

Breathe – wearing your air

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Abstract

Breathe – the air we wear proposes wearable and mobile technologies for reading and rendering in real time the air we breathe. The project proposes the ‘actioning’ for better air quality through individuals’ capacity to record air pollution. The project initiates a walk-able protest by taking air quality directly to the individual and through critical mass counter the massive problems facing our urban atmospheres. In particular, the article focuses on the pollution problems facing China today.

Keywords; Real time data visualization, wearable environmental sensing devices, personal pollution monitor, civic engagement.

Volatile atmospheres

*...His hanging face, like a devil's sick of sin;
If you could hear, at every jolt, the blood
Come gargling from the froth-corrupted lungs,
Obscene as cancer, bitter as the cud
Of vile, incurable sores on innocent tongues...*

The above selected lines by the soldier and poet Wilfred Owen forms his testimonial to the chemical weapon Mustard Gas widely used during WW1. Penned in the last year of the war (1918), Owen's poem titled *Dulce et Decorum Est* [1] portrays the effects of breathing the deadly poisonous gas: the burning of the lungs, throat, eyes and skin. Once released from its canister, the yellow coloured gas was at the mercy of the breeze, floating across *no man's land* and onto lines of men holed-up in dug out trenches. Often the breeze would shift direction returning to its source and back again. This quite visible air took the lives of the unprepared as they fumbled for their masks. Cut to an image of a number of cities around the world and you will see people wearing white masks and shielding their eyes from vapours in the air. These are not images of war but urban everyday images of people and cities shrouded in the thick haze of air clogged with particles. This we know is air pollution.

Once invisible, air has now been rendered visible by pollution, such as the emission of gases and smog from factories, coal-fired plants, car-exhaust fumes, homes and jets. Like Mustard Gas that roamed with the breeze intoxicating men

in their trenches, pollution is subject to mass migration within the atmospheric turbulence [2] circling the earth. This natural turbulence: beautiful vortexes, eddy flows and emigrational currents have become the unnatural enemy of people when mixed with pollution. Dramatic as this may sound, air is killing people. The choking of thousands of men assigned to death from Mustard Gas in Owen's poem finds an echo in the choking of tens of millions assigned to lung and blood diseases from polluted air.

The article is divided into five parts. The first, *The archaeology of air*, explores the visibility of air. The second, *The sociology of air*, discusses the social interaction of the air we share with others. The third part *The capital of air* accounts for air and industry, production and profit. The fourth, *Wearing your air* discusses the prototypes under development in our project, the methodologies for wearable ‘urban architectures’ and their implementation in terms of hardware and software, sensing technologies, mapping, domains and user testing. The article concludes with a speculation on *The future of air* and the consequences of living in unstable environments. In particular, the article focuses on the pollution problems facing China.

The archaeology of air

The years of rapid economic growth and industrial expansion have led to dangerous levels of air pollution in many cities across China. At a workshop in Beijing held on March 31 2013, a study by Global Burden of Disease (GBD) [3] estimated that in 2010 1.2 million premature deaths (40% of total premature deaths in China) and the life loss of 25 million healthy years were attributable to air pollution. According to the GBD research team this ranks China as the single most affected country in the world in terms of health problems stemming from air pollution [4]. The Chinese multimillionaire businessman Chen Guangbiao's recent marketing campaign (more self promotional than political) to combat the problem by handing out oxygen cans to the public, nevertheless highlighted the endemic situation facing China. Graphically resembling Andy Warhol's popularisation of the Campbell's Soup cans, yet operating like Coca-Cola cans - where the peeling off the aluminium seal releases the air - created images of Beijing's residents walking the streets inhaling the oxygen not unlike images of teenagers sniffing glue. While it highlighted the

problems of air pollution, the oxygen cans campaign inadvertently subverted its message by fetishising the problems of air pollution as only marketing campaigns do. The reality of Beijing's air pollution is radically changing how its society responds and functions, or perhaps dysfunctions.

On days of extreme air pollution in Beijing, children are advised to stay indoors and refrain from attending school or participating in outdoor physical exercise classes. Weibo, the Chinese equivalent to Twitter, is a platform that attracts young people who communicate their concerns about air quality with hashtags such as: #itsucks and #statedepartment. The use of microblogs and social networks like Weibo confirms a burgeoning level of awareness to Beijing's extreme air pollution and the problems facing China [5]. Recent announcements by Chinese officials have identified ‘cancer villages’, a term being used to describe areas unfit for human inhabitation due to industrial waste and toxic water, soil and air pollution.

Beijing is not alone. Mexico City, Lagos in Nigeria, Delhi in India and Salt Lake City, Utah have air pollution levels that are also threatening people's lives. In the city of Ahvaz, Iran, road traffic congestion, heavy industry and oil extraction have created some of the highest readings of air toxicity in the world. Efforts to curb pollution levels during the 1970s in the developed countries (e.g., the city of Los Angeles in the United States) have been overtaken by the rapidly developing countries of India and China. After decades of action, air has in fact become increasingly more harmful and deadly.

Pollution is a global condition. Wind currents drive the pollution plumes of industry from their source to locations thousands of kilometres away. Thus China's pollution reaches America, America's reaches China, India's reaches the Pacific and all pollution reaches Antarctica - home to the largest ozone hole in the world. The nature of pollution is to ‘fold’ within the turbulence of the urban atmospheres that surround us. To suggest an *archaeology of air* is not to mount a ‘historical dig’ to discover its roots in the centuries of miasma and foul air [6], or to mine history to understand how air became ‘vandalised’ from the late eighteenth century onwards in the industrial revolution. Rather, *the archaeology of air* asks us to fathom our present relationships to air.

The sociology of air

Air in its purity is the invisible life force upon which we share. Microscopic molecules of air are taken into our bodies with every breath we take, every few moments throughout our lives. Air is the element we continually and unconsciously share. This perhaps romantic notion of air becomes undone when air is visible and tinged with odour, taste, form and colour. The sociology of air exists through the constant exchange between others and us, yet this exchange is increasingly being filtered through materials of separation from the hazardous environments we inhabit.

The 1976 film *The Boy in the Plastic Bubble* [7] portrays a boy who, born without an immune system and by default allergic to the 'world' and its people, is forced to grow up alone inside a transparent plastic environment. As the boy turns into a young adult, his sexual awareness becomes apparent through his attraction to a young woman who visits him. His life, a life without touch of another human being, is reinforced by his desire for intimacy. This intimacy is realised in the film through their kiss performed on either side of the plastic separating them and their 'worlds' (Fig. 1). This naive yet startling image of protection and material separation is now not an isolated case.

The ubiquitous facemask is increasingly becoming a part of the 21st twenty-first century clothing accessory. Worn by millions in China to filter the air they breathe, the mask reinforces the material separation between them, and from an environment deemed harmful. Covering the mouth and nose, the facemask has become a protest symbol to graphically symbolise and, to a degree, fetishise an awareness of air pollution. Masks with large lips and unhappy smiles sown onto the surface display this new separation. Not unlike *The Boy in the Plastic Bubble*, air pollution is turning people into millions of walking microenvironments, hemmed-in by the capitalisation of air.

The capital of air

In the film *An Inconvenient Truth* [8], former US Vice President Al Gore lectures about the changes in the earth's climate from the past millennia to the present and onto a predicted catastrophic future. In this vision of the future, ice melts, smoke stacks blacken the sky and air is choked with toxins. Gore understood that data collected from a multitude of sources needed to be accentuated so as to readily communicate the depth of the problem to the public. The statistics

Fig. 1. Image from the film *The Boy in the Plastic Bubble*, Randal Kleiser, (1976).



graphically designed for his presentation weren't lies; conversely they were made possible by a breakthrough in the visualisation of data usually the reserve of physicists, biologists and environmental scientists. We were, I think, already aware of what Gore was telling us. People around the world do small things: they recycle, cycle and walk and aim in some way to consume less. On the other hand, capital depends on consuming a lot of products that, for their making, pollute the air we breathe.

To maintain manufacturing and mass consumption requires companies to dig, drill and remove the raw materials resulting in vast swathes of land degradation across the globe. Pollution from car exhaust fumes has not stopped carmakers from continuing to mass-produce the combustion engine in spite of readily available and environmentally sustainable alternatives. It is predicted that the present 1 billion cars around the world will increase to 4 billion by 2050. It is also predicted that the world's middle class,

which presently approximates 1.8 billion, will increase to 4.5 billion in 2030. It seems that what we have been told by Gore and by others about how we manage this burgeoning problem goes unabated as capital depends on continuing growth at all costs.

Air pollution is produced by capital. It circuitously returns us to Marx's concept of commodity fetishism [9], whereby one's labour for the production of goods and wages affords the ability for the buying of those goods. From the beginnings of machinery (and pollution) in the industrial revolution in the cities of Manchester, Liverpool and Düsseldorf to name a few, to the mechanisation of labour in the assembly lines of Ford Motor Co. labour, industry and pollution have been intertwined. Capital and industry have out-reached labour not only from the increased profiteering from products made by their workforce but also from the indiscriminate pollution of air made from their factories. The production of goods makes up the 'third tier' of profit (after labour and production) that drives the pollution plumes of industry. Two of the world's biggest polluters - China and America - struggling with the economies of capital and production are also engaged with the on-going environmental destruction of our urban atmospheres.

The stimulus for attaining better air quality is to combine air and capital. Set by governments, the ballooning trade in carbon emissions between companies and countries is now one way to cut pollution around the world. Still in its infancy, the buying and selling of carbon emissions around the world is a trade not unlike any stock market transaction. Nevertheless, for good or bad, this shift in pollution management emanating from commodity production and mass consumption has

Fig. 2. Prototypes under development: gloves, ear protection, mask and T-shirt react to air pollution through various visualisations in real time. Images © Authors



made air more visible, and anything made visible is capitalized upon. Air is capital and emissions can be profitable. The quality of our air is intrinsically aligned to the capital of production.

The future of air lies not in its ability to be further capitalised but instead relies on the equalizing of labour and profits. “Cheap labour”, mass production and vast profits are the capital up for renegotiation if we are to hold onto our air. To recapitalize air is to bring air back to its purity. To re-establish air purity requires us to apply the methods by which we record air quality directly to the body.

Wearing your air

To bring awareness to the present problem and find ways of ‘reading’ the harm that circulates in the atmospheres around us, detachable mobile tools (Fig. 2) have been developed that visually render air pollution levels. As precedents to our project, we selected ‘Citizen Sensor’; a DIY open-source hardware and software designed by Joe Saavedra. The project developed a sensor pack and data contextualization system that allows users to collect readings of air quality from their immediate surroundings using sensors that record the environmental conditions. One of the main goals of the project is to bring pollution monitoring from the maker into educational settings and further into communities [10]. Users choose

Fig. 3. Top image: ‘Citizen Sensor’ sensing technology - DIY sensor pack and smart phone interface. Bottom image: ‘Air Quality Egg’ by Sensemakers.

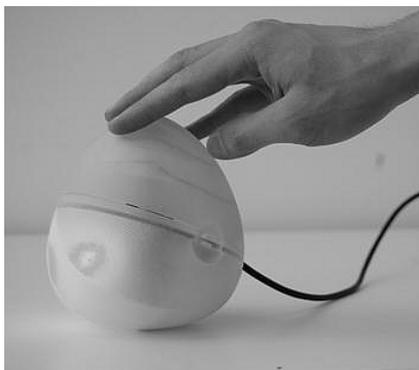
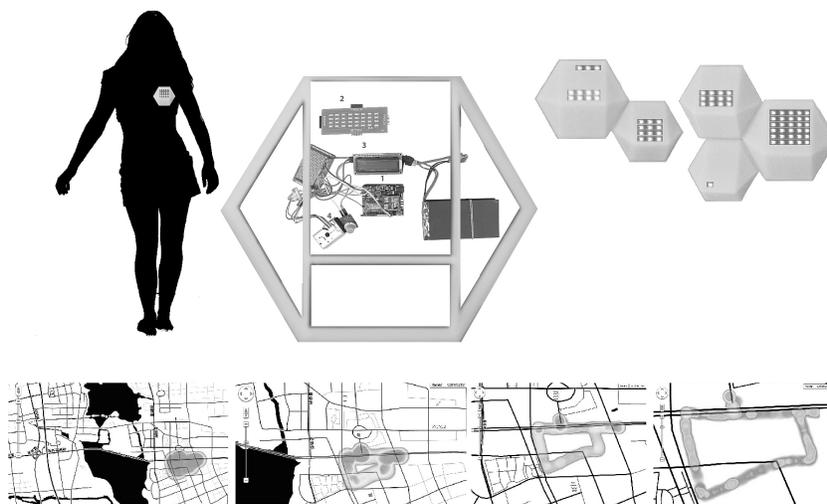


Fig. 4. “Breathe – wearing your air’ - sensing technology for the air quality recording ‘brooch’: 1. Arduino microcontroller board 2. Led’s PCB 3. LCD monitor. 4. PM sensors. Image below, the project’s online live website that maps users routes and air quality data. Maps of a user route in SIP, Suzhou, China. Images © Authors



what environmental characteristic to sense and then connect with others around the world to analyze, interpret, and share the data and knowledge gained online. The project was recently further developed as the ‘Air Quality Egg’ [11] - a static device containing a small electronic sensing system that, once plugged into a wall socket, can read the outside air quality in the immediate vicinity. The device has an RF transmitter that sends the data wirelessly to an Egg-shaped base station placed inside. The base station (Fig. 3) receives the transmitted data from the sensor box outside and relays that data to the internet via a wired ethernet connection.

In our project the focus is centred on the immediacy of rendering air quality onto people’s bodies. The accessories we are currently designing are a mask, gloves and t-shirt (Fig. 2). These comprise the series of portable wearable devices able to read the air particles per micrometre (PM 2.5) [12] of pollution and display this information in the location via global positioning (GPS) in real-time. One device, which has been designed like a ‘brooch’ to be pinned onto the wearer’s clothes, emits via LED (light emitting diode) information that classifies the quality of the air the wearer is breathing. The ‘brooch’ makes visible the air quality through cells that display variations in colour to indicate varying levels of pollution. That is, red or purple indicate variant toxic levels and green or blue indicate variant good air quality levels. Configured as a body extension, the ‘brooch’ establishes an interface between

people and air, allowing them to become informers, renderers and surveyors of the air they breathe. This interaction between people and pollution is designed to incite a critical mass of walking protests aimed at galvanizing the public to pressure governments and industries to take responsibility for the increasingly unpredictable urban atmospheres that exist around the world.

The main components of the hardware prototype implementation (Fig 4) are an Arduino-based controller board. The board controls and coordinates the functioning for the other devices contained in the ‘brooch’. The on-board java program reads the data from the sensors and compares that data with on-board parameters. Once the comparison is completed (undertaken in micro-seconds), the program decides the air quality value and displays this value by selecting what LED lights to turn on or off to visualize the air quality value. Designed in different sizes, the ‘brooch’ components can be easily assembled, which will eventually result in reducing costs for their manufacture. The project has also developed an online interface that maps people’s routes within the environs they live, recording the data taken of the air quality in real-time.

The future of air

The philosophical and historical context of this project draws on contemporary comparisons through the discursive nature of our project and the ‘currents’ that surround it: societies, governments, industry, mass production and consumption and individuals. Wearing the detachable

'brooch' operates as both a piece of design and a stance of resistance to the problems of pollution by focusing on an essential element that sustains our lives - air. Each breath is the taking-in of this essential outside element that 'lives' temporarily inside our bodies. The 'brooch' performs the reading and visualisation of our breath in the streets. This basic step to make people the renderers of air aims to bring about a radicalization of society for the protection of air.

Breathe - wearing your air is aimed at 'actioning' governments to rethink our environments [13] to create healthier living and ultimately economically viable health systems for future generations. The 'brooch' takes air quality responsibility directly to individuals who, when they collaborate/come together as a critical mass, can counteract the massive problems facing the air we breathe. To seek to counter pollution through critical action in this way involves visualising our project as a type of collective diaphragm that redraws the economic and political lines of power that exist, and formulates a new 'osmosis' between societies and air, countries and air, and within the outer urban atmospheres that oscillate around us all. *Breathe - wearing your air* is designed to confirm that we are presently living in unstable and turbulent environments. The aim of project is to incite behavioural change through a wearable protest device. *The future of air* lies in our ability to protect the air we breathe.

References and Notes

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2. According to the oxford dictionary turbulence is "An eddying motion of the atmosphere that interrupts the flow of wind." "Stormy or tempestuous state or action... violent commotion, agitation, or disturbance." Scientifically, turbulence is formulated as a flow of properties where "Dispersion numerical models in the atmosphere are frequently employed to simulate continental and regional scale air pollution transport. Moreira, Virnei Silva *Atmospheric Pollution Research* 2 (2011) 384-393.
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5. Yanzhong Huang in his article: *Choking to Death: Health Consequences of Air Pollution in China reported that* "readings near Tiananmen Square on 28.02.2013 measured the concentration of PM2.5 – fine particles in the air that are smaller than 2.5 micrometers in diameter and are considered dangerous because they tend to penetrate the gas exchange regions of the lungs—at 469 micrograms per cubic meter, which corresponds to a U.S. EPA Air Quality Index reading of 479 (the scale stops at 500). Anything above 301 is considered "hazardous" in that it can cause "serious aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly;" and there is a "serious risk of respiratory effects in general population." The PM2.5 levels in other famously polluted cities pale in comparison to those in Beijing; for instance, the highest PM2.5 level in a 24-period recorded in Los Angeles was 43 micrograms per cubic meter." East Asia Environment Region China March 06, 2013
<<http://thediplomat.com/2013/03/06/choking-to-death-the-health-consequences-of-air-pollution-in-china.html/>>, accessed 1 April 213.
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7. Randal Kleiser, *The Boy in the Plastic Bubble* (1976), film.
8. The 2006 documentary film *An Inconceivable Truth* directed by Davis Guggenheim focuses on a powerpoint presentation of images about the damages of global warming on the environment delivered by former US Vice President turned environmental figurehead Al Gore.
9. The Marxist concept of commodity fetishism, everything that Marxism was supposed to eschew: "To fetishize commodities...is to fetishize the invisible, the immaterial, the supra-sensible. The fetishism of the commodity inscribes immateriality as the defining feature of capitalism." Strallybrass, P., 1998, *Marx's Coat from Border Fetishisms: Material Objects in Unstable Spaces*, Spyer, P., (edit), Routledge, pg.184.
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12. PM2.5 is the concentration of fine particles in the air that are smaller than 2.5 micrometers in diameter and are considered dangerous because they tend to penetrate the gas exchange regions of the lungs causing respiratory effects.
Source:<http://thediplomat.com/2013/03/06/choking-to-death-the-health-consequences-of-air-pollution-in-china/>
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