

# ISUF2021

G L A S G O W

## Annual Conference Proceedings

of the

## XXVIII International Seminar on Urban Form

“Urban Form and the Sustainable and Prosperous City”

29<sup>th</sup> June - 03<sup>rd</sup> July 2021 - Glasgow, UK

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## Foreword

Dear Authors, esteemed Readers,

It is with deep satisfaction that we write this Foreword to the Annual Proceedings of the XXVIII International Seminar on Urban Form held virtually in Glasgow, United Kingdom, between June 29th and July 3rd 2021.

When, at the closing of ISUF2019, the Urban Design Studies Unit at the University of Strathclyde in Glasgow (UK) was announced as the host of the XXVIII International Seminar on Urban Form, the world was indeed very different from what, in just few months, we all came to know, and in ways which, at the time, we could not possibly imagine.

Due to the protracted impact of the Covid-19 pandemic and related restrictions to travel and in-person gathering, we found ourselves to forfeit our plan to host the conference in our beautiful and welcoming Glasgow and, very much like our colleagues in Salt Lake City, to deliver the event as fully online instead. We were truly sorry not to be able share a dram of Single Malt Scotch Whisky, have you taste Scottish haggis neeps and tatties, or take you for a spin at an evening Ceilidh in our Dear Green Place. In addition to this, just few days before the opening of ISUF2021, we were shocked and saddened by the unexpected loss of Emeritus Professor Jeremy Whitehand, founding father of ISUF, leading scholar, inspiring educator, and dear friend to many.

But despite the odds being stuck against us, and while our community is still mourning this great loss, we believe we achieved the feat of delivering a thought-provoking and engaging event, continuing the long and prestigious tradition of the International Seminar on Urban Form, while also doing our best to remember and honour Professor Whitehand as he deserved.

A difficult goal, this one, that we could achieve only thanks to the valuable experience of our colleagues in Salt Lake City, the involvement of a formidable team of colleagues and students who volunteered their time to help through all the phases of this complex event and the guidance of the ISUF Council and, to Jeremy himself who, with his meticulous and impeccable planning, granted all of us a once in a lifetime opportunity to have him at ISUF2021 after all and in many different forms, through the voices of his fellow scholars and, quite extraordinarily, through his own recorded voice.

We were able to reach a wide audience of over 370 delegates presenting and attending from some 52 countries around the world, allowing us to bring urban morphology and its values to new colleagues and friends, as well as to audiences that would not have been able to join us in Glasgow, or that would normally not consider attending a conference. We held a total of 95 sessions - including keynotes, round tables, opening and closing sessions - each moderated by a chair and supported by a host, for over 230 hours of live content. All the sessions were also recorded and made available to conference delegates for a period of 60 days after the conference, allowing people attending from different time-zones to listen to each and every one of them at their own pace. Surely, we missed informal gatherings, tours, meals, and parties but we did our best to give all delegates the best of the Scottish hospitality, through virtual walking tours prepared and delivered by current and former students of the Department of Architecture at the University of Strathclyde and lectures delivered by representatives of the Glasgow City Heritage Trust.

And now, after little over six months from the end of ISUF2021, we are finally able to release to the public the Annual Conference Proceedings of the XXVIII International Seminar on Urban Form: "Urban Form and The Sustainable and Prosperous City" a work curated by Dr Alessandra Feliciotti and Dr Martin Fleischmann. The contributions collated in this edited book illustrate the great variety of research streams investigated within ISUF and represent the heterogeneous geographical distribution of contributions, both telling aspects of this florid and growing interdisciplinary field, characterised by deep solid roots as well as vigorous far-reaching branches.

We believe these Proceedings will provide urban form researchers and practitioners of the world with an excellent reference book on the latest advances in the broad area of urban morphology, stimulate new connections and research partnerships, and be an impetus for further research.

We thank all authors and participants for their contributions.

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Conference Organiser of ISUF2021

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## Preface by ISUF2021 chair

The 28th ISUF Conference was organised by the Urban design Studies Unit at the Department of Architecture of the University of Strathclyde in Glasgow, from the 29 of June to the 3rd of July 2021. The weather was excellent in Glasgow in those days, with a daytime high of around 20 degrees Celsius and no rain throughout. Too bad we could not enjoy it, for all the good reasons that travelling had been a question mark all year round and despite all our commitment we just could not take any other decision than going fully online. Which we did, and it was a dizzy jump into the unknown for us all. Things got sorted out, eventually, and in style, thanks to Alessandra and Martin and all our incredible folks here at UDSU, the Department of Architecture and the University at large, ISUF's support and the enthusiastic contributions of splendid guests who committed themselves to enrich the environment of the conference – though virtually – with invaluable and unreplaceable insights of the real place.

We decided to focus on “Urban Form and the Sustainable Prosperous City”. The more we study cities, the more we realise that their form is never neutral. On the contrary, space is active: how it interacts with social, economic, environmental and economic systems, is central to their success. On urban form also depends cities' capacity to be and remain successful and engaging in time. Form is central across all scales of urban systems and we are at a stage in which our capacity to study social, economic and environmental systems can be related to the analysis of urban form like never before. Furthermore, new technologies, as well as new interpretative frameworks that put time and resilience at the heart of cities' life, have grown in clarity and capacity over the past years, helping immensely our understandings of these complexities.

Theories, methods and practices in the study of urban form were explored in the conference, with two special focuses proposed: “The resilient city: ecological perspectives in Urban Morphology” and “Urban Morphology for SDG 11”. Sustainability and resilience are terms often used interchangeably, while they can be regarded as complementary in capturing both normative and descriptive aspects of change. As associated to urban form, these terms are still open avenues of research as well as promising areas of growth in the ability of urban morphology to further inform urban policy and practice.

Urban morphology is an inherently multi-disciplinary field of research, and each of its many convergent strands of knowledge brings its own set of tools and practices. To the foundational backbone of the discipline, still solidly developing around the Conzenian and Muratorian historico-geographical and morpho-typological living traditions, as well as to the more recent space-syntax quantitative-configurational approach, new impulses have been shaping up in the last few years that have conspicuously marked their presence in this 28th edition of the ISUF conference: these are quantitative approaches building on geographic data science, which rely on advanced techniques of data processing to push the boundaries of large-scale analysis to unprecedented levels, and – even more importantly – without compromising the richness of information. Which is fundamental: urban morphology's core-scale, that of the building/plot, street and neighbourhood, requires information at that scale. That is why other quantitative methods that look at the form of the city as a whole, or beyond to the metropolitan or regional forms of urbanisation, have always struggled to fit in, and contribute to, the development of urban morphology. The unprecedented flood of papers in this area of studies characterized the event. They also seemed to seamlessly and even delicately find their own place and meaning in the rich flow of the urban morphology discourse, building on – and making value of – its quantitative side. In fact, “metrology” studies of urban form have always been part of the discipline since its very foundations in the 1960s. This was also the focus of Jeremy's own contribution to the round table at the conference, entitled “Urban Morphometrics in Urban Morphology: Disciplinary Roots and New Perspectives”, where he explored these roots drawing them back to the inter-war period and Herbert Louis' precursory studies at the Geographical Institute in Berlin. A young geography student at that time in Berlin, MRG Conzen was there in attendance before leaving to Britain in 1933. This red thread of urban morphology metrology studies is now quite clearly evolving into novel “morphometric”

methods of reading and understanding urban form, under the impetus of new technologies, processes and large-scale, fine-grained geo-data.

Jeremy would have liked to bring this point of view in person to the round table, with his usual crystalline open mindedness and genuine generosity. We'll miss him dearly.

Prof Sergio Porta

Chair of ISUF2021

Urban Design Studies Unit (UDSU)

Department of Architecture

University of Strathclyde

## Preface by ISUF Presidents

Over the last three decades, since ISUF's first meeting in Lausanne in 1994, our knowledge about the physical form of cities has substantially increased. Today, we know more about the different elements of urban form, how these are combined generating different patterns, and how these are shaped by different agents and processes over time. We also have a better understanding of urban form's influence on the social, economic, and environmental dimensions of our cities. Multiple concepts and methods as developed by founding scholars such as M. R. G. Conzen, Jeremy Whitehand, Saverio Muratori and Gianfranco Caniggia have proven to be quite effective in describing and explaining urban form, resulting in their widespread adaptation by urban morphologists today. Examples of these foundational tools for urban studies include town-plan analysis, fringe belts, morphological regions, typological processes, basic and special buildings, poles and nodes, to name just a few. Findings surrounding applications of morphological existing methods coupled with new tools for urban analysis continue to evolve further enriching our interpretations of urban environments. We realize how street systems can influence movement, social interaction, and the location of economic activities. We use new geometries and new mathematical models where agents have a key role and where the different elements of the urban landscape can be transformed into cells, enabling the simulation of alternative scenarios of development.

While the early years of an organization are challenging by nature, for ISUF the last five years brought unprecedented challenges. The organization of our annual conferences was first faced with significant political barriers in a world with so many authoritarian regimes. It is with great sadness and concern that we see Ukraine being invaded by Russian forces at the time of writing this Preface. On the other hand, since early 2020 the Covid-19 pandemic has completely changed our lives. And yet, between 2018 and 2020, Irina Kukina, Nadia Charalambous and Brenda Case Scheer have successfully overcome these tremendous challenges, offering us three enlightening conferences in Krasnoyarsk, Nicosia, and Salt Lake City (online conference). As the pandemic has continued to inhibit in person gatherings and international travel, the organizers of the Glasgow conference have exhibited resilience by offering ISUF's second fully online conference.

One day after the 2021 meeting of the ISUF Council, and two days before the official opening of the Glasgow conference, we were shocked to learn of Jeremy Whitehand's sudden passing. Until the last weeks before the conference, Jeremy was working with us on a Task Force on Teaching Urban Morphology, on two special sessions (on the relation between research and practice, and on quantification in urban morphology) and on a keynote speech for this conference entitled 'The nature of urban morphology' (Whitehand, 2021). Jeremy was central in the creation of ISUF in the mid-1990s, and he has always been at the centre of our organization over the last three decades. He organized two conferences – the first open event in Birmingham, in 1997, and the Newcastle / Glasgow conference, in 2004, together with Michael Barke. For over almost 25 years he has edited with singular rigor the journal 'Urban Morphology'. Jeremy's legacy (see Oliveira, 2019) will always be part of our organization and of our morphological research.

Two generations of notable and committed researchers based at the University of Strathclyde collaborated over the past two years to organize ISUF 2021. They include Sergio Porta, Alessandra Feliciotti, Ombretta Romice and Martin Fleischmann. This book of proceedings, as the conference itself, is framed by the on-going debate about the role of urban form in creating sustainable and prosperous cities. Sergio and his colleagues propose a fourfold structure for debate including four main themes that are fundamental for ISUF and for urban morphology as a field of knowledge. Theory and method are the first and second of this set. Urban morphologists should be able to establish an open, but coherent, body of theories and methods for understanding the structure and functioning of cities. In addressing these two challenges, we must find a common ground, allowing each one of us to learn from each other, while maintaining the specificity of his own work. The third theme is practice. We must continue to search for effective ways of moving from morphological research to practice in planning,



urban design, and architecture. In this task it is not enough for urban morphologists to simply assert their relevance and claim that they could play a part, if only they were asked (Barke, 2021). It is not enough to create single events of interaction; we must create effective processes, involving many moments for researchers to understand and engage into real practice, and for practitioners to be exposed to and get involved in research on streets, plots and buildings, and how these change over time. Finally, the Glasgow team proposes a focus on sustainability. Urban morphologists must be able to show the relevance of urban form to several key aspects of our daily life in cities, and in the design of strategies for adaptation and mitigation.

This book of proceedings is built from the participation of over 350 researchers from more than 50 countries, presenting their work in almost 100 sessions – including keynote, round tables, and opening and closing sessions – representing almost 250 hours of live contents. The publication of this book takes place in between the realization of the Glasgow (June/July 2021) and Lodz/Cracow (September 2022) conferences. We owe a debt of gratitude to Sergio, Alessandra, Ombretta and Martin for their remarkable work. The second conference, led by Anna Agata Kantarek and Malgorzata Hanzl, is expected to bring us back the possibility of meeting face-to-face to restore place-based collaboration, presenting our investigation, establishing and reinforcing research networks, and visiting and exploring the physical fabrics of cities – the privileged object of morphological inquiry.

Prof Vitor Oliveira

President of ISUF

Research Centre for Territory Transports and Environment (CITTA)

Division of Spatial and Environmental Planning

Department of Civil Engineering,

University of Porto

Prof Emerita Wendy McClure

Former president of ISUF

Architecture Program

College of Art and Architecture

University of Idaho

Barke, M. (2021) 'Foreword', in Oliveira, V. (ed.) *Morphological research in planning, urban design and architecture* (Springer, Cham) v-viii.

Oliveira, V. (ed.) (2019) *J.W.R. Whitehand and the historico-geographical approach to urban morphology*, Springer, Cham.

Whitehand, J. W. R. (2021) 'The nature of urban morphology' (prerecorded video), *28<sup>th</sup> International Seminar on Urban Form*, Glasgow, 29 June – 3 July.

## Organization of the Proceedings

The Annual Conference Proceedings of the XXVIII International Seminar on Urban Form: “Urban Form and The Sustainable and Prosperous City” collates 178 papers, and 3 posters and 1 viewpoint. In keeping with the structure implemented during submission, review and presentation of individual contributions, the present book is divided into four main sections: Theory, Methods, Practice and Focus. Within each section, papers were further grouped in a number of themes, as defined below.

Section I, **Theory**, contains contributions deepening our understanding of existing morphological and typo-morphological theories, models and concepts as well as exploring new avenues of knowledge and perspectives from affine disciplines, linking them up to established or original morphological theories. Themes in the theory section include:

- **The epistemology of Urban Morphology:** retracing the evolution of a discipline and charting new research paths.
- **Towards a descriptive science of urban form:** old and new models explaining generative and transformative processes driving complex trajectories of urban evolution.
- **New trans-disciplinary perspectives in urban morphology:** new hybridisations for a holistic understanding of complex city systems.

Section II, **Methods**, looks at existing and innovative tools and procedures for the reading and understanding of urban form and its dynamics, encompassing both qualitative and quantitative approaches. Within the Methods sections, contributions are divided into the following themes:

- **Innovations in qualitative research in Urban Morphology:** methodological perspectives linking to classic Conzenian and Muratorian traditions, with an emphasis on qualitative research methods.
- **Innovations in Urban Morphometrics:** perspectives bringing new quantitative methods into Urban Morphology building on the rise of the digital age, including digital cartography, big data and remote sensing.
- **Engaging with the social, cultural and institutional discourse:** novel and original research methods capturing the interaction of urban form and human life engaging with complementary disciplinary fields.

Section III, **Practice**, looks at urban form as an active player in shaping tomorrow’s cities and at the world of professional practice, policy and education. Contributions within this section address the following themes:

- **Urban Morphology for design, planning and policy:** the practical role of urban form towards the sustainable and resilient, safe and inclusive cities for all.
- **Urban Morphology, Architecture and Heritage:** preservation, reuse, valorisation of built heritage as asset for future prosperity.
- **Teaching Urban Morphology:** methods, experiences and lessons learned to shape the next generation of architects, planners, urban designers and policy makers.

Section IV, **Focus**, reflects on urban morphology in light of emergent global drivers and in relation to the wider debate on Sustainable Development and Climate Change. Contributions within this section revolve around two main topics:

- **The resilient city: ecological perspectives in Urban Morphology:** perspectives and approaches linking urban form to the overall resilience of urban systems.
- **Urban Morphology for SDG 11:** contributions relating urban form to sustainable development goal targets.

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Sergio Porta (Chair of ISUF2021), Alessandra Feliciotti (Principal Conference Organiser), Martin Fleischmann, Ombretta Romice

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**Preference and visual texture as a measure of performance: articulating the principles of biophilia.**

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**Abstract**

*There is growing evidence showing contact with nature has benefits for mental and physical health. Within the design community, evidence has been encapsulated in the concept of biophilic design. The underlying principle is that humans have evolved in nature and therefore share 'an innate love of contact with other living organisms' (Wilson 2017). , there are however a number of philosophical, ethical and practical issues that arise with the application of the 'biophilic hypothesis' in urban and architectural design. This paper reports on research that expands on these issues, centred on the computational method of visual texture analysis as developed by one of the authors (Cooper). The output of the method is the generation of a numerical measure, visual texture level, drawing on fractal geometry, combined with the identification of texture types. Looking at the results of a number of investigations and applications, the paper suggests the combination of texture level and texture type can provide an effective link between people's preferences and different types of urban tissue. Applications include the identification of character areas for urban design coding and preference filtering for property search. The paper concludes by reflecting on the potential for visual texture analysis to complement and improve on traditional methods of urban morphological and tissue analysis and provide a basis for extending and articulating the principles of biophilia.*

**Keywords:** Visual texture, fractals, biophilia, preference, character, urban design codes.

**Introduction and background**

The aims of urban design are varied and overlapping shelter; access to resources; supporting economic and social life; environmental sustainability; community; identity; character; health and well-being etc. From the standpoint of teaching and practicing urban design, one of the core challenges is addressing the many, technical objectives of urban design whilst simultaneously creating places that are attractive to the people who live in and use them. The aim is to balance the technical, cultural and aesthetic dimensions of urban design. This is a normative endeavour. We are seeking to produce 'good' places. In doing so, increasing numbers of theorists, researchers and practitioners are engaging in what might be called normative science, developing rigorous methods for assessing the performance of designs with reference to specific purposes. One line of inquiry has been the effect of the visual characteristics of the environment on mental



and physical health. If the purpose is to achieve positive health outcomes and a sense of well-being, which kinds of environments perform better than others?

In seeking answers, the rapidly developing field of neuroscience has come to play a significant role. As an indicator, John Zeisel updated his classic text, *Inquiry by Design* (1981, 2006) to include new material on neuroscience - and appended an 'N' onto the shorthand of E-B studies: Environment-Behaviour-Neuroscience. Other fields that have been brought to bear include socio-biology and evolutionary psychology. To a fair degree, these strands come together in the concept of biophilia and the biophilia hypothesis (Wilson 1984, Kellert and Wilson 1995). Kellert, Heerwagen and Mador (2008) and Sussman and Hollander (2015) amongst others have more directly applied the broader ideas to architecture and urban design. At the core of the biophilia hypothesis is the idea that humans evolved within a natural environment and are predisposed toward and have a subconscious preference for natural environments. The overlap with neuroscience is manifest in the fact that preferences are necessarily rooted within our sensory perceptions and cognitive systems. The overlap is acknowledged in the emergence of neurobiophilia as a sub-discipline of neuroscience (McMahan and Estes 2015, see also neurobiophilia.org).

The biophilia hypothesis is not without its critics (see for example Joye and De Block 2011) and there is a range of interpretations within the literature of 'nature' and 'natural'. As argued by Kellert, Heerwagen and Mador (2008), for example, there is scope in their definition of 'natural shapes and forms' to include more abstract, built interpretations and representations as opposed to solely direct experience of the natural environment or literal representations. From the standpoint of evolutionary biology and neuroscience, there are some core principles that would warn against an overly literal or prescriptive approach to the use of the principles of biophilia in design. Three issues that illustrate this point are: 1. The role of variation in evolution and therefore in human behaviour and preferences; 2. The range of cognitive subsystems within the human organism that interpret stimulus in different ways; 3. The role of culture in interpretation.

The first issue is illustrated by the range of ways that biophilia is interpreted as mentioned above. That is, within any population, there will be variability between individuals across a range of attributes and characteristics but most importantly for this paper, in their preferences. Not everyone likes the same things. Even if analysis shows there is a statistically significant proportion of a population that has a given preference, this is unlikely to be 100%. Variation can occur within an individual, we interpret our environments with a range of (interacting) sensory equipment and, as shown by developments in neuroscience, through a range of different (interacting) parts or systems within the brain. Taking the simplified model proposed by Peters (2012), we have seven 'brains', three of which, the limbic, frontal and parietal, respond to input in different ways and in different order - each affects the way the others respond. Importantly for this paper, the limbic brain, or limbic system, involved in emotions and spatio-temporal memory (amongst other things), is the first and fastest to respond. Thirdly, investigations into

functional, or psychosomatic disorders of the brain show that they can have a significant social basis (see for example O'Sullivan 2021). The implication is that the way we learn to interpret the world growing up in a particular culture, combined with our interactions within a social group, affects our individual physical health and well-being.

These considerations do not constitute a refutation of the biophilia hypothesis. Rather, they point to ways in which we might investigate how we respond to our environment and make use of that knowledge in assessing the performance of designs in achieving our purposes. This paper reports on the results of research looking into visual perception of the environment and its correlation with people's environmental preferences. The core of the research is the method of visual texture analysis, which provides a combined quantitative measure of the complexity, variety and intensity of a view or scene. A component of the method also measures the relative contribution of vegetation to the overall visual texture. By combining the two and calibrating them with viewer's preferences, the method provides a means of testing the performance of designs in terms of their visual quality allowing and accommodating a range of both component elements and viewer preference. In this paper we give a summary account of investigations on a number of fronts. We start by explaining visual texture analysis. We then relate the results of framing research looking at people's more general preferences for a home street environment. This provides the context for more specific results on the role of vegetation in pedestrian preferences and the use of property sale price as a proxy for preference. We conclude by pointing toward ongoing investigations into the application of visual texture as a performance indicator in design and as a selection filter in property search. A key part of that application in urban design education and practice is the translation between the measures of visual texture and the morphological components and their configuration that generate the measure.

### **What is visual texture?**

Visual texture refers to the amount and type of information that makes up a scene. It provides a way of measuring all morphological elements together to gauge their combined, composite effect. Visual texture analysis comprises of two aspects:

**Visual texture level** – initially based on an understanding of fractal geometry and its links to visual perception and preference outlined by several authors e.g. Cooper et al (2008, 2010, 2013), Haggerhal et al (2008), Salingeros (2012), and Stamps (2002) – we measure the complexity, variety and intensity of information in a view across scales on a 1 (low texture) to 10 (high texture) scale. We call this the visual texture level or CVI (complexity, variety and intensity).

**Visual texture type** – we estimate the area of an image that contains vegetation and present the results on a scale from urban textures (0% vegetation) to natural textures (over 50 % vegetation). We call this the EVI (estimated vegetation indicator). We combine visual texture level and texture type to create a new composite view classification. The visual matrix, figure 1, presents an example of the view classification using

our visual texture estimates. It illustrates how the classification responds to all the morphological elements making up a scene in combination – buildings, degrees of enclosure and continuity, view length, building detail, material and amounts of vegetation etc. Certain types of place can be seen grouped across the matrix by their common visual texture. Our ViewCue visual analysis tools allows us to classify and map over 1200 Google Street View images in under 20 minutes.

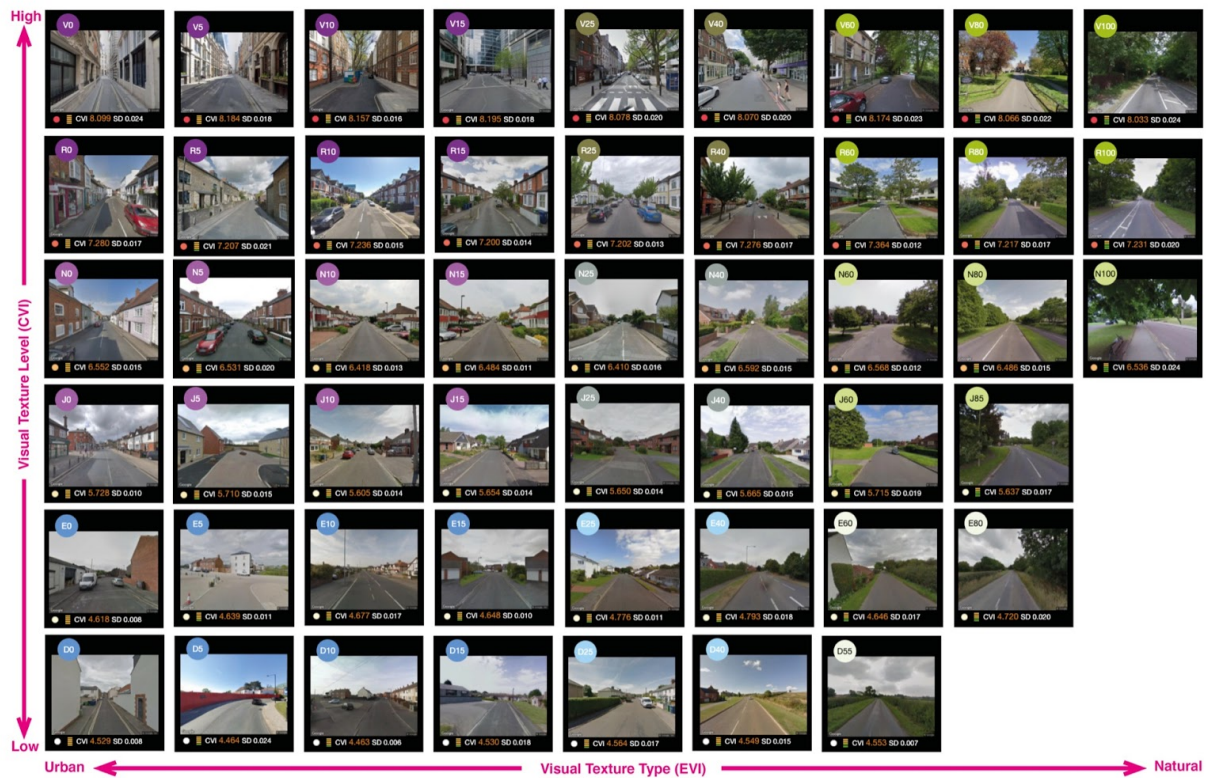


Figure 1. View classification by visual texture level and type.

### Preference: what do people say they want in their home street?

In terms of the preference for green places, or places deemed to have high levels of biophilia, what do people want? We worked with YouGov (Oxford Brookes/YouGov, 2020) and undertook an online survey of 2239 current homeowners and renters who had moved, purchased or sold a house or flat in the past 1-2 years and asked them to identify factors important to them when deciding to rent/own a property. Fieldwork was undertaken between 29th October - 19th November 2020. The survey found that when it came to what was important in making the decision on where to live, most people indicated that they want to live close to greenspace (87%), in a quiet street (86%) close to shops and restaurants etc (74%), that has off street parking (72%), is leafy and green (67%) and has good access to public transport (65%). For the majority (82%) the appearance and attractiveness of the street was important when deciding where to live. This survey shows that greenery is definitely important, and that the overall look of the place is important to people, but it's obvious that preference isn't just about places being green. Further investigation of the data reveals that the importance of greenery isn't uniform to everyone. Different people have different preferences. To get a better understanding of preference for a general description such as 'leafy' and to take account of the

variation within the population, visual textural analysis provides a method to very quickly assess differences in character that may help us to identify nuanced attributes and differences in visual preference and experience.

### **Evidence of the link between visual texture and preference. Where does biophilia fit?**

We present two cases that illustrate the relative importance of greenery in judgements of preference and illustrate the potential of visual texture analysis in understanding holistic character in terms of preference and place creation.

#### **Vegetation and pedestrian preference – UK and Taiwan case studies.**

Work by Cooper et al (2008, 2010, 2013) found strong positive relationships between increases in the fractal dimensions of scenes (the initial basis of what we term *visual texture level*) and perceptions of increased visual variety and quality. Cooper, Su and Oskrochi (2013) found that judgments of streetscape visual quality were influenced by the presence of vegetation, but they were more influenced by changes in the fractal dimension of those streetscapes. They concluded that a strong positive relationship existed between the respondent's perceptions of visual quality and levels of fractal dimension. Further descriptive comments provided to describe the Taiwanese streets confirmed speculation initially made in Cooper et al (2010) that the link between fractal dimension and perceptive judgments is:

*“...due to the differences in scaling between scenes dominated by built features and those that are dominated by the natural environment (Ruderman and Bialek, 1994). Differences in fractal dimension define the boundary between landscape and townscape and in both the UK and the Taiwanese cases vegetation had a major influence on perceptions of visual quality, but fractal dimension had a stronger effect”.*

As fractal dimension underpins the calculation of visual texture level, we can say that vegetation has a major influence on perceptions of visual quality, but visual texture level has a stronger effect.

#### **Price indicates preference - Oxford property prices and visual texture:**

In 2019, we sought to identify the relationship between the visual texture of streetscapes and the sales prices of residential properties in Oxford. We used property price as a proxy for attractiveness and visual quality. 9200 images of Oxford, UK were extracted from Google Street View and their visual texture was measured using our visual analysis application ViewCue. The images captured the street scenes around the locations of 663 properties sold between October 2017 and October 2018. Sales prices, property type (terraced, semi-detached and detached), numbers of bedrooms, age and location of these properties were recorded.

Results were subjected to multiple regression analysis that revealed a coefficient of variation (R-squared) of 0.642; showing that over 64% of the variations in house price can be explained by the variables in our model.

The model found a positive and significant relationship between the visual texture level (CVI) of street views and the sales prices of properties in Oxford. However, as shown on table 1, in this case, the % vegetation, or texture type (EVI), had no effect on price ( $p\text{-value}=0.219 > 0.05$ ). All other variables, including the proportion of houses built before 1940, significantly affect house price. Latitude has a positive effect on house prices in Oxford, but longitude has a negative effect on price – reflecting well known distributions of popular areas across the city. Number of bedrooms also increased the price. Terraced and semi-detached houses also as expected, have lower prices than detached houses.

**Table 1: Natural log of sales price and locational variables - Coefficients<sup>a</sup>**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
a. Dependent Variable: Natural log of price					
(Constant)	-325.193	27.093		-12.003	.000
Average CVI (texture level)	.273	.028	.285	9.847	.000
Average % vegetation (EVI)	-.002	.002	-.037	-1.229	.219
Latitude	6.434	.525	.300	12.261	.000
Longitude	-2.253	.292	-.190	-7.725	.000
Number of bedrooms	.232	.015	.423	15.017	.000
Terraced	-.132	.036	-.147	-3.664	.000
Semi	-.164	.031	-.196	-5.318	.000
% built before 1940	.256	.041	.165	6.242	.000

Within the data set examined, for the city as a whole, for every 0.1 increase in the visual texture level of the street (CVI) there was on average about a 3.3% increase in sales price of like for like properties. There are differences between postcode areas and wards. Our conclusion is similar to the Taiwan example: the overall visual texture of a street has more effect on preference, as indicated here by price, than simply the presence of vegetation.

### **Using visual texture Analysis.**

Our YouGov survey showed a preference for leafy streets near green spaces, but when it comes to the reality of choice dictated by budget, the overall visual texture of the place is more important than greenery. Meaningful qualitative comparisons of visual texture can only take place between like-for-like examples, such as two streets of terraced houses, rather than comparing a terraced street with a street of detached properties. Also, very different types of place can have the same visual texture level, for example, a narrow street defined by tall brick-built buildings could have the same visual texture level as a country lane defined by tall, closely growing trees. These observations led us to combine visual texture level and texture type as a matrix to create the new classification of views as shown in figure 1 above. Two examples of our current application of this new classification are described below.

### **Helping to deliver the UK's National Model Design Code:**

The automation of view classification by visual texture lends itself to the speedy identification, analysis and mapping of character areas, zones and street segments. This is helpful in delivering steps 1 and 2 of the UK's proposed National Model Design Code (MHCLG, 2021) - scoping and baseline data collection and visioning, coding and masterplanning. It also lends itself to the assessment of conformity to design codes based on agreed texture. Follow the video link below to see how visual texture analysis and the ViewCue application can be used in this context. <https://youtu.be/xl4RV59bTm0>

### **Creation of a street preference filter - HappyStreets®**

We are developing a commercial application using our view classification to help people to search for properties in street environments they prefer by locating a range of places that match their preference, rather than to make qualitative judgements about a street's appearance. Follow the link below for an explanation of our prototype street preference application. <https://youtu.be/knVaYMzh9SA>

### **Conclusions: translating texture into form: extending and connecting biophilia and urban morphological analysis**

There is evidence to support the biophilia hypothesis that humans have a preference for and get health benefits from natural scenes, likely rooted in the limbic system that evolved in our early ancestors. The research into visual texture set out above shows a positive correlation between visual texture level (CVI) and preference for visual scenes. While there is significant correlation with vegetation within scenes, it is not constant. Preference tracks texture level even if the contribution of vegetation tails off. One interpretation of these results together is that visual texture provides a more general indicator for preference than vegetation, likely still rooted in the limbic system but allowing for other factors such as variations in preferences within a population as well as responses from different parts of the brain. Automated visual texture analysis gives a rapid indication of three-dimensional street level visual experience resulting from the combination of all morphological elements that make up a place. Combining texture level and texture type



provides a means of translating a scene with a given texture level into a more distinct morphological configuration. The method has the potential to complement and improve on results obtained using traditional methods of urban morphological and tissue analysis. It also opens up avenues for exploring biophilia in a more nuanced way as well as investigating the relative contribution of social and cultural cues in determining overall preference.

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