 1) An acceptable background noise level,
- 2) A physical partition between noise-producing and noise-sensitive sections.
- 3) Adequate sound absorbing content scattered across the room to create a comfortable acoustic atmosphere. These design solutions are closely related to the Articulation Index calculation results: by using these three design solutions, a library room would have an appropriate low Articulation Index.

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##### **4.1 Background Noise Level in Libraries**

In an open-plan environment, background sound is needed to conceal unwelcome and potentially disruptive speech and other noises. The background noise should have level and spectral characteristics that are compatible with its sound masking function: it should not be a distraction in and of itself. If the background sound contains too much low-frequency energy (“rumble”), too much high-frequency energy (“hiss”), or is too noisy overall, it can be a source of distraction. Similarly, background noise will become distracting if it is dominated by an intermittent or cyclical HVAC device that suddenly changes the noise level.

HVAC systems can also be annoying if they are spatially non-uniform, so consumers can quickly localize on the soundsource. The background noise level in open research areas of libraries is ideal in speech frequencies and comparatively weak in frequencies above and below the most typical speech frequencies. In open research areas of libraries, a sound masking spectrum might be sufficient. In open research areas of libraries, a similar range may be sufficient. A great background sound has a constant level and range, both spatially and temporally.

## **4.2 Geometric Arrangement and Library Space Planning**

The paper's presentation discusses many established noise-producing components in libraries. Circulation and reference tables, loud copiers or printers, corridors, and other circulation routes are examples of these. A physical boundary between these known noise-producing areas and known noise-sensitive areas, such as open research areas, will minimize the Articulation Index and thereby improve acoustic comfort. The most popular obstacle in library environments is the judicious use of library book shelves or shelving.

## **4.3 Library Room Finishes and Materials**

Absorptive finishes are uniformly spread around open research areas in an acoustically friendly library. Absorptive finishes, in addition to raising the Articulation Index, minimize reverberation time and noise build-up in library rooms. If the reverberation time is exceptionally long, movement noise can accumulate in a library and produce an uncomfortably elevated ambient noise level during normal usage.

## **5 Recommendations and Conclusions**

The specification for acoustic comfort should be applied from the design stage all the way to installation to specifically use the available Nature and an appropriate range of Materials, facilities, and finishes.

According to the report, people's assessments of the appropriateness and comfort of soundscapes in multi-functional public libraries could be more reliant on their soundscape cognition and the reasons for using the space. Separations of spaces in the configuration of a plan can be accomplished by hierarchizing acoustic spaces for categories of users and their soundscape cognitions. In addition, different colored and patterned acoustic materials with relevant shapes, and colored carpets creating different zonings for established soundscape cognitions, can be helpful to direct users' behavior. Overall, this case study indicates that it is worthwhile to investigate the acoustic atmosphere of public libraries from a soundscape viewpoint to determine which architecture techniques could be applied to improve users' acoustic satisfaction in those spaces.



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