The Scale of Sense: Spatial Extent and Multimodal Urban Design

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1. Introduction

This paper is derived from the work of the UK AHRC/EPSRC 'Designing for the 21st Century' research project *Multimodal Representation of Urban Space*. This research group seeks to establish a new form of notation for urban design which pays attention to our entire sensory experience of place.

This paper addresses one of the most important aspects of this endeavour: scale. Scale is of course a familiar abstraction to all architects and urban designers, allowing for representations tailored to different levels of detail and allowing drawings to be translated into build structures.

Scale is also a factor in human experience: the spatial extent of each of our senses is different as is the temporal extent of the originating stimuli. Many forms of architectonic representation are founded upon the extension of the visual modality, and designs are accordingly tuned towards this sense. We can all speak from our own experience, however, that urban environments are a feast for all the senses.

The visceral quality of walking down a wide tree-lined Parisian boulevard differs greatly from the subterranean crowds of the Metro, or the meandering pause invited by a city square. Similarly, our experience of hearing and listening is more than just a passive observation by virtue of our own power of voice and the feedback created by our percussive movements across a surface or through a medium.

Taste and smell are also excited by the urban environment, the social importance of food preparation and the associations between smell and public health are issues of sensory experience. The tactile experience of space, felt with the entire body as well as our more sensitive hands, allowing for direct manipulation and interactions as well as sensations of mass, heat, proximity and texture.

2. What is Scale?

Our first task is to define scale, of course. On one level, scale is a convenience which allows the representation of larger or smaller areas with varying levels of detail. Rendering a city at the scale of a door handle or street bench would necessitate an amount of paper and time of truly epic proportions, perhaps best explored by the cartographers in Borges' short parable "On Exactitude in Science" where the king of a realm demands a map so detailed that it covers the territory it describes completely.

Scale can refer to both the factor by which a representation is reduced as well as the actual size of a development. Scale drawings are referred to by the ratio of their reduction, be that 1:50, 1:100 or 1:1250. The scale of development or urban planning can vary from huge regional projects through developments of neighbourhoods, urban blocks or the detailing of surfaces that constitutes streetscape.

Ali Madanipour comments on the ambiguity inherent in the scale of urban design:

> 'Definitions of urban design refer both to the design of cities and settlements as a whole and to the design of some parts of urban areas. The range of issues and considerations addressed at these two macro- and micro-scales of urban design, however, are very different from each other.' Madanipour 1997:13

This leads Madanipour to consider the deeper meaning of this to urban design as a discipline and the implications of each set of scales. The tension between the design of the public realm: the public parts of the city on one hand and the broader definition of urban design as

the form of and possibilities indicated by settlements or parts thereof. The closeness of this definition to planning is one factor to consider, as is the closeness of the former to architecture. Urban design occupies a position tension between these two disciplines, a product of the need for a more multidisciplinary approach to defining our cities and other settlements.

In his work on Scale in Architecture, Frank Orr defines scale with reference to its origins *scala* in music, and also as:

> 'The measuring instrument that architects, engineers, and other designers use in making proportionate drawings that differ in size but not in basic form from the physical things they represent.' Orr, F. (1985:7).

Interestingly, scala refers to both a ladder and a flight of stairs, indicating a measurement from one extreme to another. Scale has a variety of meanings both in normal conversation and with relation to the built environment. Most importantly, the use of scale as a measuring device allowing, through reference to a scaling device, comparisons in size of buildings and other elements of the city as well as pragmatic representations which depict large objects accurately, but in a manageable way. Orr defines eleven concepts of scale:

- Comparison
- Related to Whole
- Related to Parts
- Related to Usual Size
- Related to Human Size
- Proportional Theory
- Musical Analogy
- Balance
- Strength of Materials
- Psychological
- Perception

These concepts are derived from Orr's reading on the topic of scale, and are supported by the work of Francis Ching. Ching is concerned with geometry and space in his work, with a

distinctly visual approach to architecture. This influences his approach to scale, defined as distinct from proportion thus:

> 'scale refers to how we perceive the size of a building element or space relative to other forms. In visually measuring the size of an element, we tend to use other elements of known-size in their context as measuring devices.'

Ching develops this into two categories of scale: Generic Scale and Human Scale. Generic scale is relative between buildings whilst human scale uses the proportions of the human body as a measure. Both of these categories are useful and instructive with regard to the other senses as we shall see later, not just the visual which concerns Ching.

Whilst framed as a celebration of megastructures, some truths about scale and size are expressed by Rem Koolhaas in his definition of scale and essay *Bigness, or the Problem of the Large*.

> 'Scale: I think working with scale puts you in an almost godlike position... ...You can hold a piece of turf in your hand, or a house, and you can plant it somewhere, or you can crush it, smash it.' Koolhaas, R. (1997:1114)

This bigness introduces a problem of function as well as perception. Fundamentally, the relation between the interior and exterior of a building is broken by excessive scale, denying the city dweller the normal expectation of some meaningful outward expression of the building's function and activity. Instead, such buildings become harder and harder to read, being blank canvases for formal and artistic interventions which need not be legible as part of the urban fabric. Scale is not only about the big, of course. The small is not tackled in Koolhaas' critique here, and the notion that big things can be apprehended as a series of smaller events rather than a totality. Modernism gives us this totality as large buildings are flat and lacking the details that allow for this process of subdivision. Such massive accumulation of detail is

apparent in Garnier's Paris Opera House (Malnar & Vodvarka 2004:172-174) the effect of which is to allow both human and generic scale to be addressed in a large urban building.

Writers on urban design have identified a series of scales appropriate to the discipline. Whilst in some ways disparate, general agreement can be found amongst these, as related to the elements of urban design. Such discussions are related to another important concept in urban design: typology.

Ann Vernez Moudon, (1994:260) for example, considers a variety of scales:

1. Rooms
2. Apartments
3. Apartment Buildings
4. City Blocks
5. Peninsula, Roads & Streets

This suggests the importance of modularity in urban design, and the solution of typology in this. Leon Krier continues this with his critical essay on the importance of scale to urban design, offering the scales of:

1. Public Rooms
2. Blocks
3. Patterns

These are underlined by typology, and a regard for the implications of scale on the city, from its pedestrian centred, walkable scale up to the car dominated city. The approach of typology and repeatability suggested is placed opposite the zoning of Modernist planning, which sought to separate and differentiate zones by function, keeping housing in one area, commerce in another, industry in yet another zone and finally agriculture - also separated. This separation is widely recognised as damaging to the city fabric, and Krier regognises the economic centralisation at the heart of structures such as the Palace of Justice in Brussels, which is the same size as an entire medieval ward.

'My main affirmation regarding urban design will be: *urban blocks should be s small in length and width as is typologically viable; they should form as many well defined streets and squares as possible in the form of a multi-directional horizontal pattern of urban spaces*.'
Krier, L. 1984:244.

3. Range, Scale and Spatial Extent

One of the fundamental questions that must be answered in this endeavour is: how do we conceptualise the senses at all? There is a long tradition of understanding the senses as divided and combined in a variety of ways, each time responding to the needs of the time. Each taxonomy of the senses is loaded with meaning and far from neutral or given. Given the focus in our project of the urban realm, this should also be the focus of our taxonomy for the senses.

Name	Mode of Attention	Receptive Units	Anatomy of the Organ	Activity of the Organ	Stimuli Available	External Information Obtained
The basic orienting system	General orientation	Mechano-receptors	Vestibular organs	Body equilibrium	Forces of gravity and acceleration	Direction of gravity, being pushed
The auditory system	Listening	Mechano-receptors	Cochlear organs with middle ear and auricle	Orienting to sounds	Vibration in the air	Nature and location of vibratory events
The haptic system	Touching	Mechano-receptors and possibly thermo-receptors	Skin (including attachments and openings), joints (including ligaments), muscles (including tendons)	Exploring of many kinds	Deformation of tissues, configuration of joints, stretching of muscle fibres	Contact with the earth, mechanical encounters, object shapes, material states, solidity or viscosity
The taste-smell system	Smelling	Chemo-receptors	Nasal cavity (nose)	Sniffing	Composition of the medium	Nature of volatile sources
	Tasting	Chemo- and mechano-receptors	Oral cavity (mouth)	Savouring	Composition of ingested objects	Nutritive and biochemical values
The visual system	Looking	Photo-receptors	Ocular mechanism (eyes with intrinsic and extrinsic muscles, as related to the vestibular organs, the head, and the whole body)	Accommodation, pupilary adjustment, fixation, convergence exploration	The variables of structures in ambient light	Everything that can be specified by the variables of optical structre (information about objects, animals, motions, events, and places)

The perceptual systems. From James J. Gibson, *The Senses Considered as Perceptual Systems (Boston: Houghton Miffin Company, 1966*).

3.1 The Visual System

The detail we can resolve in the urban environment is a function of our own visual acuity and the luminance and contrast of the area of interest. Visual resolution, important for our abiltiy to detect texture, signage and other detail, becomes optimal above a luminance of about 1,000 cd/m2 (Padmos, Milders, 1992) and based on physiological data (Boff 1986) is around 30 seconds of arc. However the luminance range we can detect lies between 10-6 cd/m2 at our absolute lower threshold up to 108 cd/m2 where physical damage to the eye can occur. An urban park on a bright moonlit night will have a luminance of about 0.03 cd/m2 and a piece of white paper in bright sunlight has a luminance of approximately 36,000 cd/m2.

Assuming we are standing looking ahead at a building or square our field of view is approximately 2000 horizontal and 1200 vertical depending on face geometry, Fulton 2004; May, Badcock, 2002). This is influential in our ability to enjoy a scene instantly before exploring further with head and limb movements. For example standing in a very spacious urban environment as may be found in Tiananmen Square in Beijing, or the Place Massena in Nice we find our full field of view occupied by a panorama full of visual and emotional impact.

Our idea of vision is influenced greatly by technologies of seeing: perspective, film and photography. Both of these technologies reproduce vision rather imperfectly, as monocular and lacking the dynamic range or darting of the eye. Rather than reproducing the action of the eye, these constructs reproduce the sensed scene, allowing the eye to do its work on this illusory surface. The presumed visual bias in design is limited to a geometric projection of space, neglecting other factors in visual perception such as hue, saturation, sharpness, texture.

'If one says "Red" (the name of a color)

and there are 40 people listening,

it can be expected that there will be 50 reds in their minds.

And one can be sure that all these reds will be very different.' (Albers, J. 1971:3)

Josef Albers' work, *Interaction of Color* is part of a course for painters to help them to understand colour, not through colour theory and physics, but by developing an appreciation of the effects colours have when placed with each other, in the context of a painted surface.

'We are able to hear a single tone.

But we almost never (that is, without special devices) see a single color

unconnected and unrelated to other colors.

Colors present themselves in continuous flux, constantly related to changing neighbors and changing conditions.' (Albers, 1971:5)

This concern for context is absolutely fundamental to this study, rejecting the scientific basis of abstract models of perception in favour of Gibson's seeking perceptual systems and Merleau-Ponty's embodied perception. Perception is always *of something* and *when somewhere*.

Anthropologist Tim Ingold takes this up (Ingold 2007) when regarding the weather. Ingold works with Gibson's concept of medium rather than the abstractness of space. Air isn't nothingness, but has a real influence on what we see, hear, feel and taste.

In overturning the visual bias and ocularcentrism identified by Pallasmaa (1996:6-24) we should look to reassert the full quality of the visual rather than throw everything out. The ocular bias is narrow in practice, and based on our technologies of seeing and representing rather than what the eye *actually sees*.

3.2 The Auditory System

A young healthy human can hear frequencies between about 20 Hz and 20,000 Hz. However the ability to hear the higher frequencies decreases with age with the upper limit at around 16,000 Hz and 12,000 Hz for a 20 and 50 years old person respectively (Hinchcliffe, 1962). The greater part of human voice energy occurs between about 40 Hz and 1,000 Hz with some portions of the sound above this. Musical instruments can provide frequencies from below the lowest limit of audible sound up to 4,600 Hz and with musically effective overtones up 12,000 Hz (Geldard, 1972). Within the town or city we are constantly exposed to this full range of audible sound.

While we can usually hear between 20 Hz and 15,000 Hz our ears are not equally sensitive to all frequencies, e.g. 65 dB at 100 Hz does not seem as loud as 65dB at 1000 Hz. For this reason weighting networks are used which discriminate against frequencies at which the

ear is less responsive. The most commonly used network is the A-weighting, and sound pressure levels (SPLs) measured on this basis are denoted dB(A). Using this method the threshold of hearing occurs at 0 dB(A), a quiet neighbourhood would be about 50 dB(A), a train passing through a station about 90 dB(A), pain begins about 130 dB(A).

Barry Blesser and Linda Ruth Salter give a detailed account of the spatial properties of sound in *Spaces Speak, Are You Listening?* Blesser & Salter contrast instances of spatialised sound with the visual realm, demonstrating that sound has a completely different spatiality. This sense of space is undeveloped, but available to all rather than the normally identified special groups such as the visually impaired, musicians or spelunkers. Four aspects of spatiality are usefully defined (Blesser & Salter 2006:12):

Social Spatiality

Navigational Spatiality

Aesthetic Spatiality

Musical Spatiality

The example is given of an acoustically neutral chamber such as a recording studio. A sense of placelessness is given by this environment, lacking as it is in auditory cues. An allegory is drawn between sound sources and illumination. That sources of sound are used to 'light up' an environment aurally in the same way as a light source is needed for visual understanding of a space.

> 'We cannot see volume, but we can hear it. Aurally, we sense the volume of a large space by its long reverberation time and the volume of a small space by its sharp frequency resonances. Visually, we can sense volume only by mentally multiplying the three dimensions of a space.' (Blesser & Salter 2006:21)

Notions of *acoustic horizon* define the maximum distance between a listener and sound source, beyond which a sound is reduced to background noise; *acoustic arena* in which a region is shared by listeners with a common ability to apprehend a given sound source; and an *auditory channel* forming the connection between a sound source and a listener, are all useful concepts to apply to the other perceptual systems.

Sound is the most thoroughly theorised sense, perhaps even moreso than vision given the way in which vision is simply accepted as primary, it has often been neglected. Ground-breaking work by R Murray Schafer in defining the *Soundscape* and its various elements such as *soundmarks, keynotes* and *signal-noise ratio* have been further developed with reference to the urban context by Jean-Francois Augoyard and his team at CRESSON in *Sonic Experience* (2005). This valuable sourcebook has many specific examples of sonic effects relevant to the city including *Cut-out* where building corners create sharp distinctions between the sonic character of one side and another as well as *Masking*, *Ubiquity* or *Reverberation*.

Further layers are added to sonic experience of the city by the availability of both amplification technology (see Coyne, Lucas, et al 2007) and personal stereos such as iPods. This production of personal space by means of soundtrack is examined by Tia DeNora (2000) and Michael Bull (2000).

3.3 The Chemical System

The threshold of detection of odours varies considerably. For example in units of milligrams per litre of air the musky smell of musk xylene can be detected at a concentration of 0.000000075, the rotten eggs smell of hydrogen sulphide at 0.00018, and the wintergreen smell of methyl salicylate at 0.1 (Shiffman, 2001). It is estimated that on average humans can discriminate just over 100 (see Axel, 2006 and Drawert, 1975) different sensations of odour. However adaptation is a particular problem with olfaction This is an apparent decrease in intensity upon long exposure to an odorant, e.g. over a 5 min period. One example of this is

the case of violet, which contains ionone, effectively short-circuiting our sense of smell although the flower continues to produce scent, it is perceived in waves. Moving through an environment such as a food and flower market we find our olfactory sense constantly stimulated by different smells thus providing a sense of vibrancy to our experience. This mixing of scent is known as bouquet.

Diane Ackerman, in her *Natural History of the Senses* (1991), writes of a wide variety of concepts of smell, from the stereochemical theory explored by J E Amoore (1970), which seeks to understand the relationship between the geometry of molecules and their associated odours. According to Amoore, musky odours are disc-shaped, fitting a corresponding bowl-shaped neuron niche whilst peppermint is wedge shaped, slotting into a chevron-shape. Ackerman also looks into basic categories of scent, suggesting:

> 'All smells fall into a few basic categories, almost like primary colours: minty (peppermint), floral (roses), ethereal (pears), musky (musk), resinous (camphour), foul (rotten eggs), and acrid (vinegar). This is why perfume manufacturers have had such success in concocting floral bouquets or just the right threshold of muskiness or fruitiness.' (Ackerman, D. 1970:11)

Classification of scent has proven deeply problematic. Barbara & Perliss, writing on *Invisible Architecture: Experiencing Places Through the Sense of Smell* note some seven different taxonomies, each bearing some similarities, but also culturally specific to the creators.

> 'One of the most significant problems in the olfactory realm is notation, i.e., the system of denomenation and classification for working with and talking about perfumes and other odors. There have been various and successive theories and classification seeking to establish a common system for describing and organizing odors. However, there is still no

stable vocabulary of odors that is universally shared. Each perfumery has its own.' (Barbara & Perliss, 2006:114-115)

The spatial extent of olfaction is a factor of its medium: the air itself. As such, scents can have an incredibly intimate range or cover a vast territory. This factor is complex, comprising both the level of concentration of the odour discussed above as well as meteorological effects such as wind speed and direction.

By way of example, an historical study of smell in Venice is informative. Jo Wheeler (2007) writes of the stench from the lagoon as a major factor in the development of the city. The tolerance of stench is an issue of social concern, spurred on by medical thinking in the Sixteenth Century. This leads to both personal constructions of aromatic space by means of perfumes, soaked sponges or chewing of citrus seeds as well as urban design considerations of moving certain trades away from public areas of the city.

Constance Classen (2006) considers the deodorization of Dickensian London in a similar manner, looking to the way in which city smells are always problematised and characterised as stench, as undesirable. Classen cites the comments of French architect Marc Crunelle:

'We have trouble representing odours in space, essentially because they are invisible. Only the visual data of architecture can be represented. Since space, where we live, consists of air, light, humidity, temperature, and smells–all of which are invisible, transparent things–it cannot be drawn.' (Marc Crunelle in Classen, C, 2006:303)

It is clear that scents have a role to play in our experience of urban environments. The everyday experience of such smells is that they pervade a relatively small area, close to the point of origin. Such smells have a commercial function, with fresh food smells being particularly important, or other small speciality stores selling soaps and perfumes, confectionery, bakery, restaurants and bars (which often have the aroma of tobacco smokers at the threshold

since the introduction of smoking bans in several countries). Walking along a city street loaded with these scents is a rich experience, loaded with meaning and expressing the contents of a building far better than the most honest, readable facade.

> 'A special joy of travel is to acquaint oneself with the geography and microcosm of smells and tastes. Every city has its spectrum of tastes and odours. Sales counters on the sidewalks are appetising exhibitions of smells: creatures of the ocean that smell of salt water, vegetables carrying the odour of fertile earth, and fruits that exude the sweet fragrance of sun and moist summer air" (Pallasmaa, J. 1996:38)

Closely associated with olfaction is gustation. There are said to be five basic tastes: sweet, sour, salty, bitter, and umami (more recently added, and from the Japanese for a delicious, meaty and savoury sensation). Combining these tastes with the range of odours we can detect we are provided with a range of thousands of tastes. The intensity of each taste is related to the amount of substance present (Coren et. al. 1994). This sense is more relevant to us once we decide to stop and take our ease by indulging in some of the food that has already tempted us by its aroma. The closeness of taste and smell afford a useful combination into the chemical senses, particularly given our urban scale. Taste is the most personal and most intimately scaled sense, requiring the ingestion of something, needing the contact of the tongue. It is interesting, of course, to note the relation between taste and refinement: that one is said to have good (or even exquisite) taste is a mark of class, of discernment.

Synthetic systems for producing scent are becoming more feasible, with commercial concerns such as Sony and Prada keen to associate their brand with all the senses. Companies such as Scentair (http://www.scentair.com) are providing technologies for this, with scent diffusion systems industrialising the knowledge of perfumiers.

3.4 The Tactile System

Our sense of touch, or taction, is provided by signals from receptors, i.e. nerve endings, located within our skin. The receptor population of the skin is complex with receptors of different types located at various depths and with a range of densities and sensitivities depending on the location on the body. We can detect a just noticeable difference (JND) of rough surface texture of 0.1mm (Unger et.al., 2007), and the touch force JND on the index finger is 10% between 2.5 and 10N (Allin et.al. 2002). This sense is constantly being stimulated as we experience the urban environment although some, but not all, of the time it may be subconscious. For example the feel of cobbled streets, uneven paving, soft grassy surfaces, and the texture of the stone, marble, or wood on a building.

Whilst tactility is a sense dependent upon contact, it also relies upon movement across a surface, be that the movement of the whole body or the movement of a hand when grasping or feeling a surface.

'Touch, in fact, relies on movement for its full expression for both stroking and striking.'

Classen, C. 2005:3

That movement is built into tactility suggests that it is a temporal sense, incapable of totality of apprehension associated with vision. This temporality is further accentuated by the effect of weather on touch. A surface covered with moisture from rain or other precipitation is different when touched on a cold crisp day, or the height of a warm summer day.

Classen discusses the idea of a 'mother touch' (Classen 2005:13) with reference to the concept of mother tongue. Similarly, Finnegan (in Classen (Ed.) 2005:18) discusses tactile communication, considering the ways in which people greet one another and how that varies from place to place and subculture to subculture. That a people have a shared idea of what is acceptable as touch is particularly apparent from situations like the subway, (Lucas 2004, 2008) where the experience of the Tokyo metro differs radically from that of others despite

the similar building form and typology. This difference lies in the physical comportment of commuters and other station users, the ways in which people interact with one another.

The scale of touch is difficult to understand as anything other than intimate when considering the perception itself, but the stimulus has a wider distribution, creating zones of tactility tied to paving patterns, street furniture, building surfaces and so on.

3.5 The Thermal System

As a subset of our sense of touch, thermoception is important enough in the context of building to warrant its own category. The skin senses temperature through the action of Kraus end bulbs that respond to cold, and the Ruffini corpuscles that react to heat. Exact figures for JNDs (Just Noticeable Differences) are difficult to determine given changes in context: for example, the thermoreceptors have a JND of around 0.2°C if skin is adapted to a temperature of 31°C – 36°C which is roughly body temperature (Vander et.al. 1994). Our cutaneous perception of the ambient temperature of the urban environment and the temperature of say a metal or wooden park seat, all contribute to our sense of presence, pleasant or otherwise, in the urban environment.

> 'In The Architecture of the Well-Tempered Environment, Reyner Banham highlighted architects' continued fixation with defining a boundary or edge condition through formal strategies based on monumental skin and shell enclosures. In contrast to this cave mentality of capturing spatial organisations through form, Banham pointed to the campfire as a means for spatial organisation. The campfire is both a source of energy and a territorial organiser, creating micro-climates of heat, light and darkness with the potential for variable conditioning. The radiating gradients of light and heat create a soft boundary that rises in intensity before slowly dying back only to activated once again later, all while organising an individual's placement around a gradient and variable territorial boundary. It's these mechanical systems responsible for making such spaces livable throughout the

course of a year, that Banham sees as the facilitators of spatial configuration – not the skin or shell that constructs an envelope'. (Sean Lally 2006:1)

Reyner Banham and Lisa Heschong directly address the notion of this thermal sense in the built environment, offering a critique of architecture based on our approaches to heat. Banham (1969) draws a distinction between two models of space, one based on the cave, which is bounded and controlled and the campfire, which is a function of distance from a point - not bounded, but graded. The level of control desired by services engineers is addressed directly by Heschong, who likens the desire to optimum values for thermal comfort to creating an environment which consists of a single, steady colour of blue (Heschong 1979:20).

3.6 The Kinetic System

This final subset of the classical sense of touch is the kinetic system, closely associated with tactility, but more finely defined as related to balance, locomotion and presence. The kinetic system can be understood as a driver for the other, temporal senses, allowing the body to position itself at vantage points, or away from undesirable sensations.

Movement is also a social sense, as suggested by Classen's 'mother-touch' above. Edward T Hall, writing in *The Hidden Dimension* (1969) develops a theory of *proxemics* as the cultural content of personal space. Hall constantly places his proxemics in a cultural context, firmly believing that sensation and perception cannot be understood outside of their setting. Perception is never abstract, and is always contextualised. This is a fact that much early experimental psychology struggles with, attempting to understand perception in laboratory conditions by exposing the senses to stimuli. Whilst useful in producing effects such as optical illusions, such overly abstract and scientific theories fail to understand the seeking and active nature of perception as an activity rather than a simple reflex. Hall finds particular in-

terest in the city, where many different ethnic groups have settled, each with their own sense of proxemics:

> 'In other words, I think that it will ultimately be proved that *scale* is a key factor in planning towns, neighbourhoods, and housing developments. Most important, urban scale must be consistent with ethnic scale, since each ethnic group seems to have developed its own scale.' (Hall 1969:170)

Such anthropological concerns are a fruitful avenue for further research. Indeed, this strand of research is picked up by Ray L. Birdwhistell, (1970) with a particular concern on studying the patterns of movement indigenous to groups of people. Birdwhistell engages with the drive towards notation of movement normally reserved for the recording of dance by the likes of Laban or Benesh notation (the two most commonly used 20th Century systems) in order to allow cross-comparison of observations.

4. Scale and Geometry

Whilst many applications of scale suggest that it is a fundamentally geometric concept, our work suggests that scale can be reconsidered as belonging to the sensory.

Scale has the potential to refer to the size at which phenomena are possible to attend to, to be understood and apprehended perceptually. Phenomena which are out of scale are those which are overwhelming to a given sense, such as the visual impact of glass, curtain-walled skyscrapers – the key factor here is sensory over-lap and corroboration. Where senses reassure and confirm one another, a level of environmental comfort is reached.

One example would be a comparison between a typical 19th Century railway station and a theatre auditorium. The station is a large shed constructed from stone, cast iron and glass. A public announcement system such as a Tannoy us suspended from the high ceiling and supported visually by the departures board. The Tannoy relies mainly on amplitude – or

more powerful broadcast of sound, so that the large building with flat surfaces causes reverberation, distorting the announcer's voice.

Travellers are often faced with the situation where a train is given a departure platform at the very last minute, meaning that the verbal announcement is the only information given, not corroborated by the visual information of the departures board.

Often in such situations, people ask someone else upon boarding the train if this is the correct train for, say, Glasgow. This is frequently met with the response of "I hope so" – the lack of overlapping information resulting in doubt and mistrust of the announcement's accuracy.

Other situations and scenarios in railway stations mark them as being out of auditory scale.

Due to the reverberant nature of the sonic environment, holding conversations can become problematic in the noisiest parts of the station, people can be heard to raise their voices, holding quite intimate conversations at high amplitudes creating embarrassing or amusing moments when that background noise suddenly cuts out or passers-by catch out-of-context phrases from that conversation.

In quieter, but still noisy, parts of the station, an extension of Cherry's 'Cocktail Party Effect' can be heard, where the ear can filter and attend to a voice despite overwhelming background noise. Speaking to someone in such places, I can hear their words despite high levels of background noise, even when my interlocutor speaks softly. This gives credence to documented cases where the idea of the brain's role in processing and filtering emerges. The ear picks up every noise, every sound – the brain can tune into one particular strand of this, much in the way that cinematic sound designers must employ special recording devices, distortions and foley artists in order to balance sounds in a 'realistic' manner in accordance with expectations and while guiding the spectator's experience.

The disjunction between space and acoustics introduced by artificial amplification devices denies us the corroboration between senses in a way that the Classical amphitheater confirms and affirms. Similarly, the theatre typology directs gaze and aural attention towards the stage, where the spectacle is situated. even in the largest auditoria, this is a space in scale with its sensory experience.

It is interesting in this context to consider Patrick Geddes' (see Welter, 2002: 60) diagram of settlement scale, consisting of a long section drawing through a valley from hill to coast and identifying the various forms of settlement and dwelling along the way.

Upon first consideration, one would find little scope for the senses at such a scale, but this is far from being the case. The chemical senses of taste and scent are, for example, greatly affected by movements of air and water, both of which can carry stimuli over great distances. As such, agriculture or industry some distance from settlements can make their presence felt when the conditions are favourable. Such a long section may also determine many of the thermal characteristics of an urban area. The relative exposure or protection from harsh climate factors greatly in the actual experience of a settlement. Indeed, protected sites such as Athens face new problems, as what once offered protection now acts as a basin keeping air pollution over the city rather than allowing it to escape.

Writing on scale, Rem Koolhaas asserts that "Bigness is no longer part of any urban tissue". While his point refers to physical buildings, it is deeply flawed when dealing with sensory experiences, which can be felt at the immediate bodily scale as well as at vast, regional scales. Furthermore, this experience is the urban fabric proper. We do not, for example, experience the world as a presence within pure geometry – that geometry is itself an abstraction, extrapolated from the datum of the senses. Simply put, the city is experienced and understood when it comes into contact with our senses, and it is those very senses which give scale to the city.

5. Temporalities of Scale

The scalar element of the senses suggests that a temporality exists within scale. Removing the necessity for a spatial element exposes scale to time: a sensation might be fleeting, as in the case of the perfume from a flower–but that sensation is also seasonal in nature as well as developing over the course of a single day.

Lefebvre would, of course, refer to these nested temporalities as rhythms. This term suggests a pattern, however, where none might be discernible or intelligible. As such, even if the extremes of chaos or string theory might suggest that a pattern is always present, it is not a useful concept as the pattern to this recurrence is simply impossible to apprehend.

Of course, appropriating scale as an ordering principle leaves one open to a similar critique. The defence lies in the utility of the concept.

Scale remains a useful design tool–or even represents a methodology for design in which differing levels of interaction can be understood simultaneously. Multiple scales are a familiar tool to the designer. Planning street furniture in an urban design masterplan is a case in point. A simple bench is designed on several scales–the detail scale of the bench itself and how it is constructed, secured to the ground; the street scale depicts where the bench is placed in relation to buildings, pathways and planting; a city-wide strategy for placing street furniture offers yet another scale for this relatively humble element.

A simple flower bed can be said to have similar scales involved in its planting and life–from the seasonal nature of the bloom to its daily cycle from sunrise to sunrise–and finally the momentary scale as a pedestrian walks past or pauses to appreciate the scent–a scale more dependent on the manner in which olfactory receptors receive smells and then switch off to prevent overwhelming (Ackerman, above).

Even the visual has its temporal scales–the saccade of the eye as it takes in the detail of a surface, to the seasonal weather variations such as bright direct summer sunshine, sharp april

showers, or autumnal fogs. The visual obviously alters over the course of a day, particularly with the reversal of our perception of positive an negative space as windows become sources of light out to the street, lit from within rather than letting light in as they do during the day.

6. Conclusion: Representation and the Scale of Experience

The relationship of scale to sensory experience is complex and governed by a large number of factors, many of which are under the control or influence of the urban designer. Sensations can be said to be out of scale with their environment. Businesses such as music or clothing shops in a Shinjuku backstreet choose to define part of their identity by playing music through large amplifiers facing out to the street. At a certain point, the volume is too much for the streetscape, and is out of scale. Similar amplification works with the scale of Shibuya crossing, with more open space and less opportunity to be close to the source of the sound. Both create what Barry Blesser would call an acoustic arena, but one is in scale with its environment and one is out of scale in a disquieting way.

Understanding the senses allows us to judge the variety of urban elements contributing to experience and their relation to the geometry of the space. This complete experience is difficult to represent fully, and can only be approached by a suite of representational tools and aides memoire coupled with observational techniques. Attending fully to the sensate environment lies at the heart of our technique, a methodology for exposing our senses fully to the everyday detail of the environment borrows much from Henri Lefebvre (2004), Georges Perec (1997) in the concentration on boring, unimportant details, for exciting discoveries about our environment lie there. The aim of recording such experiences is to allow them to be accessed during the design process, organised similarly to Alexander's *Pattern Language* (1977) or a traditional sketchbook (see for example Unwin 2000 & 2003).

The outcome of all of this is a design guide and methodology. This is based on the sensory experience of place, with the potential to map other modalities. The method is based on representation of the senses, and their interactions with one another. Beginning with an approach grounded in Lefebvre's *Rhythmanalysis*, the priority of senses is recorded along with their corroboration and temporality. This is then given more detail with carefully non-metaphorical descriptor terms. Examples are then assembled into the Alexander-esque *Pattern* book, with the invitation for users to sketch and produce their own patterns. Such exemplars can then be used in the design process.

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