

Data + Senses



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Introduction

Data + Senses

The cross-over between the digital and the physical is being increasingly addressed in design disciplines, architecture, arts and urban studies. Artists and designers increasingly make use of hard data to interpret the world and/or create meaningful and sensuous environments or design objects. Architects attempt to measure neurophysiological data to understand better the human experience in spaces. Designers script parametric processes to translate data into responsive, meaningful and/or aesthetically intriguing installations. Scientists and architects/ artists/ designers collaborate to visualise data in new and creative ways so as to trigger and reveal further connections, interpretations and readings.

Practices such as the above attempt to break down the dichotomy between data and the sensuous (or else the digital and the physical). They translate elusive, ephemeral and intangible aspects of a place into solid data. In other instances the solid data are interpreted and represented in a way so as to be perceived by the different senses and/or experienced in a different manner.

In this context, methods and conceptual frameworks of different disciplines need to engage in a dialogue; and through these cross-disciplinary practices, new strategies and processes emerge.

This publication aims to present collaborative projects, where methods from more than one discipline are involved. This publication also addresses how collaborators from different disciplines can work together to deal with current design and social issues.

Key themes

Architecture and Neuroscience/ Neurophysiology

How does the mapping of the brain activity help designers gain a better understanding of human experience in different spaces? Could the mapping of the human experience in certain environments (through new technologies and methods) inform the design of a place? Could the use of EEG (Electroencephalography), eye-tracking and other neurological or physiological data inform our understanding of human experience? Could physiological data be used in parallel to other methods – such as observation and interviews – to assess human comfort or levels of stress in different environments?

Keeling, Roesch and Clements-Croome's study, for example, examines how the use of wearable sensors for the assessment of multisensory comfort. The measurements of skin conductivity and heart rate of the participants are analysed in relationship to the temperature, light level, sound and other parameters of the physical environment, in an attempt to assess the above correlations. The study of Brorson Fich et al examines the relationship between the 'openness' of a space and the level of stress. The study uses a virtual simulation of different types of spaces and monitors the participants' levels of the immune regulatory stress hormone cortisol while they perform certain tasks. The study of Junkner and Nollen analyses the human experience in gardens of different typologies, based on the participants' gaze. Through the monitoring of the gaze, with a portable eye-tracking device, the researchers attempt to gain a better understanding of the relationship between movement, experience, and the layout of an outdoors landscape.

Digital and Physical: Data and Experience

Recent research projects map and use different types of data to analyse, understand and represent the dynamics of urban space. Data such as hash-tag keywords, locations with geotagged photos, demographics, are being represented through visualisations which allow for a better understanding, are more appealing and immersive, allow for interpretations and reveal connections that would otherwise remain uncovered.

Etcoff and Liu's project, for example, analyses the 'mood of the city' through a linguistic analysis of a large number of data; of twitted words associated with different types of mood. The patterns observed reveal places and times - moments of the day, of the week, or of the year - where a certain range of emotions appears to peak. Ahmadpour and Heath's work examines how the use of digital GPS navigation systems impacts upon the user's experience and understanding of the city – as well as the subsequent impact of that for urban design. Ahmadpour and Heath compare how GPS users and physical map users experience and remember the same environment. Castellanos reflects upon the political and social implications of the creation, use, selection and analysis of certain types of (big) data. He questions what is and 'what isn't computed?', and how 'incomputable' data are dealt with. He expresses his concern that significant information, which – however – is hard to compute, quantify or understand, is left out and is not visualised or studied. In this study, it is pointed out that certain topics of social relevance – politics, economic flows, poverty – whose analysis relies on narrative, images, stories, incur the risk of obsolescence – due to the non-quantifiable nature of the associated information.

The conference is organised by the University of East London (UEL) and led by Dr Anastasia Karandinou. The conference is supported by ARUP, RIBA and the Museum of Architecture.

The members of the conference scientific committee are: Prof Hassan Abdalla, Dr Aghlab Al-Attili, Alan Chandler, Prof Cherif Amor, Dr Satish Basavapatna Kumaraswamy, Barbara Bochnak, Dr Julien Castet, Nefeli Chatzimina, Prof Ruth Conroy Dalton, Dr Heba Elsharkawy, Prof Ozlem Erkarlan, Prof David Fortin, Ruairi Glynn, Dr Vangelis Lypouridis, Dr Kat Martindale, Prof Rosa Mentosa, Prof Panos Parthenios, Dr Kerstin Sailer, Maria Segantini, Dr Sally Shahzad, Dr Bridget Snaith, Dr Renee Tobe, Prof Duncan Turner, Dr Louise Turner.

The keynote speakers are:

Prof Richard Coyne, Prof Deborah Hauptmann, Prof Constantinos Daskalakis and Prof Jan Wiener.

Conference Links:

www.uel.ac.uk/Events/2017/March/Between-data-and-senses

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<https://twitter.com/DataAndSenses>

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Prof Deborah Hauptmann

Deborah Hauptmann is Professor and Chair of the Department of Architecture at Iowa State University, USA. Previous to this she was the Director of the Delft School of Design, an internationally recognized platform for research and advanced education. Hauptmann's research draws on a trans-disciplinary approach to architecture, which includes disciplines such as philosophy, cultural & media studies, the social sciences and the neurosciences. Her co-edited volume, *Cognitive Architecture: From Biopolitics to Noopolitics: Architecture and Mind in the Age of Information and Communication* (010 Publishers: Rotterdam, 2010), is an example of this approach. Other publications include: - 'Northern Line', co-authored with A. Radman, in *Deleuze and Architecture*, 2013; Forward to *Writing and Seeing Architecture: Christian de Portzamparc and Philippe Sollers*, 2008; *The Body in Architecture* (ed.) 2006. Hauptmann is a Bergson scholar, she is the English co-translator of his 1889 Latin thesis *Quid Aristoteles de Loco Senserit / On Aristotle's Conception of Place*.

Abstract:

Noo-Architecture: between culture and brain

The philosopher Henri Bergson, in *Matter and Memory* (1896) notes that philosophy traditionally works through dualist accounts: idealism-realism, internalism-externalism, etcetera; which inevitably equate to the classical mind-body problem. Bergson argues that the intersection of mind and matter is to be found in memory. Through his notion of *durée* he constructs a double movement between representation and experience. Deleuze refers to this as a 'double progression' in which duration, when applied to things, or rather 'duration in things' forces the question of space to be fundamentally reassessed: 'space itself will need to be based in things, in relations between things and between durations.'

When thinking *between data and the senses* it is important to resist the tendency to imagine the digital as immaterial and the physical as material and that the cross-over between the two situates us in a dance, a *pas de deux* between body-sense and image-data; or, perhaps more logically, between body-image and sense-data. Translations created to break down the dichotomies between the two in order to either thicken our experience or expand our knowledge. In addressing transdisciplinary thinking this I will offer a brief account of another double movement in Bergson, that is between translation and rotation. The underpinnings of this account will be located in 19th century empirical psychology.

In *Cognitive Architecture*, we argued that if we are to intellectually and fully engage in matters of our contemporary world - populated as it is by technologies of information and communication, as well as the internet techno-bred minds of this generation - fields located in the so called soft sciences: whether cognitive or aesthetic philosophy, cultural, spatial, social or political theory, would need to expand their traditional reliance on thinking environment, ethos, politics & relations of power in terms of biological models (*bios*) to neurological models or system (*nous*). This developed from the belief that that the world of culture and cultural artifacts, whether material or immaterial, reconfigures brain. Culture being the matter that makes up the human sociocultural environment - music, architecture, art, design, media, and language, as well as political, social, and cultural institutions. Within a neuroscience perspective it is can be seen much more straightforwardly: environment-induced neural activation contours brain development in a manner that is essentially consistent with human-made environment. In this account,

time has become the horizon on which the contours of perception, experience, memory, and sensation are traced. Time-technologies as social machines reconstitute sensibilia through affective and intellectual processes, that is, *between data and senses*.

Prof Richard Coyne

Richard Coyne is the Dean of Postgraduate Research in the College of Humanities and Social Science, at the University of Edinburgh, where, until 2011, he was the Head of the School of Arts, Culture and Environment. Richard Coyne researches and teaches in information technology in practice, computer-aided design in architecture, the philosophy of information technology, digital media, and design theory. He inaugurated the MSc in Design and Digital Media, in which he also teaches. Richard is Academic Director of the MSc in Design and Digital Media, and Programme Director of the MSc by Research in Digital Media and Culture. Richard's research is conducted within the Digital Media Design research group. He collaborates with John Lee, Martin Parker and a team of about 10 PhD students and research associates. Richard Coyne is author of several books on the implications of information technology and design with MIT Press and Routledge. His research has been supported by AHRC, EPSRC and SCRAN. Coyne's research demonstrates the value of a broad interdisciplinary framework for examining the relationship between computing, design, and contemporary cultural theories. He is currently investigating the way we configure spaces through the use of pervasive mobile devices, such as smartphones, iPods and GPS. He is developing this theme through the sonic metaphor of tuning and phenomenological concepts of mood. Coyne recently completed a book for the Routledge *Thinkers for Architects* series entitled *Derrida for Architects*, and is co-investigator on a major funded project on mobility and aging entitled *Mobility, Mood and Place*. Coyne is a member of the ARQ editorial board and was a member of the AHRC review panel Visual Arts and Media. Richard Coyne is animated by the cultural, social and spatial implications of computers and pervasive digital media. He enjoys architecture, writing, blogging, designing, philosophy, coding and media mashups.

Abstract:

Brainwalks

Colleagues and I have explored applications of EEG to understanding people's responses to outdoor environments. Due to its constraints, the technology lends itself to two task domains. The wearer of the head-mounted EEG technology is either stationary in the environment, passively observing and listening, or mobile. In the latter case, they just walk, slowly and deliberately. I am fascinated by the walking scenario, especially as the walker cannot run, talk, kick a ball, or otherwise engage with the environment. She just looks and listens while walking at a steady pace. If there are others monitoring this experience then they need to keep their distance, and walk in silence. In this talk I introduce one such scenario undertaken at a workshop in Edinburgh. This demonstration provides an opportunity to discuss walking in general. "Why does one walk?" we say; "that one may be healthy"; and in speaking thus we think we have given the cause," said Aristotle in *Metaphysics*, Book 5, Section 2. He provides walking as an illustration of the most advanced type of causal relationship, the *efficient* or *teleological* cause. We might say walking with intention, in this case to remain healthy. I canvas some of the evidence for aligning outdoor walking with stress reduction and therefore health, as advanced through

EEG “brain walks.” The theme and the method are increasing in popularity, not least as the BBC profiled explorer Daniel Raven-Ellison’s walk across the British countryside while wearing EEG to measure apparent mood changes. I show the results of some of our own formal and informal experimentation in the area. One of the side effects of the techniques is to render the familiar act of walking strange in new ways.

Prof Jan Wiener

Jan Wiener is a Professor in the Psychology Department at Bournemouth University. Prior to coming to Bournemouth in 2009, he held principle investigator and post doc positions at the Cognitive Science Centre at Freiburg University (Germany), at CNRS in Paris (France), at Max Planck Institute in Tübingen (Germany) and at the Cognitive Neuroscience Department in Tübingen (Germany). He received his Ph.D. in Cognitive Neuroscience in 2004 from the University of Tübingen (Germany). Jan Wiener’s research focuses primarily on navigation and wayfinding behaviour. Successful navigation is a fundamental behavioural problem that involves multiple cognitive components and complex information processing. In order to address these issues he makes use of different methods such as behavioural navigation experiments, virtual reality techniques, eye-tracking, and cognitive modelling. Recent research has focused on the relation of gaze and wayfinding behaviour, the effects of typical and atypical ageing on navigation skills, and the use of signage to improve the navigability of complex environments such as airports and hospitals. Jan Wiener leads the Wayfinding Lab, and he was recently awarded a major ESRC grant on ‘Demetia Friendly Architecture’. Other recent projects of his include: ‘Decreasing spatial disorientation in care-home settings: How psychology can guide the development of dementia friendly design guidelines’ and ‘Human place and response learning: navigation strategy selection, pupil size and gaze behaviour. He is one of the Editors of the book ‘Representing Space in Cognition’, published by Oxford University press. Jan Wiener’s work has been broadly published, and his papers have been included in numerous international journals such as the Journal of Neuroscience, Spatial Cognition & Computation, *Frontiers in Human Neuroscience*, and the Journal of Environmental Psychology.

Abstract:

Experimental approaches to understanding the relationship between architecture and wayfinding

Wayfinding and navigation behaviour cannot be seen independently of the form and structure of the environment. Selected features of architectural spaces have been shown to influence a variety of wayfinding and orientation tasks. Floor plan complexity, for example, affects the ease with which unfamiliar environments are learnt and navigated, the misalignment of local reference systems impairs the users’ ability to integrate spatial information across multiple places, and wayfinding performance at oblique angled path intersections critically depends on which branch was used to enter the intersection. Most studies addressing the impact of architectural features on wayfinding behaviour, however, relied on qualitative descriptions of particular spatial situations which makes them difficult to compare and to integrate. To study interrelations between spatial properties and spatial behaviour systematically, generic formal descriptions of space are required capturing behaviourally relevant properties and allowing for quantitative measures.

In the first part of the talk I will present navigation and wayfinding experiments in which we used virtual environments technology to systematically manipulate architectural features. To describe the spatial form of these environments we used isovist analysis. Isovists describe the visible area of a spatial situation from a given observer position and can be conceptualised as two-dimensional polygons which allows for the extraction of quantitative measures, such as the area, the longest lines of sight, local complexity, etc. Results from these experiments demonstrate that such isovist measures capture behaviourally relevant spatial and architectural features that can be used to predict navigation and orientation behaviour as well as gaze behaviour. I will argue that isovist and related architectural analysis methods such as space syntax are important techniques for developing an improved understanding of the relationship between architecture and behaviour.

In the second part of the talk I will discuss dementia-friendly design principles and how neuropsychological theories of dementia and navigation can help to identify architectural features as well as design features that may compensate for dementia-induced declines in navigation abilities. Many people with dementia eventually move from their homes into unfamiliar retirement developments or care homes. Sadly, this change in circumstances occurs contemporaneously with a dementia-induced decline in navigational ability, which is particularly pronounced in unfamiliar environments. I will introduce current experimental approaches in which we systematically manipulate architectural and interior design features to identify how people with dementia learn to navigate unfamiliar environments using. Results of these experiments will be discussed in relation to current dementia-friendly design principles.

Prof Constantinos Daskalakis

Constantinos Daskalakis is a Professor of Electrical Engineering and Computer Science at MIT, and a member of the MIT Computer Science and Artificial Intelligence Laboratory (CSAIL). He holds a Ph.D. in Computer Science from UC Berkeley, and an undergraduate diploma in Electrical and Computer Engineering from the National Technical University of Athens. Prior to joining MIT's faculty, he was a postdoctoral researcher at Microsoft Research, New England. His research interests lie in theoretical computer science and its interface with economics, probability theory and statistics, and artificial intelligence. A main thrust of his work examines the computational foundations of Economics from a computational perspective, studying whether the predictions of economic theory are robust when agents interact in complex strategic environments and are computationally bounded. He is well-known for his paper 'The Complexity of Computing a Nash Equilibrium,' co-authored with Paul Goldberg and Christos Papadimitriou, where he shows that Nash equilibrium is computationally intractable. Nash equilibrium, introduced by John Nash in 1950, had been the crown jewel of equilibrium concepts in Economics for over half a century, inspiring the development of economics in the 20th century and winning John Nash a Nobel prize in economics in 1994. Daskalakis's work shows that computational barriers may actually prevent Nash equilibrium to arise, calling the universality of Nash equilibrium into question. Daskalakis and his co-authors have been honoured with the 2008 Game Theory and Computer Science Prize by the Game Theory Society, and the 2011 Outstanding Paper Prize by the Society for Industrial and

Applied Mathematics. Daskalakis has also been honoured with the 2007 Microsoft Graduate Research Fellowship, the 2008 ACM Doctoral Dissertation Award, the 2010 Sloan Fellowship in Computer Science, the 2011 Ruth and Joel Spira Award for Distinguished Teaching, the 2012 Microsoft Research Faculty Fellowship, and the 2015 Research and Development Award by the Vatican Giuseppe Sciacca Foundation. He is also a recipient of Best Paper awards at the ACM Conference on Economics and Computation in 2006 and in 2013.

Abstract:

Artificial Intelligence 2.0

Self-driving cars, Amazon Alexa, image search...we are constantly bombarded with new "clever algorithms". Algorithms understand what we say, they learn things about us, they learn foreign languages, they learn how to paint. What is behind these algorithms and what does it mean that a machine can "learn"? I will talk about the ongoing revolution in artificial intelligence, the technology behind it, and some philosophical and moral issues that arise.

1. Mobile eye tracking in landscape architecture Analysing behaviours and interactions in natural environments by use of innovative visualisations.

Junker Dirk, Christian Nollen

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Introduction

Landscape Architecture (LA) plans and realises open spaces for people; but little is known about how people perceive the environment and interact with it or with others in it. The current research project 'Point de Vue' seeks to investigate the effects of gaze guidance and usage behaviour in promenade gardens from different eras and styles by utilizing mobile eye tracking. Remote eye tracking studies in defined laboratory settings based on 2D images as stimuli have been conducted in LA before, whereas limited research has been done in outdoor mobile eye tracking in the domains of geography or architecture. As far as is known, there are no studies documenting a free and uninfluenced walk in real-world situations as mirrored by this study or even on a comparably grand scale. Mobile Eye Tracking Glasses (ETG) are used in unaltered natural settings in open spaces to initially examine the world through the participant's eyes. The ETG gaze video documents nearly the whole peripheral vision, synchronized with the surrounding audio. Supplementary methods have to be applied. This exploratory study focusses on the individual behaviours in (un-)known sceneries and - besides generating basic knowledge - aims to test if this method is applicable in, and relevant to, LA. A profound topic is aesthetics and how to reveal the inexpressible within the question why something is judged to be beautiful by the visitors. Two gardens with different styles and from different eras, Großer Garten (Baroque), Herrenhausen, D and Stourhead (Landscape Garden), Stourton, GB, are examined. This work in progress abstract is meant to present a journey into a new research approach.

Methods

To ensure consideration of the most meaningful open spaces, trials were conducted in historic parks with a high relevance for tourists and local residents as well as being embedded in the regional and cultural landscape. All participants were spontaneously recruited and intrinsically motivated to visit the park and join the trial. Subject groups were not defined due to small samples (Großer Garten: N=46; Stourhead: N=24). Estimated trial durations per participant were from 30 minutes (Großer Garten; determined by a timer) up to 60 minutes (Stourhead; no spatial or time limit). The recorded fixations are not of primary interest, however the documentation of the promenade and the conversations are. Participants walked around freely together in the group they arrived with. This is defined as the Common Shared Experience (CSX), as a refined and non-distracting Think Aloud. This is a very central method because mobile eye tracking itself is a combination of oral and technical data collection methods and is supported by interviews and a reduced mood scale to validate gaze data. Additional needs are a connection to a GPS signal and biometrical measurements such as skin conductance, heart rate, blood pressure or facial expressions.

Due to large datasets, analysis is first split into segmenting gaze videos by filtering paths, open spaces and objects of interest and secondly by evaluating standard results for eye tracking research as gridded AOIs, transition matrices or statistics.

Large-scale mobile eye tracking studies in LA are interdisciplinary linked to Arts, Cognitive Sciences or Landscape Assessment and thus have to adapt their methods if necessary. Furthermore, it is necessary to develop new visualisations to analyze the very complex concurrent interactions and eye movements in ever-shifting natural environments. Another analysis, currently being conducted, is the Verbal Mood Map (VMM) presenting the participants' expressed emotions on a map to identify salient areas. A map-based and GPS-linked method hereby introduced as the Path related Gaze Protocol (PrGP) for mobile eye tracking data is being prepared.

Results

This study is being evaluated on two layers: the experimental procedure itself and generalizable results on basis of the analysis. Without having final results to date, it seems to be probable that mobile eye tracking is an appropriate method for LA. Documented interactions and interviews confirm the unobtrusiveness of the ETG and insights into behaviours are meaningful and unique. The infrared based gaze measurement is affected by strong sunlight but by providing the participant with a sun hat it is reducible to tolerable. Due to different reasons, only 80-85% of participants were usable for analysis. An impressive finding was the role of the location for recruiting participants and the ETG set up: starting trials inside the garden leads to higher recruiting rates compared to a starting point close to the reception. This has to be counterbalanced with the loss of stimulus information. Running studies without giving tasks to participants makes the analysis more complex, but has advantages for increasing the ecological validity. While participants in Großer Garten were time limited (task: get to a specific point after the timer rings) and thereby slightly distracted and impaired, participants in Stourhead increased the trial up to double the estimated duration without mentioning impairments.

Comparing the interestingness of Großer Garten for children to the adult's assumption of how interesting the garden was for children, the difference in weighted means represents a +2.23 points greater mean (scale from 1 to 10) for the group children (≤ 18 years) and families accompanied by children (7.23, $n=15$) in contrast to adults walking without children (5.04, $n=26$).

Mood changes - potentially caused by spending time in a park - are predominantly positive. The overall mood score (scale from 1 to 7) increased by +7.63% (weighted mean; Großer Garten: +8.28%, $n=39$; Stourhead: +6.31%, $n=19$).

Conclusions

Mobile eye tracking leads to generalizable data and individual insights. It thereby provides a sensitisation for the environment which can be seen as a helpful objectification of a planner's expertise or the researcher's awareness for subtle correlations. First results show a positive effect to participants' well-being which has to be verified statistically. Additionally, the Path related Gaze Protocol (PrGP) was not in a completed state at that time but is supposed to initially represent visual connections from the subject's viewpoint towards the focal point on the object - or as a back reference. Further, it will provide

insights into the participants' interactions as to how many elements along the way they can remember or which intended viewpoints really have been consumed.

Future studies ought to consider the ecological validity and its importance for real-world trials. A potential might be the development of 3D reference models for more flexible gaze analyses and more realistic result graphics. Merging real-life eye movements into 2D reference images or reducing it to statistics will not define the future of this meaningful method. The result graphics mentioned above are being developed and the next steps will be presented in early 2017.

Being able to see and understand what catches a person's eye and the response will be a guide to better design.

2. Suitability of physiological sensors for multisensory comfort assessment

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Keywords: physiological sensors, multisensory comfort, acoustics, wearable sensors.

Summary:

We present the results from a study that tests the suitability of wearable sensors for multisensory comfort assessment. Participants' heart rates and skin conductivity are measured while they work at their desk in their own office. This is combined with measurement of background light levels, temperature, CO₂ and sound levels.

Introduction:

To define multisensory environmental experience singular environmental measures must be combined (Clements-Croome, 2013a). Most multisensory studies aim to understand the interplay of the senses by assessing their effect on a common outcome, often combining measurement of background levels (Cao et al., 2012; Huang et al., 2012) using a bottom up approach to predict their effect on a common outcome such as environmental satisfaction. In this way, these approaches all account for multisensory experience by weighting of the single senses and summing these into a single one-dimensional outcome. Typically through a bottom up, multiple linear regression type approach (Gadotti & Albatici, 2016).

An alternative approach is to contrast the qualitative differences of the senses (Pallasmaa, 2005). Pallasmaa (2005) suggests that it is not possible to combine and sum different sensory experiences, rather it is the balance and contrast of the different senses that makes an experience what it is. For instance he describes vision as detached and abstract and a snapshot in time, whereas sound is intimate, situated and can only be comprehended in terms of its unfolding in time. For him, understanding the contrasting,

interweaving of effects is more important than using a single concept, such as satisfaction, to unify them. Our study emulates this approach by aiming to understand the multiple and differing effects building environments have on their occupants.

The essence of our approach is to test the limit of using background levels to evaluate environmental experience. On the one hand background levels are useful because they can be measured by remote sensors, on the other hand they do not provide a full and complete understanding of user experience. The same can be said of physiological sensors. Physiological response can be used to differentiate markedly different environments but it is not clear if they can be used to understand the small changes in environment that occur within offices.

Hypothesis and methods:

To test this we use two different forms of analysis. Firstly, session averages of all environmental factors were compared to session statistics of personal factors. Environmental factors: air temperature, humidity, CO2 levels, lux levels, colour temperature and sound levels. Personal factors: skin conductance variability (SCV) and heart rate variability (HRV), positive affect, satisfaction level. We hypothesise relationships between each of these factors (H1). The second analysis tests the physiological response of individuals to different noises. This method breaks down an individual's session into approximately 30 to 70 events. It is hypothesised that the greater the relative loudness of the event, the larger and more likely the startle response, and therefore the larger the heart rate and SCV response (H2).

Findings:

The first analysis suggests, there are key differences to the senses. It is the combination of these differences that provide the unique richness of multisensory experience. For component factors that are more energy based (i.e. thermal comfort) sensors are more useful, for component factors that are more information processing based (i.e. sound) sensors are less useful.

The second analysis demonstrates the effect of sound levels in offices on people's heart rates. It can be used to monitor workers reaction to their sound environment in real time and reveal differences in people's sensitivity to sound. Overall, physiological response is correlated with sound, temperature and light levels. However, the usefulness of background levels and physiological response is limited because they are unable to characterise the complex information processes inherent in user experience. Both these analyses point toward the limit of using background levels of ambient conditions to understand user experience. They suggests that, until sensors can understand and summarise the complexity of user conceptualisation and information processing, they will not fulfil their promise of use for multisensory comfort assessment.

3. Measuring the embodiment of architecture

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Recently, the term embodiment frequently has turned up in connection with architectural thinking, emphasizing the importance of bodily presence in the process of perceiving and interacting with the environment. An example would be Juhani Pallasmaa's influential essay "The Eyes of the Skin", whose purpose he declares is to unfold his "assumptions of the role of the body as the locus of perception, thought and consciousness..." (Pallasmaa 2005, p.10) or the concept of atmosphere founded on "bodily presence" by Gernot Böhme (Böhme 1993). This awareness of the body as a key to understanding our interaction with the environment, being it man-made or not, suggest that a biological, empirical approach might be able to make a contribution. Any living organisms must protect its inner biological balance in order to sustain the fragile biological processes of life – a balance known as the homeostatic balance within physiological terminology - and must therefore react to its environment in order to counterbalance or prevent any threat to its homeostatic balance. In the case of the man-made environment in which we spend most of our time, design decisions therefor presumably influence this biological response in ways which we today have only an imperfect if any substantial knowledge about.

A possible model for understanding this interaction is the "the emotion-feeling cycle" introduced by the American neuroscientist Antonio Damasio. The first part of the cycle, the "emotion" part, is a completely non-conscious process in this terminology, not to be taken as synonymous with 'feelings'. Rather emotions are defined by Damasio as "complex, largely automated programs of actions concocted by evolution" that is set into motion by a stimulus constituting either a threat or an advantage to the organism's homeostatic balance. An emotion then consists of programs for adjusting the body- and the mind state in accordance with the challenge the organism is presented to. The feeling part that closes the cycle is defined as: "composite perceptions of what happens in our body and mind when we are emoting", thus the cycle which was started as a non-conscious emotional process in one part of the brain spreading to the body and brain, is perceived by other parts of the brain and might only then qualify for becoming conscious as a feeling (Damasio 2010, p. 109-111).

Interestingly, this model seems somehow to coincide with Böhme's concept of atmospheres in his concept of a new aesthetics, as he states: "Perception is basically the manner in which one is bodily present for something or someone's bodily state in an environment. The primary "object" of perception is atmosphere" (Böhme, 1993) If Böhme's concept of atmosphere as a thought experiment is taken as synonymous with Damasio's concept of conscious feelings being perception of the emotionally driven bodily adjustments, one may notice a surprisingly similarity.

If this idea, from different perspectives implied by writers like Pallasmaa, Böhme, Mallgrave and Damasio that the body is in a constant dynamic interplay with the environment is to be taken at face value, it should be possible to detect it through physiological measures, and in the case of confirmation, to reach a deeper understanding of its consequences.

To investigate if this could be possible, we have conducted an experiment. We chose to work with stress, as the stress systems seems to be the quintessence of an emotion in the Damasian sense of the word – one definition of stress is simply that “stress is a state of threatened homeostasis” (Chrousos et al. 1988). Stress can be divided into two types, although they largely engage the same stress systems. Systemic stress constitutes actual treats like e.g. pain, heat or cold, loss of blood etc. Psychogenic stress on the other hand constitutes the system trying to prevent a possible future threat. In both cases the bodies’ two major stress systems are activated.

The One of them is represented by the two branches of the autonomous nervous systems (ANS), the sympathetic nervous system (SNS) which is part of the sympatho-adrenomedullary (SAM) system. The SNS can be activated within seconds, and deactivated even quicker by the other arm of the SNS, the parasympathetic nervous system (PSN). While the ANS is quickly activated and deactivated, the other system, the hypothalamic-pituitary-adrenocortical (HPA) axis, is activated within minutes and its effect can be present even longer. It works by releasing hormones into the bloodstream, and its end product is the hormone cortisol which has a long range of effects throughout the body including down regulating the immune system, while long lasting exposure to elevated levels of cortisol can cause e.g. depression. These systems are activated to recruit resources for a fight-or-flight behavior to enable the organism to face the challenges. Energy consuming processes which are not immediately necessary like the immune system, digestion and reproductive behavior is suppressed, while the heart rate, respiration and blood pressure are stepped up, and stored energy resources are released (Johnson et al. 1992; Ulrich-Lai and Herman, 2009).

By far the strongest psychogenic stressors are psychosocial stressors, first of all to have something of importance to the “flock” evaluated by others, as the outcome might determine the individual’s place in the social hierarchy and thereby access to resources (Dickerson and Kemeny, 2004; Gruenewald, 2004). We chose to work with psychosocial stress, as it implies the interaction of architecture and behavior, or in the words of Böhme presence “for something or someone’s bodily state in an environment” (Böhme, 1993). We used the Trier Social Stress Test, as it since the early 1990’es has been probably the most used protocol for laboratory research in this type of stressors (Kirschbaum et al., 1993). A test person (TP) has to perform two tasks in front of an evaluative committee, usually consisting of two to three trained actors, who are instructed only to respond with a number of predetermined lines. First the TP is informed by the chairman of the committee that the first task will be to give a 5-minute oral presentation as if applying for a favorable job and that he will get another assignment, but not what it is. The TP is then given 5 minutes to prepare the presentation. After giving the presentation in front of the committee, the TP is given the second assignment: to count backwards in steps of 13 from 1687 - an assignment in which almost nobody can succeed, referring to a negative social evaluation. At Lund University, Sweden, a virtual version of the TSST (Jönsson et al. 2010; Wallergård 2011) has been developed, using a Cave™, a device, in which a system of

projectors coordinated by a computer project onto four large screens including the floor. When a viewer wears a set of 3D glasses and a head tracking device, the computer will coordinate the projected image and produce an illusion of three dimensional spaces. As the space is computer generated, it is possible systematically to manipulate the space, and as the stress reaction basically is a preparation for a fight-or-flight behavior, we used to different spaces, an enclosed space, and a space with three large openings through which the floor continued uninterrupted to the horizon, potentially allowing for flight (fig. 1) (for a detailed description of procedure, participants etc. see Fich et al. 2014). We measured the activation of the SNS and PNS by measuring T-wave amplitude and high frequency heart rate variability while the release of cortisol was measured in saliva samples. The results showed a significant difference in cortisol level depending on the space, but no difference in activation of any part of the ANS, (fig. 2).

It can therefore be concluded, that at least concerning openness versus enclosure, the design of a space influences the resulting body state in terms of cortisol, in connection with a socially stressful event taking place in the space. In other words, the emotional reaction is constituted by a specific combination of the trinity stated by Böhme: a bodily reaction, caused the presence of “something or someone” in an environment with specific characteristics. It suggests that at least one aspect of the experience of architectural space might be the potential behavior that the space allows for, in this case flight. With the many regulatory functions of cortisol within the body, this experiment further suggests, that embodiment taken literally actually might encompass e.g. being able to influence immune functions by way of the architectural design of spaces, qualifying architecture with a new and very strong dimension. The experiment points to the potential of interdisciplinary research. However, the present experiment in itself has a number of important limitations. One question is how strong the effect will be outside the laboratory where a lot of other variables might interact with the effect of the architectural design. Only men were included because the menstrual cycle influences cortisol release (Kudielka and Kirschbaum, 2005; Kudielka, 2009). Hence, asking the question how gender, culture, education and age would influence the result, is pointing to the need of further research. To quote Mallgrave: “The importance of our emotional well-being cannot be overestimated by architects, if only for the reason that designers are principally engaged in constructing the habitats in which we live” (Mallgrave 2010, p. 191).



Fig. 1. The enclosed and the room with openings. Due to the stereoscopic projection the participant will experience a clear 3D environment, in which the floor continuous unhindered to the horizon through the openings.

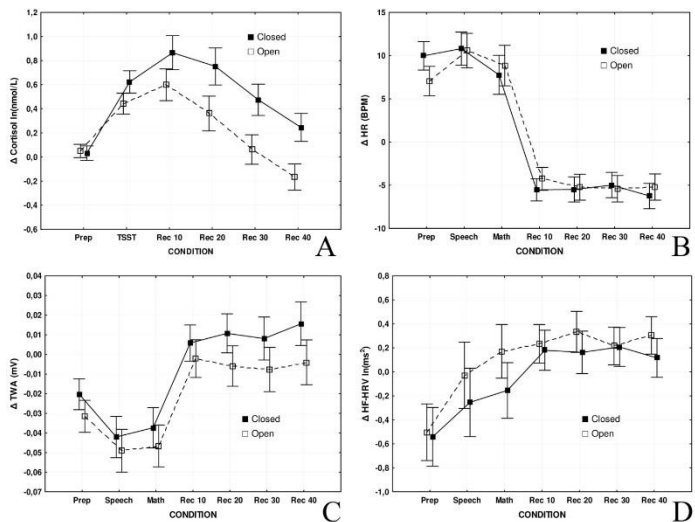


Fig. 2. A) Shows the cortisol, which was measured in saliva samples. Due to a delay between when cortisol is released into the blood stream and when it shows up in saliva, "prep" is actually baseline and so on. B) is the heart rate, C) is SNS activity. When the curve goes down, the activity of the SNS goes up. D) is PNS activity. SNS and PNS activity was derived from heart rate variability

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4. What social media sentiment tells us about the ebb and flow of a city's moods

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As part of the City of Santa Monica's Wellbeing Project, a multi-year effort to understand the subjective wellbeing of city inhabitants, we designed a social media sentiment index called the Positivity Pulse. The index analyzes and compiles the sentiment from real-time tweets emanating from within the geographic boundary of Santa Monica, and also from the Greater LA basin, as a control. Along with related urban experiments such as the Public Face 1 art monument (2008), and the MIT Mood Meter (2012), the Positivity Pulse is designed to reflect the ebb and flow of social mood of the community -- be it 71 (upbeat) or 92 (euphoric) -- back onto city inhabitants.

The index collects tweets from Twitter in real-time which have either a geotag or belong to a user whose profile location is within the target geography. Tweet text is analyzed using the Positive Emotion and Negative Emotion word classes within the Linguistic Inquiry and Word Count (LIWC) program. In previous work, LIWC word choice has been shown to predict physical and mental health (Gottschalk + Gleser 1969; Pennebaker et al. 2007). A manual evaluation of LIWC for 1000 randomly sampled tweets within our corpus achieved 76% accuracy and 61% recall.

In evaluating the index, we analyzed a corpus of 10K tweets collected from Santa Monica and 590K tweets from the Greater LA area collected over a six day period, grouped into hours. In a first analysis, we compared a plot of the normalized hourly average sentiment of the Greater LA area (Pos/Neg ratio) to a ratio of collective pronouns (e.g. 'we', 'us')

versus ego pronouns (e.g. 'I', 'me') (We/I ratio). We found that sentiment and collectivity exhibited a high degree of time series correlation, suggesting that for the most part, being with others is more positive than being alone. Interesting is that correlation was weakest at Friday 9PM (the Unhappy We), and Sunday 12PM (the Happy Alone).

In a second analysis, we compared the sentiment plot of tweets associated with Santa Monica, versus, as a control, those associated with the Greater LA community. Two differences stood out. First, Greater LA experienced seven positivity peaks over the six day period, compared to Santa Monica's twelve positivity peaks, perhaps indicating greater leisure in the lives of Santa Monica residents, or more stimuli for positivity such as a view of sunrise and sunset. Second, Greater LA exhibits a weekend effect, whereby Friday, Saturday and Sunday had greater peaks than weekdays. In contrast, Santa Monica peaks are of similar amplitude during weekend and weekdays. This perhaps suggests a different relationship to the weekend, or more continuous enjoyment of life across the week. We discuss implications and extensions of this work.

5. Navigation by GPS-based systems: Engagement with/Disengagement from the Place and the Respective Role of Urban Design

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The physical environment has started to be taken into consideration in mobile human-computer interaction more and more in order to bring humans and computers closer together. These studies focus on merging the aspects of actual situations in real world into the information delivered by mobile devices. These studies have helped to develop the computer-based technologies toward considering more human factors by adopting the principles of the physical environment. There is now a large body of research presenting how urban planning principles are applied to the design of virtual environments. For instance, Kevin Lynch's theories from "Image of the City" (1960) have been widely implemented in designing virtual cities and particularly navigation systems. Navigation systems use the design fundamentals which are initiated and developed by urban planners and environmental psychologist. However, there has to date been little study in the opposite direction; analysing the effects of digital technologies and digital mobile devices on urban places, the way people understand cities through these devices in order to draw out the role of urban planning and urban design towards these effects.

In fact, as a result of the recent emergence of the fluid, responsive, kinetic, data-driven worlds of ICT and its combination with the urban landscape, urban design faces a radical rethink of a number of its principal underpinnings. So, urban planners and urban designers need to understand the effect of ICTs and digital mobile devices on traditional urban principals (city imaging, way-finding, context, comprehensibility, space, neighbourhood boundaries, etc.). In addition, it is important to recognise the way that people interact with their physical environment in order to find ways in which they can fruitfully and desirably combine real urbanity and virtual urbanity. This would lead to the opportunity for creating

networked public spaces that can value the traditional physical qualities of cities whilst embracing the digital aspects of the developing ubiquitous world.

In this light, this study attempts to understand the effects of using GPS-based navigation systems on people's navigation in the urban environment and the respective role of urban design and planning. People's tendency for using GPS-based navigation systems is increasing and people movement through the city, in many cases, cannot be separated from their engagement with their smartphone screen. As such, it could be claimed that people are losing their connection to physical place. New Yorker architecture critic, Goldberger (2009) claims that such devices keep people isolated in an "individualistic bubble" and release people from the physical place. Baker (2004) suggests that this is leading to "the dissolution of place" and the decreasing the importance of physical place and physical objects as part of the way-finding process. So, increasing use of GPS-based navigation systems in urban environments is increasingly raising questions over the role of physical places in navigation. These include: How to maintain a connection between people and the physical places they inhabit? and How to retain the value of legibility related to physical objects within our towns and cities?

To answer such questions, it is essential to know how GPS users understand and interpret the physical environments they inhabit. By doing so, it can help in the design of successful places which can work for all types of users, by enabling a better understanding of the interrelation between people and the physical environment. This paper will therefore examine people's understanding of the urban environment and their spatial knowledge through using GPS-based mobile maps to investigate and focus upon people's knowledge of urban places. This research by using both quantitative and qualitative methods analyses the different level of spatial knowledge between people who use GPS-based navigators compared to those who experience the same environment 'non-technology aided. In addition, the study focuses upon which physical features of the place that the GPS users could best remember. These analyses enable a better understanding with regard to what physical objects and features GPS users are able to engage with and remember. This paper presents part of a bigger research project, which has studied different aspects of navigation in an unfamiliar environment by using GPS.

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6. FELT: Emotion, space and communication

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When we inhabit, wear, and make textiles we are deeply in conversation with our pre-historical and historical past and in a sense already connected to what is to come by the structure of the fabric which operates as a mode of understanding the world. Textiles bind

us together as a species in every culture on the planet, though we humans may use and make this material in different ways. In architecture, textiles made of animal skins or plant fibers were probably used to make the first shelters, as both protective clothing and enclosing space. As a liminal space between the body and environment these textiles became places of exchange and communication of information between people their communities and other societies through shelter and clothing. This communication is an expression of personality and mood which makes an impression on those who would look upon the shelter or clothing. This communication is directly related to the expression of the material.

The hypothesis of this paper will be that textiles communicate emotion through material expression via vision and touch. Furthermore, computation augments what designers can communicate about emotion to people by transforming textile expressions. I claim that through the use of computational textiles, which are textiles embedded and connected to sensors and micro-controllers designers can augment people's emotional connection and communication with textiles through computation. If architects, designers, artists, engineers and others can begin to understand how emotion is produced by computational textiles, and other materials, then they can begin to design objects and spaces which explicitly address wellness, health and well-being through materiality.

I will present the process of developing FELT a 150cm x 180cm computational textile wall panel which has been designed to explore which emotions are communicated to people who see and touch it. The design process for FELT has included working with data from 3 studies in which I have asked if there are specific families of textural expressions which produce specific emotions in people.

This paper will make a contribution to neuroaesthetics and perception in design. By considering computational textiles as communicating via seeing and touching, this study frames a new avenue for computational material research wherein emotional communication from a material is a source of creativity in humans' interactions with computing. The paper will include a framework for understanding of what gets communicated to people from computational textiles through vision and touch. In addition the paper will contribute a design for FELT a computational textile wall panel which can be used to study how textural expression can communicate emotion at a fairly large scale.

In addition to presenting FELT and the results of interactions with FELT I would like to propose this project as a collaborative project to work with any neuroscientists at the conference at the University of East London to see if some of my results and data could be compared or extended with work using neuroimaging.

7. Thermal Perception and Experience of the Sensory Environment: a conception tool for including thermal and sensory comfort studies in urban and environmental design processes

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The present study aims to contribute to building knowledge capacity by bringing together research and practice in order to juxtapose objective (measurable) and subjective (perceived) data and to create an urban comfort database with users as data generators. The paper proposes to link the evaluation and monitoring of environmental quality and comfort with the urban design process for outdoor public spaces.

Our understanding of urban comfort is structured by means of many different representations such as unimodal urban senses (e.g. thermal, visual, auditory and kinaesthetic conditions), multisensory experiences, as well as spaces of influence. The bodily experience of moving outdoors relies on the sensory realm, determining the comfort and satisfaction pedestrians derive from it (Middleton, 2010). Urban comfort requirements in the built environment are evaluated as physical, psychological and physiological (Sarkar, 2002). These comfort categorisation can be evident in different scales of influence for the bodily experience. This project focuses on the space of navigation. There are detailed tendencies that govern navigation behaviour when moving in the built environment that include the attraction effect, the distance effect and the comfort effect of the users. These effects combine the influence of visual stimulation in the surrounding space, the preference of the shortest path, different speed ranges, thermal and sensory distress mitigation and environmental diversity (Lam, 2012). The environmental, thermal, visual and acoustic conditions that prevail in each different space play a significant role in the duration of pedestrian activity outdoors, users' experience and perception of comfort and the choice to move freely (Sauter & Wedderburn, 2008; Henshaw, 2011; Axelsson, 2010). Environmental sensors and applications are available to users in order to calculate and control the state of their thermal, visual, acoustic and air quality comfort, based on indices of prediction. However, the direct link between monitored microclimatic and environmental conditions with the subjective evaluation of the user experience has not been developed sufficiently to provide user-specific solutions in outdoor public spaces.

While walking in the city and using outdoor urban spaces, the thermal and sensory state of users play an essential role in human behaviour, social interaction and economic vitality of the place, providing rational grounds for knowledge and action. Traditionally, different scientific disciplines (such as architecture, sociology, psychology, urban studies, psychogeography) have understood the thermal and sensory comfort as separate channels for collection of information about environmental quality. Recently, it has become clear that a multi-sensory process is necessary in order to gather knowledge and evaluate users' state of urban comfort and satisfaction when using outdoor spaces. The paper presents a new research project that studies in depth the dynamic thermal and sensory comfort of pedestrians using outdoor spaces. The innovation of the project lies in identifying how outdoor thermal and sensory studies are currently used by architectural

and consultancy practices to develop an urban project from conception to construction and to evaluate post-construction urban environment conditions. The link between the evaluation and monitoring of environmental quality and sensory comfort with the urban design process for outdoor public spaces is based on two main strands: the first being a critical review of existing information (grey literature) with the aim to create a database on the input of sensory comfort data in the design process of architectural practices, and the second being a series of surveys, sensory walks (Vasilikou, 2016) and consultations with a network of different audiences that take part in the design process, bringing together the designer's and user's perspective for the same outdoor space based on data collection. The present paper will focus on analysing the methodological approach used to identify gaps in the design process that relate with user experience and affordances of outdoor public spaces and to create a conception tool for including thermal and sensory comfort studies in urban and environmental design processes.

8. Virtual reality and EEG: Affective intensities in the virtual realm

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Virtual reality (VR) is becoming more integrated with our everyday life. Forbes Magazine heralded 2016 as the year that launched VR for the everyday user (Ewalt, 2016). VR is an emerging technology that can potentially have multiple applications. We have tested this claim for Virtual Reality in two small pilot projects. The projects combine portable EEG (electroencephalography) technology with a head mounted VR display (HMD). Our aim was to explore the generation of emotional experiences in virtual reality spaces. We adopt the notion that VR is an "affective medium" (Riva et al., 2007). We investigate links between geometrical, lighting and sonic parameters of the virtual space to the users' affective responses. We claim that VR in combination with EEG could help architects understand better the emotional impact spaces have on their users.

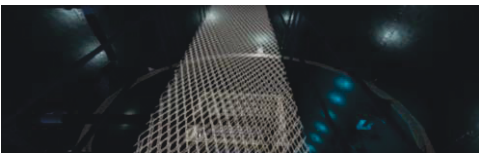
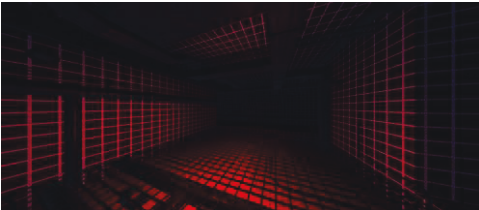
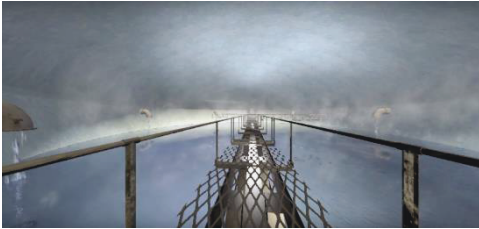
Experiments have shown that VR can engender particular emotional responses from the users (Riva et al., 2007). Responses in the VR environment are comparable to responses to sensory stimuli in the everyday lifeworld (Slater et al., 1996). When intense emotions are generated in VR, the sense of engagement with VR is stronger (Riva et al., 2007).

VR has been used together with wireless EEG technology (Török et al., 2014) in psychology, in studies of human perception and cognition (Moussaoui et al., 2007). However, these studies focus on everyday offline environments.

We take a more exploratory approach based on the view that VR offers the opportunity for users to experience exciting, novel, and unfamiliar environments (Morie, 2006). More specifically, we experimented with two Virtual Reality environments. The first was a simple space consisting of a long, concrete, dark and confined corridor that led to an open, green space. We intended that the two spaces, the corridor and the green space, would be perceived by the VR user as offering spaces of highly contrasted character (confined versus open). We examine how transitioning from the corridor to the green space affects the

emotional responses of the users. In order to record intense affective responses from the users we designed a second experiment with two VR environments in which the users transit through more complex spaces with imaginative, unfamiliar and exaggerated geometrical and atmospheric qualities. For instance, we encouraged teams of designers (students) to produce game-like spaces with widely varying lighting conditions, building scales, sonic qualities and vertiginous and claustrophobic architectures. The spaces they produced could be characterised as futuristic and dystopian.

Some representative snapshots of the environments in Virtual Reality



Architecture is formed in the transition between different atmospheres (Wigley, 1998). These spatial transitions generate a sense of expectation from the user navigating from one space to the other, which itself generates an affective threshold. Our intention in this second experiment was to evoke a sense of vertigo. According to French sociologist Roger Caillois (1961, p.23) vertigo puts a user into an unsettling state where perception is disrupted for a very short time.



Participant wearing the HMD VR and portable EEG headset

Our setup includes an HMD VR, a portable EEG headset and a pair of headphones. Users were immersed in a VR environment while their neural data was recorded and labeled with affective tags. We used Unity3D, C sharp and JavaScript to create a platform that interfaced positions and movements in VR spaces with EEG recordings. Second, we attempted to use the affective data in real time to alter certain architectural parameters of the spaces such as scale, height, lighting, and acoustic quality, in order to generate positive or negative valences by counteracting the user's affective state or intensifying the state they were in already. Based on theories of tuning, we examine this dynamic calibration between the space and the user (Coyne, 2010, 2016). We will present some of our pilot affective data in this paper.

We ran pilot experiments with both environments (the concrete corridor and the futuristic game world), which involved 42 subjects in total (29 for the first experiment and 13 for the second). The experimental participants were undergraduate and postgraduate students at the University of Edinburgh who volunteered to take part in our research. Their ages spanned from 18 to 25 years old with the exception of two participants who were older. The research did not examine gender differences, and both male and female students were involved. The protocol of our experiments was as follows. We first described the procedure and explained the technology used to the participants. We then helped the participants put on the gear which included a portable commercial EEG headset, a VR headset, earphones and a pair of noise cancellation headphones. The subjects were exposed to a commercial demo VR environment to familiarize them with the Virtual Reality technology and the first-person movement experience. We then gave them instructions on how to navigate the space and what their goal was.

The users were free to navigate the VR environments. In the first, simpler VR experiment (with the concrete corridor), we later added a simple task of finding an object. That VR environment was simple and somewhat monotonous, so having a goal helped the participants to avoid wandering in the space indefinitely and ending up feeling nauseated due to VR sickness. The experiments were not time restricted and the amount of time spent in the environments depended on the user. The average time spent was estimated at 10 to 15 minutes. We set spatial and temporal markers in the virtual environment that helped us understand the way the users navigated in the space and register their emotional responses at particular locations of interest. After their engagement with the VR environment, we asked the participants to answer a questionnaire with questions based on their VR experience.

With the potential that VR provides for immersive 3D architectural representation, VR is emerging as a new enhanced tool for the evaluation of architectural design proposals (PR Newswire, 2014; Sheng et al., 2011; Academy of Neuroscience for Architecture, 2013; Drettakis et. al., 2007, Mobach, 2008; Taewoo, H and Yong-Ho, 2013). Portable EEG technology has been used successfully to measure emotions in virtual reality environments (Rodríguez et. al., 2013 and Academy of Neuroscience for Architecture, 2013). Neuroscience can help architects understand better the effect that environmental stimuli have on the users (Eberhard, 2003; Edelstein and Macagno, 2012).

Our findings indicated variation in the emotional responses of the users while they navigated through the various VR spaces. At a first glance, we have noted some similar tendencies in the emotional responses among different participants for the same VR environments. We also observed in some cases what appears to be an emotional shift

during the moments that one passed through a spatial threshold, particularly where such transitions are between spaces of contrasting character. We adopt theories of environmental psychology, emotion, psychophysics and psychoacoustics, in order to interpret the affective data we retrieved and correlate them to the spatial and atmospheric qualities of the VR environments.

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9. “New” natural materials

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Semantic surfaces

Perfect imitation of nature is frequent in contemporary range of materials and surfaces for architecture and interiors. Natural effect finishes record high sales, despite criticism from architects and designer, especially due to a hundred-year-old ethic debate on definition of “honest” materials, widely supported by Modern Architecture cultural heritage and in particular by the moral influence of Adolf Loos writings on ornament.

On the other hand, market and users do not feel the urgent need to find direct correspondence between the semantic qualities and the actual structure of materials, as it was normal in the near past. The natural “look” nowadays, conveys the feeling of a sustainable beauty, with a somewhat looser link between external aspect and constituent material, given the mastery of modern design and technology to reproduce natural materials.

The concept itself of authenticity seems to be questioned and expresses an intellectual orientation, often subjective, while the widespread preference for the so-called natural materials is mainly based on their aesthetic and sensorial superiority.

Neuroscience – through experimental evidence – could investigate the reaction of our neurocognitive system to the perception of natural versus “in imitation” materials in different conditions.

As said above, production and sales state a higher preference for products that reproduce wood and stone in primis, but many other example could be named. Thanks to digital technologies aesthetic features of artificial materials can perfectly mimic those of natural

ones and in the most recent industrial products they include also some “imperfections” and a number of different veins, textures and patterns (within the same product) that give them a “casual look” even more precisely delineated than that we can find in the original ones, a sort of ideal identikit of the very essence of the material that they intend to mimic.

The mood for wood

The present project suggests an unreleased series of experiments - to be done in laboratory - that consist in recording and comparing brain reaction in selected groups of people that look and touch real WOOD surfaces and their imitative artificial reproduction.

In general terms, some sets of scientific experiments would be done in order to observe the human brain reaction when exposed to hedonic perception of natural wood and wood perfectly reproduced in laminates and ceramics. During data recording participants are asked to observe and evaluate along visual analogue scales the characteristics of finished surfaces and material samples. Experiments would be important to test the response in case the participants DO NOT know whether the wood “effect” is genuine or an imitative industrial product. Finally other sets are to be repeated after participants get accurately taught about precipuo and intrinsic features of material samples used during testing.

In particular, the series of experiments is to be developed in:

EXPERIMENT 1

First experiment explores the reaction of participants to the vision of real WOOD samples (e.g. boards for floorings or walls finishes) where WOOD is used to build up the scene. Constituent materials are either “artificial” (laminates and ceramic) or “natural” (e.g. solid wood and veneers). Thus, their exterior aspect is either “artificial” or “natural” and visual stimuli are either “surfaces” (e.g. a floor) or “objects” (e.g. sample of wood).

The experiment is repeated in two groups of 25 participants: naïve and experts. This gives rise to a 2x2x2(x2) mixed factorial design (group: between, all other factors within).

Wood surfaces and boards are presented continuously for 30 seconds, during which Skin conductance response (SCR) is continuously recorded. At the end of the 30 seconds participants receive a signal indicating which type of material they are looking at (natural/artificial), while SCR is recorded.

Hypothesis: the mismatch between the feeling given by the visual object and the knowledge about its constituent material gives rise to increased level of SCR. An opposite pattern is expected for “experts”.

EXPERIMENT 2

Equal to Exp 1, but now the information about the constituent material of the visual stimulus are given by tactile manual exploration of a real surface (Crossmodal matching).

EXPERIMENT 3

Procedure is identical to Exp 1, but now the information about constituent material is given before the actual visual stimulation. An opposite pattern is expected for “experts”.

Hypothesis: The fluctuation of SCR may be reduced in the mismatch situation, given a higher level of arousal in the mismatch situation.

EXPERIMENT 4

Equal to Exp 1 and Exp 2, but now participants are presented only artificial wood samples in two different conditions:

- 1) they know it's a "fake" artificial material;
- 2) they don't know it's a "fake" artificial material.

Test sessions are both focused on visual and tactile perception. Normally wood (but the same could be repeated with stone) is associated to a specific touch feel given by texture and, even more precisely, by surface temperature. In the case of wood, latest imitative products are getting very close to original ones, not only laminates, but also in ceramic by special superficial finishes that give warmer touch effects. No significant innovation has been done for the typical wood smell yet, although even industrial "real" wood furniture and parquet flooring have largely missed this characteristic that can still be found only in handicraft limited productions. Nevertheless, further experimental investigations should include smell and acoustic tests.

In general terms, these tests record neural activity in different sensorial situations in groups that are aware of the nature of wood samples and again repeated without providing any clue/information on actual composition. Common people (naïve) and experts (architects, designer, manufacturers) groups are finally to be separately tested and compared. It is of great importance to repeat testing with distinguished groups sharing similar cultural background in order to value the influence of a specific expertise and previous experience. As said above common users and architects express different attitudes towards real or imitative materials: people preferences seems not to mirror conceptual idealization shared by designers community. Nevertheless all humans show a general common positive value in the natural "look and feel" of wooden surfaces, with no socio-cultural distinction or geographical borders. Love for wood seems to be a kind of universal feeling.

Research activity and experiments are conducted in cooperation with Prof. Angelo Maravita and Dr. Alberto Gallace, members of the Psychology Department at Università degli Studi di Milano – Bicocca.

Primitive or primordial?

Metal, glass, plastic and industrial products in general are relatively recent invention, but stone and wood are part of human experience (both in landscape and in tools) since ancestral times. Moreover, the perceived beauty of natural materials has no peculiar geographic location but can be observed in a worldwide scale and cannot be deputed to a merely functional need although they are a true expression of an ancestral stringent reliance of humanity from natural sources. Philosopher Carlo Sini noticed that " what we name 'nature', what is 'natural' for us from time to time, is nothing but the reflection of the social organization of homo faber: a man that fabricates living practices of language and knowledge, in which he summed up gradually his being sapiens; homo sapiens is the inhabitant and also the product of his technique". In his "La materia delle cose. Filosofia

e scienza dei materiali”, the philosopher describes human body, in practical experience, as a tool, as a mean, as a material for the action (hence, the first material of history).

When we observe natural materials and their surfaces we also see the traces left by processes that transformed them in tools or decorative finishes. These surfaces are not to be assimilated to untouched nature because they always show human action to transform them. Veins, patterns, textures are always the outcome of a combination of organic characteristics and human purposeful action. Passion for natural materials may be referred to the eternal symbiosis with nature as well as to the ancestral actions to adapt environment to our elementary needs for survival. Imitative materials don't actually recall only nature but also the processes that humanity developed to transform them.

Furthermore imitative materials don't overshadow interest for natural ones, that obviously have limited availability, performance restrictions and often higher prices. On the contrary, many of them have been rediscovered in the last few years, like natural stones, a booming business, with new processes that allow greater versatility to match a more “natural” aesthetic effect. New technologies multiply the choice of finishes and innovative superficial treatments control even the color tone. Matt effect, silk, satin, these are just some of the new sensual words that companies are using to identify commercial products. Again technical innovation goes in the direction to stress visual roughness (although with a soft touch) and different shading colors.

The so called “natural” feel has become a new “category “ of the senses and today it is used to describe an aesthetic trend. “New natural materials” can be described by (1) uneven, (2) slightly rough surfaces with (3) muted colors and tones inspired by the landscape. With little surprise these features belong to nature-made materials as well as industrial-made imitative ones. From a merely sensorial point of view, we are witnessing the reformulation – maybe the cancellation - of the already tenuous distinction between natural and artificial materials, which now refers to the expressive characteristics, rather than the substance of the materials.

Are these features enough to define the essence of “natural” with reference to our sensorial system? “Natural” is synonymous of a range of very well defined visual and tactile features. Can we consider them a universal stimuli that meets a dedicated sensitiveness or even a pre-set neural system area? And also can we regard natural materials – or their features – as a universal canon of beauty?

In the last ten years a relevant knowledge has flourished from studies that put attention to idealization of beauty in relation to art, music and literature, precisely identified by the neologism Neuroesthetic, a sub-discipline of empirical aesthetics, pioneered by Vilayanur S. Ramachandran and Semir Zeki. Today interest is extended to human spaces and architecture with a special focus on perception. A deeper knowledge of perception mechanisms can get advantage from scientific research by experimental investigation. To produce remarkable results, this activity has to take in utmost consideration the cultural strong connection with design culture. Principles that guide architectural design apparently depend on cultural and technological issues, nevertheless scientific research open new possibilities to tune future spaces on biological needs and mechanisms, which doesn't mean that a new method or formal language should be derived directly from biology. An unprecedented chance is given to architects to design spaces and their materic features also by distinguishing inner needs by temporary trends. Certainly materials

industry can get advance from these studies, if properly understood and meaningfully interpreted.

Natural materials and surfaces evoke a specific sensorial and semantic feed-back that suggests they could be associated to dedicated biological structures but there's no scientific evidence that proves they are triggers of any kind of human brain pre-set organization, despite empirical observation of a "universal" positive valuation. Data record and classification is the first step of research, not to be confused with the postulate itself. A theoretical schema (if necessary) may be the subsequent output of further studies. Nevertheless one of the major problems of this possible innate knowing is that sensory inputs remain without meaning if not executed in a parallel construction of form and significance.

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10. Sustaining National Identity: Past traditions and their place in contemporary residential design in Dubai

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Dubai is one of the Arab cities that have been developed over an incredibly short period of time from fishing town to global metropolis. One of the most used statements about Dubai is its lack of cultural identity or cultural homogenization. With this amount of dispersion and short history to Dubai (UAE) one questions the impact the statistic (expat 84%) is having on the local (16%) with particular focus on residential design.

Traditional architecture in the UAE was influenced by lifestyle, customs, the environment and limited building materials. Traditional elements are secondary after 1970 when oil was discovered and the population jumped three fold in ten years.

This paper will focus on past architectural and interior spatial planning traditions, common to the Middle East and consider their place in the contemporary residential environment in Dubai. The purpose of the study is to find a way to create a long lasting authentic experience within residential design for all. The value of tradition within an urban context must not be mistaken, this identity is often one that has evolved over centuries and can play a major role in stabilizing group identities. There is little concern with the true or honest nature of the term tradition for this research, rather the idea of what is tradition to people within the UAE. That could refer to materials, colours, layout, wind towers, proximity of buildings to each other and the courtyard for example.

In current day Dubai there are few surviving examples of traditional neighbourhoods, most have been demolished, making way for predominantly western style residencies. What these older developments demonstrate is housing that comes from a traditional background, it is more flexible and humanistic in scale. These neighbourhoods are now engulfed within an area of Dubai that are impoverished. The local Emiratis have moved out and into the more modern villas, often much larger in scale and very grand. Mapping of the human experience in the traditional quarters of Dubai, often known as Emirati National Housing will be undertaken as a means to understanding the value that tradition plays. Then a further three types of case study would be selected at different stages. One of the communities Maqam, Al Ain, is a well established community this would be used as a case study to understand the importance of tradition from a historical residential context. For current case studies Abu Dhabi have several developments specifically for Emiratis such as Al Falah, Watani, Ain Al Fyda and Silaa which are all currently inhabited. They all offer 'traditional' aspects. As part of Dubai's 2020 plan some 20,000 Emirati houses are being developed as part of the Dessert Rose project. This development will also include 10,000 low income houses for expats. This case study would be used as an example of combined local and expat together.

Cognitive research strategies would be used to understand the importance of tradition as a visual tool in contemporary residential context as, the human brain does not treat the senses equally it leans towards vision. There is proof the ecological, architectural, society and cultural environment in which we live, has impacts on us in the way we behave, feel, communicate and interactive. Mapping between the traditional and contemporary residential case studies will be observed in order to evaluate residents' behaviour and emotion.

If we look to past cognitive approaches used to measure the environment, we can see that there are several main areas of exploration they are: environmental perception, privacy, territoriality, personalization and way finding.

Using these categories as a focus point a combination of theoretical and measured research would be at the base of this research. Research would be focused on the residents of the case studies, to observe their understanding of tradition. Observation of behaviour and reaction to the environment (considering how people use space, navigate or change it), analysis of plans and architectural information and environmental perception (what do residents perceive of importance) would be considered. Techniques

like visual stimuli for example, can give insights to aspects of social values, materials and architectural details.

This would be a unique opportunity to offer current academic thinking with scientific methods to enable a comprehensive study into the value of tradition within an advancing Gulf state.

11. MANOAJE(1): a proposal to re-found the “language” of “architectural thinking”

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ABSTRACT

This research explores the problem of the nonexistence and need of an operational and integral definition of “language” in the field of re-presentation in architecture, despite the widespread and historic use and tacit validation of ‘drawing’ and ‘modelling’ as such, both in academic environments and in professional practice.

KEY WORDS

Architectural thinking, Language, Grafoaje, Manoaje, Cognition, Enaction, Sensorimotor Intelligence, Architectural intelligence, Thought, Representation, Drawing, Modelling

In addition, the study and the set up of architectural re-presentation have been made through many of loans —rather impositions— categorical, procedural, structural and conceptual, accruing from linguistics and from the 'General Theory of Signs' (De Saussure and S. Peirce). In other words, architectural re-presentation has been studied in an imprecise way, treating it as a language and/or operating it on highly poetic metaphors ("thinking with hands", "conceptual space" and "reading buildings" are three examples). This question has generated profound and incalculable categorical, procedural, structural and conceptual slants and blindness, hindering and/or directly impeding the development of an epistemological and/or an integral theory of architectural re-presentation. This also has many practical effects, for example in the field of teaching. If we consider the link in the language-mind-thought-cognition-learning polynomial and literally transpose it into drawing-mind-thought-cognition-learning polynomial, on the automatic and unthinking assumption that such a nexus operates in the same way, we are not investigating the existing differences and different evidences, practices and theories, which have been shown since the last century.

The research reviews from different perspectives the common metaphor of "thinking with the hands". This concept is reviewed through the critical differences (psychological, neurological, cognitive, linguistic, sensory, among others) between “thinking”, based on the agitation of single organs/limbs (like the tongue during speech), or “thinking”, based on the agitation of dual organs/limbs (like the hands while drawing or modeling). For this purpose it is also necessary to reconsider the pertinence of the common use of the concept of ‘thinking’, instead of the concept of ‘intelligence’ (Piaget, Wilson) in projective practices.

Methodologically, this work summarizes a field research with documental character and generalist tone. It seeks to link to each other topics that have been studied in depth in different disciplines, but which continue to be not connected among them, in part because of the disciplinary splitting and/or impurities based on generalizations and/or conceptual inaccuracies. From this point of view, this paper examines the problem of the partial incompatibility of language (and Maturana's 'lenguajear' (2)) as a support of thought, learning and human cognition, in general (Wittgenstein Piaget, Vygotski, Chomsky, Sapir, Bruner, and others) with the particular mental processing inherent to "architectural thinking" (Sperry, Edwards, Seguí, Zumthor, Pallasmaa, Bruner, and others). This "architectural thinking" is based on the visual thinking/ visuospatial thinking (Arnheim, Letelier and others), sensorimotor intelligence (to Piaget, spatial intelligence and cenestésico-corporal, to Gardner) and hand use (Wilson, Bell, Bergen, Sacks, Seguí, Pallasmaa and others) specific to the "enactive knowledge" (Bruner, Varela) involved in projective practices and architectural re-presentations.

The underlying hypothesis of this research assumes that '«manoaje» is a homologous neologism to "language"(3), but argued on the basis that in-tensional making with the hands, is the material base of "architectural thinking", and is also responsible for the project configuration by means of the architectural work' (CÁRCAMO PINO, 2013). In other words '«if for an adult human being language is the material base of thought» (ITZIGSOHN, 1995), for architects, manoaje is the material base of "architectural thinking" [and redefined architectural intelligence]' (CÁRCAMO PINO, 2013).

As described above it is done by reviewing first; The structural logic of language from its historical material support (the tongue as a unitary organ); Through the constitutive structure of the same (additive sound sequences with signifiers, meanings, syntax); By the conditioning relationship that keeps the language with the thought and its effects on the learning (material base of the thought and cognitive conditioner); And by the way, introducing itself into the dynamics of thought and the way of cerebral processing involved (Aspectuality, discreteness, sequentiality, opposition, hierarchy)

Secondly, disciplinary practices and processes are characterized (projective drift and recursive testing), the pedagogical tradition of the workshop (lab) (solving problems via test and error, e.g.) and the means of architectural re-presentation (drawing, model, assembly, diorama, among others) distinguishing between representation, presentation, prefiguration and preformation, to make a counterpoint among them with the logics of thought (verbal) and their procedural corollaries (method, process, systems and others), learning and cognition described above.

This demonstrates the inadequacy of natural language, verbal thinking involved and, in short, all verbal cognitive mode to operate aspects of the projective practices in architecture, mainly in the aspects linked to the production of form and figure, operations of qualitative integration (like composition, harmony, balance, tension) and spatial mental imagery. This scenario is reviewed, this time, from: The use of the hands (Wilson, Bell, Bergen, Sacks, Seguí, Pallasmaa), The cerebral functional specialization (Sperry, Edwards, Wilson, Bergen, Rizzolatti among others); The incarnate simulation (Bergen, Rizzolatti, among others); Intelligence (Piaget, Wilson, Gardner, Goleman, among others) and learning (Piaget, Vygotsky, Bruner, Varela)

Thirdly and founded on the dissonance mentioned above, it is established that it is necessary to re-found conceptually a "language" proper to the discipline, endorsing and proposing the concept "Manoaje". This concept is considered as a generalization of the «grafoaje» coined by Perez Carabias in his text «grafoaje and creativity»: an ad hoc "language" that «aids urban designers, architects, industrial, graphic, and interior designers; and also sculptors, painters and sketchers, in the mental processes of handling space, form or figure (spatial mental imagery)» (PÉREZ CARABIAS, 2006). The previous expansion and/or generalization of the work of Carabias seeks to extend its scope, extending it beyond the graphic and, directly, incorporating the manipulation of physical objects as an enactive experience that integrally includes the extra-graphic and non-linguistic means of the architectural re-presentation.

Finally, the discussion focuses on possible consequences that may arise from the conceptual redefinition made, and from the ex novo neologism «manoaje». From this perspective, and considering the operational characteristics that this neologism sets, this research explains the utility of this epistemological exercise to approach and to specify countless issues that persist in the academic and disciplinary work even today.

- (1) *The concept of Manoaje is conceived as an integral definition of "language" of architectural re-presentation, which encompasses drawing, model and assembly, among other presentations. Is a «Homologous neologism to language but with hands. Based on the intentional agitation of hands and the impact this has on matter to communicate or self communicate (to "reflect"). Although, in strict definition, it is not a language, manoaje frees the "language" of the semantic weight that the noun «tongue» imposes ("tongue" is "lengua" in Spanish), keeping only the essential condition of the "set of signals that suggest something" (RAE, 2012), certainly with the substantive differences this implies, even in the definition of the communicating something» (CÁRCAMO PINO, 2013). It is the generalization of grafoaje, understood as «[...] the system of signs for the representation of threedimensionality, that aids urban designers, architects, industrial, graphic, and interior designers; and also sculptors, painters and sketchers, in the mental processes of handling space, form or figure (spatial mental imagery)» (PÉREZ CARABIAS, 2006).*
- (2) *Neologism that refers to the act of being in the language, without associating such an act with speech, as it would be with the word speak" (MATURANA, 1989)*
- (3) *In Spanish the word "lenguaje" (language) and the word "lengua" (tongue) share the same Latin root: "lingua". Therefore, in the neologism "manoaje", the word "mano" (hand) replaces the Latin root word "lingua" (tongue).*

12. HeartMade: design installation for an embodied algorithmic design experience

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The dominance of computational algorithms in architectural design and their use in interactive design practices have changed the understanding space-time relations remarkably. Right now, there is a new paradigm that we discuss form-related issues in architectural design under spatiotemporality. In this regard, an architectural form no longer stands for a matter of existing probabilities; on the contrary, it stands for never-ending possibilities in experience. Thus, the role of experience and its affective role in computational design practices need to be reconsidered thoroughly, so that new design techniques and technologies could be developed to enhance the meaning of form in computational design. In fact, one of the appropriate research field for these reconsiderations is called embodied or enactive cognition. Simply, embodied cognition is a research program where the philosophy meets science in terms of mind-body relations in cognitive approaches (Gallagher, 2014). In particular, it is a research program that discusses the phenomenological aspects of body-mind relations in a scientific way neurophenomenology. Therefore, as part of an ongoing research in neurophenomenology and design, we reexamine the embodied algorithmic design experience under a neurophenomenological framework.

So far, form-related issues in algorithmic computation have been criticized for not being affective enough as opposed to analog or traditional design approaches. When it comes to the first-person experience or pure affects of design compositions, the algorithmic computing, and its environment have not considered as effective as traditional design approaches for a long time. However, with its complementary tools and technologies, algorithmic computing allows us to embed the first-person data in design process like none of the analog approaches do. Without a third-person data, the physiological outcome of experience, and affects can be directly linked or related to the computational design process. In this paper, we offer to reinterpret an embodied algorithmic experience from a neurophenomenological perspective. For that, we discuss the phenomenological aspects of an embodied design experience and conduct it with a neurophenomenological interpretation of an exemplary work called "HeartMade."

HeartMade is a preliminary work of an ongoing design-based research and an interactive installation designed to be exhibited in the Academic Work section of IKSU 3rd Istanbul Design Biennial, 2016. Although the initial idea behind this installation was to create an awareness of spatiotemporality for a participant in design experience, this paper focuses on the phenomenological side of its experience. One of the most influential thinkers of architecture, Juhani Pallasmaa posits that "we experience a work of art or architecture through our embodied existence and capacity of projection and identification" (Pallasmaa, 2009: p.133). When he affiliates architecture with lived-experience, he says "architecture does not invent meaning; it can move us only if it is capable of touching something already buried deep in our embodied memories... The art form of architecture mediates and evokes existential feelings and sensations" (Pallasmaa, 2009: p.136).

Referring to his phenomenological view on architecture, HeartMade is exemplified to emphasize that an embodied algorithmic design process leads to a new way to understand phenomenological aspects of form or composition. The set-up of this interactive installation includes a webcam to recognize participant's movement, a pulse sensor, and a micro-controller dev board to collect and convert the pulse rate into a design parameter (RGB color code), so that the design process would involve both a conscious parameter (bodily action) and an unconscious parameter (pulse-rate) of a human body. With this installation, participants were able to create different 2D compositions of their spatiotemporal experience. As they moved with the pulse sensor in front of a webcam, they were able to create patterns in with different colors; and the colors of these patterns were dependent on their pulse rate.

During the exhibition, I had a chance to discuss our work with different kind of participants (from senior to junior designers). From all the observations and discussions, I realized that assigning a specific color code for the pulse rate of a participant, made it easy to recognize when the participant referred to his/her lived-experience. So, as a next step, I aim to use the same installation on a particular designer to examine his/her design engagement and look for the traces of her lived-experience in the design decision-making process. With that, I will reinterpret the first-person experience and its neurophenomenological aspects on an algorithmic design experience.

keywords: embodied cognition, phenomenology, algorithmic design experience, Arduino

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13. Indra's Net of Things

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I could be bounded in a nutshell and count myself a king of infinite space...

Shakespeare, Hamlet II, 2

Far away in the heavenly abode of the great god Indra, there is a wonderful net which has been hung by some cunning artificer in such a manner that it stretches out infinitely in all directions. In accordance with the extravagant tastes of deities, the artificer has hung a single glittering jewel in each "eye" of the net, and since the net itself is infinite in dimension, so are the jewels, and their reflections, are infinite in number.

Avatamsaka Sutra of the Chinese Huayan school 5th Cent AD

A new shape for the new millennium?

Human life is nurtured and born into a finite world which is enveloped by surfaces; as if as a defence against the infinite space that both lures and threatens its very existence. As sociologist Bruno Latour paraphrases it, Sloterdijk's contention is, "to define humans is to define the envelopes, the life support systems, the Umwelt that makes it possible for them to breathe." Buckminster Fuller's geodesic domes may be arguably, the shape that could be used for representing last century's predicaments as well as solve multitude of its problems. Our century has started with multiple revolutionary technologies that bring with them both the perils and promises. How can we extend Bucky's spatial wisdom and geometric intuition to define, even, embellish today's situation? This paper will extend a possible scenario, which is common at the nanoscale; that can be applied in our own world and, which can augment our reality, or create a cyber or a virtual world with immediate consequences for our daily lives.

I propose to explore an uncharted possibility for creating space. Space has always fascinated and inspired thinkers and artists alike; they aspire for a new geometric order as a conceptualizing tool. In this presentation, I would like to share a fascinating twist to one of the most popular applications in geometry, i.e., tessellations. Two dimensional tessellations display a net that has all angles meeting at each vertex adding to exactly 360 degrees. Interestingly, almost all forms developed in the history of mankind are convex, i.e., they are bounded by a surface that negotiates the limits of their finite volumes against the expansive infinite space -- very much like the skin where our finite body ends and the infinite begins. If we unfold the volume of a convex form, we get a two-dimensional net wherein the sum of all the angles at a vertex will be always less than 360 degrees.

For many years, I have been working with my colleagues at the CEPT University to develop more than a dozen, alternative two-dimensional nets which are like the unfolding of a surface: i.e., they have uniform angles at each vertex that always add to more than 360 degrees. When we fold these unusual 3D nets, they create sponge-like forms with the most fascinating properties. These forms have a set of two independent, interwoven 3D spaces

of infinite magnitude that never intersect and are separated by a single surface which has a negative curve. I call these configurations Indra's Net of Things©. We can draw inspiration from the micro-molecular structure of Clathrates (chemical substances containing a lattice that traps or contains molecules). Some of the deposits of clathrates contain around 6.4 trillion (6.4×10^{12}) tonnes of methane is trapped on the deep ocean floor. Their molecular structure is primarily based on one of the configuration of Indra's Net. Interestingly, millions of forms of Zeolites used for filtering also have the same configuration; for the same reasons—to be able to process the content, enveloped by a maximum surface in a minimum volume. Here we can again usefully introduce Sloterdijk's philosophic concept of Spheres.

BioLogic basis of Morphology:

Peter Sloterdijk elaborates the concept of being-with, after Heidegger's Dasein, to suggest an always being-with- another, which entails the existence of a dwelling that has been built and in which we are enclosed. In Sloterdijk's theory of spheres users produce small envelopes or micro- spheres. As an alternative to the single globe environments of early cultures, Sloterdijk advocates a plural-spherology where co-subjective bubbles live together simultaneously and create what he defines as foam. This implosion of the solitary globe into a foam made up of multi-chamber systems, whose cells are separated by a thin membrane, allow exchange through osmosis. Bruno Latour complements Sloterdijk's Spheres with his concept of Networks. Together, the networks describe long-distance and unexpected connections starting from local points, and spheres designate local, fragile, and complex "atmospheric conditions."

In nature, some structures or organs found at Nano-scales require a very large surface-to-volume ratio—i.e., lungs, jelly, filters and some inorganic molecules. Many organic substances with Bucky balls in their molecular structure are able to perform their extraordinary tasks because of their unique morphological properties. Some of these specimens had travelled to earth on extra-terrestrial meteorites and they also might have contributed to the origin of life on the earth. I will show in particular the micro-structure of alveoli in lungs that also uses polyhedral maze with a negative curve in order to maximize contact of oxygen with the blood and for the extraction of impure CO₂. Using bio-mimicry we can apply these morphologic configurations for environmental control or architectonic experiences.

Spatialisation of Information Order:

The unusual double 3D-maze created in Indra's Net can also serve as a model for spatial design of Big Data for Navigation purposes or for the Graphic User Interface design for organising and spatialising information processing. The Geometric definition of complex 3D mazes will be ideal also for creating sets for movies or as background for video-games.

Prospects:

Thus, when we move from the familiar convex forms to these sponge-like forms, we traverse from Hamlet's claustrophobic universe to the Avatamsaka Sutra (both quoted in the epigrams at top), with a set of vast doubly infinite (sic) universe with as many possibilities.

Understandably, the unique configurations that make Indra's Net of Things© can have far reaching applications in many industries involving design in two, three or higher dimensions -- in graphics, interface design, architecture, infrastructure, entertainment, information design, pharmaceutical, petroleum, marketing, etc.

14. Making the Invisible Visible: Art Interventions that Examine the Future of Public Art

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The aim of this paper is to analyse the various types of 'Public Art' commissioned by the Arts Council in the UK. The proposal includes gathering information from an open source database created within a specified timeframe to produce a Virtual Reality visualisation in the form of an information graphic as a potential artwork for exhibition.

The objective of illustrating the range of contemporary artworks sited within the major cities of London, Glasgow, Manchester, Liverpool and Bristol is to reflect on the future use of public urban spaces in the UK. The outcome will produce a qualitative visual illustration from quantitative data, to be used by the Arts Council as a tool for public engagement and as an aid for arts organisations and councils immersed in the commissioning process. The work will be made available to the public and combine 'Google Earth VR' with 'Sketchfab' to enable visual access through 'Vive' headsets and VR room. The map could be further developed into a mobile app for an arts audience to use on site to locate and visit UK works of art.

The VR Map outcome will appeal to various disciplines, including architects and urban designers. The visualisation of data may reveal the multi-faced nature of public art and create a platform for further debate regarding its future. The data may be broken down into groupings that illustrate our cultural identities and values in society. The timeframe of works will initially be narrowed down to include only works installed within a 5yr period due to the big data size currently available. The VR Map could potentially include centuries of public art documenting a historical sculpture narrative of the UK.

Gaining further knowledge and an understanding of the spectrum of works that have been commissioned is also beneficial to artists engaged in public art practice. I am applying to the Arts Council to develop the project offering them and ComRes online surveys participation and collaboration. The Public Monuments and Sculpture Association have an ongoing National Recording Project and the VR Map could also subsequently be extended to include recent works held within their historical database. The 3D virtual reality map of the UK representing artworks located in urban environments will reveal how specific data visualisations can be used to analyse and assist organisations with public arts commissioning programmes. I am also collating the database to create a legend so that the viewer can make selections as to the criteria and interact with it. The data capture will ideally reveal the public art creator, organisation, nature, title of work, gender, ethnicity and age range.

The University of Central Lancashire data visualisation engineers, app developers and VR equipment are assisting with completing the proposal outcomes. A possible collaboration with the Bartlett School of Architecture, Smart Cities Research and the Centre for Advanced Spatial Analysis (CASA) University College London has also been established for further development.

The mapping process is a work in progress that will be continually updated to explore the relationship between 'Public Art and the Law'. As commissions are ongoing the critical issues presented will change over time, along with the many interventions of artists working in the public domain, encouraging critics and media organisations to evaluate their effectiveness. The VR mapping of artworks will form a platform for debate and act as an innovative method of communicating the many aspects of commissioning art projects. I do not believe that such a work has yet been created. A few public art apps exist mainly in the USA but none offering VR or 4D technology.

Websites currently documenting new public art commissions offer limited data capture, many have selected a single region or are representing a single organisation or council. The resulting spectrum of websites contain artworks that have not therefore been centralised into a single entity, the resulting scattered and often incomplete data is disparate and problematic for anyone gaining an overview of the arts in the UK. Internationally various cities have attempted to construct public art databases, but the enormity of the task must not be underestimated. Once collated however on the proposed VR map the statistical information will be easily broken down by the audience into specific areas of interest such as equality and diversity, density and descriptive nature of the art form.

The work supports allied interdisciplinary projects and provides an ideal teaching aid for schools, colleges and universities. The work aims not only to elevate the status and significance of public art, but also to disseminate the kinds of work that can be made, not only encompassing the permanent sculpture but also include the ephemeral temporary interventions that require recognition. The collaborations from the conference will hopefully provide a network of connections between additional art science projects and software development research. Stake-holder decision makers would benefit from the collaborative skills and expertise to explore the similarities and differences in city planning regulation globally.

The 'UK VR Public Art Map' could also be used as a place-making tool in that it acts as a rehearsal for the real 'practiced space', where artwork not yet installed can be visualised in advance for their appropriateness on site. The increase in local authority revenue generated from visitor tourist attractions appeals to councils, as the additional benefit to the locality is improved social well-being.

Whilst the phenomenological experience of space is difficult to reduce into statistical analysis, generating statistical interpretations as to the numerical incidence of similar artwork outcomes or a series of art events is possible. The prospect of using 3D visualisations within exhibitions conjures up a fresh method of engaging with a seemingly incomprehensible mass of data and the subject matter is an interesting aspect of VR technology in expanding the findings to new audiences.

15. Sensing the City: Mapping of Beirut Central District through Physiological Emotions

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Human response to architecture is usually based on subjective emotions. : I like that building, I hate this space; this room is so open, this office is oppressive. But something more nuanced is happening to elicit these responses. (Outcome of the 2014 conference of the Academy of Neuroscience for Architecture- ANFA by Berg N.) Neuroscientists have found that distinctive processes occur in our brains—consciously and subconsciously, cognitively and physiologically—from the moment we step into a space. These processes affect our emotions, our health, and even the development of memory. They argue that buildings can shape our brains. This paper raises a problematic of the sensory depreciation in spaces creating an environment for the future user that seems to be turning increasingly into a non-existent area, without a clear meaning, and affecting negatively on the user's emotions and behaviors. Our daily urban experiences are the creation of our perceptions and senses (Quercia, 2014), and the improvement the quality of these urban environment is considered essential requirement and been raised by several researches; Cedric Price, who proposed that “mental, physical and sensory well-being is required in our environment”, taking into consideration the full perceptual field related to our sensorial scale going beyond the visual dimension and introducing a new approach “the sensorial urbanism”. Although, sight was considered historically as an important dimension in urban planning of cities for Lynch “Nearly every sense is in operation, and the image is the composite of them all” (Lynch, 1960) and for Kraiser “visual quality may be the most important influence on how people experience and respond to urban areas and planning initiatives” (Kaiser et al. 1995), but considerable number of architects extended their interests towards the complete sensorial experience introducing the sound, smell, touch aspects in their designs. “There is too much visual noise in our environment for me,” remarked Peter Eisenman.

The aim is to accentuate on the linkage between the architecture and neurosciences, by identifying the new paradigms in studies introduced by different researchers, aiming to develop a new track in the creation of architectural spaces that support a better human life, focusing in the urban areas and taking Beirut the capital of Lebanon, specifically its BCD- Beirut Central District the “vibrant financial, commercial, and administrative hub of the country “as a case study. It was selected due to its importance, hosting the Lebanese Parliament, the Lebanese Government headquarters, the Beirut Stock Exchange, the regional offices of the United Nations, International Labour Organization, UNESCO, and World Bank, as well as the headquarters of the ESCWA and the Union of Arab Banks; and for its history, where it faced a reconstruction phase that started in 1990 by Solidere after the devastation that occurred caused by the Lebanese Civil War. For Libeskind, it takes a long time for a public space to shape itself. No matter how sad, how tragic a site might be, how abused by history, architecture has the notion of a future. In great cities, the great buildings tell you things you don't know and remember things which you've forgotten. Architecture is the biggest unwritten document of history. (Libeskind, 2015). Towards more sustainable society in a city that will focuses on people's emotions rather than other

factors to acquire better well-being. It emphasizes on the influence of the built environment and its fabric on the human through investigating a relationship between his senses, his emotions in a specific location. Each place or spot in the city has a significant influence on how habitats, visitors, tourists, feel and behave. The methodology used in this paper consist of mapping and recording participants senses and emotions, while walking in a specific path, identified by the researcher, passing through different landmarks in the BCD, in a particular timing of a day, and in a duration that will not exceed 30 minutes. Therefore, the studied area or path will be assessed on two levels: sensorial and emotional, where the evaluation of the last one is an essential, by processing the sensory input data that will enables us to recognize objects in our surrounding. For the first level, the city identity will be evaluated by its visual aspects, smell and soundscapes; where in the second, an emotional analysis (positive and negative emotions) will be the outcome, by specifying the stress level, belonging and attachment to the surrounding, and other criteria to be identified later by the researcher.

The volunteers were selected, 15 females and 15 males, from Beirut, having an age range between 18 and 30 years, (the selection criteria will be mentioned in the complete paper), in order to complete a questionnaire mentioning their sensations and emotions while perceiving and moving along the specified path of the study, recorded by each participant for reliability of data, using the mobile application "My tracks" and by photographs. The recordings or data collected will have both qualities: subjective and objective.

The overlaying between the sensorial and the emotional layers will give a new type of mapping for BCD and an assessment of the presented built environment situation through humans, plotting the different analyzed spots, highlighting on the stimulated sense in each area and showing emotions recorded.

This can give the architects, landscapers & urban designers a full image of the human experience in that area in order to in order to integrate the people's feedback into the urban planning, by the identification of livable areas and set future plans to develop the areas that miss a specific identity. Furthermore, this map will be a useful guide for people visiting this urban area with a new target in experiencing it, not only visiting its remarkable architectural landmarks to see them, but feeling the whole environmental surrounding through their senses, their body and their interactions. As Juhani Pallasmaa wrote in his book "The eyes of the Skin, 2005", Architecture is the art of reconciliation between us and the world, and this mediation takes place through the senses.

keywords: urban space, neurosciences, emotions, senses, monitoring tools

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16. The User Factor: Understanding the Impact of Working Environment on User Performance and Wellbeing

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Arup – Our Vision for collaborating across disciplines to develop forward thinking design and people focused challenges

Arup is an independent firm of Designers, Planners, Engineers, Consultants and Technical specialists offering a broad range of professional services. Through our work and interdisciplinary collaboration we make a positive difference in the world by being best known for helping to shape ambitious buildings. While our most recognisable work is in complex, ground-breaking structures, many of which Arup's input made possible, it is better building performance that drives us. What defines a building's performance will depend on its purpose. Listening to the things that make an asset valuable to our clients, and to their buildings' users, gives direction to our designs. With world-class expertise – creative and technical – we help to realise buildings that are better because they are more useful and attractive to the people who own and inhabit them, more sympathetic to their context and more commercially sustainable.

When it comes to people and skills, a wide array of attributes and limitations need to be acknowledged, including the psychological and social aspects. Arup believes there is no better approach for improving your design than gaining a better and early understanding of the people you are designing for. Human factors encompass all aspects of a user's journey. They are fundamental to understanding what the precise users' needs are and where opportunities for improvement lie. Our total design approach is based on a robust understanding of different skills, including physical ergonomics, cognitive psychology, human-machine interactions and organisational behaviour, to optimise the Design philosophy (structure and human assurance and performance) across the built environment. Core to our work is focusing on the human and structural sustainability of our design methods and ensuring that the user and their wellbeing is implemented throughout the design and performance review cycle.

Research Introduction

At present, Arup's Building Performance & Systems and Operations Consulting team are leading a new research initiative into how the built environment design and performance effects users' wellbeing at work from a psycho-social and sensor data joint perspective, and if so, then what and why are these impacts occurring and how can they be managed and optimised. The project is currently live and in the data analysis phase of works. Final results and conclusions will be provided during the conference 23rd-24th March 2017.

Given the growing nature of time spent at work within high performing teams, many organisations are focusing on how to optimise the working environment space for their staff. The likes of tech giants such as Google and Facebook are placing their users at the heart of their working environment design, so that features like sleep pods, gyms, food kitchens, biophilia, green spaces and gaming areas are now the norm there.

The need for this research piece is supported by Arup and a key client (landlord and tenant), partnered with the UK Green Building Council (UKGBC), and is driven by their growing interest in understanding:

- The relationships between working environment (using sensors: temperature, relative humidity, carbon dioxide and light levels) and users' needs and perceptions of their workplace (questionnaires, observations and deep-dive interviews), and whether there are any effects of their environment which inhibits or promotes their ability to perform their work effectively, productively, comfortably and happily
- How to develop cutting edge ideas within the built environment, which improve their properties and human sustainability, and ability to maximise their productivity and wellbeing at work and reduce the impact (behavioural and cost) of inefficiencies within this space.
- The value of the WELL assessment standard (USA standard which presents a list of working environment points that need to be implemented within a workspace so that it can be awarded a specific building rating (e.g. access to water fountains, green spaces, massage, sit-down and stand-up desks) are valid or whether our revised, more specific method could reveal any other key societal features to be considered (from a design and well-being perspective) to improve well-being at work- and therefore supersede the WELL standard.
- How teams can collaborate across disciplines i.e. human factors with building performance engineers to ensure that relationships between sensor data and user needs are fully understood and fed into the design at the beginning of the concept stage in accordance with the client/ Landlord.

Project Aims:

The overall project aim is to understand how engineering (sensor based) and user centred design (behavioural) methodologies can be combined to enhance building performance from a user perspective.

Bridging the gap between building services engineering and user centred design has been achieved by collaborating across technical disciplines at Arup, such as: Building Performance Engineers, Human Factors, Behavioural Psychology, Human Resources, Service Design and WELL Accredited Professionals.

Understanding how to enhance:

- User performance and wellbeing at work – understanding how human behaviour and user needs influence and relate to design and well-being (mental and physical).
- Office and performance – system and human focused 'pain' and 'pleasure' points within office space
- One new and integrated Arup Service offering formed with the following disciplines: Building performance, Human Factors and Wellbeing
- WELL *standard gap analysis* against the research approach and data collected

Supporters and Participants:

- UK's largest commercial landlord
- Participating tenant from UK's largest commercial landlord
- UK Green Buildings council (UKGBC)

Methods

- Indoor environment sensors (including temperature, relative humidity, carbon dioxide and light levels) placed across a workspace with 85 employees
- Behavioural-based research engagement with users in their work environment (observations, interviews and workplace questionnaire)
- WELL standard gap analysis (including water and air quality readings taken and assessed in a laboratory)

Value and Impact:

- Project is supported by client and Arup research investment funds
- First internal project focusing on creating innovative ways for researching the relationships between building performance data and behavioural based research insights
- Product: new Arup service offering that assists clients (such as participating landlord) across the design and review cycle on how to maximise the design of space and positive impact of this on users' performance at work and perception of landlord and customer care and foresight in wellbeing.
- User and business insights for participating tenant: understanding the impact of their colleagues' wellbeing (mental health, sickness and absenteeism, workplace design) on optimising work practices, ROI, savings (illness, workplace stress- absenteeism, loss of talent) and invest and promote in targeted supportive resources e.g. HR, Arup, and Landlord.

Preliminary Results & Conclusions

Given that this is a live project and currently in the data analysis stage, it is envisaged that data collected from this project will develop this idea by developing practical and sustainable solutions which place user needs and their workplace experiences at the forefront of working environment design and wellbeing at work schemes.

17. Synthesizing the Gaseous State: Mapping the Geographic Convergence of Knowledge

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Computational complexity within architecture and design-related fields has been largely oriented towards the research of spatial data in its numerically manifest forms: structural, infrastructural, material, procedural, or geometrical. Within our collective efforts towards a radical redefinition of what the built environment should be, it is important to question the role our data has in propelling us towards certain aims, and more so, what are the

data-types we are discarding? As these may involve hidden branchings that challenge our design and practice orthodoxies

The fundamental question: What are we computing? — brings forth the lines of questioning, research, and the accelerated growth which have been enabled by our tools — the rapid customization, manufacturing, and analysis of complex building processes. However, should we ask: What isn't computed? — we would open a wider range of questioning around topics of social relevance, such as: poverty, economic flows, and politics; topics, that due to their reliance on narrative (word based) data-types are perceived as uncomputable, and thus, too complex to understand.

What is not computed incurs the risk of obsolescence due to the comparatively slow evolution of its study. The measure by which our collective explorations into material systems, form-finding, advanced structural design, manufacturing, spatial analysis and occupation patterns, far surpasses the rate of growth of our studies into poverty, gentrification, theory, social unrest, cultural impact, city growth, religion and spirituality, and the assimilation of economic flows throughout the urban fabric. These are topics that are often carried by the social sciences at a far slower pace due to an inexistent framework for comparative synthesis of these narrative data-types.

The amount of data produced by the vast majority of the world's population is by far narrative, in all its manifest forms: text, audio or video. It is the most direct form of expression, ranging from individuals to massive populations. Failure to engage with these primary forms of expression results in a lower resolution understanding of the cultural implications of building and the social/environmental repercussions in that given region.

This research seeks to extended our set of available tools to enable an architecture that can engage with the massive amounts of public opinions, debates and ideological forces which compose our noetic landscapes. It is meant as a higher resolution layer of analysis with the purpose of increasing our capacity to modulate struggles between environmental and human forces, in culturally sensitive ways.

Synthesizing the Gaseous State is an ongoing research effort that uses neural networks to map word relations, hierarchies, gaps, and foci of terms within large data sets of architecture theory and public opinion, as they are graphed geographically and by epoch.

The methodology employed by the software in order to achieve this relies on each term stored according to its contextual relations (words directly surrounding the term in a sentence) that are referenced according to their place in multiple texts and occurrences within the same text. While this context is dynamic, as dependent upon the weighted relations traced through texts loaded upon the data set, it is balanced against a static or fixed context - the definition of these words, their author, place, and date. Relying upon the information acquired, each term behaves as an active agent, seeking out relations based upon new contexts and visually graphing them according to place, author, and date, as opposed to abstract or empty space. This comes with the purpose of visually revealing the movement of architectural thought through the terrain, while describing how it converges and diverges from certain concerns locally, as compared to global currents across time, as a Computer Aided Epistemology of architecture theory.

The fitness criteria used while evaluating the optimization of the software is its capacity to graphically seek out a determined proximity measures between associated terms, while still being constrained to a certain latitude-longitude range in position, associated with the author's affiliated institutions.

Through the author's affiliated institutions and the places referenced within the work, we can derive real vectors of ideas and opinions, from one location to another. These vectors can be self-referential (a collection of vector points of associated terms) — which exhibit a sequence of proximity relations to terms queried by the user which represent a single geographic point, or they can be other-referential (a collection of vector lines of associated terms) — which can be abstracted when one work refers to other places, authors or times, as a line where one set of terms in a geographical point refers to another set in other latitudes.

Currently the software uses a 1GB database of architecture theory taken from assorted periodicals (Architectural Design Magazine and Architectural Record), for proof-of-concept purposes. Next steps will include collaborations with Charles University, Prague, and the ICCIT, University of Toronto, to synthesize 20+ years of PhD theses, in order to acquire a knowledge map of most related and commonly used terms, most discussed topics, authors cited by hierarchy, sites of intervention and least discussed subjects. The software allows any language to be entered and analyzed.

Applications for this can span various scenarios, such as: a) the need for aid in traumatized regions due to war and natural disasters, where acquiring/organizing information from the ground, can give a clearer and more rapid picture of the necessities of the people affected, as these are instantaneously built into a database sourced from social media feeds, b) an interface for exploring our collective knowledge, the most pressing stimuli upon our profession and our obscured topics as they are hierarchized through time, c) a synthesis of the diversity of public opinions upon the built/urban environment, whether a single building or regionally, without sacrificing variables, or channeling opinions through surveys, d) ideological or economic movements through the terrain, such as protests, gentrification and educational inequalities, in data-substantiated ways, that can give further insight into other statistical analysis, and e) a dynamic graph that can connect the user's interest, with particular places, authors, or historical facts, of the subjects he or she has queried.

Videos:

<https://vimeo.com/175917417>

<https://vimeo.com/175916884>

<https://vimeo.com/175918318>

18. Rezoning New York City through Big Data

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Computation has become a cognitive plateau for any subject of study, making computer science relevant across all disciplines. New technologies enable new means to lenses to see reality, which as a consequence inform it. Disciplines continuously expand until new forms of transdisciplinarity or entirely new disciplines emerge. For instance, ecology has expanded many disciplines, but one of the most relevant displacements today has been the representational shift activated by computation in formalizing fluid dynamic simulation by processing Big Data. New digital techniques allow, for instance architects, to represent, analyze and manipulate fluid dynamic energy understanding now space as environment.

Digital signs represent information, and in linguistic terms, they determinate how we understand and reference reality. Computation by representing reality through codified linguistic signs creates new objects¹ independently from the reality is coding, therefore creating new realities informed by the simple implementation of a system of measurement, reference and representation. Although this is a known communication problem relative to media, it has not been critically understood by design professionals that deal with data. Problematically Big Data is usually understood as a *visualization* problem, for instance, separating an apparently inert content from the form of the media used to represent it². *Authorship*³ becomes once more an issue with regards to the determinism brought by computation. After several declarations of the death of the author in multiple disciplines through understanding the limits of language⁴, today with shared platforms, algorithms and common means to measure and represent data, designers, architects, planners and information architects are increasingly relegating authorship. The promise of Big Data as a new form of a diversified structuralism is to build up large sources of information statistically, avoiding categorical preconceptions in how to interpret emerging patterns.

While Big Data allow us to understand reality before framing categorically what's under question, a single algorithm searches for, collects and represents data. Often, such algorithm is not developed by the single data entry point person responsible for the search categories that are input to collect and represent data. There is no data without

¹ Alain Badiou identified how the humanities and the sciences create objects when addressing reality. He points out that this does not happens with Mathematics, which resolved the question of *being* that Philosophy raised. Badiou, Alain *Being and Event*, trans. Oliver Feltham, Continuum, London 2005.

² "The medium is the message" Marshall Mc Luhan; "The method is the message: rethinking Mc Luhan through Critical Theory" Paul Grosswiller, 1999; "The method is the Message", in "The Politics of Parametricism" Laura Kurgan, 2013. Rather than analyzing media through problems of perception, the argument is to disclose through deep structure the ideological projects implicit in protocols and algorithms that structure information. These issues present an interesting conflict in an apparently post-structuralist society, arguing a disjunction between a perception-based society in class conflict with undisclosed authoritative corporate interests, currently extensive to governments.

³ In ACADIA 2010 Conference at The Cooper Union, the author as co-chair stated the necessity to recognize, critique, displace and create new algorithms and systems of representations usually authored by software developers.

⁴ Roland Barthes declares the death of the author by claiming that language is the ultimate barrier for writing. Barthes, Roland *Writing Degree Zero*, trans. Annette Lavers and Colin Smith, Hill and Wang, New York 1968 orig. 1953.

representation and since information does not exist without a form of representation, the critical political issue resides in the representation of data. Before data mining, data is previously created or input through problematic cultural and political categories. There is a politics of data classification and measurement that actively uses this differential for civic representation, displacing the science of data measurement to activate ideological agendas. Categories confirm cultural and ideological biases that need to be addressed and critiqued. Data sets are developed by a centralized authority, such as the government, a survey entity or a media conglomerate. The common imposed top down *authority* of data generation and data ownership becomes also an issue. The centralized authority of a single control mechanism to categorize, represent and communicate field of information is problematic.

This activates a reflexive loop between the politics of representation, aesthetic ideology, the senses and an implicit Gestalt⁵ process between the represented data and an apparently inert objective reality.

Big Data is originated through information processing software, interfaces and algorithms which organize data in the form of information through data mining representational strategies. While the promise of Big Data is to avoid a priori judgment, new *objects* will inevitably emerge due to the intrinsic ideological conditions of the methodology of data categorization, the territory in which this is created, the cultural context and the implemented system of representation. Once data is “visualized” it will infer signification beyond its initial condition and, in the best cases, will challenge the same data it is indexing. A clear and critical means to represent information would acknowledge the irreversible act of representation in which the relational form of the data mining would be able to produce readings and relationships of valuable emergent content beyond the original data set. In a new form of representation, if interesting enough in terms of its autonomy and relational potential, this form of representation would produce readings that could not be anticipated. In this regards, an artistic sense, an artistic language, an aesthetic value based on artistic visual cognitive logic becomes active once form is constituted. If the data mining relational representation is powerful enough, it would create an artistic autonomy, a new state of being no longer reversible. In this regards there are further implications, since the actual problem of data mining is the generic form of relational interfaces that visualize different types of data that become information. Common generic visualizing strategies tend to structure data in determined simplistic terms, homogenizing reality the same way government categories create types of citizens. Furthermore, recognizing the simplicity of current algorithms and the structuring homogenizing force of computation what happens is that data will match the system of reference for measurement, meaning that one would only be able to find through data mining what the system allows to, engaging in a looping parametric enclosed system in which the results would be only possible within the spectrum of the system. This is the reason why Big Data becomes the subject matter of current design agendas, expanding any project to the measurement system that validates it. Any system of measurement distorts reality to confirm the reference. Moreover, data is categorized to match the understanding of what is being looked for, a common problem that Cities are facing by confirming their own assumptions by developing systems of measurement that instead of solving problems create objects that raise as independent factors from what the system is suppose to be measuring. Additionally to this issue is that if one would be able to identify

⁵ A Gestalt of information representation also expands to continuously perceptive change in the subject that engages with these issues relative to the situation, extending the problematic relation between data and the senses relative to representation into semiotics.

an interesting measurable problem, creating critical categories and an interesting data mining relational system, one would still have to work on displacing the common systems of representation in relation to the emerging content, almost to the point in which to each identified measurable problem, one would have to develop a measuring methodology and an intrinsic-to-the-problem representational system that would be able to formalize the right kind of relationships necessary to disclose the question being researched. This is the definition of an architecture of information⁶.

These issues are activated through the experimental specificity of a research academic architecture studio which proposes a rezoning of New York City in relation to environmental forces. This research studio understands architecture as to organizing space-environments. The studio projects work at different levels several design strategies to overcome the discussed problems. The research methodology starts by recognizing, displacing (but also opening up possibilities for new systems) systems of representation in the constitution of Bid Data which defines a project.

First, these architecture projects identify and activate an emerging architecture problem in the City of New York by means of creating data categories, mapping information and reading the city as a mediated process of representation, working actively with the separation from the object of study. Survey becomes the first act of measurement of reality, and due to the described problems, the implicit first act of design, the creation of a specific territory. By default, this process becomes an expansion of the common notion of *authorship* necessary today with the given implementation of new technologies that create new paradigms and new fields of study. The technology of the survey mechanism becomes the initiator of the conditions that will inform the project. In this respect, the projects that are able to displace conventional means of collecting, representing and creating data, producing their own conditions are the ones that can claim a higher level of authorship on a continuously expanding project. This is the reason why survey methodologies, including new emerging technologies for survey and representation became a politically charged project, since they become an opportunity to disclose cultural problems and engage with the conformation of cultural projects. One of the projects develops a rezoning of NYC by reorganizing sound. This project creates a sound mapping (Fig. 02e-f) by identifying the means to collect crowdsourced data, by accessing portable cell phones microphones, that as measuring devices of participating individuals, displaced the typical *authority* in data gathering (to a certain extent filtered by communication companies). But then the project goes beyond an indexed mapping to develop a critical reading of the city. The architecture of data becomes then a *platau* for the architecture of the project. By developing Big Data processing mechanisms, the projects of this studio engage ideologically with the definition of the conditions of politically and culturally charged territories.

Second, the projects aim for two kinds of transfigurations. Some projects develop a transfiguration of the existing, “naturalized” reality, by activating a displacement of a revealed structure of the City (Fig. 02a). Other projects displace the territories created through Big Data processing in simulating environmental forces. By formalizing fluid dynamic processes, these techniques allow to represent, analyze and manipulate fluid dynamic energy, organizing the increasingly complex space-environments of a city like New York (Fig. 02d). Other projects map and design specific building zoning envelopes defining variability in height indexing a diversified ground condition, working with latent

⁶ Lorenzo-Eiroa, Pablo and Spreche, Aaron ed., *Architecture In Formation*, Routledge/Taylor and Francis, London 2013.

conditions previously categorized in simpler terms as the proximity of the bedrock to the ground surface (Fig. 01).

Third, the existing zoning mechanisms by which the city is formed, such as the city grid, blocks, blocks backyards, setbacks, building envelopes, orientation, public space, and also latent ecologies, environments and other parameters are re-coded to make sense of the mapped conditions. But this act of design avoids any linearity between the analyzed data and the proposed rezoning of the city, implementing a critical reading, expanding design to a re-coding of the parameters that formalize the city. By understanding the differential between the creation of data, data gathering and mapping which will create signification beyond its original understanding through actualization and representation, an informed reading of the city becomes then a design project, which inevitably will challenge the data that is indexing the project.

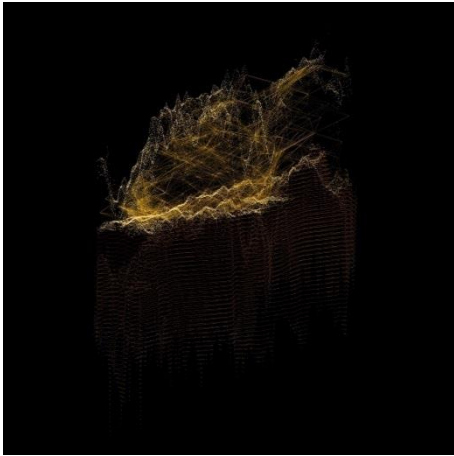


Fig. 01: NYC variable soil density and variable building height (not just bedrock). Rezoning New York City through Big Data; Master Program Studio, The Cooper Union, Fall 2015; Professors: Pablo Lorenzo-Eiroa (head professor and coordinator), Dorit Aviv and Will Shapiro; Student: Bing Dai

Fourth, a certain deconstruction of the single data gathering mechanism and design proposal is placed in motion when all participants of the research studio build up information layers to place back together a new reading of the city, integrated and synthesized at a higher cognitive level. Eventually this layering becomes topological and a continuously expanding platform, a multidimensional open-sourced design platform in which designers, as well as different professionals and citizens could continuously enter data democratically and also affect the measuring methodology that informs a continuously modeling of the environment they are part of.

In order to avoid a linear indexing relationship between data and proposed design, a critical reading becomes a solution to recognize the potential accumulative effect given by the recognizing the latent potential of opportunities to transform the entire structure of the city. This topological project becomes active each time there is a reading of the implicit latent realities that inform the city.

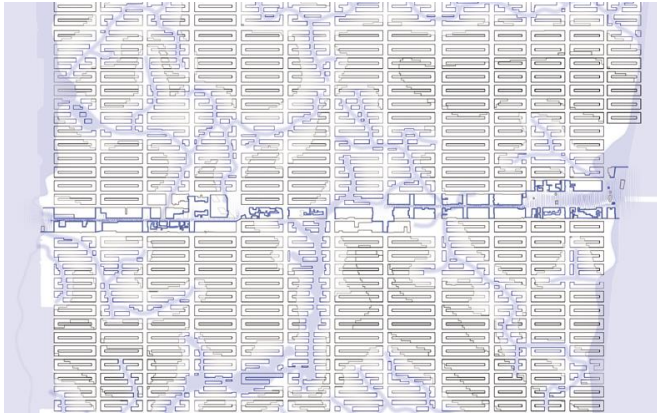
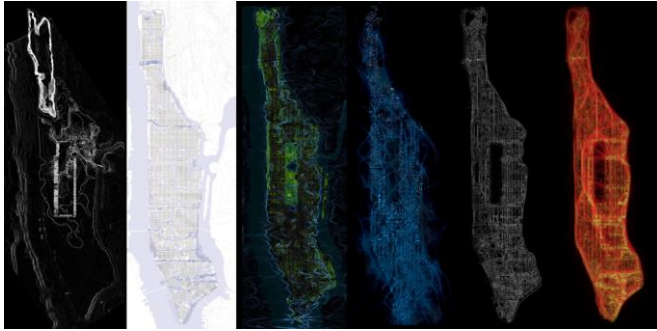


Fig. 02a: NYC mapping flooding levels to displace the centrality of Central Park. Fig. 02b: NYC blocks' interiors are connected to develop a parallel city, revealing latent suppressed ecologies. Fig. c: balancing heat island effect by modifying open space in NYC. Fig. d: wind vortex manipulation for city's space-environment conditioning and energy harvesting. Fig. e: NYC grid redesign affecting sound patterns. Fig. f: NYC sound mapping. Rezoning New York City through Big Data; Master Program Studio, The Cooper Union, Fall 2014 and Fall 2015; Professors: Pablo Lorenzo-Eiroa (head professor and coordinator), Lydia Xynogala, Dorit Aviv and Will Shapiro; Students: Cansu Uzun, Jaebong Jeon, Yuan Gao, Seung Hwang Kim and Jin Woo Lee.

Fig. 02b detail: NYC blocks' interiors are connected to develop a parallel city, revealing latent suppressed ecologies. Rezoning New York City through Big Data; Master Program Studio, The Cooper Union, Fall 2014; Professors: Pablo Lorenzo-Eiroa (head professor and coordinator), Lydia Xynogala, and Will Shapiro; Student: Jaebong Jeon.

19. #CMLA1602R (Architecture and Social Media)

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Aesthetic categories, such as the beautiful, sublime, and picturesque, have historically been defined by theorists and artists as the emotive experiences with which they are associated. In an age of digital inundation, the canonical definitions for these aesthetic categories no longer need rely on the imposition of a few minds, but instead are collectively defined by many. Applications like Instagram allow individuals to publish their content with associations to specific words simply by including a #hashtag. By electing to associate a photograph with a word, the individual implicitly contributes to the collective definition of that word.

This presentation focuses on “#CMLA1602R,” a study developed to help inform a new design process which relies on social media as a tool for mining public desire and bias. The study reveals a key opportunity: that social media can be used to gather accurate, highly nuanced representations of collective aesthetic taste at specific points in time for specific groups of people. Consequently, these representations can then be used to inform architectural design decisions.

Phase 1: “Using Crowd-sourced Data to Redefine Terms”

Phase 1 of the study, “Using Crowd-sourced Data to Redefine Terms,” examined the ways specific design-related adjectives have been redefined from their historical definitions through social media. Seven different hashtags were monitored for one week, using IFTTT (If This Then That online application) to automatically download over ten thousand social media posts and their associated hashtags. The data for each hashtag was then catalogued in two ways: first by type of imagery (environments, selfies, etc), and second, by a log of words associated with each image, ordered by frequency of use.

The resulting categorizations generated a graphic, dynamic dictionary, redefining terms that once had static, conventional definitions. #beautiful, for example, was most commonly associated with the female face; #art was primarily associated with fine art and personal sketches; #aesthetic returned pink hues and selfies. #sublime returned imagery predominantly related to the human body, describing physique and frequently tagged together with #beauty. These associations contrast significantly with philosophical works, including the writings of Burke and Kant, which previously looked at the sublime as an emotional experience triggered by incomprehensibility, vastness, and as antonymous to beauty. In comparing the “current” definition of these words with significant historical works, the study reveals that social media serves as a new type of dictionary of aesthetic preference. Moreover, Instagram as a platform itself may be redefining what aesthetics are by providing finite parameters for framing, filters, and feeds.

Phase 2: “Towards a Digitally-Informed Architecture”

The results of #CMLA1602R Phase 1 suggest unique associations, scales of context, and even materials and palettes that the architect can draw on to make aesthetic and

experiential design decisions. To better explore this, the authors have begun Phase 2, “Towards a Digitally-Informed Architecture” (anticipated study completion date January 2017). In a process similar to Phase 1, ten different hashtags will be monitored for two weeks, using Zapier (online application) to automatically download content. Phase 2 looks at two categories of hashtags: Category 1 logs the “aesthetic adjectives:” #awesome, #beautiful, #wonderful, #serene, #exciting, #experiential, and #picturesque; Category 2 logs “architectural nouns:” #architecture, #architectureporn, #architect, and #design. The presentation will focus on the cataloguing and analysis of these two categories, with the intention of extracting techniques for introducing themes from the aesthetic adjectives into built designs.

The ultimate goal of the study is to bolster the public’s collective perception of built architectural work in hopes of observing more architecture-related imagery tagged under the aesthetic adjectives in the future.

More broadly, the relationship between social media and architecture participates in the larger discussion regarding the intersection of digital and physical worlds, addressing the responsibility of design disciplines to progress and adapt with virtual behavior. This presentation will open the discussion regarding the possibilities for architects to actively engage and affect preferences via social media, by examining how design professionals use digital media as a tool to create and share architecture that is culturally desirable in this hyper-visual, crowd-sourced context.

The title of the study, #CMLA1602R, stands for Cuevas Masset Los Angeles (authors’ last names and current location), research project ID number 1602. The hashtag will be used to catalog the study on Instagram throughout the process of Phase 2 in January of 2017.

20. Pod architecture and the age of Instagram;

Using publicly available big data to site student accommodation
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This paper is set within the conflicting frameworks of Bio-semiotics, Speculative Realism and Accelerationist thought. More specifically, the ideological frameworks of sign systems (semiotics) and object systems (ontology). While semiotics and biosemiotics are phenomenological in essence, Speculative realism is centered on the problem of ‘being’ outside of the anthropocentric world view. In both cases, recourse is made to empirical data. We are interested in the possibility of forms of architecture and human habitation that are responsive (not reactive) to capitalism and market place dynamics (since the Internet), an architecture unconstrained by geographic locations and time zones. Our approach to the technological follows from our design studio teaching at the University of Edinburgh, and our collective research into the potential for architectural computation and business analytics. Further, a cursory reading of Lewis Mumford’s ‘Pentagon of

Power⁷ and Le Corbusier's 'The Radiant City'⁸ where the groundwork for 'biotechnics' was laid out, give credibility to our hypothetical position on biomimesis and biosemiotics and as evaluative tools for reading contemporary urbanism. We attempt a synthesis of the various positions by revisiting the human habitation unit, or in our case the autonomous/semi-autonomous human habitation unit.

Our investigation began as a real estate speculation, tabling travel destinations for study and tourism amongst university students and young professionals. The objective of the study was twofold: first, to determine upmarket real estate development potential for students housing and short stay serviced accommodations, and second to determine the potential for predicting trends using data mined from Data Analytics and Social Media APIs. The justification for our study followed assumptions about the current trends of social mobility, wealth, and immigration, and our arguments for the real potential of a population explosion following these trends. To this end, we began investigations into a few European cities including, London, Paris, Berlin, and Rotterdam, to identify potential sites for real estate development. Further, we decided to populate these sites with mobile housing units, following experimental/avant-garde proposals explored in publications such as Bustler⁹, eVolo¹⁰ and Death by Architecture¹¹. What we discovered was that the seemingly radical proposal for mobile and semi-autonomous housing units wasn't too far removed from the short stay sleeping pods already existing in airports and cities such as Tokyo.

The concept of the basic habitation unit dates to CIAM and Le Corbusier's proposals in 'The Radiant City', for modern living following the development of the automobile, 'high-speed' travel and urban-rural-migration. We are again confronted with similar phenomena; however, unlike Le Corbusier and CIAM, our methods downplay the 'human' as basic scale of reference and take a broader view of humanity's place within the framework of Speculative Realism.

The first part of the paper traces the historical development of biomimetics¹² in architecture since Otto Schmitt in 1950 and identifies parallels between communication and data transfer in biological systems, spatio-structural metamorphosis and networked structures in architecture and urbanism. The second part of the paper is a provocation, on capitalist acceleration, within Housing, Real Estate and Hospitality, in the age of Instagram, Trip Advisor, Airbnb and Budget Travel, through a synthetic analysis of publicly available data. In another word, we investigated 2 semiotic urban systems the first autopoietic, the other rhizomatic (swarm based). Our research through Data Analytics and Social media allowed us to develop a further hypothesis into biological syntax as analogous to swarm dynamics. In this way allowing us to justify biosemiotics as a form of urban analytics.

Using data analytics in three different stages, we tracked non-European student and young adult destinations for study, personal relationships and work, using hashtags as attractor

⁷ Mumford, L. (1974) *Pentagon of power*, Vol. 2. New York: Harcourt Brace Jovanovich

⁸ Corbusier, L. (1967) *The radiant city: Elements of a doctrine of urbanism to be used as the basis of our machine-made civilization*. London: Faber & Faber.

⁹ Bustler (2016) *Bustler: Architecture competitions, events & news*. Available at: <http://bustler.net>

¹⁰ eVolo, *Architecture magazine* (2006) Available at: <http://www.evolo.us>

¹¹ Cipresso, M. (2007) *Death by architecture*. Available at: <http://www.deathbyarchitecture.com>

¹² Gruber, P. (2010) *Biomimetics in architecture: Architecture of life and buildings*. Vienna: Springer-Verlag Vienna.

indices, and concluding our search in Berlin, Germany. The first stage of our enquiry used a structured query language (SQL) to retrieve, collect and analyse the data from online governmental databases. The second stage of data query consisted of a reading of geographical data via Google's API system. In the final stage of the enquiry, we extracted data streams from Instagram's API, using MySQL during the period December 2015 to April 2016 in Berlin. The results of each stage have been mapped and presented through a data infographic showing the overlaps and differences in such data sources related to mobility within Berlin.

Extensive research has been carried out into understanding cities through studies of integration. Of note in this regard is the work of the Space Syntax Group. What we propose is a disintegrated/disaggregated reading of urban phenomena, not along axial lines, but along migratory and settlement patterns analogous to scatter diagram, p-systems and swarm intelligence. To conclude, we extend a form of human habitation already seen in airports, train stations and a few cities around the world: a self-organizing variation of the mobile habitation unit as a possible housing future in an age of accelerated global capitalism.

21. Navigating Thamesmead: Applying Geolocation and EEG recordings of brain activity in Wayfinding Design

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Digital applications identifying spatial location through GPS, when used simultaneously with 'wearable' technology, such as portable electroencephalography (EEG) devices, may offer new, and persuasive methods of measuring, and representing embodied responses to place, with practical application in urban regeneration projects.

This paper describes early empirical findings of fieldwork by a small team of practitioners and academics from the University of East London, exploring the emerging methodological and technological potential of brain activity measurement, geolocation and spatial design practice, at the interface of architecture and neuroscience. The field work is being undertaken in autumn 2016, as part of a live 'Wayfinding' commission for a major housing provider, engaged in large scale regeneration in South East London.

Recent research by Karandinou and Turner (pending publication) has found measurable changes in brain activity allied with decision making during a journey. The authors found peaks of 'Beta' brain activity are characteristic of decision making points along a route. Within a positivist framework such approaches offer the advantage of producing quantitative, objective data about place, but the time required to link collected neurological data through video analysis into spatial mapping may limit application of this technology in spatial design practice.

Our empirical fieldwork develops the methods employed by Karandinou and Turner, and investigates the potential for locating Beta peaks spatially as they occur, using GPS

systems, rather than video recording, as a way to provide objective data supporting proposals for spatial or graphic wayfinding interventions in particular locations.

Data collected using EEG/ GIS technologies will be complemented by those generated using the qualitative research methods of participant observation and interview. The findings of these differing methods will be further compared with a priori predictions of 'subjective' professional expertise.

The paper presented will provide a comparative assessment of early findings from this study and reflect on the potential for currently available technology to complement existing methodologies within contemporary spatial practice. It will reflect on client perception of the data generated through the different methods employed, ease of use in the field, relative performance alongside 'traditional' methods, and scope for further methodological and technological development.

22. Does Mind-Body Consensus Exist in Thermal Comfort?

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Built environments are crucial for the quality of life since people spend almost 90% of their lives indoors. In Europe, buildings consume almost 40% of the total energy. Primary contributor of this energy consumption is heating, ventilation, and air conditioning (HVAC) systems with almost 50% of the energy consumption. What makes these building systems important is not only their significant contribution to the energy consumption, but also their influence on occupants' thermal comfort. To date, thermal comfort has been defined as the state of the mind representing one's satisfaction with the thermal environment. However, due to this emphasis on "the state of mind," addressing thermal comfort at the system-level requires human-centric approaches. There are two fundamental approaches for estimating the thermal comfort of humans; survey-based and sensing-based (environmental and/or physiological) approaches. Survey-based approaches (e.g., subjective thermal votes) provide information about perceived thermal comfort while sensing-based approaches use ambient environment measurements or human physiological measurements to understand human comfort. Although using both approaches would facilitate better understanding of personal thermal comfort, there is no established consensus between subjective and objective measurements in terms of personal thermal comfort. Former represents the state of mind while the latter represents physical response, bringing this problem of personal thermal comfort to the philosophical domain of Rene Descartes' famous mind-body duality problem. Descartes indicated body and mind as two distinct realms. His idea was followed by Cartesian dualism pointing out the causal interaction of mind and body, thus the theory of interactionism focused on the two way causal interactions of mind and body. This theory of interactionism is very compatible with common-sense beliefs in daily life. Humans perceive the physical world

through their senses, and respond to the physical cues behaviorally. Occupants of the buildings perceive their microclimate through their senses, and respond behaviorally by interacting with building systems and/or elements. These interactions, as well as other occupant related factors (such as preferences, habits, behaviors, personality and so on) influence a building's energy consumption.

For investigating the mind-body interaction with respect to perceived thermal comfort, we used a hybrid environment to bring together Immersive Virtual Environments (IVEs) and Physical Environments (PEs), where we measured users' perceived thermal comfort, physiological responses including thermoregulatory system responses and neurophysiological signals, and interactions with the built environment (i.e., adaptive occupant-system interactions) in the context of thermal stimuli. In a human subject experiment, we used subjective thermal votes, surveys, physiological and neurophysiological measurements, ambient room temperatures and humidity sensing. In addition to subjective thermal comfort and satisfaction votes per occupant-system interactions, we opened a new avenue by including questions about perceived ambient room temperatures. We measured occupants' perceptions of ambient room temperatures prior to (i.e., perceived initial ambient room temperature) and subsequent to their dynamic interactions with building systems and/or elements (i.e., perceived posterior ambient room temperatures). The perceived values are perceptual representations of mind, and they are compared to the physical ambient room characteristics data (i.e., ambient room temperature data). This comparison allowed us to understand the interface between the thermal stimuli and their perceptual representations in human mind. In this context, this interface is defined as the 'human body' with all receptive sensory capabilities. We elaborated the understanding of role of human body in thermal comfort research by integrating the physiological response (i.e., thermoregulatory response through non-invasive infrared skin temperature measurements), and neurophysiological response (i.e., non-invasive brain signal response measurements). As a result of this body-mind interactions, occupants tend to showed adaptive behaviors (i.e., occupant-system interactions). For understanding the type and hierarchical order of these interactions, we pursued an observation technique during the experiment, and recorded their interactions. Participants were recruited in hot (28 C), or cold (18C) environments. In each environment, participants were given different options (e.g., desk fan, thermostat, local heater/cooler, hot/cold beverage, radiant heater, and so on) to choose from for making themselves thermally comfortable. Subjective perceived thermal votes, physiological thermoregulatory system and neurological responses, and types of adaptive behaviors (i.e., occupant-system interactions) in IVEs and PEs were analyzed using analysis of variance (ANOVA). We hypothesized there exist causal interactions bridging mental-physical body responses (i.e., adaptive occupant-system interactions) while mental (i.e., subjective thermal comfort, satisfaction and perception votes)-physiological (i.e., skin temperature) responses are not always in agreement. Novel contributions of this work are increased understanding of occupant-systems interactions using brain computer interfaces and mapping of the mind-body interactions in the context of thermal comfort.

Keywords: Thermal perception, building systems, occupant-building systems interactions, perceived thermal comfort, immersive virtual environment, virtual reality, physical environment.

23. Between disciplines and experience: Understanding Big Data as “monuments of cyberspace”

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What do we see when we look at data? This recurrent question when confronted to Big Data, is largely answered by two different disciplinary visions dominating the debate during the last years, concluding that data are raw and Big Data is a hubris. While disciplines still treat just a part of them, we experience a wider and wider spreading of Big Data. The notion of “monuments of cyberspace” discussed here helps understand their peculiar nature and delimit related issues of method, of wealth and of experience. In Knowledge Management, data are traditionally seen as a resource, a mine of information to be processed into knowledge. This view, dominant in the realm of the knowledge economy, conceptualised data according to the specific objective of the production of knowledge that is useful for the manager. In this context, however, data are defined in a negative way, being just “unstructured” (Gandomi and Haider, 2015; Bellinger et al., 2004; Earl, 2001):

Data is raw.. It simply exists and has no significance beyond its existence (in and of itself). It can exist in any form, usable or not. It does not have meaning of itself (Bellinger et al., 2004).

More recently, along with the expansion of Big Data, researchers examining large amounts of data coming from digital platforms have been engaged in a process of identifying their meaning. Thus, we have entered a realm where data are to be understood as such and not only as a means to achieve a goal, a part of a procedure having an objective of production.

Yet, most research methodologies still describe data as an effect of the very action of the researcher. For instance, in quantitative research (Yin, 2003), data are collected on the basis of a research question, usually resulting from the identification of a gap in the literature. Hence, the structure of the data to be collected is normally designed by the researcher. Consequently, from the perspective of the research community, Big Data have been characterised as an “hubris”, as they “are not the output of instruments designed to produce valid and reliable data amenable for scientific analysis” (Lazer et al., 2014).

Overall, it seems that the Knowledge Management approach, admitting that data exists beyond the action of the researcher appears to be more relevant to Big Data than the methodological approaches considering data as the result of a researcher’s action. Still, management is not the only discipline that seeks value in them. Moreover, Big Data as a research object are yet illy defined. How to qualify their “raw” and “unstructure” nature?

A unified view

To clarify the nature of contemporary data and, thus, the corresponding data situations that scholars and practitioners are called to address, this paper proposes the distinction of two conceptual levels: (1) resource versus result and (2) action versus research.

	Action	Research
Resource	Knowledge Management	<i>Unknown 1</i>
Result	<i>Unknown 2</i>	Methodology

Table 1: Data situations.

As indicated by Table 1, we are today confronted with two new situations, two situations of unknown in relation to the well-known disciplinary views. The first situation concerns the condition where data are seen as resource for research, yet they do not originate from the action of the researcher and where their relevance to a research domain (research question or even related discipline) remain unknown. The second condition is when data are the result of action (of a system or a collectivity) but their usefulness remains to be discovered (we don't know what to do with them...).

Treating the unknown data situations as monuments

To treat the unknown data situations we propose that an investigation of the experience of data generation is a prerequisite. We propose to treat data as monuments (e.g., similarly to the study of ancient manuscripts), positioning them in a sequence, in a sort of a chronicle, portraying this way the evolution and the ruptures in the process of their creation. Thus, we the intrinsic mode of knowledge edification in digital settings can be described as "monuments of cyberspace" (Chrysos, 2016). More specifically, each digital interaction is not only limited to an exchange of information, a transaction, nor is it always the effect of a mobilisation of already existent relations. A digital interaction is always inscribed on the technical substratum, the cyberspace. A common place is thus developed during an event of digital interaction. A monument of cyberspace can be visited long after its creation by unexpected visitors seeing the technical substratum as well as the traces left by the interaction in it.

Implications

The configuration of the four different data situations enables a better understanding of the unknown situations and opens the way for more relevant methods of data analysis. Moreover, the distinction of two contemporary situations of unknown helps avoid misunderstandings among disciplines enabling the identification of the specific data situation under study and mapping the field of research of this new phenomenon. In addition, seeing data as monuments of cyberspace helps identify the dimensions to explore in the unknown situations. In the condition where data are the resource for research, the common place of their generation has to be further explored, as well as the chronicle of the interactions that occurred in it. In the condition where data are the result of an action, beyond its objective, the means of the action and specifically the design of the technical substratum has to be studied from a new perspective: the one of enabling new types of interaction, unforeseen during the initial design process of the setting used.

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24. Human motion as input for the development of design strategies

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Keywords: human movement, public space, architecture, interventions, design process

This paper focuses on human movement in public space and how qualitative observation can lead to new insights into the architectural design process. Human movement is a topic, which gains a lot of attention in several field of interest, such as photography, geography, philosophy, computer technology, etc. ... While in the field of architecture the concept of human movement seems to have lost attention during the last decennia. Within this ongoing study we aim to find a method to visualize human movement on the one hand and on the other hand we search for design strategies through practice-based case studies.

During the sixties Gehl, renowned architect and urbanist, searched for design qualities in the urban environment which affected the daily human movements, through quantitative observation of human activities in public spaces.¹³ The results of this research lead to new insight concerning design of streets, plazas and other public space and induced a reevaluation of existing public spaces. While during the same period landscape architect Lawrence Halprin was searching for a method to design urban landscapes starting from the human movement, inspired by his wife and choreographer Anna Halprin. Halprin believed that the urban space is a stage for public life and that human movement is choreographed by its spatial elements.

Both Gehl and Halprin perceived human movement as a core element of public space and searched in certain way on how to enhance the quality of human movement through the design of spatial elements. Also Paul Virilio¹⁴ strongly believed in experience of architecture through movement and the quality of that movement. He conceived the oblique as a new architectural form - different from the horizontal and vertical - that encourages an awareness of gravity by which the body is brought in a tactile relationship with the building.

¹³ Gehl, J. (2011). *Life between buildings using public space*. Washington, DC: Island Press.

¹⁴ Parent, C., & Virilio, P. (2004). *The Function of the Oblique: The Architecture of Claude Parent and Paul Virilio 1963-1969*. London: AA Publications.

Within this study we search for design strategies to provoke this quality of movement. Different from Gehl's study we look for qualitative data in human movement. The term *Qualitative movement diagnosis (QMD)* is introduced by Knudson in the field of kinesiology and is defined in his book as followed: *"systematic observation of the quality of human movement for the purpose of providing the most appropriate intervention to improve the performance."*¹⁵ Also aspects as pace and rhythm will be taken in account. Besides we also look to the ephemeral space that is created through the movement. An essential thought within this context is the idea that movement is a valuable form of communication, which emphasizes other aspects than language. As Sheets-Johnstone (2011) states:

"Corporal concepts in each case derive from experience and in no way require language for their formulation. ... If anything, language is post-kinetic. Fundamental spatio-temporal-energetic concepts come from experiences of movement ..."¹⁶ Hence we believe that through visualization of human movement in public space a non-spoken form of communication becomes visible and communicable to others.

This study is practice based in its nature. The method that we use is grafted within experiential learning. We make use of the Lewinian learning model (fig. 1), where the main idea consists of actions and reflection on the actions, which forms a base for the following actions. Learning/understanding is conceived as a four-stage cycle, as shown in figure:

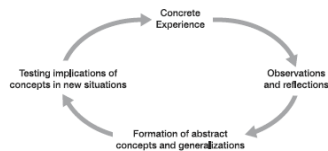


Fig. 1 Lewinian experiential learning model. (Kolb,1984)

Learning/understanding is conceived as a four-stage cycle, as shown in figure: *"Immediate concrete experience forms the basis for observation and reflection. These observations are assimilated into a "theory" from which new implications for action can be deduced. These implications or hypotheses then serve as guides in acting to create new experiences."*¹⁷ Translated to this study this means that through observation and reflection on human movement (the

concrete experience of people) some abstract concepts will be expressed in the form a preliminary design strategies. These design strategies will be tested in the form of a design intervention from which a new situation derives. This situation again will lead to new experiences whereby the process can be repeated.

In the previous discourse of this study two main categories of design interventions were developed. On the one hand two-dimensional interventions that existed of tape lines which only intervene on the floor level. And on the other hand the addition of three-dimensional objects, which rearrange or disturb the existing space. Both categories exposed to have certain effect on the human movement.¹⁸

¹⁵ Knudson, D. V. (2013). *Qualitative Diagnosis of Human Movement: Improving Performance in Sport and Exercise*. Human Kinetics, pp. 4.

¹⁶ Sheets-Johnstone, M. (2011). *The primacy of movement*, Maxine Sheets-Johnstone. (Expanded 2nd ed.). Amsterdam: Philadelphia, pp. 438.

¹⁷ Kolb, D.A. (1984). *Experiential learning: experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall.

¹⁸ Lagrange, T., Vroman, L. (2016). *Case Movement*. In Lagrange, T. (Ed.). *Look space! A story of analogous spaces* (pp. 56-78). Gent: LUCA School of Arts, Grafische cel.

Additionally some explorative observations were done in a busy square. From these observations first reflections lead to several manners to intervene in the public realm, which may have an effect on the quality of human movement. During these observations we noticed that for instance some people walk rapidly and slow down a little later, while others rather meander on a constant slow speed. These fundamental different ways of moving, results in a different experience of the space.

In this stage of the research we search for interventions that could generate a specific moving pattern, enhance the quality of the movement and the experience of space. The first design interventions are planned in the courtyard of the Faculty. The courtyard is mainly used as transition area between the entrance, the administration building and the main building of the school. As most of the people are only passing in this area and move directly from one door to the other, we search for interventions which make people to slow down and rest or to change trajectory, speed, pace and rhythm. These first interventions will enact as test cases and allows us to build up certain expertise and skills on how to capture and visualize movement. We will make use of Adobe After Effects for detailed video annotation to illuminate space related aspects of human motion. With the visualizations of these aspect we seek for qualitative characteristics of movement in relation to the space.

In a next stage we will intervene within the urban fabric. We selected four places, which have certain similarities. We defined those places as *hybrid places*, which are places that does not allow an instant reading by its spatial appearance, e.g. streets with sidewalks which are not accessible for cars. The investigated hypothesis is that by using motion-orientated design strategies we can fundamentally change the spatial dynamics and qualities in these places.

25. Sounds for us to see: designing information through acoustic landscapes

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This Design project is born in a context of Information Representation Research, exploring the boundaries of Design while working with real data produced within a rather different and usually distant disciplinary field of science – Bioacoustics. The opportunity arose after the discovery of the PANP database (Portuguese Natural Soundscapes Project) whose content was considered to be, both in quantity as in density, relevant for a reflection on the role of Design when visually representing other worlds.

The project we are now facing implies the need to design a visual interface that enables diverse approaches and readings of a large set of audio recordings collected throughout Portugal. The main goal is to design and afterwards validate a digital user interface so that

different types of users are able to intuitively navigate through the data collected under the PANP project, coordinated by the biologist Paulo Marques under the ISPA-IU (Instituto Superior de Psicologia Aplicada – Instituto Universitário) in a partnership with MUHNAC (Museu Nacional de História Natural e da Ciência da Universidade de Lisboa). According to the MUHNAC, the national archive of Portuguese biodiversity sums up to nearly 2800 hours of the Soundscapes Project recordings, from around 21 locations.

The first objective of the work we are now presenting was to design a clear map of this database of sounds. However, when listening to the soundscapes, knowing the places where they had been recorded, we were transported to images of the sites, hence becoming landscapes. That changed the perspective of our project.

The main purpose is now to create a cross-modal and sensorial-rich digital experience, which weaves sound and image; a synaesthetic journey through the sounds of life and the images from where it all happens. Such experience should be capable of portraying the recorded territory and displaying its potential as an acoustic and visual site, allowing a natural navigation through the recordings, so that their intrinsic information can be fully enjoyed by a diversity of individuals.

To make sure that the several dimensions of knowledge contained in each recording were addressed – recording site, variable conditions such as season and time of day, recording time, type of landscape portrayed, the team responsible for collecting the audio, technical equipment used, audible and identified species in the audio track – we needed a deep understanding of the audio collection. This task required extensive analysis and familiarization with the data's nature and the development of notations to properly catalogue it. Assorting this information and displaying it in an organized manner, along with the implementation of a search mechanism, helped to streamline the process of reaching and exploring the data, broadening its spectrum of users.

Perusing this kind of raw data granted us a singular perspective on a very rich physical, cultural and visual territory. Ensuring the user is offered different fruition levels, such as the ability to study the species, listening to a compilation of sounds or immersing themselves in the identity of a place, became part of the design brief. Digital platforms, such as websites, arise as an optimum medium for sensorial-rich data and physically distant places – allowing the combination of sound and image, making for a representative experience of what visiting a certain place would feel like. The pliability of the digital medium allows it to be shaped both as a scientific archive, flexible enough to display the data from different perspectives and to stack knowledge layers, and as a poetic library, available to experts and laymen. Considering that the developed notations have substantial reach, the system is able to accommodate the addition of posterior recordings, thus being able to grow and support a larger database, both in terms of time, for diachronic samples of existing sites enabling a comparative evolution of ecosystems, as in geography.

Enlarging the audience poses some questions that we must face. From an optimist perspective, we see it as an extraordinary opportunity to communicate these territories, inviting users to physically experience the sites. On the other hand, if these sites are not prepared, having already some kind of infrastructures in place (e.g. national parks), bringing too many people can alter the balance of ecosystems that are still very well preserved, being precisely this one of the first reasons to be portrayed.

This possible “acoustic tourism”, much more sustainable than massified tourism phenomena, has a largely untapped potential in this parallel tourism market. The role of Design here is not to replace the traditional experience of place, but to essentially “tease” the potential visitor. Digital media is used to portray the place’s natural soundscape and give potential visitors a glimpse of the immediate experience, without being an end in itself – the relationship with place is not intended to end on-line; it is supposed to lead the spectators to a physical visit, without digital mediation, in order to fully experience the recorded sites.

As a kind of by-product of this archive of sounds, we also expect that these acoustic travels enhance each individual’s contemplation of their surrounding acoustic environment, heightening their senses for a more complete perception of our everyday worlds.

26. Richard Neutra and Charles W. Moore: at the roots of the relationship Architecture and Neurosciences

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The relationship between architecture and neuroscience, so important for the contemporary project, has its roots – considering a scientific approach to the subject – in the works of two architects of the XXth century: Richard Neutra (1892-1970) and Charles W. Moore (1925-1993).

Neutra referred initially to the Gestaltpsychologie and to the teaching of Wilhelm Wundt, founder of the experimental psychology, the author of Principles of Physiological Psychology (1874) and the father of the architectural empathy, that was a way to modernize architecture, so recognized by Neutra that he wrote in the 1940 the essay (unpublished) Empathy-Infeeling.

Furthermore, Neutra knew Freud himself and his works since he was a young student, with a deep involvement in psychoanalysis and its many architectural implications, modelling his role as an analyst with neurotic patients.

Neutra’s project was based on physiology, neurology, psychology and anthropology, aiming at the client flourishing. The complexity of his method: the bio-realism, is expressed in his buildings, starting with the Lovell Health House (1928) and the Van der Leeuw Research House (1932). Since now, the clients’ needs and their habits were the starting point of a project, such as in public buildings, for example the Corona Elementary School of 1935.

With the Kaufmann house of 1946 he developed a new regional approach, not only sensitive to the local climate but unusually sensitive to the client and inhabitants.

Neutra’s thought and method have been especially recollected in his essays. Mystery and realities of the site (1951) focuses on the importance of the natural setting in its different configurations, analyzed through Neutra’s projects of villas, based on the relationship

between senses and setting. *Survival through Design* (1954), the result of twenty years' work, published in many languages, defined a strict relationship between brain and senses contemporary knowledge with the project and architect's responsibility of a place, and it can be considered still nowadays the starting point of a lively discussion. Moreover, in his book *Life and human habitat* (1956), he theoretically defined his renowned biological-realism in its complexity.

Also the architect and professor Charles Moore based his projects on the sense of body (haptic) and on memory, involving client's physical and mental senses.

He realized his idea of architecture in private houses (Moore Houses at Orinda, 1962 and New Haven, 1966) and public buildings (Kresge College, University of California, 1974), and expressed his thought through his essays: *The Place of Houses* (1974) and *Body, Memory, Architecture* (1977), in which he manifested the need (wishing it could become a common need) to design architecture analysing ways of living and building perception.

The body experience - he said - defines the third-dimensional sense, which is the base to understand "the spatial feeling" created by buildings, and subsequently is recognized a relationship between memory experiences and those of body.

Neutra and Moore worked mainly in the same place: the California State, but with a different approach: more scientific the former, interested in a Baroque revival of senses the latter; so that it will be interesting to analyze common roots of such an interest, but different methods to solve it.

Starting with a close examination of their theoretical contribution, the paper will examine specific buildings of these architects, mainly representative of their thought, if possible through new archival sources, aiming at a definition of their legacy in the contemporary debate on this matter, already recognized by authors as Sylvia Lavin and Harry Mallgrave.

In *Form Follows Libido* (2004) Sylvia Lavin analyses Neutra's architectural contribution in a psychoanalytic culture, contributing to recognize him as a leading figure in this field.

Harry Mallgrave in his important books *The Architect's Brain: Neuroscience, Creativity, and Architecture* (2010) and *Architecture and Embodiment* (2013), analyses the implications of the new sciences and humanities for design, referring to many authors and architects of the past.

Thanks to this historical reading, it's possible to say that many words and sentences expressed by Neutra and Moore – neglected for decades - can be considered useful for the contemporary practise of the project, and in particular their method to create a relationship between the architect and the client, to understand better his needs, is still valuable.

27. Building Envelope Form and Data: The Effect of Architecture Trends

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The amount of data involved in architecture during form finding is huge and highly variable, and the process of using the human brain to change this data into a product is still vague to a certain extent. Thus, the first logical step when introducing a form finding simulation study is to set the data constraints. In this case, the material type, environmental effect (solar rays' effect) and aesthetic iconic geometrical forms are the input data to be analyzed by grasshopper.

Starting with the common constraint for both trends, i.e. sustainable and form-oriented trends; for this study the material type is to be shape memory alloys (SMA). The main reason for this choice is to theoretically relate the material to the form in an appealing way for both trends. As an introduction, SMAs are materials that can change their form due to a change in their temperature. The reactivity to the temperature is an appealing point to environmental sustainability, while on the other hand, the ability to change form is an appealing point to form oriented architecture; i.e. the envelope can have more than one aesthetic face. The usage of such materials introduces the material geometrical constraint (for example, when dealing with a plane, the area is a constant value that should never change regardless of the transformations going on due to temperature changes as shown in figure 1).

Moving away from the only common constraint (material type) for this study between both trends, the form generation process is to be considered which in turn will lead to different constraints per trend. For applying a coherent analysis upon different forms using parametric computer software as a form generation tool, a starting point should be introduced; i.e. a flat plane initial form is to be provided in order to analyze the different transformations that fell upon it. In other words, the transformational form generation should be considered. This form generation type has been used since the classical architectural eras. It continued to be distinguished by three types currently of which the first two are of most concern. The three types are as follows:

- The Traditional Strategy: Depends on different contextual constraints; i.e. relevant to generating smart envelopes' forms
- Borrowing: Depends on copying from a sculpture or a given form; i.e. relevant to form oriented architecture
- De-construction or De-composition: Depends on decomposing or deconstructing a given concept or form and recombining the products to reach a new whole; i.e. relevant for certain conceptual contemporary trends.

Starting with the form related architecture, due to the subjectivity of measuring aesthetics; the borrowing strategy is to be used. First, grasshopper parametric tool is to be used to analyze a computer generated standard 3-D model for an iconic architectural figure of a form-related architectural trend (Heydar Aliyev Center by Zaha Hadid Architects). Then, using this analysis, a grasshopper script using basic definitions in the

software is to be generated depending on the virtual analytical data received from the iconic figure 3-D model; which is based on analyzing cross sectional curves by calculating the slopes generated when joining multiple evaluation points for that curve. In other words, a script is to achieve the same form when optimized parametrically using genetic algorithm. This will typically lead to a parametric transformational borrowing strategy where changing the input data (the iconic figure from which the constraints are calculated) changes the output. Yet, that output is assumed to be aesthetically pleasing in the same manner as the basic iconic figure, i.e. aesthetics are measured using geometrical equations derived from aesthetic figures.

Moving to the sustainable architecture trend, the measurement of the efficiency of reaching this trend's goals is much less subjective, especially in the sustainability of energy department. This is mainly because energy consumption is a measurable aspect, unlike aesthetics, and its minimization is highly appreciated and easily simulated upon parametric tools. For this analysis, honeybee plugin to grasshopper is to be used mainly to analyze the effect of the building envelope (building shell) form upon solar loads in the interior space. This is to be done regardless of the openings and ventilation to minimize the calculations. Yet, the energy consumption calculations are subjective when it comes to the needed daylighting and heat loads; where in certain cases, maximizing the solar loads is much appreciated and vice versa. Thus, this tool is to be used to optimize the building shell form to reach a certain value which is assumed to be optimum for the daylighting and heat gain conditions. Therefore, the optimization is applied using a plane -whose width can be parametrically controlled- arrayed along a south elevation in Cairo, Egypt as shown in figure (1); where genetic algorithm is used to iterate the external plane dimensions, and Honeybee plugin calculates the solar loads upon the south elevation for each iteration; i.e. sustainability is assessed in terms of heat loads optimization.

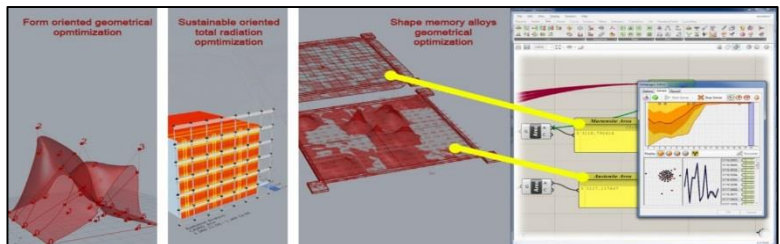


Figure (1), From left to right, 1) Form oriented borrowing form generation, 2) Sustainable oriented heat loads optimization, 3) SMA geometrical optimization for high temperature (Austenite) and low temperature (Martensitic) states

After generating different envelope forms for both architectural trends, a comparative analysis is to be introduced from both the form oriented and sustainable oriented points of view. In other words, each trend is to use its own form generation tools to test the other. First, form related architecture is to be tested using the heat loads measuring tool to reach an optimized state while maintaining its introduced aesthetics. Second, the sustainable oriented form is to be tested using the form oriented borrowing approach. This is yet very subjective; however, using the same methodology, the grasshopper is to be used to find the geometrical similarities between the sustainable generated form and the iconic form; if present. Using these tools, the usage of input geometrical data of initial

iconic forms, form analysis data and daylighting data; it is fairly easy to develop different forms each intended to reach a different architectural trend and compare between them using the parametric tools that generated each.

28. Spatial Solutions and Solution Spaces: The use of Virtual and Augmented Reality in Design Exploration

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The recent wave of Virtual and Augmented Reality (VAR) technologies has coincided with new technologies for processing, analyzing and evaluating large amounts of data. In general, the purpose of Data Visualization is to enable the user to discover and understand patterns in data. Good visualizations present large amounts of data in a way that is easily understood, and good interactive visualizations promote intuitive means of exploring relationships. Over the past few years many researchers have looked into the development of immersive Virtual Environment platforms for Big Data visualization, such as, iViz (Donalek et al, 2014) and the work carried out by Masters of Pie and Lumacode for the Big Data VR Challenge in 2016 (Lumapie, 2016). Filtering, combination and scaling have all been identified elsewhere as important interactive techniques used in contemporary data visualization (Olshannikova et al, 2015). Of these, scaling may be the most familiar to architects: for centuries, designers have attempted to experience architectural space in different scales simultaneously, by using models at different scales (Yaneva, 2005), and by employing various drawing techniques to achieve an embodied perception of the designed space. With the use of VAR technologies this becomes easier than ever. At the same time, designers increasingly must understand not just the experience of a design proposal but also the data associated with it.

To experience data as part of a design process emphasizes that architecture addresses wicked problems (Buchanan, 1992; Rittle and Webber, 1973) requiring negotiation between various disciplines and performance objectives. Critical criteria including aesthetics and contextual suitability further complicate design process because of their resistance to quantitative and objective measurement. Reaching a resolution to these myriad constraints and conflicts is a learning process through which numerous potential schemes are explored. The application of computers, especially through parametric modelling and optimization algorithms, significantly facilitates this process by generating and analyzing a large number of design alternatives (Woodbury 2010 and Turrin et al, 2011). The trade-off for this power is the need for well-defined parameters to generate schemes and the need for strictly applied criteria to evaluate these schemes. Brander et al. (2014) identify opportunities to use design optimization not to find the best performing solution, but to gain understanding about the design space, which is often used as the starting point for design exploration. Since the candidate points are equivalent in that each represents an optimal solution according to particular combinations of objectives, a selection and evaluation phase is required in order to extract useful information (Shir et al., 2013). Typical approaches to visualizing the space of multiple potential solutions

(Chaszar et al., 2016; Sileryte et al., 2016; Ashour and Kolarevic, 2015) plot candidates as isomorphic points embedded in a low-dimensional space, which makes it difficult to develop an intuitive approach to navigating this solution space. Recently there has been much effort applied to create better design space exploration software. Nevertheless the full potential to efficiently generate and meticulously examine candidate solutions from the perspective of multiple disciplines has not been fully realized (Flager and Haymerker, 2007). Maile et. al (2007) attribute this to poor user-experience in this class of tools.

We address these issues by considering some of the opportunities and challenges of using VAR technology to simultaneously experience spatial and non-spatial data related to architectural design. We do this by reflecting on application of VAR technologies in the design process in a large architectural practice. Two key approaches are identified:

- 1) a superimposition of data in embodied interaction with design schemes
- 2) a spatial experience of higher dimensional data related to design schemes, facilitating the designer in navigating the solution space or morphospace.

We discuss the merits of each of these approaches with reference to application in the design of tall buildings. The effectiveness of multi-objective optimization (Gerber and Lin, 2014) and design decision support systems (Singhaputtangkul, Natee, et al., 2013) in the design of tall buildings have been demonstrated elsewhere. Building on these precedents we demonstrate the potential of immersive interaction in navigating and understanding individual design options and groups of candidate solutions.

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29. Archi-lab + Citi-lab

Bringing together digital information, ideas and technologies for interactive 'real-time' visualisation that can help create better places

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Fusing the virtual world of gaming software with 'hands-on' real-time simulation or augmented reality in urban and architectural environments is a game-changer for the development industry. Citi-Lab and Archi-Lab software has been created to provide design professions, developer agencies and assessing authorities with a higher level of performance and accuracy in the development and assessment of project designs within their context during the critical early stages of project implementation.

The software enhancement can generate demonstrable or measurable outcomes within the CAD modelling space, and with the capacity for feedback loops to display immediate responses, these services can enable much more effective use of digital data in early stages of urban design and architectural environments. Working with a base CAD model, attributes given to elements and spaces can be assessed with algorithms to provide

quantifiable values under differing conditions, boosting creativity and productivity through more efficient use of intelligent data during the design process.

Initially architectural 'real-time' simulations have been applied to creating interactive experiences for display suites, or audio-visual overlays that can put potential users/buyers/investors into a high quality immersive model of a project. Further development has also provided architects and councils with computer generated and certified shadow diagrams and solar access analysis, required as part of the development approval process to quantify sunlight in living spaces or the public domain.

Archi-lab

The built environment comes under increasing pressure as urban densities grow, adding to the challenge of managing the design process for both buildings and the spaces between them.

Overshadowing and solar access impacts are a common and serious problem for new developments, particularly for high density residential DA (Development Application) approvals that face court action when Councils reject a submission, with serious financial consequences due to time and cost issues. When neighbours want to ensure adequate sunlight will be available to them post development, Councils are increasingly seeking detailed analysis of overshadowing impacts to ensure there is sufficient solar access.

Current methodologies for solar analysis are cumbersome, slow and expensive, often requiring weeks of iterative manual work and subsequent reporting. Archi-lab, through its capacity to integrate 'real-time' environmental analysis within complex 3D CAD models, can provide coherence, certainty and consistency for solar access analysis and overshadowing studies to:

- generate a comprehensive spreadsheet report, screenshots and views from the sun for any particular time interval,
- encourage users to modify designs and generate instant reports in line with scheme changes,
- augment existing software packages for greater workflow benefit and minimal business disruption.

Sensors and controllers are regularly used in commercial buildings to manage and optimise services for tenants and patrons, with thermostats for climate control, ambient light sensors to control lights and shading devices, and security passes for access.

With the fast growing connectivity in the urban environment through the Internet of Things (IoT), data flow between devices within buildings and people with mobile devices can give architects another realm for design evolution. Feedback from smart buildings and cities can generate circular flow of information between users and the places they engage with, but how IoT this is managed and best utilised in such ways still 'work in progress.'

In the newly emergent 'smart cities' paradigm, architects and urban designers can move from designing edifices to creating 'place experiences' for the users. Through real-time feedback systems exchanging data with smart consoles, architects in collaboration with network and software engineers can lead a new wave of creative design where everything can be monitored and managed via an IoT environment.

This will generate new ways in which buildings are conceived, built and managed, but could also enable processes to monitor and gauge emotional reactions or feelings through VR technologies and neural sensing (subject to resolution of privacy issues!).

With continuing work being done to develop a VR interface with various aspects of the Archi-lab and Citi-lab systems, more 'democratic' engagement with project stakeholders should become possible at a number of levels.

Citi-lab

Cities are like intricate living and breathing organisms that grow in complexity, their design and patterns shaped by the forces of human evolution, technology and economics. Citi-lab aims to take future users into projected virtual environments like those created in many gaming products, and enable levels of interaction and consultation that can assist in a more collaborative process of assessment and response to evolving design strategies.

Architects are able to imagine and create complex 3D designs incorporating spaces, form, colour, patterns and textures - elements that influence our interaction and well-being in the urban environment. But the modelling of these environments, and appreciation of their future psychological impacts on users during the design process, is limited by the capacity of those users to visualise design intent based on traditional presentation.

Augmented reality and immersive visualisation can be undertaken to:

- help stakeholders understand implications of design concepts and variables in spatial conditions, climatic variable or material finishes,
- assist authorities responsible for assessment of performance and compliance, or in strategic evaluation of planning proposals,
- build a useable and sustainable database to manage, amend or upgrade projects in the future as urban areas develop.

Through algorithms linking elements/volumes/areas and proportional evaluation of uses, there is also potential to efficiently assess block modelling in the conceptual development stages of urban form for:

- Gross Floor Area and Floor Space Ratio
- Extent of uses and occupancy capacity
- Car parking requirements and distribution
- Ratio of open space to building footprint
- Heat generation and heat island effects
- Solar power generation and natural ventilation potential

With further research extended to the spaces between buildings, it will be possible to evaluate security, view sharing, way finding and environmental conditions in real time that can assist design evolution in more dynamic ways, by testing and amending concepts in a more efficient and consultative manner than the conventional and iterative step by step process. A fluid model that can provide data feedback in multiple layers and with multiple strands of analysis could see a quantum leap in reaching optimal solutions, providing immediate appreciation of environmental impacts, resource usage and compliance capacity.

30. People, Data and the Built Environment: Future Façade Systems should be less wall and more skin

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SKIN

Architecture is the result of both creative inspiration and a variety of external inputs. It is both object and tool providing an experience to people around and within. Regardless of its capabilities, architecture at its most basic, defines space.

Generally we accept that a building's purpose is manifested by the use of its interior space by the occupants within. However, the exterior surfaces of architecture are what influence the collective external space and directly impact our environment. Because of its permanence, architecture becomes an immediate imposition and a future disruptor.

When discussed casually, architecture is reduced to form, how it looks. The shape of the object described is made up of a variety of individual systems and assemblies that comprise the building enclosure, it's skin, developed with a lot of design and technical consideration. Within the overall envelope, the (mostly) vertical façade is the system or systems which are primarily responsible for appearance and are the most responsible for a building skin's various performance capabilities.

Facades built today are in some ways very advanced and in others not very different than their predecessors going back centuries. The building skin has experienced a leap forward in construction and fabrication techniques influenced by developing technology. Digital visualization now also allows for the exploration of countless geometric algorithms meaning our buildings can look like nothing else before them. The challenge today is that when all buildings look different, they all start to look the same. Cities around the world are losing their identity as they chase the tallest, thinnest and most provocative imagery. The object takes priority over the context and the design community seems to be worshipping not form, nor function but image. With the computer a part of every aspect of life and the honeymoon phase over in terms of designers using digital tools to warp mathematic possibilities of a building's skin design will future architect's benefit from experiential data over digital?

DATA

Design and construction methodologies are being influenced by data in many ways. From realization, as evident in the increasing use of Virtual/Augmented Reality, to complex, parametric modeling (3D), management of component cost and schedule tracking (4D & 5D) all the way through fabrication.

These modern advances mostly deal with the building of architecture, it's execution from ideas, to plans to construction. They provide the means to assemble hundreds of thousands, if not millions, of components together relatively seamlessly, quickly and

efficiently. Data has provided architects the means to construct nearly anything, establish systems performance criteria, choose materials based upon life expectancy and value.

However, there is comparatively little data readily available about how buildings, systems, spaces and environments actually impact and influence people. While most buildings built now perform better than in years past does that mean they are better for people? With current technology, form and function are interchangeable and meaning can be lost. Would the built environment designed by data extracted from psychology, neurology and emotion – how we feel – dramatically alter the architect’s approach to design? Do modern facades create positive experiences by bringing joy, encourage exploration, push interaction amongst occupants and neighbors or are they simply a large scale example of consumer waste, the ultimate epitome of our out of date and obsolete mobile device?

Technology combined with the disposable nature of western modern society, means that architecture must rethink a fundamental question: Can data nudge architects away from how to build towards why to build?

CO Architects will discuss recently completed projects as case study examples of how modern façade assemblies function as a tool and experience. Each case study will cover the functional aspects and challenges of the various façade assemblies and the aspirational goals behind the individual systems - flexibility, branding, wellness, healing, communal and local.

Using these examples to establish a baseline of the modern façade assembly methodology we look beyond the present. CO has identified six characteristics that façade assemblies should incorporate to allow them to move beyond object – Permanent, Generative, Upgradeable, Interactive, Adaptable, Degenerative/ Disposable – Data will be an intrinsic part of all future design and construction activities. Choosing what data to incorporate into a façade design that focuses on people, internally and externally will be a major driving force in design and will shape our buildings, neighborhoods and cities hopefully for the better.

31. Immersive Data Visualization Informs the Design of a Responsive Surface

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Our research is testing the capabilities of an augmented reality design tool, for real-time, immersive data visualization experience within a virtual space. Our cross disciplinary team brings together an architect and interior designer, a digital interactive sound specialist, and a data visualization artist, to research how an immersive experience can provide multisensory feedback for the development of AuralSurface, a responsive surface that mitigates sound.

Conceptualized as a response to distractions in the workplace, AuralSurface is a responsive surface inspired by the need to control ambient noise created from everyday life in the office, while also serving as an adjustable separator that maintains a sense of open space.

For workplace performance and comfort, the responsive surface optimizes interior environments by adapting to the changing reverberation rhythms of voices and footsteps. AuralSurface can also be parametrically calibrated to a desired acoustic setting, which allows for increasing or decreasing acoustic dampening depending on the needs of the interior space and its occupants.

As office cultures trend toward collaborative working environments with mobile workstations, office space designs are becoming increasingly open. There is a growing need to mitigate distracting and interrupting noise. AuralSurface seeks to reduce fatigue and stress in the workplace by controlling ambient noise disturbances. AuralSurface's design allows it to autonomously deploy an acoustic material at specific locations when the perceived decibel levels are higher than normal. In addition to a physical response, the acoustic material may be seen as a visual cue once deployed. Those holding conversations may recognize this as a subtle sign to speak more softly or to take a conversation to another area. AuralSurface, a panelized surface, is an otherwise seemingly typical modular system. AuralSurface's array responds to commands from an automated control system based on noise levels and proxemics, and can be operated manually by occupants with a smart phone or tablet interface. It can also be seen as an aesthetically pixelized scratch pad where users can doodle with various visual arrangements and consequently a desired privacy level (both visually and aurally).

For an experiential effect, panels can be programmed to create dynamic patterns across one single module or an entire surface. Programmed arrays can also provide an interactive response to human proximity, maintaining a one to one scale interface of human and system interaction.

With the introduction of our immersive tool (Microsoft HoloLens), we are able to visualize data and metrics in real time, via augmented reality. This visualization tool provides layers of graphic information ovetop a virtual responsive surface. Project constraints have required our physical responsive surface prototypes to be limited in size. Through HoloLens' virtual environment, we are able to view a digital prototype in a space at full size. The information seen and collected through HoloLens assists in the design refinement of our current digital prototype. The virtual environment provides a better understanding of how the responsive surface responds to multisensory input (proximity and sound), as well as how it performs in various spaces.