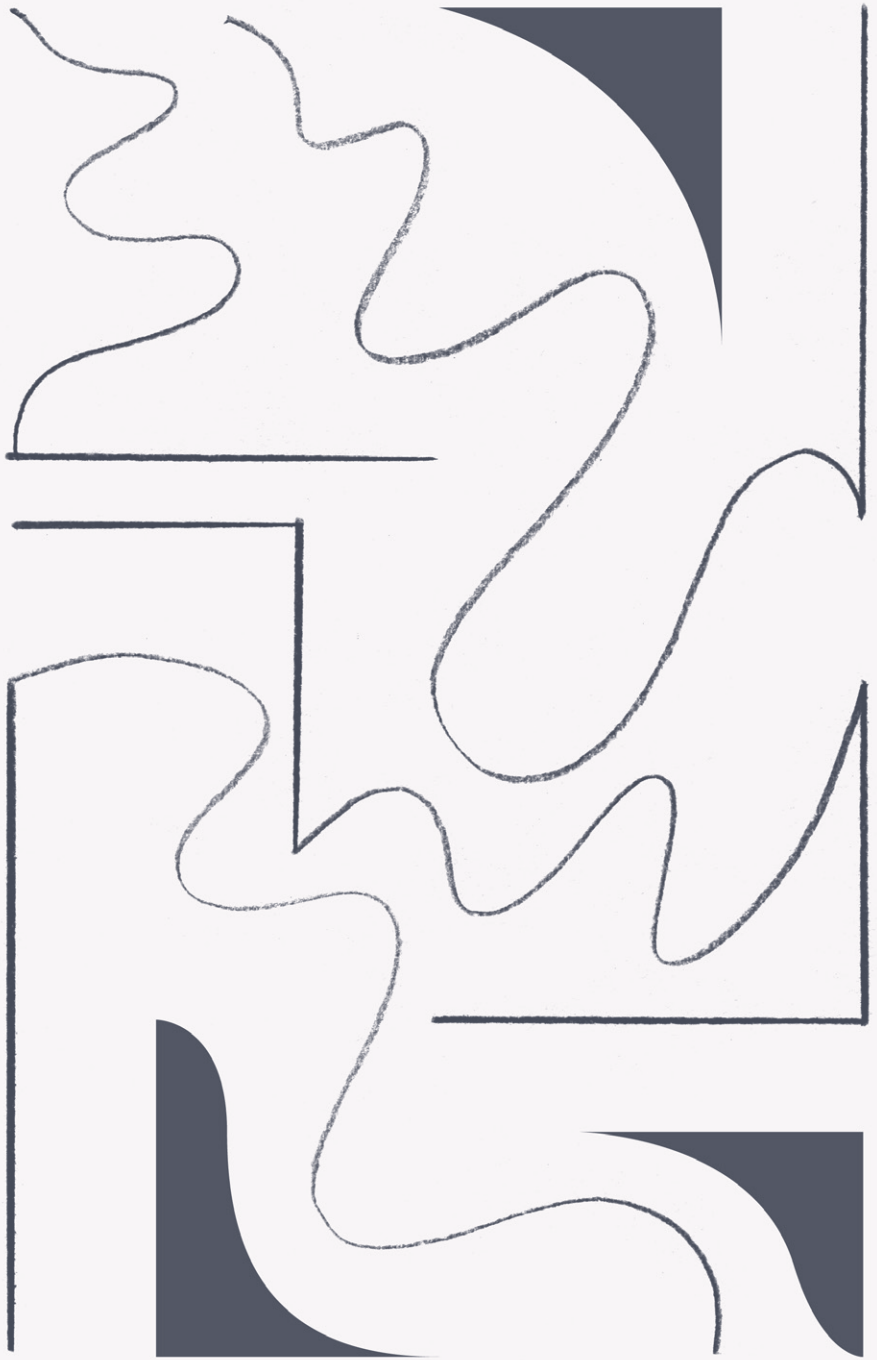
Tangible Evidence 02
Systems, Platforms & Prototypes

Panel Illustrations throughout
by **Will Edmonds**



This second edition of Tangible Evidence takes the form of a pocket book. In the year that bought us both; the Hyperloop™ – Elon Musk's pneumatic railway – and water on Mars – another one of Musk's targets – the format could seem seem rather anachronistic. Within the leaves however you will find writing exploring various coalescences of technology, infrastructure and culture and drawings that give these form. The ideas here collectively speak to the agency of the systems we have built and the platforms that float atop them. To give these coalescences form in words and pictures is to focus the lens but for a short time, and not to pretend otherwise. Tangible Evidence indeed.

Facilitating critical thought at the intersection of design, technology and people is not straightforward. For the MA Interaction Design Communication students represented here Tangible Evidence is a record of their efforts to balance a philosophy of prototyping at human scale with a weather eye™ on the potential network effects of their design speculations. In this context we worked this year, on – amongst other things – designing interactions that promoted

awareness of the increasing autonomy of surveillance and targeting systems, working with scenarios from parking meters to drone strikes. This work, inspired by NGO's campaigning for UN regulation of autonomous weapons systems prompted our dialogue with the research consultancy Strange Telemetry. Their contribution to Tangible Evidence records here, the shimmy from the parking lot to the pre-emptive strike with startling historical and contemporary clarity. TE™

Ben Stopher
Programme Director:
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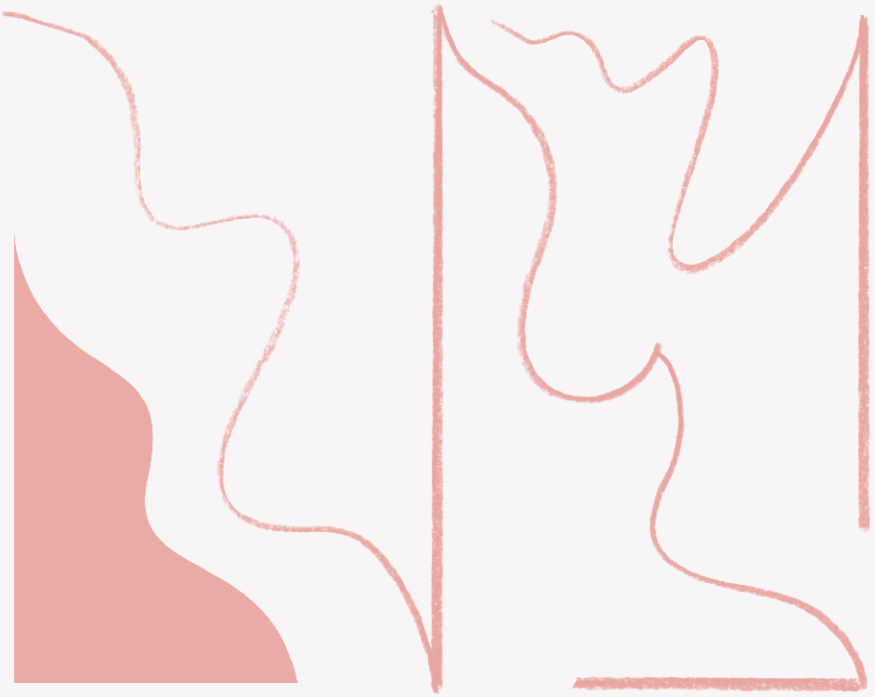
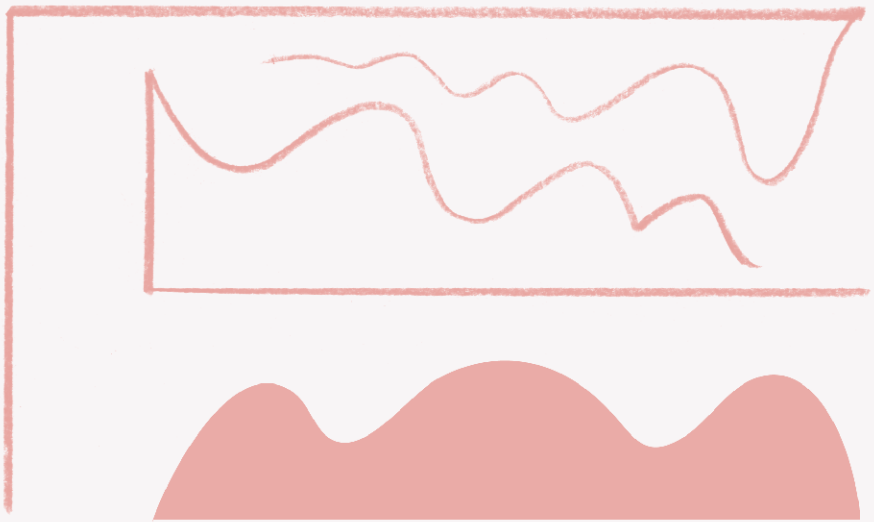




The Internet of Bombs
An Essay on Autonomous Weapons

Words by **Strange Telemetry**
Illustrations by **Luke Best**

Strange Telemetry is a research company and consultancy. They explore and illuminate the contexts in which technologies are imagined, built, used, and controlled.

As individuals, they have worked across design, ethnography, economics, policy, and strategy. Together, they run custom research projects, helping people understand and intervene in complex sociotechnical systems. Supporting thier research and design work, they talk, teach, and run events and workshops.

strangetelemetry.com

War Pigs

On the origin of autonomous weapons, their animism, and psychological warfare.

"You can't mistake my biology
(The way that we talk / the way that we walk / it's there in our thoughts)
The magic number's in front of me
(The way that we talk / the way that we walk / so easily caught)"
Biology, Girls Aloud, 2005

The Greek town of Megara lies near to the Gulf of Aegina, on the Aegean Sea. It has a long heritage as a monied region, packed with citizens who excelled in philosophy, philanthropy, architecture, and city-building. Byzas, the legendary founder of the city of Byzantium, came from Megara; so too did Euclid, the philosopher who battened together planes and systems of logic to create his eponymous geometry. If you want non-human, intelligent, autonomous incendiary devices – that is, pigs set aflame and sent into battle – then the good people of Megara have you covered.

The use of animals in wartime offer examples of some of the earliest autonomous targeted weapons systems. A pig may, at first, seem categorically different from an axe or a bomb; but, as weapons, animals have proven capable of inflicting harm and damage. The hog and the axe are both tools, deployed as a way to extend and amplify human action. In the First World War, American aviators flew with messenger pigeons on-board. In modern Tanzania, Belgian non-profit organisations train Gambian pouched rats to detect landmines. Small animals can creep through the

tightest of tunnels, whilst larger beasts can rampage across enemy lines, sowing fear and unsettling troops - think of the effect of Hannibal's elephants on the nascent Roman Empire. Animals can fly, breathe underwater, and run faster than humans. Their senses may, in certain situations, be more acute than those of their human handlers. But perhaps most crucially they can also – in theory – be trained to act without instruction.

In ancient Megara, the attraction of pigs as weapons came from their heft, speed, and physical independence, with a fully-grown hog reaching up to 2 metres in length and 350kg in weight. In 255 BC, with the city under attack from Macedonian conqueror Antigonus II, Megaran citizens pushed back with aggressive counter-measures. Enemy camps had been set up just outside the city gates. Trapped inside, the townsfolk rounded up their pigs, doused them in pitch, and set them alight, before pushing them out of the city gates. The terrified animals scrambled across enemy lines, racing through the camps and setting the tents alight. They also panicked the Macedonians' own war animals, a phalanx of elephants, who broke ranks and trampled their own troops. "Elephants," noted Roman scholar Pliny the Elder, "are scared by the smallest squeal of the hogs"; and flaming pigs utter rather more than gentle squeaks.

While the life of a Megaran war pig was nasty, brutish, and short, making little use of the animal's native intelligence, later efforts to use animals as autonomous weapons focused on their capacity for training. As Donna Haraway reminds us in 'The Companion Species Manifesto', trained dogs were once amongst the best intelligence systems available for military needs. Used as 'instruments of terror' in the European conquest of the Americas dogs were also deployed by the Soviet Red Army during World War II. By hiding food in tank undercarriages the Soviets conditioned their (underfed) dogs to investigate and explore military vehicles. This worked well enough in training but, set loose in the field –now with 20lb of bombs strapped to their backs – problems with the Soviets' methods became apparent. German tanks used petrol, but the dogs had been trained on Russian diesel tanks; and when unleashed, they ran towards the familiar scent of petrol. Some dogs never even made it that far; frightened by the sounds of the battlefield they retreated, seeking shelter with the familiar faces of the Soviet trenches – whereupon they exploded.

In a similar vein, Russia and the US have continued dolphin training programs begun during the Cold War. While speculative tales of kamikaze cetaceans, and underwater assassinations of frogmen, are more thrilling than the mundane, confirmed, reports of dolphin involvement in mine-tracking and rescue duties, it is testament to the cultural role of weapon animism that military dolphins create such spiraling urban legends. In these stories, we

find a key aspect of their effectiveness as autonomous weapons. Roman elephants, Macedonian pigs, and Soviet dolphins all carry an element of chaos in their movement, and an alien illegibility in their intent.

Discussions of autonomous targeted weapons systems often default to thorny ethical questions about surveillance systems and machine intelligence, but in the deployment of war animals we can more easily see the trade-offs between autonomy and control. Physically and mentally independent from their human counterparts in the military, yet capable of being trained, animals embody this ambiguity. As autonomous creatures, war animals sacrifice accuracy and true targeting, bound by their own will and desires through the fuzzy logic of firing neurons – something not engineered from scratch, but emerging in conjunction with human culture and civilisation.

We're All Targets
On indiscriminate targeting, dread, and the city.

"Bowden was instantly visible. That gait. Strange, impossible. Not properly describable, but to anyone used to the physical vernaculars of Beszel and Ul Quoma, it was rootless and untethered, purposeful and without a country. [...] How expert a citizen, how consummate an urban dweller, to mediate those million unnoticed mannerisms that mark out civic specificity, to refuse either aggregate of behaviours."

The City and the City, China Mieville, 2009

By the start of the Second World War Allied and Axis powers had both followed the path laid by pilots in World War One – designing and manufacturing new kinds of aircraft, and developing strategies for battlefields that now stretched up into the sky. Yet navigating the battlefield of the air proved challenging. British bombers found it difficult to hit specific targets, with only one in five succeeding in dropping their payload within five miles of their target.

So strategy changed. In the early part of the war, pilots were instructed to go after small and well-defended military and industrial material infrastructures, such as factories and military bases. By 1942, when it was apparent that bombing was insufficiently refined as a tool of destruction, British bombers were

instructed to target entire cities, which, spread over a wide area, could be more easily hit with violent indiscrimination. The new system of 'area bombing' ushered in a new generation of weapons, with new meanings. Instead of carrying the heavyweight bombs needed to raze a factory, fighter pilots now loaded up with incendiary devices (flaming pigs!) capable of igniting an entire city.

Cities contain the bricks and mortar which bind and channel the daily rhythms of civilian life – schools, hospitals, churches, shops. The savage Allied attacks on city centres had a more powerful psychological intent than discrete targeting, enacting the same effect as elephants, pigs and dolphins, taking aim at the 'morale of the enemy civil population'[†] to cowe them into submission.

The psychological horror of indiscriminate targeting is dread; literally, fearful anticipation, the terror in the gap. There can be no certainty in whether one might be destroyed when targets and 'collateral damage' are interchangeable. No certainty about when the whine of engines might puncture the silent night; and no certainty about whether those bombs are coming for you, when the sky opens. Survivors of both the Doodlebug V1 attacks on 1940s London and those of US Predator drone strikes tell similar stories of an existential fear of the skies above, and what they might contain.

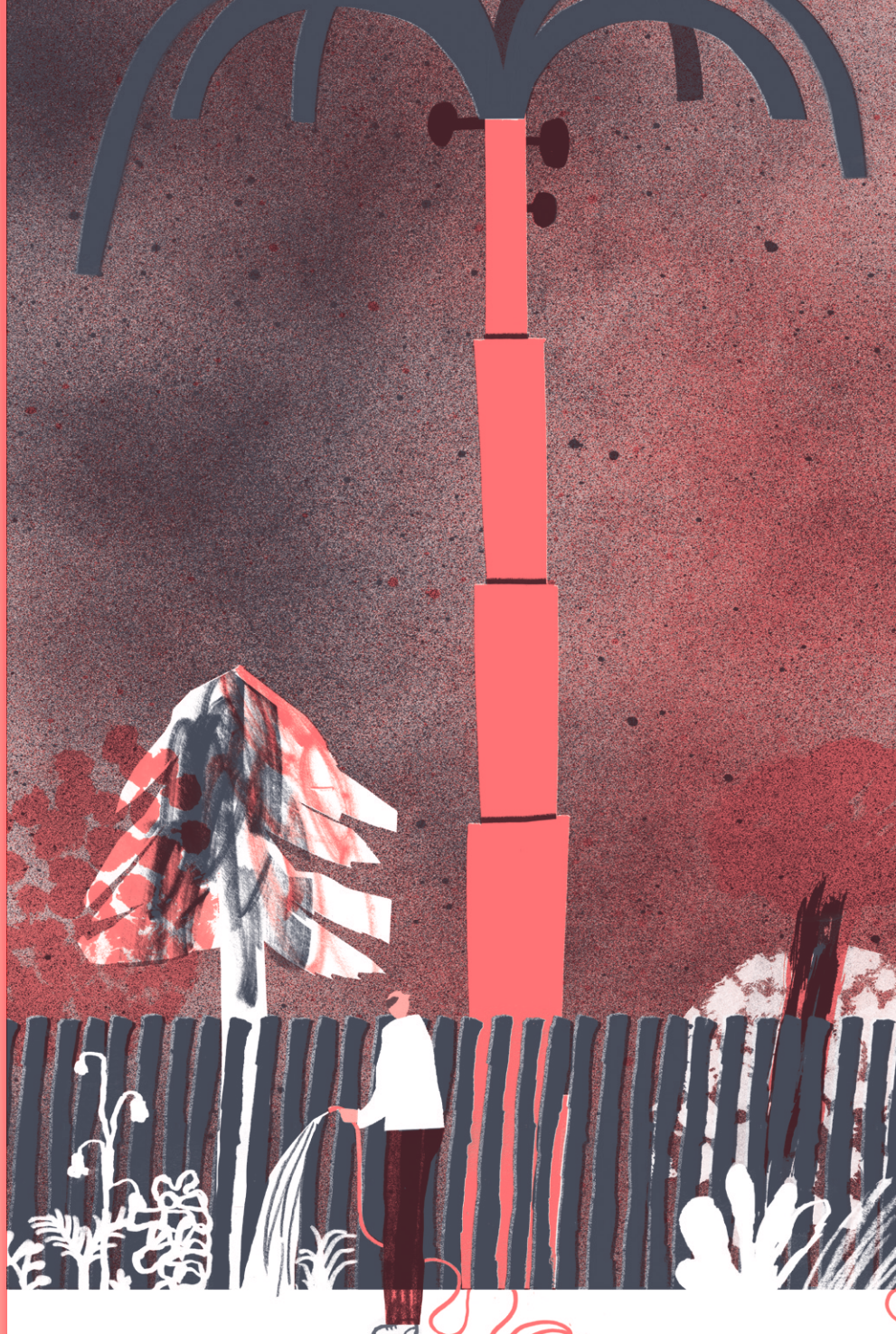
Away from the front lines, military-driven dread has found purchase in the civic infrastructures of the surveillance state, packed with sensors, software, and consumer electronics which have slowly evolved into a dragnet for potential targets. As target bombing indicates, defence decisions have been woven into the physical form of the city. Walled cities and urbanism were born of the need to persist in the face of siege weapons. After the advent of guerrilla warfare, espionage, air strikes, the jet engine and mechanised warfare, the siege wall has become irrelevant, but the idea of walls persists. London's 'Ring of Steel' is a cogent example of this. A dragnet of 649 CCTV cameras around the City of London, the 'Ring' was constructed in the early 1990s in response to the threat of the IRA, borrowing its name from the material fortified perimeter around Belfast's centre. Add to this the 1,517 Automated Number Plate Recognition cameras, 646 Congestion Charge cameras, 342 Low Emission Zone cameras, and 498 general traffic cameras.[‡] Add the newer walls without lenses – phone metadata harvested by shops and recycling bins, fake cell towers pinging data to GCHQ, to Facebook, to Google, to Uber, to Nike, to Apple, to Microsoft. For the urban citizen there is no transparent certainty about the ends to which this data will be put.

As Rob Kitchin notes, 'Continuous geo-surveillance relies on the production of spatial big data'. Big data – those data sets so large that traditional means of analysing them are inadequate – contains within it the mean to track targets and erect new walls.

The Smart City is the collective assemblage of those walls. It promises more efficient and effective services through the profiling, targeting and sorting of citizens along computationally reductionist lines. Its evangelists stalk the halls, ringing bells heralding the age of this or that, of Attention, of Sharing, of Internets and Economies of Things; and all the while, each of these little epochs serves to steady and solidify the data dragnet and its indiscriminate targeting. Far from citizen-soldiers, the Smart City makes citizen-targets of us all.

† http://www.nationalarchives.gov.uk/education/heroesvillains/transcript/g1cs3s2t.htm

‡ http://www.nationalarchives.gov.uk/education/heroesvillains/transcript/g1cs3s2t.htm



Capitalism and Computers
On efficiency, the computer, and dual-use technology.

‘Enhance...’
Various

The techno-capitalist ourobouros of ‘efficiency’ offer a good starting point for an ideological understanding of automated targeting and autonomous warfare. It was not cost-efficient for 80% of World War II bomber pilots to waste their payload, nor for Russian tanks to be destroyed on the whims of hounds.

It should not be surprising that the technologies underpinning automation come from the interplay of capitalism and warfare. From the 1940s to the 1960s the US armed forces were the single most important driver of computer development, with military users acting as proving ground for initial concepts and prototype machines. As market forces raised a commercial computer industry into place the armed forces and defence industry served as their major buyer – the marketplace of the ‘military-industrial complex.’

In 1949, the Soviet Union detonated their first nuclear weapon, and the US Air Force were obligated to confront a problem that they had been stubbornly ignoring: the defence of US airspace. Addressing this issue meant answering difficult questions about communication and control. How could analysts recognise and track an incoming Soviet bomber? How could the US air force mount a coordinated response involving thousands of aircraft? Computing systems, largely conceived with economic applications in mind, were annexed to the problem, reshaping technological possibilities around strategic early warnings and controlled air defence.

As the Cold War rumbled into play, nascent forms of automated algorithmic target finding were summoned into being.

The trajectory of their development was intimately entangled with US military strategy, and the idea of the ‘closed world’ which underpinned it. In the closed world metaphor pushed through US political bodies, the entirety of global politics could be treated as a system subject to technological management, bound by the ‘cold capitalist efficiencies of cost-benefit analysis’. A closed world was one that operated under global surveillance and controlled through advanced technological military power; and the metaphor bled into machines. As Paul Edwards states:

“Weapons of war were understood to be focal elements of the economy, of national politics, and of scientific research. Computers were a primary example of this inseparability of weapon from tool, tool from metaphor, metaphor from political action”

US government spending focused on the development of technological means to project military force across the globe, with computers binding will to action. Computers afforded increased speed and scale to military action, overcoming the labour-intensive efforts of the Bletchley Park decryptions that generated piles of ‘bulky analogue material’ – that is, paper – which required cross-tabulation and storage. In part, computers offered a means to locate soldiers away from the battlefield; in 1976, US General Westmoreland mapped out a 10-year timeline preparing the ground for a fully automated battlefield, stating: “I welcome and applaud the developments that will replace wherever possible the man with the machine.”

These systems were concerned with building systems of control and dehumanisation. Under a regime of automation, warfare is efficient, disembodied and precise. Located in beliefs that control of information increases agency, efficiency in warfare means reducing decision time, reducing human casualties, reducing risk to soldiers, and, crucially, reducing the costs of training and deployment.

As artefacts found in ‘times of peace’ are often co-opted by the military, so things made for wartime have a tendency to slide away from the military and into civilian life. Work on defence research and ‘dual use’ technologies – broadly, those which can be used both for military and civilian ends – unpacks the purpose and composition of technology: SAGE computers repurposed for wartime, GPS developed from initial military research in monitoring enemy satellites. Yet these technologies also operate as a system of social relations. In places of war, drones move overhead, monitoring the world below at high resolution; but so too do satellites, paradoxically spinning miles further above places in peacetime. Remote-controlled digital CCTV cameras track people and objects, casting an impartial ‘eye’ over criminal acts and potential criminality alike. Sensors, actuators, and RFID chips are bound into both military unmanned autonomous vehicles and consumer ‘Internet of Things’ widgets.

Systems of warfare and the peacetime of civil society are tightly threaded together. The ideology of body tracking that shaped the creation of the Apple Watch underpins the origins of the Predator drone. The ideology that created the Nest smart thermostat also created the conditions for predictive policing. Machines have material effects through their functions within systems of ideas. As the material aspect of war changed, targeting revealed a new place for humans in the world: as subjects to be read, and targets to be tracked. The shift to automation also represented a shift in the meaning of work and leadership for the small-c conservative military-bound services. Military leadership shifted from skills learned in battle to the management of automated systems, employing pre-programmed plans based on reductionist strategies.

Modern warfare exists within capitalism: government defence agencies simply do not have the resources to design and build every machine and line of code necessary for global engagement, but must outsource their needs. This reliance of the modern state on a military-industrial complex is apparent in the fact that the US has been in constant military deployment since December 1941. Automated warfare is a continuation of the disembodiment of warfare enacted by this relationship of war and capital, representing a perspective where the only human not to be scrambled or disembodied is the target themselves.

It is impossible to consider the rise of automated warfare and its attendant technologies without understanding them as entangled with civilian technological progress. Over time, as the military hunger for new technologies has accelerated, this relationship has become more complex as, in an effort to speed and make deployment efficient, the rules, standards and understandings of how and where these technologies should be use is blurring. At the same time, automated technologies demand new types of military strategy and leadership - one of management rather than charisma and martial prowess, further blurring boundaries and powering the revolving doors of the military-industrial complex.

Faith in Algorithms

On efficiency, the computer, and dual-use technology.

New media theorist Lev Manovich observes how, since the 1990s, the computer has framed all aspects of cultural production and consumption. In providing a heuristic of cultural production and the organisation of data,' the interface directs both how users perceive computers and other media objects, and their idea of how things may appear in the world. Algorithms operate not by database logics but by the logic of rules – if this, then that. Manovich emphasises that neither the algorithm nor the data it works on (organised in a particular way for efficient search and retrieval) are passive objects. Data does not simply exist – it has to be generated, before being collected and organised. Algorithms act on data, but they are also man-made; hand-crafted, even; operating according to an underlying logic which has been built in by humans.

The data-driven society labours under the unconscious assumption that the algorithm is ineffable, objective. But algorithms see the world in their creator's image. The algorithm will perform what is asked of it rather than what should have been asked of it.

As we see through the sliding creep of 'smart' rhetoric around city, these technologies are rarely in service to the people who primarily interact with them. Predictive policing technologies, developed more with shareholders and advertisers in mind; and, like any product bound by market forces, will need to prove their worth at finding targets by – indeed, finding targets and so targets will be found.

Boardrooms and Battlefields
On systems, responsibility and control.

"Gentlemen, you can't fight in here!
This is the War Room."

Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb,
Stanley Kubrick, 1964

Looking at the development of weapons of mass destruction we see how the moral weight of combat has shifted, from soldiers to Commanders-in-Chief. Nuclear, chemical, and biological weapons are powerful political tools taking responsibility from soldiers enclosed in what military theorist Carl von Clauswitz termed the 'fog of war' of the battlefield to the still of the command centre. Decision-making is pushed upstream, into the clean inner spaces of power, accountability and structural control; spaces modelled after the proven efficiencies and optimisations of Taylorism, scientific management and factory production lines. The defining contemporary image of precision warfare is no longer the noble violence of the battlefield, but the boardroom where Barack Obama and Hilary Clinton sat to watch Operation Neptune Spear which resulted in the death of Osama bin Laden. Composition and control, centralisation, trust and accountability. This picture does not capture the messy wetwork of quasi-legal extraditions, drone strikes and JSOC

raids that form the core of contemporary warfare. Instead, it presented target-finding at its finest: the very top of government peering through a screen at the most wanted man in the western world, with the violence and irrationality of war hidden from view. Our vision of war now comes beamed via satellites from the nose of a drone 5,000 feet above a desert.

The first deployment of unmanned aerial vehicles took place at the end of the Vietnam War. Used as reconnaissance craft, by the late 1970s, UAVs had become a mainstay of US military aerial operations. The vehicles proved to be highly successful, inoculated against the noise and chaos of the battlefield. As machines, they are incapable of autonomous wrongdoing; their accountability resides in quiet boardrooms. Vietnam itself offered a suitable backdrop to the rollout of the clean, bloodless UAV. Public discontent with the ideologically driven war led the US government to realise that, domestically, the cost of engagement far outweighed any tangible military benefits. The war itself became an operation of intricately choreographed PR exercises – the carefully timed return of body bags and press releases of minor victories backed up by anti-communist propaganda.

The command centre fractures and atomises responsibility. The decision-infrastructure is so large and sprawling, spread across continents, secretive data centres and mobile command units, that it is difficult to identify any single trigger-finger. Ultimate responsibility does rest with the Commander-in-chief and he or she is duly demonised for mistakes as in any other policy decision, but the matrix of technologies, accountabilities, boardrooms, and battlefields complicate the apparent clarity of, for instance, a pitched field battle.

Automated targeting operates within its own form of cyber infrastructure. As Paul N. Edwards identifies, the term 'infrastructure' itself comes from the military, talking about fixed facilities such as airbases. From the bottom, infrastructures themselves are responsible for a sense of stability of life in the developed world: "the feeling that things will work, and will go on working, without the need for thought or action." [†] They provide systemic, society-wide control over the variability inherent in the natural environment – an ethos mimicked and embodied by the 'closed world' perspective wrought by Cold War technopolicies. Responsibility for the creation of these weapons and systems lies across a matrix of consumer, military and industrial technologies, swayed not solely by military structures but by the global interplay of entangled demands, trends and needs.

This entanglement complicates the process of identifying and appropriating blame and praise. It is prosaic to point out that war has become more secretive, likely as a reaction to the

popular stress of the Cold War and public reactions to later events such as the Iraq invasion. But as war itself has become secretive, its management and control has also quietly atomised. There are few great generals, adored by the populace; few great wartime prime ministers or leaders, the distinction between wartime and peacetime rendered redundant in an age of constant proxy war. There are no figureheads for our wars, no Allied Command, no effective successor to NATO. Instead, strategic committees, advisory boards, security councils, military consultants, private contractors, civilian operatives, supply chain managers and all manner of bureaucratic business form a protracted web; at its heart, a Hellfire missile streaking in on a warm desert evening.

† Paul N. Edwards, Modernity and Technology, 2004

Countermeasures

"We don't need more essays on data. We need to talk about power, control, agency, capital, & exploitation directly and how tech enables them"

Eleanor Saitta

Finding modes of resistance against algorithmic targeting and the precision of the automated system seems daunting, possibly pointless. When we begin to grasp the complex entangled nature of automated warfare, algorithmic targeting, its technologies, business strategies and military bureaucracy, how could we possibly resist its inevitability in civilian life?

As Manovich observes, 'an algorithm is the key to the game experience.' Games are a cultural form which require algorithm-like behaviour – if this, then that. To resist algorithms, one might have to learn how to unpick and work with their underlying logics – in other words, how to game them. This first involves understanding the system that underlies a weapon or targeting apparatus, its processes and functions. With this knowledge it's possible to understand the system's limitations and from there, to exploit them.

Paul Edwards describes how guerrillas learned to fool Americans on the Ho Chi Minh Trail by giving their sensors exactly what they wanted. Noise sensors picked up the sound of tape-recorded truck noises; scent detectors closed in on the smell of bags of human urine. Fooled by context-free information provided by the decoys, the sensors triggered the release of countless bombs into the empty jungle corridors; the guerrillas waited, and then could move with relative freedom through the allegedly controlled space. The system's weakness was bound up in its reading of data as objective truth, and its inability to parse context. For the sensors of Nakhom's Infiltration Surveillance Centre, the sound of a truck indicated the presence of a truck and warranted appropriate responses.

Similar decoy and exploitation activities can be used to resist against contemporary algorithmic surveillance systems in a more civic context. The Unfit-Bits project offers Fitbit-spoofing as a service, investigating DIY fitness spoofing techniques which, through existing mechanical tools, 'help produce personal data to qualify you for insurance rewards, even if you can't afford a high exercise lifestyle.' As the Vietnamese guerrillas more crudely did in decades previously, Unfit-Bit's team also undertake research to understand how fitness devices interpret and respond to data. Metronomes, power drills, and bicycle wheels simulate walking, running, arms swinging, gait and footfall, collapsing the human form into a series of discrete and slightly ridiculous forms of motion.

Other exploits might include turning existing base technologies to new uses. Mesh networks are horizontally distributed networks built by their users that offer functions similar to the Internet without the hierarchical control. Their popularity is surging in places where Internet connectivity has historically been poor and in places where the threat of surveillance and recrimination from the state is a very real threat. For more aggressive tacticians, the Critical Engineers have proposed a series of products that allow users to weaponise readily available technologies to increase awareness of and resists surveillance culture. Devices like the Transparency Grenade scoop up and blast out wi-fi data while No Network offers a mobile jamming station in the bitingly sardonic form of a model tank.

Alternatively, you can collapse material presence in on itself. Adam Harvey's 'CV Dazzle' project plays on the constructs placed in automated face recognition technologies. These algorithms look for specific patterns in their image analysis: colour distribution down the nose, light and dark in the cheekbones, some baseline symmetry. Obscure those features with carefully applied black and white make-up and chunky fringes - Adam Ant by way of TRON - and the algorithm develops its own form of prosopagnosia (that is, face blindness). Named after the blocky black and white dazzle camouflage used during World War One, to break apart the gestalt image of warships by obscuring their size and movement, CV Dazzle transforms the human face into a 'mess of unremarkable pixels' (as journalist Robinson Meyer described his experiences in the make-up).

Resistance can also come from seeing the system itself: much of artist James Bridle's work is devoted to materialising the obscured networked systems of surveillance and warfare. His 'Drone Shadows' create full-scale outlines of otherwise unseen unmanned aerial vehicles (UAV) in public spaces; and his UAV Identification Kit mimics the aircraft recognition kits of World War II, but containing models of contemporary military drones including MQ-1

Predator and the RQ-4 Global Hawk (and do think on the aggressive animal imagery which these names intentionally evoke), as well as human figures, 'included for scale'.

Yet systems are bigger than forms of individualised resistance allows for. What happens when the system is so wide, so entrenched, so pervasive, that hiding or distracting only nudges the system onto another node of action? What happens when targeting comes not from a single laser-eyed source but the entire structure of the cityscape around us? The 'closed world' of the Cold War has returned to wrap itself through the streets.

In these spaces, we see a shift from a place for the citizen soldier, the armed population, or even the professional standing army, to helplessness in the face of a pervasive surveillance where the very role of the human is minimised, distanced and obfuscated. In the Smart City of continuous warfare it is not enough to resist the blunt end of the technology. We need to climb up the super-structure of the deep history of targeting and warfare to the very psychology of the bureaucrats and managers that built and control it.

The challenge is in making the very idea of automated targeting and warfare untenable, to undermine the very reason for its existence in the first place. The war machine that lives in the city is built on principles of efficiency - its metrics are key performance indicators, cost-benefit ratios and acceptable risk. It's the cognitive dissonance between this reductionist view of the world and the nature of lived-experience where resistance lies, in not allowing the absolutist mentality of military strategy to permit the dual-use membrane of technology. The dream of total efficiency that drives automated warfare is just a dream, a receding target that can never be met, only accelerating 'progress.' We have to undermine the dream.

Thesis Extracts
Written work from
MA Interaction Design Communication

How can we incentivise and change people's behaviours in order to make them more responsible towards energy saving through gamification?

by Adriano Mescia

The idea of turning everyday tasks into fun activities by introducing game elements has been considered by a great number of scholars and game designers and, as reported by Dale (2014, 82), "this idea has been used since around 2003 as a way to influence online and real-world behaviour, giving rise to the movement of gamification" (sometimes also called funology, ludic design, playful interaction, serious games, or game-based learning). Such a concept has been defined as "the use of game design elements in non-game contexts" (Deterding, et. al, 2011) and has been applied to many fields, from business to teaching, from entertainment to productivity. Old-school companies like DirecTV, Volkswagen and Nike have fully embraced the concept and the gamification industry, which is seeing massive growth, is predicted to be worth £3.4 billion by 2018 (Dale, 2014, 82).

As reported by Lieberoth (2015, 230), "in the last few years, this concept has been subject to countless critiques which call attention to the psychological impoverishment brought about by mobilising only a few game elements like points, badges, leaderboards, and set collection in non-game contexts compared to leveraging full games, e.g. in education or workplace facilitation" (as per Deterding, Khaled, et al, 2011; Ferrara, 2013). We can see that gamification might be in need of a rethink, and this is supported by Fuchs, Sizek, Ruffino (2014), among others.

Deterding (2014, 305) argues that the main challenge has become to work against the grain of existing preconceptions of

gamification, which don't even begin to engage with the psychology and sociology of game enjoyment, let alone realise the promise of translating its insights into other fields. Instead, current gamification evangelists have generally embraced troublesome ethics while exhibiting a disregard for the complexities of design and motivation within games.

"The main task of rethinking gamification today is to rescue it from the gamifiers."
Sebastian Deterding

According to the Gartner Gamification Report (2011) "a challenge exists because a key gamification principle is that games must be fun and challenging". But are the processes often implemented in apps such as Joulebug (which attempts to gamify the sustainable use of energy) fun or challenging? The use of leaderboard and a small number of reward badges cannot, by themselves, lead to fun or challenge for the player.

In order to improve gamified systems for behaviour change it's important to reflect on the science behind gamification which, as explained by Dale (2014, 85), "is founded in the fundamentals of human psychology and behavioural science, and rests on three primary factors: motivation, ability level and triggers. For a behaviour to change, three things have to be present: a trigger, the ability to do the behaviour, and motivation." The last two, motivation and ability, are shown by Dale to be a compromise: If the player has a low level of ability, they will need far higher motivation, and vice versa.

The player can be motivated to undertake activities extrinsically or intrinsically,as Dale explains (2014, 86):

"activities are intrinsically motivating if they help you fulfil your inherent desire for personal growth by achieving some kind of competence ('I am good, getting better, mastering this'); if they help learners feel they are working towards their own set of goals with some amount of autonomy ('I am in control and doing things that match my values'); and if they contribute to the sense of relatedness that learners feel by being part of a group, or some kind of purposeful movement larger than themselves ('I am a part of something here that I think is kind of cool or important'). Extrinsic motivation on the other hand is all the trifling enticements and punishments that are used to make subjects do what they are told to do: salaries, grades, threats of prison time, as well as points, badges, leaderboards, and other tools of gamification."

The focus of gamified systems needs to move from extrinsic motivation to intrinsic motivation if it is to maintain engagement and have a chance of effecting the kind of change it

promises. To explain this concept Deterding (2014) utilises the definitions of the philosopher Roger Caillois who distinguished between two poles of play: paidia and ludus. (314) "Paidia captures the free-form, exploratory, autotelic recombination of behaviours, actions, and meanings prototypically found in children's pretend play, whereas ludus denotes the rule-bound, goal-directed overcoming of challenges. Gamification, in its current form, has focused squarely on the ludic: it almost invariably constitutes an addition of structure, of goals and rules to a given activity in order to afford gameful experiences of challenge and competition".

Mitigating Unconscious Bias in the Tech Workplace with Virtual Reality:

A proposal for how the tech industry can adopt everyday anti-bias methods into the workplace using virtual reality's proven impacts on empathy development.

by Clorama Dorvilias

Unconscious bias (also known as implicit bias) has come to the forefront of American society and mainstream culture with news of subtle discrimination impacting all types of minorities in various institutional environments. Tech giants such as Google, Apple, and Facebook have come under fire recently when, after being pressured into releasing diversity reports to the public in 2014, these reports revealed an overwhelming disparity in race and gender among employees, with the companies exhibiting a homogenous, white male employee base in no way representative of the available diversity in the workforce or among their users. (Molla, 2015)

These revelations have triggered a public discussion in Silicon Valley about the nature of its employment practices, having the resounding effect of sparking confidence in a numerous minority of tech workers to turn to social media and express their daily struggles of working in a white male dominated industry. It was seen to be common experience, with minorities of all traits describing the culture of Silicon Valley as unwelcoming and/or hostile, both socially and professionally. (Miller, 2014)

Physical characteristics like race, gender, sexuality, disability are just a few examples of identity characteristics that trigger unconscious bias. In addition there are other traits that are equally

as affected that don't get the same attention. For example, the various differences of physical traits like height (Dittman, 2015), weight (Puhl et al, 2007), hair (Tharps, 2014), and beauty (Graham, 2013) are also subject to unconscious bias treatment and influence the availability of opportunities, social treatment and professional assessment to the same extent as gender, race, sexual orientation and disability will be predicated to unconscious bias.

While much has been done by companies and federal government to curb overt discrimination in the job industry, this 'second generation' wave of discrimination through unconscious bias continues to go unaddressed. This leads to low retention rates of employees, reduced work performance, and even goes as far as to be a real threat to a company's long term sustainability in our rapidly evolving society (Gates, 2015). On the social scale, these unconscious biases form invisible barriers to many individuals who possess or have the potential to acquire the necessary qualifications but do not fit into the homogenous identity promoted within society of these roles. The consequences of this marginalised population of workers creates an adverse affect on the economy. Even if hired they are likely to receive lower compensation, find a larger discrepancy in wages, and are more likely to be overlooked for promotions.

Beyond the individual there are consequences on a societal scale, we can look at the economic state of San Francisco to get a sense of the toll these disparities will take on the community. San Francisco has seen severe socioeconomic impact with the growing presence of tech companies and the rise of start-up populations (HARDY, 2015). Housing prices have dramatically increased over the last few years leading to long-term locals having to move to more affordable places outside of San Francisco. Cultural clashes and personal conflicts have arisen between the new wave of tech workers and long-term residents, and the economic disparity has begun to resemble that of developing nations. The income inequality in San Francisco is now equal to that of Rwanda (Knight, 2015).

Narrations/Phenomena of Bodily Movement

by Kalypso Kaplani

"dance in my experience"

Hélio Oiticica, 1965

Brazilian artists of the neo-concrete movement during the 1950s and 1960s re-evaluated the aesthetic principles of Modernism in their works. They questioned representational tendencies in art by establishing new relations between the inner and outer spaces of body. The notion of visuality was eclipsed as artists such as Lygia Clark and Hélio Oiticica concentrated on the body and explored tactile space through haptic, auditive, olfactory and kinetic propositions in their work.

Hélio Oiticica (1937-1980), most notably worked with ephemeral materials and created multi-sensorial objects in whose artistic development processes the spectator was involved. His works became more and more interactive as he moved away from his object-based works towards projects where the body became centre of the work and where the participation of the user became its central focus.

His first works were object-based, for example Spatial Relief in which coloured, wooden, geometric structures hung from the ceiling that could only be fully perceived through the spectators movement around the object and through the space, but he moved on to work on the so-called Trans-objects (Bólides), that could be experienced by using multiple senses and which would only be activated through their exploration by the user. Between 1964 and 1968 Oiticica designed a series of textile structures, the Parangolés which, in 1965, he invited people from the favelas to interact with during an exhibition opening at the Museu de Arte Moderna in Rio

de Janeiro in what was quite a radical intervention as part of an official, institutional event. The Parangolés communicated through the user's experience and emphasised the dynamics of life. They existed in opposition to artistic attempts to see the world as something systematic and static. Oiticica, who was at the same time artist, performer and thinker placed his work between the avant-garde, Brasilian pop-culture and in the context of the Brasilian reality of underdevelopment and political radicalism in the 1960s. Through his work he succeeded in reflecting changes in art and society and articulated questions on issues of freedom in contemporary society and culture.

In the latter part of the 1960s Oiticica expanded the spatial properties of the Parangolés, and created two larger spatial installations that he described as experiences. Tropicália and Eden referred to a spatial context, situated as they were within natural environments such as water, plants and sand. Oiticica invited people to step barefoot into these environments and to inhabit them. Establishing new relationships between surroundings and bodies; these 'environments' transformed increasingly into immaterial spaces. Oiticica's works created temporary situations that enabled a more open and physically related experience of space.

Artists such as Lygia Clark and Hélio Oiticica generated a unique interactive vocabulary which they explored through their work – a vocabulary that is highly relevant for architectural production and spatial, interactive artworks today.

Thinking What Things Thought
How to Implement Personalities to Objects to Explore the Interaction Design Potential?

by Qiaozhi Zhao

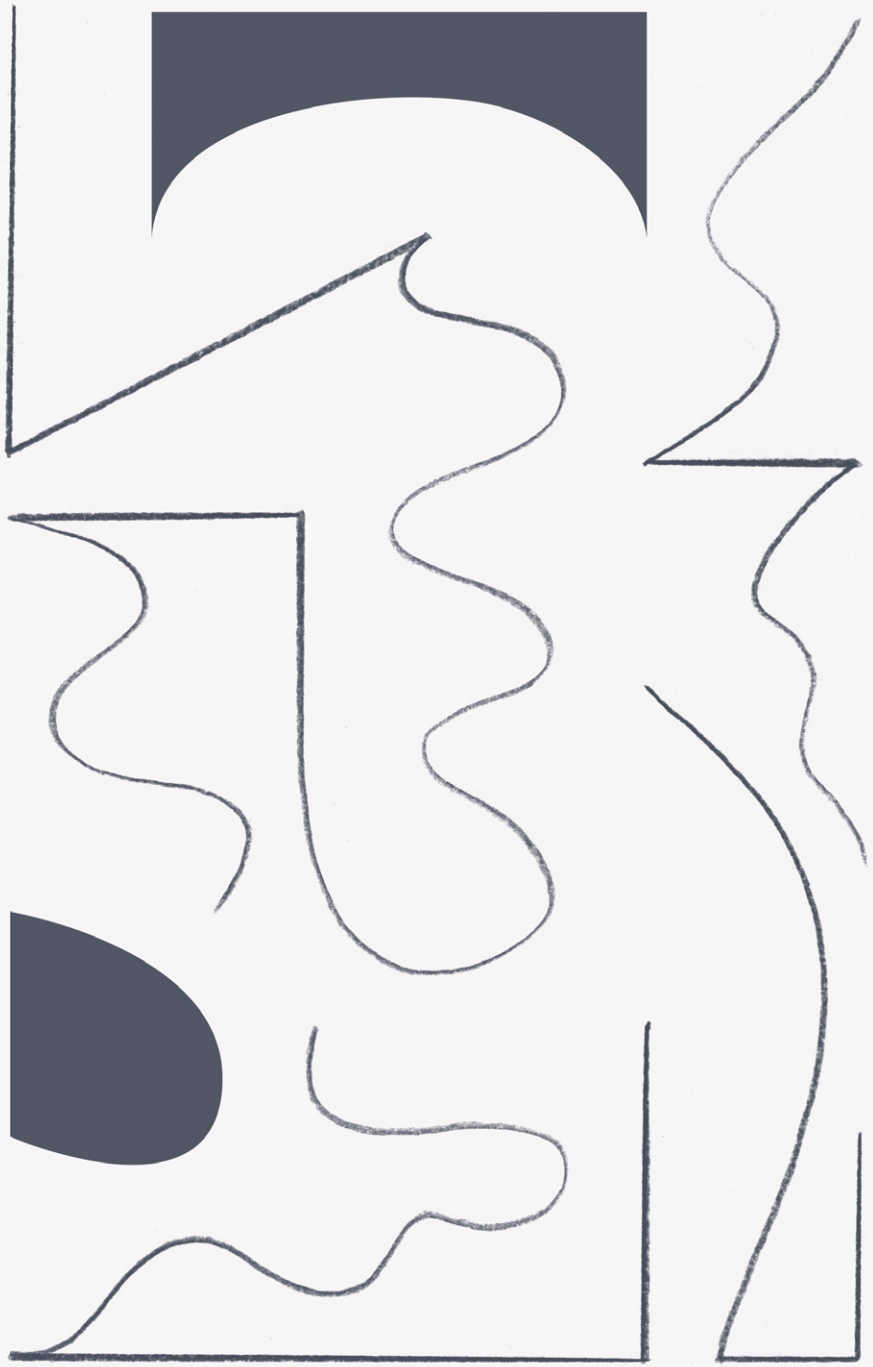
Animism is a philosophical doctrine which traditionally proposes that non-human entities, such as animals, plants, and inanimate objects also possess a soul. However, current notions of animism question the boundaries between human and non-human and it is these that we are interested in here.

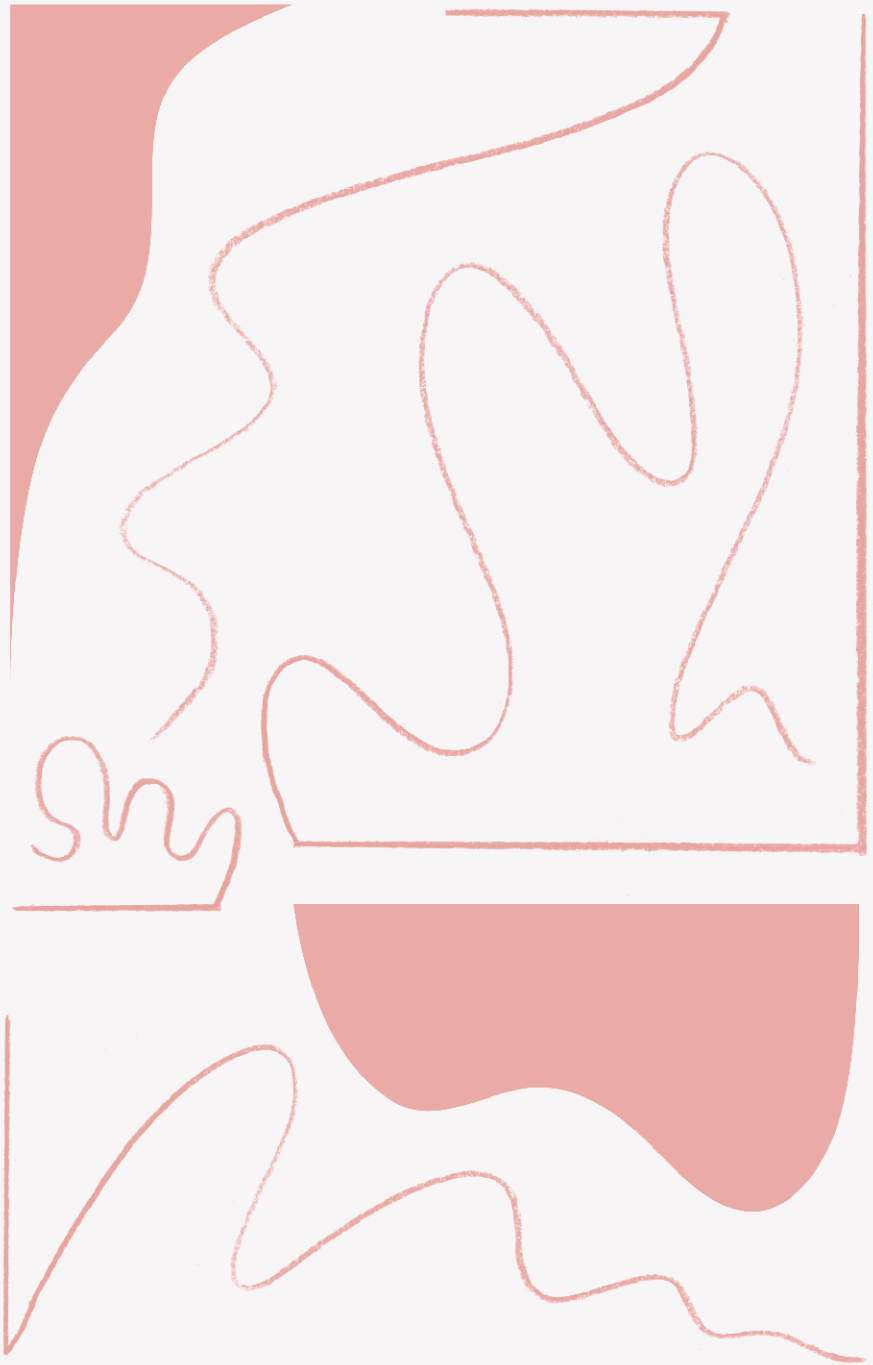
Anthropologist Nurit Bird-David proposes a significant reconceptualisation of animism. She argues that animism is a "relational epistemology" (Bird-David, 1999). In other words, an object maintains its recognition and identity primarily by having a link or association with others rather than through its independent and distinct features. According to this view animism becomes a tool to explore our relationships to objects. Bird-David explains "we animate the computers we use, the plants we grow and the cars we drive", by reframing objects relationally we learn "what they do in relation to what we do, how they respond to our behaviour, how they act towards us, what their situational and emergent behaviour is" (Bird-David, 1999: 78). Further, Graham Harvey (2013), in his Handbook of Contemporary Animism, defines the animist perspective. He argues that the animist takes an I-thou approach in relating to his world, where objects and animals are treated as a "thou" rather than as an "it".

In the context of ubiquitous computing, especially IoT, Brenda Laurel (2008:1) puts forward a manifesto of "Designed animism" forming "the basis of a poetics for a new world". At the Ubicomp conference in 2006, she raised the questions "What new forms of narrative and experience may emerge from such systems? How do we understand them, in terms of structure, causality, narrative and experience? What are the poetics of this newly animistic world? And, does it have a soul?" showing that designed animism may help us make crucial changes to how we create and experience a world of connected objects.

Research has shown that, from early age, human beings assign specific qualities to things and their surrounding environment, in order to become accustomed to them. As Inagaki and Hatano (1987: 1013-1020) have found, children may be using a "constrained personification" to understand their surroundings, using humans as an analogical "base domain" to compensate for their undeveloped cognitive abilities and restricted awareness of the world. In many ways, adults have the same imagination. For example, the smartphone is no longer a mere communication tool for us. It provides us with a wide range of information, can be quite restricted and firm in its functions and operations and occasionally temperamental. This animation and active response has enabled humans to often consider smartphones as a live device, allowing them, in a sense, to become a trustworthy friend with distinct features, characteristics and functions.

According to Van Allen (2013: 2247), "animism can make valuable contribution with ubiquitous computing contexts where objects with designed behaviours tend to evoke a perception that they have autonomy, intention, personality and an inner life". By using the metaphors of animism, he argues, designers have the ability to influence myth-making narrative abilities of humans, and enable a more spontaneous, deep and creative link between humans and objects.





STUDENT PROJECTS FROM
MA INTERACTION DESIGN COMMUNICATION

OUTPUT
2015

EMPATHE(TECH) WORKSPACE:
Mitigating Unconscious Bias with Virtual Reality.

Clorama Dorvilias
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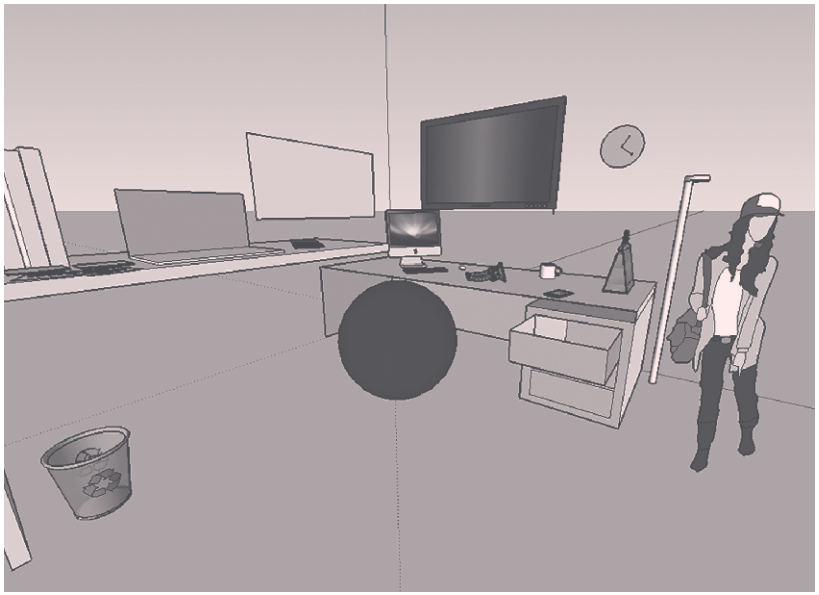
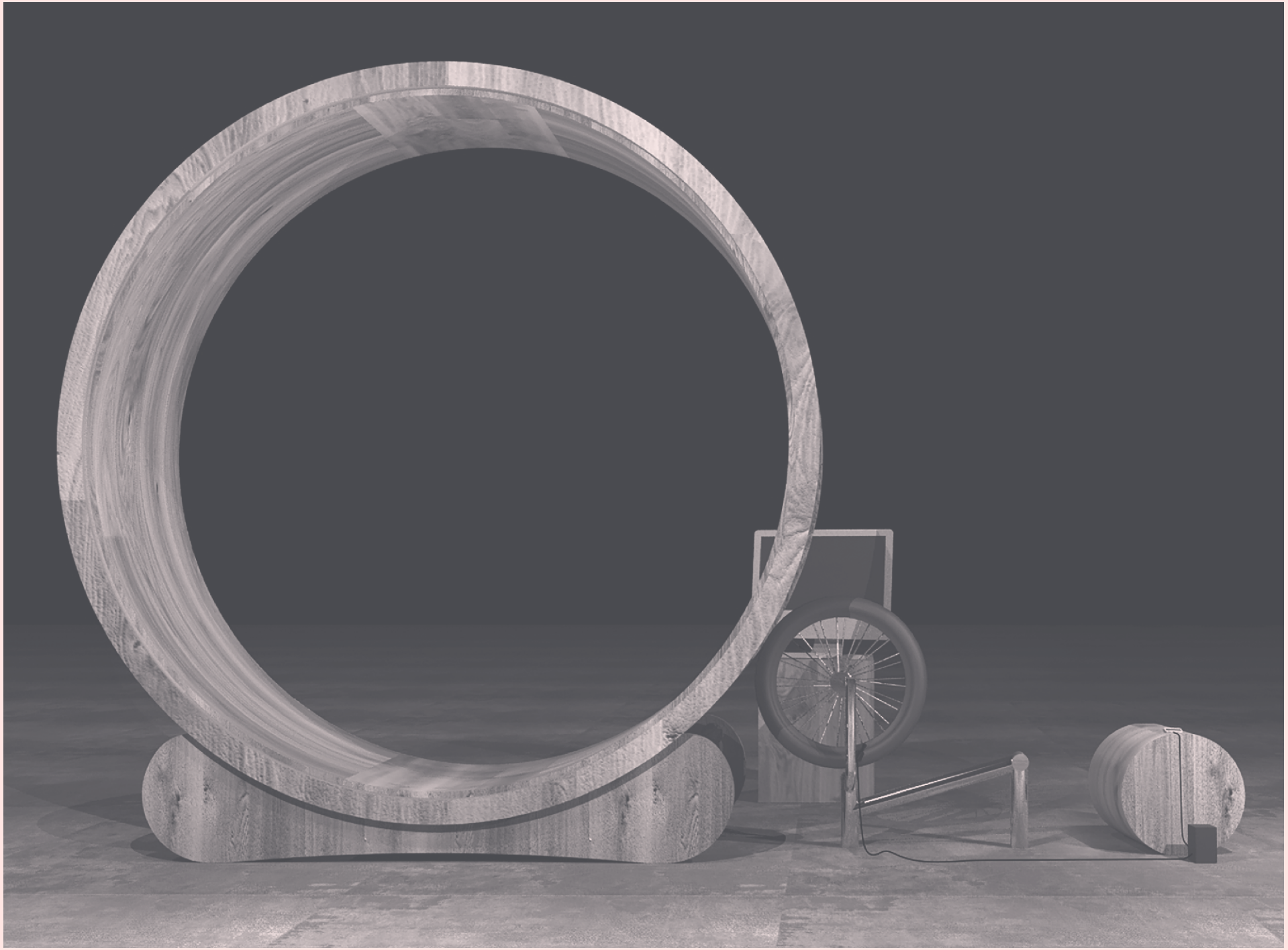
This is a prototype that proposes how tech workplaces can utilise virtual reality games that are designed to promote empathy. This is in order to mitigate targeted unconscious bias practices in the workplace. Using the Oculus Rift this proposed solution uses an interaction design approach as a cost-effective strategy that can be seamlessly integrated into the day to day functions unique to the 'tech' workplace. The goal of this project is to promote inclusion, awareness, and healthier social/professional environments for all workers. In return these positive effects are proven to boost business revenue, deriving creativity and innovation from the strengths of a more diverse workforce. Unconscious bias has been show to be a major issue in building a diverse and inclusive workplace. VR games that challenge the prevailing - yet unintentional - unconscious bias have been revealed by research to promote such creative innovation and this prototype explores modes of interaction design in this context.

OUTPUT 2015





HUMAN-SIZED HAMSTER WHEEL

(image previous page)

Adriano Mescia
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A 2 metre diameter, wooden wheel which allows people to charge their phone as they run on it.

Kinetic energy is turned into electric energy due to a bicycle dynamo that is attached to a small (12") bicycle wheel. This is put in contact with the human-sized hamster wheel.

This project shows how technology-dependent people have become, so much so that they are willing to run like a hamster just to charge their phone!

As well as the critical aspect, this project is also based on the theory of gamification (applying game elements to non-game activities.) It shows that when applied it changes people's behaviour, making them more responsible towards energy-saving. Although, in this case users do more than save energy, they will actually produce energy. They will do this thanks to the "gamified" everyday activity of charging the phone, which is turned into a fun and profitable (users exercise and get fit in this way) activity. Attached to the structure is an app which shows users performances and ranks them with other users (players). This feature is not to be underestimated as it adds extrinsic motivations for users, which will increase their engagement and satisfaction

EXQUISITE NOSE

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The exquisite nose is interactive cabinet with nose-shaped holes, each hole releases a smell / odour to evoke particular memories. Speaking into the engraved mouth below the nose, people can share the specific memory evoked by the smell, which will be recorded by the cabinet. All spoken memories captured by this wooden cabinet will then be compiled into an audio "exquisite corpse".

The project is based on my research question "Interfacing with the non-visual (sense)". I find it interesting that sense of smell is rarely explored and developed in the design field. There is a strong relationship between smell and our memories, and it is the most sensitive of our senses to activate the brain's cognition. Based on my research of smell, I designed questionnaires that aimed to determine the various types of specific smells that people have strong memory links to. By speaking of their own memories out loud to a recorded machine (unawares in this instance), the audiences' memories are "hacked" by this exquisite nose to create an audio exquisite corpse.

CIRCADIAN KEEPER

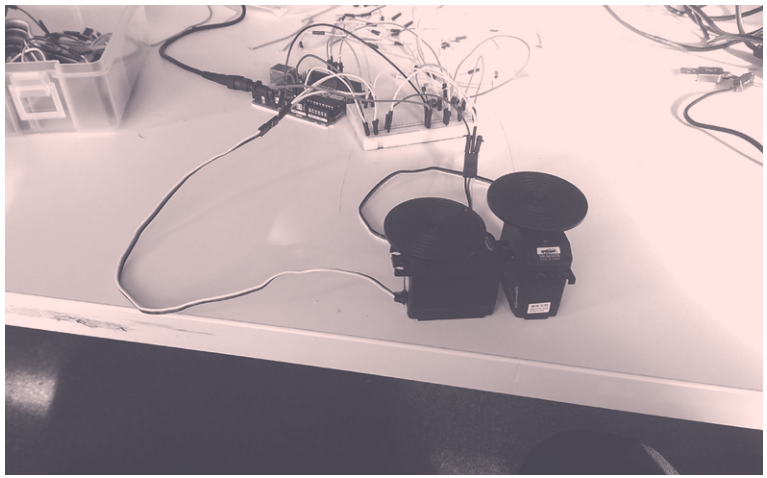
Eric Yuan-Tang Lin

A regular sleep pattern is a key to good health. With the growing consumption of the internet content through mobile devices and social media, modern citizens often go to sleep later than normal due to these activities taking place predominately late at night.

Circadian Keeper is a desk lamp with a built-in clock that alerts the user to go to sleep on time. Once the time for sleep is reached the head of the lamp will slowly droop along with the light dimming accordingly. A slight touch of the lamp will set it back to its upright state but it will keep "falling asleep" if the user is still active.

A motion sensor on the lamp tracks the user's sleep overnight, and wakes the user up in the best stage of sleep in the morning. It promotes the healthy habit of having a regular sleep pattern. The lamp does not force this behaviour but rather suggests a healthier alternative. Over time the user will hopefully take on the routine of a regular sleeping time.

The approach is inspired by Marc Hassenzahl's practice of "aesthetic of friction". It suggests that behaviour cannot be forced into people or established by self-regulated method. By applying small amount of friction to daily life, people can be slowly persuaded into alternative options to their habits.



IRRITATING SPACE

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In the context of IoT the objects that were once considered passive in the world now have the capacity of perception, reliable delivery, intelligent processing and sharing. In a sense the original mute objects are awake and, "assuming the role of socially relevant actors and strong-willed agents"(Bleecker, 2006), they may enunciate for themselves.This has led to new thinking about how the perception of objects has shifted and their transformative relationship with humans.

Using the speculative methodology of animism, inspired by Usman Haque's critical thinking "A truly smart product might do something that we might not understand or even disagree with." The project asks what will happen when the objects have complete autonomy over their personality? What if they begin to annoy us instead of interact with us in a friendly way?

With this speculation, the project, "Irritating Space", offers a new kind of narrative of the emotional effects objects will have in our daily lives.

LIVE AS PARTICLES

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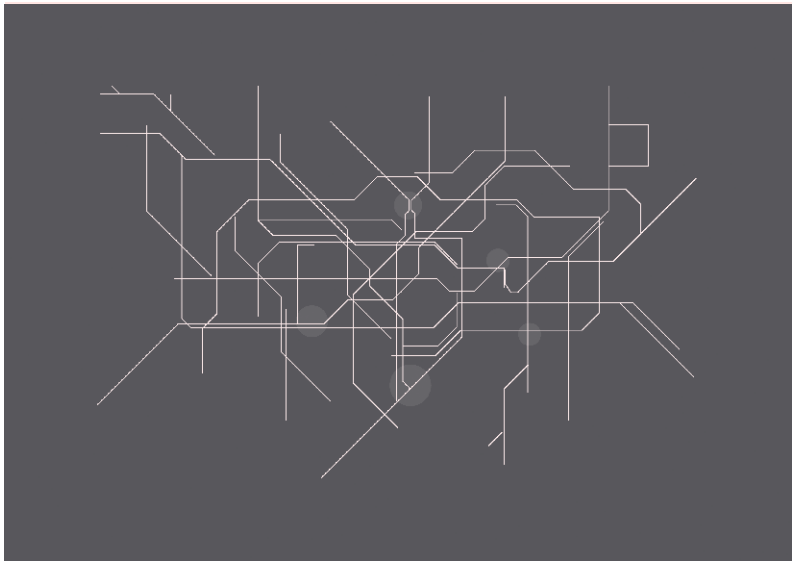
Live as Particles is a data sonification exploring the housing situation in London. Based on the data such as 'House Price Index' and extracted from various sources, showing the house prices changes over the years in London. It explores certain districts where people are relocating as well as the established community changing over the years. The data is responding to human activities and city development in these areas and uncovering some of the factors that are making these changes. Together with noises from other data sources such as the stock market, social media, news etc. the project hopes to give the audience a mixture of melodic and discordant sonic representation behind the soaring numbers.

By interpreting the data commonly used in trading markets, commercial entities or government, it is aimed to provide an alternative "observation" of the data through sonic experience. People can explore the sources of information interpreted by digital generation of sound, interacting with the fast changing city with other areas of our perception.



SONIC INTIMACY

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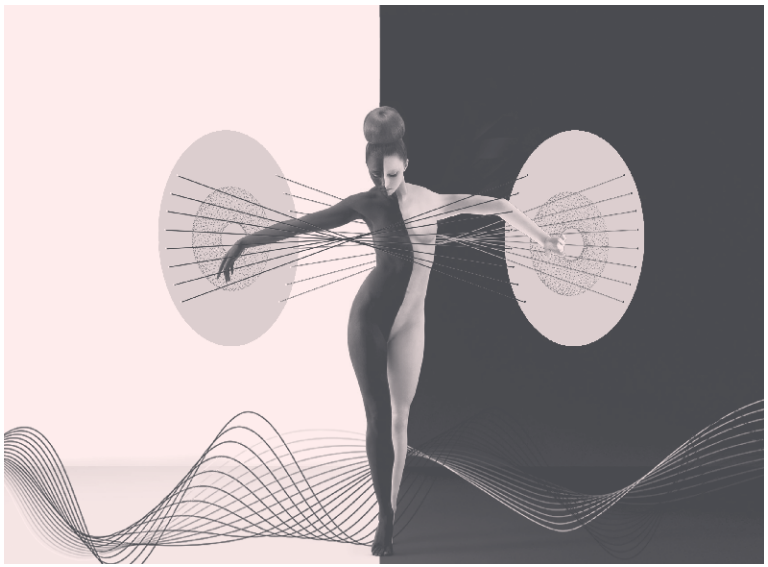
"Sonic Intimacy" is a performance with wearable electronic devices that attempts to challenge the 'proxemic' relations between people. According to the anthropologist Edward Hall the value in studying proxemics comes from its applicability in evaluating not only the way people interact with others in daily life but also "the organisation of space in their houses and buildings, and ultimately the layout of their towns".

In the performance the costume of the performer represents a persons intimate space, which according to Hall is 45cm radius around us and indicates a closer relationship or greater comfort between individuals. This can be seen often during intimate contact such as hugging, whispering or touching. The performer acts with two transparent Perspex circles that they are connected with elastic strings. This act is turned into sonic performance and the pitch of sound is controlled by the elasticity of the strings through embedded sensors.

The interaction between the performer and the audience emphasises the impact of proxemic behavior - the use of space - on interpersonal communication.



THE MINANKGABAU CURTAIN

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"The Minankgabau Curtain" is a collaborative project that aims to narrate and reveal the politics behind a model of a Sumatran Palace, which is exhibited at the V&A museum. It is an art installation that attempts to dissolve the boundaries between the object and the spectator and create an immersive experience for the participants.

A big part of the research is dealing with the narration of the historical, cultural, social and anthropological features of the Minankgabau civilisation. Interviews of different types of Malaysians enriched our narration to the "Sumatran Palace". The story of the roof's shape, the history of the name, the customary laws system in Minankgabau society, personal experiences and memories from residents of these houses and the role of women in society are some of the questions that Minankgabau people were asked to answer.

Further to gaining significant knowledge about the object, these interviews gave a different perspective to the approach of this narration. As a result it becomes a crucial part of our installation. The interviews comprise the core of our installation as they set to be the emergent piece that we aim to reveal. A wooden curtain wall that consists of 21 panels, whose shape is an abstract form of the roof of Minankgabau architectural type, is interactively revealing the videos of the interviews following people's movement.

LUNCHBOX PROJECT

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According to the American Academy of Pediatrics a father's voice tends to better stimulate the senses than mother's familiar voice. Thus when fathers read fairy tales to children every day, this can help children to develop their intelligence.

For this reason I have been interested in the relationship between fathers and children. In the past we have focused on the problem of children separated from fathers to study abroad, so that there are a significant number of countermeasures in order to help children. However, it is time that people concentrate on the mental problems of so called 'goose fathers' as many have committed suicide out of loneliness and solitude. Research has been conducted concerning objects that goose fathers can use to share their thoughts with their faraway children. Through the research goose fathers definitively wanted to have some time to share their life, enjoying something together with their children. Cooking was considered one the best ways for them to do this even though they need to invest a lot of time to prepare the recipes and cook. Above all, while people eat together, they can feel that they are with their children.

My project explores the interaction potential of lunchboxes to help the goose fathers not to feel loneliness as they can both eat and listen to their children's voices at a pivotal moment in their day.

FORBIDDEN KNOWLEDGE

(image overleaf)

Lama Assaf
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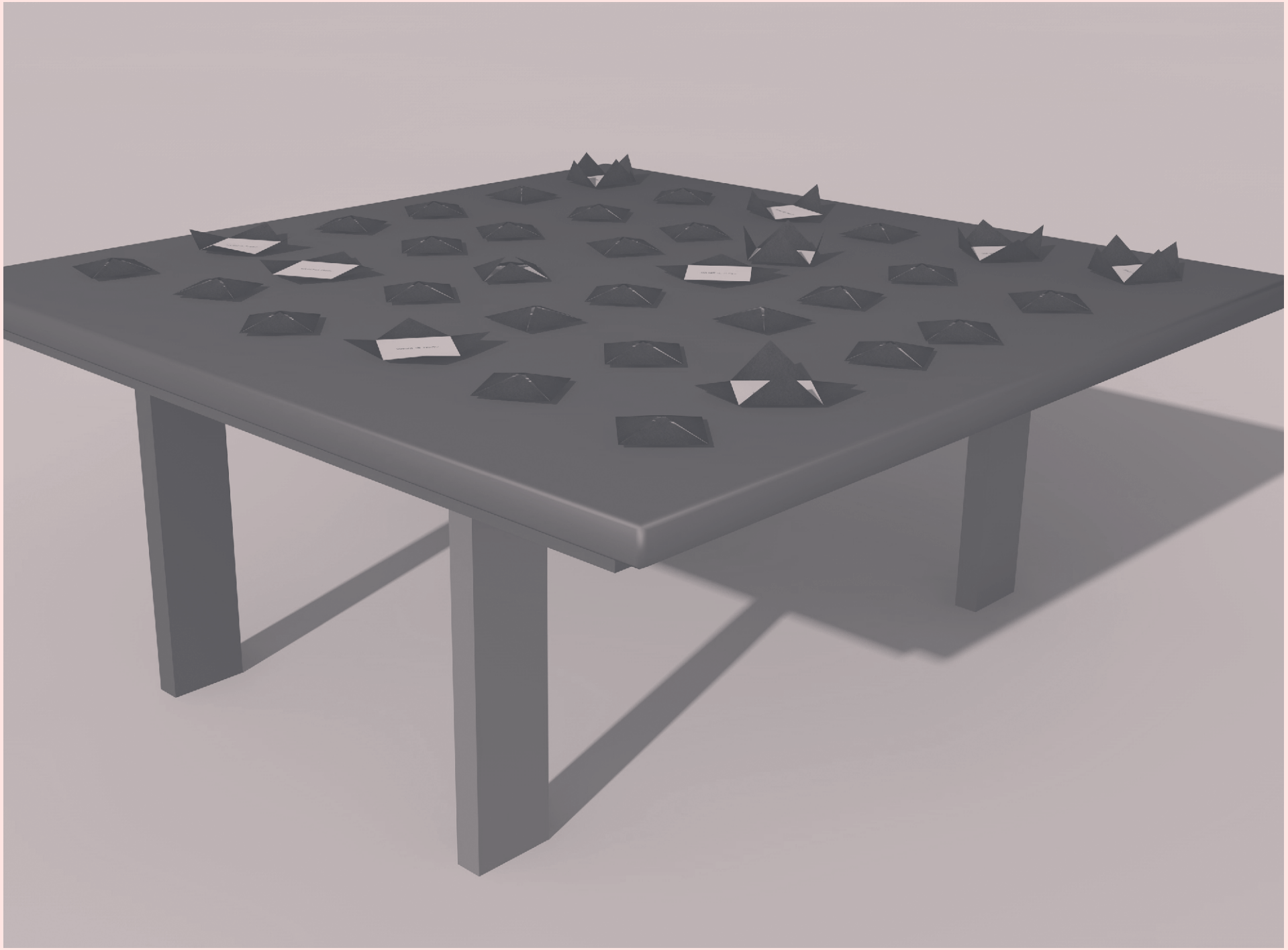
"We are unaware even today, as we study technique -the techniques that relate to men - that we are drawing on the great stream of magical techniques."

Jacques Ellul
The technological society

The world of Interaction Design is filled with examples of inventions that seem to break our understanding of everyday objects behaviour, thus creating the impression of a magical experience. Forbidden knowledge is an interactive installation that aims at creating a magical experience for its users using technological artifacts. In the work a series of hidden messages unfold on a table under the user's hand. They will find themselves controlling paper, sound and knowledge without the need to touch them. Through touch users leave a mark of their presence. Using muscle wires, Photochromic ink and capacitive sensors in this installation users find themselves controlling seemingly inert objects with their presence.

Magic brings a feeling of enchantment and wonder, which is a crucial part of everyday life - one which we are forgetting in our 21st century - by engendering the belief in the impossible as I tried to do in this project, new ideas come to light expanding my understanding of our imaginations and thus our possibilities in the field of interaction design.



THE RIDDLER

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“A box without hinges, key, or lid,
Yet golden treasure inside is hid.”

J.R.R. Tolkien
The Hobbit

This project targets riddle fans. Inspired from puzzling games this project aims at reviving social physical interactions with brainteasers in theatrical “Folie imposée” (imposed craziness) scenarios. Placed in a public space this seemingly curious wooden box is not as easy to open as one would think. Communicating through a thermal printer it pushes the user to solve the puzzles needed, go to the given locations and interact socially with the box in the aim of solving all the enigmas and finding out the contents of it. From rubbing to shaking to running around finding hidden spots, this box tests the limits of the user’s curiosity playing the role of a black box that never actually opens.

The concept behind The Riddler was to create an interactive object for a social environment that invites the users around it to interact with the space and the people around them.

SIX EMOTIONS:
Interactive
cinema-facial tracking

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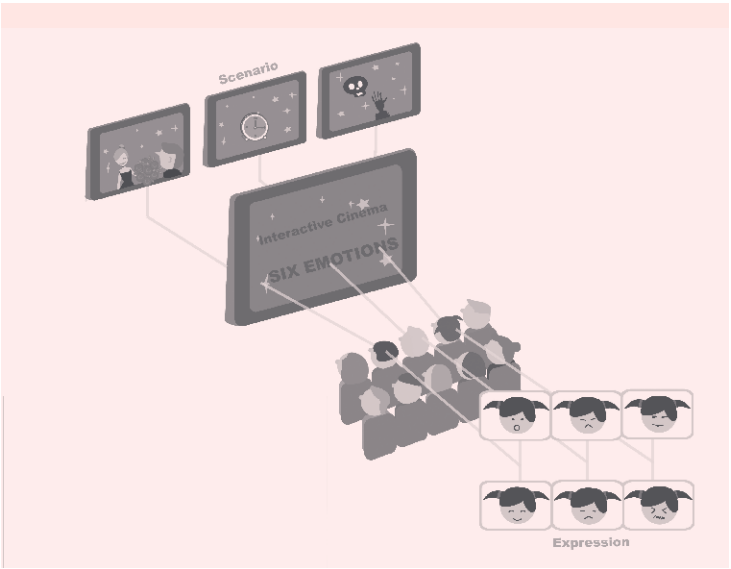
Through interactive film & cinema and facial tracking technology, one is able to enhance the audience experience with dynamic narratives. This creates a customised interactive experience based on the unconscious behaviour of the audience member.

The technology behind the film will read facial expressions and emotional responses elicited from the audience. They do not know they are watching an interactive film clip with facial tracking so they will be expressing genuine emotions and thus, unconsciously changing the storyline. These inputs, detected by the sensor systems before the film begins, will influence the outcome of the storyline.

This short interactive film is called Six Emotions, written specifically to display a wide array of emotions. In order to make it interactive (dynamically adapt the storyline to the facial and emotional input), I had to prepare several different storylines using these six emotions: happiness, sadness, anger, fear, envy, and desire. The six emotions represent the six storylines of the project.



KALEIDOSCOPE

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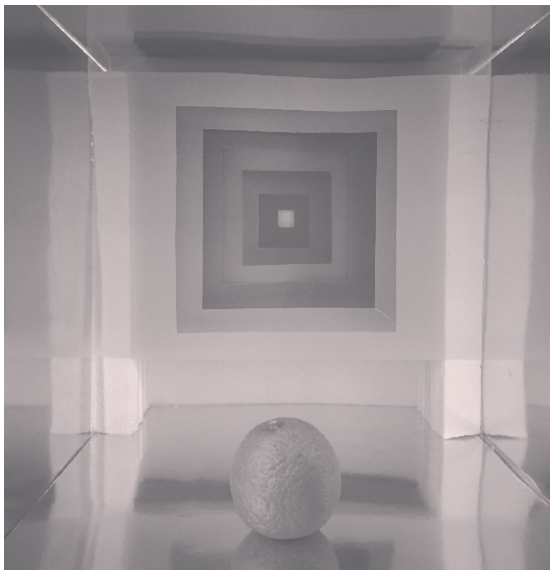
My project is based on the kaleidoscope design often used by children. By revising some components a new style of imagery will be created to allow a new user experience. Traditionally people use it to alternate between patterns of colour by peering through an empty circle to see the changes inside. I chose to let the audience interact with the device to allow a more immersive experience of the game, “Webcam”. Inside the pattern is generated based on the way the user looks through it, changing both distance and will cause a change in the pattern. The user can freely move their head and interact with “webcam”. By understanding previous designs of toy Kaleidoscope and the experience they provide I have found that “distance” plays an important factor in achieving its unique effects; people are able to freely manipulate their desired distance between them and the scope to create a range of patterns. By using the illusionary effect of the kaleidoscopes patterns images will appear larger on the inside of the scope than the outside. The visual impact this tool provides is of great interest in relation to providing a playful interactive experience. For these reasons I have chosen to pursue this design and explore possible modifications to achieve the best interactive experience.



PORTAL OF DISCONNECTION

Shail Mehta
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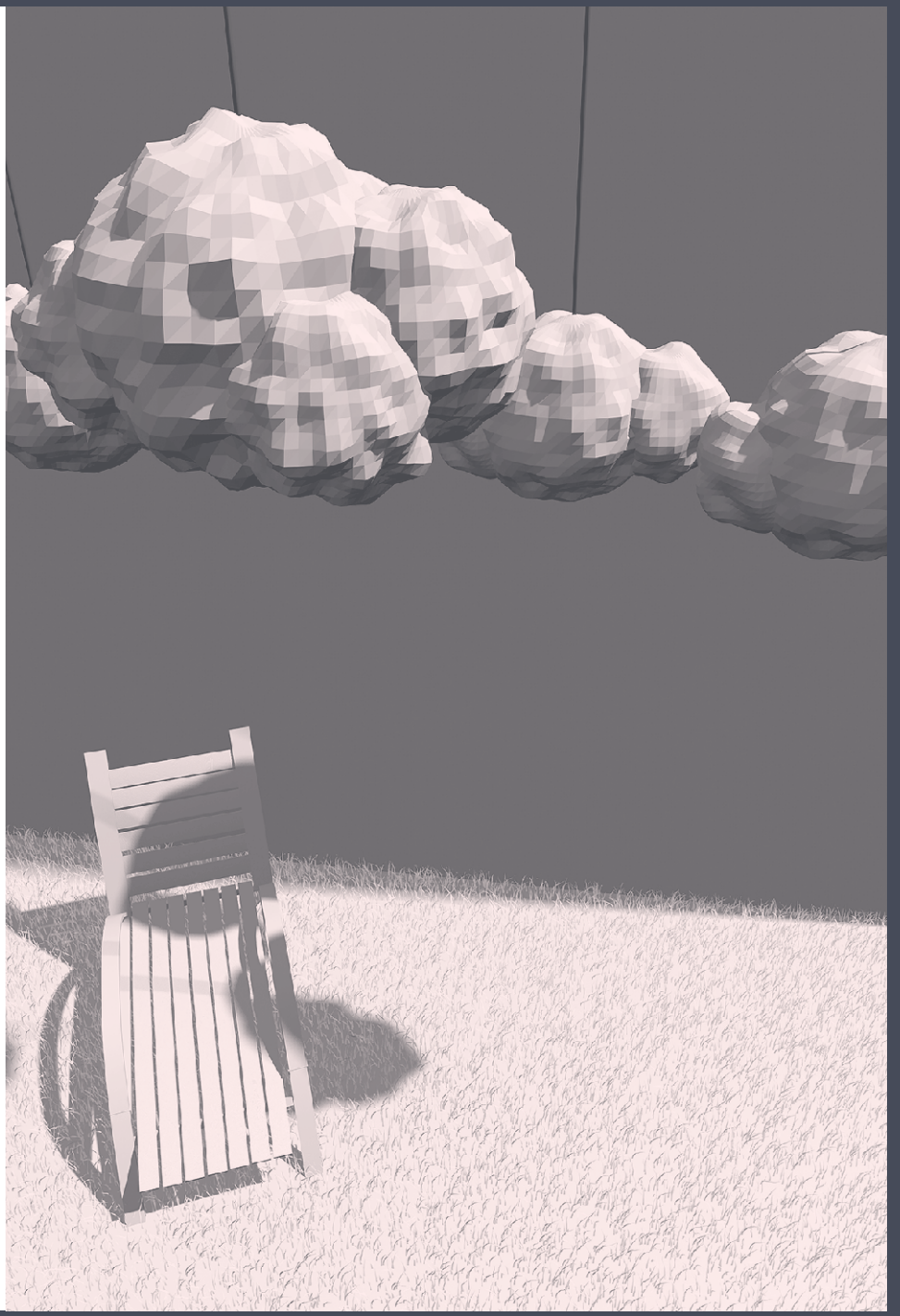
"The senses... are sensors detecting the constituent of substances via mucous membranes. What we have conjured as the world is a synthesis of perceptions sensed by these membranes in the seat of sensation"

Kenya Hara

The project focuses on the disconnection between the visual representation and the haptic environment. The purpose was to subvert users expectations of a visual environment at the moment of interaction.

The project constitutes a false space depicting a more comfortable and visually appealing environment with embedded motion sensors thereby activating the space with the presence of the audience. Once the audience enters the space it immediately switches from a pleasant experience to a completely discomforting haptic environment causing the audience to experience disappointment.



GO-OGLE HOUSE:
A CRITICAL PROJECT OF INTERACTIVE ADVERTISING

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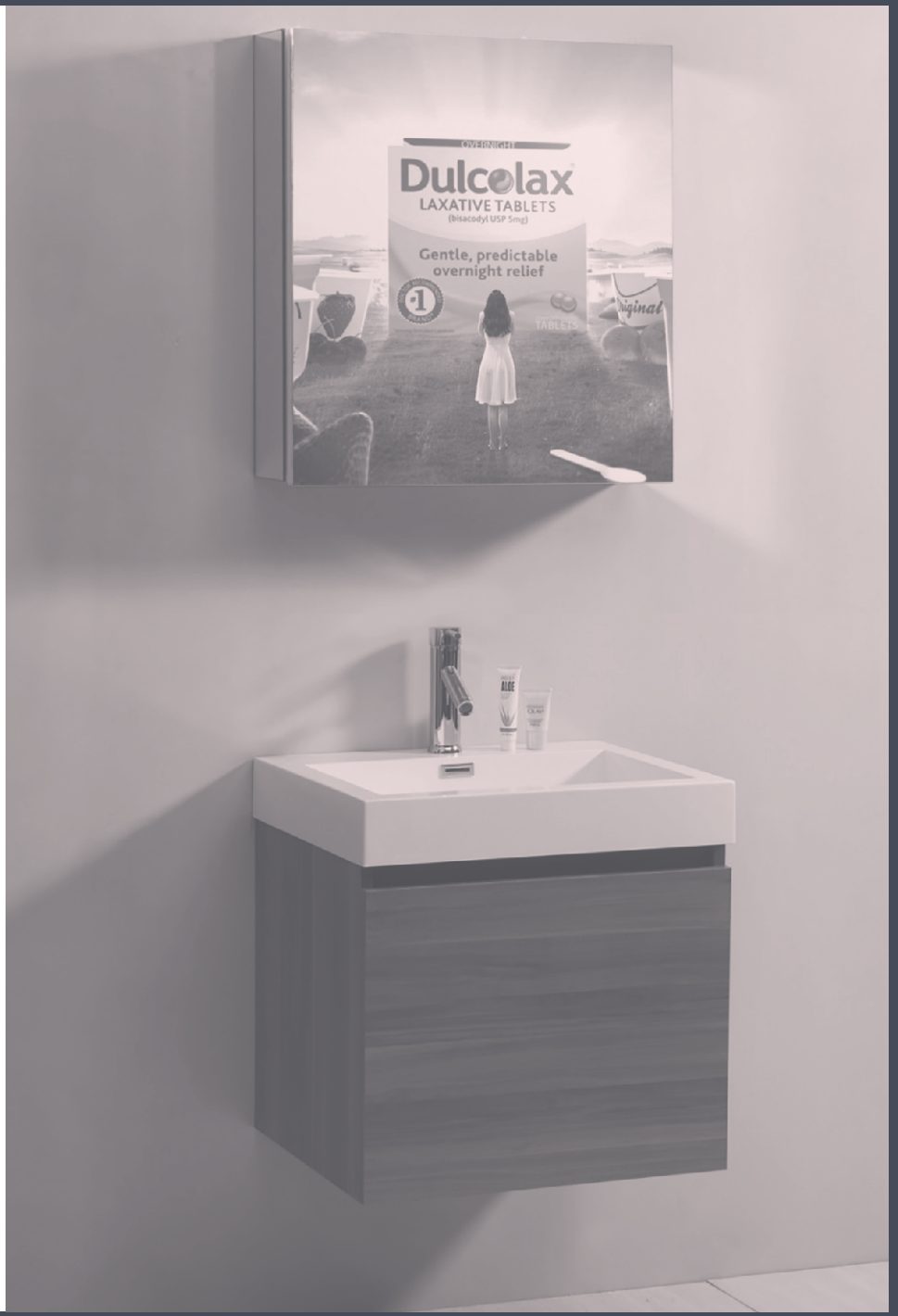
This project speculates the scary future possibilities of interactive personalised advertising, embedded to social housing in a form of a demonstration house. It criticises the recent and upcoming form of personalised and User-Generated Content of online and tangible interactive advertising. It is a prediction of the future interactive advertising design that will possibly be dominated by personalised, intrusive and annoying contents, from the gradual evolution of embedded technology.

The Go-ogle House consists of rooms: toilet (sink) and living room (TV unit). An advertisement banners as image advertisements are distributed to common domestic objects. They are interactive in different ways. The interaction utilises a combination of common interactive technologies: motion tracking camera, pressure sensor, Leap Motion hand gesture sensors and proximity sensors which are connected to Arduino and computer controlled. This assembly of sensors and actuators show just how close this future maybe.



ACCELERATE.
Your driving habits do matter.

Oleksii Perekatov
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Many of you heard about the ongoing VW scandal. I decided to find out and communicate what impact do car emissions really have on us and what can we possibly do to reduce negative impact.

The installation itself is a glass cube with a smoke generator connected to it and a projector to communicate visuals. Users are invited to press the accelerator pedal and observe how added fuel consumption and emissions associated with extreme revs and speed will affect people on earth if all drivers are going to drive that way. As the accelerator is pressed the rev number starts to increase gradually, smoke starts filling in the cube and number of potential victims is displayed on the smoke.

RHYTHM:
we shaped the computer and now the computer shapes us

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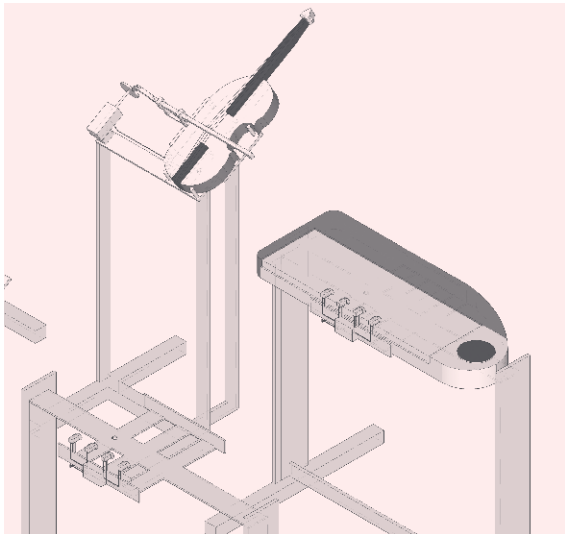
"Rhythm" is a critical design installation warning of a potential future crisis that is predicted between the relationship between humans and machines.

The animal-like capacitive fur of this object is used as Natural User Interface (NUI). It features a series of automatic instruments that requires interaction from audiences to fix the music through natural movements and gestures—like stroking, scratching and patting. It challenges the idea that smart machines will replace the value of creativity and skills, and that supervisory role humans will solely play.

The project is inspired by Anna Flag's "Smart Fur" introducing the development of the NUI. It is projected to redefine the social role of machines, transforming the way we interact with them by seeing them as living species—no longer just machines and tools.

The objects will be designed to fundamentally shape this new dynamic. When people receive the "living" reaction from the machine, they will feel a sense of empathy. A new intimacy between human and machine will be established, and empathy is a vital factor to this.



THE ROUGH SLEEPERS SHOWER KIT

Ashraf Saifullah
me@ashworf.com

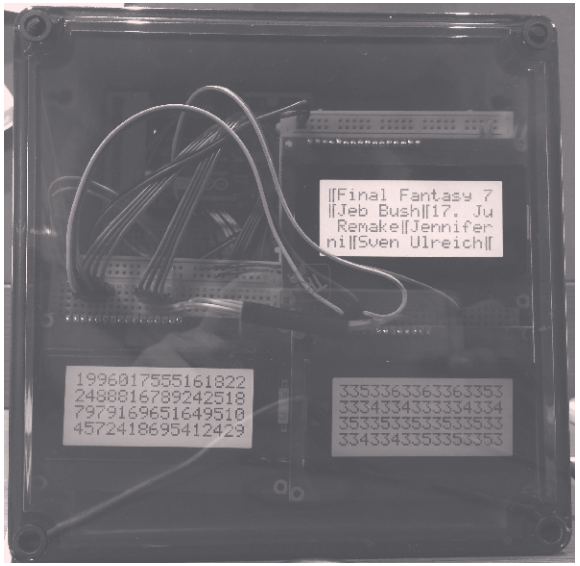
Other than a roof over our head, the next most important thing is hygiene. Hygiene is important because it can help us prevent diseases and conveys important social information. To have a place to shower is a luxury to homeless people especially rough sleepers. This Urban IxD project is a kit for the rough sleepers to hack unused telephone boxes turning them into nomad-like showers.

Rainwater is collected in a box supplied by the kit that is then heated up. The heat is created using solar thermal energy connected to an array of plastic bottles, which then are placed into an insulated water container. The kit additionally contains a set of tools and a manual for people to build their own shower bags using materials that they can find on the streets combined with the premade materials. If it is not raining, rainwater can be replaced with water from any nearby water source. This kit can be handed to a group of rough sleepers in order that their own community produce the shower, take responsibility for the shower and share the resource communally.

MACHINE POLITICS

Pim de Wit
contact@pimdewit.nl

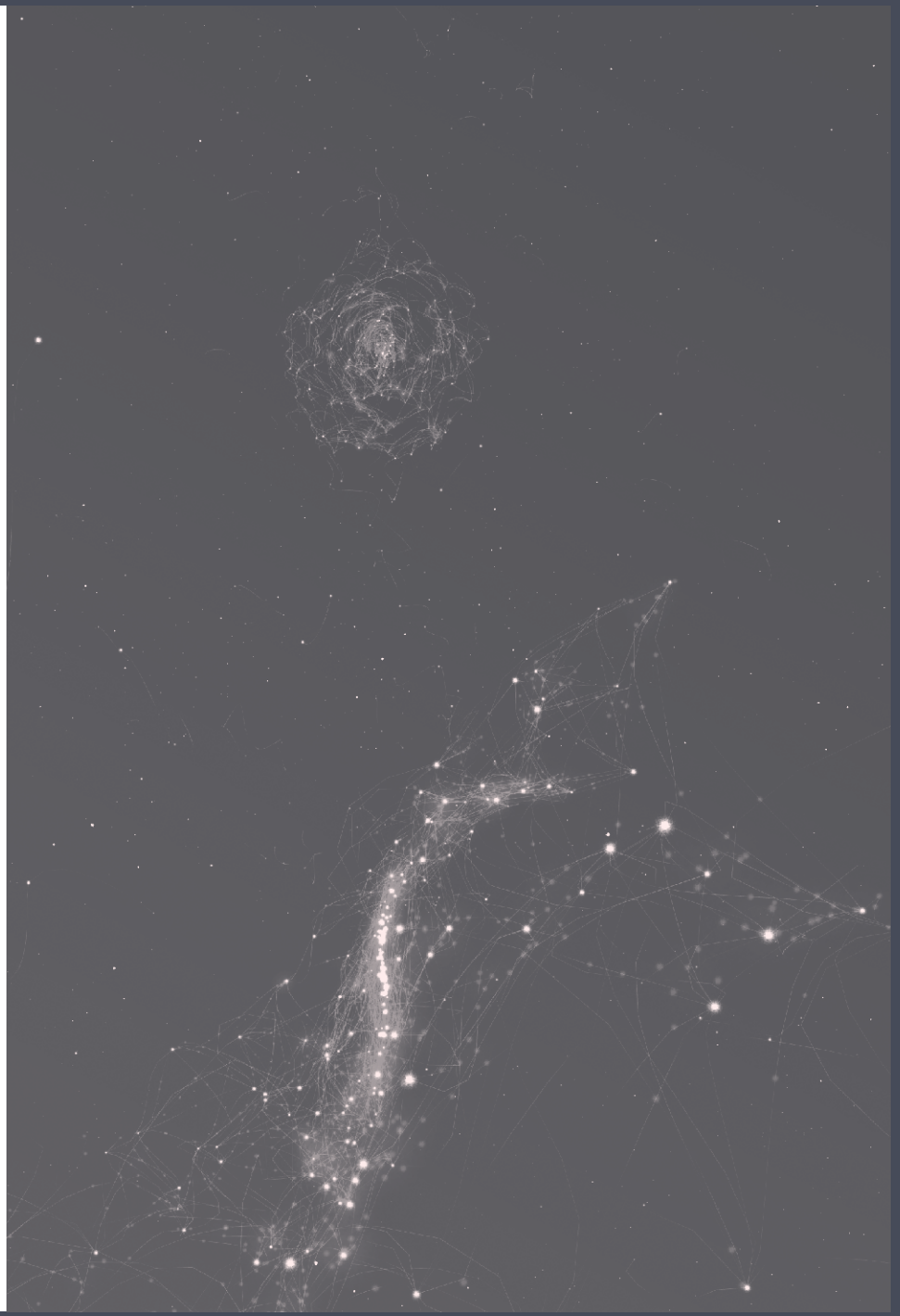
'Machine Politics' tries to take a step closer to Artificial Intelligence(AI) biggest question. Is it possible to create a machine that can think with reason and show emotion? This project introduces a system where a module decides which machine is 'allowed' to show its data. The module will make the decision by looking at the data and its relevance to human interest.



TECHNO-SOCIAL INFLUENCE

Pim de Wit
contact@pimdewit.nl

My final major project is about techno-social influence. It visualises how many people you can reach with a single status update by displaying friends of friends, followers and predicted connections. For every username it generates a unique structure which connects with other accounts based on daily presence, follower activity amongst others.



MA INTERACTION DESIGN COMMUNICATION

MA Interaction Design Communication is a practice-led design course that prepares students to design for an increasingly technologically informed and interdisciplinary design world with skills in the following areas: interaction design, design prototyping, physical computing, user-centered design, open source digital platforms, design research, foresight and insight, experience design, communication design, speculative and critical design, interactive design and digital arts.

Tutors & Visitors 2015

Ben Stopher
Programme Director

Eva Verhoeven
Course Leader

Nicolas Marechal
Tutor

Visiting Tutors:

Tobias Revell
tobiasrevell.com

Oliver Smith
oliversmith.cc

Other Visitors:

Claire Rowland
UX/UI Consultant

Alex Gluhak
Intel Labs

Ben Barker
Pan Studio

Natalie Kane (with Tobias Revell)
Hauntology Workshop

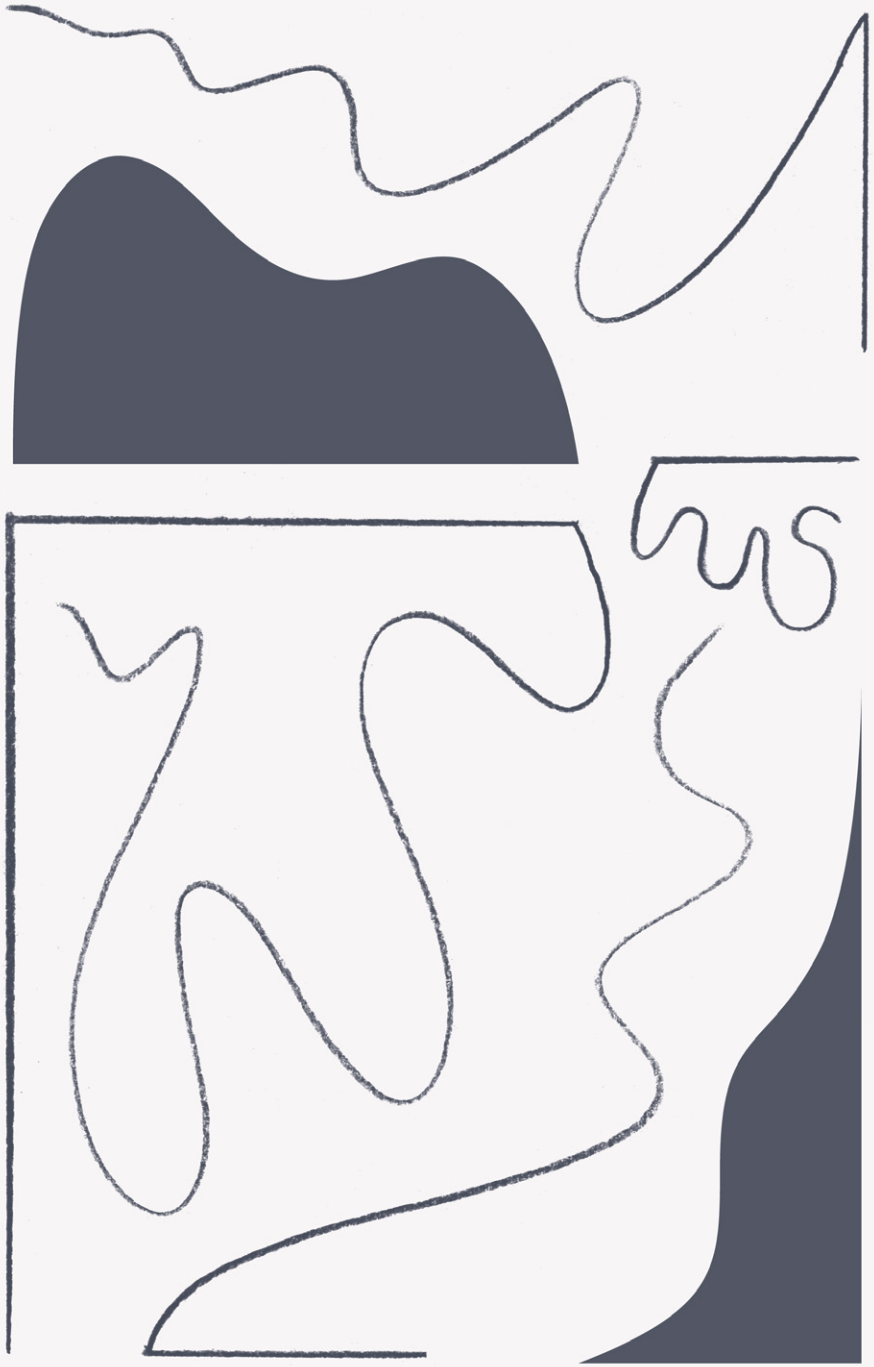
Joseph Popper
Film Making Workshop

William Bondin
Arduino Puppeteering Workshop

Specialist Technical Staff:

Physical Computing & Design prototyping
David King

Tom Lynch
tomlynch.co.uk



Thesis Extracts
Written work from
MA Interaction Design Communication

Narrations/Phenomena of Bodily Movement

by Kalypso Kaplani

The body is a medium of constant communication, 'We cannot not communicate' (Watzlawick et al. 1967), and the physical movement is a semantic element in interactions. Given the strong communicative role of the moving body, we need to analyse it as a mediating artefact (Vygotsky 1978) to allow technology a reading of bodily movements beyond touch and click into the spatial (shape) and temporal (frequency, repetition and scale) realms. In fact, we must explore the moving body as the interface through which one may control, access, influence and interact with digital technology. Research in bodily movement comes from such different fields of study as architecture, philosophy, anthropology, new interactive media, performance studies, dance and social semiotics, and the convergence of these can help us read the narrations of bodily movement more accurately.

Movement generates a non-determined concept of space where spatial and bodily boundaries are constantly blurring. Movement and architecture usually appear in direct opposition, as dynamics and stasis , with architecture generally considered to be static in contrast to the moving human body (Hansen, 2011). French philosopher and phenomenologist Maurice Merleau-Ponty has argued that the body is not a static component of space, but instead he considers the body, 'le corps propre', as the expression of an intermediate state between subject and object. He presents a concept of spatiality in which the 'living body' becomes the centre of focus, using the term in 'Phenomenology of Perception' to describe his embodied understanding of bodies and their surrounding environment which, according to his approach, barely defines how we perceive our own existence. He introduces the idea of a moving and interacting body-subject that is characterised by a corporal consciousness and it is not fixed and static as it was considered in the humanist practice.

In anthropology, physical movement has been interpreted as non-verbal communication in relation to verbal communication. The anthropologist Edward Hall (1966) argued that we communicate through the use and position of the body in proximity to others. Ray Birdwhistell (1971) founded kinesics as a field of research and developed a deciphering system of facial expressions, posture, and so on, to be interpreted in the context of other means of communication. In cognitive science, the role of our bodies is increasingly taken into account. Alva Noë (2004) argues that our perception and consciousness depends on, and is a result of, our bodily capacities and activities. Rolf Pfeifer and Josh Bongard (2007) show how thought is constrained as well as enabled by the body, by analysing the making of artificial intelligence. In an embodied communication perspective Ipke Waschmuth et al. (2008) argue that human communications go beyond verbal communication and that our bodies enable "parallel and highly interactive couplings between communication partners".

New and interactive media focus on the body captured and surrounded by technology. Simon Penny (2004) suggests a framework for interactivity that goes beyond the theories of visual art, as interactive images are procedural, and previous theories do not include the 'ensuing activity'. Mark Hansen (2004) proposes a philosophy that encompasses the development of images in communicative processes, where their perception is bound to the activity of the body. Following on from Kathrine Hayles' (1999) disconnect of information from a body or medium, Anna Munster (2006) also discusses new modes of sensory engagement, implying that digital aesthetics have reconfigured bodily experience and reconceived materiality.

In contrast, performance studies has a long tradition of reading movement like a text as a part of a mediating scenario, 'a showing of a doing' (Schechner 2002, p. 141). As traditional performance increasingly makes use of interactive technologies the per-

formed movements are not only expressive but functional in that they enable other media, such as computer vision and video projection, to express and mediate. In dance movement is studied as the main mediating material. The communication focus, however, has been on the role of tacit or bodily knowledge and whether it may, in fact, be seen as knowledge, as this kind of communication does not fit tightly within the structures of language (Sigman, 2000). In the non-verbal communication field, 'typically, gestures are thought of as arm and hand movements, but head gestures are also well known' (Knapp and Hall, 2006). When movement is read by technology it is usually interpreted together with language.

Towards an Invisible Magical Interaction

by Lama Assaf

"A computational process is indeed much like a sorcerer's idea of a spirit. It cannot be seen or touched. It is not composed of matter at all. However, it is very real. It can perform intellectual work. It can answer questions. It can affect the world by disbursing money at a bank or by controlling a robot arm in a factory. The programs we use to conjure processes like a sorcerer's spells."

Abelson and Sussman, *Structure and Interpretation of Computer Programs*

Consider entering a space only to find in it a collection of white balls hovering steadily in mid-air. You could grab a ball, reposition it on its axis and let it go and it would could continue defying gravity, like magic. This was exactly what visitors to the public library of Aarhaus encountered during a long-term field study of 'Aerial Tunes'. Aerial Tunes is a tangible music interface, consisting of 6 white balls floating above 6 white cubes, by manipulating each ball's vertical position, users create their own soundscape. While users may have been aware that this was a technologically realised interactive installation, when asked for feedback they described it nonetheless as magical.

Despite the fact that technologies of all sorts impact almost every aspect of our daily lives we continue to live with relatively little conception of how they work. We use them and rely on them without question, just a sense of enchantment. Since the European Enlightenment magic has been regarded as primitive and ignorant, has often been disregarded for being irrational, and has

not been seen as part of modern society (Mulcahy, 2010). But, despite this, and in the face of the fact that science continues to replace magical explanations with scientific ones, magic still pervades our modern society, from belief in superstitious actions such as knocking on wood, to teaching children that Santa Claus brings presents and the Tooth Fairy pays for teeth. Furthermore, and somewhat ironically, magic is still a big part of the technological realm - one need only look at the way products such as Apple's Magic Mouse are described and marketed.

The field of interaction design is filled with examples of objects that do not seem to behave the way you would expect them to. This break in the physical causalities of artefacts is what creates the appearance of a magical reality. We do not necessarily see this reflected in the field of technological research, however, despite Arthur C. Clarke's Third law in 'Profiles of the Future' which states that "Any sufficiently advanced technology is indistinguishable from magic." (Clarke, 1962). We can see from Tognazzini (1993) that the field of magic is still considered separate from that of technological research.

Nonetheless, there are some research examples that defend the idea of magic being an important attribute for interactive projects to possess. In their paper, 'In search of metaphors for tangible user intefaces' Svanaes and Verplank (2006) suggest that magic and paranormal phenomena could be an effective way to look for new TUI interfaces. Landin (2005) then points to the creation of objects which transcend common sense, thus making them surprising while remaining recognisable, causing them to appear magical.

Today our sensory capabilities are excited more by digital or screen magic than stage magic or physically enacting magical fantasies. What we consider to be our reality is consistently changing but we will forever be lured by the concept of the fantastic. One of the functions of magic 'consists in the bridging-over of gaps and inadequacies not yet completely mastered' (Malinowski, 1954) and it is a system that relies on the belief in new perceptions and experiences, without assuring their realisation. The real potential is to promote a trust in the unknown, a relationship with uncertainty which can aid the consideration and design of invisible, interactive, and even magical, interfaces.

Thinking What Things Thought
How to Implement Personalities to Objects to Explore the Interaction Design Potential?

by Qiaozhi Zhao

Bruno Latour (2005) in an exhibition titled "Making Things Public: Atmospheres of Democracy" argued that what unites people are things, they play a role in linking people which may not be visible but can be vital for community development and integration. Materialist philosophies (Coole and Frost 2010) and anthropological theories (Ingold 2013) claim that things are communicative and independent and that they can be freely moved around and used by people across the world. Here new materialist theories reflect the agency of and symmetry between human and nonhuman actors. In a special issue of Critical Inquiry, 'Thing Theory', Bill Brown (2001) argues that, rather than being merely objects, things reveal particular subject-object relationships in specific temporal and spatial contexts. We will examine this relationship between subjects and objects in the realm of the Internet of Things (IoT) currently expanding across the globe.

Once a "Thing" is connected to the Internet it can perceive its environment, analyse data, and deliver data to other things and, thereafter, things can communicate and interact with each other independently. Through this connection the boundaries

between humans and things become difficult to distinguish and the basic relationship between them is subverted. Mitew (2014: 6) argues that the IoT enables humans and objects to interact and interconnect actively, and that this transformation and amalgamation of behaviours and activities forms diverse agencies in both things and humans. In this context, things assume the role of socially relevant actors and strong-willed agents that create social capital and reconfigure the ways in which we live within and move about physical space (Bleecker, 2006: 2). Arguably this shift or transformation allows formation of new social objects (Kluitenberg, 2006: 8) and, therefore, we need to consider the identity-shift when previously obscure and mute objects acquire agency. To put it more plainly, we need to explore what might count as an object and what might count as a subject, when both object and subject can act and react to each other in new ways. How might these things act on, react to, or catalogue their world? How might humans experience this agency? The following examples should begin to catalogue and contextualise this.

To distinguish the instrumental character of "things" merely connected to the internet from "things" actively participating within the social networks of the internet, Julian Bleecker (2006) uses the neologism "Blogject", literally 'objects that blog.' According to Bleecker, a Blogject is an object that collates information about itself and the surrounding environment. He pays particular attention to the participation of 'objects' and 'things' in the sphere of networked social discourse variously called blogosphere, or social web. In Bleecker's opinion, Blogjects do not just publish, they also circulate conversations. The location of Blogjects can be traced both in space and time and stored for access in future, along with their embedded histories of encounters and experiences, allowing their continued, active, participation and discussion in a social environment, as first-class citizens, at the same level as humans in the same environment. (Bleecker and Nova, 2006).

Likewise, Bruce Sterling's (2005) book 'Shaping Things' coins the word "spime", referring to a thing, an object that is more an instantiation of data, a collection of relationships. Spimes are neither old-fashioned artefacts nor complex machines. In fact, a spime can keep track of all movements and activities of an object, including those within the social and environmental realm. According to Sterling, spimes become "material instantiations of an immaterial system."

So, objects may record data and pass comment on their world and, indeed, themselves but how might this manifest for humans? To get a sense of this we can look to the 'Hello Lamp Post' project, developed as collaboration between PAN Studio, Tom Armitage and Gyorgyi Galik. An experimental, citywide platform

for play, Hello Lamp Post allows the citizen to explore the city's infrastructure and make conversation with the objects. The objects offer an opportunity to rediscover your local environment, share your memories of the city and uncover stories that other people leave behind.

It is crucial to emphasise that artefacts have a rich array of information which can be accessed by humans and other objects, as with the blogject and the spime. Furthermore, we see that the information within artefacts can create an animated environment, a space for social interactions across the world and with diverse, previously mute objects which operate as a connection between thei immediate environment, but also society at large which includes several people and non-human objects. (Mitew, 2014: 8).

Hyper Cinema:
Can Hyper-Narrative interactive film enhance viewer's engagement without altering the narrative by creating shallow distraction?

by Shail Mehta

"According to this widespread notion, viewers' identification with the camera leads them to inadvertently believe that not only what they are watching is real but that they are actually the ones looking or even creating it"

(B. Shaul, 2008).

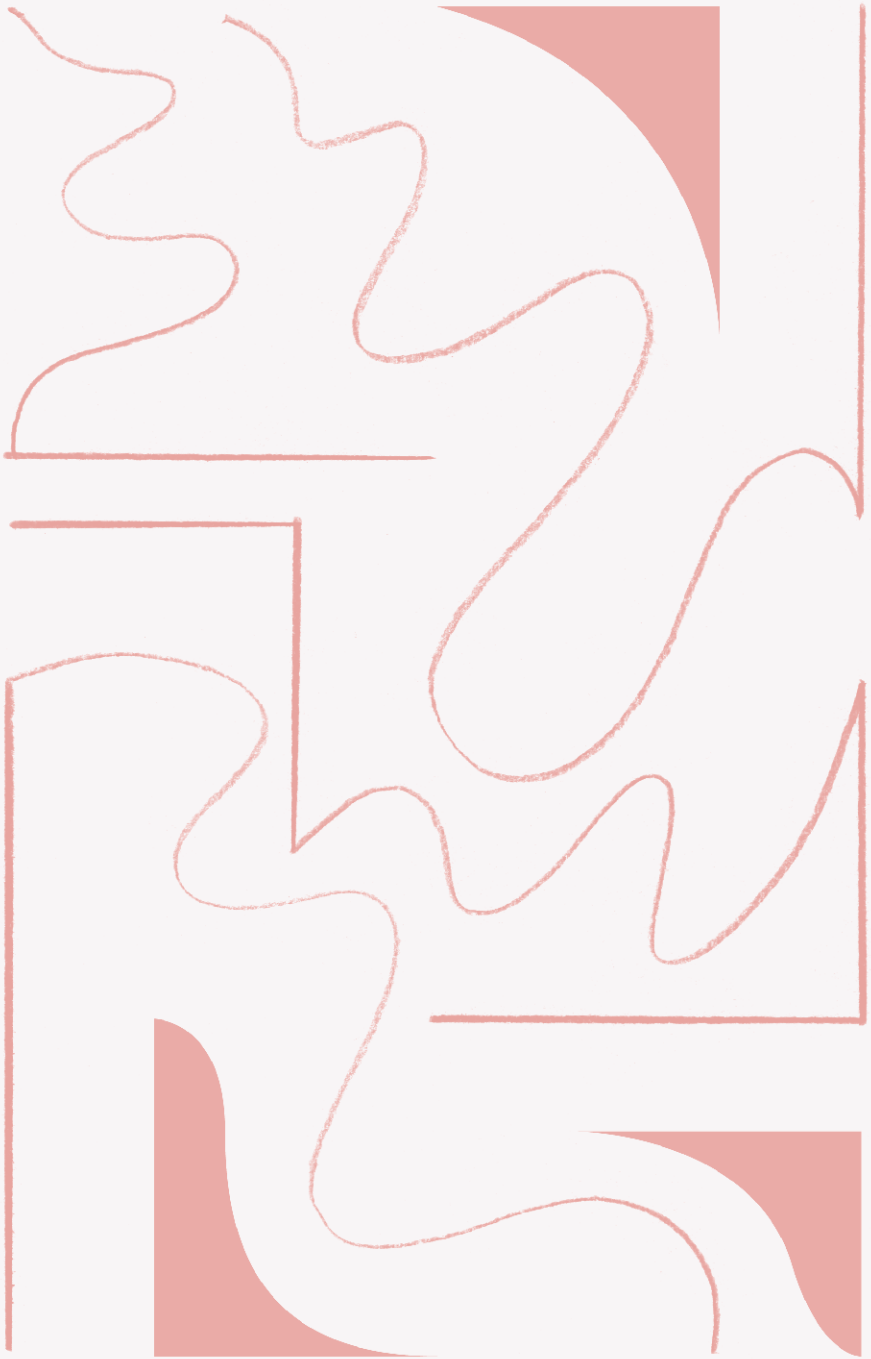
There is a widespread presumption that a user of an interactive system can somehow be positioned within the hyper-narrative as a protagonist is placed in traditional film narrative. This theory is commonly used to explain why viewers are emotionally involved with the characters and implying that this is so because "viewers are both predisposed and manipulated by the film into thinking or feeling that they are the characters" (B. Shaul 2008). These types of user viewpoint configurations are widely and often used in computer games, either through a first-person fictional camera point of view, as in the first person shooter Call of Duty (2003) or a totally altered avatar representing the player in the virtual fiction environment and responding to their commands. The recently introduced Oculus Rift by Oculus VR gives the viewer the direct camera view of the protagonist, creating the illusion of the user being the protagonist.

However, theorists believe that the presumption that such virtual figuration can lead the viewer to experience the situation they are involved in as real, as opposed to simulation, is groundless. The key explanation being any such experience is a drastically reductive version of the actuality faced in a real environment by the user. The user cannot help but be aware that the interaction is in a virtually altered environment, and the avatar is an incomplete representation of them. In fact, Nitzan believes that, as viewers are intelligent and well informed before they begin the interaction, they are aware that the interactions are pre-programmed and their P.O.V is a manufactured robotic surrogate obeying their commands. "Through such a type of shallow interaction with an 'other' it is impossible to generate deep engagement" (Carroll 2008).

The immersion related notion of identification, which suggests that viewers are capable of being manipulated to hold the belief that they are the protagonists of the already altered narrative is rejected by cognitivists who raise the question of how the viewer, or user, could identify themselves as a protagonist who does not hold their understanding of the ongoing story, coupled with the transitions between shots awakening the viewer to the fact that the film is not real but in fact a constructed artifact.

Noel Carroll suggest that it's not the point of view or the virtual reality gear but the 'what if' hypothesis of traditional narrative, under which viewers are under constant cognitive interaction with films, that will enable the user's immersion. It's the viewer's empathy with characters that makes the cinematic experience captivating. Such a notion gives the viewer a more emotional and cognitive response to the fictional character than the irrational notion of identification. "Empathy can not only better explain emotional or cognitive engagement with fictional characters but also innate reflexive empathy of viewers to events happening to characters such as when 'hit' an imaginary break when a character's car is about to dive into an abyss" (Carroll 2008). Nitzan further suggests that rather than falling in to the 'identification' theories placing the viewer's avatar as a representative protagonist, we view the avatar as a virtual friend of the viewer, towards whom he or she develops empathy. "With a friend we cannot nor (usually) want to have total control upon his decisions and actions, we often expect our friend to tell us of places and experiences we have not experienced, and we know that whatever we suggest to a friend he may take it into consideration and accept or reject it... establishing such interaction opens up the hyper-narrative camera to all the different points of view" (Nitzan, 2008).

Positioning the viewer as friend, family, advisory or even an empathising agent for a protagonist, opens doors to a highly engaging interaction and immersive hyper-narrative films.



Imaginary Apparatuses

A three day worshop with students from MA Interaction Design Communication and MA Illustration and Visual Media.

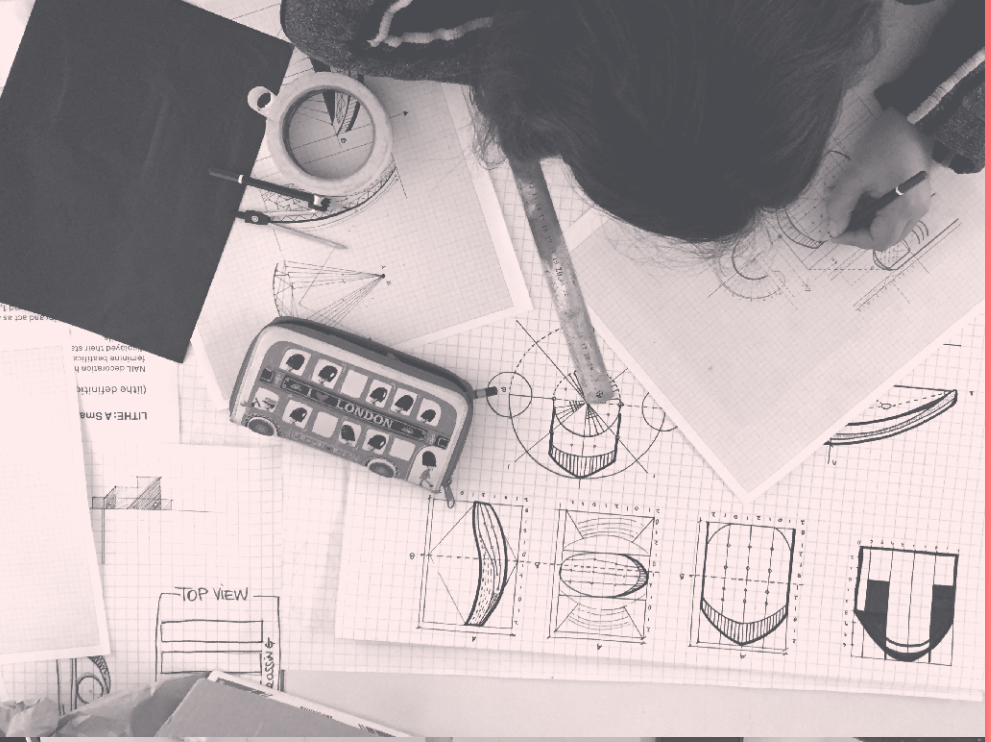
Apparatus
1. the technical equipment or machinery needed for a particular activity or purpose. 2. the complex structure of a particular organisation or system.

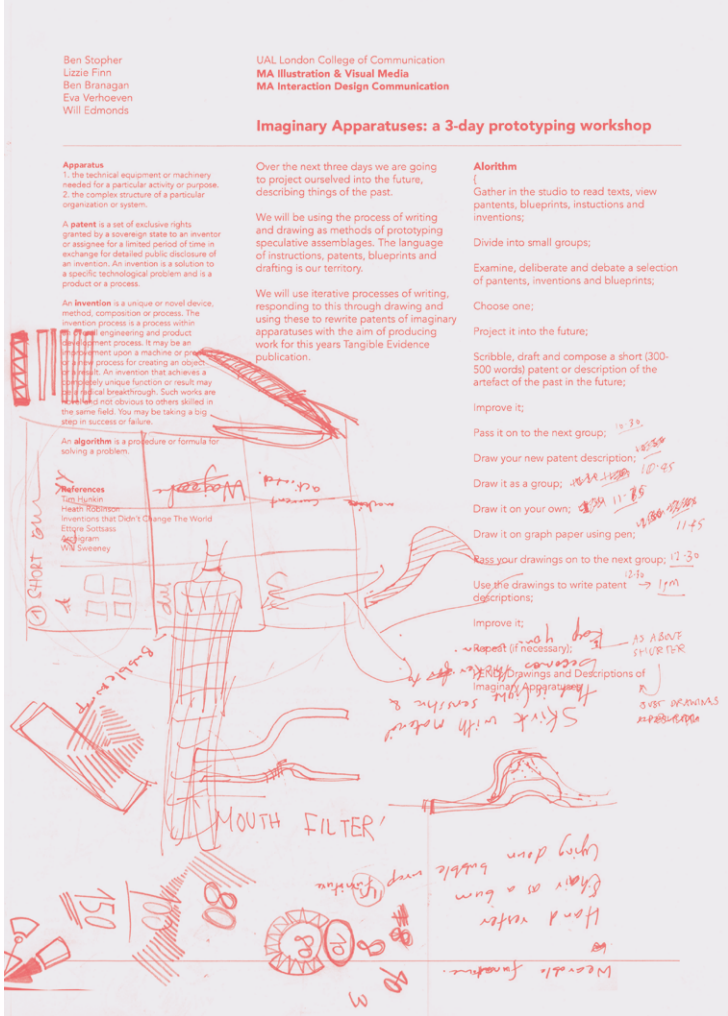
A patent is a set of exclusive rights granted by a sovereign state to an inventor or assignee for a limited period of time in exchange for detailed public disclosure of an invention. An invention is a solution to a specific technological problem and is a product or a process.

An invention is a unique or novel device, method, composition or process. It may be an improvement upon a machine or product, or a new process for creating an object or a result. An invention that achieves a completely unique function or result may be a radical breakthrough. Such works are novel and not obvious to others skilled in the same field. You may be taking a big step in success or failure.

An algorithm is a procedure or formula for solving a problem.

References:
Tim Hunkin
Heath Robinson
Inventions that Didn't Change The World Ettore Sottsass
Archigram
Will Sweeney





Ben Stopher
Lizzie Finn
Ben Branagan
Eva Verhoeven
Will Edmonds

UAL London College of Communication
MA Illustration & Visual Media
MA Interaction Design Communication

Imaginary Apparatuses: a 3-day prototyping workshop

Apparatus
1. the technical equipment or machinery needed for a particular activity or purpose.
2. the complex structure of a particular organization or system.

A **patent** is a set of exclusive rights granted by a sovereign state to an inventor or assignee for a limited period of time in exchange for detailed public disclosure of an invention. An invention is a solution to a specific technological problem and is a product or a process.

An **invention** is a unique or novel device, method, composition or process. The invention process is a process within the fields of engineering and product development process. It may be an improvement upon a machine or product or a new process for creating an object or a result. An invention that achieves a completely unique function or result may be a radical breakthrough. Such works are considered not obvious to others skilled in the same field. You may be taking a big step in success or failure.

An **algorithm** is a procedure or formula for solving a problem.

References
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Heath Robinson
Inventions that Didn't Change The World
Ettore Sottsass
Archigram
W.N Sweeney

Over the next three days we are going to project ourselved into the future, describing things of the past.

We will be using the process of writing and drawing as methods of prototyping speculative assemblages. The language of instructions, patents, blueprints and drafting is our territory.

We will use iterative processes of writing, responding to this through drawing and using these to rewrite patents of imaginary apparatuses with the aim of producing work for this years Tangible Evidence publication.

Alorithm
(
Gather in the studio to read texts, view pantents, blueprints, instuctions and inventions;

Divide into small groups;

Examine, deliberate and debate a selection of pantents, inventions and blueprints;

Choose one;

Project it into the future;

Scribble, draft and compose a short (300-500 words) patent or description of the artefact of the past in the future;

Improve it;

Pass it on to the next group;

Draw your new patent description;

Draw it as a group;

Draw it on your own;

Draw it on graph paper using pen;

Pass your drawings on to the next group;

Use the drawings to write patent descriptions;

Improve it;

Repeat (if necessary);

TERM/Drawings and Descriptions of Imaginary Apparatuses)

(brief)

MAKE-UP

HISTORY OF ARTS

ARTS THAT CHANGE EXTERIOR THINGS

CHOOSE A SPECIFIC CHAIR - FIND OUT MATERIA

CHAIR

USE TO MODIFICATION

FIND EASY WAY TO ASSEMBLE (IKEA) (LEGO (PUZZLE MODULARITY

HISTORY OF CONTROL SYSTEMS

CAMERA

ON YOUR PHO

SMALL (HAND-SI

THAT TAKES PICTUR WHAT EXACTLY YO CAN SEE IN REEL.

THIN LAYER & CONTROLS TO CHANGE VIEWS & ZOOMS ETC....

GLASSES

TABLET

DEVICES

SENSORCHIP
A sensor chip for all your censorship needs

Sensorchip is a mouth insert designed to fit comfortably under your tongue and sense when you are about to say something offensive or politically incorrect. It can be customised to alert you silently when you are about to swear, unintentionally insult someone or say something hurtful.

The Sensorchip has not only been proven to improve your likeability in everyday social interactions between loved ones and colleagues, it is also well received by parents as an effective child-rearing tool at home.

(Early prototypes have proven popular in celebrity circles—coining the phrase, 'The TMZ Proofed Tongue". There has also been large take up amongst political figures when addressing the public in casual discourse or speaking on social issues).

(artefact 1A)

(artefact 1B)

CubUS

CubUS, interactive objects created from shape memory alloy. Initially it is presented in the form of a cube using muscle wires that can be programmed to morph into any pre-defined shape that the users determine.

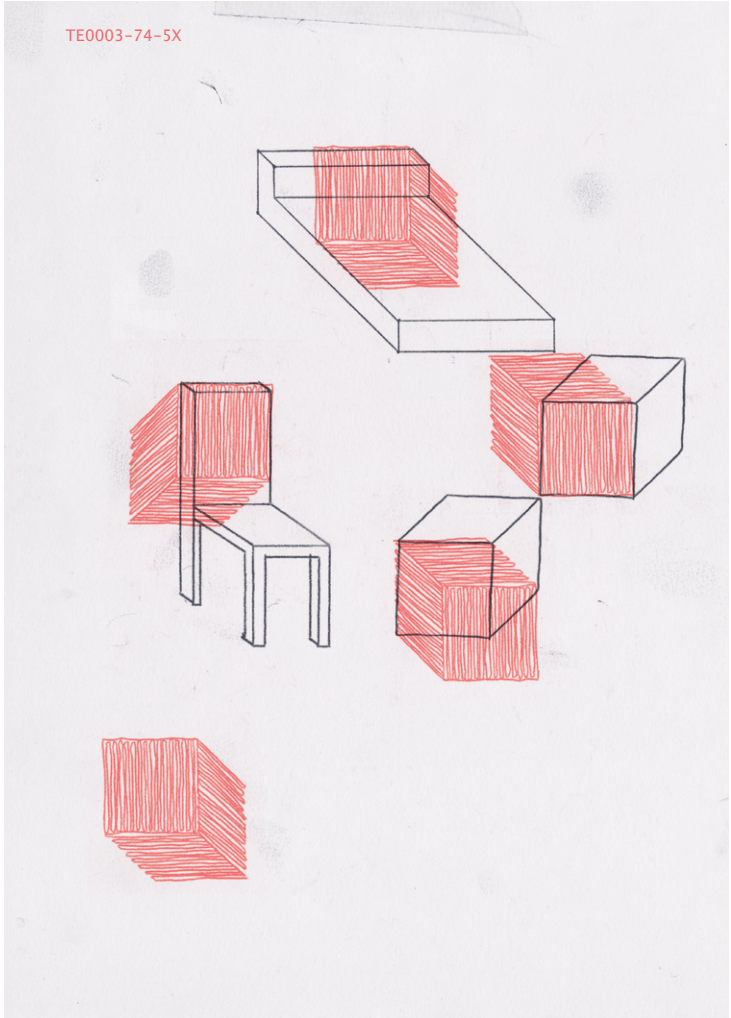
CubUS is designed to reduce the need for separate pieces of furniture as it can perform multiple functions as it can change into any single piece that is needed at a particular moment. It also saves on space. CubUS morphs into an object, it stays in that shape until the user changes its state either back into the initial neutral configuration (cube) or into another piece of furniture.

CubUS comes with a set of pre-programmed essential pieces of furniture (One single bed, one table, one chair), but additional pieces can be downloaded and programmed into CubUS. A virtually unlimited selection of items can be purchased and downloaded from the CubUS.com webstore, therefore creating additional variations of the cube modelling.

Various model sizes of CubUS are also available, giving the user the ability to customise smaller objects (e.g. foot rest, spice rack, coffee table), or bigger ones (e.g. space dividers, internal studio doors).

CubUS is not an open source device and its programmable items are property of CubUS ltd. and all its associates.

(artefact 2A)



(artefact 2B)

Your Street

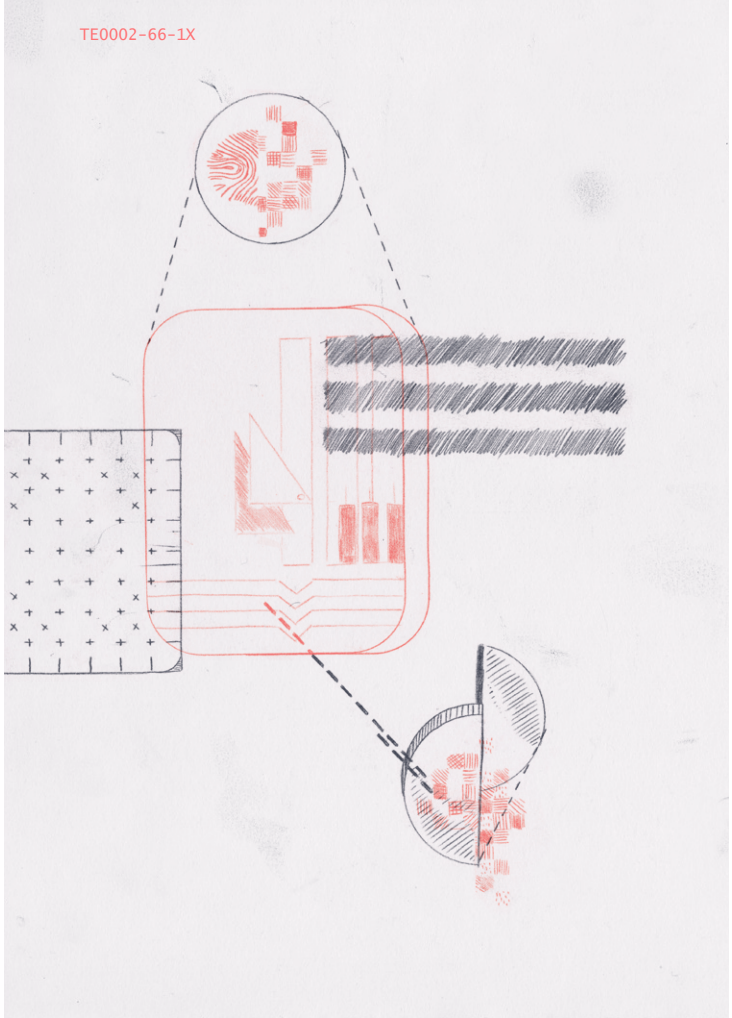
'Your Street' is a form of priority crossing service for Londoners to cross streets in style. Simply activate your privileged access with your fingerprint and stop traffic at leisure. Choose from the three options we have:

Individual Crossing: Cross like a royal without stopping for anyone, Group Crossing: Cross with group like marching Spartans, Musical Crossing: Cross the street with your favourite music, flashmob style and make the whole street jealous of your exquisite music taste.

Just pay a small amount or a daily cap and take control of the streets.

Potential Integrations:
Our service can collaborate with Spotify and iTunes to provide you with the latest hits, City Mapper to get the easiest route for your journey and a service to connect with people with similar street habits like you on Match.com to find your perfect 'street soul mate'. The pedestrian will earn points with every crossing and can use these to spend on the next service for free.

(artefact 3A)



(artefact 3B)

LITHE:

A Smarter Way to Nicer Nails

(lithe definition : slender and flexible)

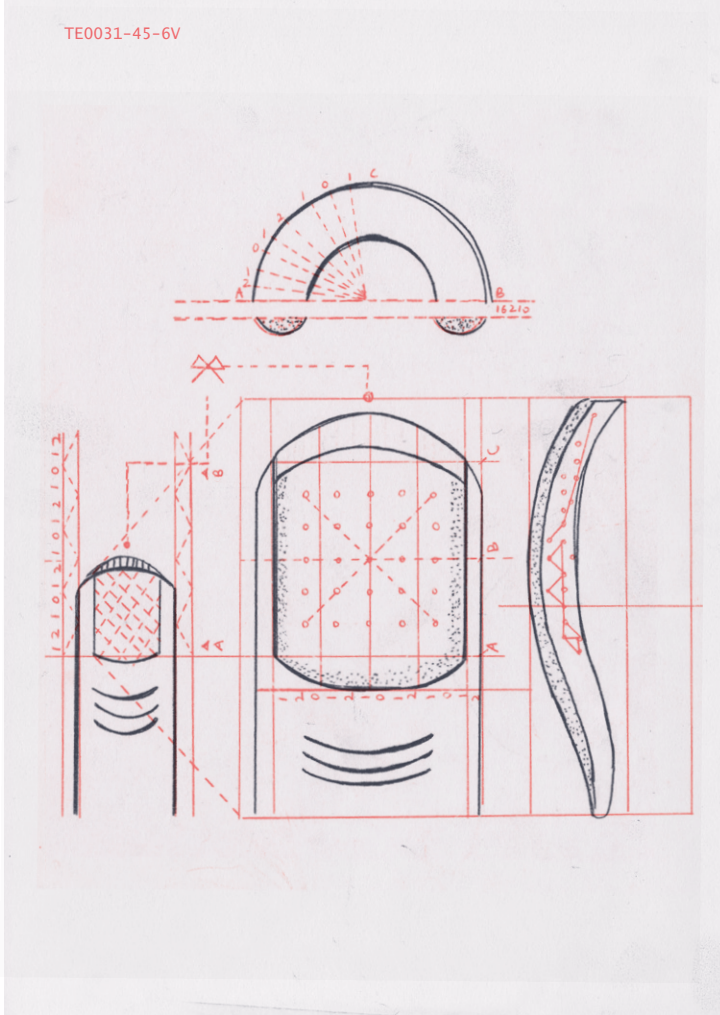
NAIL decoration has always acted as mark of status and a form of feminine beatification. For example the ancient Greek upper classes displayed their status by wearing empty pistachio shells affixed to their nails.

Nails represent feminity and act as a symbol of empowerment. Beauty industry experts surveyed 1,500 women (20-45) and found that women will spend £450 a year on their nails. Nail decoration is now so popular that women will go out more often with fake acrylic nails rather than painstakingly prepare their real ones. In the survey Over 70% of women last year (2014) bought a nail varnish comparing to 59% in 2013. Nail varnish is now considered a cheap luxury.

LITHE proposes to re-conceptualise and monetise gel and acrylic nails. A 0.1mm AMOLED screen - a new state of the art technology - will be applied to natural nails. These screens will be connected via Bluetooth through a Smartphone app. The user will then be able to manipulate the visuals produced by the AMOLED screens. The users will get the option to change the colours, patterns and overall design on-the-fly.

This product is a fast and affordable way to always have perfect dynamic nails in all social situations. No artistic skills or professional nail salons required meaning we expect creative disruption to the nail bar sector. This product's durability is expected to be 3 to 4 weeks depending on the growth of the natural nails enabling subscription models to be developed.

(artefact 4A)



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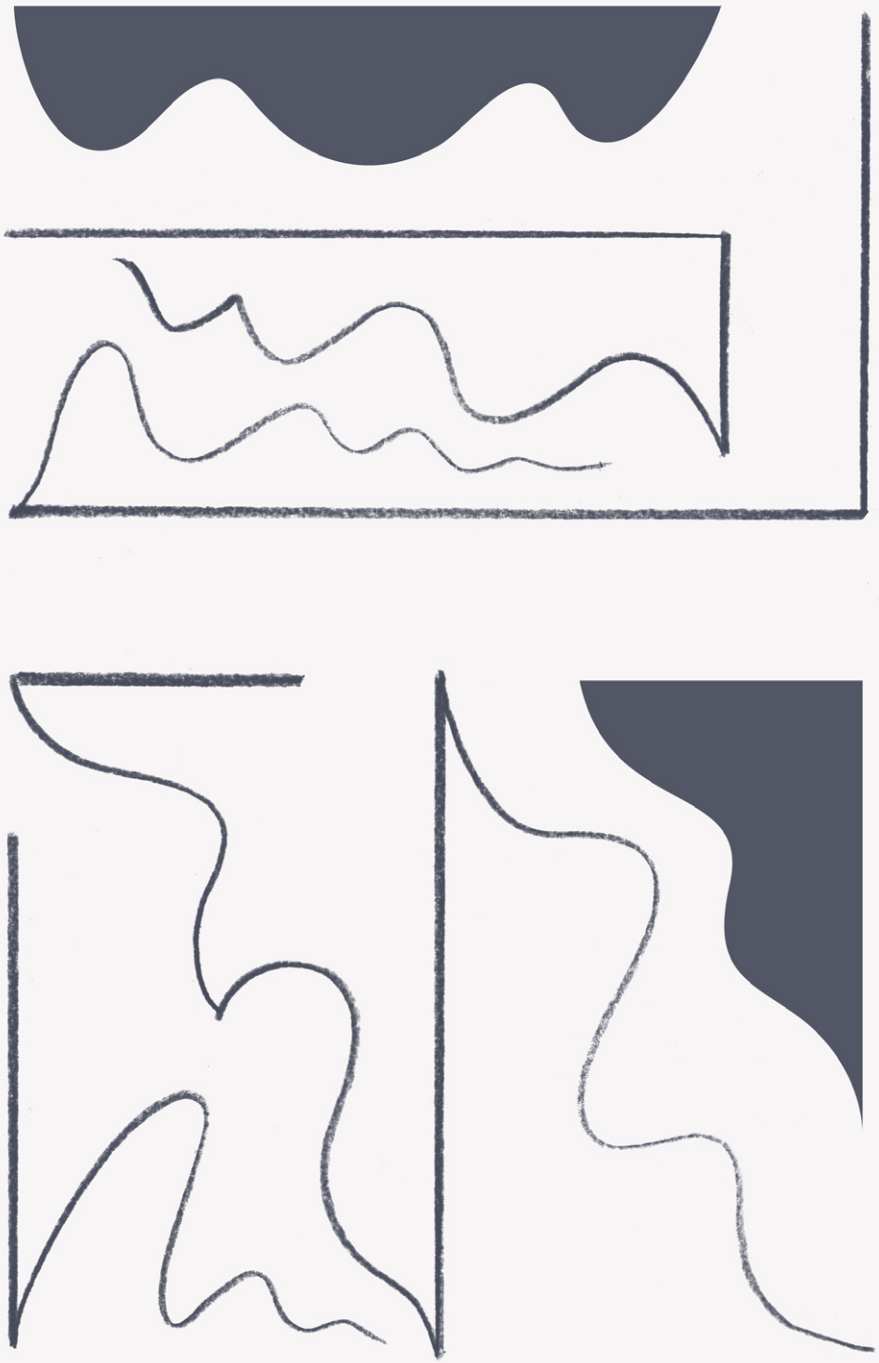

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