Sound and the Restaurant Environment

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Non-refereed

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Restaurant

res·tau·rant *n*. A place where meals are served to the public. *n:* a building where people go to eat [syn: eating house, eating place]. French, *restorative soup*, *restaurant*, from present participle of restaurer, *to restore*, from Old French restorer.

Café

ca·fé also ca·fe *n*. A coffeehouse or restaurant. *n:* a small restaurant where drinks and snacks are sold [syn: coffeehouse, coffee shop, coffee bar]. French, *coffee*, *café*, from Italian caffé, *coffee*, from Ottoman Turkish qahveh.

Introduction

The potential danger of "recreational" noise exposure has been well documented. It is a well known fact that many restaurants are noisy.

Think about the last time you dined at your favourite café or restaurant. Could you hear the conversation of the person next to you, or did the background sound of the voices and other noise sources cause you to strain?

Personally when asked about a particular dining experience, I always remember the noise environment rather than the food!

However, to the best of my knowledge there are very few independent reviewers who comment on the noise levels when undertaking reviews of café and restaurant environments.

It is my opinion that noise levels, and their consequence on the overall ambiance (dining experience) should be included by all reviewers. Readers could then use the information to decide whether a restaurant will be an appropriate place for a romantic dinner or a night out with friends. Remember the food may be great, but the atmosphere may be less than pleasing, requiring the patron to choose among restaurants that consider and embrace the acoustic environment for one reason or another.

Whether it's lots of noise creating a busy vibrant feeling or a low level hush creating a romantic mood, the sound in a restaurant is one of the most important aspects of its atmosphere.

Different premises will cater for different types of patrons and therefore have their own idea of the ideal acoustic environment and brand for their restaurant.

Due to design aesthetics or functional requirements, the majority of restaurant environments have hard surfaces, creating noise build-up within the restaurant. This can be annoying at the very least, however relatively simple and straightforward steps can be taken to control this excessive noise.

Unfortunately, some professionals who are involved in the design of restaurants do not embrace or understand the importance of acoustics and as a result, noise is not always addressed in the design phase.

It may also be the case that acoustics is not always seen, so it's not always thought of until it becomes a problem.

The purpose of this research report is to

1. Measure noise levels in a variety of restaurants to determine if dining out should be included on the list of potentially harmful recreational activities, particularly given the fact that many employees work eight or so hours, unlike the patrons who spend on average a couple of hours in the restaurant environment
2. Carry out additional research into the legislation, design, and function of the café/restaurant environment, and present this in a discussion format.

This paper is taken from part 1 of a 6 part report. The full report provides discussion on several other topics regarding restaurant and café environments, namely;

- A discussion on legislation, rules, standards and guidelines relating to restaurants, cafes

and entertainment premises
- A discussion on sound perception indoors, including sound absorption
- A discussion on sound insulation
- A basic design guide for non acoustic professionals
- A discussion on acoustics as a function of sustainable design

Background

Sound is part of the environment and all activities. Different levels and types of sound are associated with different activities. Factors that influence the annoyance or discomfort caused by sound are influenced by:

- Time (day or night)
- Type of sound
- Level of background sound
- Sensitivity of the recipient
- Level of sound insulation and sound control provided by the building
- Level of sound absorption within the internal building environment
- Frequency of sound (e.g. low frequency sounds are harder to control)
- Duration and exposure to sound.

Restaurant noise can be divided into two categories:

(1) Noise sources affecting people; such as noise from within the restaurant itself or noise sources not associated with the restaurant such as exterior noise eg. traffic noise etc.

(2) The restaurant as a noise source; noise sources from the restaurant affecting other parties. This is related to noise produced from within the restaurant, which may affect other people ie. inner city residents, businesses etc.

Noise Sources Affecting the Restaurant

The Customer

As expected, one of the primary noise sources in a restaurant is the customer talking and socialising.

This noise is compounded by other noise sources, such as the kitchen. In quieter settings people will tend to speak quieter, however in a restaurant setting "noise breeds noise" meaning if the environment is noisy patrons will talk louder to be heard, causing the overall noise level to increase.

Certain areas in the restaurant will be more active, e.g. at the bar or counter as opposed to the toilet areas.

The Kitchen

A common development in today's restaurants is to incorporate the kitchen into the main seating area to make it open and visible to the patrons. When the kitchen is open

it is audible. This type of planning is usually a design aesthetic and not functional regarding noise. The open plan design usually causes a build up of noise from kitchen noise sources, which can dominate the environment.

Building Systems

When undertaking the design of the restaurant space, it is important to consider the building systems in all areas including penetrations which could allow for flanking transmission.

Heating and ventilation (HVAC) systems can provide unnecessary noise.

A loud HVAC system for example would cause additional build up and encourage patrons to increase their noise level.

Music: Amplified or Acoustic

Many restaurants choose to play music as background music or sometimes with live bands. Music may help to mask other background sounds. However, this can add more noise to the space, especially if the space has hard surfaces.

Exterior Noise

Noise sources from outside the restaurant can impact on the interior noise environment.

Depending upon the sound insulation of the building façade, outdoor noise such as traffic can "transmit" through the façade.

This can be a serious concern for restaurants situated near major roads or adjacent occupancies, which may create a lot of noise.

Restaurants as a Noise Source

Restaurants and their operations can impact on their surrounding environment. Just as the adjacent occupancies may negatively impact on the restaurant, noise from the restaurant can negativity impact on the adjacent occupancies.

"...Restaurants and their operations can impact on their surrounding environment..."

Outdoor Areas

Outdoor areas are a large concern for the surrounding neighbourhood; typically people feel more comfortable speaking in a louder voice outside, therefore generating more noise.

Parking

Parking as a noise source is typically not a problem if managed well.

Rubbish Collection and Bottle Disposal

Rubbish collection and bottle disposal is one type of noise source, which is commonly overlooked. It is common for the restaurants to empty glass bottles late at night or have rubbish collected early in the morning, especially in the inner city areas.

Deliveries

Delivery of goods usually begins in the early morning hours and continues throughout the day.

Mechanical Equipment

Noise producing mechanical equipment is sometimes required for restaurant operations. Outdoor mechanical equipment could pollute the environment with noise if not treated appropriately.

Room Acoustics

The acoustical conditions in rooms must be such that the intended activities are optimally supported and are not hindered by the room.

Two basic aspects govern the acoustical conditions in rooms such as café's

1. The amount of background noise, and
2. The acoustical properties of the room itself, as determined by the geometry and materials of the room.

Background noise levels must be

limited to a suitable maximum value appropriate to the use of the room

Room acoustics are conventionally evaluated in terms of an optimum reverberation time.

In relation to the acoustic environment for any building, including restaurants, there are two chief categories of material which the reader needs to be able to differentiate between, these are sound *absorbers* and sound *insulators*.

Sound Absorption and Insulation

Materials that absorb sound and prevent it echoing around a room are sound absorbers. Sound absorption materials are often soft to touch, such as glasswool insulation, carpets, etc.

Sound absorbing materials are used to produce the required internal acoustic environment in terms of reverberation time, but it is important to note they do not prevent sound from outside the premises or adjacent rooms entering indoor spaces: that is the job of sound insulators or barriers.

The second type of materials are sound insulators. Sound insulation reduces transmission of sound through the subject material from one area to another.

Sound insulation materials are used for keeping internal noise in or out ie. stopping sound transmission between internal spaces (inter-tenancy and sub-tenancy) or external noise (outside to inside and vice versa).

Sound insulation is concerned with the design and specification of

Table 0: The Surveyed Premises

1. **Premises 1: Restaurant, Blair St Wellington**
   Sunday 15th February 2004 between 18:45hrs and 19:45hrs.
2. **Premises 2: Café, Wakefield St Wellington.**
   Sunday 22nd February 2004 between 12:55hrs and 13:55hrs.
3. **Premises 3: Café/Restaurant , Kelburn, Wellington**
   Saturday 13th March 2004 between 19:30hrs and 22:55hrs.
4. **Premises 4: Café/Restaurant 4, Tory Street Wellington**
   Sunday 2nd May 2004 between 18:40hrs and 20:30hrs
5. **Premises 5: Restaurant 5, Blair Street Wellington**
   Thursday 20th May 2004 between 17:45hrs and 19:00hrs.

building elements such as walls, ceilings, doors, windows etc.

There are no similarities between the two categories of materials. Good sound absorbers are poor sound insulators and vice versa. A material that is an effective sound barrier is generally a very poor absorber of sound.

Both types of materials are necessary for providing a functioning acoustic environment in any building space.

The combination of acoustic insulators and absorbent materials can provide a very cost effective and space efficient solution if realistic design targets are set beforehand, in the design stage.

The Study

The following section of the report discusses an outline of the study methods, techniques and results.

Although the results speak for themselves, a brief discussion concludes this section of the report listing some key points and summarising the overall results (in an objective (eg. based on the observable scientific results) and subjective approach (eg. particular to a given person; personal: *subjective experience*).

Study Area and Location of Premises

All premises were cafes and restaurants. It is important to note that no bars or clubs were investigated.

All premises (except Premises 3 which is zoned *Suburban Centres* under the Wellington City District Plan) were located in the Central Area Zone of Wellington City, as defined in the Wellington City District Plan. The "physical" Central Area extends from the Thorndon Railway yards to the Basin Reserve and is bounded generally by the line of the existing motorway to the west, Webb and Buckle Streets to the south and Kent Terrace to the east.

The Central Area contains Wellington's main commercial heart, and is bisected by a number of busy streets and main roads. As a centre for commercial and entertainment activity, the Central Area is an inherently noisy place. The Central Area is a diverse area in that it not only contains commercial premises but also a growing population of residential sites.

Purpose of Measurements

The purpose of these measurements was to quantify the sound levels within each restaurant and café sampled.

"...The noise sources within each location generally made communication and hearing difficult..."

Measurement Locations and Times

Noise measurements were undertaken during both day time and night time. Night time is the time when residential sites are less noise tolerant and generally

District Plan noise limits are set lower. This reflects people's increased sensitivity to noise during these hours. Five (5) restaurant and café environments were investigated as shown in Table 0.

In general, this group of restaurants (sample) could be judged to represent the characteristics of the wider population of restaurants and cafes in the Wellington Area.

There were many common features among the sample which would be common to most premises in the wider restaurant and café population, these are discussed below:

Architectural Features

The majority of the surfaces within the cafés and restaurants consisted of hard floors, walls and ceilings, which is reverberant, even when full of diners and music.

All premises were open plan (single story), with open kitchen facilities. The building fabric varied between premises, however the majority were glazed entrance facades with either timber or aluminium windows. The general shape, size and volume between premises varied.

The majority of furnishings were hard or closed cell. This is likely to be due to cleaning and hygiene practices etc.

Internal Noise Sources

Noise within the different premises was generated by a number of sources namely, patrons, staff and kitchen.

Music (Amplified)

All premises had amplified (background) music during the measurement periods.

External Noise Source and Environment

All premises were located in busy areas with a number of external noise sources such as traffic, people and general noise sources associated with city or suburban environments. External noise sources were not generally audible inside the premises due to the high internal sound level which "drowned out" all background sounds.

Mechanical Ventilation and Building Systems

There were no 'boisterous' building systems that caused patrons to increase their noise level. In all cases, the dominant noise source was from within the premises eg. patrons etc.

General Observations

The noise sources within each location generally made communication and hearing difficult.

The analogy of "noise breeding noise" would best describe these environments; hence people tend to raise their voices to be heard, which in-turn increases the noise level in the room.

In the case where groups of people are together observations show that when sound levels increase the group dynamic changes.

A larger group which may be in conversation breaks up into smaller sub-groups so they can communicate with their neighbours or people in close proximity.

Loudest Period				
	Start Time	**End Time**	**L_{eq} 30 min**	**Std. Dev. (30 Min)**
Premises 1	19:00	19:30	81 dBA	0.7 dBA
Premises 2	12:55	13:25	78 dBA	0.5 dBA
Premises 3	20:18	20:48	68 dBA	1.7 dBA
Premises 4	19:05	19:35	81 dBA	0.8 dBA
Premises 5	17:45	18:15	69 dBA	0.7 dBA
Quietest Period				
	Start Time	**End Time**	**L_{eq} 30 min**	**Std. Dev. (30 Min)**
Premises 1	18:45	19:15	78 dBA	0.7 dBA
Premises 2	13:18	13:48	76 dBA	0.5 dBA
Premises 3	19:38	20:09	68 dBA	1.7 dBA
Premises 4	20:00	20:30	73 dBA	0.8 dBA
Premises 5	18:30	19:00	67 dBA	0.7 dBA

Table 1: "loudest" and "quietest" measurement results for each of the five premises. All results (L_{eq} (dBA) 30 minutes).

Measurement Procedure

The measurement procedure involved the Sound Level Meter being attached to the waist and the microphone being clipped to the shirt. The measurements were started before entering the premises and stopped after leaving.

All measurements were

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continuous. The equipment was set up to perform automatic data-logging of time varying sound levels. Four of the five measurements (Premises one to four) were carried out during the weekend period, when all premises were full of patrons (worst case scenario).

The fifth measurement (Premises five) was carried out during a quiet week-night; generally this restaurant was empty during the measurement period (best case). There was no pre-determined measurement period: measurements were purely carried out during the time interval of a typical meal. Measurements were carried out between the beginning of February 2004 and the end of May 2004. All measurements were carried out by the author.

Following completion of the measurements, all data was downloaded from the meter and analysed using proprietary acoustic software (Acoustic Editor). Data was "exported" from the editing software and used to produce graphs and tables in a spreadsheet.

Measurement Results

Table 1 illustrates the "loudest" and "quietest" measurement results for each of the five premises in terms of L_{eq} (dBA). Figure 1 is a graphical representation of Table 1.

Discussion of Measurement Results

The highest measured level was L_{max} 91 dBA at Premises 1. The lowest measured level was L_{min} 56 dBA at Premises 2,3 and 5. The greatest variation between the L_{min} and L_{max} for the same premises was 33 dBA (Premises 2), whilst the lowest variation between the L_{min} and L_{max} for the same premises was 20 dBA (Premises 4). The remaining 3 premises had variations between the L_{max} and L_{min} of between 20 and 30 dBA.

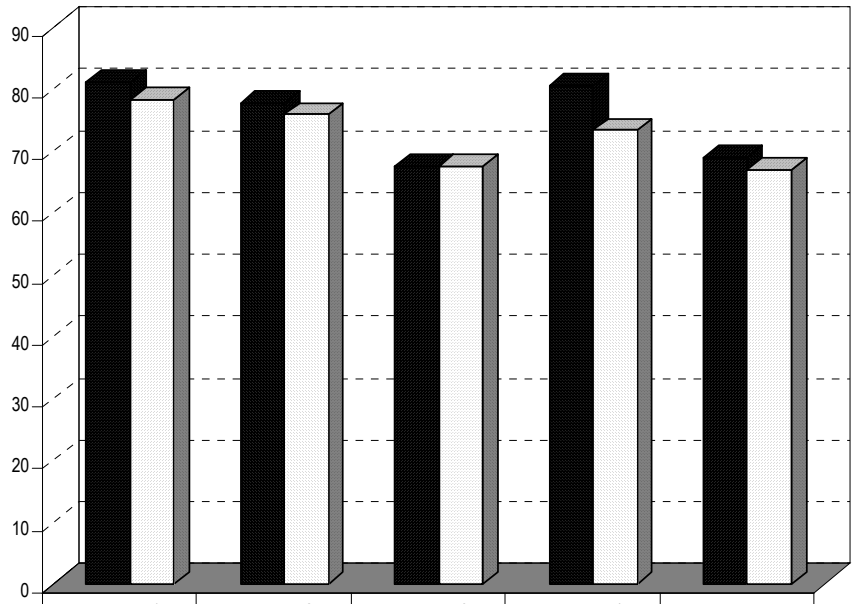
The difference between the 4 premises that had measurements carried out in the weekends with full patrons (worst case) varied between 74 dBA L_{eq} (Premises 3), and 80 dBA L_{eq} (Premises 1). Comparing these results to the measurement carried out during midweek with a nominal number of patrons (best case) there is a significant difference.

This best-case scenario yielded an L_{eq} of 68 dBA (Premises 5).

These results, as expected, indicate that one of the main "drivers" of noise levels within the spaces is "people based noise".

The loudest 30 minute L_{eq} period was at Premises 1 and 4 (L_{eq} 81 dBA), both measurements were undertaken during the weekend (Sunday evening). The quietest 30 minute L_{eq} period was Premises 3 (L_{eq} 68 dBA) during the weekend (Saturday evening). It is interesting to note that Premises 3 has the same loudest and quietest 30 min periods, but also the largest standard deviation (fluctuation of sound) for these two periods.

This objective measurement correlated well with observations, as these three premises were



	Premises 1	Premises 2	Premises 3	Premises 4	Premises 5
Loudest Period Leq 30 min (dBA)	81.1	77.7	67.5	80.6	69
Quietest Period Leq 30 min (dBA)	78.3	75.9	67.5	73.3	67

Figure 1: "loudest" and "quietest" measurement results for each of the five premises. All results (Leq (dBA) 30 minutes).

subjectively judged to be the "loudest" and "quietest" overall.

Generally most people would expect a busy restaurant environment to be "loud". As stated the purpose of these measurements was to quantify the sound levels within each restaurant and café sampled.

Subjectively, only Premises 5 was significantly quieter than the other four premises, however this was expected due to the small number of patrons and the sample being taken mid week.

The variation in measured levels between the remaining four premises did not significantly differ.

However, despite Premises 4 having the highest overall noise level, subjectively this restaurant created an intimate dining environment. This was due to the layout of the environment and in particular our table being situated in a small alcove.

The relevant criteria for assessment of indoor sound levels is the Health and Safety in Employment Act 1992.

"...during a high percentage of time, speech would not be clearly understood..."

The Health and Safety in Employment Regulations 1995, states the maximum levels of noise to which employees may be exposed.

Simply put the maximum level of noise to which an employee may be exposed is L_{eq} 85 dBA over an eight-hour period. All measurements were less than or equal to 80 dBA L_{eq}.

Although measurements were not strictly taken over an 8-hour period the relevant stability of the time varying results would allow one to deduce that these Health and Safety requirements are complied with for this particular set of measurements. Noting that the Health and Safety requirements only apply to staff not patrons.

There are many complex factors

relating to the perception of any environment. In relation to café and restaurant environments three acoustical factors are important, namely hearing, speech communication and speech intelligibility (being able to clearly determine what is being said).

In most premises, people are seated 0.2 to 2m apart. The approximate maximum level of background noise to ensure speech intelligibility at a distance of 0.2m is 69 dB for a normal speaking voice. This recommended criteria would be hard to meet in the surveyed premises.

Furthermore, for a speaker to listener distance of 2m apart "speech spoken with slightly more vocal effort can be understood only when the background sound pressure level is at or below L_{eq} 50-65 dBA" [See Ref 2 in the complete paper].

Comparing the measurement results to this relationship, it could be deduced that during a high percentage of time, speech would not be clearly understood. This assumption holds true to what was perceived during most of the measurement periods concerning speech communications and intelligibility.

Reverberation can amplify sounds within a room in addition to minimising speech intelligibility. Reverberation time within each room or space is different. Speech intelligibility of sound and subjective quality of sound indoors are typically rated by the reverberation time of the space.

Subjectively speech intelligibility was generally poor for most of the premises, with this being affected most of the time by high levels of noise, high reverberation times, and a combination of other factors.

Although not measured, subjectively the reverberation time in each the five spaces could be described as "live"— that is, a room characterised by a relatively small amount of sound absorption.

The final discussion of the results relates to the Café & Restaurant Acoustic Index (CRAI). This index was developed to assist diners in choosing a suitable eating establishment for a function. The scale is subjective (personal).

The index includes information such as "how much noise do you like in restaurants? How much would your experience of noise in this venue adversely affect your decision to return?"

Having filled out this table for each of the 5 restaurants used in this report, my personal opinion is that such noise reviews should be carried out by patrons so that future patrons can use the information to decide whether a restaurant will be an appropriate place for their requirements.

In all instances, the five restaurants surveyed using the CRAI system scored poorly in the areas related to the "overall dining experience" and "noise" effects on communications.

As expected, this illustrates that communications among patrons is difficult in noisy environments.

Conclusions

The objective measurement results from this study indicate that the five restaurants and café environments studied should not be included as potentially harmful recreational activities, for either patrons or staff. This however does not mean that this conclusion holds true for all restaurants and café environments.

It is critical to understand that only basic comparisons can be drawn from the data. That is to say there are many complex variables that determine the perceptions and levels in each restaurant environment relating to the overall acoustic setting.

It is concluded that although the above comparisons can be drawn, it is important not to forget that the type of atmosphere which has been created by the restaurant or café owner, may not be one of a low level hush which certain patrons may prefer.

It may be in fact that the owner's objective is to create a busy vibrant feeling. Although comparisons are drawn to certain standards and guidelines, different premises will cater for different types of patrons and therefore have their own idea of the ideal acoustic environment and brand for their restaurant. ❑

Music vs Noise...

Subject: [ProAud]
Re: lossless audio coding

Date: Sat, 10 Jul 2004

Just as a followup to the previous discussion on compression ratios using lossless compression, I checked some other styles of music. I had previously reported that with a direct to two track recording I had made of chorus with chamber orchestra, the compressed file was around 40% the size of the starting file.

With a commercially released electric blues combo (new Clapton CD), the compressed file sizes averaged around 63% of the starting file size. With a commercially released hard rock recording (new Velvet Revolver), the compressed file sizes averaged around 73% or the starting file size.

I hate to admit it, but I think that my mother has been proven correct by mathematics: hard rock is closer to noise. It must have greater entropy, since it compresses so much less than classical music.

Chris Caudle (from the internet)