SenseMaker

CO-CREATING SENSORS FOR JOURNALISM

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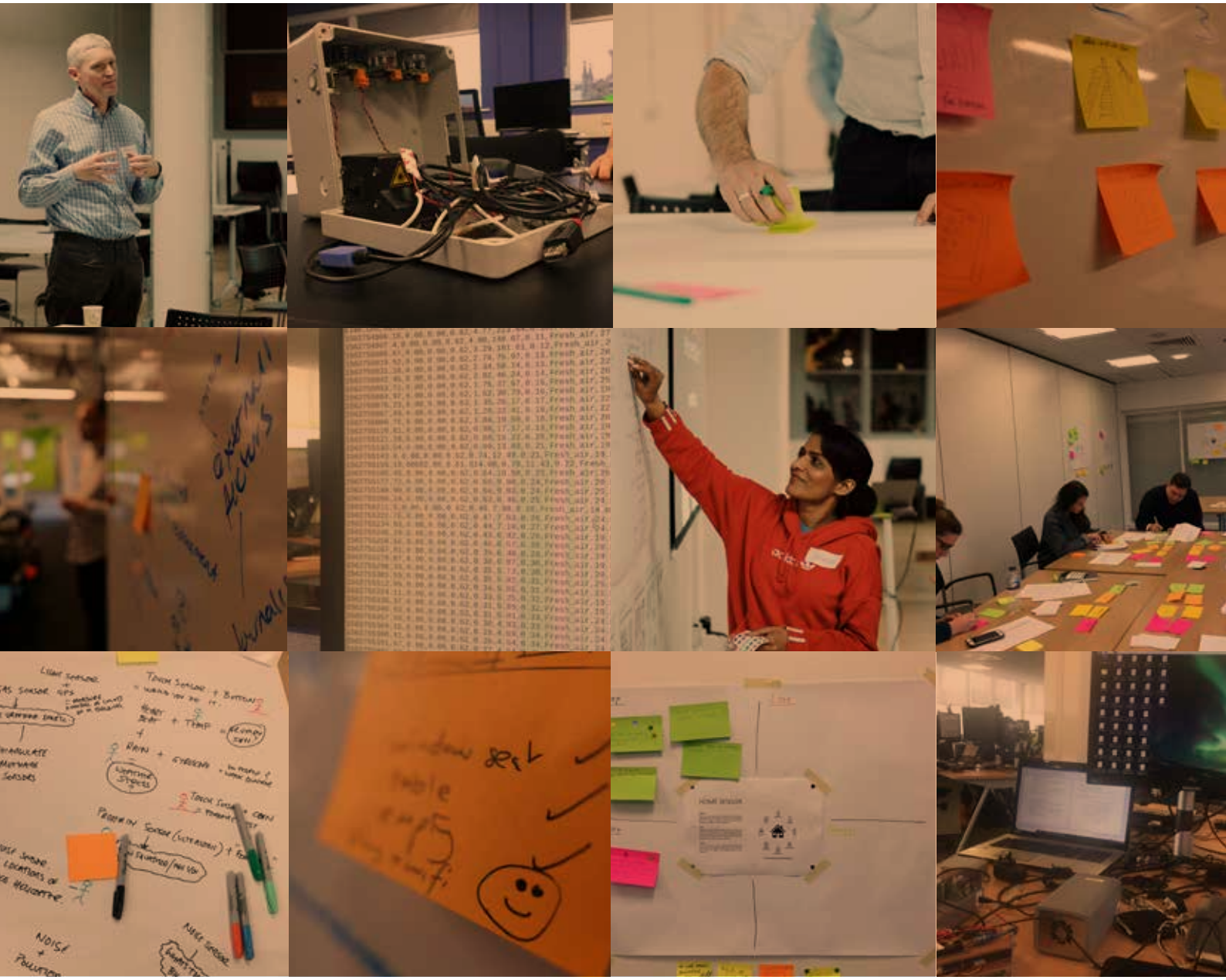

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CONTENTS

INTRODUCTION

SenseMaker started with a simple question: what happens when journalists, engineers and communities come together to design and build sensors for storytelling?

The project was underpinned by the desire to create new 'sensing' devices. These sensors would have a tangible benefit for journalists and storytellers who seek to capture data to reveal, drive or enhance stories in their communities. The core enquiry sought to understand how open collaborations, centred on research and development, can create new editorial opportunities, particularly when data, sensors and narratives combine.

In short, the core to SenseMaker was:

- To co-design journalism sensors
- To use them to create, prompt, underpin and develop content
- To provoke, prompt or challenge public debate

Partners included the Media Innovation Studio and Engineering Innovation Centre teams at the University of Central Lancashire (UCLan) and Reach PLC, specifically with the involvement of the Manchester Evening News (MEN).

Initially, the project, which is funded by the Google Digital News Initiative, was also supported by Journalism.co.uk, Open Data Manchester and the Greater Manchester Combined Authority.

SENSING > DATA > COMMUNITIES > STORIES > IMPACT

Data journalism, both as a practice and an output, was a key focus of this work. The project was designed to find new ways for data to be generated, but also to put the power and ability to collect a broad range of data into the hands of both communities and journalists.

The project was also set against wider editorial agendas. These stories included the news that London was breaching its annual target for air pollution just a few days into a new year, along with increasing concerns more generally about air quality in urban areas.

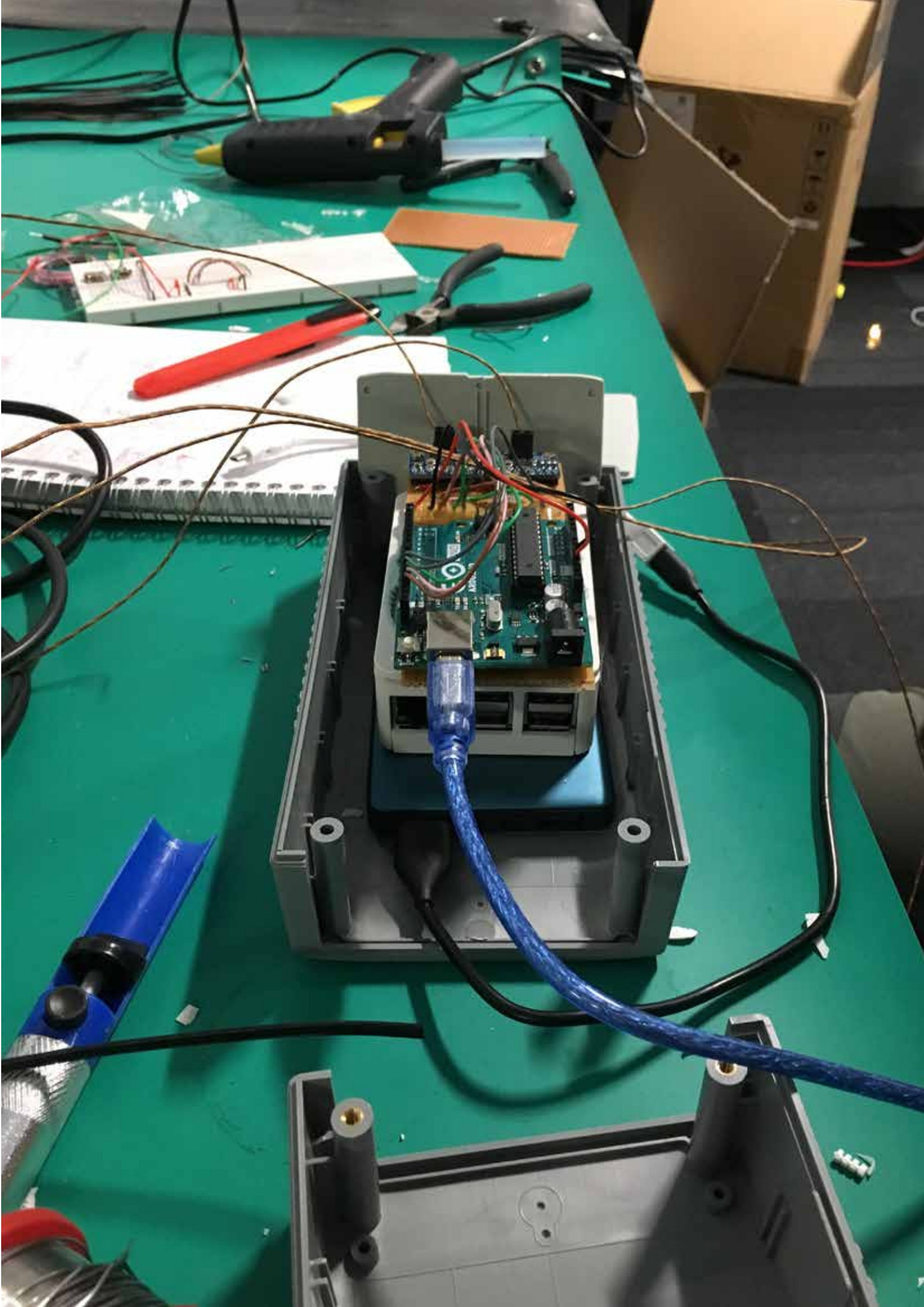
From a data journalism perspective, our work was inspired by a number of data journalism and sensor journalism projects. These included German news publisher Stuttgarter Zeitung and its city-wide network of dust and pollution sensors, which produces a daily feed of air-quality data for its website. Barcelona's Smart Citizen project was also a key motivator. It saw the creation of low-cost air-quality sensors that are deployed around the world. The Smart Citizen sensors allow their users to not only record air-quality measures, such as the levels of nitrogen dioxide (NO2) [1] and other particulates that get into the atmosphere when we burn fuel, but the data generated is fed into an online portal that enables it to be mapped and shared globally. We felt there was incredible potential to translate or reimagine these approaches in combination with journalism and storytelling, but also in building relationships with local communities and co-creating sensors with them.

But we also wanted to take things further.

In addition to co-creating a variety of prototypes and generating content and impact, the team sought to examine potential revenue models that could come from these emerging sensor tools, and whether our sensors could be scaled and commercialised beyond the confines of the project.

We were also keenly aware that data-led stories about the environmental issues we were exploring are only one means of prompting change. Our aspiration was to work locally to establish what could be done to change some of the potentially negative findings we discovered. In this way, SenseMaker sought to align not only with data-driven journalism and community co-creation, but to make a tangible impact based on the data we would collect.

[1] https://docs.smartcitizen.me/Smart%20Citizen%20Station/



Open Innovation

SenseMaker's innovation process was also a vital part of the project. Centered on co-creation, the project would work closely with newsrooms, technologists and community members to create a wide range of sensor prototypes. The project plan involved open workshops designed to gather data and inspiration around user requirements, test ideas and concepts with those who engaged, and to deploy the prototypes. Once active, the data from the prototypes would feed directly into newsrooms and so help journalists to generate a range of new stories.

THIS REPORT

What follows is an outline of the project as it progressed, the ideas that were generated and the concepts that we couldn't move forward, and our insights into the innovation process as we saw it. Broadly, we outline the process we took, and the rationale behind it, the concepts we created and the ones that went no further than initial viability, feasibility and desirability tests. We outline our interim findings and insights from this project, and note the potential for future work in related spaces.

The project was initially scheduled to take place over the course of a year, but SenseMaker will have been live for 25 months when this report is published. We also envisage this document as an 'interim final report' as our work will draw to a close without us realising the full outcomes of our initial plan. Our data collection and final workshops were stymied and indeed halted by the Covid-19 global pandemic of 2020, severely limiting our capacity to engage with communities, deploy prototypes, consult with newsrooms, hold public media events around the issues we uncovered and wrap-up workshops. The project also encountered other hurdles. These included the challenge of building prototypes robust enough to be operated in public or editorial contexts, as well as taking the necessary time to ensure they, and the process used to create them, met a range of best-practice standards, from legal and ethical perspectives.

Despite a sometimes challenging 'innovation journey', our experiences of the project to date, and specifically the engagement and prototyping work, mean we are able to produce this report as both an account of the work done, along with our initial findings.

SenseMaker had a number of successes, ranging from productive idea generation events with newsrooms and communities, deployment of prototypes around Manchester, and some impact and action that emerged directly from the sensor data captured.

Nevertheless, like many innovation projects, we had false starts, explored dead ends and were limited by real-world challenges that our aspirations couldn't quite overcome. This report is a record of all of the above – and looks firmly to the future – to the potential pathways for research and development.

BACKGROUND

As discussed in the introduction, SenseMaker was inspired by a range of sensor journalism projects that have emerged around the world over the last decade. These include the city-wide air-quality measures generated in Stuttgart and work on the Smart Citizen device network in Barcelona, which quickly allowed people to measure noise levels and prompt action from local policymakers.

There are now a wide range of sensor journalism activities taking place in the media ecosystem and sensor journalism has been used for some years by a number of journalistic publishers.Here we review some core areas of interest that span sensor development, co-creation and journalism. This section is intended to be a brief overview of example projects, including work that helps to illuminate the SenseMaker project's operations and aspirations.

As Schmitz Weiss suggested in 2016, journalism prompted by sensors and the data that they afford is not new. But she argues that the activity offers the chance to engage communities in new ways, develop new stories and offer new angles on editorial material.

A range of activities have emerged in the last decade that explicitly combine sensing and journalism. Air quality was a feature of work conducted by Stuttgarter Zeitung, but this is far from the only one. An early example is the BBC's work monitoring air quality and pollution using a pm10 sensor in Beijing in the run up to the Olympic Games in 2008. This project demonstrated that, initially, pollution levels in the city continued to rise, despite measures introduced to limit emissions, showing complex manmade and natural influences on a place's air quality.

CITIZEN SCIENCE, JOURNALISM AND POLICY ACTION

The notion of devolving data power to communities and utilising affordable technologies, and aligning this with news coverage, is demonstrated in the Cicada Tracker. Produced in the United States by the National Science Foundation, in partnership with New York's WNYC radio, the project focussed on the 17-yearly emergence of the Cicada insects, which appear when the ground temperature hits 64 degrees Fahrenheit. The project encouraged people to make their own sensors and mapped the data to plot the emergence of the thousands of insects.

[2] https://medium.com/editors-lab-impact/the-air-you-breathe-in-europes-car-capital-88cde48da5f9

[3] https://smartcitizen.me/

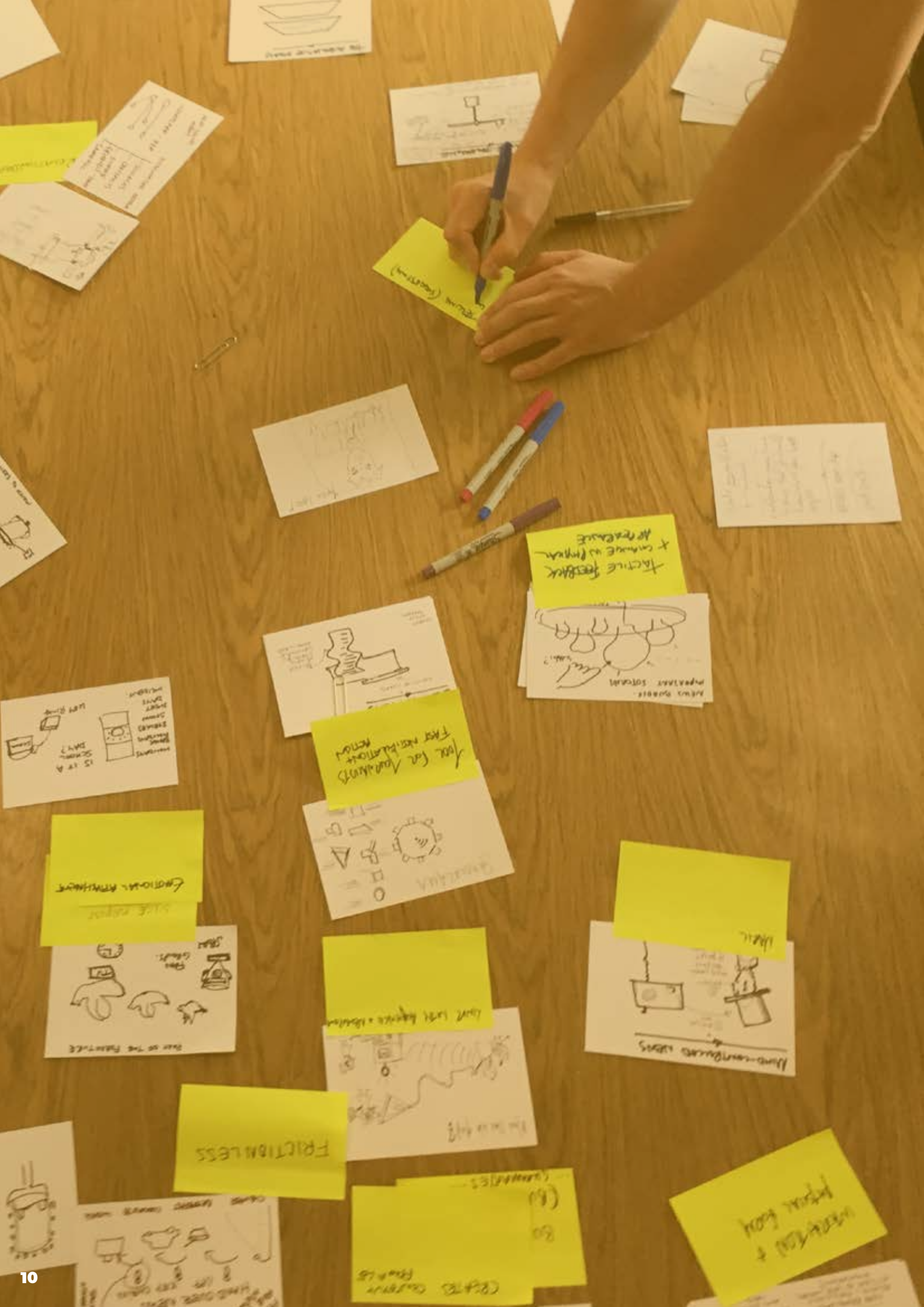
[4] https://medium.com/@dangerbui/flags-noise-and-tourism-in-barcelona-c249252998d5

[5] Schmitz Weiss, A. (2016). Sensor journalism: Pitfalls and possibilities. Palabra Clave, 19(4), 1048-1071. DOI: 10.5294/pacla.2016.19.4.5

[6] http://news.bbc.co.uk/1/hi/magazine/7532603.stm

[7] https://project.wnyc.org/cicadas/


OSCAR WILDE
DON QUIXOTE
JONATHAN STRANGE
Samuel Beckett
MURPHY



Further projects also combine the co-creation of data, stories and action. The Harlem Heat Project from WNYC News deployed temperature and humidity sensors to assess heat stress caused by Harlem's building design and urban environment. In partnership with the AdaptNY news service and climate reporting project iSeeChange, one aim of the project was to share the data and make it available to the community so they could lobby their representatives.

Other examples of citizen-science and newsworthy projects, and with a particular environmental focus, also include the We Count project. Funded by Europe's Horizon 2020 programme, We Count equips citizens with traffic- and air-pollution sensors to enable them to create datasets to prompt policy action. The X-Snow project at Columbia's Earth Institute also took a public-news approach when it sought to understand how climate change was changing the shape of snowflakes through providing people with snowflake imaging kits.

From a wider research perspective, the Massachusetts Institute of Technology's (MIT) Senseable City Lab unites notions of sensing, innovation and change within an urban environment. Formed in 2004, the lab has been engaged in such work for some time. Recent projects include City Veins, which mapped vehicle emissions in real time by fitting devices on vehicles as well as buildings, while Singapore Calling combines a range of socio-economic datasets with smartphone data to better understand the relationships and inequalities throughout our city scapes.

This short selection demonstrates the wide potential of sensing phenomena, the ability to combine this activity with newsworthy subjects and for prompting new content, and how communities can shape the innovation outputs.

[8] https://current.org/2016/07/wnycs-latest-sensor-journalism-project-zeroes-in-on-heat-island-harlem/

[9] https://www.we-count.net/

[10] https://gothamist.com/news/climate-change-might-be-messing-up-snowflakes-as-we-know-them-but-you-can-help

[11] https://senseable.mit.edu/

PARTNER MOTIVATIONS

In light of this kind of activity, the partners felt there were opportunities around connected sensors, and an interdisciplinary collaboration between industry newsrooms and data units, combining engineering expertise and journalism-innovation knowledge. Through adopting a co-creation approach, this would not only involve those skills and people, but also enable community-led insights and needs to direct the innovation pathways.

This view emerged from a range of related experience from the partnership between Reach and the Media Innovation Studio at UCLan .

The pair had worked together previously on the NewsThings project (2016-2018). Also funded by the Google Digital News Initiative, the project sought to create Internet of Things (IoT) devices that would convey or help create journalism in newsrooms and in people's homes. It also involved creative design agency Thomas Buchanan.

At the end of NewsThings, Reach and the Media Innovation Studio felt that harnessing connected sensors could provide data sources not just to deliver content, but also to help create it. This would see sensors providing the raw materials for content creation that could be used by Reach's Manchester newsroom and their dedicated data unit.

The Manchester Evening News is the largest regional news website in the UK and has a reputation in the industry for digital innovation. Reach was the first UK regional publisher to set up a data journalism unit and it has largely been based in Manchester, working in the offices of the Manchester Evening News. There is also a vibrant open data community in the city of Manchester itself, which journalists at the MEN have contributed to.

For SenseMaker, the newsroom was interested in using sensors to gather data that would enhance the reporting of some of the issues faced by local communities.

From an academic perspective, and particularly from the Media Innovation Studio team, there was interest in the agency of data that could be collected from 'connected sensors', i.e. what potential and impact could and did the data have on a whole range of individuals and organisations, and specifically placing sensors and sensor data within the realm of the Internet of Things. Live data streams, and their impact on storytelling and communities, were a key motivator behind their involvement. To understand how located sensors might influence content and the action that could emerge from it. This approach builds on previous projects at the Media Innovation Studio that focussed on connected objects and journalism - which encompass interactive newsprint, wearables and IoT devices - and how co-created prototypes can offer value to journalists and the communities that they report on. The research team was keen, too, to understand if this activity could influence policy development, and hoped this project could sit within a form of constructive journalism.

The Engineering and Autonomous Systems team at UCLan has a long track record of producing 'sensing devices', including equipping drones with thermal-imaging and air-quality monitoring sensors. Uses have included monitoring air-quality levels in and around developments in China, mine detection in Cambodia, and search and rescue operations in the UK's Lake District.

SenseMaker offered an opportunity to find a new context for sensor and autonomous-systems development, and to continue to build interdisciplinary research collaborations within the university.

SenseMaker, then, sought to leverage an interdisciplinary team, engage with newsrooms and communities, and respond with sensing devices that would create useful datasets. This approach was only possible due to the range of disciplines and the supporting partners involved in the project.

However, the process of innovation would be another essential part of realising the potential of the project. We'll now turn to how we arrived at our concepts...


WELCOME
THE ARDUINO STARTER KIT
EN
ARDUINO

PROCESS

SenseMaker was envisaged to have a core process through which the innovation journey would take place. Rather than adopting a rapid-prototyping approach to deliver on a range of prototypes, the initial concept was to embed the research and development much more deeply in communities around Manchester, and within the editorial operations at the Manchester Evening News.

We therefore held a series of newsroom- and community-engagement workshops that covered multiple phases. We also embedded student-led development hacks to help us move the designs forward to a point of implementation. The aims of taking this approach were to take insights and inspiration from users and communities, and respond to their requirements in the creation of multiple sensing devices. We planned to return to the newsrooms and communities to validate concepts, and share findings with the groups.

The project, broadly, kept to this approach. What follows is an overview of the methodological approach and the concepts it prompted.

PHASE 1
WORKSHOP 1: KICK-OFF

Methodology

Location: Manchester Evening News

Participants: Engineers, academics, editorial staff, commercial staff, developers and members of the Reach data unit.

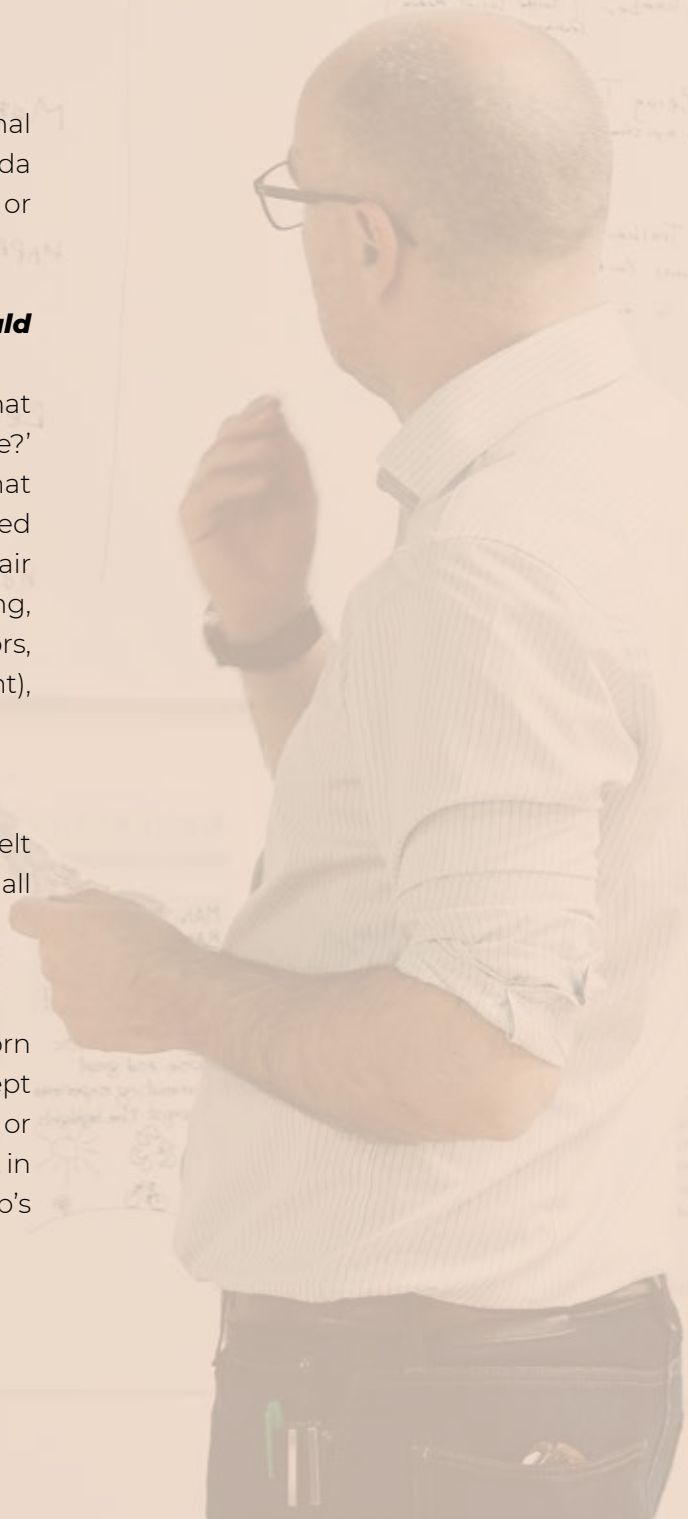
Method: The goal of the session was to uncover potential insights around sensing and storytelling. The session saw the introduction of the core project aims and then moved on to complete multiple phases:

What stories could we sense?
The session began with an overview of stories that additional or sensed data could add value to. What news agenda items did the group feel were ripe for sensors to create or add value to?

What sensors could we build and what insights could they generate?
The session then turned this process on its head. It asks 'what sensors could we create?' and 'what data could we capture?' Rather than mapping sensors to stories, we asked 'what stories could emerge from sensors?' The team presented a rich list of sensor options that spanned pollution and air quality, proximity sensors, cameras and thermal imaging, temperature sensors, colour sensors, heartbeat sensors, touch sensors, moisture detection, gyroscope (movement), machine-vision tools and sound/vibration detection.

What ideas and underpinning themes emerge?
The participants were then asked to vote on what they felt were the most interesting and feasible concepts across all the ideas generated.

Unicorns
A final exercise was to give all participants one shiny unicorn sticker. They were invited to place this under one concept or element that they felt wasn't necessarily a reasonable or legitimate notion, but it was just magical and should exist in the world. This enabled the team to understand the group's preferences in a number of ways.



Findings

Breadth of news agenda: the range of voices in the room identified a rich mix of potentially newsworthy approaches that sensor data can add value to.

They spanned:

Transport: traffic levels, Northern rail chaos, speeding outside schools, Metrolink and bus delays and journey quality, dangerous junctions, health (and related topics such as pollution levels).

Business: footfall on high streets.

Socio-economic: mapping food banks and frequency of usage, time of usage.

Sport: measuring the atmosphere of stadia, footfall, match pollution.

Green spaces: is it possible to measure the use, maintenance and perhaps even gentrification of green spaces?

Homelessness: groups felt that sensors could have an impact on understanding homelessness and related issues. This would include capturing temperatures, understanding numbers of people living on the streets and other environmental issues.

Health and wellbeing: this was a richly represented area that ranged from notions of personal safety in an urban space, understanding happiness or 'joy', measuring alcohol levels.

Cross-cutting themes were: capturing people's emotional responses to the city in multiple ways, a recurrence of pollution and air quality in a number of contexts, and a combination of public and private space. A further element was the need for 'lite' news stories as well as harder news. A number of concepts traded on 'fun' data – such as capturing 'what colour Manchester' was or what people were wearing in the city.

More general insights were that newly created data that was specifically captured by journalists or community users could 'debunk' official data, or data provided by other sources.

CONCEPTS

Following this session, the development team went away and focussed on a range of concepts suggested during the workshop. We shortlisted six ideas that were judged to be responsive to the data and embedded cross-cutting themes. The ideas were:

HomeSensor
The HomeSensor provides a rich selection of data about an individual's home environment. The pack can be deployed and left to capture a range of data spanning humidity, pollution, air quality, noise and damp.

Colour Tracking
Image recognition to map the colours people around Manchester are wearing. This allows us to see colours and tones that occur most frequently, infrequently or not at all.

CitiSense
CitiSense combines crime data, Twitter semantic analysis and the ability for users to upload information about areas where they feel a palpable sense of risk. An app will alert users when they enter a part of Manchester where people feel unsafe.

Manchester's Roar
Placing microphones around key locations – home and away stands, pubs around the city–we'll be able to monitor the decibels created during sporting events and specifically 'derby day'.

The Smell of Urmston
Using air-quality monitors and pollution sensors, this project would investigate what really causes the unique 'odour de Urmston'.

Taxi Stress Detector
Taxi drivers will be invited to wear a wearable device that monitors their stress level over the course of their shift. We'll develop a smart-watch app to let drivers log particularly stressful areas of the city, and at what times.


SNOW!
FOOD BANKS

WORKSHOP 2: DEEP DIVE AND CONCEPT VALIDATION

Methodology

Workshop 2 was designed to validate the concepts generated in response to the initial data dive. The core team felt that it was key to validate some of the concepts with the help of an editorial group, but also drill down into the ideas, to potentially create new insights that the design team could respond to.

Location: Manchester Evening News

Participants: Community reporters, data journalists, senior managers and data visualisation specialists.

Method: This was a rapid-fire session lasting just less under an hour. The concepts were shown to the group, who responded using four tags: 'Keep', 'Lose', 'Change' and 'What's the Story?'.

Participants were then invited to review everyone's inputs and vote on the key elements and comments, and then vote on what they felt was most important.

They were also given the opportunity to generate new ideas based on the conversations and insights from the session.

Findings

Two tiers of finding were identifiable from this approach. Tier 1 represents direct comments on the concepts, which function as an appraisal of their suitability and various risks attached to them. A second tier was also perceptible during this session, specifically around how people voted or where people placed their unicorn stickers, to allow them to state a preference that was arrived at via a looser and perhaps more creative judgement.

This analysis then led into the development of 'Phase 2' concepts, which aimed to satisfy two key purposes:

- to build on notions that received positive feedback
- to create devices that were feasible/viable/desirable but also buildable/deployable within the timescales that we had available.

Tier 1

Concepts that generated most interest and responses included: HomeSensor, CitiSense and Colour Tracking.

HomeSensor: participants felt this could provide useful stories to cover housing standards, poor landlords and provide insights into pollution that was detectable in the home or work environment.

Colour Tracking: there were concerns around how accurate this device could be, but there was potential for fashion and sports stories.

CitiSense: this device generated a number of negative points of feedback. There were concerns that areas would have negative connotations wrapped around them, would be dominated by social media content and that conclusions drawn would be limited as it wouldn't include data that wasn't submitted, but, that it could be equally valuable in telling the story of a place. Suggestions for improvement were around around focussing on positive elements, rather than both positive and negative.

Tier 2

Co-created journalism: concepts such as the HomeSensor produced positive responses when audiences were intended to be involved in the storytelling. For example, having readers hosting the devices would ensure a relationship between the audience, the device, the journalist and the content produced.

Comparison data: although the devices would generate data in isolation, participants suggested that by repeating trials or combining with other data, a wider and potentially more usable data picture would be created.

Trust: although the core aim of the project was to put data creation in the hands of the journalists and communities in a bid to verify, extend or debunk existing datasets, concerns around truth and deception emerged. Journalists were concerned that the sensing devices may be tampered with. Trust is therefore a key issue, specifically in relation to the sensor data having the potential to provide new or alternative information but also a need to ensure the new devices are trustworthy in and of themselves. Another related concern is the safe and trustworthy conduct of sensor hosts themselves.

Positive and lite stories: the discussions also flagged a need to be lighthearted with the sensor data, as well as using it for 'harder' news stories. Concepts such as colour tracking sought to present data that could be used in these different contexts.

Sensing emotions: throughout both workshops, the project team took away that understanding that audience and citizen emotion was a real area of interest. How do you understand how people feel? This also presented a challenge to the project, as it moved sensing into a space that engaged with people at a deeper level and raised questions around how this could actually be achieved.

News agenda: in the drill-down workshop, participants tied the validation of ideas to the wider news agenda in the newsroom. This mapping across editorial priorities continued throughout the duration of the project.

Negative community impact: A number of concepts were seen to have potentially negative ramifications, particularly around community perceptions. These potential negatives were problematic and in a number of instances suggestions for how to remove them were made.

Empowering action: a number of contributions reinforced the notion that data could be used to empower communities and foster action. HomeSensor was a concept that reinforced this particular aspiration.

PROTOTYPES

The team then focussed on a selection of prototypes to develop:

- Colour Tracking (renamed as What is Manchester Wearing)
- Taxi Stress Detector (reimagined as a tool that journalists would use to measure their own experience of commuting, to monitor of hotspots of stressful or dangerous zones within the city)
- HomeSensor

These devices were developed to various degrees of fidelity, with HomeSensor and What is Manchester Wearing? progressing to prototype, while the biometric travel sensing device not making it past a viability and feasibility test.

Key concerns around the Taxi Stress Detector revolved around the acquisition of biometric data and safety concerns for drivers. Conversations also covered how newsworthy it would be in practice and how manageable it would be for the newsrooms to run a trial.

This pointed to an emerging element throughout the project — understanding the barriers to uptake and exploitation beyond the simple ideation stage.

Barriers and limitiations

Barriers and limits were caused by a multitude of different elements. This will be discussed in more detail in the analysis section, but it is worth noting here that early phases of the project saw influences such as:

- Available resources (money, time, skills)
- Extended approval times from university ethics committees
- Questions over feasibility and desirability alongside aligning the prototypes with the needs and availability of newsrooms to utilise the devices

A final and key element was the need to create robust prototypes that were deployable by non-engineer or non-project members. As this was a prototyping project, a divide between testability and usability emerged.

For example, HomeSensor worked in lab settings, or within the homes of the team, but when transported and installed in external locations, issues of connectivity and reliable power supplies meant that some data was lost. This provided valuable learning to the engineering team, but also raised questions around project aspirations and resources.

HomeSensor

The HomeSensor was implemented using simple, off-the-shelf sensors and microcontrollers. This was done to ensure the cost of each device was kept relatively low, and to allow the devices to be easily manufactured and maintained. While more expensive sensors would have improved the sensing capabilities of the device, it would have made development and maintenance more difficult, especially for someone without a technical background.

The system was built around an Arduino Uno acting as a sensor interface, and a Raspberry Pi acting as a data logger and an IoT connection. This combination of technologies can interface with a huge range of sensors, ensuring the device could be built upon in the future.

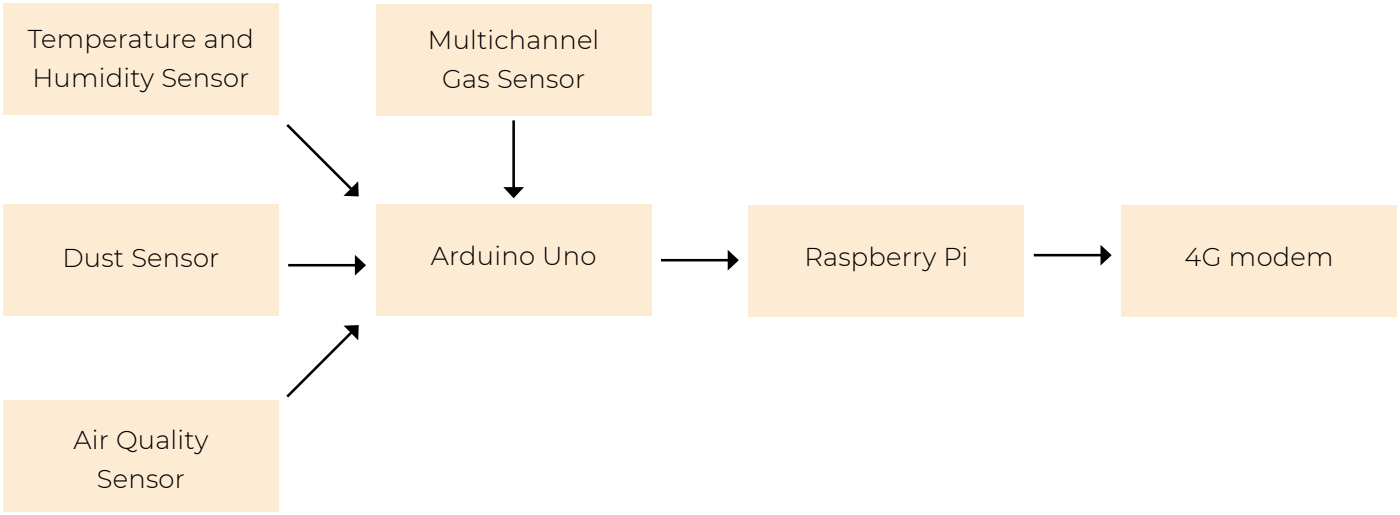
The sensors used in this device were from the SEEEDstudio Grove range as they are cheap and include an Arduino Library, ensuring the device could be quickly set up and easily modified if needed.

The sensors used in the device were:

- **Grove Dust Sensor:** this provides a rough measure of the particulates in the air, although it has no way of measuring their size
- **Grove Air Quality:** this sensor provides a qualitative measure of the quality of the air depending on the concentration of several harmful gases including carbon monoxide, alcohol and formaldehyde
- **Grove Temperature & Humidity Sensor:** this sensor provides an accurate reading of the temperature and humidity of the area
- **Grove Multichannel Gas Sensor:** this sensor is capable of measuring the presence of a large range of gases and for this system it was used to measure carbon monoxide, ammonia and nitrogen dioxide

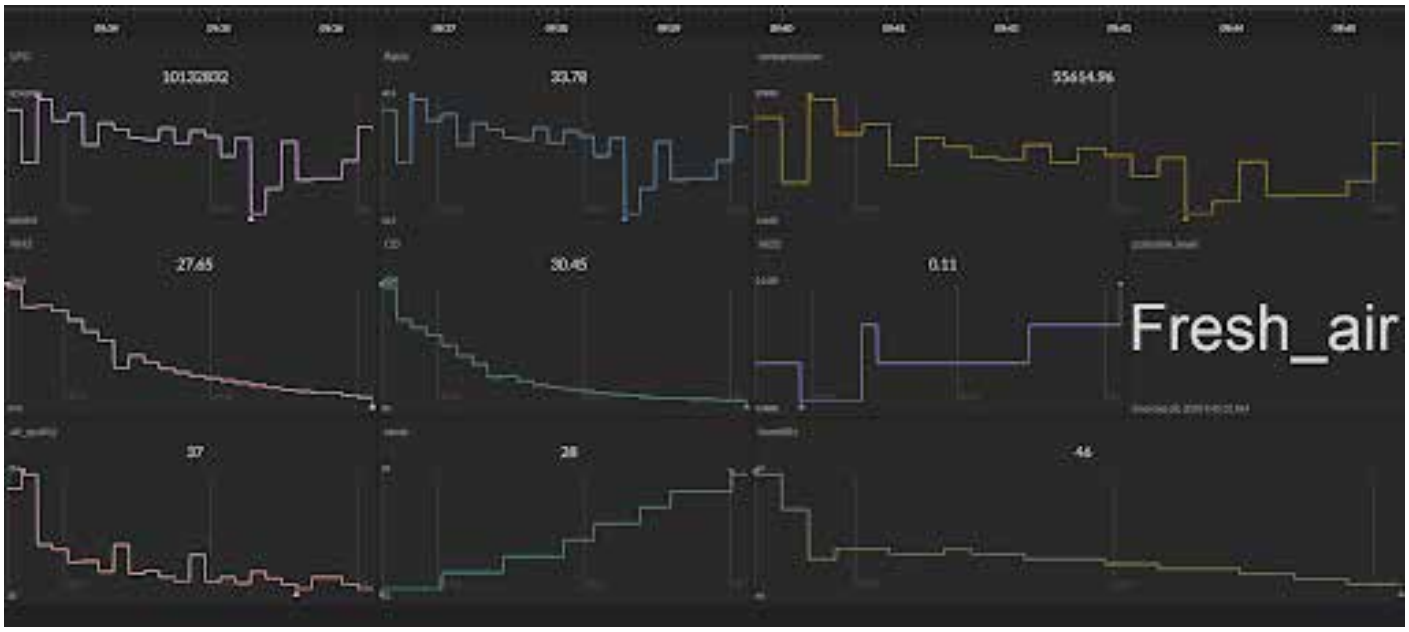
This combination of sensors delivers an excellent overview of the air quality of an area, as well as data on basic pollution levels.

SYSTEM ARCHITECTURE



This diagram shows the system architecture of the HomeSensor. The Arduino is used to collect data from each of the sensors and combine it into a single data packet to be sent to the Raspberry Pi. Once the data is received by the Raspberry Pi, it is decoded and logged in a CSV file.

The Raspberry Pi also transmits the data to an IoT dashboard using a 4G modem. Once the logging has finished, the data can be retrieved from the Raspberry Pi using a Syncthing connection, or downloaded from the IoT dashboard.



What is Manchester Wearing?

This prototype was developed as an image-processing algorithm developed using OpenCV and open-source computer vision library. OpenCV was used to ensure the algorithm could be used in any newsroom without the need for expensive software licences. The software was split into two Python scripts. The first script was used to process a pre-recorded video, and used the colour-checking algorithm that located people in an image and then converted the average colour that they were wearing into a HEX colour code. This was logged in a file. The second script read the colour codes from the file and generated a mosaic of colours.

This diagram below shows the steps that the algorithm uses to go from an image to colour codes that can be stored and used by the second script.

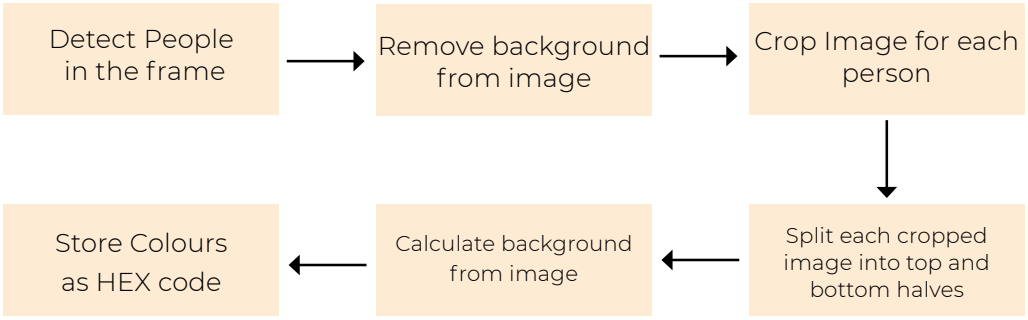
1. Detecting people in the image: the first step is to use a pre-trained Haar cascade algorithm to find people in the image and then draw boxes around each person. A Haar cascade is a feature-based object detection algorithm and is often used to detect faces in an image.

2. Background removal: the next step is to remove as much of the background as possible using the built-in OpenCV background removal. This prevents the colour of the background from skewing the colours detected.

3. Image cropping: each box drawn in the first image is cropped so that no other person is included in the colour check.

4. Colour check : each box is split into two parts, one for the person's top half and one for their bottom half. The colour of each half is then averaged to get an idea of the colours they are wearing.

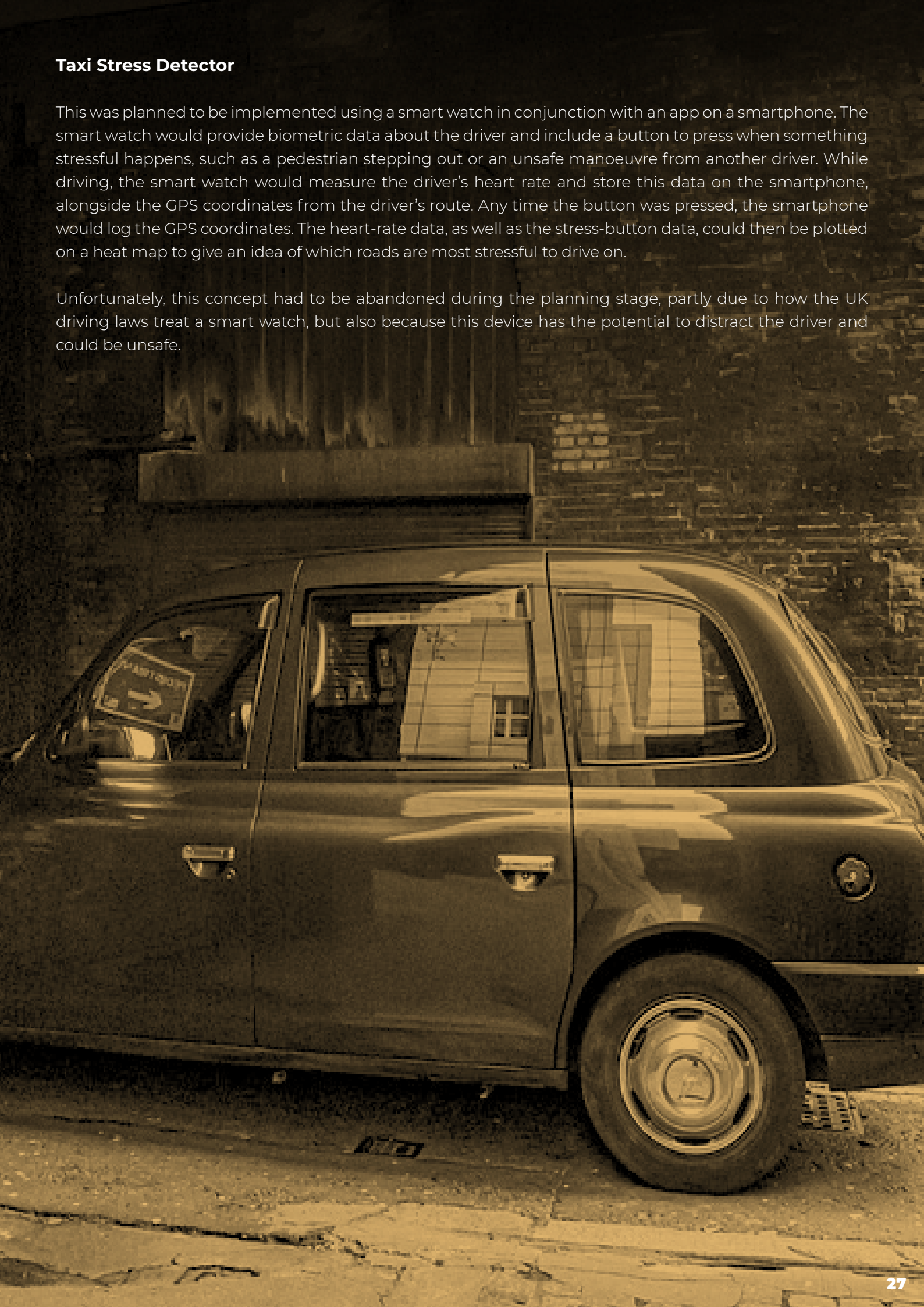
5. Recording: once the colour is detected it is converted into a colour HEX code and written to a log file.



Taxi Stress Detector

This was planned to be implemented using a smart watch in conjunction with an app on a smartphone. The smart watch would provide biometric data about the driver and include a button to press when something stressful happens, such as a pedestrian stepping out or an unsafe manoeuvre from another driver. While driving, the smart watch would measure the driver's heart rate and store this data on the smartphone, alongside the GPS coordinates from the driver's route. Any time the button was pressed, the smartphone would log the GPS coordinates. The heart-rate data, as well as the stress-button data, could then be plotted on a heat map to give an idea of which roads are most stressful to drive on.

Unfortunately, this concept had to be abandoned during the planning stage, partly due to how the UK driving laws treat a smart watch, but also because this device has the potential to distract the driver and could be unsafe.




sensemake
workshop

PHASE 2: PUBLIC WORKSHOP

Methodology

The next phase of the project was geared towards presenting and validating the concepts generated so far, and outlining how the initial prototypes had been envisaged. But another key element of this phase was to throw open the doors to the wider community in order to help the team generate new ideas for prototyping. The session's location took place at Federation House in central Manchester and involved a wide range of expertise from the city including sensor developers, open data experts and participants of the public who dropped by. The session was advertised in the MEN and on the Eventbrite events platform.

The approach to the workshop was phased.

Introductions: to the project and capturing informed consent to be involved in the project.

Mapping issues: this element invited participants to discuss key news items that were important to them and their communities, and to think about what types of data might help to tell those stories.

Paper sensor hack: we then introduced a range of sensors and asked groups to create a conceptual sensor. And for them to tell us what stories they could create with them.

News from the future: Participants then wrote a story 'from the future'. This was designed to tell us what the future would be like if the sensors inspired by their input came into being and had tangible impact. This approach was designed to allow participants to imagine the future and understand what their motivations were in getting there.

Voting and Unicorns: Voting and unicorns: Finally, participants reviewed everyone's input, and voted on, for them, the key elements. As a last exercise, participants were also given a unicorn sticker. This provided a different kind of voice. Rather than a vote of utility, unicorns were given to things that were perhaps unfeasible, bonkers, unavailable, but had a little magic and should simply exist because it would be amazing if they did.

Following the session, an expanded project team met to discuss new prototypes and changes to existing ones. New skills brought into the conversation were human-computer interaction and interaction design.

Findings

There were a number of core findings from this session. They span areas of interest and potential ideas, which, as abefore, are outlined as Tier 1 insights, followed by recurring themes that operate on a wider level, detailed in Tier 2.

Tier 1

Transport and commute: this was a core and recurring theme. Transport and commute concepts covered cycle-route monitors, commute and travel-delay monitors, speed monitors around schools were all mooted as potential designs, as was understanding ongoing flooding on the A555 road (a new route that had been plagued with flood closures). Beyond these ideas, a number of workshop teams suggested different ways to capture car-pollution rates. A key insight from these discussions was the suggestion of using vehicle data to extrapolate environmental pollution.

Local environment: understanding footfall on the high street was one notion that gained traction, but the local environment was also a ripe area for sensor discussion. Understanding air, noise and light pollution came up frequently, and was linked to traffic and other environment issues. Public safety also featured within this local environmental theme.

Understanding emotions: a number of groups talked about sensing people's emotions, asking: 'are the people of Manchester happy? How do we find this out? What opportunities are there to collect this form of data?'.

Community facilities: questions about how often playgrounds and other leisure facilities are used were also present in the ideas generated. This pointed towards a desire to understand how often public services were being used in specific areas. Smart bins and other smart devices that sense were a point of discussion.

Data ownership: generating data on where individuals were being tracked in the real world and in digital spaces. This would allow people to understand their own digital footprint and who else might have access to it effectively making a more positive impact on their 'data literacy'.

Being microwaved: a number of concepts revolved around mobile phone data in urban areas. Understanding what frequency levels are, alongside usage blackspots, and the potential to monitor this at a hyperlocal level, were appealing.

Journalism sensing: One group spent some time thinking about sensors as a way to monitor journalistic output. 'Would it be possible to sense factual inaccuracies, immersion into an echo chamber or establishing if inaccurate information from social media is making it into journalistic content?'.

Tier 2

Emotion and environment: a core insight that emerged from this stage of the project was the interest in both the emotional wellbeing of the city and how sensors could potentially add value to that. It became obvious that insights into how a city was feeling could be a key value of the SenseMaker project within the context of public-led requirements. The challenge, though, was how we could create sensors that would enable us to both capture the data and leverage it within an editorial context.

Equally, environmental concerns came to the fore. And these were multifaceted. These ranged across transport, pollution, air quality, understanding how local community assets were used and how mobile data signals — beyond visual perception — could be detected.

During the session, we completed a rapid-fire thematic analysis, and then invited participants to vote on these themes and some potential responses. The standout input was around neighbourhood liveability and how happy Manchester is. These areas generated far and away more stars than others, and attracted significant numbers of unicorns.

CONCEPTS

Cycle Aware
This concept will provide a physical, potentially in-car, and digital experience of cycle danger in and around Manchester. It could also map safer areas for both motorists and cyclists throughout the city.

Rail Rater
Rail Rater would allow commuters to rank and rate their experience of public transport. It would combine datasets that are publicly available and other app-based data (such as GPS and SMS prompts) to understand what type of rail experience people are having. It would also – potentially – offer a number of services (such as 'claim a refund') that would provide a benefit to users.

The insights would fire potential news stories.

Mobile Signal Strength
A simple device to measure both signal strength, and the ability for mobile owners to use their service provider, throughout Manchester.

Happy Measure
An app and webcam-based facial recognition service (or just images that aren't processed by an algorithm, but still allow the MEN to tell a story) that provides a read on people's emotions.

Playful Playgrounds
A local device or measure that would monitor how often a local playground is used.

Car Detector
Using number-plate recognition to capture data on traffic use. This could span pollution, the value of cars passing by, the colour of cars, the value of a car park and other data sets yet to be imagined.

Hidden Cycle Lines
A development of an existing 'Desire Lines' project understanding people's responses to cycle journeys and developing a SenseMaker approach through deploying other sensors to monitor road conditions and, potentially, pollution.

Stress at Work / Commute
Trying to understand happiness or otherwise. Creating a prompt tool to understand people's experiences of travelling around Manchester.

Temperature Sensors for homelessness
Understanding real-world environments for people living on the streets. The sensors would create a live picture of temperatures for those sleeping rough. Other datasets could also be captured.

DECISION MAKING

Decision making at this phase became challenging. We were operating under strict time constraints and also had significant questions about whether the concepts we'd generated would be buildable by the team, and in light of the resources we had available. The team also introduced a further matrix around desirability, feasibility and viability. This resulted in a number of key technologies being selected, partly in relation to how they could be traced back to the original inspiration from the public workshops, but also reflecting the project team's understanding of how impactful they could be, from a number of other perspectives. These included how they might support or catalyse news stories produced by the Manchester Evening News and their potential for capturing novel data.

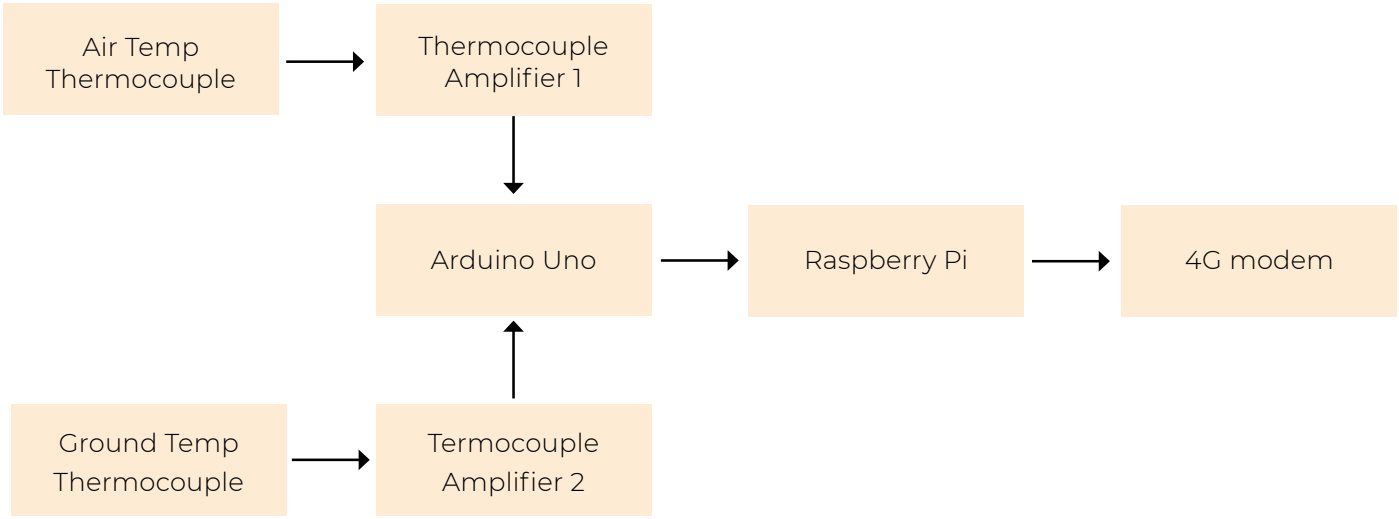
The team then shortlisted concepts that were achievable, valuable and could be created in the timescale.

The shortlist included Rail Rater, Homelessness Temperature Sensor, Mobile Strength Detection and Car Detector.

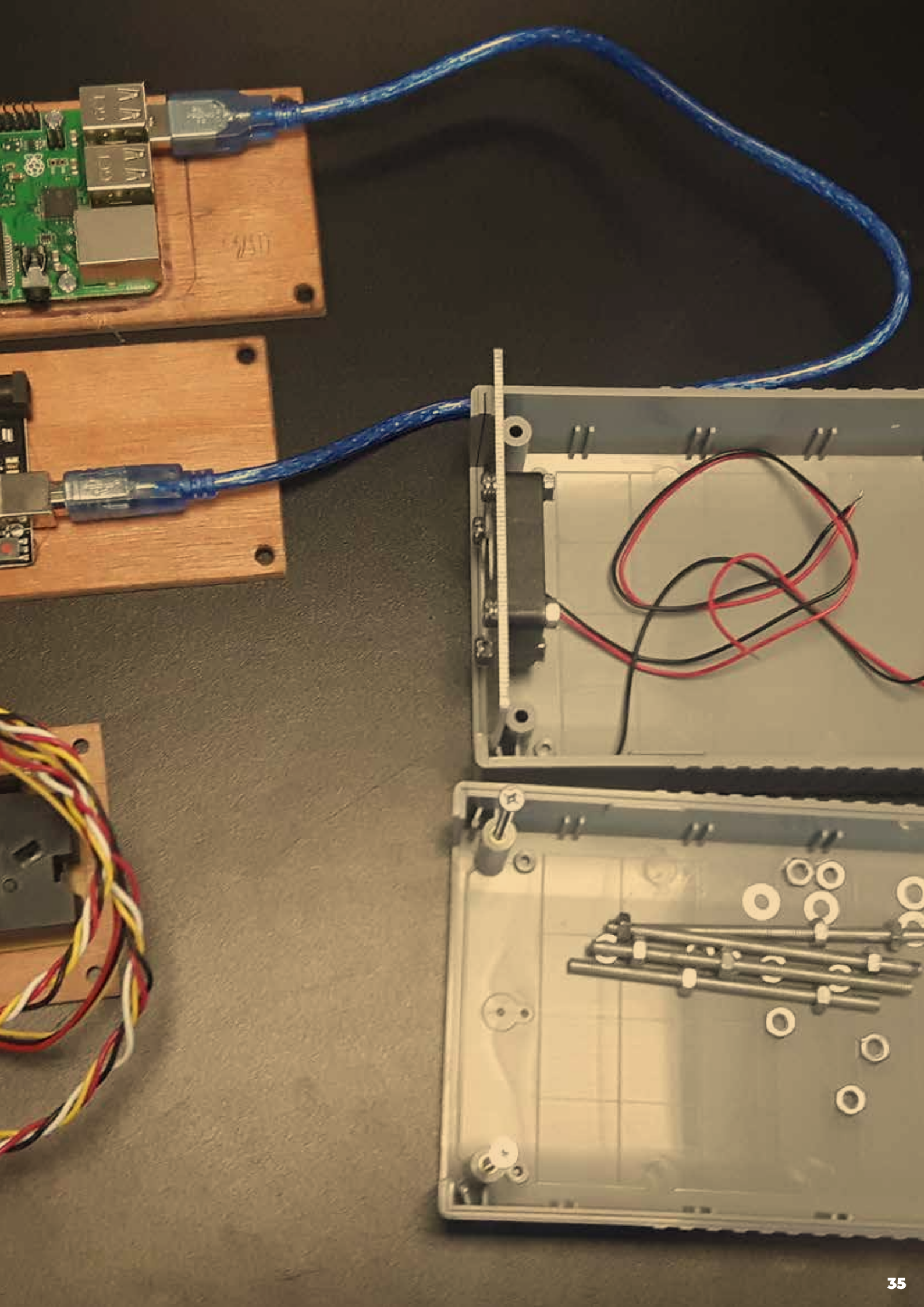
PROTOTYPES

Homeless Temperature Sensor

The Homeless Temperature Sensor was developed using almost the same system architecture as the HomeSensor. The Arduino Uno and the Raspberry Pi remained the same but the air-quality sensors were swapped for two thermocouples. One thermocouple came out of the side of the case to get a measure of the air temperature and one thermocouple came out of the bottom of the case, touching the ground to get a measure of the ground temperature. The system was designed to be powered by a mains connection for extended tests but could also be powered by a battery for around five hours.



Each thermocouple was connected to an amplifier circuit that communicated with the Arduino using I2C. This circuit amplified and digitised the analogue signal from the thermocouple, ensuring the Arduino got an accurate temperature reading. Once the temperatures were read by the Arduino, they were then transmitted to the Raspberry Pi for logging and transmitting to the IoT dashboard.

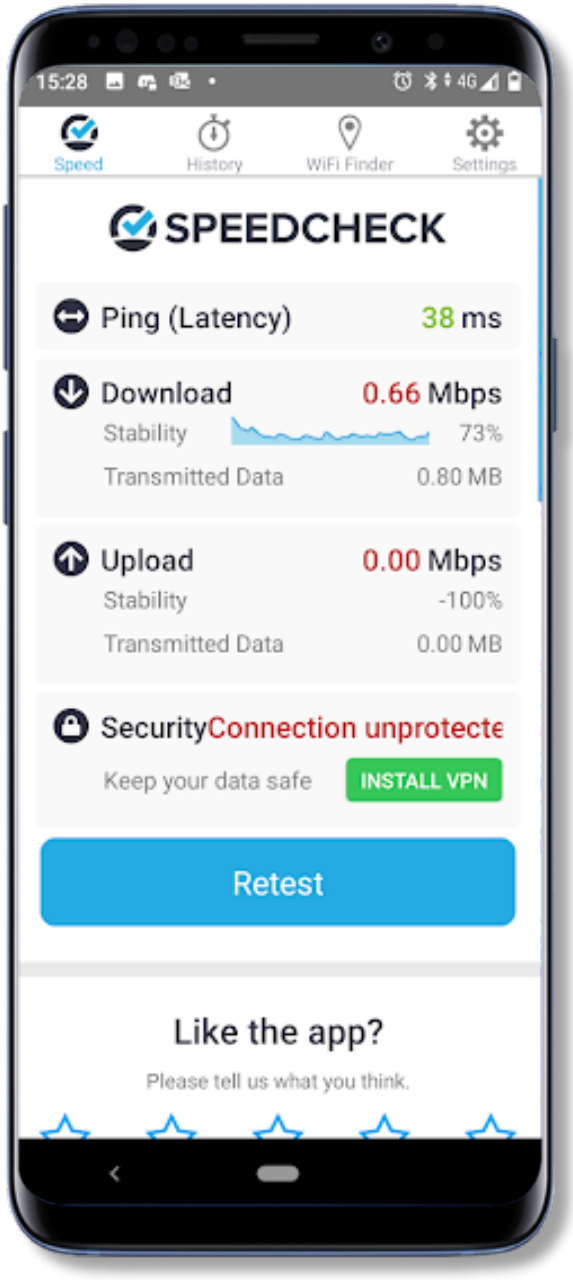


Mobile Strength

Rather than developing a custom app, it was decided to use several pre-existing apps to get the same functionality, as this drastically cut down the development time, while still being able to capture the same data. Four identical smartphones were used to test the four major mobile phone carriers in the UK: Vodafone, 3, O2 and EE. Each phone had three apps installed on it, allowing the phones to measure the general signal strength, as well as test the internet speed and stability on each of the networks. The apps used were:

My Signal Tracker

My Signal Tracker is used to track the signal strength in an area. The app runs passively in the background and produces a map showing the quality of the internet signal (2G to 4G), as well as showing the overall signal strength (red to green). This app allows the user to gather signal strength data over a large area quickly and easily.



Speedcheck

Unlike My Signal Tracker, Speedcheck needs to be triggered manually, but provides a much more detailed picture about internet connection. It measures both download and upload speeds and gives an estimate of stability for both.

GPS Logger

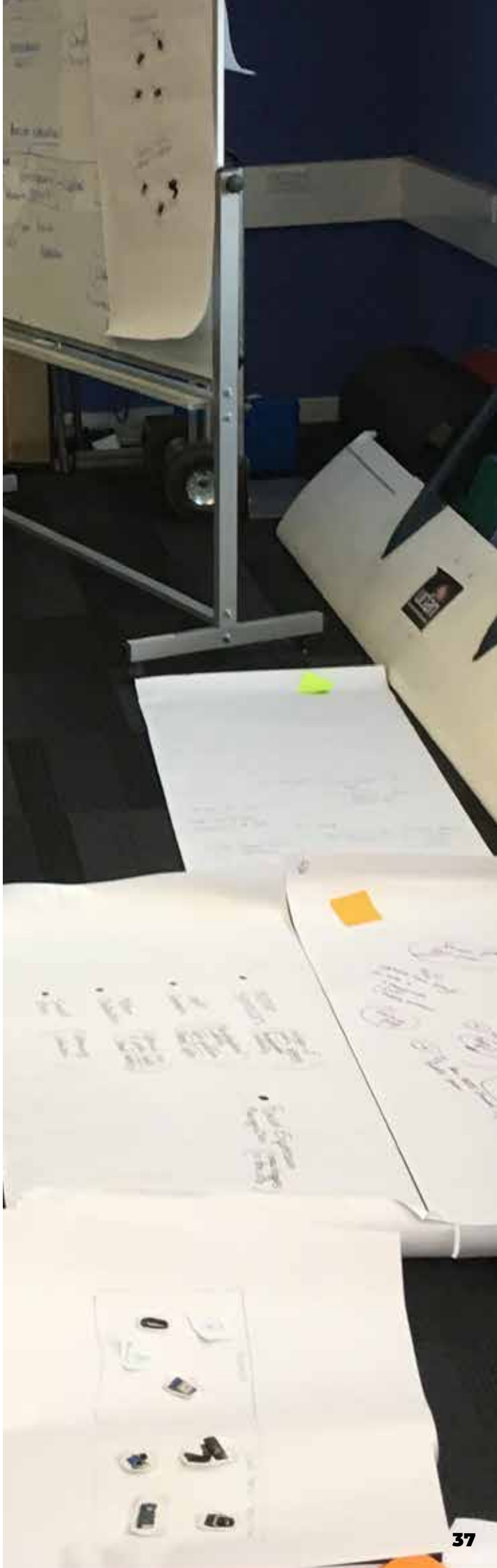
The GPS Logger was used to record the position of the phones during testing. This record could then be used to accurately find the locations of the manual internet speed tests by comparing the time stamp in the speed test to the route recorded by GPS Logger. This was done to save the operator from having to manually record the locations of each of the speed tests.

Car Tracker

The goal of Car Tracker was to get an idea of the types of cars that are driving around different parts of Manchester, asking, for example: 'are there more diesel or petrol cars in certain areas?'. This was implemented using an automatic number-plate recognition system (ANPR) alongside the Driver and Vehicle Licensing Agency (DVLA) number-plate-search API. The software was implemented using two Python scripts, one running OpenCV with the ANPR algorithm and one running the DVLA's number-plate-search library. The response from the DVLA included a huge range of data about the car, such as fuel type, CO2 emissions and the size of the engine. This data would allow a newsroom to write a range of different stories.

The first script used pre-recorded video and tested each frame. If a number plate was detected in the image, the ANPR algorithm would return several attempts at reading the number plate, each with a confidence rating of how accurate the reading was. The Python script selected the top three and recorded them in a CSV file.

Once the full video had been processed, the second script could then be used to collect the specification of each of the cars detected. For each correct number plate, the script stores the following parameters, although more can be added.



DEPLOYMENTS

HomeSensor

The HomeSensor was developed with a real-life newsroom scenario in mind. The Manchester Evening News often receives calls from tenants who are unhappy with the living conditions in their rented property. It was hoped that the HomeSensor would help them gather environmental data to support these cases.

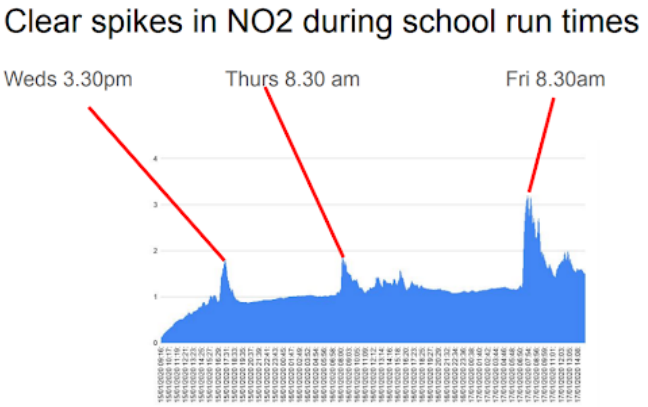
The newsdesk spoke to two readers who had contacted the MEN with these kinds of concerns to see if they were interested in using the HomeSensor. In both cases, their complaints were resolved before the sensor was deployed, when the landlords learned that the tenant had approached the MEN.

A different opportunity then arose to deploy the sensor, in a way that would help schools and communities campaign about the environment.

A community reporter at the MEN saw this Facebook post and suggested that the project should approach Cringle Brook Primary School to see if there was interest in using the sensors.

The MEN contacted Louise Taylor, the deputy headteacher at Cringle Brook Primary School in Levenshulme to install the data sensor and measure air quality over a few days. The sensor was also installed in a solicitor's office near the school entrance to monitor air quality on the main road outside the school. Again, the solicitor's firm was very keen to take part in the project to help the local community address an important issue.

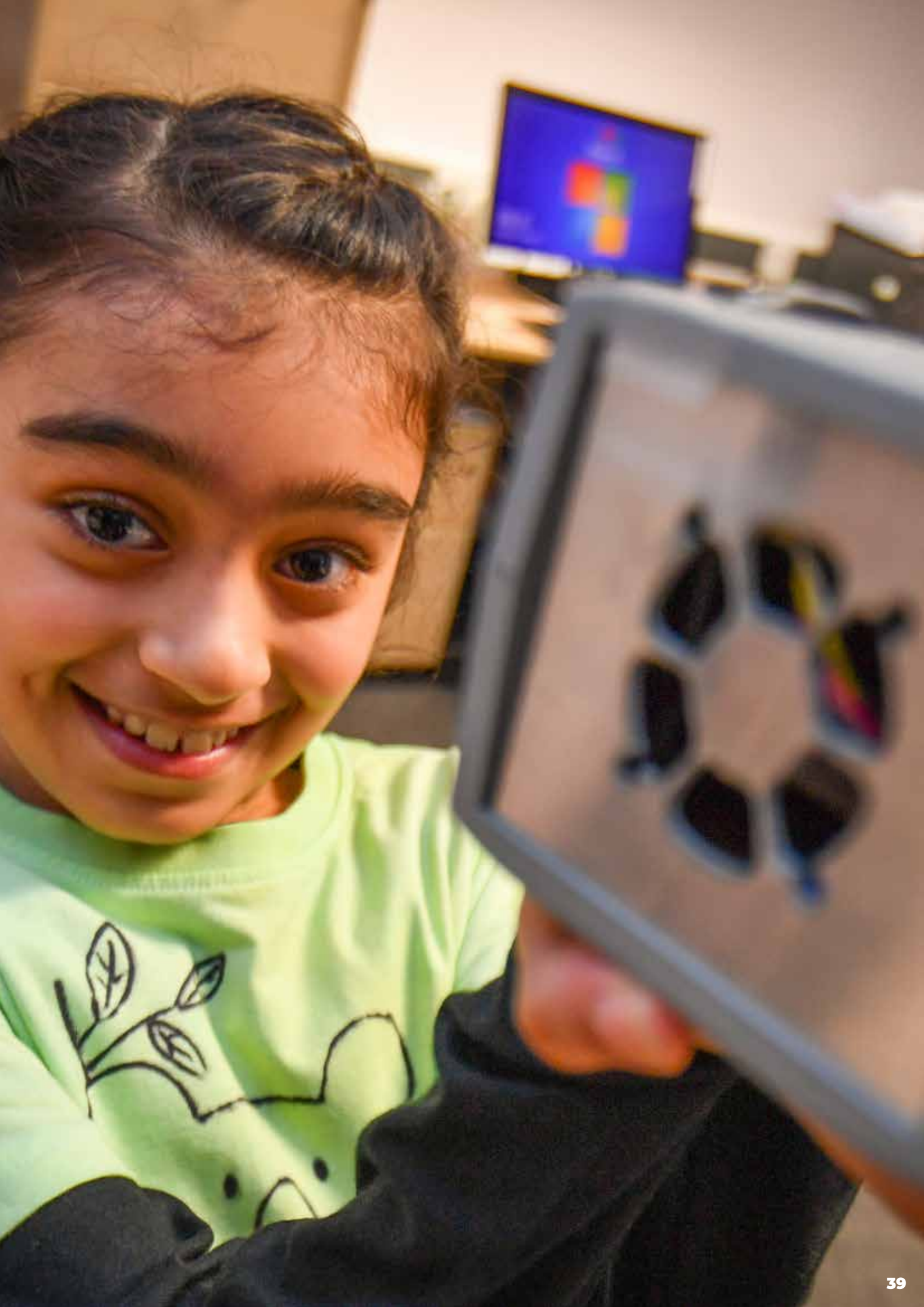
The result was a dataset which clearly illustrates spikes in NO2 during school runs, as shown in the chart below.



The school presented the data to parents at a meeting to encourage them not to drive their children to school, or to park further away from the school gates.

Louise Taylor told us the experiment was valuable to the school, not only to help change behaviour of parents, but also as an exercise to engage the pupils in environmental issues. The experiment was reported in the Manchester Evening News.

https://www.manchestereveningnews.co.uk/news/greater-manchester-news/environment-sensor-project-fallowfield-school-17574299



The sensors have since been deployed in other schools and businesses in south Manchester. The sensor was also used in Leeds to measure the effects of a Car Free Day on levels of pollution in parts of the city.

They are currently being deployed in a social club in Eccles, which is adjacent to the M602 motorway, with a view to gathering data about the effects of a new speed limit. The speed limit is intended to reduce pollution and the MEN hopes to use data from the sensors to determine how effective the speed limit has been.

What is Manchester Wearing?
The colour sensor was developed in the workshop to answer the question: 'what is Manchester wearing?'. The initial idea was to see if a particular colour was in fashion on the streets of the city. With the Manchester City v Manchester United football derby in December 2019, journalists saw an opportunity to use the sensor to address a different question - 'is Manchester red or blue?'. The MEN has previously covered this perennial issue by using data to map the results of a survey.

In this case, the colour sensor was placed in the centre of Manchester ahead of the match to see how many people were wearing the red of United and how many were wearing the blue of City.

This produced a dataset that allowed the MEN to write an article which was widely shared among fans ahead of the match.

UNDEPLOYED CONCEPTS

Mobile Strength
As mentioned above, this prototype offered develp a way of gathering and reporting data on mobile phone signals in a particular area. This would allow journalists to demonstrate the areas in the city that have poor phone signal and the intention is to deploy these at football stadiums to determine which parts of the stadium have the best signal during the course of a live match.

Covid-19 prevented the full rollout of this concept.

Car Tracker
The UCLan rapid hack helped to pave the way for how this would be approached, and the engineering team developed both the image-recognition software and used the APIs from the vehicle database, as as described in detail before.

However, other concerns materialised pre-deployment. The team explored what General Data Protection Regulation (GDPR) and other data collection issues might be at play, and what the project would need to do to gather informed consent from drivers it captured. Viewing the project using this frame, it became apparent that, although deeply rooted in the community workshop, the real-world mechanics and potential frames of 'acquiring data' in this way may be problematic.

https://www.manchestereveningnews.co.uk/news/greater-manchester-news/environment-sensor-project-fallowfield-school-17574299

INTERIM INSIGHTS

As we complete the project, and look to the future for potential follow-up work, there are a range of key insights that can be derived from the project. These span the experience of running such an innovation project, and the devices that were made and deployed.

Prototypes were aligned withparallel news agendas

As we developed concepts, the ones that project, and the devices that were made and deployed. were ideas that often mapped against an ongoing news agenda or campaign. For example, sensors to better understand homelessness or environmental impact tallied with other editorial work being conducted either at the *Manchester Evening News* or Reach more broadly. This 'piggybacking' was essential for creating legitimate and useful ideas.

Utilising data for action: creating tangible benefits followed

Although perhaps not on a scale initially imagined, the project has demonstrated that putting data creation in the hands of communities can prompt action and change. Cringle Brook's hosting of the HomeSensor, the insights into raised NO2 levels and the resulting travel plan, shows that the project's aspirations have real potential. Full development and roll out of the prototypes more widely was limited due to Covid-19, but this one example demonstrates the merit in the approach and the the opportunities it presents.

The potential for a [co-created] constructive approach

More broadly, it also points towards a data-fuelled approach to constructive journalism. The process that the project went through to deploy the prototypes created impact and action, albeit on a smaller scale.

One central insight was that, although the actual editorial output – which the project team initially thought would demonstrate the impact of the sensors – was relatively limited, the process itself created value rather than an intrinsic relationship between content and action. This is something that the academic team would like to pursue in further, follow-up work, to better understand how the process of creating and deploying the prototypes fires change, rather than the potential stories that arise from them.

PROTOTYPING IS HARD: THINGS OFTEN DON'T WORK

Ideas can be exhilarating, but the long, and sometimes hard development and deployment process can be exhausting. SenseMaker hit challenges at the moment that ideas moved to fabrication. This was due to difficulties in satisfying the university's ethics committee's requirements, which in turn exposed the difficulties that interdisciplinary and sometimes experimental research has when it attempts to push boundaries. We also found that iterating the prototypes in a timely and effective manner was challenging. As such, at the conclusion of the project, the team have a number of reflections:

Engage university compliance officers early in an innovation process: this allows an innovation team to both fully understand key legal, ethical and compliance issues, and involves those charged with oversight in the conversations as early as possible. Interestingly, SenseMaker revealed some gaps in the knowledge of central university systems, and the UCLan principal investigator was asked to join the university's ethics committee to advise on future action-research and prototyping projects.

Resource is key: although SenseMaker had a multidisciplinary team, at various points, the team realised it didn't quite have the skill sets or volume of time need to realise some of its aspirations. This is a perennial challenge for co-creation projects, as being responsive to a community's requirements is only possible within the confines that the project has available. A central insight for the project is to more effectively anticipate skills requirements and create a structure where these skills can be identified quickly and early, and for people to be pulled onto the project if required.

Boots on the ground: the configuration of skills is also important to note. To deploy the prototypes, and to manage them and the community times during the course of the project, further resource should be factored in more effectively in future projects to ensure this work can be scaled as necessary.

Always remember the end user: while it can be easy to test a prototype in a lab in perfect conditions, it is extremely important to remember that the end user (partner journalist or project participant) may not have the same technical skills as the engineer. During the project, problems occurred with the HomeSensor in its first iteration due to the usability of the system. While this was improved in subsequent iterations, of the HomeSensor, the problems could have been avoided entirely if there had been more consideration of the end user.

IDEAS THAT DIDN'T MAKE IT...

What became evident early in the ideation process was a need to filter ideas against real-world concerns. We centred, particularly in the second phase of development, on a feasible (is it technically possible?), viable (do we have sufficient resources and time — is it deployable within the project resources?) and desirable (does it map against editorial and community needs that were identified both in the workshops, and in consultation between the partners?). This framework allowed us to pursue initial build and testing.

However, the nature of a co-creation process resulted in multiple ideas that could move forward and ones that strayed away from the initial brief. At the end of the project, the team feels that, based on the needs and requirements of the workshop, and the opportunities for editorial content generation, there was scope to develop a range of prototypes that would enable content creation and point towards tangible impact. Resource was a limiting factor, and although we were able to deliver on the number of prototypes outlined in the initial bid, many more could have followed. The partners feel that the ideas suggest future development pathways that are ripe for exploration.

FUTURE WORK

SenseMaker demonstrates a range of future opportunities for co-created, connected sensors. Below is an overview of our end-of-project thoughts.

Expanding the notion of 'sensing': due to the responsiveness of the project, and its open approach, we found quickly that we opened up the definition of sensing beyond the 'usual suspects' of air quality and pollution. During the project, We considered sensing via thermal imaging, image recognition, biometric data, mobile-data signals and sound. We also considered some digital tools to acquire people's emotional response and other inputs. This early work demonstrates real potential in expanding notions of sensor journalism as far as possible in order to generate useful sensors and resultant datasets.

Pollution is a key driver: despite the expansive approach to sensing mentioned above, at the end of the project, we achieved most impact through either measuring air quality or pollution levels, and considering new ways to measure them, than we did from the other concepts (although these were limited by Covid-19 interrupting our deployment phase). As such, there is potential to embark on work, in both greater depth and scale, in this area. This is reinforced by ongoing debates about air quality, and negative impacts it has on health and wellbeing.

Understanding emotion and wellbeing: a central finding throughout our industry and public engagement is that sensing emotional states was seen as an important area for Manchester to develop. Charting the highs and lows of a city, and the many nuances in between, was borne out from the industry-focussed work and from the community representatives who engaged with the project. The challenge here is about how to do this. During the project, the team explored image and facial recognition, chatbots, surveys and social media trawling. As a cohort, we decided that feasibility and viability issues provided blocks in real progress. Nevertheless, this was such a central finding that the team is eager to pursue follow-up work in this space, to explore these emotional mapping requirements.

Connecting with infrastructure: at the start of the project, we aspired to connect with open-data networks throughout Manchester. CityVerve was one key infrastructural element that would allow connected sensors to stream data back to central databases. The prototypes created during this project, and their level of fidelity, led in a different direction. However, in terms of scale and adoption, future projects could use these networks for a fuller and more effective roll out.

Data revenues: one area that the project was unable to address, at its current interim end point, was an exploration of the commercial viability around sensors. A full exploration of what revenue models sensors, the content they generate and revenue streams they support and/or generate, is an important inquiry, and the project team intends to pursue this beyond the interim final report stage.

AND FINALLY...

The project team would like to end this report with a thank you to everyone who has been involved along the way. Participants from Reach, staff and students at UCLan, and citizens from across Manchester, who helped inspire us and deliver the project as it progressed. Co-creation as a method of innovation can be a challenging approach, but it always demonstrates a rich vein of perspectives, insights and motivations. Without the people involved, we would not have been able to learn, build and deploy prototypes in the way that we did.

Although we were ultimately limited by Covid-19, the team is keen to expand this work, to learn more about the insights and opportunities we discovered, and to push into new areas.

ACKNOWLEDGEMENTS

The report writers would like to thank a range of project members, and the wider supporting industry and community for their assistance in developing, securing and delivering this project. They include Alison Gow, Professor Darren Ansell, Claire Miller, Professor Erik Knudsen, Dr Mark Lochrie, Mathias Caelenberghe, Sarah Cullen, Luke Robinson, Gareth West, Andy Dickinson, Kirsty Styles, Debbie Dearnley, Sarah Smith, Aisha Malik, Madalina Ciobanu, Alex Flahive, Louise Taylor, and all the workshop participants from Reach PLC and those who attended our public workshop. Thanks also goes to Sarah Hartley at the Google News Initiative for her support throughout the project.

Data visualisation from ‘What is Manchester wearing?’

December 2020