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Climate Anticipation. Working towards a design proposal for urban resilience and care

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Abstract: The 'winter of...' and the 'hottest day since...' are narratives that describe our experience with a climate that informed our behaviours of the time. What was, isn't necessarily what will be, and as global climate change shifts and pushes us into unfamiliar climatic experiences, we seek a more meaningful way to anticipate climate change. In this instance climate is viewed as a disruptive element in society with its shift, apparent unpredictability, and impact affecting those less equipped to anticipate. With extreme changes in temperature, high air pollution levels, and lack of rain water, climate change is felt and seen. CAPE (Climate Anticipation Personal Environment) is a conceptual framework to inform society of impending environmental extremes by communicating immediate futures. Four case studies explore current technologies being applied in our surrounding terrestrial and extraterrestrial environments. Together they represent our anticipated materialisation of CAPE. This paper seeks to enable vulnerable communities to be better prepared through warning systems, to better seek relief through interventions, and to develop anticipation and care in large cities, those lacking green spaces and natural approaches in order to align climate anticipation with the needs of society. [STYLE: _RwS Abstract]

Keywords: Climate Change, Anticipation, Sensing, City, Communication

1. Introduction

An abundance of data exists to help us understand and alter our behaviours and inform our climate resilience, however, we remain ever challenged by our ability, or inability, to realise its' relevance to our person and our accumulated urban behaviours. The material aspects of climate are held in the matter they affect as its sensorial capacity clings to incidents. Changing environmental habits, labours, and traumas, decay and regenerate under our feet and before our eyes.

Try to imagine two strangers passing on the street, the fibres of CAPE (Climate Anticipation Personal Environment) intertwine as they brush past one another. The material grip exchanges data through proximity. Once passive passersby share a tangible correspondence, the immediacy paralleling the level of intentionality on a spaceship. Just as information is exchanged in the cloud, as a data conversation via satellites, it also occurs at a much more intimate scale on the ground between material, people and their surrounds.

CAPE is understood to be a distinct way of exploring and doing. Aspects have been prototyped, but it remains immaterial and unwearable at this time. What began as a material fabulation has become a methodology, not a method (following Tunstall 2013), which encourages a way of talking about climate change, society, and how we monitor and make sense of the environments we are passing through.

CAPE explores the socio-ecological as a coefficient system beginning with developments upon the authors work in thought experiments and systems thinking (CAAS - City As A Spaceship). Building upon this familiar platform, as a means to communicate futures, CAPE considers current work of others on climate and sense-making as well as key writers and thinkers work on the topics of survivalism, anticipation and care.

Donna Haraway's continuing development of the SF acronym, exercised through her stance in staying with the trouble, is where we position CAPE. Haraway's SF acronym is comprised of many interweaving concepts, for CAPE the pertinence exists in the inclusion of 'science fact' alongside 'speculative fabulation' as it encourages the heuristic and factual to coalesce. Considering our place in the Chthulucene, CAPE works within the problem in order to keep moving.

Alongside Haraway we draw from the work of Forensic Architecture, a design collective bringing narrative to the realms of data accumulated from the actions of citizens, data banks of governments and publically available satellites, 'making sense' of history and historical events. These reflect the position outlined by Matt Ward (2017), who argues that the speculative trajectory that design has followed needs to change and redirect itself along a route of care, with a narrative accessible by everyday citizens.

CAPE comes from a place that is messy, imperfect and actively generative. It relies on collective thinking and a recognition of the inseparable threads of society, ecology and technology. Following Cameron Tonkinwise (2017) we find it necessary to consider nothing in isolation due to the inherent interlinkedness of social stresses. CAPE demonstrates this premise and draws from the collective living environment of a spaceship, where closed-loop, multicultural and confined with limited resources, remoteness and isolation informs possible options for survival. This paper aims to demonstrate the approach through the themes of reciprocity, sense-making, resilience, hope and trust, leading us to communicating futures through insights and actions.

1.1 Reciprocity: City as a Spaceship (CAAS)

City As A Spaceship (CAAS) is a platform of work originating from a female collective of designers, architects, engineers and scientists. It is a well documented thought experiment that explores reciprocities between extra-terrestrial and terrestrial living (Fairburn et al, 2014). The CAAS platform was founded in the exploration of science fiction (SF) science fact (SF) speculative fabulation (SF) string figures (SF) and societal fictions (SF). CAAS began with the premise to take Space beyond science fiction to science fact. CAAS, as citizen science, endeavors to provoke awareness of the inseparable challenges we face by visualizing the state of our current environment through various lenses (Fairburn et al, 2017). A spaceship in its' ideal state is a fully functioning biosphere where resources are carefully re-created; water and air are recycled and put back into the loop. An ideal spaceship is a technologized habitat that includes biological systems, leaves no trace, offers life-support systems in a full closed loop, and is powered by renewable energy. CAAS's approach focuses on the key themes of cities, technology, environment, and society – thus drawing the paradigm of spaceships – onto and into cities.

1.2 Sense-making: Climate and Data

As we move through cities, we carry data – mobile phones, wireless nodes, computing power, and sensor platforms – we emit signals, we convey information to others. The urban environment is one part of this, it is the true ‘cloud’ that we inhabit as we move between locations, transit through spaces and navigate our surroundings making our location visible as we journey through our day. We constantly share our observations of what we see and what we do with others. We use data to communicate problems with traffic and the unexpected, dangerous routes and unexpected encounters with urban skunks. Equally, we share opportunities, such as a preferred route (a tree-lined street showing it’s finest autumn colours) or an unexpected concert. Digital pathways within our cities send instructions to buildings and public spaces – why? – for our comfort and to reduce energy demands, but this can also contribute to individual or group-based ‘environmental bubbles’ as systems learn our daily routines, usage patterns and preferences.

The greatest climate impact is seen in cities and Planet Earth has seen a run of 627 months in a row of above-normal heat (Khan, 2017). The evidence supports that the established warming trends, global and local, are likely to have a substantial and negative effect on the thermal comfort (Brown, 2011), health (Vanos, Warland, Gillespie et al, 2012), and well-being of many urban dwellers. The impact of climate change in cities becomes more complex when air quality factors are added to urban heat complexes: heat accumulation, sun/shadow and wind effects.

Is there a gap in how we understand the environment that our bodies are situated in and how we mediate through? Hannah and Selin’s (2016) response to this question with their project ‘A Year Without Winter’ which extends the understanding of climate beyond a scientific reliance on data analysis and modelling to informing a collaborative narrative that accompanies the data. Offering provocative visuals alongside a narrative that harnesses the scientific knowledge of climate change, they seek to motivate ‘adequate political, economic and technological responses’. While some reference the global concept of climate, they reference the ancient concept of ‘Klima’ and adopt the language of agency whereby climate ‘refers to all the changes in the atmosphere which sensibly affect our organs’ and influence ‘the feelings and mental conditions of men.’

1.3 Resilience: Survival and survivalism in urban uncertainty

“For social agents to act consistently and to take responsibility for their community, they need to have reasonably well-founded expectations in the future.” (Hastrup, 2013)

The concepts of survival and survivalism conjure up images of Henry David Thoreau's cabin at Walden Pond, stockpiling cans of baked beans and a certain level of solitude within the wilderness. We aim to understand survival in urban settings, that are not in isolation of others. A recent article published by CityLab looking at post-hurricane resilience surmised that levels of communal trust and cohesion were critical predictors of survival. Aldrich (2018) argues for the investment in schemes to encourage the building of ties and connections in communities (like Neighborfest in San Francisco) as local social networks are of great importance to the durability and preservation of the affected individual. How might we embed the link between survival, climate change and nature, in the context of urban communities?

Survival in urbanity is a community priority and a way to make durable society (what Bruno Latour argues is a responsibility of designers). The commons, as community, can be understood as an action, as a way to do and continue doing. Maldonado in *Design, Nature and Revolution: Toward a Critical Ecology* focused on the “human environment,” which he characterized as “one of the many subsystems that compose the vast ecological system of nature” (Maldonado, 1972). Following a

systems theory model, he claimed that among subsystems, “only ours possesses today the virtual and real capacity of provoking substantial—that is irreversible—disturbances in the equilibrium of other subsystems.” It is for these reasons that we will not understand the social or ecological as separate systems, but instead consider from the synonymous perspectives of our 'human environment', the 'socio-ecological' and (as above) the Chthulucene.

The communication at play between these ecologies in relation to survival is necessary to consider. Survival is rarely disassociated from nature and survivalism typically references both knowledge and skills in how to co-exist with nature. Design has an increasing library of how-to-books and user-manuals which aim to assist in navigating our constantly changing human environment. The *Extrapolation Factory's User Manual* (Montgomery & Woebken 2016) opens up design future practices for the people whereas the *Augmented Ecology Fieldguide* (2018) for the wired wilderness (2018), employs drone ecology and satellite sensors on living systems to generate a visual expression of the living landscape that extends our view, as a form of citizen science. Space literature similarly contains how-to's, as astronauts reflect on their time in space by approaching our daily life. Chris Hadfield's (2015) *Astronaut's Guide to Life on Earth* tries to help us build our awareness to life on earth, drawing experience to our everyday through reflections on survival and hope in space.

1.4 Hope: Anticipatory practices and implementing structures of care

Anticipation, as recognised by the geographer Ben Anderson (2010) is comprised by a series of styles, logics and practices. Practices, as the most relevant to CAPE, are considerations of how futures are made present through modes of affect, thought objects and materiality. Within anticipatory practice Anderson [ibid] argues it can be broken down into one of three categories : calculating futures, imagining futures or performing futures. We extend this further to communicating futures, considering specifically how hope is a generative tactic with which to anticipate what may come. Within this frame of hope we look to the everyday efforts of people in understanding and anticipating nature, this includes climate modelling (Halstrup 2013), changes in urban snail populations (Zhang, 2018), utilisation of pigeons to monitor air quality (Haraway, 2017), development of specific vocabularies in the face of natural disasters (Widianto, 2018) and day-to-day engagements with changing weather conditions.

We acknowledge that anticipation as practice, style and logic is an affective state of the present. It is a lived condition shared by societies. This survivalist state draws together notions of collective imagination and affect. By understanding imagination to be a knowledgeable condition, "a frame of mind that prepares someone to do something" (DiBattista, 2017), it takes on an active, affective role in the present. We consider affect and imagination from the perspective of the individual and society. Marina Garcés (2012), in her article 'Honesty with the Real', writes about the notion of being affective. Garcés demonstrates that letting go of one's subjectivity facilitates understanding as a body of people. How then does a citizen becomes affective within their city? Like Latour, Stengers and Haraway we understand nature to be something that has to be done, or actively manipulated from within. Therefore the affective actors, a system in themselves, act and respond with and within the ecological system.

Citymapper (Figure 1), the app that structures multiple ways to reach a destination, has a section where users can opt to be 'rainsafe' i.e. arrive at their destination as dry as is possible in the circumstances. This is available even in times of extreme drought. Public transport becomes protection. In a constant state of anticipation, this option is survivalist in nature. In this case the user has the ability to ensure safe transit and the app does not have to respond to the weather. This localised engagement with weather (which we understand to be a form of physical climate

provocation) is a preventative technological development enabling users to decide how they want to interact with the daily climate of their city. In the case of the 'rainsafe' option the sensing of the surroundings is revoked from the individual, making the app 'affective' on behalf of people who wish for protection, the routes mapped have elements of care and empathy.

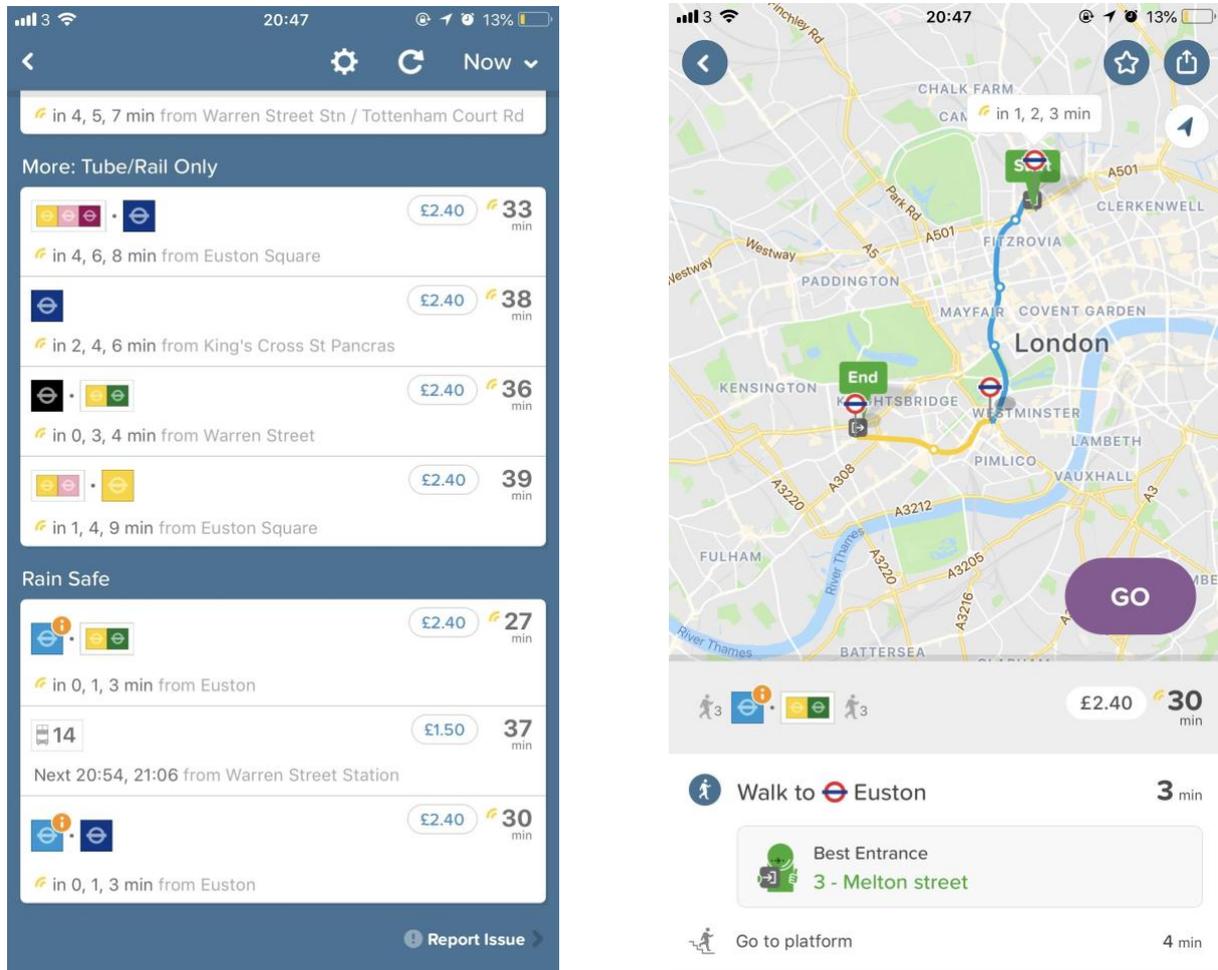


Figure 1: Citymapper interface mapping multiple Rain Safe routes regardless of present weather (Credit: Citymapper).

We have taken a long time to understand how to position speculation in relation to CAPE when the present quality of anticipation is so important to the system. Matt Ward argues that the speculative trajectory that design has followed needs to change and redirect itself along a route of care (Ward, 2018). Critiques surrounding speculative design argue about the accessibility of this narrative to the everyday person. Interventions of care are functional, sited, tangible and ongoing. Where speculative design tends towards provocations, dialogues of care enable design to be accessible and mobile through a humanitarian lens where locals take on an affective agency. In this frame people can be more than bystanders of the 'what-could-be' and instead actors in their possible worlds. Through hope, affect and care (all active forms of participation) CAPE can engage in localised settings by working intently with the present moment.

1.5 Trust: Communicating through civic engagement and collective imagination

“The imagination is not a privileged act; everyone engages in it. The imagination allows me to give a credence and an integrity to any existence outside of myself.” Mary Ruefle (2017)

Forensic Architecture (FA) is an investigative practice which uses architecture as an optical device when looking further into state violence and human rights violations. FA utilises data gathered through new evidentiary methods that are both top-down as well as bottom-up (Forensic Architecture, 2018). Bricolages of audio, visual and textual reflections are gathered from social media platforms, satellite imagery, and materials sourced and leaked through hacks and recordings in order to weave together a post-real-time narrative. Their practice oscillates between critical reflections and calculated interventions, and serves as an exemplar of data-driven civic engagement and communication. Of interest is their new forensis in which “civil society groups use a variety of scientific and aesthetic means to co-produce and present evidence in the pursuit of public accountability” [ibid]. Big data and fabrications piece together narratives that have occurred in order to reveal the truth surrounding injustices within society.

In a recent interview Anab Jain, of speculative design studio Superflux, spoke of the importance of imagination in relation to their work (Jain, 2018). This was not their own imagination but the imagination of those confronted by their works, which query the entangled landscapes of technology, culture, society and the environment. By materially articulating and probing collective thought individuals have the opportunity to critically rethink the world we may live in by reclaiming their imagination. This is the use of fiction and fabrication which we understand through Donna Haraway and Matt Ward. In order to understand how CAPE nurtures this position it is best to outline our developing methodology.

2. Methodology

CAPE builds upon the CAAS methodology, which is immersed in the broad field of Design Research. In appearingly contrasted and extreme environments, CAAS sought insights arising from their overlap and potential reciprocities, leading to potential hypotheses (Fairburn et al, 2017). CAAS and CAPE align with Malika Bose's (2007) recognition of design processes as being similar to the critical analysis undergone in scientific work, to pursue goal-oriented problem solving by furthering the research question toward the theme and focus of the project.

Research through Design: taking design or case studies for research analysis,

Design through Research: taking research results as a basis for design oriented outputs

CAPE methodology also assembles the ‘SF acronym’ of Donna Haraway as a conduit to consider the hidden systems and intangible connections underpinning society and the environment in their everyday. Just as the patterns ascertained by CAPE will be processed and felt in real-time they at times malfunction, go off-course and in their anticipatory capacity imagine the possibles to come.

In this paper, we use case studies as snapshots of approaches, trialled and analysed in this time, to foster place-making and to inform our thinking and doing; future materialisations. These case studies allow CAPE to be understood through and significantly, with these material interventions as we recognise the capacity of objects to generate contexts (Appadurai 2013).

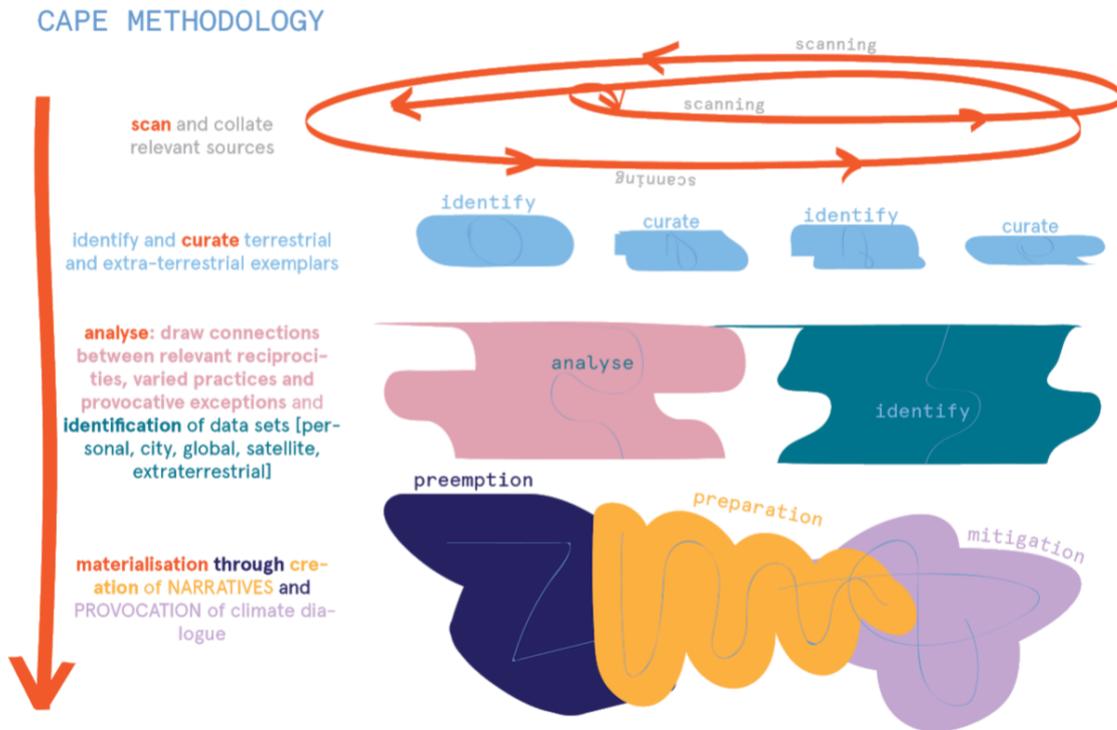


Figure 2: CAPE methodology visualised in progressive stages of design through research and research through design (Credit: J Cunningham).

3. Case Studies

The four case studies presented progress in a scaled approach through human and non-human approaches of engaging with our surrounding terrestrial and extra-terrestrial environments. The case studies are materialisations of different facets of CAPE - how to capture surrounding data on air quality in an urban context, how to collectively write in the SF acronym, how to remotely monitor city wide air quality through combining Earth Observation technologies with Machine Learning and how to navigate unfamiliar environments with a closed-loop wearable. Like the archetypal survival handbooks, these how-to's act as guides for CAPE, so that we can further understand how-to navigate in this socio-ecological situation.

Each case study progresses through considerations of **preemption**, **preparation** and **mitigation**. **Preemption** allows us to consider the thinking and relevance behind each case study with regards to CAPE. In referencing **preparation** each case study was analysed for its 'doing' capacity, what its action is in the present and how it does so from within. **Mitigation** is included to convey the impact of such interventions, who they benefit and how they can be applied in different contexts. We begin on the ground with a citizen science workshop where participants built an air quality monitor, move to the writing of collective fictions based off of the position of satellites in the sky, after which we align urban streets and satellites with the work of an Indian space start-up using data analytics to deliver social, economic and environmental intelligence and finish somewhere in lower earth orbit exploring the suited human-in-the-loop as data conversations.

3.1 Citizen Science: Who makes decisions about the air we breathe?

Preemption Luftdaten is an open source data platform that crowd-sources information for the comparison of changes in environmental factors through a series of stationary self-built sensors (see figure 3) which track and communicate real-time data about the surrounding environment. This development began and continues as a Citizen Science project. They aim to make the data about our surrounding environment such as temperature, relative humidity and air pollution visible and accessible (without significant delay) to the wider public.



Figure 3: Luftdaten device camouflaged in an urban wilderness, enabling nature to aid in localising data collection and understanding (Credit: J. Cunningham).

Preparation "Who makes decisions about the quality of air we breathe?" Controversial plans to erect an incinerator in the Torry area of Aberdeen, Scotland led a local to ask this of a nearby MakerSpace.¹ This provoked a response in the form of a DIY air quality workshop held June 2018 at a local public library where we as citizens of the city made individual Air Quality Monitors. Although collected data is available to witness on a global scale, it was clear that the individual wants behind this hyper-localised data collection vary from person to person, emphasising the continued position of Luftdaten within citizen science.

Mitigation Even though citizens cannot modify the placement of their sensor on the map there is the capacity to programme the device to pick up incorrect signals, thus making the data and corresponding visuals inaccurate. This device hacking if in areas with few air quality monitors could affect people's perceptions of their surrounding environments and in some cases could be utilised as a tactic to disempower action. The beneficial capacities of the Luftdaten network increase with

¹ This emerged from a similar anxiety after realising the surrounding air quality in Stuttgart, Germany presented the highest levels of Particulate Matter (PM) in Europe.

quantity of devices. The question then arises - once the visualised data has been processed by an individual, at what point do they act?

The current stationary aspect ties data to place and not person meaning it is complicated to understand what the individual has experienced and inhaled over the course of a day. To personalise the system Luftdaten wish to allow public entry and grading of symptoms common to areas with high levels of PM and NOx suggesting the documentation of coughing, wheezing, sneezing and itchy eyes as well as the "geographic mapping of symptom frequency and intensity". By overtly tying personal health to the tracks of individuals the AQM becomes comparable to current health wearables however with the critical difference that a shared map creates a collective knowledge of the surroundings so that Luftdaten is for the people and not just for the person.

Themes: Sensemaking, communicating

3.2 Collective narratives: Maybe we should call it Chronotaph 23/7?

Preemption As part of the V&As programme of events with exhibition 'The Future Starts Here', Sattelogy: A map for Future Use was hosted by The Open Space Observatory (OSO). OSO is an initiative for gatherings and infrastructure for the observations of satellites, spacecraft and space junk (OSO, 2019). Satellites encircle our skies and critically support our infrastructure. In the Sattelogy workshop we developed methods to read the history behind satellites and wrote the first collaborative speculative fiction for a growing wiki of satellite constellations.

Preparation As a group we were given a map of the night sky on 23 July 2018. The image laid the positions of named satellites over constellations as well as outlining some key facts about the satellites alongside (such as how it would be categorised, its owner, launch site and launch date). These facts allowed us to draw connections between various satellites as well as recognise the contradictions within them individually. As a group we looked further into the satellites on show and historical constellations on show looking into specifics. Our aim was to create a myth surrounding the satellite constellation we sketched, which we called Chronotaph 23/7.

Mitigation OSO through actively attempting to develop a method of writing a collective narrative that invited research into temporal snapshots of the night sky enabled a group of strangers to explore questions of history, ownership, placement and myth using space infrastructure to think through. It was a test site for developing collective imagination. Different individual narratives fed into a commons of communication which took the form of shapes, facts and reflections, all of which built our temporal constellation. We created a wiki which will act as a repository of the satellite constellations. There is no time pressure for their creation but encouragement that other people host Sattelogy workshops to write more Speculative Fictions. There was a sheet of questions to consider which gave the wiki its structure, allowing for a framework to be followed by those who write SF.

Themes: Sensemaking, communicating, hope, trust

3.3 Monitoring: Can we be witnesses to climate change from space?

Preemption Humans are fragile creatures and we can only live in a very narrow defined environment, within a precisely defined quality of air, and range of temperature. In the case of India, where 1.3 Billion people reside, the urban air pollution quality indicators growth rate is alarming and threatening survival. India has 14 of the top 20 most polluting cities in the world. A recent study (Maji et al., 2016) revealed that air pollution was a significant contributor to 80,665 premature deaths of adults aged over 30 years in Mumbai and Delhi in 2015.

Preparation Air pollution has direct implications for public health and productivity, and the particulate matter is visible (see figure 4). The most common air pollutants include CO_x, NO_x, SO₂, ground-level ozone (O₃), lead and particulate matter (PM₁₀ and PM_{2.5}). Primary data sources for air pollution monitoring are fixed ground stations with automatic equipment at breathing height that take readings every 15 minutes. Operating at the city and regional level, Earth Observation is an approach involving predictive analytics models at various scales to relate and apply data on urban air quality to habitability, agriculture, water security, renewable energy, and insurance. Use cases range from estimating crop acreage, to mapping urban heat islands or tree cover for cities, and identifying viable rooftops for solar power harvesting or rooftop horticulture.



Figure 4: Accumulated particulate matter on Delhi foliage in Khirkee village (Credit: S Fairburn).

Mitigation Initiatives like E2O (Earth to Orbit, 2018) are pushing the applications for Earth Observation through a hybrid solution that uses composite satellite data from 3 different satellites - INSAT-3D (Indian), MODIS (American), and Sentinel (European). The solution uses Machine Learning (ML) on data from satellites combined with weather data to monitor particulate matter yielding high resolution actionable intelligence on air quality. There is an urgent need for city level air pollution monitoring and this is most likely to be achieved through a cloud of shared data from ground stations, satellites and mobile devices including wearables and wardrobes.

keywords: reciprocities, sensemaking, resilience, communicating

3.4 Inhabiting: Can spacesuits teach us about data conversations?

Preemption: Humans are fragile creatures and can only live in a very narrow defined environment of air quality, atmospheric pressure and temperature. On venturing to space, they must don a spacesuit; a tight-fitting biosphere, a microclimate, a mini-spaceship that replicates Earth conditions. While different suits are designed to address the needs of different contexts (outside the vehicle, surface activity, and microgravity) each suit houses a Portable Life Support System (PLSS) to sustain the basic physiological needs as well as to monitor the status of their portable biosphere (figure 5). Spacesuits house an extensive array of sensors to monitor the suit's environment and the status of the space human inhabiting the suit - thus they are an extreme wearable, a wardrobe for extremes.

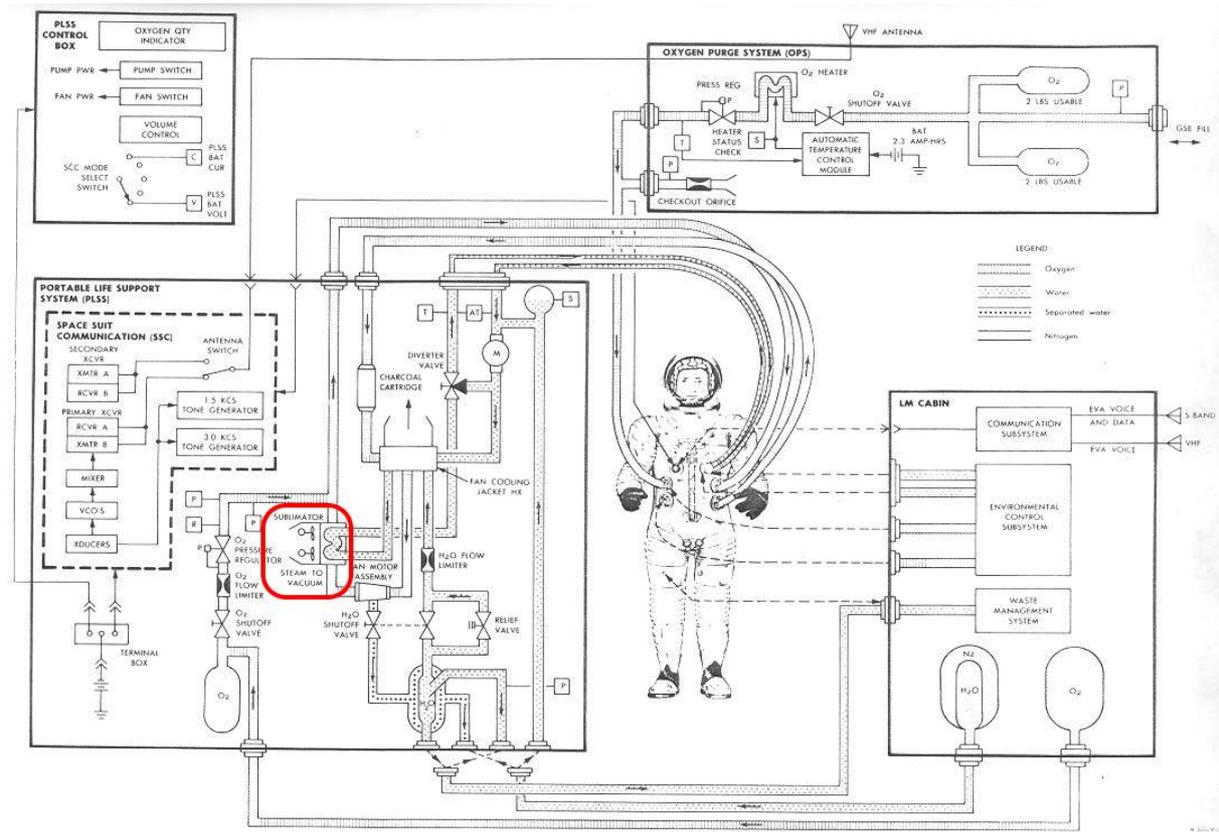


Figure 5: A schematic diagram (top) shows the individual components of the Portable Life Support System (PLSS), Oxygen Purge System (OPS) and the Remote Control Unit (RCU) (Credit: NASA, 2016)

Preparation: The spacesuit houses extensive telemetry that requires multiple levels of sense-making. Below is an excerpt from the Apollo 11 mission Air-to-Ground voice transcription (GOSS NET 1) (NASA, 1969) showing a communication exchange on temperature, between CC (Cap Com) and CMP (Astronaut). The exchange involves literal, personal reports by CMP coupled with thermal data (Spacecraft and Astronaut) available to CC. Feedback loops and monitoring (figure 5) add complexity to the system but they are a step towards reciprocity in the system and they recognise the ‘human in the loop’ (Watts and Vogel, 2016). From Apollo to Mars, Human space endeavors involve multiple layers of communication and the mode is two-part; data and conversation.

07 05 55 52 CC 11, Houston. the medics at the next console report that the shrew is one animal which can eat six times its own body weight every 24 hours. This may be a satisfactory base line

for your spaghetti calculations on Al Bean. Over.

07 05 56 11 CMP Okay. Thank you. That's in work.

07 05 59 15 CMP Houston, Apollo 11. It was slightly colder in here last night than it has been on any previous night. Does EECOMM notice any change in his data or any explanation for that?

07 05 59 25 CC Roger. Stand by just a moment. We've got to check some temperatures.

07 05 59 35 CMP Up until last night it was - if anything, a little on the warm side at night. Last night it was on the chilly side.

07 05 59 43 CC Roger there. We'll run down the temperatures for the 2 nights.

Mitigation: Imagine if we could understand data like a conversation. Those embarking on space travel anticipate the level of telemetry, though sometimes invasive, required for their survival and they trust in the stream of exchanges necessary to monitor their status and the microclimate of their environment. Data monitoring is choreographed and continuous, and data collection is constantly streamed, in situ and remotely to Mission Control (i.e. not public) to achieve a data conversation that is essential to the living and working astronaut. Mission control constantly scan for anomalies and they use data conversations and observations to detect changes, to issue warnings and to inform life-sustaining actions.

keywords: reciprocities, sensemaking, resilience, trust and communicating

Each approach draws on sensemaking and communicating at different scales, through different languages and with differing levels of engagement between human, data and environment. The *affective* actors take the form of citizens, air quality monitors, satellites, astronauts, spacesuits and Mission Control, which in '*nonarrogant collaboration*', following Haraway (2016), are *responsive* and *responsible with* and *within* our developing durable socio-ecological system. The progression of preemption, preparation and mitigation will frame CAPE as it did the case studies.

4. Insights

4.1 Preemption

Like the case studies that help inform CAPE, we understand the system we are developing to be for the people and not just the person, the community in this capacity can make a direct contribution to shared, real-time research and knowledge. Just as with the Air Quality Monitor, the beneficial capacities of the CAPE network will increase with quantity of users. However, the user in CAPE is always active, as CAPE is always active. By tying itself to Citizen Science (case study 3.1) and the building of collective narratives (case study 3.2), community and communication is central to its materialisation and for the engagement of others in environmental questions and action (case study 3.3). Socio-ecological and technological systems are intertwined within CAPE and require processing through a commons, in this case a mission control centre (case study 3.4). CAPE will join OSO (case study 3.2) and Donna Haraway in writing collective SF, but aim to do so with those that the climate will most notably affect in our immediate future.

By encouraging ways to make people aware of climate change in a preemptive way we talk about what might come. These conversations consider our immediate future as well as the long-term effect we are trying to preempt in order to survive what is coming. CAPE is a way of exchanging this information in its immediacy, in its propinquity. Propinquity as nearness in time, association,

relationship and space enables the closeness of association between citizens in urban centres to play out through CAPE. Whether this exchange be visual, tactile or olfactory, CAPE is about wearing information in a way that the passerby senses the exchange and understands what we have seen, where we have been and hence, what we are moving into. Citizens wearing CAPE would have the ability to choose the mode of sharing capable by their wardrobe. Discreet exchanges of data occur as pedestrians move through crowds, as commuters struggle for room on a bus, as cyclists wait at traffic lights. CAPE is comprised of a commons of gestures which act as wearable modes of exchange.

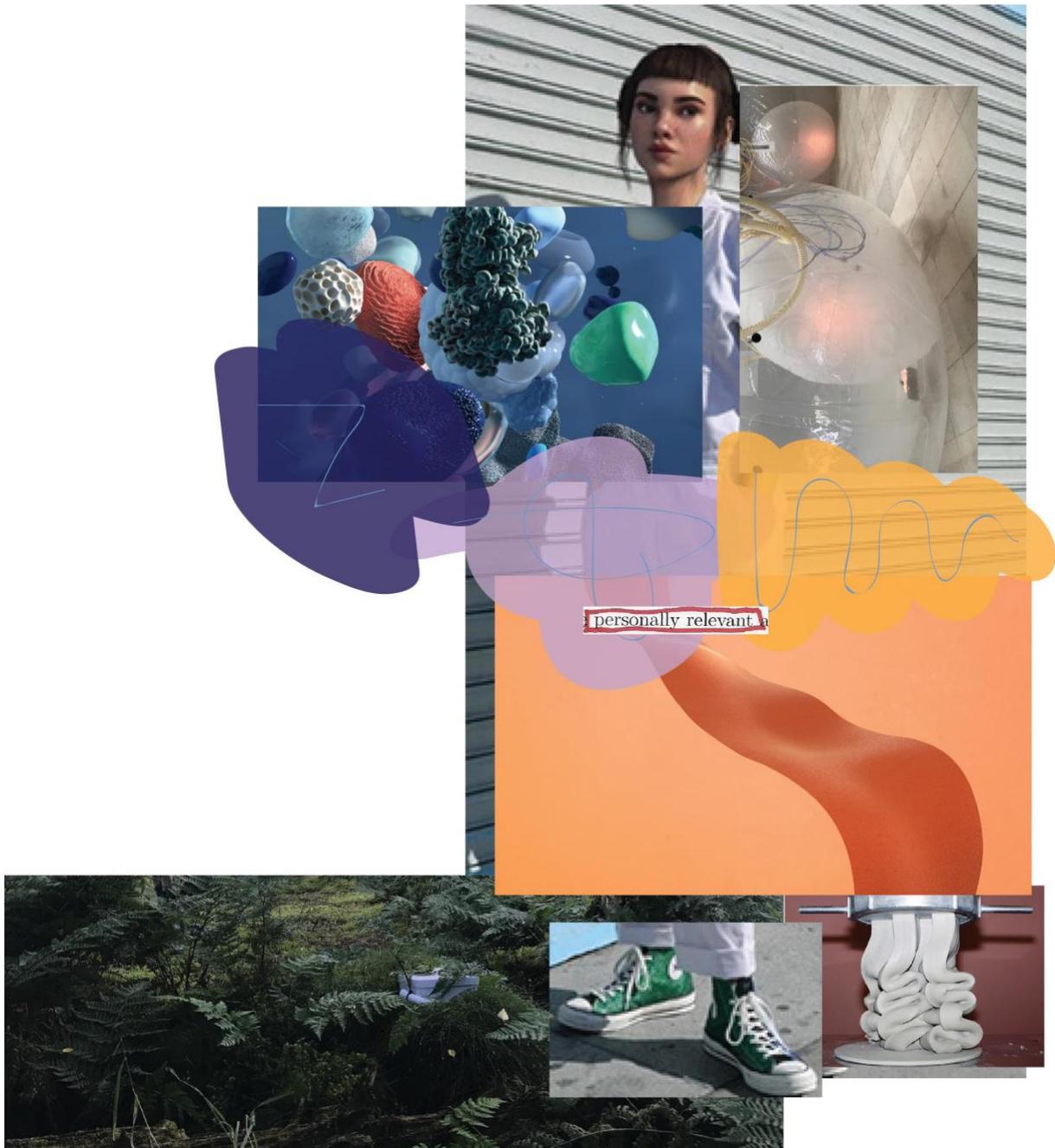


Figure 6: CAPE bricolage - a material conversation with our environment, a spacesuit for the chthulucene (Credit: J. Cunningham).

The data-exchange of CAPE within its surrounding urban landscape is time-limited. Data is only valid for seconds or minutes. This contrasts with our historical perspective on climate referencing generations and centuries. CAPE is present and its resilience is in its immediacy and its capacity to

forget in order to anticipate. CAPE is not a storage facility but a transmitter, communicating with those who are proximate. CAPE is not only a climate resiliency but an exchanged resiliency. By witnessing the range of environments that others have moved through, individuals can anticipate how to prepare themselves. Safety may be navigated through different routes, methods of transport, changes in plan, differences in wardrobe. The ultimate form of resiliency is life, it is survival. The rapidity in changing weather conditions within urban centres will require degrees of anticipation as weather forecast becomes too remote. CAPE is a narrative of the environment you have moved through, in seeing it you immediately act. It communicates elements of localised information, just as nature does, it reflects the local condition (Figure 6).

4.2 Preparation

“Cities are progressive centres for change - key to the war on climate change” (Candy, 2018)

CAPE as an ACTION We aim to use CAPE as a form of active engagement. Like a hybrid of the wiki developed by OSO (Case Study 3.2), and the field guides developed for survival, CAPE will become its own open-source how-to approach climate change. This will be built by remote communities through a series of workshops. The activities of these sessions will be divided into three sections: preparation, preservation and durability, of climate and the people. In its active state CAPE will invite civic engagement that can be on an individual level as well as a means to connect with others in the urban environment - it is a social, technological and natural network that introduces a different rhythm of use. As a guide it will look to imbue natural and social systems with self-regulatory mechanisms through the lens of survival. As a localised modular wearable system incorporating gestural and natural coding languages to inform an expandable wiki of forms, the gestures of CAPE could be proposed by the community, integrated upon; and then formally added to their language.

CAPE as a Framework Having evolved from CAAS (City As A Spaceship), CAPE is being used by members of the CAAS collective in its application to a course offering at the school of art in Berlin (Fall 2018/Spring 2019). Here CAPE is used as a provocation and a framework within a multidisciplinary project on the design of spacesuits. In this application, it is a way of talking about climate change, society and how we monitor and make sense of the environments we're passing through, but not requiring or yielding itself to a materialisation. In gathering and translating both quantitative and qualitative data, it establishes a space for co-owned narratives. The ground-up and top-down gathering methods have the capacity to be predictive, as apparel that reflects our experience and relationship to the climates we inhabit. The circular visualisations shown in figure 7 are comprised of separate fragments of big and small data.



Figure 7: CAPE as a series of gestures visualised on the ground, in the environment (Credit: J. Cunningham).

CAPE as a Studio CAPE and worn telemetry in design studio to bring awareness to how we sense the environments in which we move. In this application, CAPE will be introduced in a means similar to the Luftdaten workshops (Case study 3.1), as an introduction to citizen science through static streetscape objects and dynamic wearables within a dense modern north american coastal city. The locating of places of interest by citizen students, will lead them to identifying places of concern.



Figure 8: CAPE Framework, overlaying methodology with developments in the SF acronym and anticipatory ways of survival through personal shelter and collective mapping (Credit: J. Cunningham).

5. Conclusions (Mitigation)

If speculation is understood as being future focussed, the present-day applications invited by the notion of anticipation are relevant to CAPE. Anticipation as an *affective* state can be understood to be comprised of the triad of performance, calculation and imagination with our addition of communication, all of which can be applied at various scales of understanding, With regards to CAPE this encompasses the personal, civic commons, climate and data. Speculation, when used, follows Donna Haraway's pairings with fabulation and fiction whilst recognising how CAPE has a grounding in science fact. By developing from the SF figure we consider the relationships surrounding and emerging from anticipation - affect as a subjective state for the individuals in a commons, care as a local way to consider the human, survival as a state of preparation and speculation as a critique of the possible (figure 8). The abstract gestures of CAPE and CAAS map themselves across all aspects of the framework.

CAPE as part of an ecosystem is now its own ecosystem as well, a system within systems change. Just as citizens become *affective* within the environment, as our methodology calls for *activity*, and as Haraway recognises the the need to be *active* and rework nature from *within*, CAPE in one of its forms is an active, applied doing. CAPE is a doing, is a verb, is a way of engagement. Its active state enabling it to be a generative part within Latour's notion of a durable society, one which requires a survivalist state of mind.

CAPE will always be located within a cross-species entanglement, where we recognise CAPE's position in the present complex socio-ecological problem has no determinable stopping point and therefore requires persistence. As such the methodology and future materialisations of CAPE will not be sticky or stuck, but we encourage them to develop and learn through each stage of their enquiry.

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