The Future Sound of Cities

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Abstract

More than half of the world's population already live in cities and this is expected to reach 75 percent by 2050. In the developed world the effect of the growth of cities has often only been considered late in the day. This paper sets out future development scenarios for cities and urban areas, in developed and developing countries, and looks at the potential impact on soundscape. An evolving toolkit for city design is discussed. Proposals are made for greater protection of humans, wildlife and tranquil areas and for the preservation of important "sound-marks" that identify a place.

Keywords: Futures, Cities, Development, Scenario Planning, Noise, Soundscape, Acoustics.

1. Introduction

The Global Health Observatory [1] has stated that as of 2010 more than 50% of the world's population now lives in cities and predicted that this proportion will reach 75% by 2050. This paper looks out how this growth and changes within our cities may affect our soundscape and presents a toolbox of design tools to help guide the sound of cities.

The burden of noise in cities affects our health and as cities grow is likely to affect greater numbers if development continues as it has done historically.

Noise has always been a problem when living in large social groups. Complaints about noise in cities are recorded as far back as Roman times. [2]

Noise in a modern city is almost always dominated by motorised transport, be it road, rail or aircraft. Of these it is road noise that is often the most pervasive, slipping into almost every corner of every major city. This is the case to the extent that where the European Noise Directive [3] has required member states to identify and protect areas of tranquillity, the UK has outlined guidance on tranquillity identification in the document National Planning Policy Framework : Planning Policy Guidance : Noise Guidance [4], stating:

> There are no precise rules, but for an area to be protected for its tranquillity it is likely to be relatively undisturbed by noise from human caused sources that undermine the intrinsic character of the area. Such areas are likely to be already valued for their tranquillity, including the ability to perceive and enjoy the natural soundscape, and are quite likely to seen as special for other reasons including their landscape. (PPG:NG, 2014)

2. The Work of the Acoustician

Acoustics as a discipline can be traced back at last as far as the Greek empire, but it wasn't until the 1970s that the fields of acoustic ecology, soundscape assessment and bioacoustics began to establish themselves, notably thanks to R. Murray Schaffer [5] and Bernie Krause [ref 6]. Until then the role of the acoustic consultant was to reduce noise levels, ie reduce

unwanted sound but reducing noise levels over all, and even today this is still very much the focus of most of our work.

Noise from transport has generally increased with time, as has the amount of travelling we do, such that what small wins have been made in reducing the noise from individual vehicles have generally been more than compensated for with the increase in numbers of vehicles and the hours of the day which they are used. This holds true for both road and air transport although rail may be a special case, at least in the UK, as it spent several decades in decline following the post-war boom in private car ownership.

3. The Impact of Noise and Uses of Sound

Noise is defined as unwanted sound. As one person's music is another person's noise it has been too easy in the past to assess overall sound pressure levels when assessing noise without distinguishing whether sources may be part of the natural environment or not (although the focus is usually on identifying and quantifying man made sources).

The health effects of noise exposure include [7] hearing loss, elevated blood pressure, elevated adrenalin levels, headaches, fatigue, stress, stomach ulcers, sleep disturbance, annoyance, reduced speech intelligibility, higher rates of birth defects and impinged cognitive development in children [8].

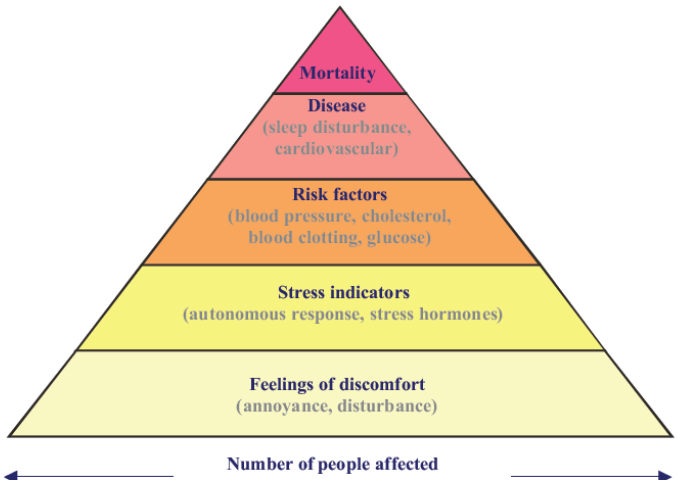

Figure 1. Babisch W. The noise/stress concept, risk assessment and research needs. **[9]**

However, research has shown that natural sounds and music therapy have been shown to help people overcome a broad range of psychological and physical problems. These include, although are not limited to:

To aid the blind to navigate [10]

- In treatment of amnesia
- In treatment of Tourette's syndrome
- In treatment of Parkingson's disease
- In treatment of Dementia
- In treatment of Aphasia (loss of spoken language)
- In treatment of depression

In treatment of Autism and for children with behavioural issues [11, 12]

Of course sound is also central to our communication and without conditions conducive to verbal communication our many complex languages would never have developed the way they have. A similar case can be made for the importance of music.

> Music listening and music therapy have been shown to help people overcome a broad range of psychological and physical problems
>
> Daniel Levitn, *This is Your Brain on Music* [13]

4. The Changing Sound of Transport

The building of railways between the 1830s and 1920s introduced a new and unfamiliar sound into the landscape, adding to the new machine noises recently added by the industrial revolution. Whereas the industrial revolution had added these noise sources to generally built-up areas the railways then connected these areas together, with the new source affecting some otherwise untouched areas in between. The population did become accustomed to the sound of steam engines but the widespread change to diesel locomotives in the 1950s lead to another new soundscape and another acclimatization process. The sound of diesel engines is now ubiquitous and the sound of a steam engine has become a sought after experience for many.

We are currently on the verge of a similar experiential change with electric cars. At high speeds where type noise dominates there is little change but at low speeds, around towns and cities, it is the combustion engine noise which dominates. This has lead to debates in many countries about what sound a car “should” make, predominately based around arguments of pedestrian awareness and safety. Add to this the driver expectation and we are already seeing some manufactures adding artificial engine noise into the sound inside the cabin [14], EU rulings on the requirement for ‘Acoustic Vehicle Alerting Systems’ for electric vehicles [15], as well as the recent debate in the current Formula 1 racing season with new quiet engines causing widely reported upset among drivers, fans and officials [ref 16].

Opportunities to lower transport noise do not come along often and should be grasped whenever they happen.

5. Living Densely

What defines a city is still often debated and changes from one geographic region to another and based on local history and governance. For the purposes of definition here a city is taken to be a developed permanent human settlement of high population density. How noise control regulation is dealt with during the process of building up an area of high population density will have a lasting outcome on the soundscape as experienced by its inhabitants.

When problem areas arise these can be dealt with through new regulation but this is generally a very slow process. The earlier in the growth of a city suitable control measures can be put in place the more successful the long-term control of its environment.

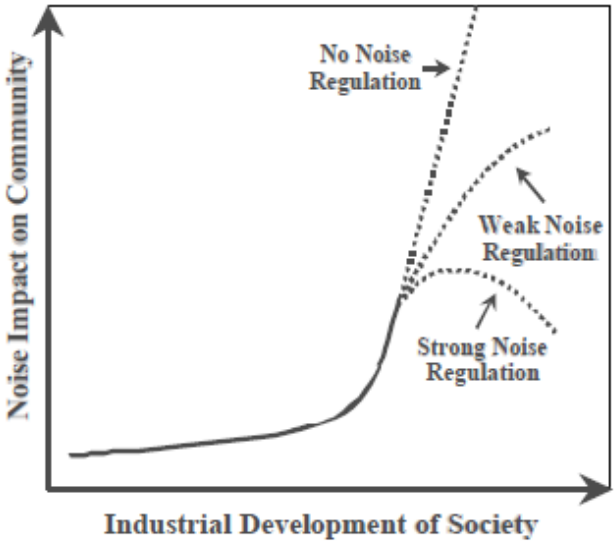

Figure 2. Noise Impact on Community versus Industrial Development of Society **[7]**

To pick two examples, an old city where noise levels have got out of control would be Cairo, where the noise of the city is one of its defining features in travel guides and the New York Times called "the city where you can't hear yourself scream" [17], compared to a relatively car free city like Amsterdam, where the sound of trams, people and bicycles can be heard even in all the main plazas.

Living in close proximity leads to an increase in the likelihood of noise nuisance, where shared partition walls and floors in flats and apartments will inevitably conduct more sound than between detached dwellings, and shared circulation spaces subject us to the sounds of neighbours coming and going.

The more people are crammed into a space the more likely that noise made by one of those people will bother another. Cities also bring with them transport issues. People will often travel to work along the same routes and at similar times to many others. A well design transport system can deal with this and take advantage of economies of scale of needing to transport a large number of people in the same direction at the same time. Train, tube, tram and bus systems are all integral to existing successful cities.

6. Gaming the City

It is an interesting thought experiment that architecture student Vincent Ocasia [ref 18] set himself the challenge of finding the maximum possible urban density within the SimCity game, and gave an interview about it. In doing this he found that the elimination of transport was a key factor, and organised the space such that every one of his virtual subjects could walk to their place of work. In realty of course this could never work, as family life will lead to people living in one location but working in another. Furthermore the focus on increasing population density only had knock on effects on quality of life and lifespan. Modelling cities in this way, using a game engine, is an interesting exercise but a lengthy process presenting a far from accurate representation of daily life. However, there is no reason that a neural network system could not be set this same task and it may come up with solutions that have not yet been considered.

7. A Brief History of Designing for the Future and the Impact on Sound

In the 1940s and '50s a post-war boom in city development and house building cleared away many slums and tenements as well as repairing war ravaged cities. This lead to experimental new designs and wild speculation on future development. Predictions of flying cars were rife. Contrast this to today where there is speculation about a future of drone based delivery systems and you see that little has really moved on.

Picking some other historical examples of futurology can help to set the scene, and remind how wildly wrong ideas can be.

In his 1910 science fiction book The Sleeper Awakes [ref 19], H.G. Wells predicts a future London where a "moving pathway", like the travellators seen in airports, allows pedestrians to navigate London at speed, a circular route with concentric rings allowing passengers to move out in steps of increasing speed. The reality we saw came to be the expansion of the underground system, which had already started operating in 1863.

In architecture Le Corbusier sought to improve living conditions in crowded cities clever layout of multi-storey blocks surrounded by or surrounding green park space [ref 20]. He produced plans for a "Ville Contemporaine" (Contemporary City) in 1922 and a "Ville Radieuse" (Radiant City), in 1924. Although never built elements of these design appeared in various locations and influenced a generation of designers and planners. For example he is credited as a major influence in Constructivist era Soviet architecture and planning.

In 1960 Geoffrey Jellicoe proposed Motopia [ref 21], where roads were kept on roof tops above residencies and views from windows were always of open green spaces. Again this was never built, but the same period brought about many redesigns of existing UK city centres with split level vehicle and pedestrian circulation. Although these fell out of fashion for numerous reasons, steps and disability access among them, isolated examples can still be seen in parts of Glasgow, Birmingham and Bristol.

Other more fanciful ideas have included Archigram's Walking City (1965) [ref 22], where an entire walking robotic city allowed inhabitants to be delivered to their place of work in the morning and retire to a more peaceful location at night.

The most successful piece of forward thinking can probably be credited to Ebenezer Howard's garden cities [ref 23], which were first proposed in 1902 and as recently as 2013 continuing to be promoted as a template for eco-towns. [ref 24]

Milton Keynes in the UK is one of the more famous examples of this approach and the zoning system employed allowed for some flexibility in changes to the town's demographics over its lifespan, although from a discussion one of the authors had with one of the towns Planners it was apparent that this flexibility could only be stretched so far and compromises would have to be made in terms of allowable land use of adjacent blocks if the town was to thrive.

In more recent years the growth of new city developments in the Middle- and Far-East has seen soundscape start to play a role in the design process. One of the author's work on King Abdullah Financial District in Riyadh included acoustic advice on market places and pedestrianised areas to create a more vibrant atmosphere, as well as placing the mosque at the centre of a web of streets that ensured the call to prayer could be heard over as large an area as possible. A very intentional design of a soundmark into a city development.

8. Future Development Possibilities

Using the experience of the above and knowledge of planned growth in cities and both transport and energy infrastructure it is possible to plot a series of scenarios for the future development of varying cities. It should be noted that these are extreme examples designed to capture as wide a range of potentials as possible and it is hoped that the majority of developments would fall somewhere within these boundaries.

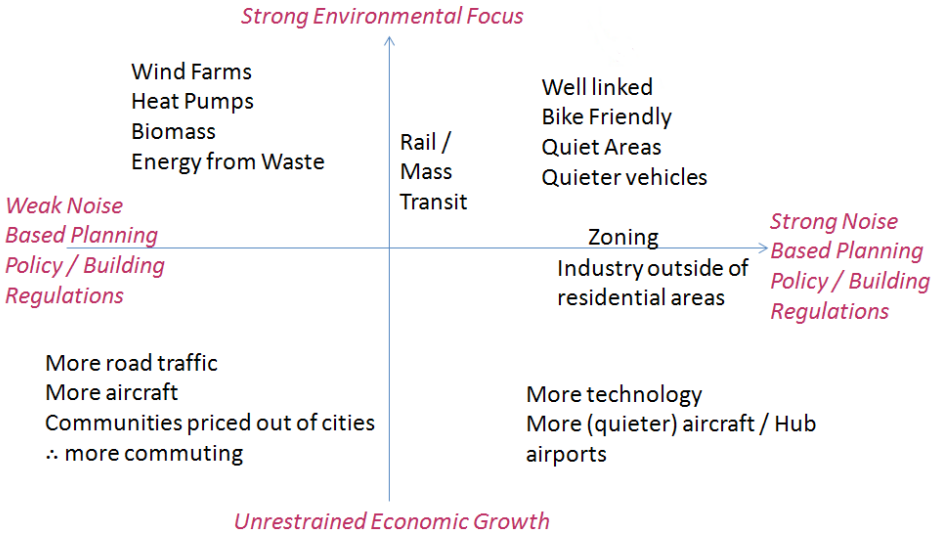

Figure 3. Scenario Planning for Future Sound in Cities.

9. Design Toolkit

Tools for improving the soundscape in urban areas have been suggested by Schfer and others, and a total of 102 non-noise related planning tools are suggested by Atkins' Future Proofing Cities report. The table below combines the most relevant of these, grouping them by area of application, as a guide to city soundscape design.

Table 1. Design Toolkit for Future City Soundscapes

Number	Tool	Description / Application	Example
1	Soundmark	Identify existing soundmarks that are unique to a place or an identifier of its character. Consider protecting them with policy. Consider incorporating new soundmarks into the design.	Maximising audible range of call to prayer in King Abdullah Financial District in Riyadh. Study into range of the Bow Bells in London and affect of changes in ambient noise [25, 26]
2	Soundscape Restoration	Where a soundscape of value has been lost due to development its restoration can be considered	Closure and grassing over of part of the A344 close to Stonehenge partially restoring original soundscape and landscape
3	Energy Policy	Moving major noise sources away from residential areas, shifting away from dependence on fossil fuels, reform of energy subsidies	Off shore wind generation, tidal energy, micro-generation
4	Labour force	Flexible working and shift working	Policies to encourage flexible working patterns can help reduce traffic congestion during peak hours, but this should be balanced against causing disturbance during rest hours.
5	Zoning 1	Mixed use zoning allowing people to live and work in the same area	Reduces transportation noise but can cause problems where noise from work activities disturbs residents.
6	Zoning 2	Sub-urban zoning	Keeping residential areas away from industrial noise sources prevents disturbance but increases transportation requirements
7	Zoning 1 & 2		Zoning policies should take care to balance potential future changes of use as well as initial plans
8	Mass transit development plans	Areas of high population density should be provided with good public transport links	Reliance on cars should be reduced and rail, tram and/or bus infrastructure built. Eg Dubai Metro. It is important to consider end to end journeys and provide effective interchanges between transport modes for longer journeys.
9	Pedestrian and bike orientated development plans	Encourage use of bicycles and of walking routes	Land design practices should encourage non-motorised transport
10	Increasing density standards	Where deification is planned standards should be put in place to prevent increase in noise complains	Improvement of building regulations and control of neighbourhood noise. For example, smart city technology like ShotSpotter(R) [27] uses microphones in lampposts to pinpoint locations of gun fire, used in several major US cities. This technology could be expanded to identify other noise sources but must be balanced against civil liberties.

Number	Tool	Description / Application	Example
11	Infill and brownfield incentives	Reusing previously developed areas to take pressure off of undeveloped land	This would help to preserve soundscapes in undeveloped areas. There is potential to assess offsetting of soundscapes / noise levels in the same way ecological sites are considered.
12	Transit orientated nodes	Major transit interchanges, such as train and/or bus stations, should be placed within a community to encourage people to walk to them	New towns and cities should be designed with rail access in mind and connectivity of residential areas maximised.
13	Restricted development on vulnerable land and relocation from vulnerable areas	Development should be limited to low density / low intensity uses on areas at high risk of flooding / extreme weather / sea level rise	Noise should be considered as a similar risk and noise sensitive development avoided in areas of high noise
14	Buffer zones	Non-noise sensitive areas should be placed between noise sources and noise sensitive receptors	Open spaces, retail units, and offices (used as barrier blocks) can all be used to reduce noise impacts on residents / schools / hospitals etc.
15	Greenbelt / growth boundaries	Defining management boundaries can be used to protect areas from inappropriate development	Can be used to safeguard land uses, soundscape, and tranquil areas
16	Improvements to public transport systems	Numerous options are open for both new and existing cities to reduce the reliance on personal car transport	Examples include: Bus Rapid Transport (BRT) / Park and Ride / Metro Systems / Public Transport Lanes / Smart Transport Information / Driving and Parking Restrictions / Car Clubs / Hybrid and Electric Vehicle Incentives
17	Recycling and Waste Management	Efficient use of local resources	Although some overhead in collection and sorting of recycling is required this is compensated for with reductions in raw material usage and transportation, manufacturing noise, disposal etc.
18	Building codes	Robust standards for new buildings encouraging energy efficient buildings and high standards of insulation	Reducing energy consumption will generally lead to reduction in noise generation too (e.g. passive ventilation rather than mechanical ventilation) and improved thermal insulation standards can be used to improve acoustic insulations simultaneously.
19	Eco-villages / neighbourhood schemes	Schemes to combine energy generation, heating, cooling, waste handing etc at a local level	Making individual areas more self-sufficient can help reduce wider infrastructure and reliance on large scale industrial areas. This can include micro generation, use of waste as biofuels, Combined Heat and Power (CHP) and district heating and cooling, Smart Grids etc.
20	Biodiversity	Monitoring and protection of habitats and important species	This should include further research into the effects of human noise sources on wildlife behaviours

Number	Tool	Description / Application	Example
21	Reforestation	Tree planting programs and reforestation	Wind in trees and long grasses are important elements of the natural soundscape and should be identified, preserved, and can be used as tools in soundscape creation. Wind noise can also help to mask unwanted noise sources. The associated areas of soft ground also provide better attenuation of noise than hard surfaces.
22	Sustainable and affordable housing	Slum upgrades and affordable housing improve living conditions	Preventing factors that price certain tenants out of areas has knock on effect of reducing commuting thereby reducing transportation noise
23	Absorbent building facades	Building facades are generally acoustically hard and highly reverberant, improvement in urban areas possible	Although difficult to hear the effect of this in cities where road traffic is the dominant noise source occasions when traffic is stopped (public events, marathons etc) present an opportunity to appreciate how much worse the reflections from building make the auditory environment.

10. Conclusion

The importance of considering soundscapes and noise control in cities has been shown with reference to growing numbers of people in cities, impacts on health from noise and the benefits to both listeners and to wildlife from better balanced soundscapes.

Future development possibilities for cities and urban areas, in developed and developing countries, have been explored and are shown in Figure 3.

A design toolkit for both new and existing cities has been tabulated, giving multiple options for investigation in any future city work. This includes examples of schemes and of benefits as well as highlighting other future city design measures which can have knock-on effect in respect to sound.

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