Downwind
Raewyn Turner & Brian Harris
2013
The Downwind installation combines art, engineering and science research and is composed of twenty pods that sense human presence and respond by breathing smells on the audience. Downwind explores our differences in olfactory sensitivity and selectivity due to the genetic basis of human olfactory variability and the perception of odiferous sequences in changed contexts.

Not only are synthetic olfactory molecules changing perception of the world, but technologies are changing perception. Is a visceral comprehension possible in a sanitised and deodorised olfactory environment suffused with new synthetic olfactory molecular architectures for smell and taste? Whether natural, synthetic or engineered, they are the olfactory cyphers of change, yet sensing them is defined by a combination of genetics and personal experiences. To increase our ability to perceive the information of new chemical signals not just with the nose but with the gut it may be necessary to retrain one’s olfactory observation and to note the feelings and emotions that arise from olfactory materials. At first the phenomena of smell may seem insignificant but humans are bound up in the transpiration and consumption/absorption of olfactory particles.

The smell compounds are ones known to elicit specific anosmias (loss of sense of smell) for some, and not for others. The revolutionary wind of genetic discovery suggests that we may not all be perceiving the same reality.
**Downwind Installation.** Twenty pods and 2 sugar dispensers in an indoor space.

**Downwind**

The pod array expresses a body of interactive and programmed robotics dressed in chinese lampshades to express precisely calibrated amounts of smells. Each lampshade houses a pump that expresses a mixture of air and smell molecules in a certain ratio via articulated arms controlled by servos controlled by a microprocessor programmed to correspond to ultrasonic distances. When activated the mechanism delivers a concentration of smell without leaving a residual smell, allowing the experiences and perception of difference, similarity and sequence of odiferous materials.

Since 1952 when Ernest Beaux, perfumer wrote ‘The future of perfumery is in the hands of chemistry’ many novel olfactory molecules have been designed and created for the perfuming and deodorising of bodies, possessions, environment and food, as well as technological means to detect them. Olfactory molecules by nature are aerosols. Contemporary studies of biological aerosol particles, scientifically investigated since the nineteenth century, may lead to a better understanding of their role in climate and atmospheric processes and may also help to improve understanding of their impacts on humans.

According to Despre et al., 2011, efficient and reliable analytical techniques must be developed for the identification and quantification of primary biological aerosol particles, PBAPs, as well as for the determination of the abundance and diversity of PBAPs and their seasonal variation on regional and global scales (atmospheric biogeography), to anchor models in a solid empirical foundation. (i)

Eschewing a nostalgic longing for the past this project enquires about the physical sensing of novel materials at a time when olfactory and gustatory perceptions of the environment, the air, cities, clothing, and the way that we perceive ourselves are being extensively altered by the natural and engineered olfactory cyphers. Further changes may also be experienced in the extra synthetic airborne particles as they undergo modifications while airborne: hygroscopic, growth, deliquescence, reactions with other acids and gases, condensation, alterations of optical properties, coagulation, and ageing.

The potential to perceive the information of these new chemical technologies not just with the nose but with the gut may be realised through practicing olfactory observation, noting the feelings and emotions that arise from particular smells. In both the nose and the gut where there are also taste and olfactory receptors it is the region that gives rise to enteric knowledge or gut feeling. (ii)

According to Pause (2011) human social chemosignals are processed as cues for significant behavioral adaptations which are meaningful in terms of evolutionary consequences. In humans, the neuronal underpinnings of the processing of social chemosignals have been investigated in relation to kin recognition, mate choice, the reproductive state and emotional contagion. Human social chemosignals are usually communicated without the allocation of attentional resources, that is, below the threshold of consciousness. (iii) An immunologically
important group of genes, human leukocyte antigens, regulate the discrimination of self/nonself within the immune system. Humans use chemosignals in social communication. Beauchamp (2000). What remains controversial is the chemical composition and appropriate label for the chemosignals themselves. (iv)

A procedure of knowing nature by observation is a method proposed by Rudolf Steiner in circa 1900 to obtain knowledge of the higher (unsensed) world. In his six basic exercises he noted that observed feelings could be used as an instrument of perception. The psychologist Roger Shepard (2001) has suggested that we are capable of describing and knowing the world because evolution has shaped our minds to understand some of its abstract, invariant properties. Nativism grounded in the fields of genetics, cognitive psychology and psycholinguistics holds that innate beliefs are in some way genetically programmed. In her paper on the innate capacity to know and of animal and human cognitive capacities, Helen De Cruz discusses innateness hypotheses which have become an important theoretical option that has been invoked to explain a wide range of cognitive phenomena. De Cruz explains that natural selection is capable of detecting invariant properties of nature on a highly abstract level. (v)

The most recently discovered area of chemosensory communication in humans is related to the detection of danger and emotional contagion. It is common across the animal kingdom that stressed individuals inform their conspecifics via chemosignals about a potential harm (e.g., a predator attack). Pause (2012)

It may become possible to perceive the human plume which trails downwind from each body carrying with it the fragrances of our civilisation and times by training ourselves to read olfactory cyphers by sniffing the wind. Most animals prefer to keep the wind in their faces when traveling so that they can scent danger ahead of them. The military and intelligence agencies also use tracking to find enemy combatants in the bush, land, sea, and desert. Combatants and animals must never be in a position where their scent could be carried towards their foe. (vi)

The arena of synthetic smell inspired Turner and Harris to explore the future scope of olfactory sensing as it relates to sensemaking in a largely visual culture. While they were working on their 2011 project 4000 Varieties of Orange where the focus was on fragrance/flavour biodiversity and food monocultures they tested the power of synthetic flavouring to conjure visual images, comparing real food flavours with synthetic flavours, for example a ripe apricot with apricot flavour, steak with steak flavour, apple with apple flavour. They found that artificial flavours invoke visual mental illusions, being designed for more of an experience of the real than the real. (vii).

Exploring intuitive responses to the signals of smell by reflection on the physical and emotional effects of undetected odours may extend sensory perception. Human olfactory sensing wasn’t pre-determined to be confined to a bottle and the industry of perfuming, flavouring, deodorising, sanitising and sweetening as Theodore Zeldin writes: what exists today is not its logical conclusion. (viii)

Besides the effects on motor behavior, the perception of stress-related chemosignals significantly alters the perception of visual social signals in humans. (Stevenson 2009).

Odours that can’t be detected may also be associated with sub-auditory and visual material that is beyond human bandwidth. It is on these unconscious signals and bandwidths that important
information is relayed. Through the communication of chemosignals...relevant changes in motivational (reproductive behavior) and emotional systems are successfully transmitted between conspecifics. (ix) The latter is of special importance whenever information about potential harm has to be spread across conspecifics efficiently, automatically and in a lasting manner.

In science research olfactory comprehension seems to be gridlocked by the complexity of interaction between olfactory receptors and the odour molecule. The central problem of olfaction remains: how the olfactory molecule manages to affect the brain, consciousness and emotions. (x)

When brain scientists talk about plasticity, they refer to the molding of the organ’s circuitry by new experiences: building new wiring patterns, pruning others. Communication between synapses changes in response to brain activity generated by new and repeated experiences. The synapse itself changes shape; even the electrical responses of the cell membranes can change with repeated exposure to an event. (xi)

Downwind questions whether a somatic understanding of the current atmosphere could be reached by initially finding out individual olfactory capabilities. Keller and all (2007) investigated whether genetic variation in human odorant receptor genes accounts in part for variations in odour perception between individuals. (xii) Indeed further studies have identified a genetic basis for the ability to detect cis-3-hexen-1-ol (cut grass). (xiii)

The collective reality is one of a sanitised and deodorised olfactory environment which is suffused with new synthetic molecular architectures for smell and taste; apart from novel smells, many odiferous similes have been regulated to a state in which everything either smells of nothing or a version of something else, mirroring Lemke’s ideas around what he names as the new materialism. Lemke writes... Foucault viewed the combination of the disciplining of the individual body and the regulation of the population as the essential parameters of establishing capitalism and constituting the national state. That combinatory process, he argued, allowed the creation of economically productive, militarily useful and a politically obedient body. According to Foucault... Biopolitics explicitly exercises the modern form of power... the procedure makes it possible to define standards and norms to determine average values; as a result life has become an independent, objective and measurable factor as well as a collective reality that can epistemologically and practically be separated from living beings and the singularity of individual experience. (xiv)

The implications of synthesised and novel particles found inside face creams, perfumes, deodorisers, air conditioning systems, water filtration systems, drugs, food additives and flavours, are far-reaching. The particles may affect the microbes and thus the immune system which establishes a distinction between self and other which eventually transforms the behaviour of living beings. This has implications for autonomy, ideology and politics, of the sense of self, citizenship and belonging, which are intertwined with observational knowledge and political and social regulation like public health and status. (source??????????)

Just as the feminist movement placed an important emphasis on the study of the everyday in revealing new perspectives on the social world, the study of people's everyday experiences of
odour similarly draw attention to key urban issues such as air quality, public health, social inclusion and the fine balance between public and private space in the city. (xvi)
The long-term patterns of social inequalities in health are also changing perception physically “Stress will activate hormonal systems that may increase blood pressure and reduce the immune response. Environments determine whether individuals adopt health-threatening behaviours in a response to material deprivation and stress… take up tobacco, use alcohol, have poor diets and engage in physical activity. Tobacco and excessive alcohol use, and carbohydrate-dense diets, are means of coping with difficult circumstances”. (xvi)
Furthermore, chemosensory communication may include much more evolutionarily significant information than those investigated so far by brain imaging studies. For example, chemosensory signals most probably convey information related to the actual health status. (xvii)

According to Sela and Sobel (2010 ) it is possible to retrain one’s olfactory sense using a range of olfactory materials. (xv) Humans are able to increase their ability to perceive the information of chemical signals. Wysocki, Dorries & Beauchamp’s (1989) research shows that ability to perceive androstenone can be acquired by ostensibly anosmic people. ( xviii)

Conclusion
The general atmosphere is saturated and awash with particles that are transpired by living beings and everything on earth. Emerging as vapours into the troposphere, fragrances arise from cultural, social and political systems that have engineered the landscapes and thus mindscapes into settlements, habitations, fields, factories, front lawns and streets.
Humans, animals and insects are immersed in an atmospheric ocean of olfactory cues which are in dynamic flux with olfactory perception.
The work emerged from discoveries made during Turner and Harris’ collaboration and Raewyn’s research residency at the Monell Centre, Philadelphia and builds on Raewyn’s continuing collaboration, Plume, begun in 2009 with molecular scientist Dr. Richard Newcomb, investigating sensing of the human plume which carries with it not only each person’s signature odour but also the fragrance of our civilisation and time. http://crossingwireslab.tumblr.com/

Turner experienced training in identifying standards in wine at the sensory lab which led to her questioning of the lack of recognition and therefore nomenclature of unconscious smell which is affecting human behavior and emotions. (xix) Together with Harris’s finely tuned robotics Downwind takes a segment of sensory research into the public domain set out as a field of experience.
Process
Harris and Turner approached Downwind with a series of investigations and experiments. Using an intarsia of olfactory discovery and engineering they explore the notion of the training of the human as an olfactory sensing instrument, including the expression of fragrance molecules, odour thresholds and the design of sensing devices. Odiferous materials, engineering, sensors, microprocessors and software, mechatronics and everyday objects were encompassed to create instruments for their experiments with body sensation and data such as quantitative and qualitative analysis. They set about creating two devices for their art projects: to detect odour and to express odour.
Before Turner’s artist residency at Monell Chemical Senses Institute in Philadelphia, Sept-Oct 2011, Turner and Harris developed the electronics and robotics for two functioning interactive devices for sensing and expressing smell: a smell output device - a gentle bellows which creates a scented puff of air, and an electronic nose which reads smell into notes and chords. The development of both devices can be seen at https://raewyn-turner.squarespace.com/kissing-bees-journal/

There are several difficulties in working with smell as a medium. Not only is it uncontainable but unlike the ears and eyes it can’t easily be blocked out. The lack of instruments for the capture of smells from nature and for the controlled release of olfactory material promoted investigation and they created two prototype electronic devices for sensing and expressing smell. They required a device to deliver the right amount of olfactory molecules on a gentle stream of air at a certain ratio when actuated, without leaving a residual smell over a given space and time – which is one of the most difficult areas of olfactory art, and one of the significant reasons that it remains an underdeveloped art form. In 2008 Turner had visited Geneva to talk with Firmenich about how to create a device for controlled release using encapsulated smell but there wasn’t a solution.

Electronic nose prototype device
Only a limited few olfactometers (a device capable of delivering odors in a controlled way without causing any thermal or tactile discomfort for the subject) are commercially available; all are limited to the presentation of liquid odorants and are therefore ill-suited to the delivery of body odours. This means that the interested researcher needs to invest the time and money in building one himself or herself, a task that can be daunting for many. ( ) ( ) Lorig et al., 1999; Lundstrom et al., 2009b also, Johan N. Lundström and Mats J. Olsson (2013) Functional Neuronal Processing of Human Body Odors, Vitam Horm. Author manuscript; available in PMC 2013 March 11. Published in final edited form as: Vitam Horm. 2010; 83: 1–23.

During Turner’s residency at Monell Chemical Senses Center in Philadelphia, Sept-Oct 2011, she demonstrated the device, dispensing androstenone which to some, smells sweet like flowers, and to others appears as rancid, sweaty.

The prototype olfactometer was built inside a small roadcase for ease of transport, and the apparatus that stored the compounds within the lampshade was an adaption of a flat circular tin with a lid that closed and shut. [https://vimeo.com/32066966](https://vimeo.com/32066966)
At Monell Chemical Senses Centre the scientists were creating their own instruments for their experiments--olfactometers, sensors, steady electronically controlled air flows, smell compounds sourced from both natural (ways of collecting and storing) and synthetics. In discussion with scientists at Monell Turner became interested in fugitive and anosmic smells as well as the phenomenon of in-nose bio-transformation of odourants which can modify the quality and also the quantity of compounds reaching the olfactory mucosa. Following feedback and testing with scientists during Raewyn’s recent artist residency at Monell Senses Centre, Philadelphia, we developed Downwind for exhibition with two pods and one sugar dispenser at Satellite Gallery, Auckland June 2012 and won the 2012 Corbans Trust Sculpture Award. [https://vimeo.com/40963173](https://vimeo.com/40963173)
Engineering and Programming
The robotics are housed inside paper lampshades which create a gentle bellows when opened and closed.

The pods sense human presence and respond by expressing controlled delivery of 20 specifically chosen smell compounds in calibrated amounts via a programmed mechanism that uses arduinos, servo motors, ultrasonic distance sensors. The pods have an animated response to a person's approach, to the extent that they seem to recoil, consider and then strike. The smell is released on the recoil, the olfactory material having been expressed at an earlier stage in the movement of the pod. The programming included a surprise element in movement and timing of response by programming in randomness, but the pod only moves in and out in a structured way that looks like its responsive. To the audience the movement of the pods makes them appear anthropomorphic and responsive.
Harris developed the device to deliver a controlled smell with an on and off mechanism which developed into an elegant solution of using hobby servos controlled by arduinos and programming to control the positions of the arms. The two motors are controlled by an ultrasonic distance sensor by programming to change the response of the mechanism to human presence. The audience can walk amongst the pods. Ultrasonic sensors on the pods pick up movement from a distance of 4 metres.

The software controlling the pods works in four stages:

1. Sniffing the air and the ultrasonic sensor waiting to see if anyone is in range. The sensors sometimes set each other off or were set off by a reflection from the other side of the room.

2. When someone came within range the sensor was set to measure and move arms according to the distance. The pods responded differently to each person because some of the constants in the algorithm changed. The pods responded depending on how close the person was when they first came into range and became a legitimate target by adding and subtracting a random amount from the scaled distance for the sensor.

3. The sensors controlled the arms within a certain distance and then when the person was within a certain range the mechanism went into an automatic routine. If the person lingered closer than a certain distance below .25m for a while it would start to go through an autonomous routine which caused the puffer to inhale and trigger the fan in the scent box on the inhale, and to quickly exhale.

4. A second autonomous cycle when it slumped in resting position and then slowly recovered and lifted its head and return to waiting position in 1.
When the pod is fully out there is a controlled ratio of air and smell molecules. The expression of smell was worked out from first principles to get the right volume of air with concentration of smell, ie a threshold smell where it is just perceivable.

Using the lampshade as a bellows the pod delivered a puff of smell without leaving a residual smell so it wouldn’t advertise its presence.
Olfactory Materials

The smells were housed in a mesh that was origamied into small boxes and placed into plastic food containers which had a fan at one end and an opening at the top. When the fan was off the top opening was sealed with a thin rubber sheet which lifted to release molecules from the box when the fan was activated. The lid of the plastic box is gilded and sitting inside the pod. It acts as a foil that contrasts with the simple paper and bamboo pod and so emphasizes a focal point like a face with a mouth which attracts attention towards it with its brilliance.

They began by using smell compounds sourced from nature, developing methods of collection and storage as well as synthetics sourced from various sources: a commercial perfumer, science sensory research establishments, supermarket materials, commercial flavour compounds and steam distillation of plant and other materials;

Turner and Harris decided to test their own anosmia with one of the compounds that was mentioned in Albert Blakeslee’s study in 1930’s. The compound was freesias which some people can’t smell. The season for garden freesias in NZ is August September, so in March and April the only ones available were from commercial varieties without any fragrance. An earlier study in 1918 found similar in people smelling verbena flowers so Turner collected verbena flowers from her garden and extracted its fragrance by steam distillation to make a lemon verbena hydrosol. The aromatic chemicals in verbena, ie borneol, geraniol, linalool, nerol, citral, dipentene, limonene and myrcene all have a greater boiling point than water which could be boiled away and collected however this would require processing of a much larger volume of verbena. Turner subsequently found that small amounts of all the olfactory materials were available from several perfumery sources including USA, Singapore, Australia and NZ.

Turner consulted with Dr Richard Newcomb, Plant and Food Research NZ and Monell
Chemical Senses Center, USA, to make a list of compounds known to be anosmic or fugitive.

1. Androstenone
2. Benzyl salicylate
3. Galaxolide: produced by IFF is a synthesised musk which produces warm, clingy backgrounds, widely sought after and used by perfumers throughout the world (Osmotheque)
4. Geosmin
5. Isovaleric acid
6. Muscone (R)-(-)-3-Hydroxytetrahydrofuran
7. Skatole
8. Beta-ionone
10. Beta-damascenone
11. Hexanol (leafy green) cis-3-hexen-1-ol
12. Isobutyraldehyde
13. Ethyl butyrate
14. Freesia Fluorescence
15. Verbena Lippia citriodora

The list also included the following compounds which were found to be unsafe:
   - Isoamyl acetate
   - Jegers ketal
   - 3-methyl-2-hexenoic acid
   - 3-hydroxy hexanoic acid
   - ω-Pentadecalactone
   - Diphenalmethane acute toxicity
   - Trimethalamine rotten fish danger extremely flammable

The above odours were replaced with extra fragrances that would punctuate the experience with familiar odours:
   - Jasmin or Hedione: produced by Firmenich
   - Castoreum blend
   - Hemp
   - Ethyl maltol" a sugary caramel note by Pfizer, allows creation of perfumes with a gustative top note called ‘tasty’ eg Thierry Mulger ‘Angel’
   - Ambroxan cetalox: animalic
   - Tobacco Absolute

The fragrances used in Downwind required investigation of perfume classifications, safety and exposure, by consulting related MSDS sheets.

Turner learned how to read the MSDS pdf’s and the toxicological information and to consult the documentation, safety information and hazard statements.

The sense of belonging to a place and a culture includes the smell of home. Dr Pamela Dalton
pointed out that the familiar background odour which is only noticed when it disappears or changes is known as background odour and includes the odour of the natural and man-made environment.

Their research included the perception of smells against a saturated background of smell - hydrocarbons, odours associated with cleanliness etc. The installation is set against a backdrop of plastic painted with the odours of hydrocarbons: Stockholm tar.

**Sugar**

Dr Dalton also spoke about taste smell integration, which may assist a person to smell below-threshold if used with a sweetener as this is an integration.

Harris and Turner subsequently experimented with using icing sugar, honey and sugar as sweetness to assist perception of smells by amplifying the olfactory sense. [http://www.youtube.com/watch?v=yg6dcLzYGAs](http://www.youtube.com/watch?v=yg6dcLzYGAs)

Alongside the pods are devices that dispense grains of sugar.

The first dispenses single grains of sugar by way of a spinning silver ball that is activated when one’s upturned hand is placed on the silver confectionary dish.
The second is a sugar bowl which lifts its lid when approached revealing a tiny sugar spoon.

https://vimeo.com/71244612

RealTime Arts review Downwind : http://www.realtimearts.net/feature/ISEA2013/11184

Raewyn Turner and Brian Harris individually and collaboratively engage simple elements with
engineering to create experiential art. Their work utilises everyday objects re-interpreted with robotics which Brian develops for cameras in the film industry, along with Raewyn's olfactory research and art aesthetic skills. Over the past 2 years we've collaboratively created experiments around olfactory perception.

Raewyn Turner  https://raewyn-turner.squarespace.com/
Downwind won the Corban's Trusts sculpture award 2012, exhibited at ISEA2013 in Sydney Resistance is Futile: Ecologies and Technologies with CNZ support.

http://www.isea2013.org/isea2013
Downwind#1 Raewyn Turner & Brian Harris 2013
http://www.raewynturner.com/index/#/downwind/
Downwind 2013
https://vimeo.com/71244612
Downwind#1
https://vimeo.com/40963173
4000 Varieties of Orange http://www.raewynturner.com/index/#/4000-variants-of-orange/
Playing a Bunch of Flowers http://kissingbees.wordpress.com/category/experiment-smell-to-sound-device

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