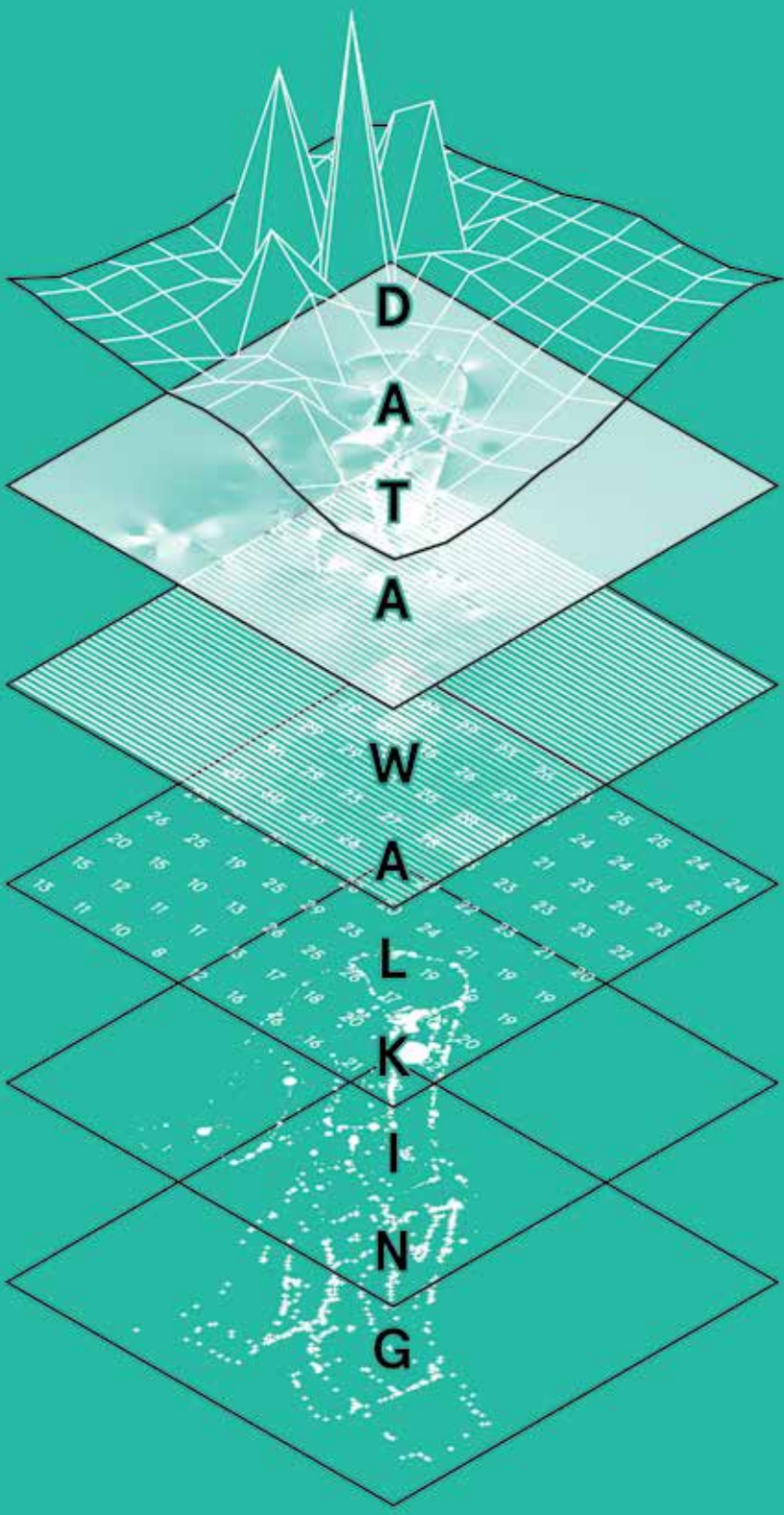
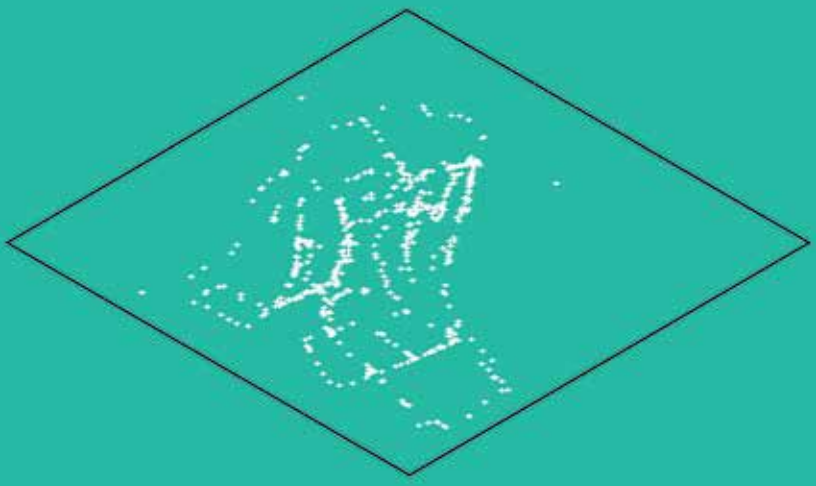

DATA
WALKING

PART ONE

PART TWO

PART THREE



photographs

people

INTRODUCTION

The world is out there for us to explore and make sense of, globally and locally, whether visiting a new city or walking through our very own neighbourhood. Travel and movement between locations has never been more accessible; yet we have never felt more chained to the computers on our desks, or drawn to refresh the devices in our hands. As designers as well as citizens we have a social responsibility to generate outcomes that are of value to our communities. Broader experiences give us balanced views and new insights to help make those valuable contributions.

It is important to understand the spaces we move through, not to merely navigate from A to B or perform tasks 1 and 2. It is through this understanding we create opportunities to make better informed decisions for the future, make sense of the present and appreciate the past. To understand our environment we must gather data, describe and catalog, and analyse it as information with the aim of turning this into knowledge, wisdom and action.

Urban environments are a complex and ever changing amalgamation of fluid and frictious elements, layered and interwoven in set and sprawling space. These elements include natural and man-made spaces, architecture, infrastructure, transport, vehicles, tangible and intangible information networks, real life and online interactions, and the people who inhabit them and the culture they make. Data surrounds us. From the air we breath to the conversations we have to the history under our feet. Its gathering and communication creates an opportunity for critical reflection and dialogue.

Cities are in constant flux, never static, always moving; just like its citizens. Walking is natural in the city. No other form of transport allows you to investigate the space you inhabit in such fine detail and high fidelity. Of course the project needn't be limited to cities or urban settings.

Data Walking is a research project with the aim of gathering environmental data while walking around a specific area, and through multiple walks over time build a rich picture of that area, a layered multidimensional `dataspace'. In this process we get to explore the potential of data gathering while walking, and then visualising that data in different ways.

The project has focused on a variety of data gathering methods including analog, photographic, microcontrollers with sensors, laptops, and how

they can be creatively utilised. Where possible it has made use of GPS technology to locate data in space and time. Data Walking has also looked at different visualisation methods and mediums including printed, laser cut, 3D printed, animated and interactive outcomes. Experimental outcomes have been encouraged, exploring new forms of expressing data, thanks to the participation of a number of notable contributors.

Learning new tools has been a key part of the project. Arduino and Processing have been used for data gathering and visual experiments. They are open source, low cost or free, and suitable for novices. As such they work will with the aims of this project, and requires only a little previous experience dabbling with code and physical computing, and a basic understanding of data vis principles, but plenty of enthusiasm.

Much of the code and data from this project is online for anyone to use, available on the project website and github repository:

`http://datawalking.com`
`https://github.com/DHDPIC/DATA_WALKING`

The project has been through a number of distinct phases in different locations, discussed in more detail later, and has broken out from those longer trajectories in the form of workshops and presentations. This report is one of the outcomes of the latest phase in North Greenwich, London, which builds on the learning from previous phases.

This report discusses the aims of the project and the outcomes, compiles some of the learning on tools and methods tested during the project, workshops conducted, as well as contributed visualisations by students, educators, and established designers and design studios using data gathered during the North Greenwich phase of the project. The visualisations are of datasets from a particular time and area, but the learning and principles from the project are universal and could be applied to anywhere you want to explore.

I hope you find this report stimulating, helpful, and I encourage you to get out and do your own walks and join the project!

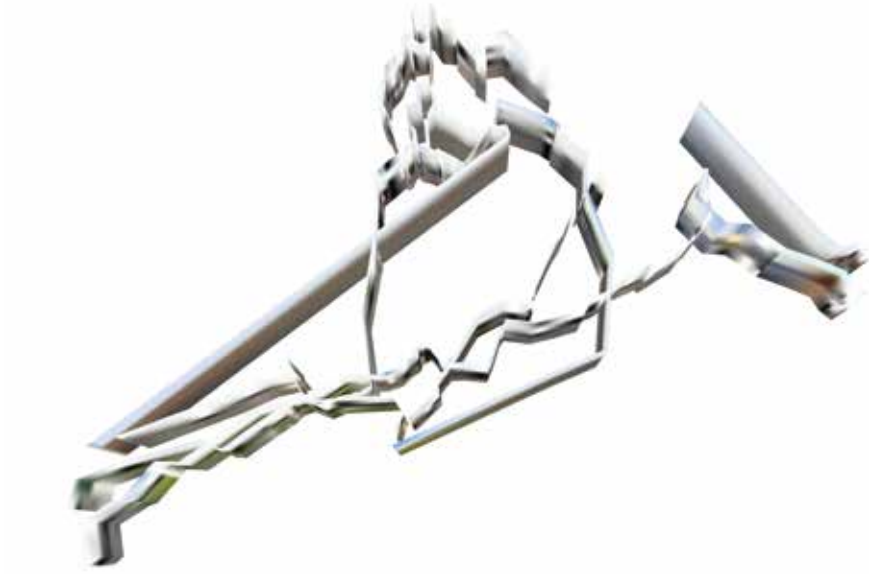
PHASES

Stratford to Barbican
Data Walking began in response to artistic walks conducted by the Mnemonic City collective who used walking to discover and discuss memories and stories of a city. The notion of cities as data rich environments became apparent, and the idea of cutting paths or a transect through this 'dataspace' worth further investigation.

As part of the Fish Island Labs incubator program Interfaces exhibition, a series of walks were conducted over 24 hours from Stratford (close to the FIL incubator studio) across East London to the Barbican Centre, the exhibition venue. Data was gathered on the environment including light levels, sound, temperature, air quality, as well as photos. The outcome was a series of 3D printed data cylinders encoding each data type recorded and mapped to the photo taken in that location. This phase of the Data Walking research project was funded by the Ravensbourne Research Office and the Barbican Centre.

Amsterdam

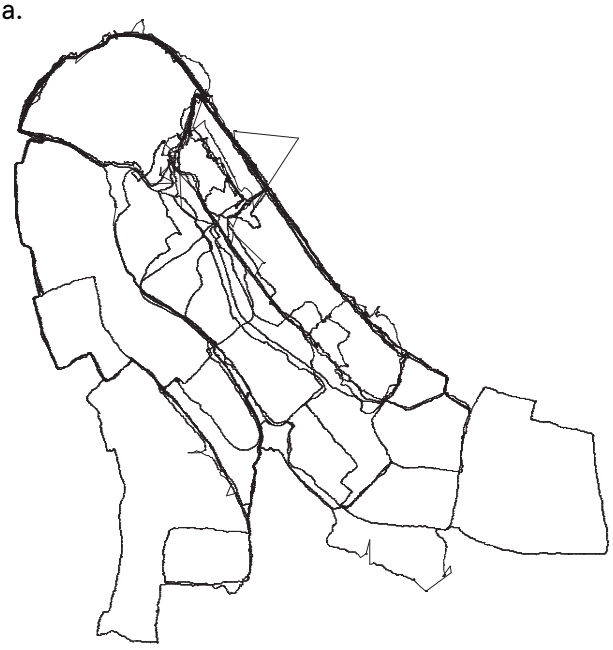
A weekend trip to Amsterdam spent exploring the many streets and canal sides on foot (with a little cycling) and taking lots of photos, became an opportunity to test ideas. The photos were used in an exploration of fulfilling one of the original aims of the Data Walking project: to imagine a city as a three dimensional volume or 'dataspace', and then be able to cut transects through that city of data. The outcome was a printed publication detailing the process of taking a collection of photos and creating maps, routes, volumes, in 2D and 3D, using custom computational design tools created in Processing.



North Greenwich Peninsula

Over one year, monthly walks took place exploring different techniques to collect environmental data while walking around North Greenwich, where Ravensbourne is situated. The walks were open to anyone, with many students from different courses joining. Data gathered was shared on the project Github repository. From this data visualisations, maps, charts, data experiences, and artistic works have been made by participants to represent the area and the process of the project. This phase of the Data Walking research project was a Major Grant project funded by the Ravensbourne Research Office.

North Greenwich was selected as the area to study for three reasons. It is where I work and spend a significant amount of time in the area; it has a large group of students, educators, and design professionals who would be interested in participating. The area is experiencing large and rapid change with an ambitious regeneration program underway. Many multi-story flats, hotels, offices, alongside significant infrastructure and transport network changes are altering the Peninsula from ground to sky. This aspect makes it an interesting area to document for a year and one that could have an impact on the large number of people who live and work in the area.



routes walked around the North Greenwich Peninsula

heatmap of sound data gathered on all walks around North Greenwich. Light areas have high amplitude readings

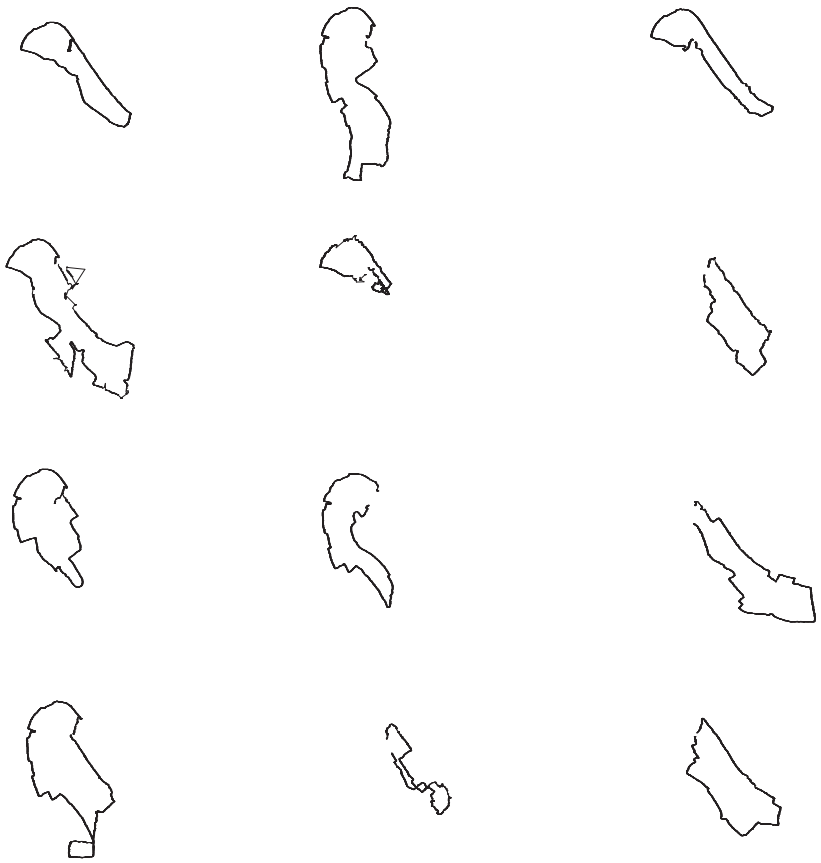
EEEE

Exploring our surroundings, from the environments we live in to the far places that interest us.

Experimenting with technology and how it can be used for creative data gathering and designing with data.

Engaging with issues and topics relevant to us. What interests and what matters to our communities?

Empowering people and our communities. Getting to grips with data literacy, sharing knowledge and tools that in turn help to create new knowledge and tools.



the twelve individual routes walked, one per month. Read from left to right, down. January top left, December bottom right

dot grid map and stippling/dot-density map of sound data in North Greenwich. Varied dot size and regular placement, or regular dot size and irregular placement. More sound means larger dots or greater dot density.

AIMS

INFORMATION DESIGN & DISCUSSION

The Visual Display of Quantitative Information, E Tufte

Envisioning Information, E Tufte

Visual Explanations, E Tufte

Cartographic Grounds, J Desimini, C Waldheim

Data Visualisation: A Handbook for Data Driven Design, A Kirk

Design for Information, I Meirelles

Thoughts on Designing Information, I Gobart, J v Looveren

InformForm, M v Neck, M d Gandre

Data Flow (book series), R Klanten

You Are Here (book series), K Harmon

The Exposed City: Mapping the Urban Invisibles, N Amoroso

Walking and Mapping: Artists as Cartographers, K O'Rourke

Where the Animals Go, J Cheshire, O Uberti

Journal (series), The Office for Creative Research

Digital Design Theory : Readings from the Field, H Armstrong

Graphic Design: Now in Production, B Andrew

The broad aim of the Data Walking project is to understand the environment around us by gathering data, analysing and visualising it, and then test the idea that through multiple walks a rich, mutlilayered 'dataspace' can be produced. The initial desire was simply to cleave a city in two and explore the hidden data all around us. Part of this involved trying out different low cost data gathering technology and sensors, particularly using Arduino, but also the potential of smartphones, and generate some data on my surroundings to look for trends, outliers, and any interesting activity or phenomena.

In my career as a designer and educator I notice many passive students and practitioners with a reliance on internet search results as the answer to all questions; I'm sure we are all witnesses to and guilty of this habit. Is sitting at a desk with a screen the pinnacle of research methodology that we aimed for? Researching should be a broad range of activities and on a simple level this project is about getting outdoors and exploring the world. You cannot do this project stuck indoors behind a laptop!

The act of doing invites assessment and contemplation—it's how we understand and improve, how we learn. The act of doing prompts greater insight and is a fundamental principle of this project. It also leads us on to iterative design processes, developing ideas and outcomes and refining them through many repeated stages and processes of experimentation, testing, and evaluation.

And how does this project relate to learning for participants? Data Walking is hands on, about discovery, and finding out things for yourself. It aims to encourage growth of a mixture of skills, theoretical and analytical, technical and practical. It enables cross-disciplinary practitioners and networks. Walking in groups is naturally communal, and Data Walking naturally collaborative, whether before, during, or after a walk, it allows participants to bind together around a number of access points, be it a shared interest in an area, an issue, a technique, or a peer-to-peer exchange of skills and knowledge.

This allows the designer, or team, to work end-to-end from data gathering through analysing, editing, authoring and visualising. Just as designers took authorship in the 20th Century by writing and generating content, so designers can now take a new authorship by gathering and generating data.

The aim is to expose designers or any participants to data gathering processes, and researchers, data analysts, scientists, or anyone

concerned with representing data to consider different forms their data can take. It is an opportunity for participants to learn about data literacy, understand the fallibility of sensors, technology and processes, the ambiguity of results, and principles like correlation does not mean causation, in the hope they are better equipped to deal with data in other aspects of their lives.

Much of the technical advice in this book already exists online, free for anyone to find and use. There are a good books and online resources on using microcontrollers like Arduinos, excellent introductions on how to code, and a wealth of books on data visualisation. Instead of collaging snippets from books and online resources, this publication in principle aims to bring the processes of data gathering and designing with data closer together as one coherent workflow, and in practice act as a guide with examples of this workflow. The creative coding movement has opened up programming to wider range of audiences, so I hope that data gathering can be explored in a similar creative context.

This report aims to summarise the events, learning, discussions, and contributions from myself and those who have been a part of the project, framed with useful takeaways for the reader. And beyond this report, the Data Walking project has developed towards a platform, sharing an approach to research, and ideas for tools and outcomes to understand the world around us.

CODE & TECH

Making Things Talk, T Igoe

Making Things See, G Borenstein

Environmental Monitoring with Arduino, E Gertz, P Di Justo

Generative Design, H Bohnacker, B Groß, J Laub

The Nature of Code, D Shiffman

Holo 1 & 2, Various

CAVEATS

The first thing to remember when doing this project is that we are not scientists (unless you really are)! No matter what machines we might have access to or topics we are interested in we do not have the level of expertise to claim we are scientists or statisticians.

There are no scientific controls. We are not studying the world through a laboratory, and we are not comparing multiple areas against one another. We are going on different routes at different times of day and year. Fair comparison of data might be difficult. Nevertheless, understanding controls and fair tests is important to make our methods and data as useful as possible.

We also need to acknowledge that we are actors in the scene and our presence affects the environment we are recording. The approach of Data Walking is not to limit our human actions; photographs don't need to be absent of participants, walks don't need to be silent just because we record audio. In fact, if a particular area stimulates a certain conversation or inspires a new method of cataloguing, then this should be encouraged. Of course it is also acceptable to be much more rigorous and controlled in how a walk is conducted, it depends on how you as a practitioner want to approach your project.

This project is not meant to be a substitute for real science by professionals with the best equipment. However, walking provides a low cost, efficient and rapid way to study an area and its aspects. If something anomalous or of interest was discovered through Data Walking such as a concern over air quality or excessive littering then a proper sensor network could be deployed or study undertaken.

Some of the equipment available is cheap and unreliable, it will inevitably be misused in experimenting, all resulting in poor data. That is part of the learning process, and highlights that this project is not a replacement for fuller investigations.

We may discover nothing of huge importance! Just because we decide to study something and record data to analyse, it does not guarantee there will be anything discovered that is dramatic or wasn't already known. This may actually be a reassurance. The focus can be on what we learn from the methods and the process, rather than the data.

histogram-like colour plotting tool from 1067 photos taken around North Greenwich in one year

CONTEXT

Democratisation of Technology
Only through the proliferation of low cost sensors, open source technology like Arduino microcontrollers, and the ubiquity of the smartphone, has this project been possible.

Big Data and Open Data
Big Data, a term coined to refer to the large and complex data sets produced and processed only recently possible due to technology. It is high volume, varied in medium, tying together text, image, video, is recorded and made available in near real-time, and is frequently the result of our digital interactions. Big Data has been touted to revolutionise practices across all sectors, including government, finance, education, healthcare. There are criticisms of Big Data, not just the ethics of gathering such vast quantities of data on people, but also myths around it as a panacea.

There is also Open Data, data which is freely available to use and be distributed by anyone. Open Data has also laid claim to empowering society through governments and scientists, amongst other data holding entities, sharing data and allowing others to use and with it build products.

Data Walking has created lots of data, not quite Big Data, but data that has a range of aspects, mediums, and is highly localised, temporal, and spatial, and in that interrelation a complexity that can be viewed through different prisms. All the data and a lot of the code for tools to gather and visualise have been made available to use online for anyone to use and participate in the project.

Data Literacy
Data Literacy, is the ability of a person to understand what data is, how it is gathered, analysed, communicated and interpreted. In this project, through getting hands on with making data gathering tools, we can have discussions around the sensors used, their accuracy, how equipment is sometimes misused, wired up incorrectly or breaks, and how data can be recorded incorrectly or poorly translated after recording. And in visualising data we can discuss appropriate forms of visualisation and chart types. So while this is not specifically a project studying Data Literacy, it is hoped that by participating in the project people will increase their awareness on the above issues.

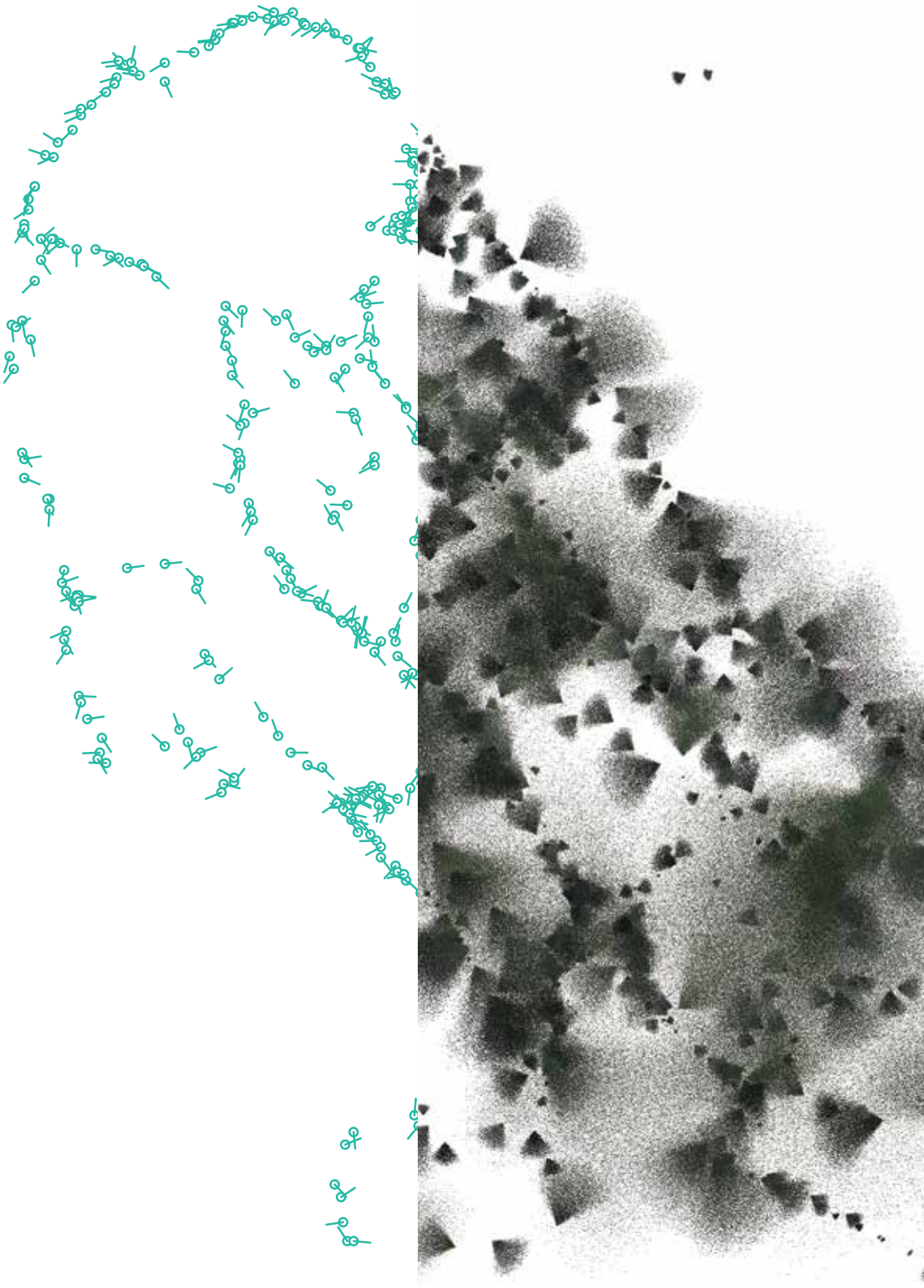
Data as Medium
Data is a medium that can be shaped into forms and images, to provide evidence of something, proof. A long time ago, the written or printed word and hand-rendered pictures conferred power and dictated knowledge by what was in books. The development of photography eclipsed written techniques for providing evidence and became the method of choice for photojournalism, crime scene recording, military reconnaissance, amongst others. Then came moving images, the ability to capture the world in motion, as we experience it. From microscopy to satellite photography and time-lapses to high frame rates, photography has allowed us to see the world at different scales and different speeds. But as systems and processes have become more complex and phenomena of interest move out of the visible spectrum, data is a new frontier in image making, a new type of proof to confirm or quash our ideas of what happened.

Quantified Self
A recent movement that many of us take part in to different degrees, is broadly defined as gathering data on one's own daily life. Although we are not necessarily measuring the self, Data Walking does tap into the 'datafication' of life, and does chart personal or group movement. In a sense we are inverting the Quantified Self and measuring that which is external to the self while also acknowledging that we are in that space and have an impact on it. In Data Walking we could also measure the participants by heart rate, galvanic skin response, gait, eye tracking, conversations.

Psychogeography and Flaneurism
The act of exploring through walking, understanding a city by building mental models that go beyond the strictly geographical. Psychogeography has its roots in Flaneurism, a 19th Century description of wandering, a way of understanding the richness of the urban landscape. These ideas are at the core of Data Walking, playing with the notion of actors in a scene, passive and active data gathering, getting lost but finding, reflecting on our surroundings.

Reinventing the Wheel vs Standing on the Shoulders of Giants
If every time we made a project we had to invent all the tools from scratch, projects would take a long time or never get done. On the other hand, if we only ever build based on previous tools then we risk opening up a gap in our understanding of a tool's fundamental operations that really make them work. And the same goes for data and using data created by others. We don't necessarily know the veracity of the data we use. We assume that reputable sources will give us reliable data; and that works most of the time. Transparent processes are key. Another way to ensure the quality of the data is to gain skills, collect data, and contribute it for others to use. It might also be the case that certain types of data are not available for a specific aspect or place, or in high enough fidelity. In which case it is time to roll up our sleeves and gather the data ourselves.

There is a balance to be struck, and in this project we are encouraging people to make their own tools to gather data, rather than just use other people's data, but not pushed to the point where they create their own programming language or print their own printed circuit boards (PCB); although those with such skills are welcome to!



plotting all 1067 photos and their direction of capture. Extracting their green pixels and ‘spraying’ in the direction and 73° field of view arc to computationally speculate on green spaces in North Greenwich.

DATAVIZ?

DATA STORIES PODCAST EPISODES

106 Data Sculptures, Adrien Segal

102 Understanding Comics and Visual Storytelling, Scott McCloud

96 Innovation from Research, Jarke Van Wijk

93 OddityViz, Valentina D'Efilippo, Miriam Quick

91 Visualising Data with RAW

90 Beyond the Chart, Brendan Dawes

88 Re-designing Visualisations #MakeoverMonday, Andy Kriebel

85 Machine Bias, Jeff Larson

84 Statistical Numbing, Paul Slovic

83 Olympic Feathers, Nadieh Bremer

80 Indexical Visualisation, Dietmar Offenhuber

79 Information Design, Isabel Meirelles

78 Visualising People's lives through Mobile Data, Mimi Onuoha

75 Listening to Data From Space, Scott Hughes

69 Data Visualisation Literacy, Jeremy Boy, Helen Kennedy, Andy Kirk

66 I Quant NY, Ben Wellington

53 Data Safaris, Benedikt Groß

51 Smarter Cities, Dietmar Offenhuber

As more data is recorded, data visualisation has become an increasingly important component in communication. Data Visualisation as a practice now has exposure to larger and more varied audiences, appearing in new forms and places, and must regularly evaluate what works, when, where, for who, and why. Just like any practice it cannot afford to remain static, and must explore its potential. Only through testing can we discover a field's limits and in an informed way define that field: what is inside and outside its bounds of success. It's in that testing spirit we approach data visualisation.

There is some debate as to what defines a data visualisation. There is the traditional view that a visualisation must define units of measure, a clear scale or axis, and serve the precise communication of information; without those elements many would not consider it a visualisation. However, there has been an emergence in recent years of work in the realm of dataviz portraying data with radical new forms, which are beautiful, complex, dynamic, but sometimes lacking those contextual elements necessary for interpretation. We could describe them as data art, generative design, or information experiences. Perhaps we might refer to such work as being data-driven rather than a visualisation. Both give form to data. Both are forms of visual encoding, but the expectation of the degree of decoding differ; from a clear and explicit visualisation, to a data-driven piece being less readable but more emotive and expressive.

"They are more about the beauty and the aesthetics and the narrative, rather than creating charts." Brendan Dawes, 2017

However, increasingly granular definitions and categories do not necessarily help us to understand a piece of work and its aims, and can add confusion and silo our thinking. Perspectives should widen, not narrow, and we should learn from other examples and approaches.

"That also explains why you resonate in a much wider context. You can bring a lot of really interesting perspectives to the data visualisation community." Moritz Stefaner (on Brendan Dawes), 2017

The wider role of visualisation is not just limited to the representation of information, it is also around validating arguments, initiating debates, raising awareness, and stimulating interest and engagement on a topic. It's in this latter role that some traditional charting methods can fall short. In our daily life we are saturated with visual messages. New forms of visual expressions are one of the tools that can cut through that haze.

"Accepting that when we say something is attractive... or has a sophisticated look and feel... or has a complex look and feel, that sometimes those are impactful purely for those reasons." Elijah Meeks,2017

If a visualisation meets all the requirements of a traditional visualisation but fails to engage its audience, it has failed to communicate. Likewise a visualisation that is fuzzy on quantifiable detail but inspires someone to delve further, has failed as a piece of precise communication but started a process of engagement. The two are not mutually exclusive and radical new forms of visualisation can be both visually captivating as well as precise and interpretable.

"...as researchers and designers we have to be creative and explore the limits and to find very intriguing and hopefully impactful ways to show things in a very surprising approach. On the other hand many of our standard mundane methods work very well." Jarke van Wijk, 2017

What is the intention of the work? For example, is it a company internal tool focusing on absolute accuracy, rapid analysis, actioning, and republishing new data? Or is it a custom visualisation in support of communication to the general public or a specific audience? There is a need to understand and balance the visual and numerical literacy of an audience and the complexity of the data required to communicate. Understanding the level of data literacy of the audience is crucial. Audiences are more intelligent than they are often given credit for, yet can also lack understanding of how charts function.

"I think a lot of these charts are made by experts for experts. How often do you grab someone else from a completely different department and ask 'do you get this?'" Mona Chalabi, 2017

Ultimately audience and context plays a role, not necessarily in defining whether a piece of work is a data visualisation or not, but whether it successfully communicates and whether it should intrigue or make plain the stats. A wall to wall data-driven animation may not be practical for the day to day tasks of a business analyst in an office, but is immersive and captivating for an exhibition on marine health.

"I think that's the real challenge for designers is that audiences are diverse... how can we address that in the visualisations we make." Helen Kennedy, 2016

Data Visualisation will inevitably have blurred boundaries with other fields, and be part of a diverse range of practitioners work in visual communication. It is more important to focus on the work itself, its aims and how well it achieves them, its audience and how well it engages them, and what we can learn from its process of creation.

POLICYVIS PODCAST EPISODES

96 Neil Halloran

95 Jen Goldbeck

94 Lilian Coral

93 Robert Kosara

92 Catherine Madden

91 Shomik Sarkar

89 Priya Krishnakumar

87 Elijah Meeks

86 Mona Chalabi

85 Anna Flagg

83 Chad Skelton

82 Rune Madsen

80 Alvin Chang

79 Jan Willem Tulp

78 Meredith Lee

77 John Yorke

74 GovTech Singapore

72 Maarten Laambrechts

71 Tracy Gordon

70 Simon Rogers

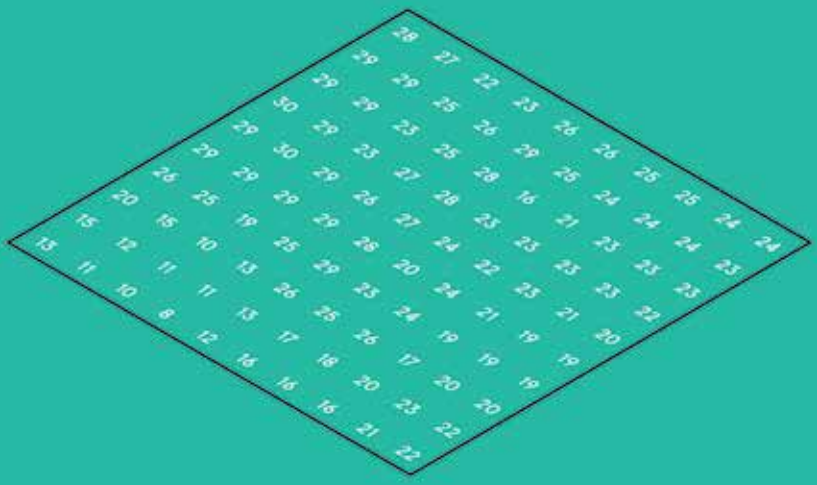
69 Hadley Wickham

68 Randy Olson

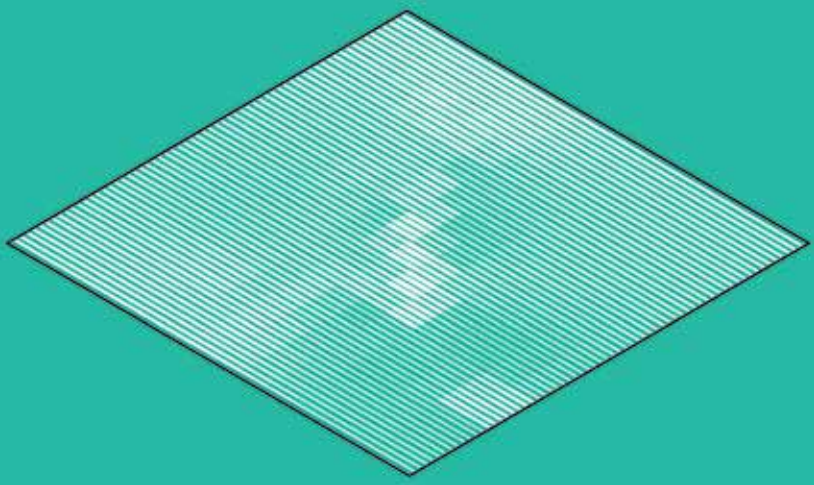
67 Wilson Andrews

59 Beth Akers, Matt Chingos

56 Andy Kirk



temperature

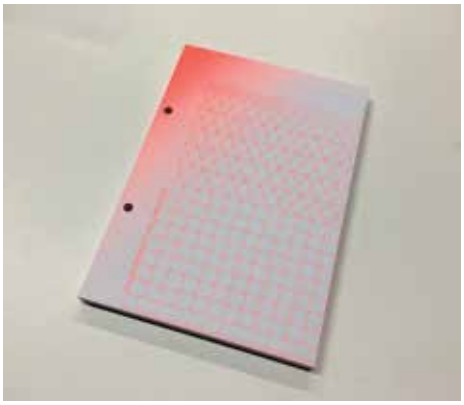


air quality

TOOLS

It might be tempting to think of these tools in terms of ones for gathering data and ones for visualising it, but in truth the distinction is blurrier than that and components of the tools we use to gather data can be used to visualise it and vice versa. There is such a wealth of tools and techniques that it would be difficult to make a comprehensive list but below are some. You can come up with your own ideas for tools and methods.

Pen & Paper



The simplest method for recording data is the pen and notepad. You can keep track of counts of various aspects you want to measure. You can write observations and take notes at the level of detail you feel necessary. You can sketch and make observational drawings as a way of recording information, the quality somewhat depending on your ability to translate what you see onto paper with a pen.

With a watch you can keep track of when something occurred. Location of events or objects can be anecdotally noted, marked on a printed map, or on a map created as you walk.

Experimenting with different mark making techniques, formats of paper, and features like grids can aid and inspire new methods of cataloguing, and translate the world around us into a visual record. Analog methods such as the pen and paper are powerful and flexible.

mobile sensor peripherals:
Lapka
Sensaris
Sensordrone

mark-making:
pen
pencil
coloured crayons
marker pens
watercolours
pastels
charcoal rubbing
plaster casts

Smartphones

The devices many of us carry around in our pockets are hugely capable. They have cameras for capturing high resolution images and video, as well as microphones for sound. It is even possible to buy external sensors to detect things like air quality that pair or plug directly into your phone. They have inbuilt GPS sensors so anything collected on the phone could be attributed to a location. Images can contain the GPS location of where they were photographed; through custom developed apps it would be feasible to have GPS located video, audio and other data.

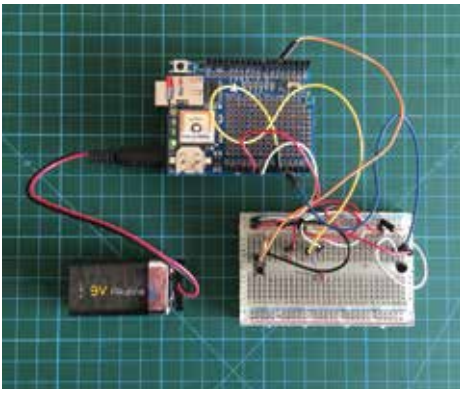
By taking a photo we can log a GPS location and time, so it can be possible to use a smartphone as a simple button for counting things such as people, trees, recycling bins, litter. Simply take photo in the location of what you are counting and you will be able to plot on a map the location of each individual instance. The image doesn't even have to be of the object you are counting, merely be in the location that it existed. Taking a photo of the object can give more data to work with such as bark texture, type of litter, or what people are wearing. Remember to consider if it is appropriate to take photos of people in public or their property. Consider how you take the photo: consistency of distance and angle to subject, and lighting. A photo contains a massive amount of data, whether of a general scene or a specific object. A photo journal of walks will contain very valuable data. Applying human and computational analysis to photos can lead to huge insights.

http://scatter.nyc/exquisite-city/

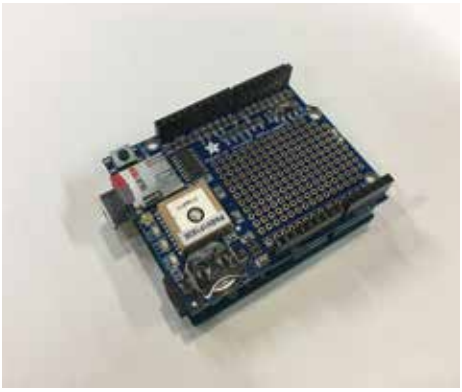
Arduino

This is an Open Source physical computing and electronics platform. Basically a small and low cost computer which you upload your own coded program to run. An Arduino is not as powerful as the computers we have at work or home, but it is very capable in terms of controlling LEDs, motors, and other electronics, as well as plugging sensors in to gather data. It can also be powered by batteries so we are not tied to a desk or wall socket and can freely wander, gathering data on the move, making it ideal for the Data Walking project or any other mobile data gathering project.

Arduinos have revolutionised the physical computing world for hobbyists and professionals, many who may never have imagined being able to use such a device, myself included. The range of applications Arduinos have been used in is staggering. Visit their website for more resources on Arduino.



Adafruit Ultimate GPS Logger Shield



We will be using the Arduino Uno and the Adafruit Ultimate GPS Logger Shield which plugs into the pins on the Arduino to form a compact unit. Shields add extra functionality without the need to prototype a whole board yourself. Adding the GPS shield allows us to track the latitude, longitude, date and time as well as sensor data and log it to a microSD card. Data points can be tied to a specific location and at a specific time. No longer is data gathering restricted to a single location or considered as a linear flow of time. Data is gathered and reconciled across space and time. This is a crucial and powerful difference allowing data gathering on the move to truly reflect where and when it occurred.

If you get a GPS shield I recommend following the Adafruit online tutorial to set it up. In brief: you will need to solder the headers, insert a microSD card up to 8GB in size, insert a coin battery to run the clock; the green LED shows it is powered, the orange LED is connected to pin 13 and blinks when loading code, initialising, if errors occur, or when saving data to the SD card, the red LED blinks every second when finding a GPS signal, and every 15 seconds when it has a signal; there is a switch to toggle between direct and soft serial mode, make sure the correct one is selected. All the code so far from the project uses soft serial. The Adafruit example code is the basis of our own.

In the Data Walking project we have used Arduinos to gather a lot of data from a variety of sensors. We have used temperature sensors, light dependent resistors (LDR) for measuring light levels, microphones to measure the amplitude of sounds and noise, a variety of air quality sensors, dust sensors, and used buttons to count things like people. All of the data gathered is tied to a latitude and longitude and time using an Arduino and GPS shield.

https://www.arduino.cc

https://learn.adafruit.com/adafruit-ultimate-gps-logger-shield

MQ GAS SENSORS
MQ-2:
Methane, Butane, LPG, smoke

MQ-3:
Alcohol, Ethanol, smoke

MQ-4:
Methane, CNG Gas

MQ-5:
Natural gas, LPG

MQ-6:
LPG, butane gas

MQ-7:
Carbon Monoxide

MQ-8:
Hydrogen Gas

MQ-9:
Carbon Monoxide, flammable gases

MQ-131:
Ozone

MQ-135:
air quality, Benzene, Alcohol,smoke

MQ-136:
Hydrogen Sulfide

MQ-137:
Ammonia

ONLINE STORES
Cool Components
Pololu
The Pi Hut
ModMyPi
RS Components
Farnell
Maplin

AIR QUALITY SENSOR ISSUES

1 powering a sensor reliably needs external power making the circuits more complex

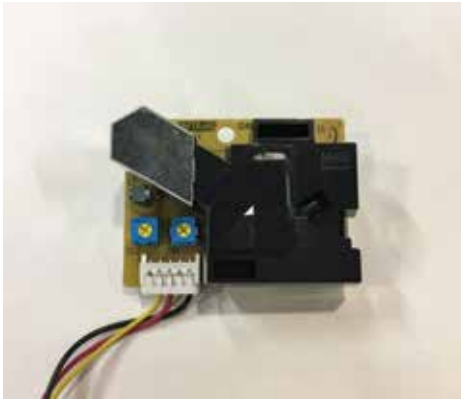
2 sensors require 24hrs heating time before first use and preheating before each use

3 the sensors is affected by ambient temperature and humidity, and potentially also the wind too.

Air Quality Sensors

Cheap air quality sensors are readily available from many online hobby electronic stores and they provide a low cost first step into detecting chemicals in the air. They plug into an Arduino easily, produce data instantly, and the code is simple with plenty of examples online. However despite enjoying using them, there are issues with their suitability for the Data Walking project. Each sensor must be calibrated if you want to return concentrations of gas as parts per million (PPM), and involves some fairly complex maths. Concentrations of specific gas are only indicative, and if you want more accurate results then a more expensive sensor is needed.

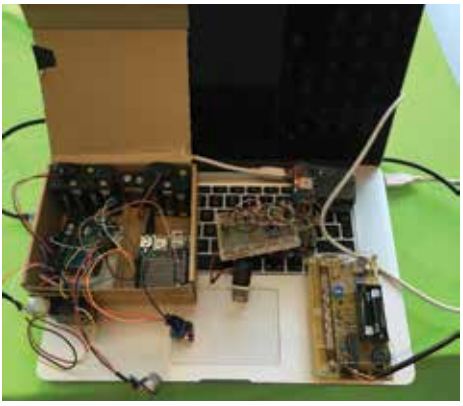
In summary, air quality sensors could be a useful tool, but require significantly more investment of time, energy and expertise to get working reliably.



Laptop

When an Arduino does not enable the right functionality or high enough resolution sensors, a sufficiently charged laptop can also be used to gather data on the move. Laptops with webcams can be used to record pictures, video, slit-scans or other custom imaging applications. It is also be possible to work with other types of camera like thermal cameras, or infrared structured light cameras like the Kinect, to build three dimensional representations of areas. Other environment sensing units can also be plugged in, such as Geiger counters to detect radiation levels.

An Arduino with a GPS shield can be plugged into your laptop to transmit the GPS data to the laptop so any peripheral sensor data can also be tied to specific latitude and longitude and time just as data gathered on the Arduino is.



http://davidegironi.blogspot.co.uk/2014/01/cheap-co2-meter-using-mq135-sensor-with.html

Software

Processing

Processing is a free and open source creative coding program suitable for developing data gathering applications making use of sensors, cameras, and other peripherals. There are a great number of fantastic books and online guides for learning Processing, and it is a wonderful environment to first start programming. Enough can't be written on the positives of Processing.

And Processing is at the heart of the visual experiments created with the data and available on the project github. Alongside Processing, Til Nagel's Unfolding Maps library has been extensively used. There are lots of contributed libraries that extend or make easier what is possible with Processing. Harnessing these in conjunction with your ideas will make for unique and varied outcomes.

While this project has focused on using Processing, other software is available for working with code, data, and generative design. There is also a whole other world of javascript libraries and tools for the web to make things with data. There is a wealth of software tools out there to try and see which ones fit your process and output best.

Text Editors, Spreadsheets, Vectors

A simple text editor is often needed to edit the data. A computer OS will provide a text editor as standard, but there are other editors available that have extra features. Editing data can also be done with spreadsheet software which will also have the bonus of being able to create simple charts of the data. Depending on the software you can probably export the chart as an image or preferably a vector format like svg, eps, or pdf. Working with vector as opposed to bitmap can allow you to radically overhaul the visual aesthetic of any graphics in high resolution, but remember to remain honest to the data!

ExifTool

Developed by Phil Harvey, ExifTool is a Perl library accessed through the command line to extract Exif data from images. It has many useful functions, we have used it to extract the time and gps information from a folder of images and create a csv file.

It is worth discussing a little the range of ways that data could be outputted. These are mentioned in brief below as a starting point. It should be noted that each of these outputs also probably require specific software/tools to convert the data ready for output, not including any translation and mediation into form that you as a designer might also perform between collection and final outcome production.

Screens

We are surrounded by screens, attached to our computers, attached to our hands. They are increasingly high resolution, register touch and gesture, or use other sensors to enable interaction. They can render immense detail, flat artwork or moving elements. Screens have become the default way in which we engage with visual material, certainly graphics and increasingly text.

A branch of screens might be projection, from 4K video driving rock concert visuals, to palm-sized pico projectors that can be hidden away. When considering projection onto alternative surfaces interesting possibilities open up with what materials could be projected onto, how the material reacts to light; and with site specific projection the surface's form and situation in real three dimensional space, often referred to as Projection Mapping. The nature of the content projected should help inform decisions around how something is projected.

A subcategory of screens is the rapidly moving technology behind Virtual/Augmented/Mixed Reality (VR/AR/MR) headsets that use combinations of screens, projections, and lenses close to your eyes.

useful libraries:
Unfolding Maps
SimpleOpenNI
Open Kinect
OpenCV
Isolines
HE_Mesh

creative coding:
Processing
OpenFrameworks
Cinder
vvvv
MaxMSP/Jitter
Nodebox
TouchDesigner
D3.js
Mapbox

text editors:
Sublime Text
TextEdit
Notepad
TextMate

https://www.processing.org

http://unfoldingmaps.org

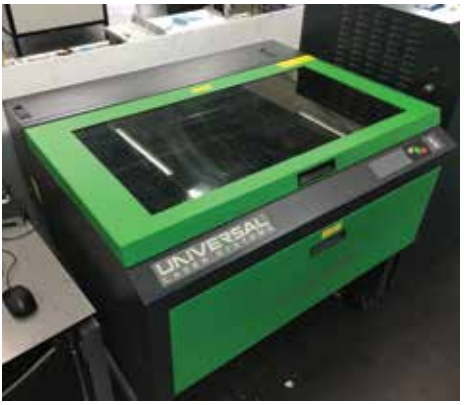
https://www.sno.phy.queensu.ca/~phil/exiftool/

http://www.warning-office.org

Printers

Outputting to hard copy rather than screen is another high resolution option with advantages. There is a permanence and tactility to printing as well as a long history only outlasted by stone carving and cave painting. Once created, printed items can be viewed, stored and shared without electrical power. We associate printing with paper, of which there is a huge range of choices of types, but other materials can be printed on too. Different printers have different characteristics and finishes. There are ink-based professional offset lithographic printing presses, screen printing presses, inkjet printers, toner-based laser printers, ribbon-based dot matrix printers, thermal 'receipt' printers, and also more exotic processes like UV printers which can apply graphics to a whole range of materials and surfaces. Understanding the huge potential of printing is well worth exploring, but outside of the scope of this report.

Laser Cutters



These are awesome! They can be used to cut a wide range of materials, everything from paper through to acrylic. They are fairly simple to operate and prepare artwork for, and work precisely and rapidly. By designing flat interlocking shapes, or through aligning and gluing/bolting, three dimensional structures can be built. Laser cutters can also be used to 'engrave' where the laser beam ruptures the surface of the material without cutting through. This can add texture or recess a surface, but is a slower process. With flexibility of material, speed of operation and the ability to make two or three dimensional outcomes, laser cutters are very powerful. Alternative processes to consider are bladed plotters for cutting, acid etching of metal, and water jet cutting.

3D Printers

Rapid prototyping with additive manufacturing processes have exploded in popularity in recent years thanks to reduced cost of the equipment, but it has been around since the 1980s. In truth, 3D printing is not as fast as you might imagine. It can take hours to print something depending on size and complexity. Nevertheless it is magical and if you have access to a printer then it is relatively cheap, and much faster than many other methods of manufacture. There are different types of 3D printing, stereolithography, filament extrusion, light processing, laser sintering, inkjet binding, selective lamination. All have their own strengths and weaknesses and selecting the right one for your needs is important. You will need to use 3D software to prepare your model for printing.

CNC Milling Machines & Robotic Routers

3D printing is an additive manufacturing process. There is the reverse process too, where a large volume has material removed until only the desired final form is left, like a Renaissance sculptor chipping away at a marble block to make a human figure. This is known as subtractive manufacturing. CNC milling machines, and robotic routers use rapidly rotating bits (similar to a drill) to carve material away.

Sculpting Type
written by
Edo Smitshuijzen

3D software:
3ds Max
Blender
Cinema 4D
Fusion 360
Maya
Rhino
Sketchup
Solidworks
ZBrush

Digital Fabric Printing, Textiles and Embroidery

Designs can be printed onto fabric just the same as any digital ink printer would print on to paper. Ink can be transferred directly to the fabric or can be printed onto a transfer sheet which is then heat-pressed onto the fabric. Which process depends on the type of fabric. There are also digital looms and embroidery machines that can weave and stitch textiles and motifs from designs you prepare or generate.

As mentioned at the beginning of this chapter it is quite feasible and appropriate to use the same technology to gather data as to display it. It makes sense that once you have gained skills to record data you can extend those skills to display data. Not only that, but each technology has its own characteristics and qualities that might be suitable for representing a specific type of data.

Arduinos
Arduinos can be used to control LEDs, motors, and other actuators to display data, as well as buttons or sensors to allow interaction with that data. Data could be recorded, stored and `played back', or displayed in realtime, an exciting facility to make the invisible around us visible as it exists at that time.

Smartphones
Smartphones have a powerful combination of technologies which could yield fascinating visualisations and experiences of data. Combining touchscreens and GPS to make location-based interaction with data, through a custom developed app. At the time of writing, there are large strides being made in the fields of VR/AR/MR involving mobile phones, and holds potential for geolocated visualisation and in situ interaction with information. Experiments are probably well underway in a studio or laboratory somewhere in the world.

Pen & Paper
Most of the methods of visualisation we know were developed before the advent of smartphones or computers. Illustrators, calligraphers, and other craftspeople continue to create compelling work displaying data with traditional tools.

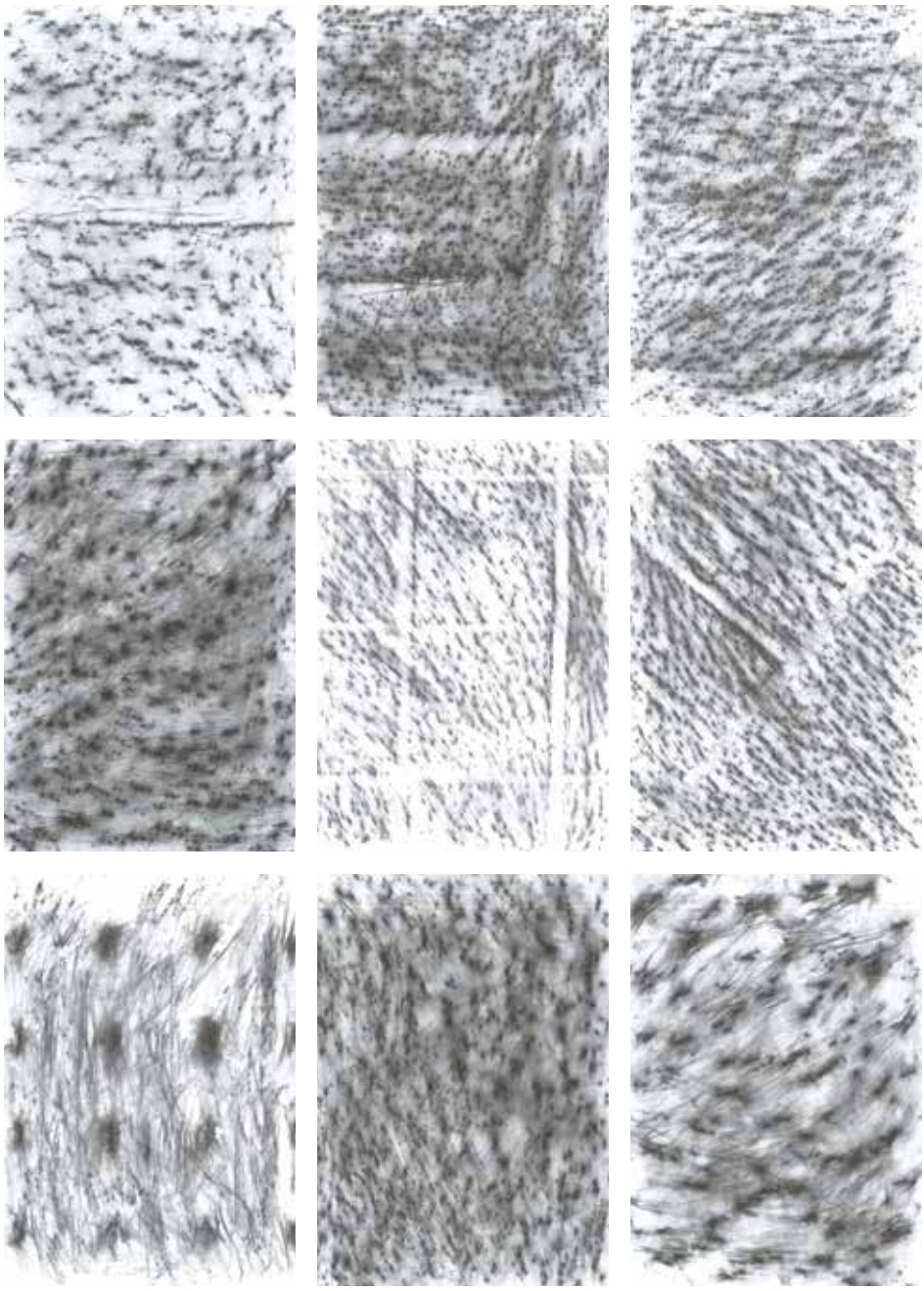
In summary, there are a wealth of methods that can be used to create inputs and outputs in different mediums. They can be purchased off the shelf, and custom built, or perhaps be some fantastic concoction or amalgamation of many different technologies. There are no rules or limits on what to use to record or represent data.

http://www.phillipstearns.com

http://chomkoandrosier.com

https://theconditionalorchestra.com

http://www.dear-data.com



charcoal rubbings of pavements in North Greenwich

POWER

Gathering data on the move with electronics like smartphones, laptops and Arduinos requires power. Phones and laptops have internal batteries and can last a reasonably long time for a walk depending on how intensively you use them.

Arduinos need external power, and include a barrel jack which you can connect to batteries. An arduino needs between 7 and 12V before problems occur. Even though Arduinos run at 5V they need a bit more through the barrel jack. 9V batteries with a PP3 adaptor are a popular choice, but they tend to discharge very quickly. For a longer duration, a clip of six AA batteries will give you plenty of power and last for longer. Most batteries have milliAmp hour (mAh) information on them, indicating how much energy they hold and how long they will last before needing replacing or charging.

Lithium ion or lithium polymer (Li-ion/LiPo) batteries, often used for charging smartphones, can be used as an alternative power source. Ensure it delivers enough voltage; it may require a step up voltage regulator, which are inexpensive but requires extra circuit building. A phone charging bank plugged into the Arduino USB port may turn it on but not provide enough power to properly work or read reliably from analog pins.

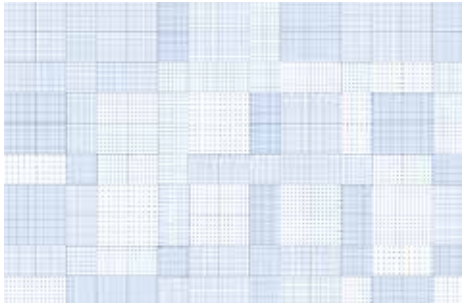
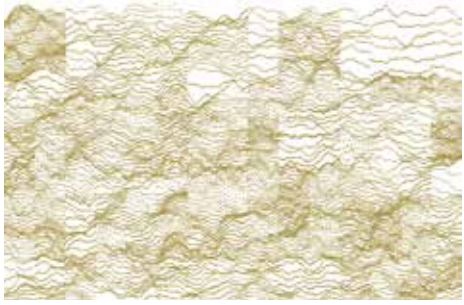
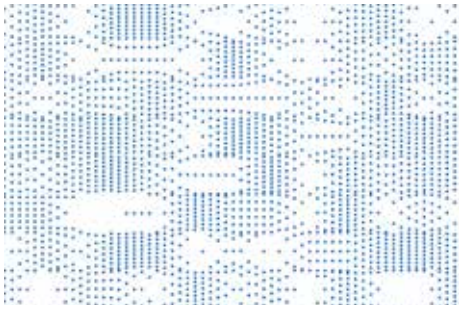
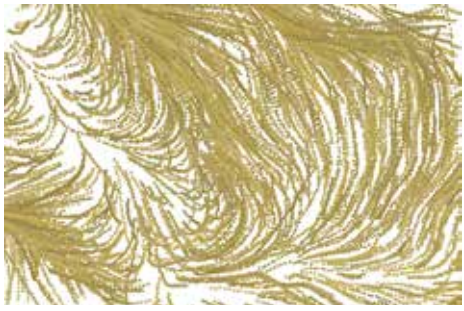
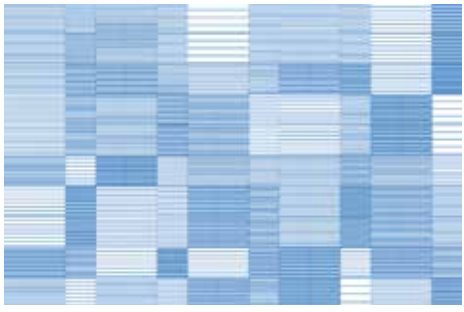
There is also the VIN (voltage in) pin and 5V pin on an Arduino, either of which can also be used for power by also connecting GND (ground) pin to a power supply. It is not recommended to power an Arduino through the 5V pin. Be wary of applying too much voltage, giving more than 5V through the 5V pin, having USB or VIN powered simultaneously as 5V, powering VIN backwards, shorting any connection, or changing component connections while still powered; all of which may damage your Arduino.

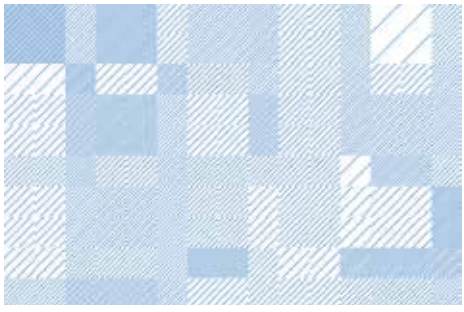
Certain components or sensors in a setup might need powering through an external source separate to the Arduino. This is the advice for air quality sensors like the MQ range, and dust particle sensors.

https://www.pololu.com/category/133/step-up-step-down-voltage-regulators

https://www.maplin.co.uk/c/batteries/power-banks

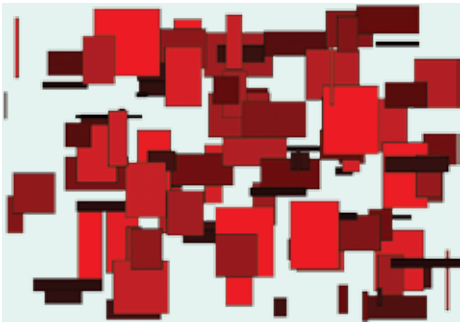


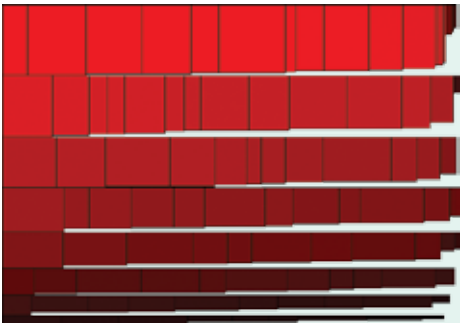








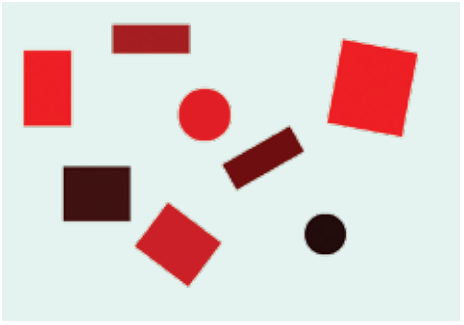
visual experiments in representing air quality (left) and dust particles (right) data

strip-packing algorithm: takes an assortment of shapes, sorts and arranges them based on height. More complex and economical packing algorithms are available.

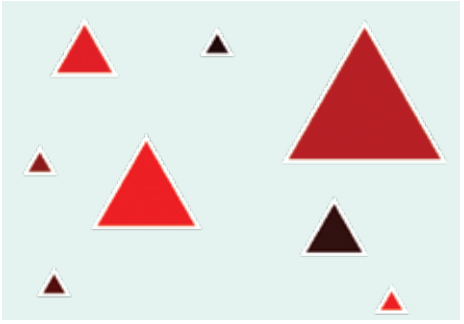


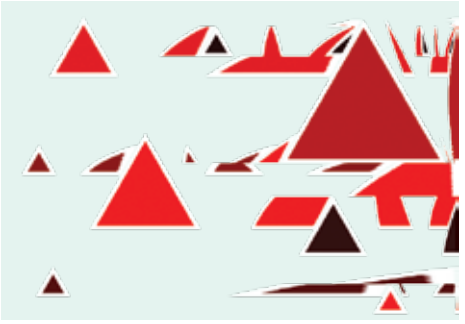


squidging/ sucking algorithm: removing and collapsing empty pixels vertically, distorting original forms.

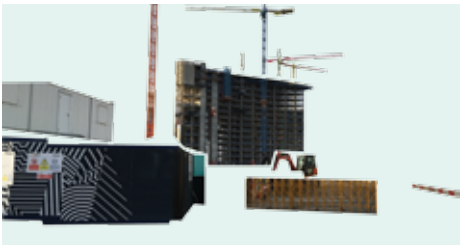


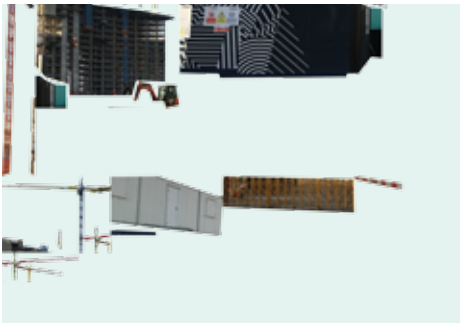
horizontal copying algorithm: starting top left, on finding a horizontal length of empty pixels, copy the previous pixels and fill that empty length. repeats and distorts original forms.

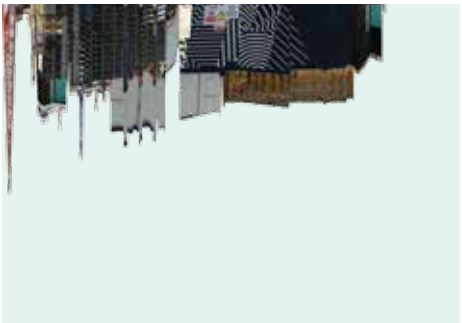




square-crawling algorithm: starting top left, on finding an empty pixel measure the largest square before finding another filled pixel; fill that largest rectangle.

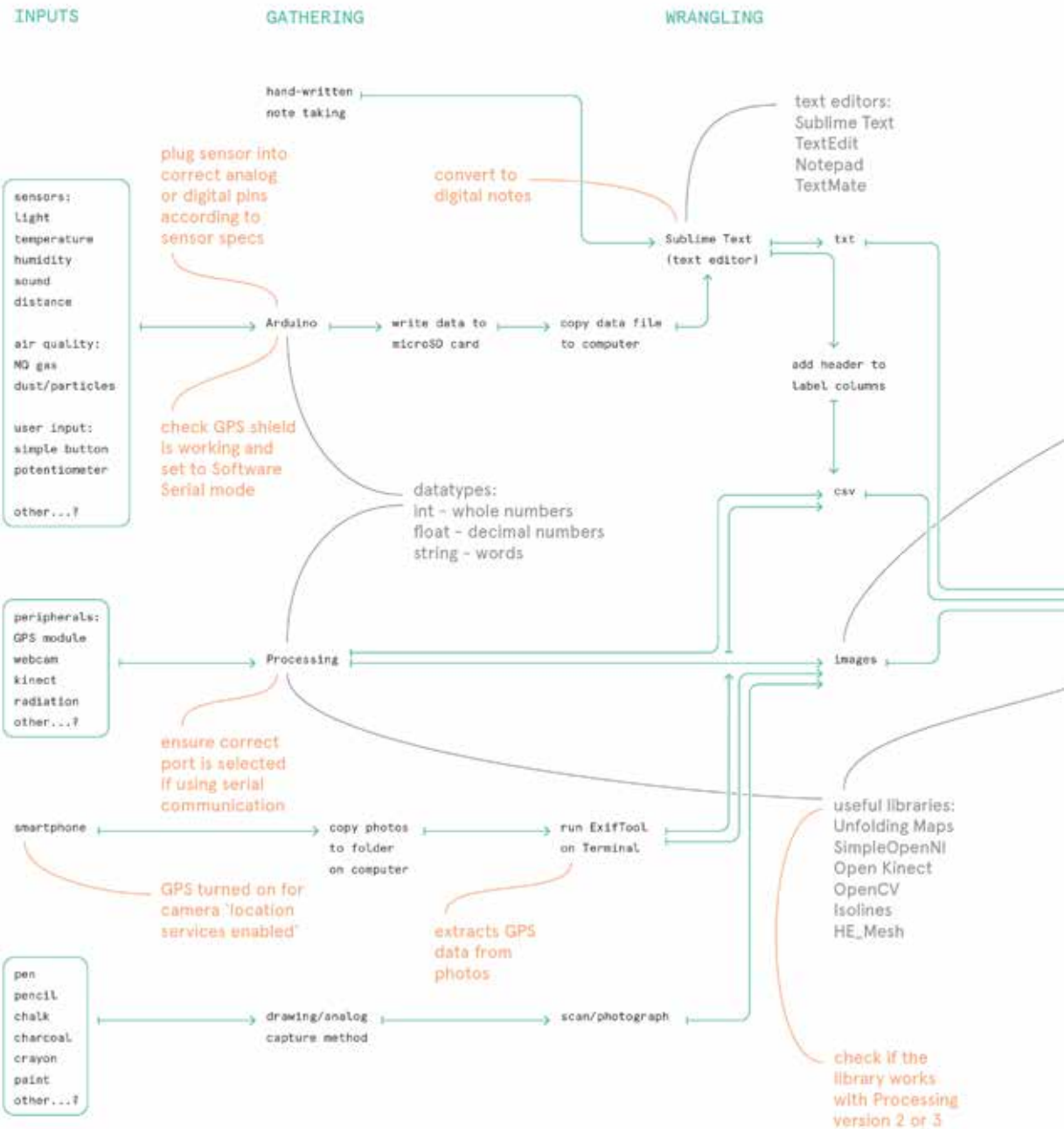





sorting, deforming and filling algorithms applied in sequence to visual pollution extracted from photographs

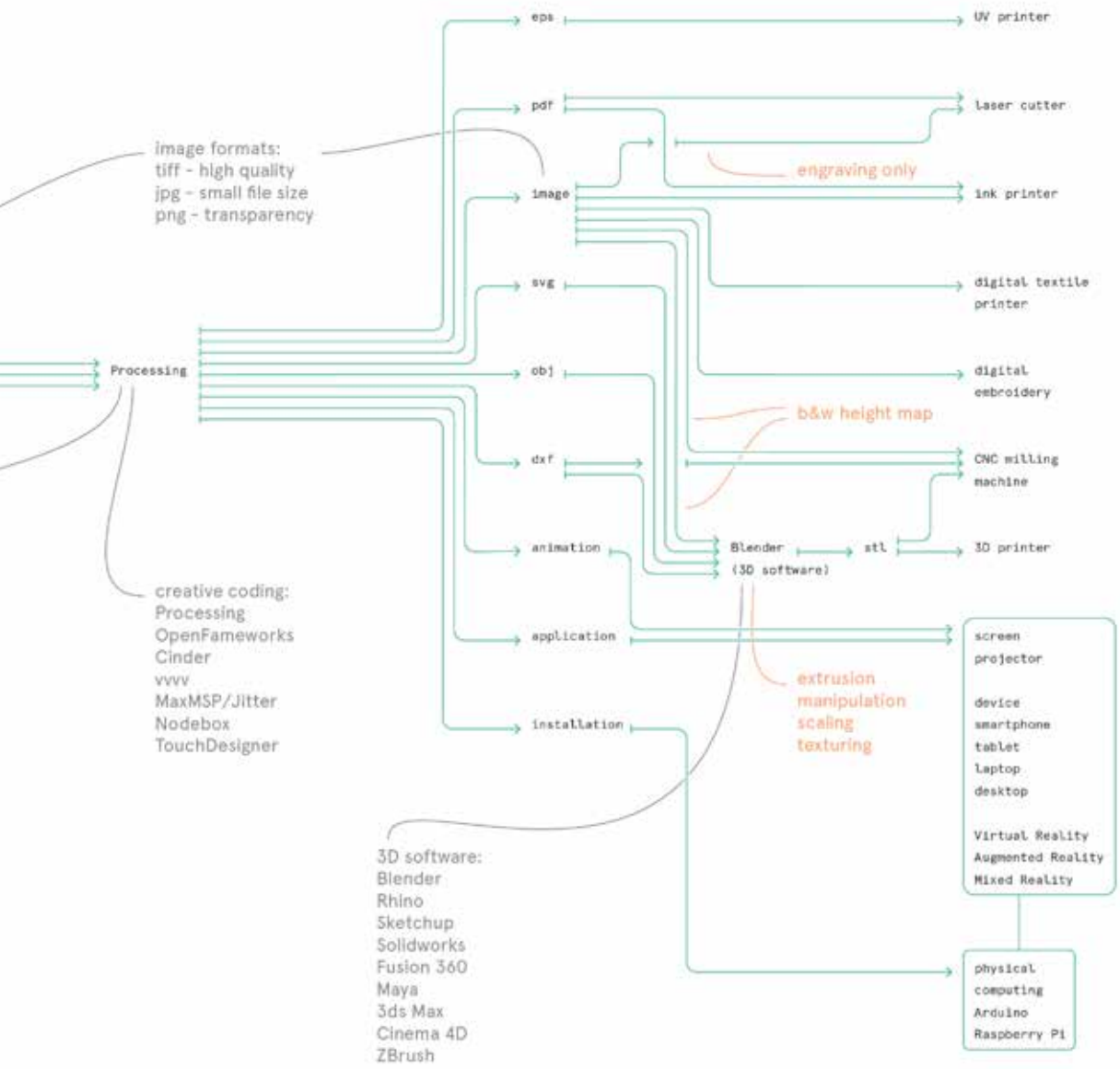
WORKFLOW SYSTEM DIAGRAM



VISUALISING

OUTPUT FILES

OUTPUTS



EXAMPLE WORKFLOWS

WORKFLOW 1: Basic Data Gathering & Charting

Introduction

This workflow from the project github shows you how to make a basic circuit to collect light data with a photoresistor connected to an Arduino with Adafruit GPS Shield. Then the data is used in Processing to create a chart of that data.

PARTS LIST

Arduino Uno

Adafruit GPS shield

MicroSD card

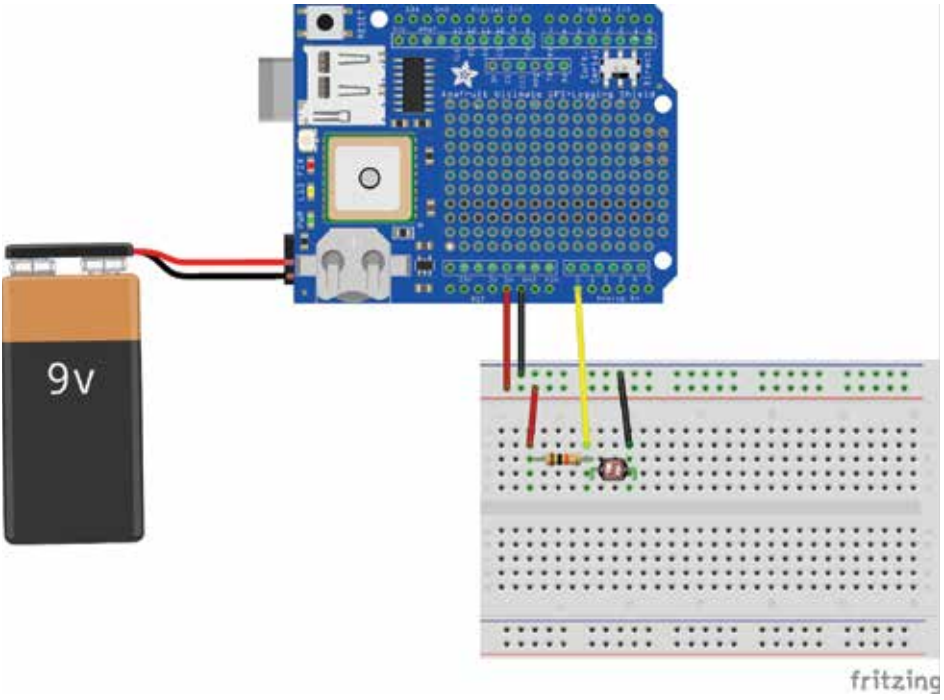
4 * AA battery or a 9V battery

Photoresistor

150k Ohm resistor

Jumper cables

Breadboard



INPUT: Build the circuit
Make sure your GPS Shield is switched to Soft Serial mode, and the microSD card is inserted. Check the wiring diagram above on how to connect the photoresistor to the Arduino.

Upload the Arduino code
Download the example code from the Data Walking Github. Connect the Arduino to your computer via USB and upload the code.

Input_1 is a basic Arduino program to capture the GPS data and a sensor input into an analog pin. This example gathers light data using a photoresistor. Photoresistors are very cheap and often included with an Arduino starter kit.

The photoresistor sensor data, time and location data is written to the GPS Shield microSD card as a txt file.

Go walk!

Copy and wrangle the data
Put the microSD card into your computer and copy the txt file to your computer.

Change the txt file extension to a csv file. The data points are already separated by commas. Open the csv file in a text editor (such as Sublime Text) and add a 'header' to label each column in the csv file. The header lets us know what aspect the values relate to, and can make it easier to get those values with code.

Save the amended file and copy it to the data folder of the Processing sketch.

Run the Processing code
Make sure the csv filename referenced in the code is the same as the one you copied over to the sketch data folder.

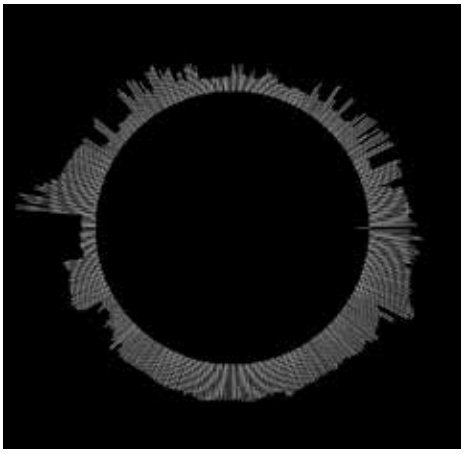
Output_1_1 renders all the data points (in this case light, but other data could be used) as single pixel lines from the top of the screen down, akin to an area chart. It is extremely basic, and lacking things like axis and key but it should get you started. The data values are mapped from a range of 0–255, to 0-height of the sketch. The graphic might be longer than the output canvas so the chart is made as large as necessary to show all data points. By moving the mouse across the canvas, the chart scrolls horizontally. Press 's' to save a tiff of the chart.

Output_1_2 renders all the data points (in this case light, but other data could be used) in a circular fashion, like a radial column chart. A red line marks the start of the data, plotting in a clockwise direction.

Extending
There are a huge range of sensors and creative uses of sensors available. Make sure you connect them to the Arduino correctly and take note of the range they return data in, eg. analog 0–1024, digital 0–255, or something else. We use the map() function to convert the data value into a usable range. You might want to adjust the mapping range based on the values you record. Some people believe your axis should always start at 0, but there are use cases where this may not be best. Adjusting the range allows you to focus on and magnify subtle but important changes that might be difficult to visually perceive. Ultimately you have to judge (and test) that your chart communicates effectively and is not misleading.

How could you tie the circular chart to the time a datapoint was captured? Could you make a three-dimensional spiral? How can we use small multiples to compare multiple walks or datasets?

exported chart from Output_1_1



exported chart from Output_1_2

WORKFLOW 2: Data Gathering & Mapping

Introduction

This workflow builds on Workflow 1 and adds a temperature sensor and push button to the light sensor circuit. The button can be used for counting instances of something. That something might be people, types of objects, or occurrences of a phenomena. Then the data is used in Processing 2 to map the data using the Unfolding Maps Library.

PARTS LIST

Arduino Uno

Adafruit GPS shield

MicroSD card

4 * AA battery or a 9V battery

Photoresistor

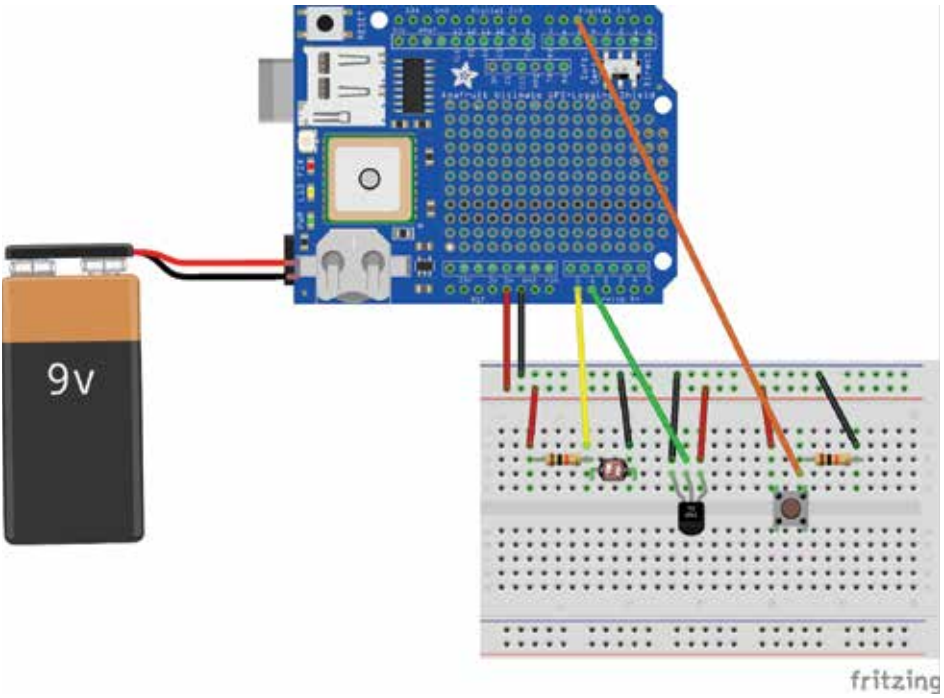
Temperature sensor

Push button

2 * 150k Ohm resistor

Jumper cables

Breadboard



INPUT: Build the circuit
Make sure your GPS Shield is switched to Soft Serial mode, and the microSD card is inserted. Check the wiring diagram above on how to connect the sensors to the Arduino.

Upload the Arduino code
Input_1 is a basic Arduino program to capture the GPS data and photoresistor, temperature sensor, and a push button inputs into analog and digital pins.

The push button data is recorded as the number of presses between readings. If no presses are made a 0 is recorded. For example if you were recording people you walked past, and passed a single person then the button should be pressed once to record 1, and if you passed a couple then the button should be pushed twice to record 2. This allows to record the amount of 'something' in a location at a time.

The sensor data, time and location data is written to the GPS Shield microSD card as a txt file.

Go walk!

Copy and wrangle the data
Put the microSD card into your computer and copy the txt file to your computer.

Change the txt file extension to a csv file. The data points are already separated by commas. Open the csv file in a text editor (such as Sublime Text) and add a 'header' to label each column in the csv file. The header lets us know what aspect the values relate to, and can make it easier to get those values with code.

Save the amended file and copy it to the data folder of the Processing sketch.

OUTPUT: Run the Processing code
Make sure the csv filename referenced in the code is the same as the one you copied over to the sketch data folder.

Output_1 renders all the data points from one of the datasets we are recording on a map. Make sure you have the Unfolding Maps library downloaded and installed in Processing 2, available using the Sketch>Import Library>Add Library... menu function. Changing the column used can visualise the different datasets. Press 's' to save the map and data visualisation. Notice it save the map as a .tiff image, then each data layer as a .pdf. This allows us to visualise datasets on separate layers and use different materials or machines to render different data layers.

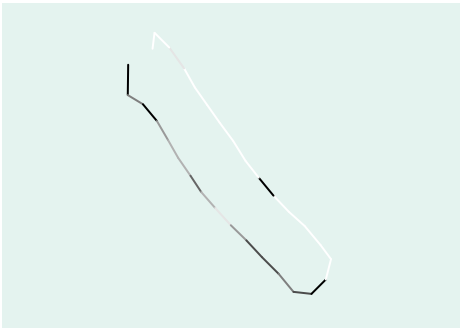
It's worth mentioning data literacy at this point. Looking at the data of the test file, the temperature reading seems very high; at the time of the recording the temperature for London was 17°C not 30+°C! Perhaps the sensor is faulty, not connected properly, or not getting enough power? Further to this when mapping the data some appears in the middle of buildings or off the path walked. GPS is only accurate to about 5m, and can be further out when signal is weak or obstructed by large structures. It is necessary to understand that data isn't the absolute truth, have a pinch of salt and common sense approach to whether results seem plausible, and remember double-triple-checking is worthwhile.

Extending
Here is another opportunity to experiment with different sensor types and how you use them creatively to measure the world around you.

Counting and being able to tie that count to a specific time and location is a simple but surprising powerful method, and can be used across all observable or perceptible phenomena. Add more buttons to count more things or different categories of things such as people dressed for different roles, different vehicle types, different tree species.

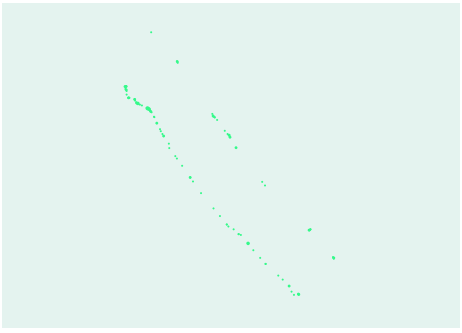
Combining datasets in one visualisation affords an almost never ending world of combinations exploring the relationships between datasets, and experimenting with machines, materials and interactions appropriate to communicate the dataset effectively.

How can multilayered visualisations work physically, as three dimensional objects, as tactile experiences, as tangible objects that can be interacted with? What is the potential of LED, projected or on-screen interactives for filtering and focusing your data? Where should an outcome be situated?

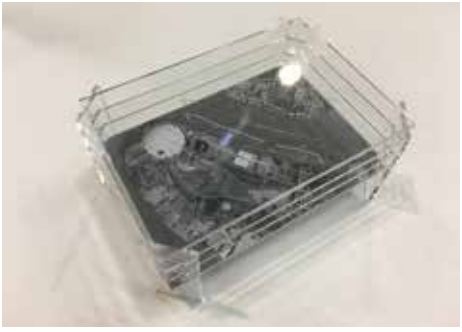


light data

temperature data



people data



each dataset and a map is UV printed to an individual acrylic layer and stacked

WORKFLOW 3: Sound Data & Heat Map

Introduction

This workflow shows you how to collect sound data using an Electret MAX4466 microphone and then create a heatmap of the data in Processing. The sound data could be swapped for any data you are interested in. A heatmap can be used in 3D graphics as a heightmap for modifying a three dimensional form based on the image grayscale values.

PARTS LIST

Arduino Uno

Adafruit GPS shield

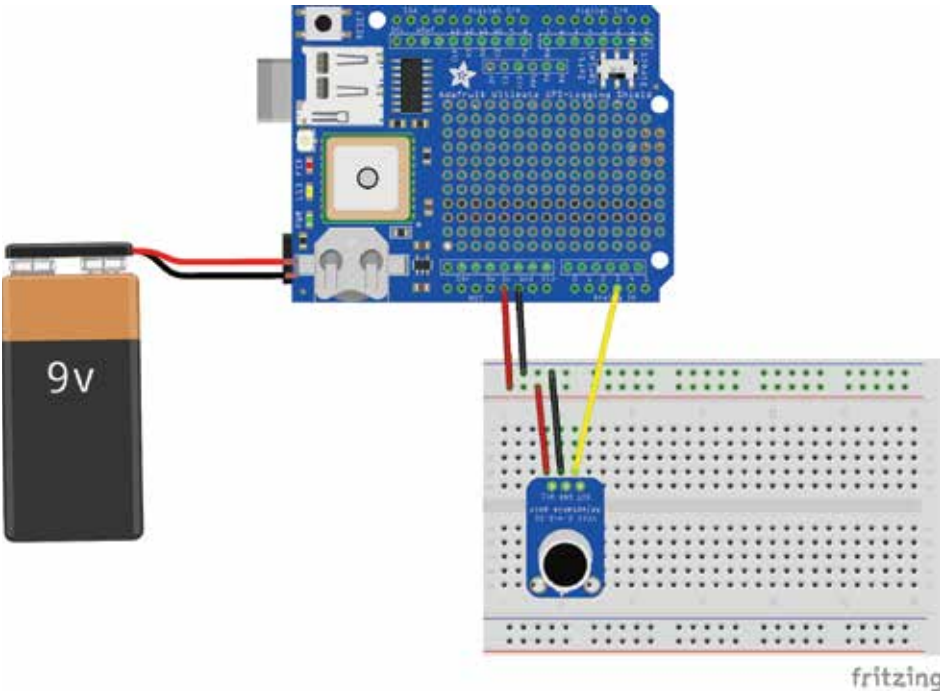
MicroSD card

4 * AA battery or a 9V battery

Adafruit MAX4466 electret mic

Jumper cables

Breadboard



INPUT: Build the circuit
Make sure your GPS Shield is switched to Soft Serial mode, and the microSD card is inserted. Check the wiring diagram to the right on how to connect the microphone to the Arduino.

Upload the Arduino code
Download the example code from the Data Walking Github. Connect the Arduino to your computer via USB and upload the code.

Input_1 is a basic Arduino program to capture the GPS data and a microphone inputs into analog an pin.

The microphone amplitude data, time and location data is written to the GPS Shield microSD card as a txt file.

Go walk!

Copy and wrangle the data
Put the microSD card into your computer and copy the txt file to your computer.

Change the txt file extension to a csv file. The data points are already separated by commas. Open the csv file in a text editor (such as Sublime Text) and add a 'header' to label each column in the csv file. The header lets us know what aspect the values relate to, and can make it easier to get those values with code.

Save the amended file and copy it to the data folder of the Processing sketch.

OUTPUT: Run the Processing code

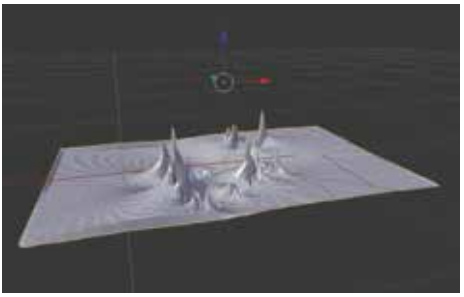
Make sure the csv filename referenced in the code is the same as the one you copied over to the sketch data folder.

Output_1 plots all the data points from the microphone. Make sure you have the Unfolding Maps library downloaded and installed in Processing, available using the Sketch>Import Library>Add Library... menu function. Press 's' to save a .tiff of the canvas output. Press 'h' to create and render the heatmap. This can be a slow process with large datasets and a large output canvas. Inside the Processing GUI console area a % readout should show you the progress of creating the heatmap. Once the heatmap is shown in the output canvas, then press 's' again to save a .tiff of this. The heat map is rendered in grayscale so it can be used as a heightmap for 3D manipulation. You can modify the Heatmap class to output colours or use an application like Photoshop to map a colour gradient to the grayscale values.

From the heat map, we can use it as a heightmap in Blender (free 3D modelling software) to generate a 3D version of the heatmap to 3D print, mill, or use on-screen in some way.

```
Make a 3D model of a height map in Blender
Import height map-
User preferences > add ons > import images as planes
Import > image as planes
Select plane
[tab] to enter edit mode
Tools menu: Subdivide: number of cuts =  300
Modifiers menu: add modifier > Displace
Set texture to your heatmap
Set texture coords > uv
(Experiment with Strength parameter if you like)
Apply

Give it a base-
[tab] to enter edit mode
[a] select all
Extrude: [e] [z] drag down or [shift]+[arrow]
Set all those vertices to same value: [s] [z] [0]
[n] to launch side panel
Set z median to value you want (try -0.5)

Set units and size-
Scene menu: Units > millimetres (or your preferred
units)
[tab] to enter object mode
[n] to launch Transform panel
Transform: Dimensions = whatever size you want

Give it a thickness-
Modifiers menu: add modifier > Solidify

Export to stl for printing-
File > Export > Stl
```

exported heat map of a walk



that heatmap given 3D form by displacing in Blender

3D print in white PLA of the heatmap

Extending

We could increase the fidelity of our data by running an FFT (fast-fourier transform) on the incoming sounds and extract data on the different frequency bands. Are there more high pitched sounds or deep bass sounds?

We could use full audio recordings, not just looking at amplitude or fequency spectrum but the types of sounds, what produces them, and their meaning.

Heatmaps are widely employed in spatial data visualisations of scalar data, so could be used to display different aspects you want to collect and examine. Isoline and choropleth maps are alternative visual forms to consider.

Finally, heatmaps can be rendered in everything from flat colour artwork through to data sculptures, animations, and beyond... what materials and dimensions relate to the data you have gathered?

http://johnflower.org/tutorial/make-mountains-blender-height-maps
https://blender.stackexchange.com/questions/60993/creating-a-3d-printable-terrain-model-with-blender
https://blender.stackexchange.com/questions/31367/how-to-set-object-dimension

WORKFLOW 4: Slit-Scan

Introduction

This workflow shows you how to capture a slit-scan where each strip of the slit-scan is GPS tagged. It needs two sketches one for an Arduino to get the GPS data, and a Processing sketch to use the webcam as a slitscan. It also has a Processing 2 sketch to plot that slit-scan on a map.

PARTS LIST

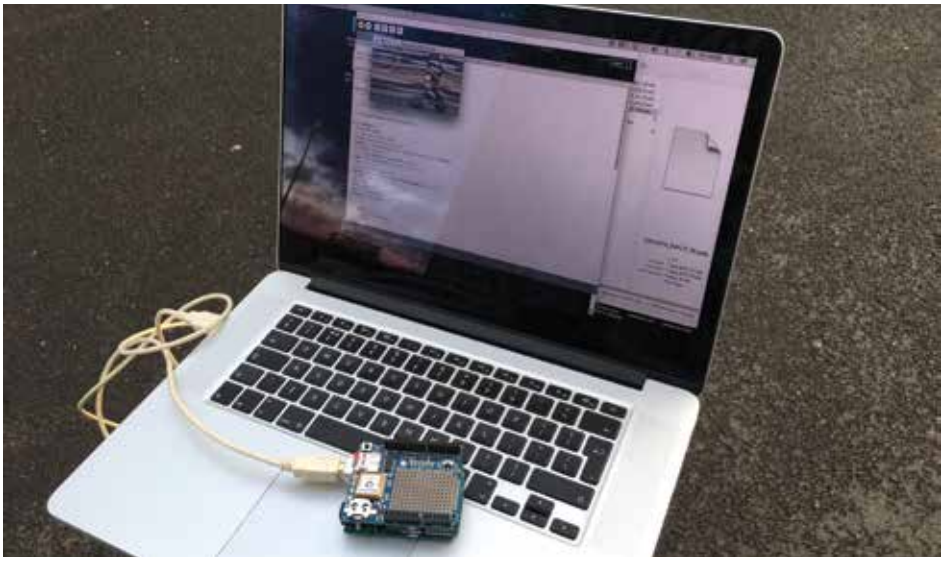
Arduino Uno

Adafruit GPS shield

MicroSD card

USB cable

Laptop with webcam



INPUT: Build the circuit
Make sure your GPS Shield is switched to Soft Serial mode, and the microSD card is inserted. The Arduino can be powered directly from the laptop USB port.

Upload the Arduino code
Download the example code from the Data Walking Github. Connect the Arduino to your computer via USB and upload the code.

Input_1A is a basic Arduino program to capture the GPS data and send it over serial communication (keep the Arduino plugged in to the laptop via a usb cable) to the Processing sketch. No circuit diagram is needed, just plug the shield onto the Arduino, plug the Arduino into the laptop, load the code, and it is ready to go.

Run the Processing code
Input_1B is a Processing sketch that needs the input from the Arduino file, and a webcam. It exports a csv file with the GPS, date & time data, and RGB hexadecimal colour values for the 'slit' so each scan can be reconstructed. It is possible to export each slit as a 1 pixel wide image (it is commented out in the code).

Note that because the GPS is only updated every second, lots of slits have the same location. It would be possible to interpolate those values between GPS data points.

The size of the slit depends on the height of the sketch. I have kept it small (180px high) but larger is possible, and leave it to you to experiment.

The Processing sketch also renders the slit-scan to its canvas and an image when the canvas fills before resetting. You could stitch these images together in a program (like Photoshop) and rebuild the whole slit-scan as one seamless image.

Go walk!

Copy and Wrangle the data
You could add a header to label each column of the csv file, but this is optional. The data is clear between date, location, hexadecimal colours, and there are many colour columns to label. You may need to delete 'false starts' of incomplete data at the top or bottom of the file.

Save the amended file and copy it to the data folder of the Processing sketch.

OUTPUT: Run the Processing code
Make sure the csv filename referenced in the code is the same as the one you copied over to the sketch data folder.

Output_1_1 renders a map and plots points of the route walked with the slit-scan. You can vary the detail it renders by the number of points. The more points the more sluggish the performance, but greater detail. Press 'p' to plot the slit-scans, and 's' to render a tiff.

Output_1_2 takes the saved canvas exports from Input_1B and stitches them together to create a very long png.

Extending
What other way could the slit-scan be captured? Perhaps using a kinect, or conversly a low tech approach?

How can we improve the jerkiness of the image? Use a bicycle or trolley, make a steadicam rig, sense movement with an accelerometer?

How else could we render the data? Could a 3D plane be used and apply a large texture to it? Could the output be mapped allowing a user to virtually move around the slit-scan in three dimensions? How might we make the slit-scan physically exist and using what materials?

Output_1_1
spatial plot of
slit-scan using
GPS data

long slit-scan
of stitched
images as can
be created by
Output_1_2

WORKFLOW 5: Get Green

Introduction

This workflow uses photos taken on a smartphone and extracts the pixels that are of an organic green colour. This way we can crudely estimate how much foliage and plant life there is in each picture. The final part of the workflow maps the image locations.

INPUT: Setup the camera
For input use a smartphone or digital camera, or a film camera and scan them. For the output and mapping the photos, make sure your smartphone allows the GPS to be used by the camera, such as switching on 'location services'. Take photos during your walk. Consider how you want to take photos. Bear in mind keeping similar distance/ height/angle from a subject if you are trying to measure the size of plants. Maybe use a timer if you are trying to assess how much plantlife is in view at a regular intervals along a walk.

Go walk!

Copy the data
Transfer the photos from your phone or camera onto your computer.

Download and install ExifTool from Phil Harvey's website, which can be used to get the GPS data from the photos. Use Terminal (on MacOS) or another UNIX command line application to change the directory [cd command] to the one with the walk photos. Then run this exiftool command:

```
exiftool -csv -filename -datetimeoriginal -gpslatitude
-gpslongitude -n ./ > data.csv
```

Check the data.csv file created in the images directory. It should contain GPS data for those images which can be used to map them. If it doesn't then it is likely that the images failed to record the GPS data; check your phone settings.

Copy the csv file and images to the data folder of the Processing sketch.

OUTPUT: Run the Processing code
Output_1_1 takes the photos from the data folder and extracts pixels that fit within a certain range of hue, saturation, and brightness. You may want to tweak these values according to the types of plants that grow in your area and the lighting conditions. The program creates and saves a version of the image with only the green pixels, and then a image with all the green pixels compacted into a square, and a composite of these images to see a comparison.

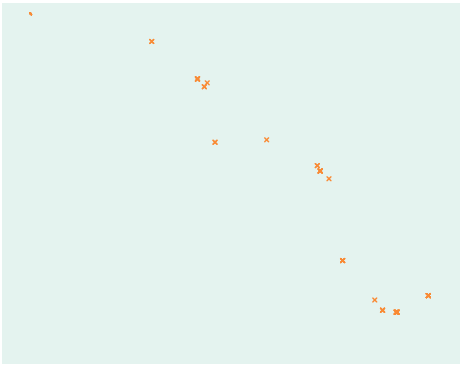
Similar colour extraction functions can be performed by the OpenCV library, and a number of other programs. But there is merit in writing and exploring our own computational methods.

Output_1_2 uses the data.csv file created using the photos and Exiftool to plot the photo locations on a map in Processing 2 using the Unfolding Maps library.

Output_1_3 adapts Output_1_2 and renders the square boxes of organic green pixels generated in Output_1_1 and plots them on a map using Processing 2 and the Unfolding Maps library.

Extending
Photography opens up a world of potential in terms of data extraction and visualisation, and geolocation allows us to easily and accurately situate photos in the world. Computational image analysis is an interesting and evolving field with many powerful tools available in libraries like OpenCV and new abilities emerging from machine learning, all in an effort to extract meaning from images.

Output_1_1 export showing clockwise from top left: original image, isolated pixels, compressed pixels, square of compressed pixels



Output 1_2 spatial plot of photo locations

Output_1_3 location plot of extracted pixel squares embroidered onto fabric using a digital embroidery machine

WORKSHOPS

ASPECTS
natural environment:
light
temperature
trees & plants
wildlife

pollution:
litter
air quality
noise
visual

infrastructure:
buildings
green spaces
transport
services
signage

materials:
made of what?
textures

people:
number
where
gender
age
conversations
clothing
use of tech

human experience:
path width
lighting
smell

data:
wifi
mobile networks
coverage
speed

cultural:
food
music
art
markets
shopping

religious:
places of worship
evidence of practice

contemporary issues:
in Taipei, what is happening right now?

historical:
ages
periods

define your own aspects!

Data Walking: Taipei
with Tatung University Masters Program

Introduction

In late 2016 I travelled to the city of Taipei, Taiwan, to run a workshop with a class of students from the Tatung University Masters program. We had three days to immerse ourselves in Taipei's different districts, learn about the districts' individual characteristics and gain some new skills in gathering data and design outcomes with our findings. As masters students, authorship and championing their creativity was key. Below is the brief they were set to complete over two days followed by a morning of presentations on the final day.

Task

You have been put into seven groups each group assigned to one of the seven central districts in Taipei. Explore and understand your given district through data gathering and visualisation. Together we can understand central Taipei, its history, culture, environment, and contemporary issues.

In your groups you should decide on one aspect for each member to explore and gather data about. A broad variety of aspects and techniques is encouraged. Then as a team you should work together to visualise this data, either as a combined visualisation or separate visualisations per aspect.

Outcomes

A visualisation of your gathered data. Creativity is key so there are no limitations– you can create anything in any medium! Be experimental. Communication and understanding is also critical. Your outcome will need a title, and consider a key or legend to understand data encoding.

Process and Presentation

The groups worked incredibly hard over the three days. It was extremely positive to see how quickly the students could harness the technology, develop an idea, gather the data and then create an experimental visualisation in such a short time. They worked well in their mixed teams and brought their own skill sets and thought processes to create unique outcomes. There was a broad range of mediums used from 3D software generated visualisations, to physical paper constructions, and campaign concepts. It is also worth noting that all the presentations were made in English, not their first language, and all were able to articulate their concepts and had a good grasp of technical language.

It was an honour and I thank Tatung University and particularly Nikii Wang for facilitating the workshop, assisting across the three days, and making me feel at home in Taipei.

TECHNIQUES
analog:
pen & paper
notes
drawings

smartphone:
GPS camera
microphone

Arduino +
sensors +
GPS shield:
LDR
microphone
temperature
air quality
distance
button

laptop:
webcam
kinect
microphone
wifi

OUTPUTS
visualisation:
maps
charts & graphs
timelines
compositions
sequences
photographs
images

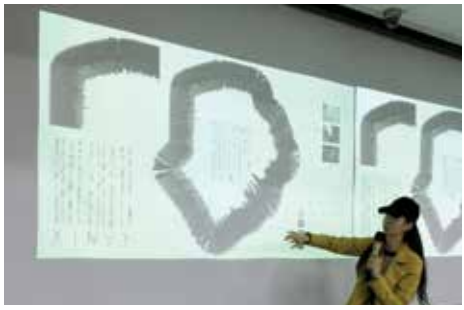
material:
printed on paper
3D printed
CNC machined
3D constructed
from flat layers
sculpted
sequential

screen:
static
animated
interactive
data-driven app

mixed:
physical
computing
interactive
tactile/material
environmental
projection
mapping

TOOLS
Arduino
Processing
Nodebox
HTML + CSS + JS
3D software
Illustrator
Photoshop
Excel
Google Docs

decide your own
tools!



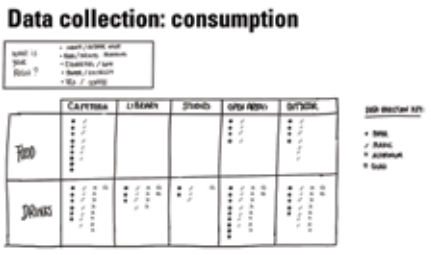
Data Walks at Ravensbourne
with Valentina D'Efilippo and Piero Zagami

Data is Everywhere
How do we conceptualise, understand, and visualise data? These pursuit are all intricately linked in information design practice. Also, they were primary objectives for our introductory data visualisation workshop for Graphic Design students at Ravensbourne.

Data is everywhere. Not simply in the way we consider "big data" and its digital presence. Data is literally everywhere within our physical environment. Simply put, data exist as a set of values, which vary quantitatively (or qualitatively). These can be observed in where we go, what we touch, and everything we see.

Data in Your Bag
We began with an exercise organising student personal possessions from their bags into taxonomies. Sorting metrics included size, colour, cost, and conceptual approaches like personal value, frequency of use, length of ownership and necessity for survival. There was no shortage of findings: observing what we carry provides perspective on who we are and what we value.

Walking and Harvesting
Following this introductory session we applied these concepts of data classification to a broader landscape: the college itself. We asked the students to walk around the college, observe and record information. For these `Data Walks', groups were assigned specific environmental aspects to observe: gather data on consumption, noise, and visual pollution within the college. Students were to look for stories, not just data.



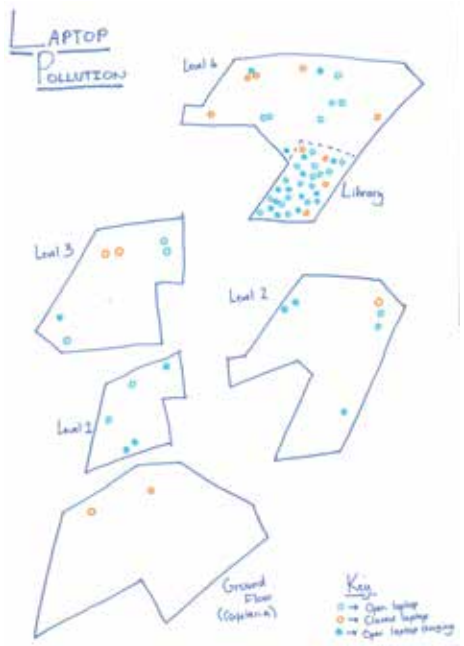
Processing, Sketching, Prototyping
With their new recorded sets of data, students could start analyzing their findings. Through guided activities related to student's observations and research, we mined insights by quickly visualising outcomes using different charting techniques.

Instead of facing an endless spectrum of visual possibilities, students were to think about specific fields of visualizations such as magnitude, relationship or geographic representations. Students shared ideas and responses to these targeted questions in small groups as they visualised their data in various formats. It was impressive to see them generating a rapid range of functioning proofs of concept in such little time!

Then, once the optimal way to visualise insights was established, groups worked independently on large scale visualisations which best illustrated their findings.

Finally, through a facilitated group discussion and critique we evaluated the final sketched solutions. These displays of information not only offered various stories for participants to interpret, discuss, and reflect on, but they also made students realise how important user testing and dialogue is in shaping the final outcome. Thinking aloud through graphs and statistics offers multiple benefits.

It's inspiring to see how quickly students were able to absorb new techniques and ways of thinking. Likewise, it's refreshing to get back to basics and see how much data there is around us, and how removing the spreadsheet between us and our topic can free our minds.



Collections & Reflections at Learn X Design Conference with Becky Ford and Maaike van Neck

Process

A peninsula is a piece of land almost completely surrounded by water—or depending on your perspective—water almost framing a piece of land in its entirety. It's the idea behind 'perspective' that lead to the collaborative workshop 'Collections and Reflections'.

The workshop route started at Ravensbourne `[51.501617, 0.005410]`. The participants walked anti-clockwise, with the river (nature) on our right and the O2 Arena (culture) and its large secure and gated area on our left. The walking paths were clearly sign posted and dotted around with installations of 'The Line'—a modern and contemporary art walk since 2015.

Where a desire path will indicate the preferable or most easily navigated route between one point and another, the path on the Peninsular was very much led by the natural form of a peninsula combined with the architecture and urban environment of the O2 Arena forces the walker to stay within the suggested circuitous route with little opportunities for alternatives. The walker can move forward or walk backwards only.

The physical constrictions of the 45 minute walk created an interesting opportunity for data collection. All ten walkers were asked to focus on a specific theme prior to the walk. These included the documentation of a variety of angles, as well as people, messages, security, litter, flora and fauna. As it was a relatively short workshop the tool of documentation was the camera phone.

In terms of data collection the camera phone—although a common device owned by many—allows for acquiring of multiple datasets that go beyond the visual alone. Metadata of the file reveal quantitative data such as GPS, date and time but also focal depth and DPI. The singular image can be analysed and categorised using a variety of qualitative and quantitative methods and interpretations using LATCH as well as other methods of organising information.

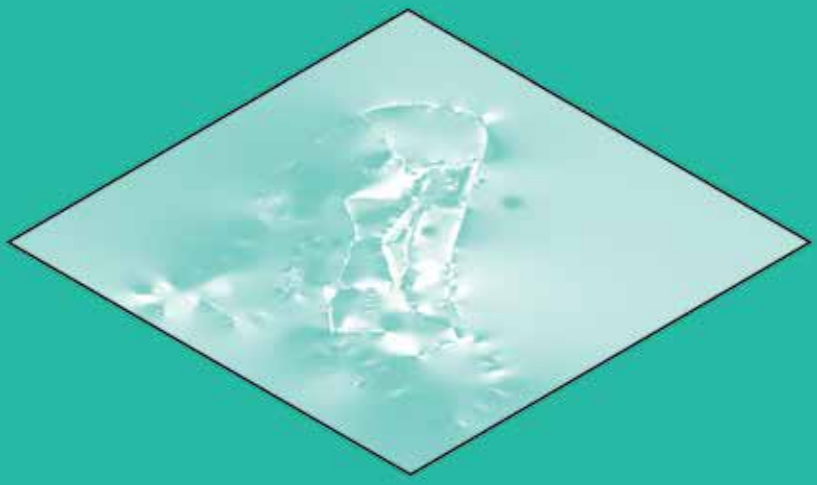
LATCH
sort and organise data along the below aspects:
location
alphabet
time
category
heirarchy

The collection of images totalled 386. The amount of images per participant varied. From 39 for Fauna to 30 on Security. There were also interesting contextual overlaps, particularly between the datasets for `messaging' and security. Visually, there were similarities in vantage points between security and fauna. Due to the timings of the workshop there was not enough time to go more in-depth with the selecting and ordering of data.







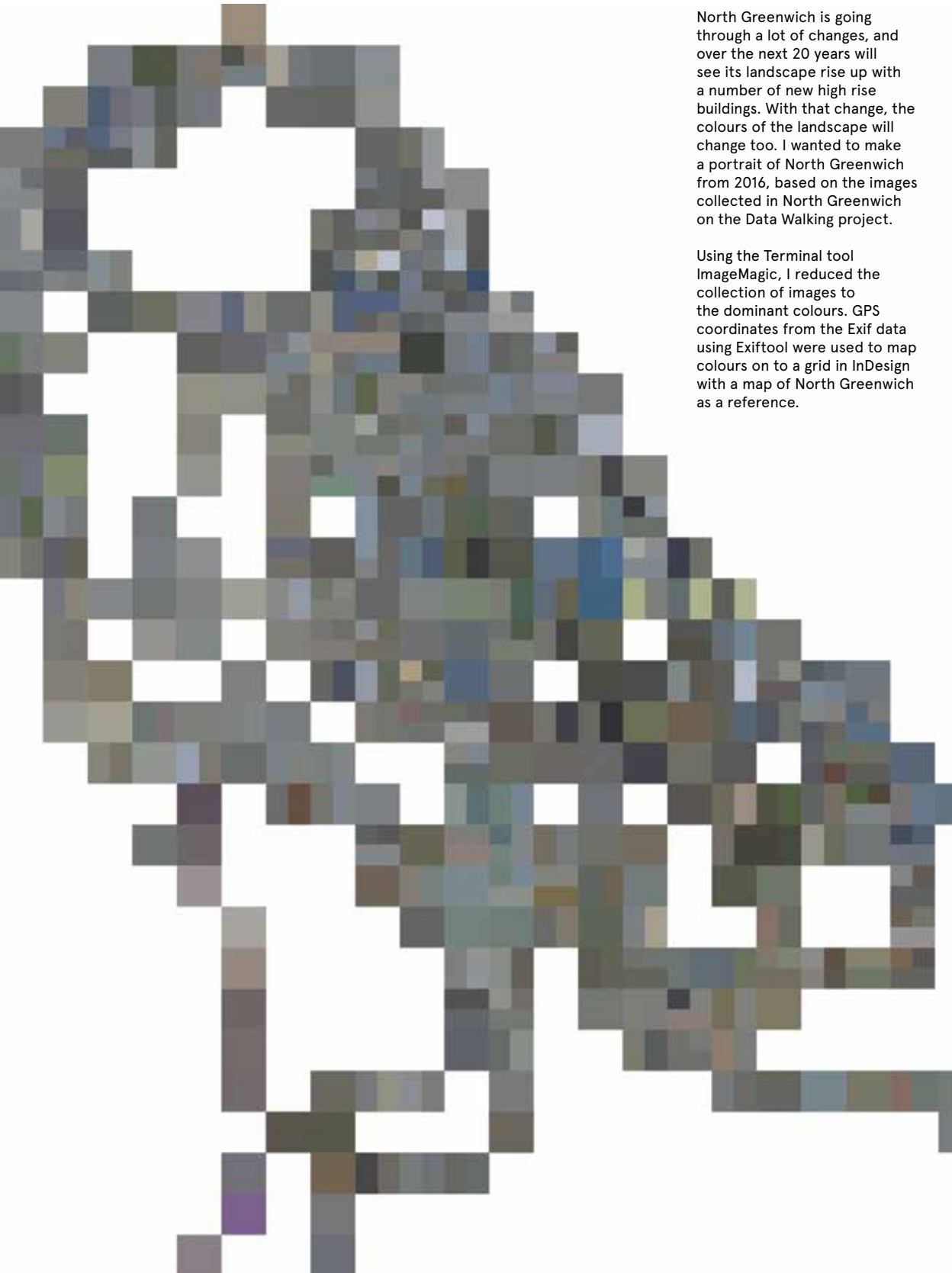



sound

VISUALISATIONS

THOMAS WALSKAAR
ERIN BROWELL
FRANCESCO TACCHINI
TEKJA
CHRIS DAVIES
CALUM HALE
BRENDAN DAWES
TYLER FIELD
JACK HUBERT &
CALLUM STEPHENSON
EVAN RASKOB
LUKE RIDEOUT
THE ROYAL STUDIO, JOÃO NOVAIS &
NON-VERBAL CLUB
TOM LONGMATE
CATALOGTREE

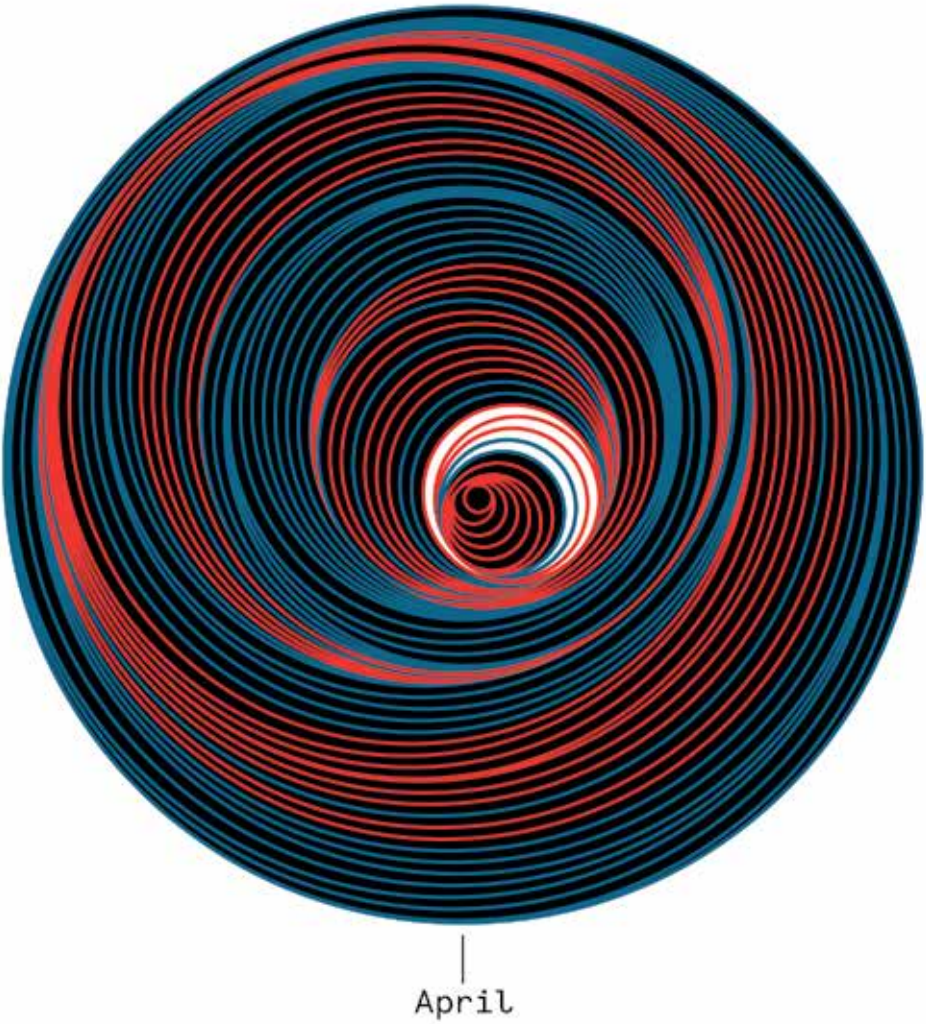
THOMAS WALSKAAR



North Greenwich is going through a lot of changes, and over the next 20 years will see its landscape rise up with a number of new high rise buildings. With that change, the colours of the landscape will change too. I wanted to make a portrait of North Greenwich from 2016, based on the images collected in North Greenwich on the Data Walking project.

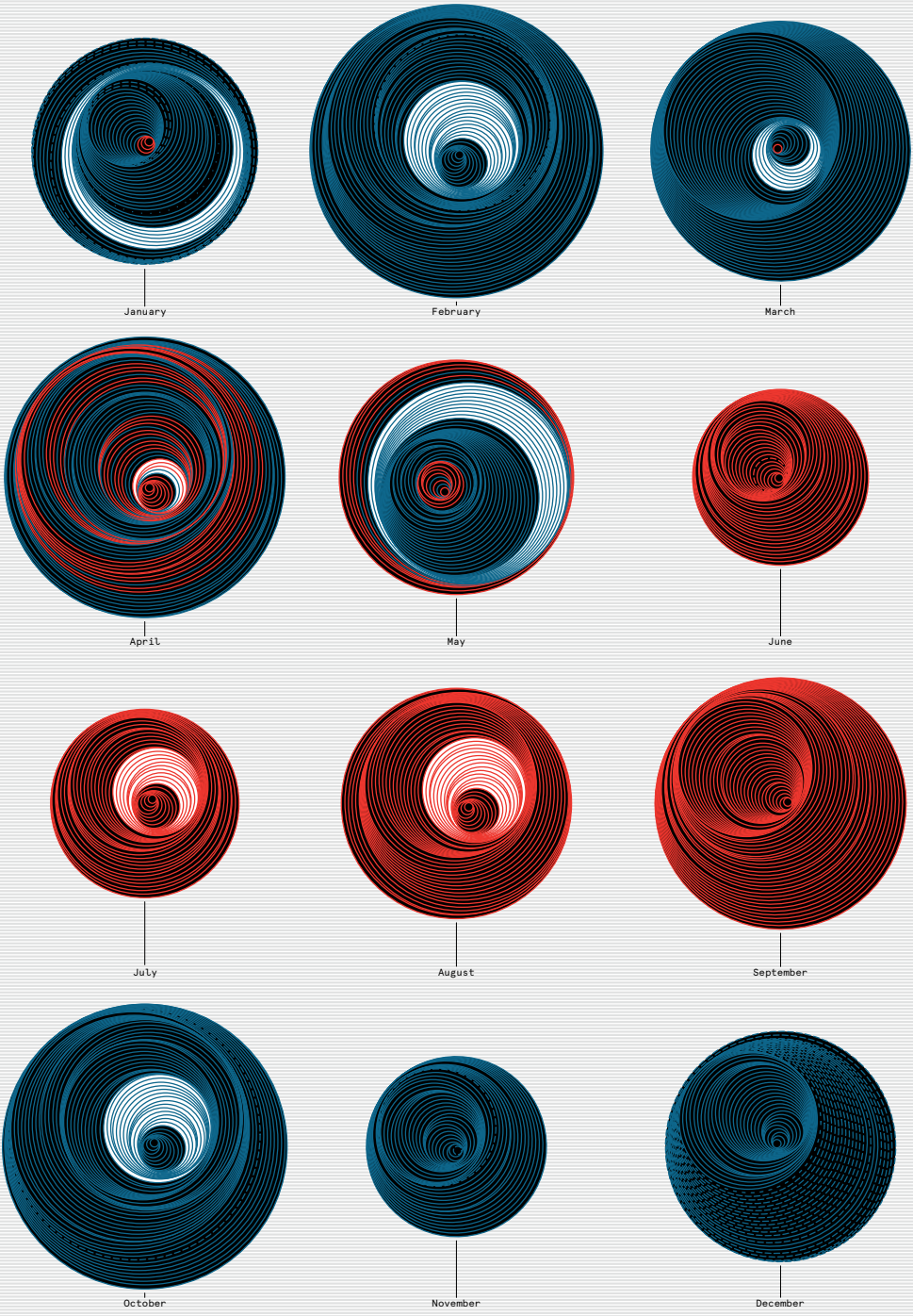
Using the Terminal tool ImageMagic, I reduced the collection of images to the dominant colours. GPS coordinates from the Exif data using Exiftool were used to map colours on to a grid in InDesign with a map of North Greenwich as a reference.

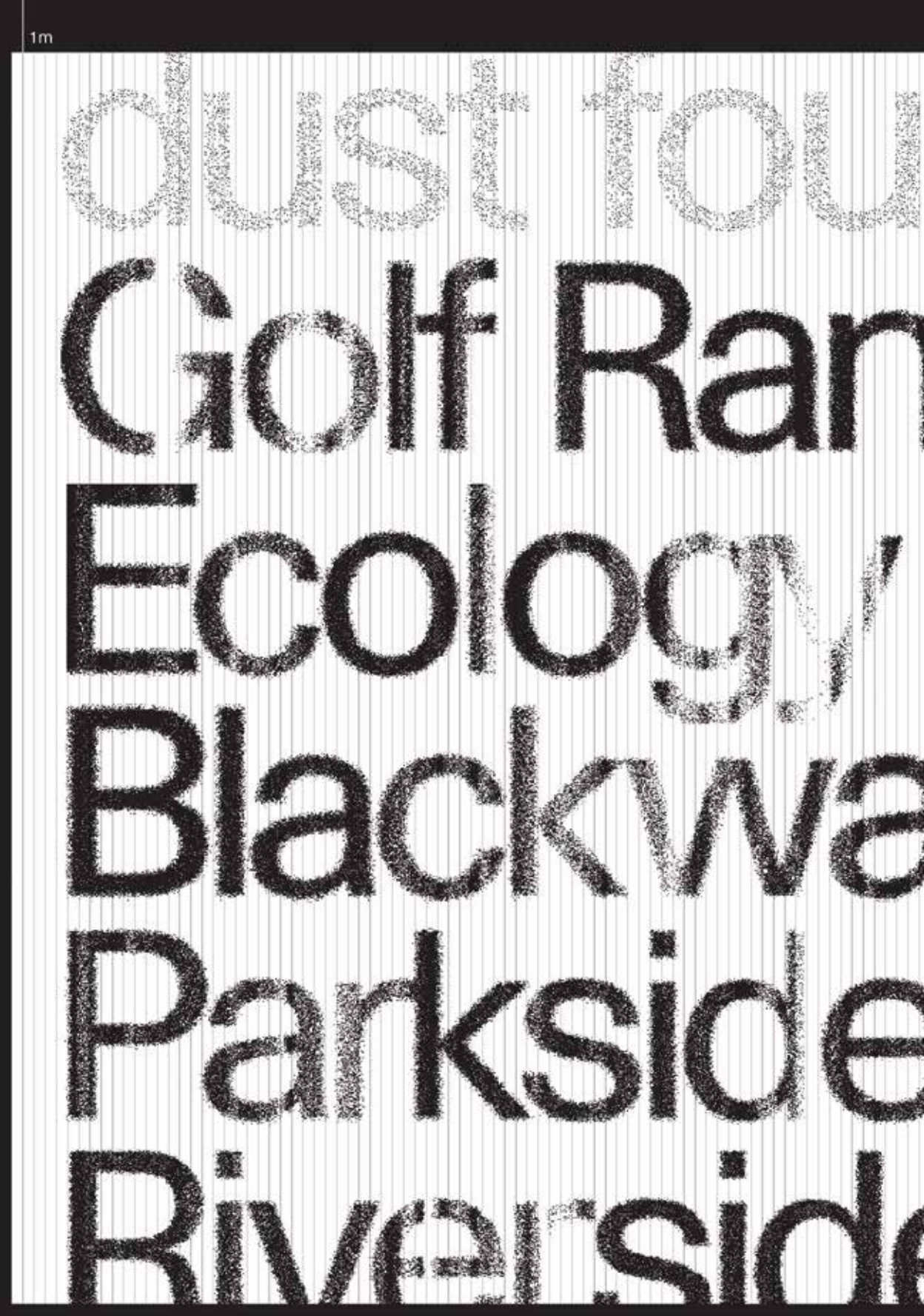
ERIN BROWELL



Informative Study:
Walking around Greenwich Peninsula

Each complete circle represents minute progression of walks; direction walked relevant to previous co-ordinates, temperature, light intensity, and hemisphere position when crossing the GMT line. Showing all 12 Data Walks by David Hunter throughout 2016.




dust fou
Golf Ran
Ecology
Blackwe
Parkside
Riverside


41m
44m
54m
1h
1h8m
Park
Tunnel

FRANCESCO TACCHINI

The piece visualises the amount of dust found during five consecutive walks undertaken monthly in the North Greenwich area of London.

The horizontal axis of the piece represents time, each vertical bar being a minute of walking. On the vertical axis the five main locations of each walk are spelled out.

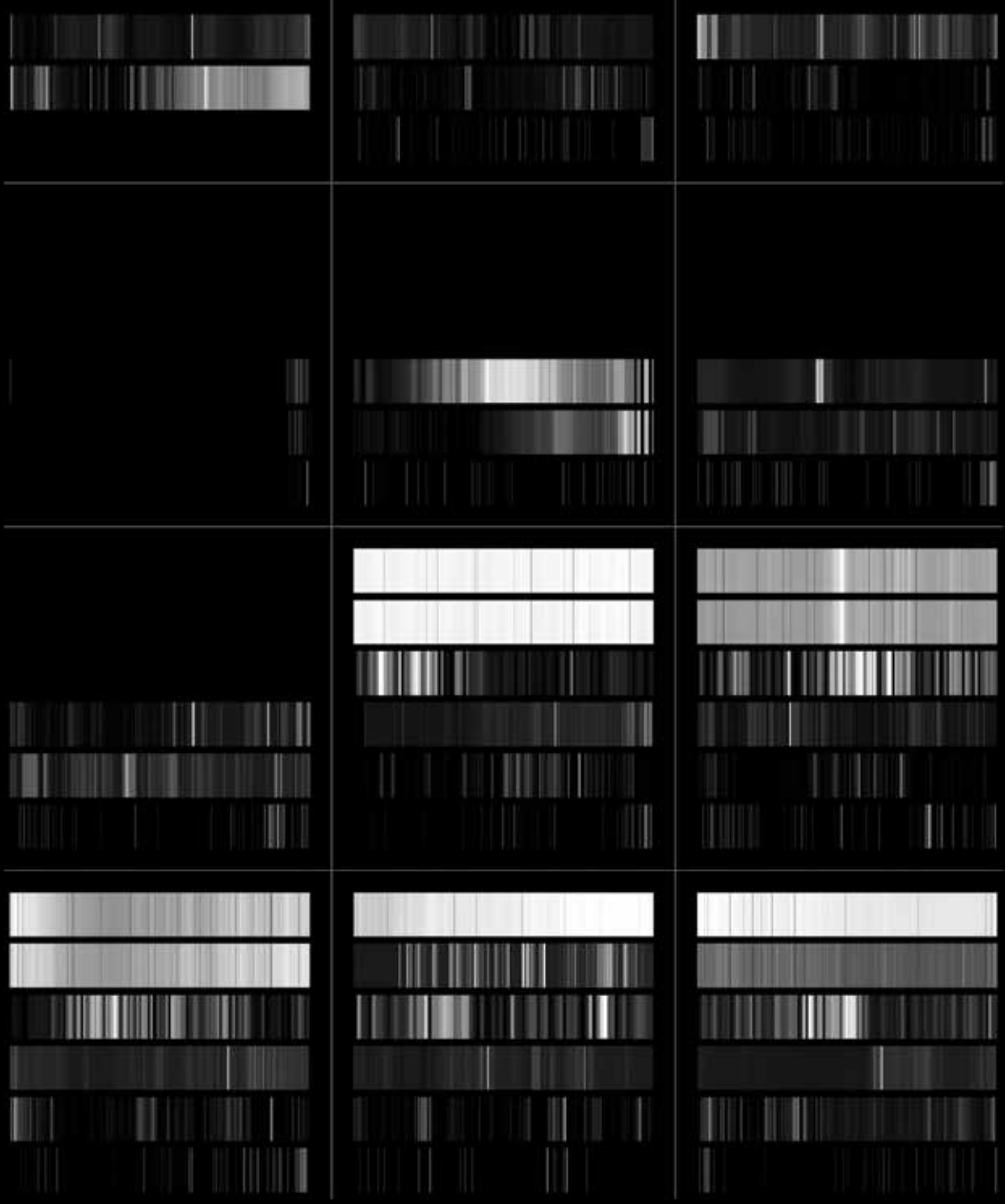
The type composing the location's name is distorted by small white particles representing dust. The higher the amount dust sensed at any given point of a walk, the more white particles are represented in the relevant bar.

The September walk undertaken in the Ecology Park, for instance, has the highest concentration of dust in a span of ten minutes halfway through the walk.

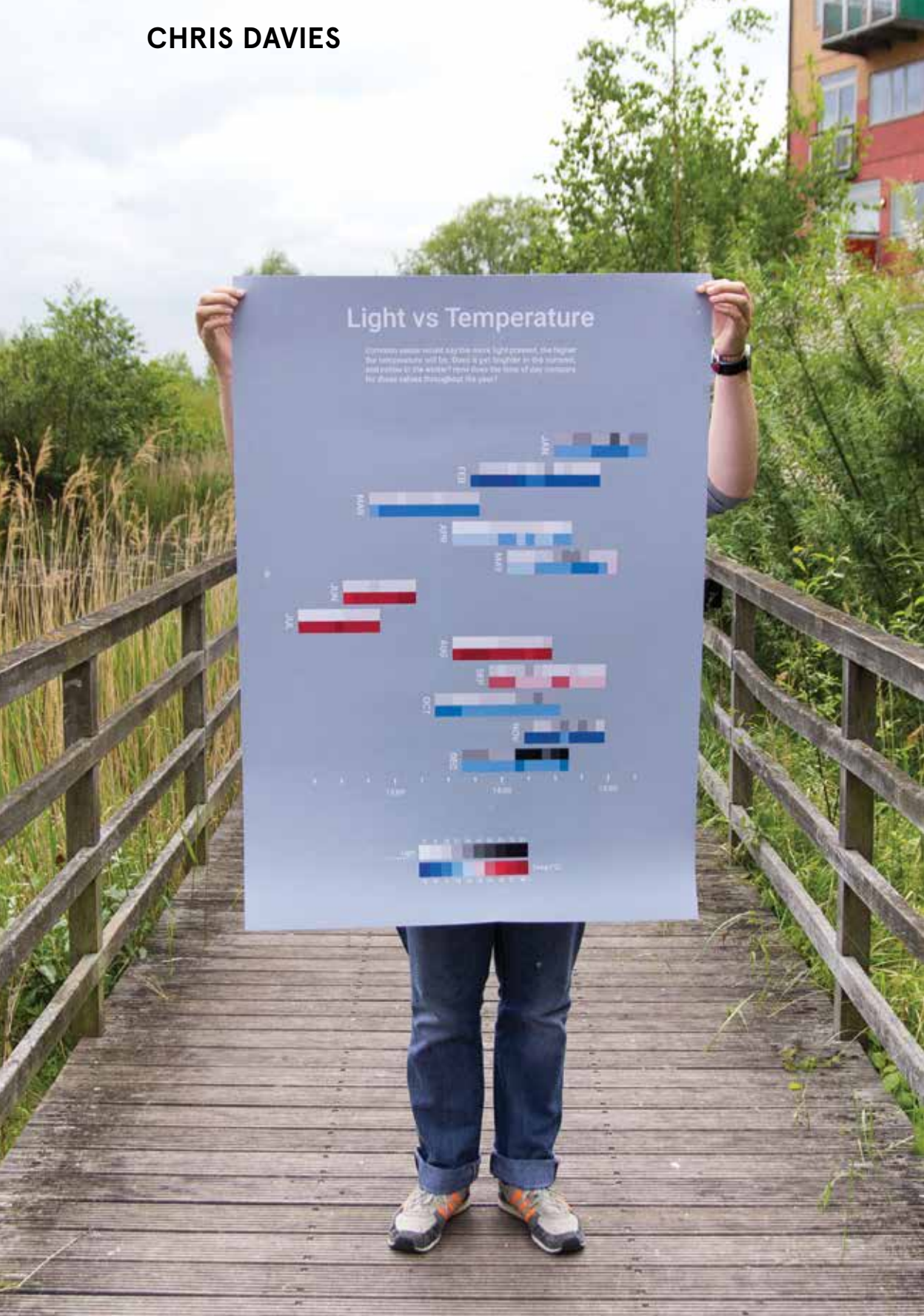
We've plotted six sensors as rows (MQ135, MQ2, dust, light, sound and people) across the 12 walks (the 12 squares).

The lines change brightness based on the value (white = high, dark grey = low).

TEKJA

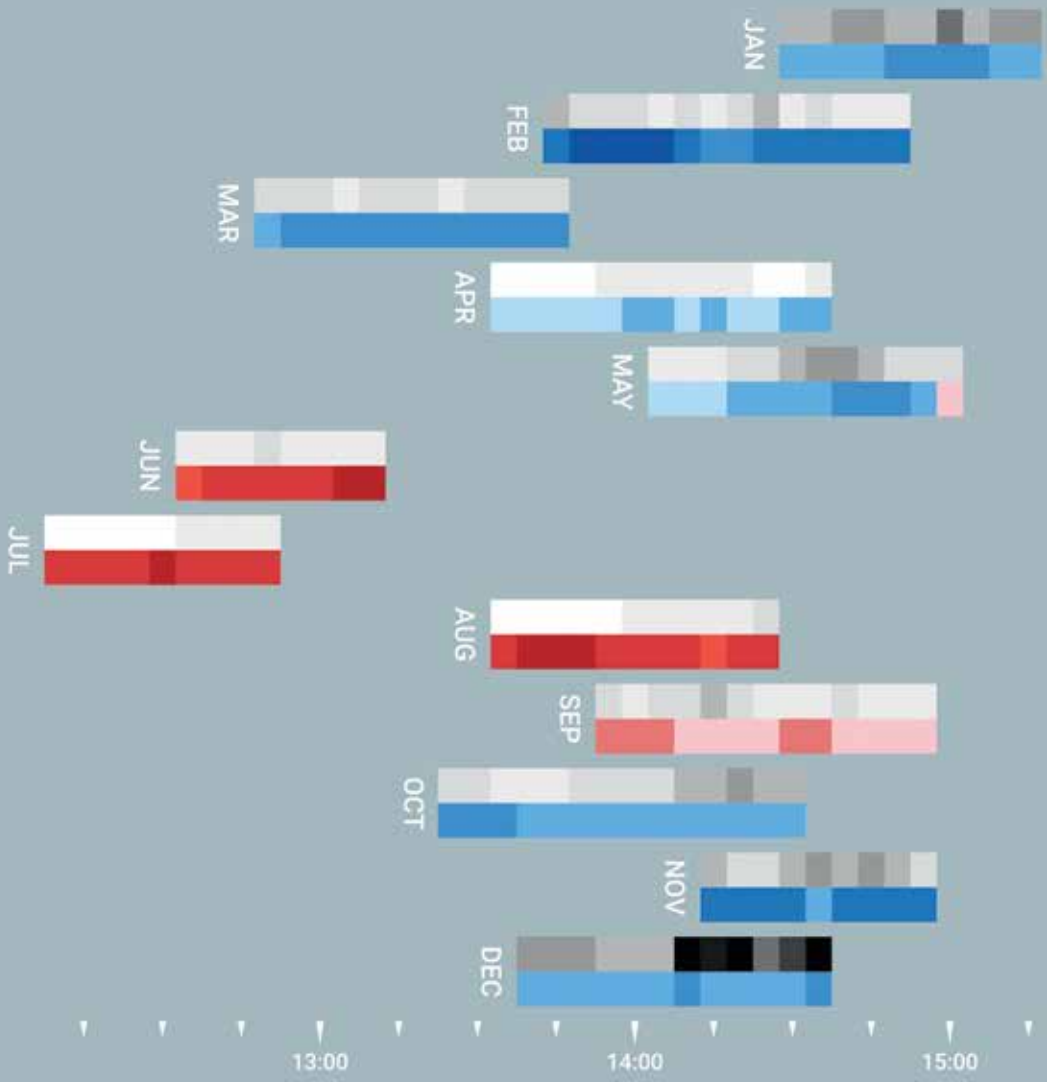


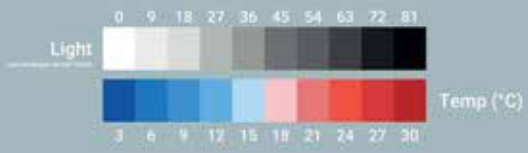
CHRIS DAVIES



Light vs Temperature

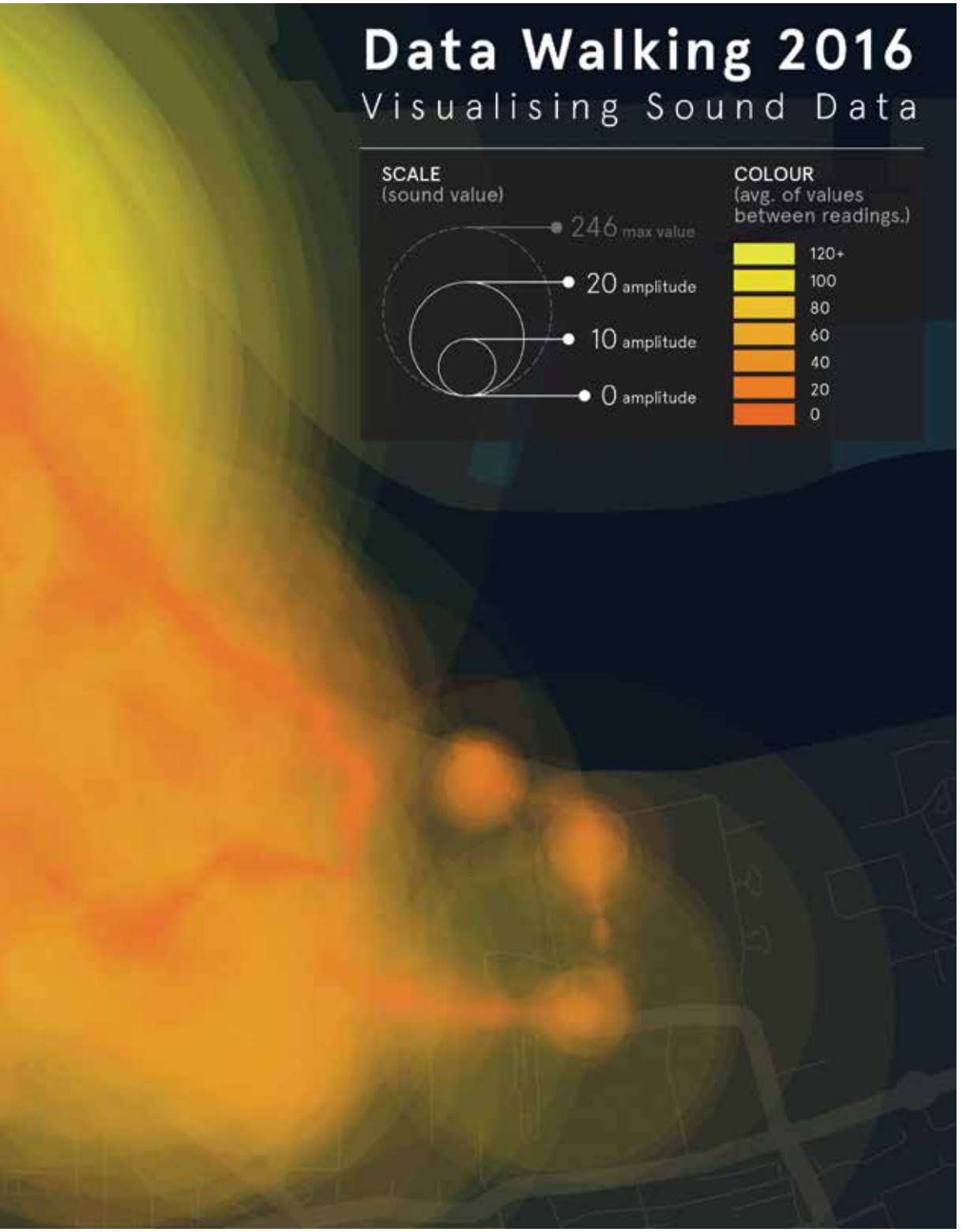
Common sense would say the more light present, the higher the temperature will be. Does it get brighter in the summer, and colder in the winter? How does the time of day compare for these values throughout the year?





CALUM HALE

When looking at the raw data I was intrigued by the 'sound average' values, and was wondering between the combination of parks and motorways found in North Greenwich how that sound changed across the data walk. To see the pattern in the data I plotted a series of points scaled by the sound amplitude. Through this I discovered that the sound is louder nearer main roads, which is to be expected, but also quite loud at some key locations by the river and near The O2. It was also interesting to see the sound patterns change over the year as the location of the walk changed.

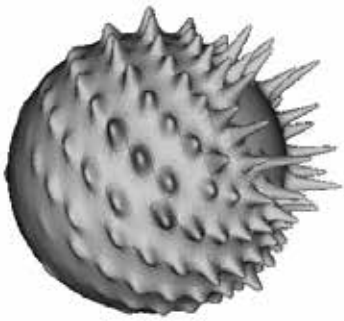

Data Walking 2016
Visualising Sound Data
SCALE
(sound value)
246 max value
20 amplitude
10 amplitude
0 amplitude
COLOUR
(avg. of values
between readings.)
120+
100
80
60
40
20
0

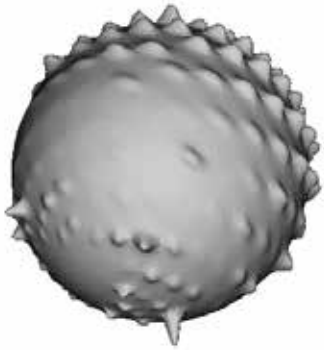
BRENDAN DAWES

Amongst The Leaves transforms the environmental data collected by David Hunter into physical data objects you can hold in your hands to get a "feel" for the data collected on a certain day.

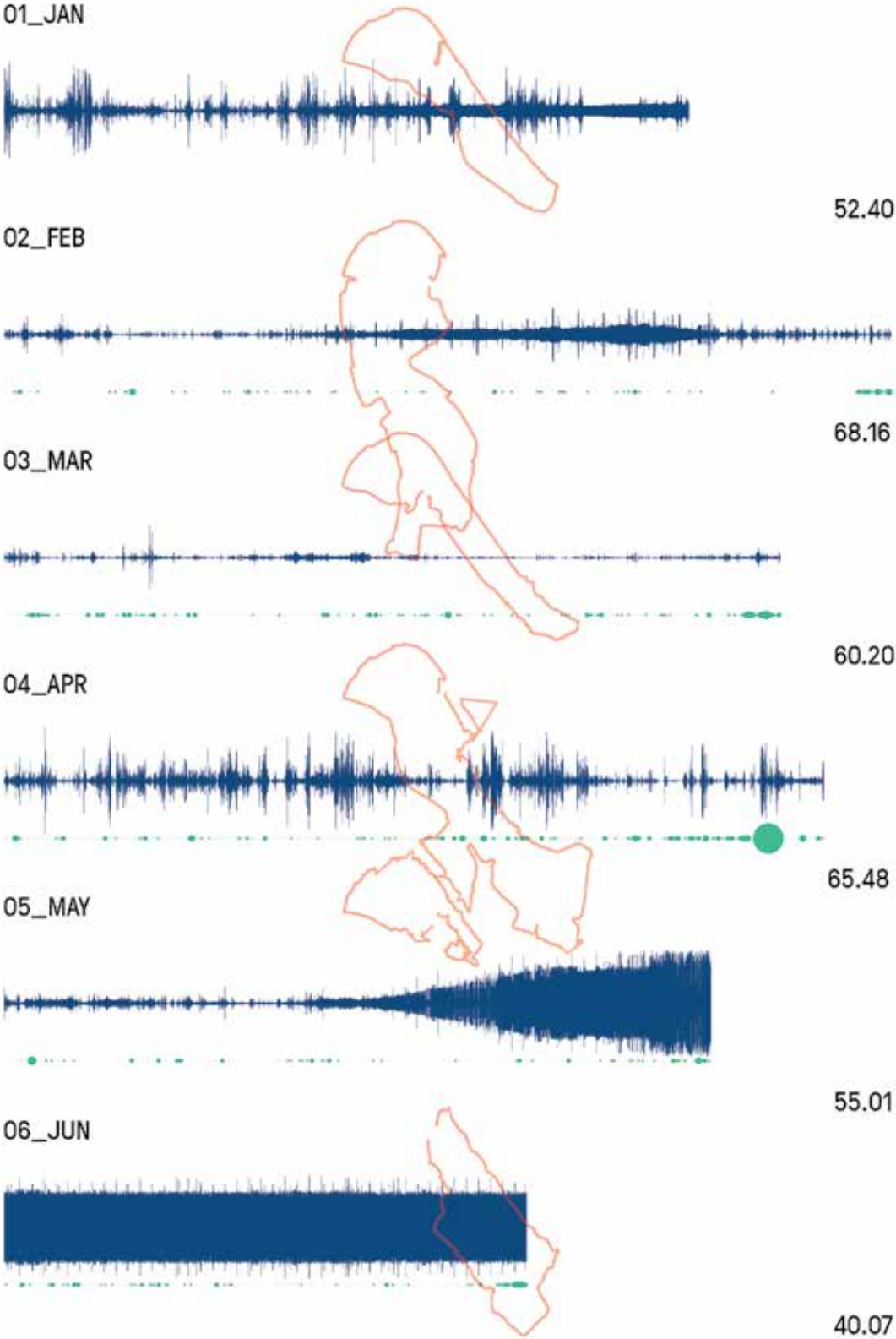
Inspired by the shell of a Horse Chestnut conker, these forms are designed to be put back into the environment alongside other fallen debris, for others to find and to ponder other. Each form uses the sound data collected on three different days throughout the year.

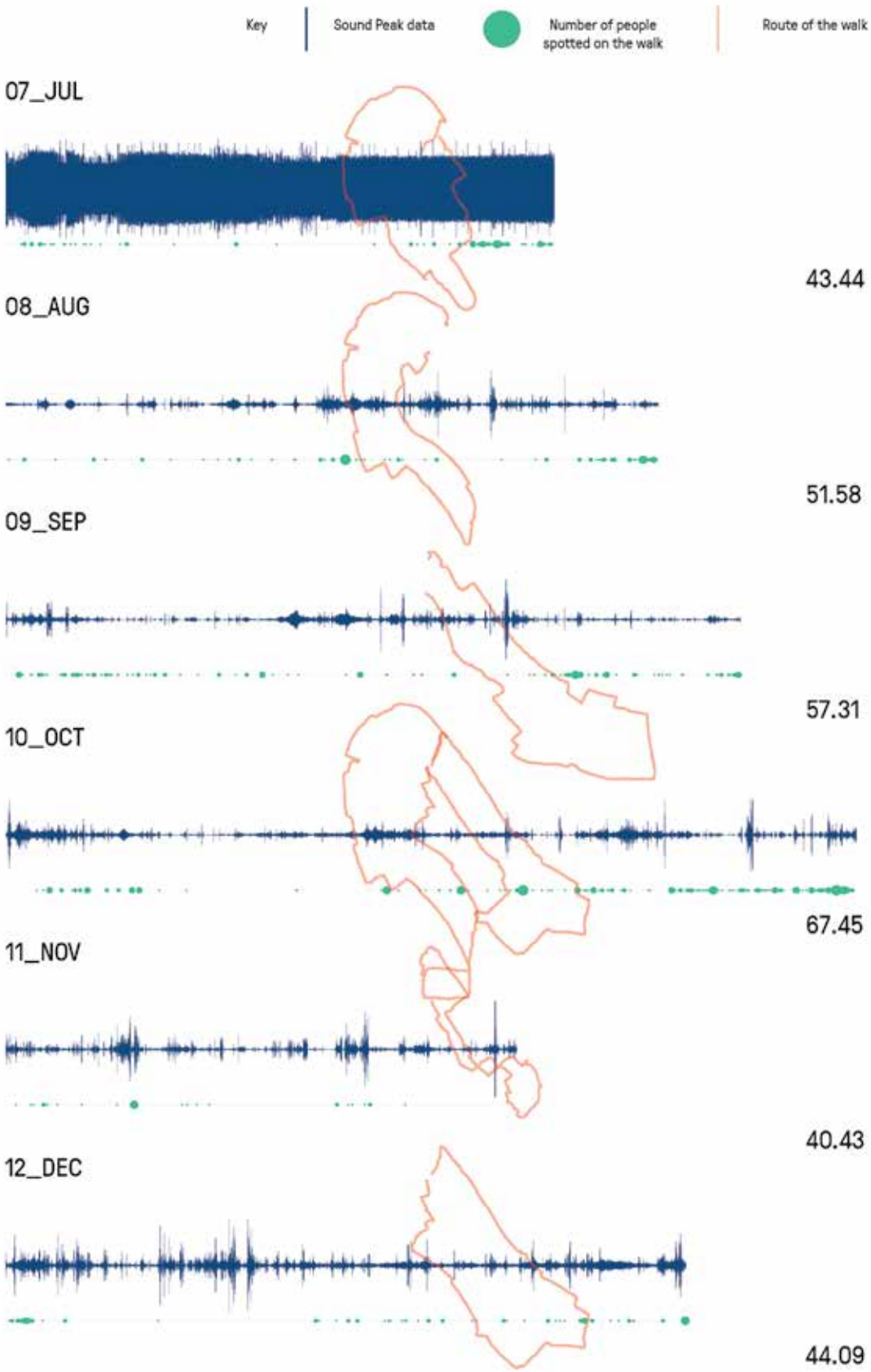
Whilst currently 3D printed, in the future might we bump into this type of data formed in real-time from self-assembling nano-bots, so that this often invisible though ever-present data becomes a familiar part of our landscape.





WALKING SOUNDS

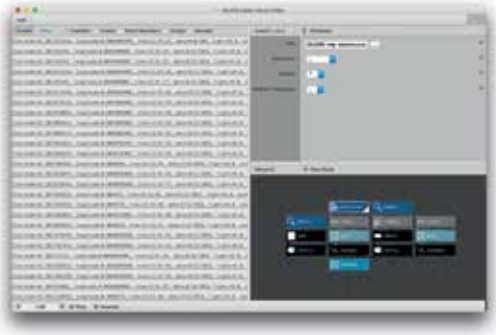


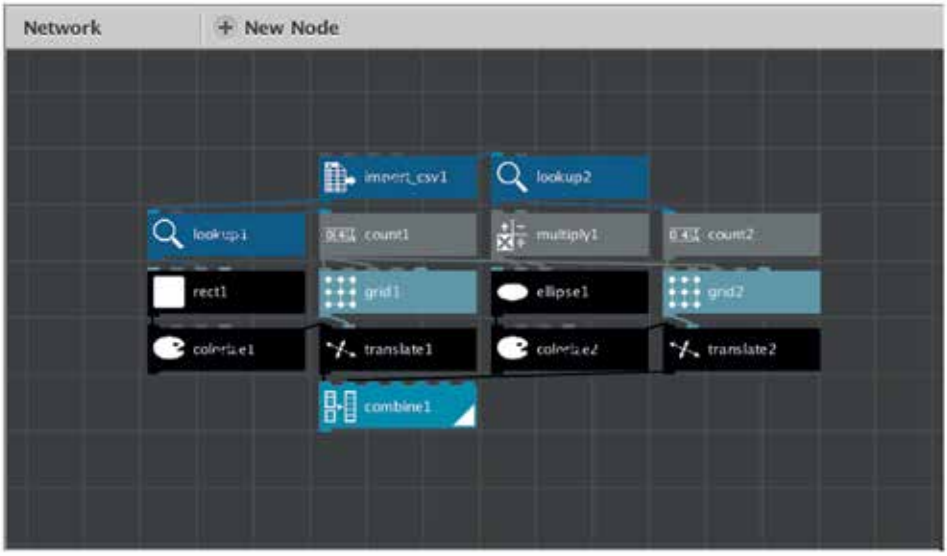

Key
Sound Peak data
Number of people spotted on the walk
Route of the walk
07_JUL
43.44
08_AUG
51.58
09_SEP
57.31
10_OCT
67.45
11_NOV
40.43
12_DEC
44.09

TYLER FIELD

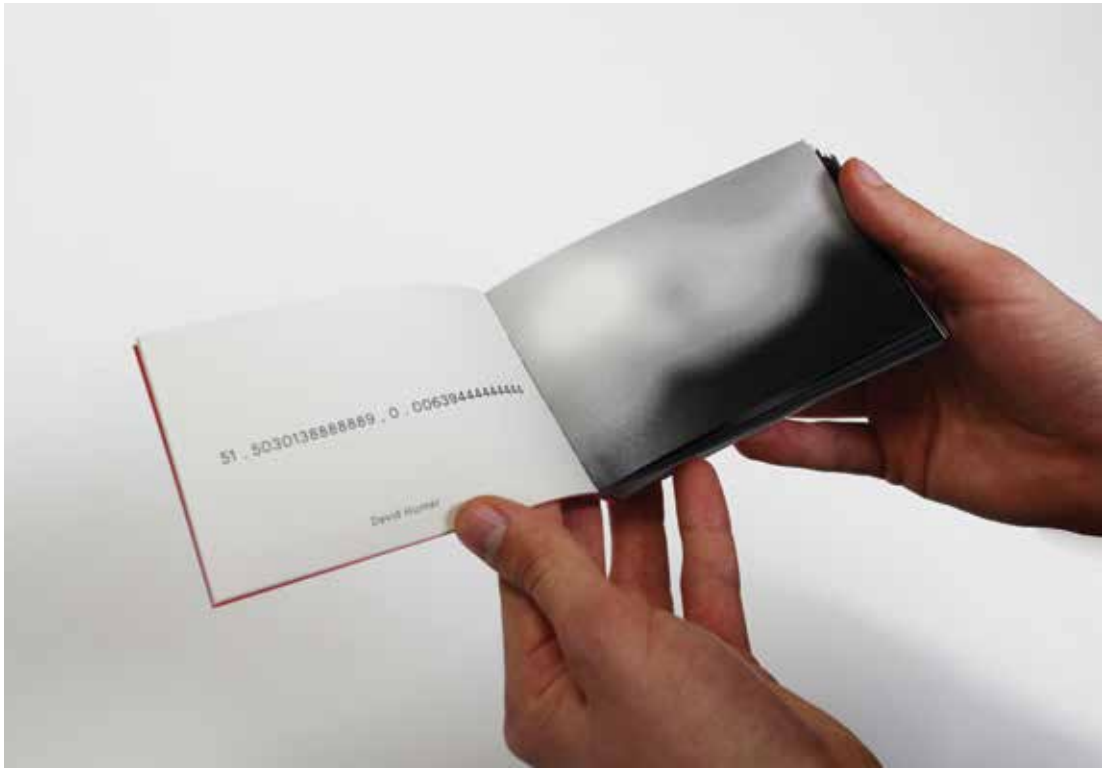
My project from the Data Walking data, was to present the walks in sound amplitude and if there is a connection between the sounds to the people spotted on the walks. From the data visualisation, you can see the route of the walk in the background with the sound amplitude rendered and a series of circles which represent the people spotted on the walk. The sound amplitude data is from the sound peak dataset from the Github. I made my data visualisation using a free program called Nodebox, where you link up nodes to create a network which forms a visual from a dataset or numbers.

tylerfield.co.uk



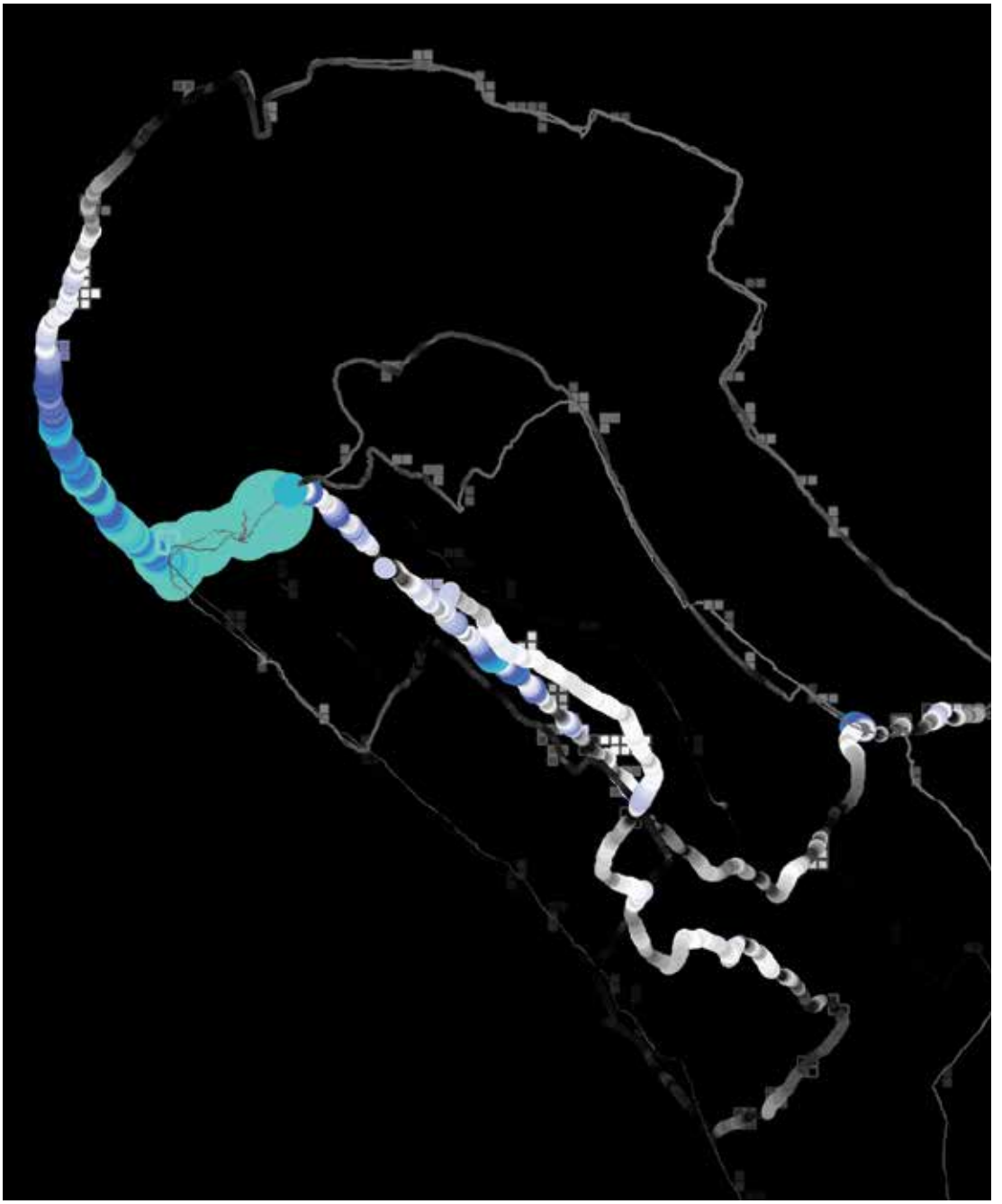


JACK HUBERT & CALLUM STEPHENSON

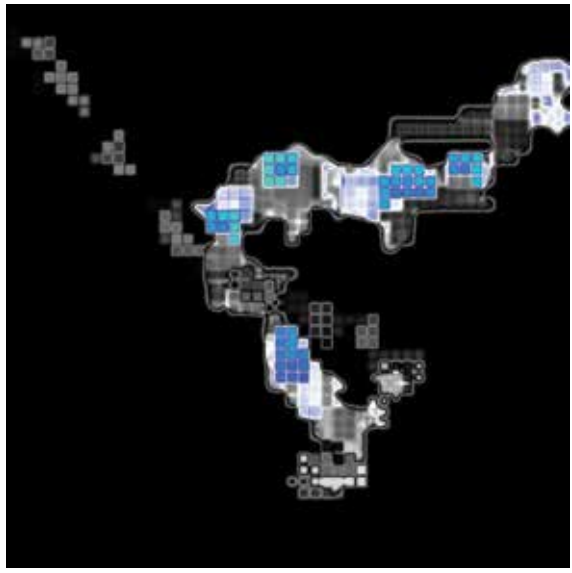


We wanted to create a flip book that makes light data easier to read through. `51.501617, 0.005410' (the co-ordinates of North Greenwich Peninsula) turns light values into black and white images. When flicked through, co-ordinates and imagery change at the speed the light, making it easy to find out where the brightest parts of the peninsula are.

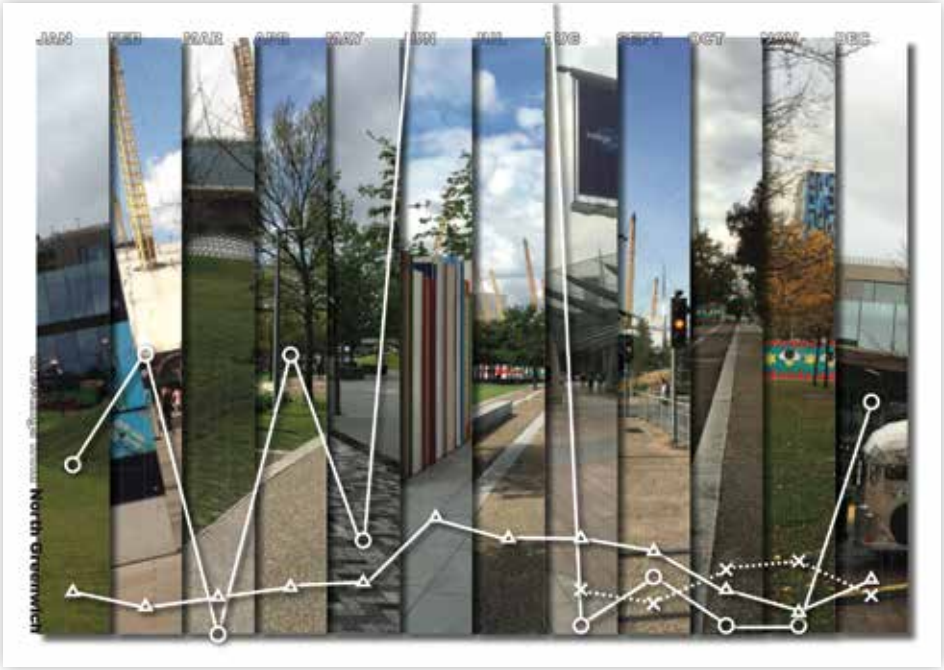
EVAN RASKOB

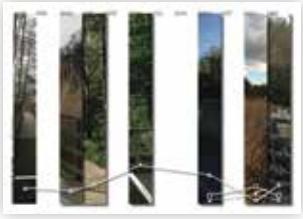


Air is a gas and so it has a flow rather than absolute position. I wanted to capture some of that fluidity in these data artworks. They are using the data from the MQ135 sensor and plotting them on a map using the latitude and longitude recorded with each sensor reading, but with a twist. Over and over again, the data is re-plotted on the screen and little "walkers" with a primitive path-following AI are generated to spread those values around the map. Their trails are then fed into a cellular automata network that "grows" them outwards and mixes them together, using similar procedures to how seashells are formed and their intricate, repeating patterns are woven together from generations of cellular growth.



LUKE RIDEOUT





We are experiencing an exponential increase in the development of urban space. Cities constantly mutate to suit our desired interactions with environment. It is possible though, that by moving so quickly that we risk forgetting where we came from? Why is it important to reflect on the history of a city and what methods are available to achieve this?

Greetings from North Greenwich documents a period of intense change in London's East End, the development of the Peninsula. A set of six postcards paint a picture of environmental fluctuation, allowing both sender and receiver to reflect on physical change. Simultaneously the project questions the throw away visual content of the format, usually a cheap joke or a touristic vista, can the humble postcard instead be used as a medium for critical reflection?


MON
North Greenwich

THE ROYAL STUDIO, JOÃO NOVAIS & NON-VERBAL CLUB

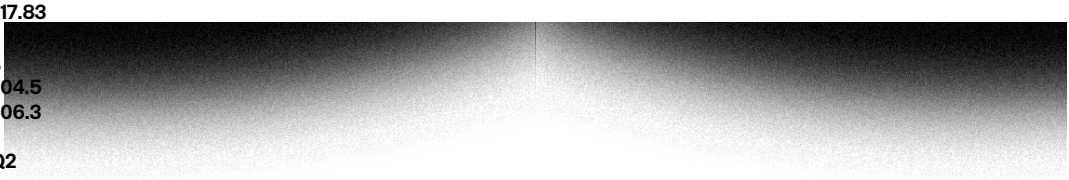
It is the hypochondria, the thrill to belong and the drive to let go. The terrain, the arrogance to let it go and still to flow along it. It is the sunset and how it feels warm. No more than the temperature to meet the touch. Nothing else than light to make us aware of sight. What does dust taste like? It is the long drive, the longest walk that in the end has a sound average lingering in its memories. It is the smell, the barometer, the gas, it is that city and the lack of its society in numbers.
Data Walking is an allegory to the senses. How can one evoke the 5 senses via a series of generative graphics with emotive goals, while being true to the average numbers of each sensor in its respective month? Interpolating data with how it feels to be human, the abstract flows, per month and per sensor:
Smell — Gas / Sound — Sound Average / Taste — Dust / Touch — Temperature / Sight — Light

The Royal Studio with João Novais and Non-Verbal Club
www.theroyalstudio.com
www.nonverbalclub.pt

Smell

05.
538.72
824.62

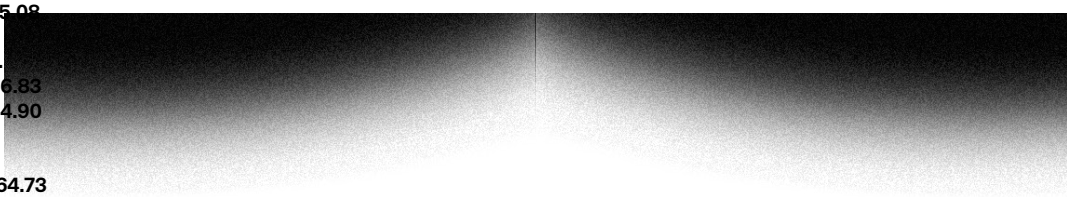
06.
513.95
317.83



07.
504.5
506.3

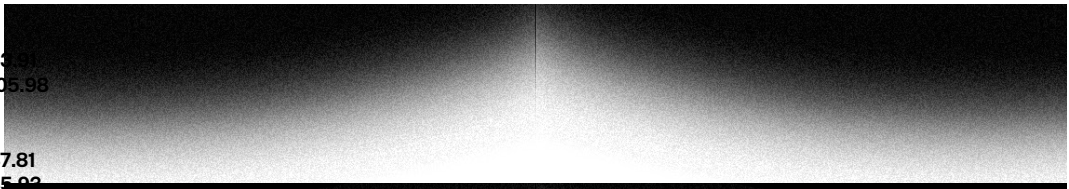
MQ2

08.
74.29
75.08



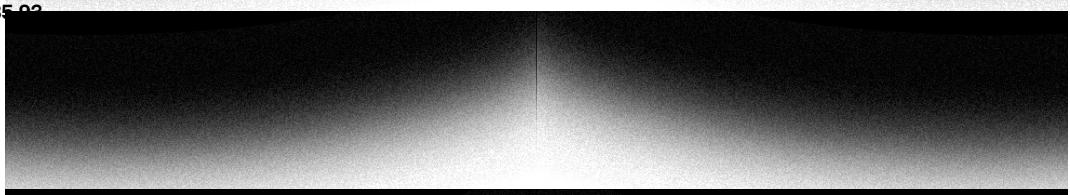
09.
66.83
64.90

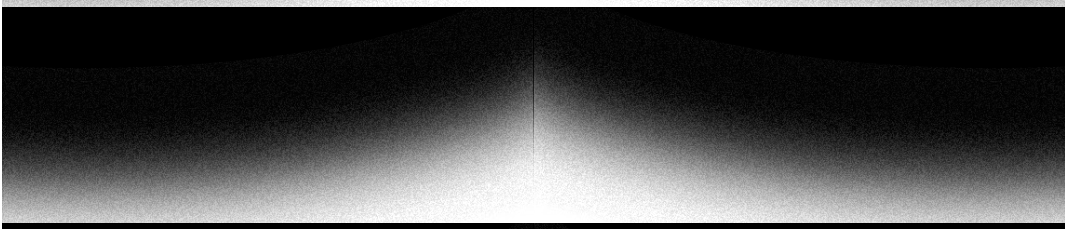
10.
164.73
125.94

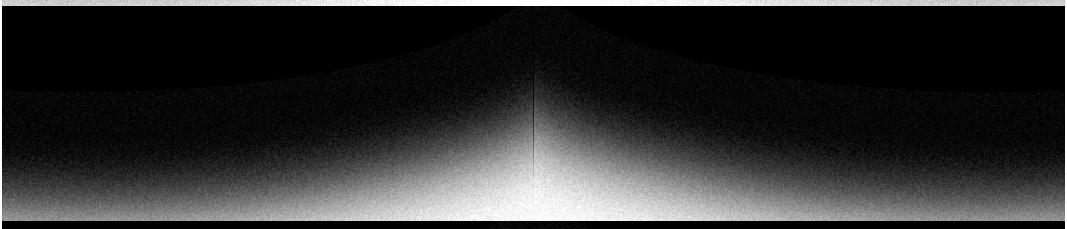


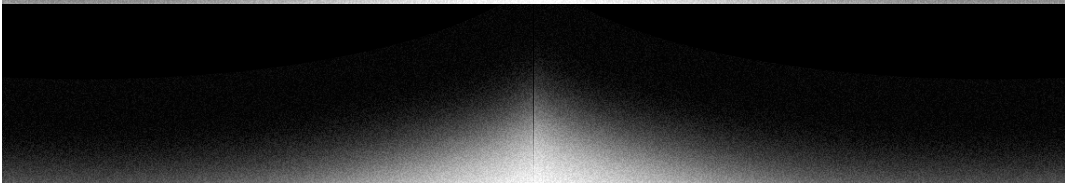
11.
63.91
105.98

12.
87.81
85.92









08.
1398

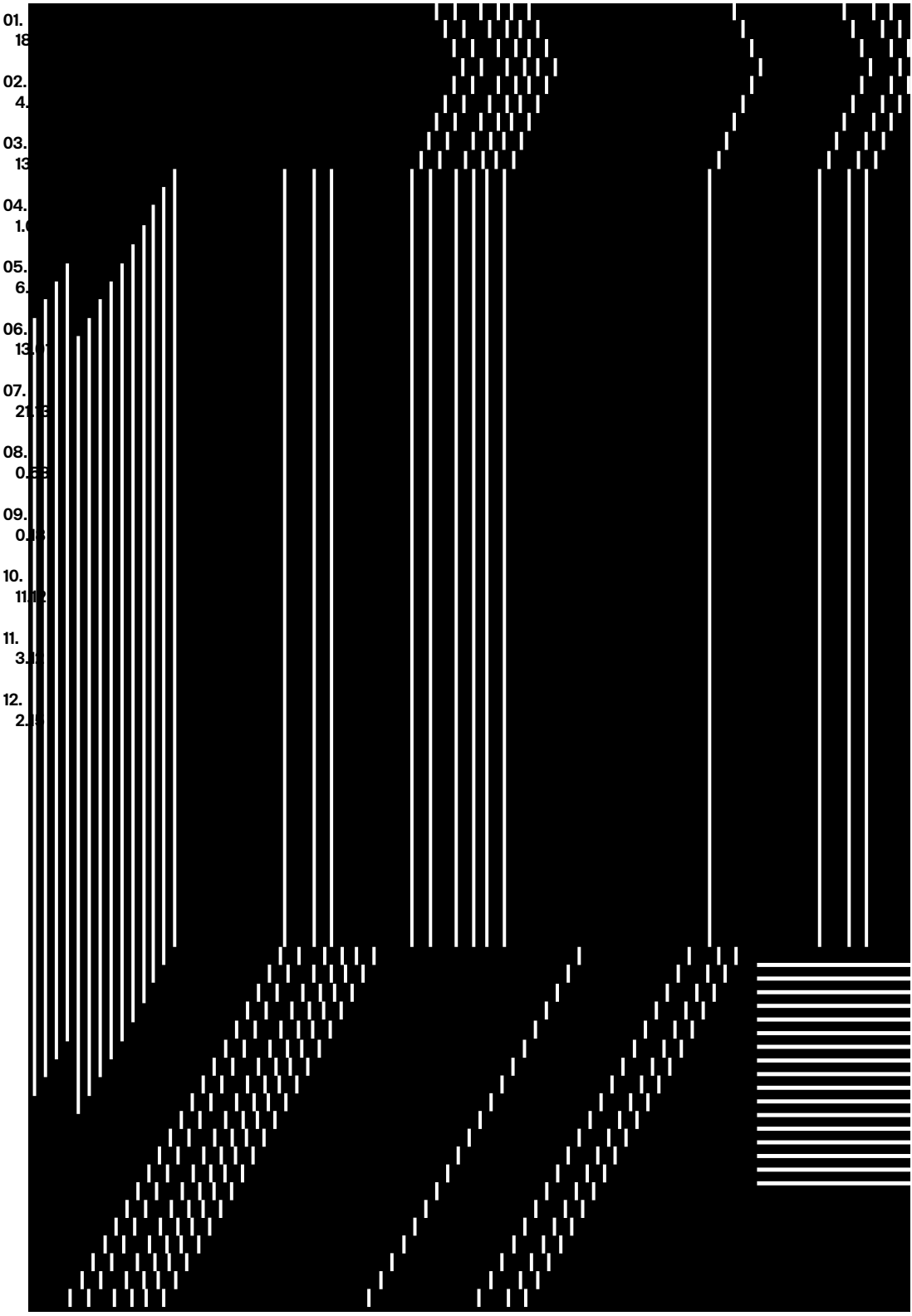
09.
9487

10.
13

11.
4

12.
12

Sound



01.
12.1

02.
8.3

03.
10.4

04.
13.9

05.
19.6

06.
29.8

07.
28.9

08.
29.6

09.
21.6

10.
12.9

11.
6.

12.
12.5

01.
33.6

02.
12.5

03.
21

04.
9.3

05.
21.6

06.
14.8

07.
8.4

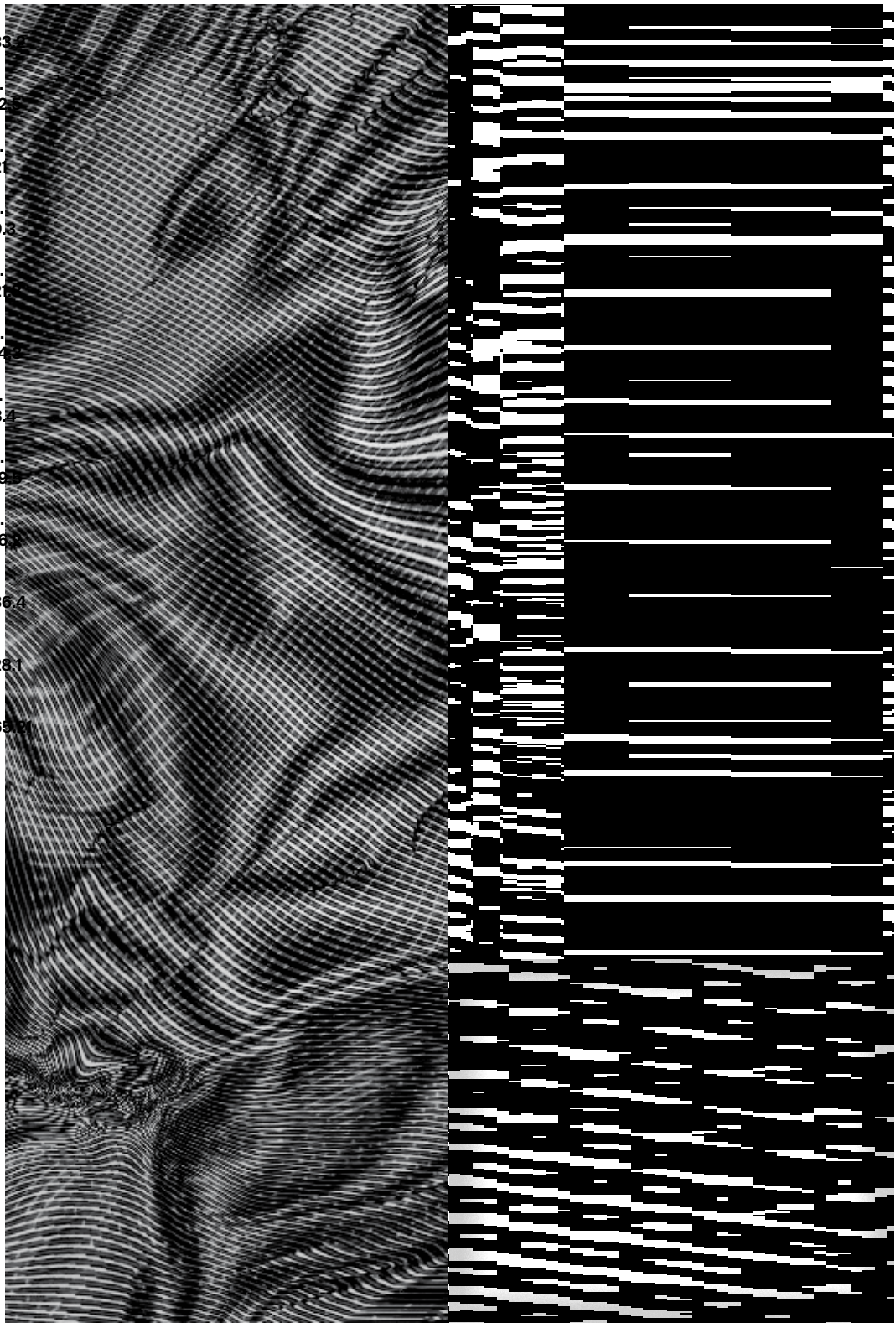
08.
19.9

09.
16.9

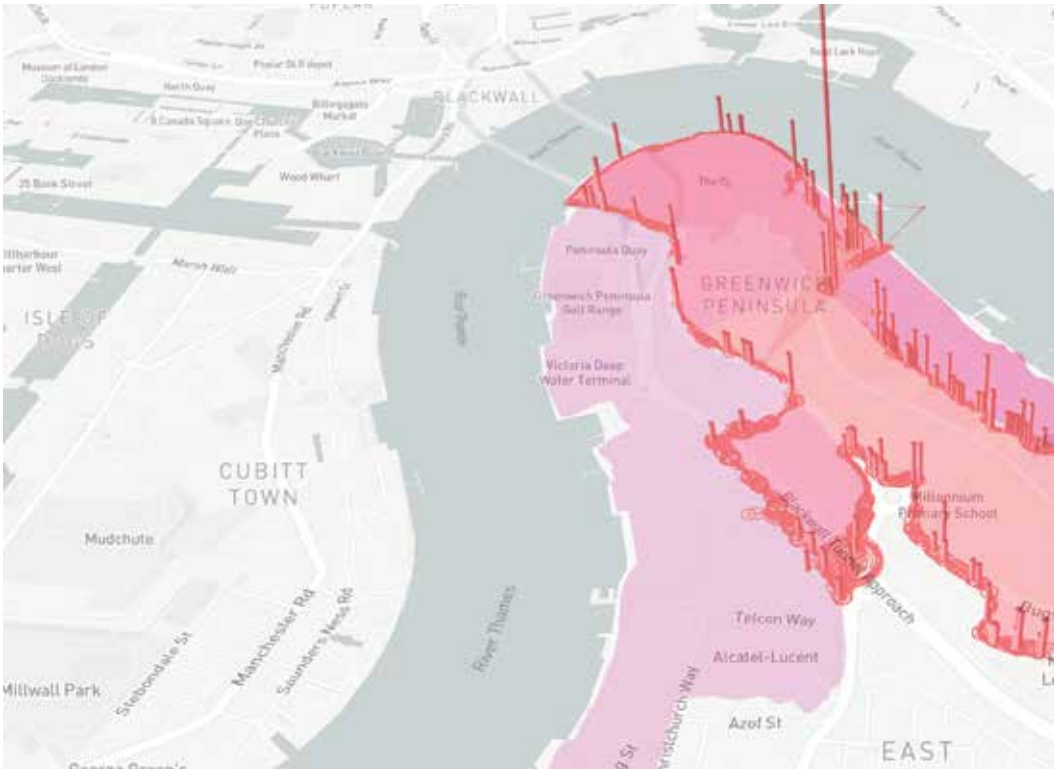
10.
36.4

11.
28.1

12.
65.81



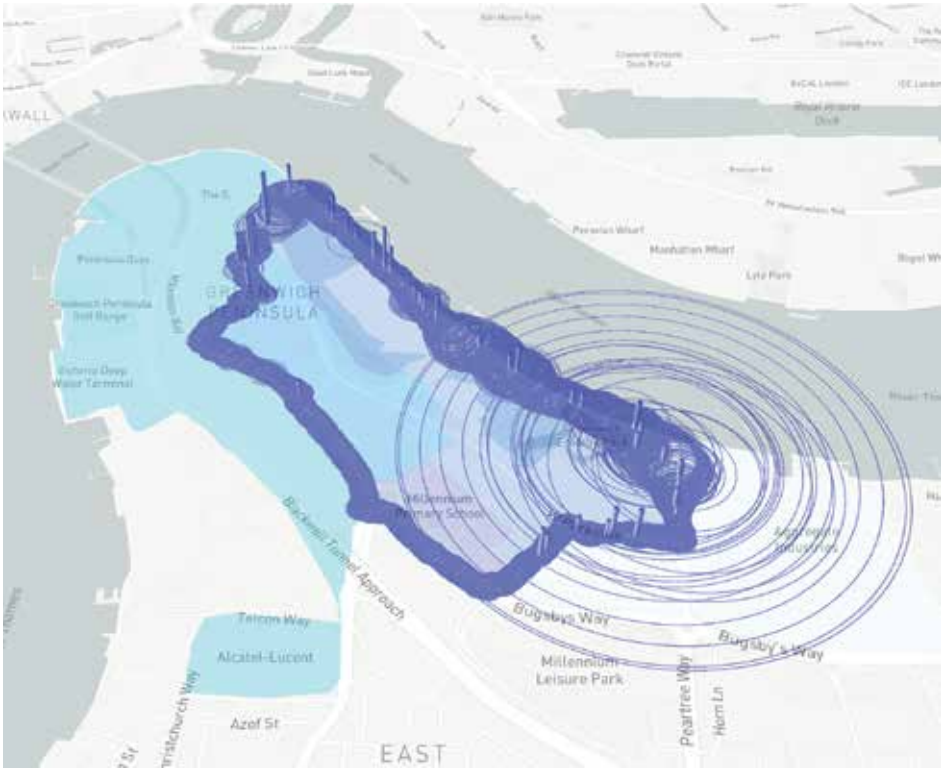
TOM LONGMATE

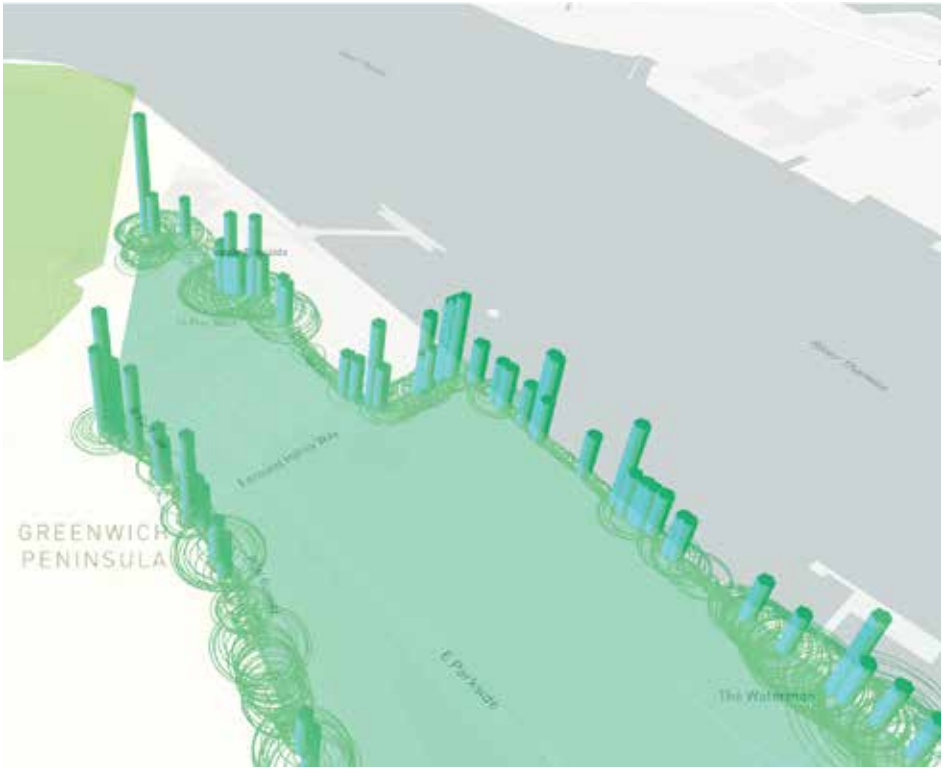


My aim was to create a tool to allow the user to visualise not only the information gathered throughout the duration of the project, but also the associated metadata inherent to the datasets (walk length, date, time, speed, area covered, bearing). I intended the user to experience the data gathering process & appreciate the scale of the undertaking, through the creation of an interactive, animated data portrait of a year on Greenwich Peninsula.

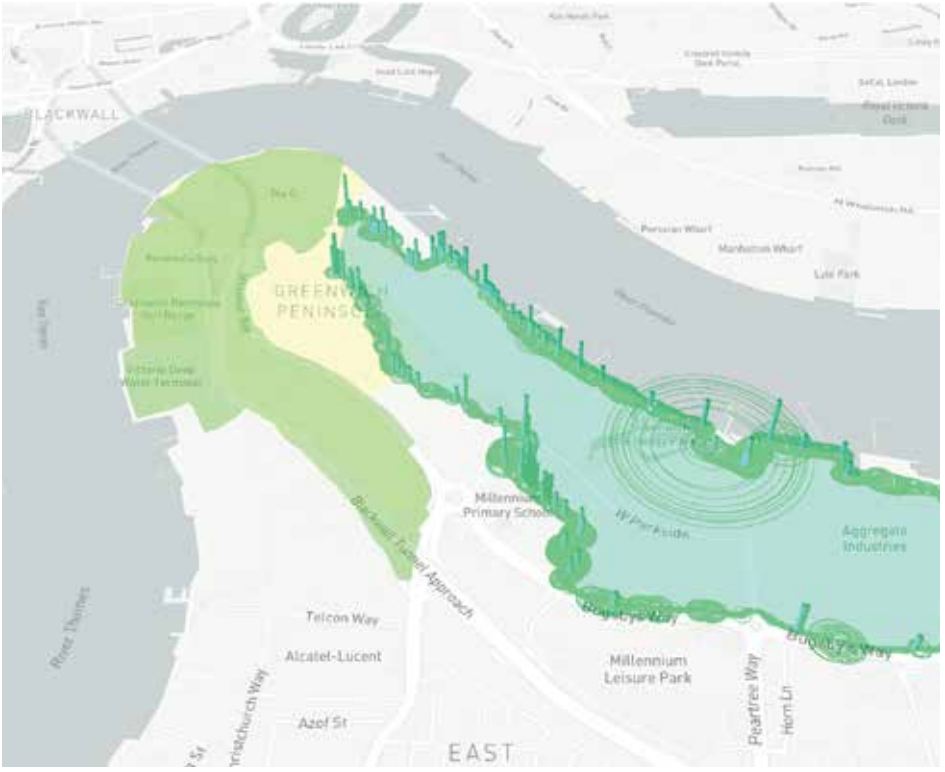

ExCeL London
ICC London
Royal Victoria Dock
Silvertown Quays
Peruvian Wharf
Manhattan Wharf
Royal Wharf
Thames Barrier Park
Lyle Park
SILVERTOWN
River Thames
W Parkside
Aggregate Industries
Sainsbury's Distribution Centre
Meridian Trading Estate
Bugsby's Way
Horn Ln
Gallions R


Holly Court
Holly Court
Becquerel Court
Becquerel Court
Millennium Primary School
School Band Rd
Edison Court
W Parkside
Farnsworth Court
Holiday Inn Express London Greenwich
Hop St
Cottrell Court


Victoria Deep Water Terminal
Millennium Primary School
Blackwall Tunnel Approach
Tetcott Way
Alcatel-Lucent
Azef St
Millennium Leisure Park
Pearcroft Way
Horn Ln
EAST


GREENWICH PENINSULA


Enderby Wharf
Alcatel-Lucent
Azof St
Christ Church C of E Primary School
EAST GREENWICH

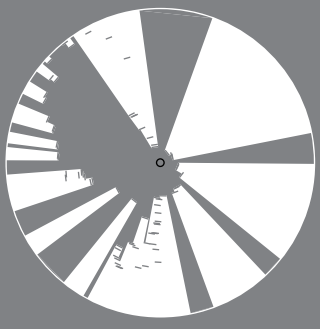

BLACKWALL
Millennium Primary School
Aggregate Industries
Telcon Way
Alcatel-Lucent
Millennium Leisure Park
Azof St
EAST
Peartree Way

Field of Vision°

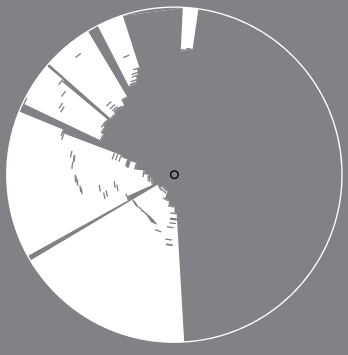
MAR 20 12:10:56 15:41:40

MAY 18 15:08:42 15:59:40

JUN 22 13:35:31 14:14:27



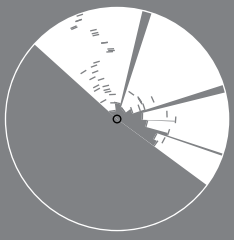
JUL 29 13:10:04 13:52:51



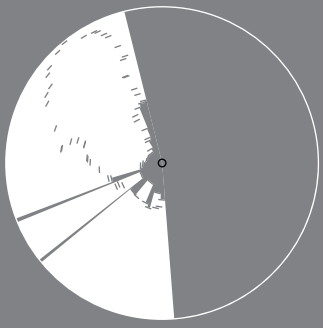
AUG 2 14:15:47 15:29:51

SEP 23 14:59:07 15:56:14

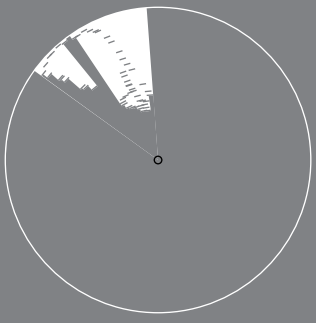
OCT 20 14:24:51 15:28:40



NOV 18 14:19:22 14:57:57



DEC 08 13:40:17 14:34:20



All photos are replaced by Google Streetview images, creating a panorama or a Field of Vision of the chosen path.

Stills from the movie Field of Vision°

catalogtree.net

CONCLUSION

Overall this has been a very interesting project to initiate, conduct, and develop. We have gathered a lot of data in various forms and explored lots of techniques for gathering data and giving it visual form. There has been knowledge gained across a wide range of technology including microcontrollers, sensors, smartphones, fabrication machines, as well as programming languages. Through testing sensors we have called into question the viability of sensors for mobile projects, as well as the difficulty getting meaningful data in a citizen science project.

The learning has been broad rather than deep, and in that sense the aims of the project were too wide. A topic such as air quality is a whole project in itself. However, this broader approach is suitable for a project that aims to encourage people to get started and go with it where they want to. Knowledge gained from this project has folded back into workshops and regular teaching activities, as well as sharing resources online for increasing project reach and access.

Data Walking has allowed us to reflect on issues like data and visual literacy, and different audiences, both in terms of the people who take part in a project but those who may view the outcomes of it too. Through the project I have felt an increasing need for a better understanding of statistics and their methods to help with data analysis. Recognising when expertise is needed is important and collaboration with people with those skill sets would have added a new dynamic to the project. Greater collaboration across all aspects of the project would be welcomed, and the github repository hopes to foster this beyond this report.

There has been some great involvement from students, but it has also been inconsistent. More than ever, students have pressure on them regarding academic and part-time job commitments (as well as trying to have a social life) so that extracurricular projects can understandably fall by the wayside. I have learned a lot about running a participatory project and the energy required. Despite not building a consistent group of regular walkers we did have students from a range of courses and abilities joining the walks and creating great visualisations. We have also had some fantastic contributions from education and design professionals, and I'm truly humbled by their generous and talented efforts. Thank you.

Workshops have been a huge positive of this project as a framework for quickly learning new skills, evaluating techniques, gathering snapshots of data and prototyping visualisations. Ideas on how to best use workshops have developed, dependent on their duration and the participants joining a workshop. Initially workshops were technology driven but have evolved

to explore other methods, moving from quantitative to qualitative techniques and analysis, gaining insight by examining the characteristics and nuances of collections, recognising the importance of discussion in learning and raising issues like data and visual literacy. The process is often as important as the outcome, and new skills and knowledge is the most valued outcome of a workshop. It has been fantastic to meet people on workshops, and discover new artists and designers using walking in their practices. In presentations the project aims and outcomes have been well received.

Examining the methods and design of the program, gathering the same data every month and slowly adding new techniques had the adverse effect of delaying visualisation efforts because there was always the 'promise' of new data and a more 'complete' dataset next month. If I ran the whole 6-12 month program again I would treat each month as a stand alone workshop. Each month would be a unique experiment focused on a different topic and explore creative ways to gather and then visualise that data. This approach would inject some urgency to prototype ideas and deliver outcomes on that topic, and not to keep accumulating data. Be creative with what you have got, and enjoy the process! This approach would make a natural fit for publication of an instructional manual, exhibition of outcomes and tools, or proposing a follow on more refined phase of an experiment.

Looking to the future, there are no shortage of extensions to this project. Potentially a workshop format is a more natural fit for the project, and I hope to continue walking-based workshops. A residency-style project would also be suitable to dig deeper into a specific topic in a particular location. Further investigation of certain topics such as air quality, noise, visual pollution, impact on the natural environment, would be personally interesting, as would exploring technology like a Data Walking app, web-based visualisation tools, AR for data visualisation and other forms of immersive visualisation.

Ultimately Data Walking is a platform that promotes taking research outdoors to explore our surroundings, experimenting with technology for creative data gathering and designing with data, and sharing that knowledge with others so that anyone can take the project in a direction they find interesting and valuable.

THANK YOU

Contributers
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www.datawalking.com

The colours used in this publication for underlines and side notes are extracted from the photos taken on the walks.

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