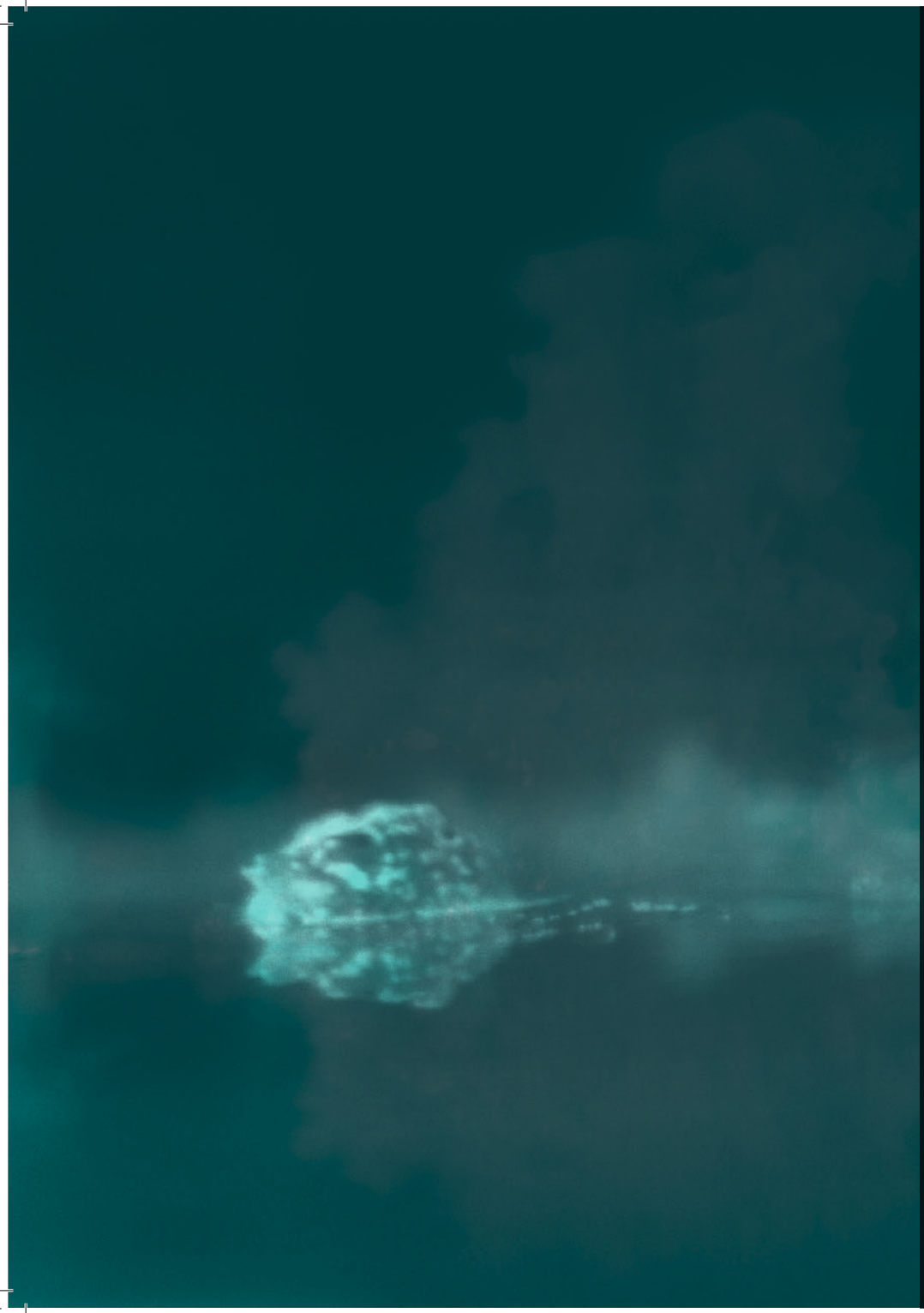

SUPRA SYSTEMS

#1

SUPRA SYSTEMS

Systems happen all at once
Donella H. Meadows

Everything happens so much
@Horse_ebooks

Networked technologies are increasingly present across our lives. They manifest in many ways, yet their 'all-at-once' nature makes them difficult to parse. How can we get to grips with the power that these complex systems produce if we can't easily comprehend systems themselves?

Supra Systems examines what it means to articulate the forces and politics underpinning networked technologies. Our authors – artists, designers, curators, academics, writers, and researchers – look to almanacs, artificial intelligence, artificial tornados, data aestheticisation, machine learning, online sex work, parking lots, radical softness, skip-diving, speedrunning and more, as they explore ways to experience, articulate, and interrogate the systems surrounding us.

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SUPRA SYSTEMS

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SUPRA SYSTEMS

EDITED BY GEORGINA VOSS

INTRODUCTION

SECTION I: EXPERIENCE

SECTION II: ARTICULATE

INTRODUCTION

INTRODUCTION TO SUPRA SYSTEMS

GEORGINA VOSS

*Men in a wide array of fields were prompted to redefine the syntax of the systems they dealt with in the syntax of verbs rather than nouns—to ask "What do the systems **do**?" rather than "What are they made of?"—and then to ask the most difficult question of all: "What **should** these systems do?"*
Horst Rittel and Melvin Webber, 1973[1]

There is a problem in discussing systems only with words. Words and sentences must, by necessity, come only one at a time in linear logical order. Systems happen all at once.
Donella H. Meadows, 2008[2]

I am overwhelmed by airplanes. Every airborne trip is a powerfully visceral experience of sensation, stimulation, and the sublime—a horizontal beast of a speeding carriage - bigger than a building, roaring miles above the tangible planes of earth and sea. I have my rituals—running my fingers down the metal on the door upon entering, patting the ceiling after any strong bouts of turbulence. "You've done so well," I tell each plane when we land.
My preference for window seats is less about the view—I am, in truth, terrified of heights—and more about the ability to lean into the curvature of the fuselage and locate my small self in its huge form. Each artefact and event along the way is a gift, an offering from some larger complex place, a system

far beyond my ken—machine-readable barcodes on boarding passes; lines of regulation-yellow paint on the runways in standardised hex colours. A tall, tall tower in each airfield, full of people coaxing beasts around the sky using, until recently, software written in the decade of the first moon landing.

I mean: how are you actually meant to kick off a book about systems, a form that, as Donella H. Meadows notes, cannot be adequately described using words? I've written and rewritten this introductory chapter in so many different iterations over the past month; I've stumbled again and again whenever I've attempted to form a good, serious, critically-engaged written argument for the need—the very, very urgent need—to engage with and interrogate the politics of networked technologies through design practice. Joke's on me, lads: the words haven't submitted themselves willingly to such a task, and I'm now writing this on the morning before the final print files are meant to be sent to the publisher, hammering through on cheap coffee.

So, perhaps, let's have some rudimentary context. Networked technologies are systems, a set of things interconnected in such a way that they produce their own pattern or behaviour over time.[3] These networked technologies are increasingly present across many of our lives, manifesting in many different ways. There are three critical points to note. First, these technologies work as a *social process* that bind together their impacts on society with the governing choices made by dominant social groups.[4] Second, to paraphrase Nick Seaver, these technologies are *cultural* because they are composed of collective human practices.[5] And third, as structural forms, networked technologies have the capacity to manifest potentially systemic, invisible, and intersectional forces that act through social structures and institutions.[6]

More context: to try to get a grip on how the politics and power swirling around these networked technologies manifest, my colleagues and I have founded *Supra Systems Studio* (SSS), hosted in the Design School at London College of Communication, University of the Arts London. This book marks the launch of SSS at London Design Festival 2018; together with the opening of an exhibition, *Everything Happens So Much*, which explores the all-at-once nature of systems; and the debut of a multi-performance installation work called *Supra Systems: Office Rites* at the Victoria and Albert Museum, in which the cult and ritual of Bacchanalia are manifested through digital, data-driven, automated, and algorithmic decision-making processes in a mundane office setting.

As I've been hauling together the exhibitions and the studio, I've been churning through an enormous range of works that could be loosely described as the canon of this field, in order to strengthen make the case that SSS needs not only to exist but also to operate through design practice.

New institutes and programmes such as the AI Now Institute in New York and the Ada Lovelace Institute in London have made impassioned pleas for the fields of machine learning and artificial intelligence to move past technical framings around emergent arrays of data-driven technologies, in order to draw on disciplines that prioritise "human contexts, experiences, and socio-political issues". [7]

Scholars in science and technology studies (STS) have been grappling with the co-constitution of power, materiality, technology, and society for so long, analysing how social interpretations of problems give meaning and physical form to particular technologies[8]; how "technology" operates as a network of power populated by humans, machines, and other actants. Artists and designers have engaged critically for over a century with the networked systems and two-way real-time transfer of information (see, for example, Vladimir Tatlin's *Monument to the Third International*, or Dada, De Stijl, Bauhaus). Systems theory, too, has been around for several decades, developing through the work of the RAND Corporation and gaining influence in the deployment of networked technologies by the United States Armed Forces during the Cold War.[9] These militarised systems, described metaphorically as the "closed world", are uncanny harbingers of the centrally-controlled power apparatuses currently populating our domestic, commercial, and civic spaces with networked widgets and artefacts."

Words, words, words. Whilst these works offered deep and critical insight, nothing quite seemed to *stick* or get under my fingernails — not like the smell of burnt plastic from a laser-cutter or the frantic sweat of a looming deadline. But I stumbled across the foundations of a possible framework in *Thinking in Systems* by Donella H. Meadows, who was not only reporting on systems operations but actually getting to grips — instinctually, elegantly, practically — with ways to do work on systems on their own terms.

At its core, *Thinking in Systems* argues that in order to discuss systems properly we must use a language that "shares some of the same properties as the phenomenon under discussion". [10]

"At a time when the world is more messy, more crowded, more interconnected, more interdependent, and more rapidly changing than ever before, the more ways of seeing, the better." [11]

Published in 2008, *Thinking in Systems* seems like a timely response to the groundswell of networked digital technologies making their way into the world in the wake of increasing Internet speed, saturation, and infiltration into other media and spaces. In reality, Meadows wrote the manuscript in 1993, drawing on systems analysis of the past thirty years, since the height of

the Cold War. Her analysis is not based on the interpretation of a given system in light of its context in human history; in her approach, systems *are* the context.

Thinking in Systems is filled with visual representations—graphs, diagrams, flowcharts—and elegant literary metaphors that propel the reader across the structure and terrain of the system. Our existing mental models are not sufficient to help us comprehend the complications of the real world. Whilst systems happen all at once, they reveal themselves as a series of events over time and in surprising ways. Not satisfied with an exclusively technical framing, Meadows moves us into a realm of affect, intention, sensation, and aesthetic form. "You can see all parts of a picture at once," she says while asking us to consider what it means to feel and experience our way through these assemblages, which transcend the human lifespan, scale, and sensory faculties.

I fell hard for *Thinking in Systems*—not only for its theoretical insight but also for its generosity of spirit. Meadows asks us to approach complexity with care and humility. She opens up questions rather than shutting down answers. As she says:

"I don't think the systems way of seeing is better than the reductionist way of thinking. I think it's complementary, and therefore revealing. You can see some things through the lens of the human eye, other things through the lens of a microscope, others through the lens of a telescope, and still others through the lens of systems theory. Everything seen through each kind of lens is actually there. Each way of seeing allows our knowledge of the wondrous world in which we live to become a little more complete." [12]

There is a brute pragmatism at play here. Certainly, there are many other calls to find ways and modes of parsing the complexities around systems such as networked technology and climate change.[13] In relation to these directives, Meadows states, "I am interested in analysis only when I can see how it helps solve real problems." [14]

This statement is echoed in one of the first pieces developed for this book, a conversation with Sara Hendren of Olin College in which we pawed over the tension between committing to an idea in the form of practice and tearing that idea apart as a form of provisionality. As Sara states:

"Thinking in principles is really quite different from getting shit done. In some issues, you're not just materialising, you're materialising in a world where it's eventually going to have to be delivered. Maybe that's scalability, maybe it's not—but it's going to have a life…That's the difference between designers and

armchairs philosophers, for whom first principles are simple ways of thinking. It's harder for designers to hang onto them—not because they forget, but because of the commitment and provisionality."

Supra Systems responds to and extends *Thinking in Systems* in exploring the experience, articulation, and interrogation of networked technologies and systems. This book contains many deeply personal, reflexive pieces in which the authors—designers, artists, curators, writers, academics, and researchers—look at their own lives, works, emotions, and practices in order to draw out the interplay of affect, structure, behaviour, aesthetics, and intent necessary to engage with (or at least make a pass at) complex systems.

Section I: Experience opens with **Shannon Mattern** pondering those spaces of force and flow that make things happen. Articulating the peculiar quality of systems—the spatiotemporal scale that makes them imperceptible to the constituents in their sphere of influence—Mattern asks how we feel our way through. **Natalie Kane** goes from reflecting on growing up online, to maintaining—even more, demanding—emotional vulnerability in the face of platform capitalism. "'We are becoming aware of what it means to place ourselves in networks, to reckon with edgeless spaces," she writes, "and yet we still choose to enter them headfirst". **Ewa Winiarcyzk** also explores affect and emotion in online networked space, unpicking how emotional labour and social risks play out in the online sex work known as "camming". Finally, **Sara Hendren** explores the unfolding of systems in engineering, design, and arts education; the dance between provisionality and commitment; the possibilities of rehearsing those relationships; and the practice of humility in interdisciplinary work.

In *Section II: Articulate*, our authors explore ways of investigating the structures and politics of complex systems and argue for the necessity of a historical perspective in doing so. No matter how shiny the technology or groundbreaking the narrative, there is no *tabula rasa*, only long, entangled histories and layers of stuff.[15] Interrogating the notion of objectivity in the popular perception of data, **Wesley Goatley** unpacks the influence of photography on scientific documentation under the premise that technology would remove the subjectivity of the human hand. Drawing on his own practice, he argues for a critical data aesthetics that reveals the constructed interpretations underlying the representation of the phenomena in question. **Luisa Charles** also reflects on her own practice as a filmmaker, studying how systems and structures frame and filter the creative process, and debating whether they are forms of creativity in their own right. Like Sara Hendren, **Joel Karamath** runs a studio for undergraduate design and creative practice; in conversation, he discusses the meaning of future-facing technology; the benefits of developing pedagogy beyond the constraints of a single

discipline; and the joys of skip-diving as a way of bringing defunct technology into the classroom. **John Fass** and **Alistair McClymont** draw a link between, on one hand, the depiction and recognition of lemons in seventeenth-century Dutch still life paintings, and on the other hand, the observation of images and "recognition" of the objects they portray by computer vision systems. Finally, **David Benque** situates the almanac in a historical trajectory culminating in today's big data systems; he reflects on his artistic construction of a contemporary almanac as a way of challenging our faith in predictive algorithms and complicating our polarised understanding of future forecasting as whimsical superstition or infallible scientific calculation.

As interlude, a visual work by **Paul Bailey** contemplates the instabilities of our self-locating between place and space, reading and watching, alluding to the idiosyncrasies of scale and form in which systems manifest.

Systems are surprising, Meadows reminds us. But through intent and intervention we can pull out and poke at their unexpected qualities. **Alistair McClymont** launches *Section III: Interrogate* by kicking against both artistic and scientific systems of work to question how his own practice embodies and communicates a phenomenon — but, equally, how his practice conceptually challenges and unites the conceptual divide between art and science by developing multiple artefacts across different realms. In mourning for the progress bar, **Oliver Smith** asks what we learn when something dies. By looking under the bonnet of seemingly frictionless user interfaces, he deconstructs the progress bar's attempts to be an "accurate representation of the chaotic, unpredictable nature of computers and their users". In his essay on speedrunning — the art of finishing a video game as quickly as possible — **Tobias Revell** takes on the notion of the system itself. Looking back on a long history of gamers exploiting the "glitches, cuts, tricks, shortcuts, and hacks" built into the very constitution of a video game, he argues that speedrunning offers us new ways to interact with systems, to "play the playing of the game". Finally, to conclude this book, **Molly Wright Steenson** makes a case for embracing the unexpected. She argues that in networked technologies' unexpected and unwelcome responses to being poked –– offer us ways of understanding the boundaries and permeability of machine learning and artificial intelligence.

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9. Edwards, ibid. p7.

10. Meadows, ibid. p5.

11. Meadows, ibid. p6.

12. Ibid.

13. See, for example: Zylinksa, J (2014). Minimal Ethics for the Anthropocene. London: Open Humanities Press; Stengers, I. (2015). In Catastrophic Times: Resisting the Coming Barbarism. London: Open University Press; Knox, H. (2018). What Is Going on with the Weather? Reflections on Gaps Between Data and Experience. EPIC. [Online]. Available at: https://www.epicpeople.org/data-and-experience/ (Accessed 2nd September 2018).

14. Meadows, ibid. A Note from the Author.

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SECTION I
EXPERIENCE

EXECUTABLE SPATIAL SCRIPTS

SHANNON MATTERN

We're in a supermarket parking lot, in a small city where, as every local teenager will tell you, "nothing ever happens." Our city is nowhere in particular; it's anywhere and everywhere. Yet this generic patch of asphalt is coded, claimed, and conscripted. It's been recruited, many times over, into various networks and zones, territories and registers and archives. Even this most characterless of plots—where, like all boring spots, very little of significance ever seems to happen—is a conduit for forces and flows that *make things happen*—here, there, everywhere, all the time.

Our parking lot—like all plots—has myriad cartographic identities. It probably lives in the form of assorted analog maps at the municipal archives and as digital files at the city planning office. These encoded representations determine who can dig or build or buy. They make real estate and development, historic preservation and resource management *happen*—or not. Our parking lot also exists as an aerial image on a Google Maps server in a data centre somewhere probably far away. If a Street View car or Uber autonomous vehicle has come to town, our plot has also been imaged, sounded out, laser-beamed by cameras, sonar, radar, and lidar sensors. These encodings generate multidimensional maps that shape the way future visitors, planners, and intelligent machines will encounter and navigate through our tedious town.

Our prosaic plot—or any plot, for that matter—is defined by its property boundaries, a delineation of ownership. Yet it's also ringed and bisected and circumscribed by an array of other boundaries, at multiple scales, embodying a variety of spatial categories: plots, zones, wards, districts, counties, kingdoms, continents, galaxies. For instance, our plot lies within a zone defined by a postal code, a script that renders itself legible to both humans and machines. While the postal barcode on a letter prompts robots in a mail-sorting facility to direct that letter into one delivery bin or another, the code as a spatial "brand" (consider the cachet of London's SW1X or New York's 10012) draws retailers looking for desirable target markets and parents desperate for good schools. The borders of the school district, another spatial delineation, don't necessarily match those of the postmaster's terrain, yet they reinforce a similar politics and privilege of (social) mobility. The police precinct is another domain. Two neighbours on adjacent blocks might go to the same school but report to different precincts. Our plot lies within an electoral district, too, whose drawn boundaries can swing elections and determine how evenly political representation is distributed.

Those multiple encodings are executable scripts that *make lots of things happen*, but often at temporal and spatial scales that aren't perceptible to their constituents. They activate particular socioeconomic and cultural practices that unfold over time, through small gestures and slow moves, and thus seem opaque to those living inside the borders. These scripts mobilise opportunity and effect marginalisation. They patch zones and districts into city-wide circuits and planetary-scale systems—or not. And this connectivity, or lack thereof, has the power to make things happen in people's lives—or not. Even that *not happening* is itself an event of note, one that proscribes the richness of human lives.

IT IS IN YOUR SELF-INTEREST TO BE VERY TENDER

NATALIE KANE

We are seeing more of other people than, perhaps, we ever have. We are seeing them experience the world in uncountably large numbers; we are making judgements loudly and boldly. We are choosing what we decide to experience with others and what to hold back. We are negotiating the narratives of our selves, and doing what we can not to compromise them. We are being brave, yet guarded, in the face of uncertainty.

For those of us who were swept along in the rise of social media and lived through the slow, timid death of the chatroom at the turn of the millennium, sharing our relentless juvenile emotions through convoluted usernames became an early performance. We may not like to think of ourselves as performers, but that is what we are whenever we search for authentic feeling. As Leslie Jamison writes of Chris Kraus's blisteringly honest explorations of self, writing in the first person feels more sincere but is no less a show. We live through a mediation of who we understand our own first person to be, at various times facilitated or contradicted by the media and digital platforms that surround us.

As young people developing, nakedly, on the Internet, we survived our selves through LiveJournal, on MSN Messenger and AOL Instant Messenger, where we pretended to be older, and sexier, and bolder than we actually were. "Sorry, wrong window" means something intensely painful to some of us. Wandering deliberately into an over-30s chatroom to see who liked the sound of the person we were pretending to be, bearing witness to the clumsy

scatter of "a/s/l" throughout other people's conversations. I learned quickly to adapt the awkward manifestations of my personality to these new structures of representation. The world we occupied offline seemed small and oppressive, especially to those who didn't quite feel like they belonged. The Internet, above all, had other people on it—other people who we didn't know and who didn't live within a ten-mile radius of us and who couldn't tease us for our societal transgressions. All it took was the discordant purr of a dial-up tone. Being "online" was seductive to me as a 14 year old, just like it was seductive to the generation above us who, ten years older, were already deep into their attempts to make sense of what that truly meant.

As I got older, as MySpace's more social functions closed and AIM became quieter, these experimental behaviors manifested in new arenas, and in new ways. The Internet became a place for radical softness, a place for my own hard edges to be worked through, and the feelings that I was allowing myself to feel exposed in a carefully curated space. Radical softness can best be understood as the tendency to be unashamed of our emotions as we encounter them; to favour them over the instilled obligation to be rational, rejecting the expectation of "strength" as a requirement to battle a difficult world. Radical softness is the permission to feel everything, and the necessity to do so. As Jenny Holzer reminds us, "IT IS IN YOUR SELF-INTEREST TO BE VERY TENDER." (from *Survival* series, 1983–85).

On Tumblr in particular, I found (often unattributed and decontextualised) images of sex, love, emotion, anger, and deviance interspersed with guts-out poetry and playlists that you desperately wished someone had made for you. I met the greatest loves of my life on Tumblr. The soft boys and unapologetic women that I previously had only dreamed about appeared as artists and poets with feelings that I struggled to find in others, and perhaps myself, in my everyday life. Cy Twombly's deep, lustful complexities running under Frank O'Hara's explicit romance; Sylvia Plath's anger swarming amidst the deepest reds and blacks that Mark Rothko could conjure into existence. Everything was a difficult feeling to work out. Perhaps I leant on these patron saints of emotion too much, using these fully-formed feelings to support the complexities I had to prepare for in growing up.

A few of us grew older together on Tumblr, and I'm still friends with some of them today. I watched them get real jobs, find partners, have children, become seemingly more stable versions of the selves I ran my own chaos alongside. I once sought solace in the blogs of individuals who I imagined building intense, fulfilling friendships with; almost ten years later, we are starting to meet each other in the flesh. It is delicate territory, reconciling a user's aesthetic sensibilities with their real-life, vulnerable body. We tried so hard to show ourselves to each other through what we reblogged, what we

commented on, what we took out of context. One of my fondest recent memories is meeting an artist friend who, for almost ten years, I sent them a photo of whenever I saw the Windsor typeface in my daily life, from thousands of miles away. We met in May, had coffee on my continent and then, a month later, breakfast on his.

Who we grew up to be is inextricable from what we grew up with. Radical softness was essential then and is even more vital today, as the fragile territory of the Internet becomes increasingly co-opted by capitalism, with all of our anxieties on the growing application of algorithmic efficiency. Amazon and Google can't really understand the messiness of our emotions, but they'll be damned if they stop trying to quantify them. Those who seek to profit from our emotional expression by using our data reduce this intimate knowledge to something easily processed. But as long as these companies see potential profit in subjecting these vulnerable spaces to machine reading, however crude, they will continue to profile depressed, isolated teenagers and their neighbours, communities, and friends, to advertise objects of desire to them as remedies. We are becoming acutely aware of what it means to place ourselves in networks, to reckon with edgeless spaces, and yet we still choose to enter them headfirst. Sharing online, which can be a life-giving exercise for those who feel disenfranchised by the alienation of the everyday—for a queer teenager in a conservative town, one of the only means to explore their queerness— has become an exploitable form of labour for those that understand the value (and profitability) of feelings.

When I think of sharing, I think of Frank O'Hara, a poet who has affectionately been called a "prophet of the Internet" because of his tendency to inform the world, status-like, about everything (and everyone) he experienced in daily life. He knew what it meant to reach beyond allegory and say what he meant to say, and he knew the risk of doing so. You knew if Frank was in love with you, you knew what Frank liked, what filled his world with colour. You could never resent him for it, because he wanted to share all he loved with you; every poem feels deliriously intimate and personal. In "Having a Coke With You", Frank ends a great rant about art with a line that I keep in my back pocket at all times.

> *"…it seems to me they were all cheated of a marvellous experience which is not going to go wasted on me which is why I'm telling you about it."*

Frank collapsed and reassembled the world with care and tenderness in a context—1960s America—that was brutally cruel to a homosexual man coming of age. He is the king of radical softness. For me, he is a model of the kind of Internet where I feel at home, albeit one that I feel too shy to take part in now that I think that I'm grown up. In today's networked, cached,

monetised and indexed version of the Internet, we are told that to say too much, too loudly about the tender parts of ourselves is too much. Frank was too much. Though I hide this vulnerability behind password-protected blogs and Twitter accounts, sometimes it finds its way out.

Regardless of one's feelings about football, it recently became the unlikely domain for one of the few revolutionary turns in how we understand and connect with one another in hard times. Gareth Southgate's management of a young, inexperienced England team evoked a surge of emotional energy and an unconditional embrace of softness in public forums that can otherwise seem unbearably hostile. It's a far reach, but in times of trouble, this networked appreciation of kindness is crucial. Maybe it's my own echo chamber, but no mockery was made on Twitter of Southgate's gentle yet firm cradling of his player's necks as they wept following their defeat in the semi-final against Croatia. Not even the *Daily Mail* shook that delicate branch. A quiet light, a faint glimpse of something kinder.

The Internet I occupied as a teenager allowed me to play with the emotional scaffolding I would later need to face the harsh politics of the world through my body, as unsure and untested as it was. Our contemporary networked living is so sharp and treacherous that finding a space to place a steady foot feels unequivocally necessary. Before I became aware of (and involved in) the politics of the network, I wanted the Internet to save me. Olivia Laing, writer of the dark night of the sensitive soul, reminds me of the value of acknowledging the world beyond the door:

> *We are in this together, this accumulation of scars, this world of objects, this physical and temporary heaven that so often takes on the countenance of hell. What matters is kindness; what matters is solidarity.*[1]

1 Olivia Laing (2016) The Lonely City: Adventures in the Art of Being Alone, London: Canongate.

WAVE TO PROVE YOU'RE REAL

EWA WINIARCYZK

You are too pretty to undress here i will pay if you don't do it.
(nickname hidden), chaturbate.com

It can be argued that emotions were never more commodified than in the times we live in. Researchers are being paid to predict the emotional reaction to advertisements in different groups, psychologists are used to increase corporate productivity, and some people are employed as emotional performers to varying extents. Emotional labour connects different activities such as education, communication, consoling, or entertaining, to those more closely connected to gender such as nurturing, domestic labour, or sex work. Historically, the discourse around this type of labour was tied to the Anglo-American feminist tradition focused around reproductive rights or domestic work.[1] Later it was expanded by the discourse of immaterial labour from post-operaismo, a movement emerging from Italian workerism.[2]

Washing machines, according to some, enabled women to participate in labour outside of the domestic sphere.[3] Online learning tools decreased the human interaction involved in teaching and made it possible to learn through interactive technologies. In these examples, the shifting role of technology has been associated with a reduction in the time and engagement demanded by this kind of labour, largely through the production of new

tools and systems. However, technology can also change existing forms of labour in more complicated ways—as in the following example.

I am drawn to the connection between various kinds of sex work and affective labour in particular, but also intrigued by their difference: the physical aspect of labour may decrease for those privileged enough to have access to new technologies without limits, yet the emotional aspect intensifies. The Internet created space for camming services—websites offering private or public shows in exchange for users "tipping" tokens, or currencies defined by the platforms. These services are reductively described as virtual sex, but in reality, the environment embeds a much more complicated variety of transactions. Camming models are often stereotypically perceived as lonely women in their bedrooms or studios, performing sexual activities completely on demand of the viewers. In reality, the gendered aspect is very often controlled by the website, presenting a kind of biopolitical Internet power: the performers are limited to women and the viewers have to be registered as men.

Less regimenting platforms also exist, expanding the direct interaction into an act of voyeurism. Many models decide to perform as couples, challenging the argument of direct oppression put forward by some sex work abolitionists; instead of soliciting particular actions by women in exchange for the tokens, the viewer pays to look into someone's "private" life, which is an important and rarely mentioned aspect. In the sex work discourse, camgirls are often perceived as bodies controlled through the Internet, and their work is simplified to the supply of virtual sex. Yet many of the models decide not to undress, speak, touch themselves, or show their faces. These disavowals have the potential to expand our understanding of what sex work is. The product is therefore not only sex but also care, feelings, relationships, conversations, or consoling—the same forms of emotional work already performed by women in other, less-stigmatised industry sectors.

Virtual sex work seems to differ in the conditions most associated with danger—contact with both clients and the police. In a way, technology has created space for non-physical, seemingly safer types of sex work, yet it may intensify social stratification. It is popular in the U.S. and Europe, but illegal in the Philippines and restricted to heterosexual performances in Russia.[4] Digital labour in general is characterised by a lack of materiality and defined geography, but here it directly influences physical safety. The worker's space shifts very often to their private bedroom, bathroom, kitchen, or garden, and the geographical location is carefully camouflaged. In my observations, I've seen a viewer comment, beneath the woman's performance, "I know where you are, only in Western Europe wallpapers are so ugly."

The digital environment creates new dangers: the videos are recorded and can, potentially, last forever. The violence directed towards "virtual" sex workers is not directly physical, yet can have disastrous consequences, as in the recently launched cam engine tool. The creators of this system, which lets a viewer look for "models similar to your crush", have defended their invention through dehumanizing arguments—not even acknowledging the possibility that "your crush" could also be a camgirl. In reality, already existing and continuously developing forms of digital surveillance pose the biggest potential harm to the virtual and disembodied forms of sex work.

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2 Weeks, K. (2007). Life Within and Against Work: Affective Labor, Feminist Critique, and Post-Fordist Politics. ephemera, vol. 7, no 1.

3 Greenwood, J. (2005). Engines of Liberation. Review of Economic Studies. vol. 72, pp 109–133

4 Farvid, P. and Henry, M. (2017). 'Always hot, always live': Computer-mediated sex work in the era of 'camming'. Women's Studies Journal, vol.31, no.2

LIFE IN EXPLODED VIEW:

A CONVERSATION WITH SARA HENDREN

Sara Hendren is an artist, design researcher, and writer based at Olin College of Engineering. Her work includes assistive and adaptive technologies, social design projects, and mixed media collaborations that engage technology and the human body. At Olin, she is Principal Investigator for the Sketch Model initiative, funded by the Mellon Foundation, designed to bring three years of programming and partnerships with practitioner in the arts and humanities to engineering students and faculty. She also leads the adaptation + ability group, which explores encounters between humans and the built environment.

GEORGINA VOSS: I've been thinking about how we articulate technological systems, in teaching as well as through practice, and why that's so important. What we do through design is materialise; we think about the world as we materialise the world. But I sense a lack of systems literacy or understanding of what it means for technologies to work in this way. That's what's keeping me up at night at the moment. Does that resonate with you?

SARA HENDREN: I find myself talking to students a lot about what is dispositional about design. We agree that there's something really compelling about materialising and externalising ideas; but equally I'm trying to cultivate in students a sense of, on one hand, commitment, and on the other hand, provisionality. It's one thing to externalise the ideas that are in your mind; it's another to have the kind of deep cognitive and affective elasticity needed to commit to an idea, to externalise it in a way that says, this is a software issue and I'm going to commit to this idea and see if I can mock it up in software, hardware, or whatever.

But provisionality is difficult to hold in tandem with commitment. Can I dial back from that thing, can I rip it open at the seams? Then can I re-commit to another direction? And then can I do it again, and can I do it again? That's the hardest thing for students to understand: it's not only not falling in love with a special technology because it's there, but also not falling in love with your own first idea, while not being afraid to flesh out an idea because you don't want to waste time on half-finishing something. This approach is about deep dynamism and trying things out.

Someone asked me recently, "I hear about design thinking everywhere, what do people mean by that?" and I said, "At its best, it's an agility with questions, like inverting problems. You are presented with one thing as a challenge and you can see it as parts of a whole; you can redesign the box, the supply chain, and the footprint entirely." He said, "Isn't that first principles thinking?" and I said, "You're right. It describes something rather simple—the capacity to think systemically when you're looking at a product, to think ecologically about how everything affects everything else and therefore is responsible to everything else."

But thinking in first principles is really quite different from getting shit done. In some issues, you're not just materialising: you're materialising in a world where it's eventually going to be delivered. Maybe that's scalability, maybe not—but it's going to have a life. And you have to hold onto your first principles and do this dance of commitment and provisionality—and, by the way, round up all the stakeholders and work with them and their material, institutional, and governmental constraints.

That's the difference between designers and armchair philosophers, for whom first principles are simple ways of thinking. It's hard for designers to hang on to them—not because they forget, but because of the commitment and provisionality.

There's something to recover here historically, at least in the American tradition, from pragmatism and John Dewey and those folks. In Richard Sennet's new book on cities, he points out that the pragmatists were not about practicality. What defined them was their continuous will to iterate, to prototype, to see the world being actively prototyped.

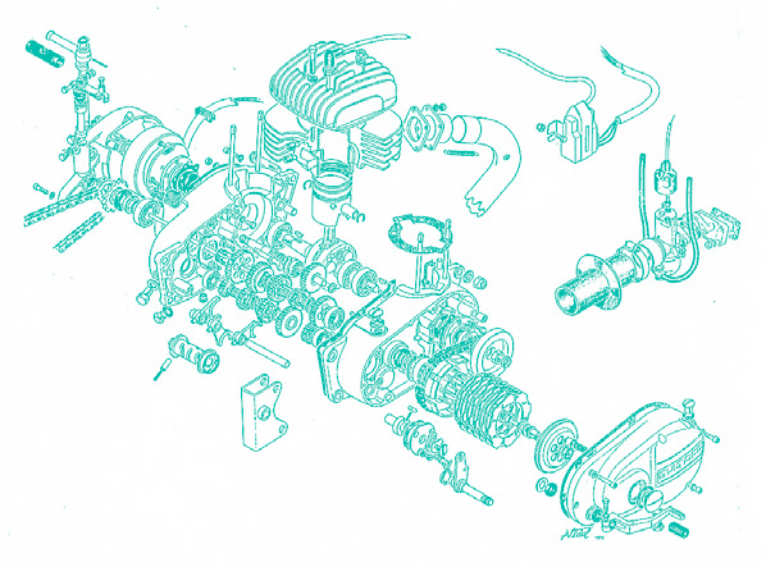
I never get over how rare it is, even today, for people to see systems as unfixed. When presented with a challenge of some kind, people say, "Well, what are you going to do?" These are the options, Box A, Box B or Box C. People do not think of themselves as co-creators in an emergent type of future, nor do they see the constituent parts of that future as malleable and transformable.

The best thing about engineers and technology people is that they see the world in exploded view, that beautiful form of drawing. They see the constituent parts turning and sparkling in their un-fixedness. They can tell that the world is up for grabs. That's what I'm trying to harness for students, but the commitment-provisionality approach eludes them. It has to do with this contextual or social stuff. Can you stay plastic in the face of new information—especially in the face of overwhelmingly difficult information about, say, climate change, in your developmental moment at 19 or 20, or 26 or 27 years of age?

GV: I've been thinking about how we experience and articulate systems themselves. The engineering point of view is super interesting—that exploded view, that CAD diagram where everything is coming apart. I saw a talk recently by David Ha from Google on machine learning where he referenced John Berger and talked about seeing the constituent parts of a system. But we can never see the whole system—the political, contextual, and so on. Instead, we have rubrics to "see" with. It's not just seeing each nut and bolt exploded out but developing a partial framing, bringing together a set of metaphors that are deeply politically and culturally and personally loaded. What parts are you pulling out? Because you're not getting everything. Think about machine learning: there's a road with some white dots on it, are they sheep or something else?

SH: That's where the "exploded view" analogy falls apart. The important part is not the idea of omniscient representation of all the elements, but the disposition to understand that there are spokes to all this other stuff. These days I am haunted by how people talk about interdisciplinary or transdisciplinary new media, hybrid practice, or antidisciplinarity. I hear a lot of backlash towards that as a kind of neoliberal erasure of disciplines. I really think people want to know, "Can I actually give my students a literacy about the implications of exploded view?" Look at your practice through super-wide filters: if you're trying to deal with the environment, you're trying to deal with healthcare. Your little piece is finite and spoked by all this other stuff. You may not be able to intervene right now, but I'm hoping that ten years down the road, when you find yourself as a civic actor, you're actually going to make the right phone calls to the right people. That's pretty elaborate as a deliverable at the end of education.

But it's unclear how much disciplinary knowledge students really need in order to do interdisciplinary work. At an engineering school where everybody majors in engineering, no matter how interested they are in the arts, they're still a paltry preparation. Students don't understand the richness of the way symbols are acting in the world or think with history in mind.



GV: People rightly say that we can't conceive of AI as a technical problem; that the problem is not technology, it's capitalism. Fine—but what do you do with that? Do you burn it all down and conceive of a post-capitalist Internet? Or do you take as your starting point the material world we live in now, our human lifespan, our impending death?

SH: Talk about a first principles trump card. This is why I love the pragmatism of engineers; I suppose it's a pathological optimism. To what end do we dedicate our energy and dignity and consciousness?

GV: I keep coming back to your advice for young engineers to court humility. In design education we challenge the idea of the lone hero, looking instead at these processes as networked and part of a larger system. But we also challenge the heroic narrative in technology and engineering. When it comes back to, "Why design?" I'm nervous about saying, "Only design can do these things for us!" I did my PhD in a policy school; I recognise what a well-crafted piece of legislation does to many buildings.

SH: That is the essence of "courting humility". A lot of us are secretly wired to believe that our way of describing the world gets at the most essential parts of the world. The mathematicians I know are delighted by the capacity of distilled mathematics to describe the world, and they're attracted to its purity and abstraction, that it's not involved in what Stephen Toulmin would call the local, the particular, the oral. People who go into psychology think, "Why doesn't

everyone study this? We're studying the foundations. If I'm studying psychology, I'm studying human behaviour - what could be more foundational than that?" And if I'm studying food science, what could be more foundational than that? Everybody needs it to live. If I'm studying medicine, what could be more foundational?

And I think designers are just as subject to that same impulse, particularly because designers are interveners. I've been reading a lot of Maxine Greene who was a philosopher of aesthetics. She would say that when we talk about arts or artefacts, what's really important is social imagination. When people gather around an artefact in some frame, making meaning with each other emergently through that thing, that's social imagination. She described it as "thinking as if things could be otherwise". It's like a launchpad for stuff to be other than it is.

What interests me in the implication of the exploded view is how young technologists are part of a larger ecosystem attempting to repair the world or build a better one. Their part may be foregrounded at some points and muted at others. Can you cultivate the kind of self-awareness to see that design is a compelling way to describe the world, but we're at a point where we need policy or doctors? It's about being a civic actor. That brings us back to the question: what is education for? Can you see yourself as a product of your own history and therefore an agent in your future? Perhaps engineers and designers need to hear that more than other people—especially in the U.S., where engineers are given so much cultural prestige and monetary rewards. I'm also thinking about Donella Meadows—have you read much of her stuff?

GV: She was how the exhibition was named! She has that great line in her Systems Primer that "systems happen all at once" and from there it was a straight jump into "everything happens so much".

"Systems happen all at once": when I think about how we experience and conceive of them, both the exploded view and the metaphors, I look to her.

SH: I had read little excerpts of hers for years, but not until January did I actually dig into *Places to Intervene in a System*. Everything about her prose sparkled with intelligence and wit, because it was informed by this humility. In *Places to Intervene*, the pinnacle is: be detached from the idea of paradigms altogether. Hold everything in the provisional—the joke's on you because your view is so partial. I was so moved by that, I had to put the book down and take a walk. I can't believe the world lost this person, what a bright light.

GV: We have always had systems and we will always have systems. Why do this work now?

SH: I'm of two minds about this. When I worry about very particular kinds of network technologies and being outpaced in terms of ethics or logical understanding of what they mean, my historian friends say, "But isn't attributing so much agency and power and effect to those technologies a technocratic inheritance?" I am so immersed in an engineering environment that I may be subject to that. But then I look at Meredith Whittaker's recent work on Project Maven, and ask myself: what are our specific responsibilities?

GV: I'm going to rewind to industrial economics. One big notion in innovation studies is the idea of technological regimes and sectoral patterns of technical change. Technologies do have different affordances: if you look at the way that biotech has developed industrially, it's a very different system to IT or to construction, which again comes back to materiality and presence. The question I'm interested in is, "What is specifically different about the articulation and quality of these networked technologies?"

SH: When I hear you articulate that, I think that it's precisely the wrong thing to do, to land in just one kind of system—particularly for undergraduates in engineering. Even if you err on the side of relevance and specificity, even if you have a thousand social, contextual, and ethical qualifiers, you will still be constrained by the particular. And this is where historians always win.

This gets back to disciplinarity. Mimi Onuoha is our incoming artist-in-residence at Olin, and what makes her work so compelling is that she's an anthropology undergraduate from Princeton. She understands that these systems have specificities and you can attend to these specificities, and therefore her practice responds to those things by taking a multi-pronged approach—journalism, installations, collaborative community work.

What should I point my students toward as an ideal of bringing one's whole identity and civic ideals and convictions into a system that has these particularities, while also attending to them? What do you need in your toolbox? You need disciplinary literacy and chops—narrativity and aesthetics, but also practical communication about engagement, to say nothing of the broad humility of a historical view.

I think the utmost that we can do in the classroom in design or technology is to rehearse this relationship to systems thinking, to try and enact a kind of alternating, provisionally committed approach to questions.

GV: There's the "prehearsal" aspect of the classroom as a place for exploration, messiness, uncertainty, and failure as well, before heading out into the world. I've been thinking about how SSS can produce critically engaged but publicly facing work, particularly in the face of demands for "industry responsiveness".

SH: You have to keep claiming the latitude for exploration and articulation. This is why design matters so much. It's not only articulating a utopian world in which you name the relationships and the policies by which these technologies will operate; you need to prototype the future with an unapologetic latitude about what needs to lead. That is the argument for speculative design: you stay way out in front, not just in terms of scenarios, but also training and rehearsals and prehearsals to sculpt how these technologies look and feel and connect to one another. This is the hill that I'm willing to die on, I think.

But how are you going to test this proposition to lead networked technologies instead of responding to industry demand? How are you going to do that unless you're at a place where people nominally came to get into industry?

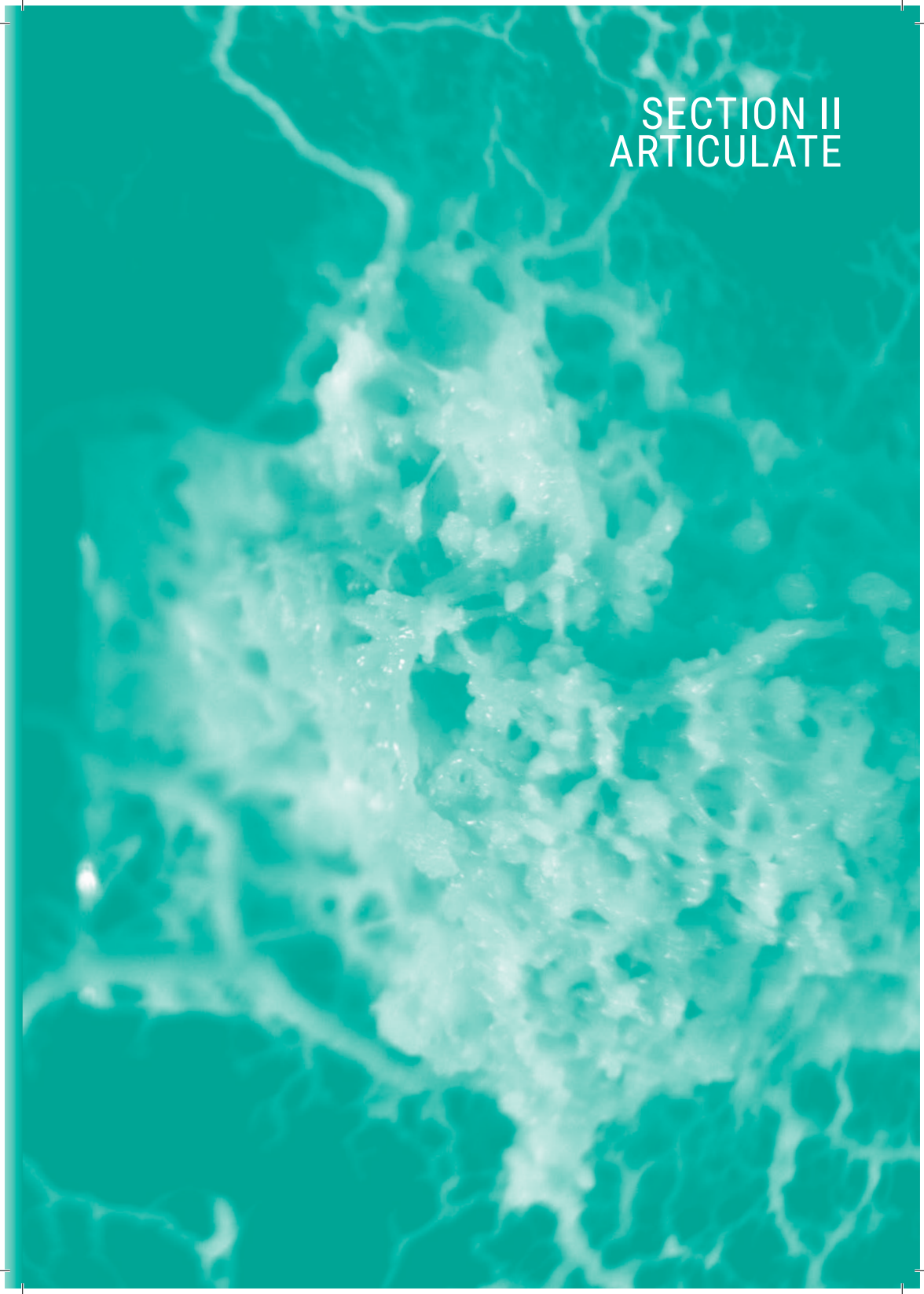
GV: There's something about the need to work at industry speed, with responsiveness and urgency, that traditional academic styles struggle with. We're always going to be bound to some extent by funding and support; but it's also that when something happens fast, it happens really fucking fast. I was talking to a colleague about how coming up with an idea has to happen pretty quickly, because making it is going to be so hard and everything is going to go wrong. As much as we think about retaining plasticity and consider political and ethical forms, once you hit the material realm you've to move and keep going. There's always a lack of time.

SH: That's exactly right.

GV: I love working in a space that inhabits those properties, but it's a really specific way of doing things.

SH: You learn why first principles—or design thinking—always fall apart when you understand that the exploded view is only half the road. You learn that when you iterate through and account for all the parts and execute the thing you think will work in a certain way. Of course, invariably it doesn't work in that way, even though it follows all the rules you've learned from sociology and anthropology and wayfinding and everything else. The energy and willingness to do that is difficult to teach. It's the resilience to do that, when so much of our time here is about artificially elongating the research, ethnography, and anthropology parts just to teach slow time and slow thinking.

(Interview conducted on June 8, 2018, and edited and condensed for clarity)



SECTION II
ARTICULATE

AGAINST TRANSPARENCY

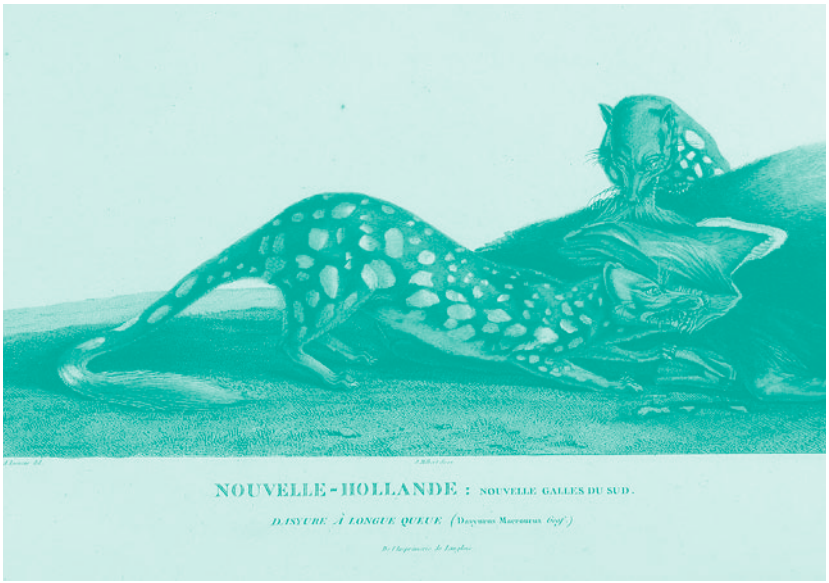
WESLEY GOATLEY

When data is confused with an objective view of the world, free of the biases and subjectivity of humans, it can become a tool of exploitation. New forms of data-dependent governance, such as the "smart city" projects emerging across the world, are predicated on the understanding that data gathered from a city is a mechanically precise and unbiased account of the city in which it is gathered, and that this data can be used to make better decisions in government. The faith in data's infallibility and objectivity endows it with the authority to drive decision-making processes and "smart city" logics. However, this same faith may place the individuals and communities of the city's population at risk by devaluing their subjective voices in relation to the "objective" voice of data.[1,2]

Similarly, data scraped from human online interactions and behaviours is deemed valuable because it claims to be an accurate depiction of the complex, contradictory, or hidden desires of consumers, satisfying the long-held goal of advertisers to know more about you than you know about yourself. Beyond its exploitative potential in a consumerist system, such data has life-changing ramifications when it is used to make "predictive assessments", based on its supposed accuracy, about the right of an individual to cross a country's borders.[3] Given these stakes, can the notion of objectivity be challenged by examining how data is perceived? And how can critical artistic practice further explore this subject?

This investigation begins with the belief that technology allows us to surpass the "limitation" of our subjective perception and grants access to an objective view of the world. In their 2007 book *Objectivity*, Lorraine Daston and Peter Galison call this "mechanical objectivity" and examine the belief through

scientific atlases. These atlases were often heavy tomes of encyclopaedic intent; one typical format coupled images of flora and fauna drawn by artists with descriptions written by scientists. Daston and Galison chart the tensions between artist and scientist in the field of atlas production, where many scientists felt that the artists' interpretations of how to best represent the flora or fauna introduced an undesirable subjectivity to a process intended to be as objective as possible.[4]



Page from *Voyage de découvertes aux terres australes* (1807-1816) by François Péron.

In the eyes of some scientists, the advent of photography resolved the conflict between the "subjectivity" of the artist and the objectivity desired by the scientists. Early adopters of this technology in the scientific atlas community saw the camera as "exactly representing the objects as they appear, and independently of all interpretation…without the least contribution of the hand of man". In other words, the exchange of the artist for the device removed the "hand of man",[5] finally realising an impartial view through the mechanism of the camera. The camera was seen as a transparent and objective component of the process, neither adding to, subtracting from, nor altering the scientists' view of the world.

To a contemporary photographer, this may seem like an incredibly naive understanding of photography. Photography combines technical and material components such as the camera body, lens, and film/image processor with the skill, experience, and "eye" of the photographer, each layer involving subjective interpretation and decision-making. Far from

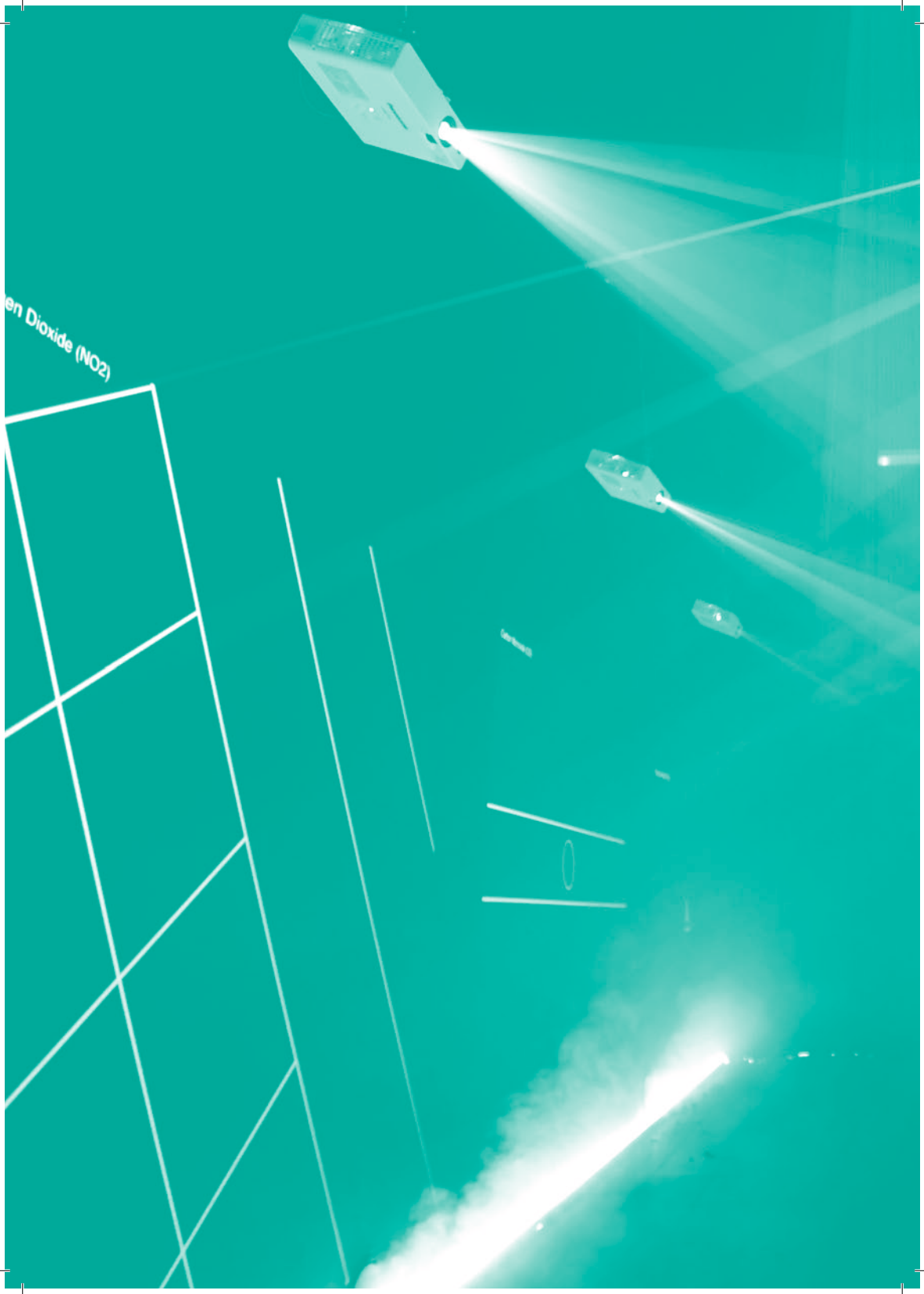
being transparent or objective, photography is irrevocably bound to multiple forms of human subjectivity—the decisions made by the creator of the device, which define what it can and cannot capture, and the unavoidable judgement of the photographer themselves.

This same logic can be used to identify subjectivity in the collection of data and to unravel its claims to objectivity. The data gathered by a given sensor is determined by the decisions made in its material construction, placement, activation, units and precision, amongst other factors. Further judgements are made about how the data is stored, arranged, "cleaned", and otherwise processed, even before it is applied or published. These judgements constitute the layers of data's subjectivity, each step requiring the subjective judgement of human decision-making (perhaps from more than one person). In the same way that a single event can be captured in many different guises by different photographers with different cameras, data produced in the world is not the objective "truth" but just one possible view of it, constructed through subjective decisions.

The subjectivities inherent in data collection, analysis, and storage also carry over into the practice of data aestheticisation—an umbrella term for methods of making data perceptible, such as visualisation, sonification, etc. Data can only be perceived by being aestheticised, whether visualised in an Excel spreadsheet or plotted in the coloured panels of a stained glass window.[6] The necessity of aestheticisation grants it a substantial role in perpetuating and influencing our cultural understanding of data.[7,8]

When the process of creation is broken down, the subjectivity of aestheticisation becomes evident: even in its most simple and common forms, such as the line graph, decisions are made about what data to include, how much of it, in what format, in what visual language, where to present or publish it, and for which audiences. Much like the collection of data itself, there are no "innocent" or impartial decisions in the process of data aestheticisation; these decisions enact the values and ideologies of their authors. Neither data nor its aestheticisation represent an *a priori* truth, but rather a constructed, fallible, and subjective view on the world.

Nevertheless, the previously mentioned belief in "mechanical objectivity" attempts to reassert in itself in the work of data aestheticisation through the declared goal of "transparency". In this context, transparency implies that aestheticisations can and should be objective representations of data that do not "distract" from or misrepresent the underlying "truth" (much like the scientists' ideology in the history of scientific atlases). In this way ironically, by claiming to be "transparent", subjective methods in the process of data aestheticisation masquerade as objectivity.


en Dioxide (NO2)

Atmospheric Disturbances,
installation view.
Wesley Goatley, 2018

In his influential 2001 book *The Visual Display of Quantitative Information*, Edward Tufte sets transparency as a central goal in data visualisation when he calls for their authors to employ "graphical excellence" that tells "the truth about data"[9]. Telling the truth, from his perspective, is not to foreground data's subjectivity but to visualise data "truthfully", and therefore without the personal bias of the author.

Tufte's claim that "graphics reveal data" implies a transparency and innocence of aestheticisation, framing it as a practice that merely shows what is already there.[10] In fact, aestheticisation creates a representation of data which is phenomenologically distinct to the data itself, in much the same way that data is not equivalent to the phenomena in the world that it measures. Aestheticisation is something new; it has left the data behind through the act of representation. The underlying issue is a matter of ontology, not aesthetics: graphics do not transparently reveal data—they create a new subjective interpretation of data.

Given the inescapably partial nature of data aestheticisation, "transparency" is thus an unachievable aim — one that promotes the discourse of data's objectivity through the sublimation its layers of subjectivity. Striving for transparency also misses the most potent affordance of data aestheticisation—that it can express far more than the data alone.

Aesthetic forms have their own cultural contexts, their own narratives of how and where they are experienced in the world.[11] When these forms are applied to data, their contexts become entangled with it, producing something far more than just the sum of the data. Rather, they generate hybrids of different modes of knowledge and aesthetic experience overlaid with data's epistemological claims. Aesthetic interactions with art have no defined result, no preconceived form of consequent knowledge. This capacity for "unfinished thinking" in artistic practice, to use the terminology of Henk Borgdorff, produces open-ended interactions between the artist, the work, and the audience.[12] This resonates with Immanuel Kant's account of aesthetic experience as inducing thought without defining it, and therefore eluding resolution—an interaction defined by the subjectivity of the perceiver.[13] Situating data within the interpretative framework of artistic practice is a fundamental challenge to the notion of data as a form of empirical objectivity, of data as the "answer" to problems of a complexity beyond the capacities of human rationality according to other logics (from ethics and economics to religion and nationalism) that are more explicitly entangled with human subjectivity.

Deconstructing the premise of transparency in this way repositions aesthetics: it is no longer in the service of data but rather coupled with data to engage with the world through a greater multivalence of forms and methods

and a broader scope. An experimental and expressive practice of aestheticisation highlights data's subjective and interpretative character; if used conscientiously, it can draw out the politically and ideologically contentious nature of data, its situatedness and shifting relationships. When these affordances of practice are explored rather than vilified and (rather hypocritically) denied, they can provoke new perceptions and interactions with data. Using aesthetics *with* data places it in dialogue with the wider world.

This repositioning is something I pursue in my own works of data aestheticisation. In my 2018 installation *Atmospheric Disturbances*[14], air pollution data collected in Milan was sonified using voices from Giuseppe Verdi's 1848 opera *La battaglia di Legnano*: as the measured pollution increased or decreased, the voices rose and fell in volume. *La battaglia di Legnano* was an explicitly political revolutionary opera that dramatised the twelfth-century victory of the Lombards over the Holy Roman Empire, set in and first performed in Milan at a time when the Italian states were struggling for independence against the Austrian Empire.

In the context of *Atmospheric Disturbances*, Verdi's work acts as a paradigm that exemplifies the critical and political capacities of creative practice. From Tufte's perspective, aestheticising the data through such an allegorical and metaphorical language embodying a particular political agenda would be contradictory to a nominal goal of "transparency". But my work entangles this historical political narrative with the contemporary process of reading air pollution data. As the staging of Verdi's opera used a historical war to make a political statement about ongoing events, *Atmospheric Disturbances* reflects on the collection of air pollution data in the age of anthropocentric climate change as an explicitly political act. No data on this subject cannot be understood as neutral, objective, truthful, or complete—and neither can any aestheticisation of that data.

Rather than "reveal" the data, the aestheticisation in this installation is implicated in a much wider political narrative and a much longer historical chronology.

When data can be measured or created about almost any phenomena, when so many different aestheticisation methods are available, aestheticisation has the potential to be a socially critical, politically engaged, and aesthetically potent creative practice. To expose the notion of "transparency" as a trap, to untangle the mutually reinforcing claims of objectivity in aestheticisation and truth in data, is to interrogate the subjectivities of both data and aestheticisation and to make their affordances more apparent and more powerful. This line of enquiry extends deep into the critical study of data: it investigates how it manifests in the world, where its effects are felt, and who wields it as a source of power.

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4 Lorraine Daston, Peter Galison (2007) Objectivity, New York: Zone Books.

5 ibid. Donné 1844-45, quoted on p.131

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7 David Beer (2017) 'Envisioning the power of data analytics', Information, Communication & Society, 21(3), pp. 465-479.

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13 Immanuel Kant (1790) Critique of Judgement, Trans: Werner S Pluhar edn., Indianapolis: Hackett Publishing.

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STRUCTURES AND THE CREATIVE MIND: ON MAVERICKS, RELUCTANT SUBSCRIBERS, AND NERDS

LUISA CHARLES

The first time I really thought about the role that systems play in creative ventures was while co-producing a film for the 48 Hour Film Project (a self-explanatory competition in which you make a short film from scratch in just two days). Working alongside Lucio, my fellow producer, we tried to structure and organise a hectic weekend in a way that would best allow for creativity to flourish. Yet it became clear that we each looked at structure in a very different way. Whereas I was excited by the prospect of creating a shooting schedule so efficiently foolproof that we could have members of the team working around the clock, Lucio was far more concerned with ensuring that our goals were attainable, that our deadlines actually kept us on track. A third member of our team thought that we shouldn't bother to organise the endeavour at all, reasoning that by attempting to plan out a creative activity we would take away the artistic integrity entirely. He even went so far as to suggest that, rather than booking actors, we use passersby once on set.

When speaking about systems and creativity, it is important to define the two. Jonathan Plucker and Ronald Beghetto define creativity as "the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context."[1] In other words, original thought isn't creative simply because it is "out there", but requires some sensitivity and response to

contexts, practicalities, and needs. A system, as defined by Donella Meadows, is an "interconnected set of elements that is coherently organised in a way that achieves something."[2] Speaking to fellow designers, artists, and creative professionals about systems within creativity, I discovered three main archetypes, which I have chosen to call the maverick, the reluctant subscriber, and the nerd.

The maverick tends to be an artistic soul, seeing organisation and structure as barriers to free expression and enemies of creativity. That perception resonates with the "double diamond" model of the design process, in which divergent thinking such as brainstorming is followed by convergent thinking that narrows down ideas.[3] During the divergent stage, individuals must "have the interest, enjoyment, and commitment necessary to identify problems, generate multiple ideas, and not be distracted by extrinsic concerns." [4] Externally enforced structures such as assessments and formal processes are particularly harmful to ideation at this stage of the creative process. Constraints can create an environment in which people do not feel free to express their ideas for fear of "getting it wrong", causing mental blocks and preventing creatives from coming up with something novel.

Novelty, however, is not the only requirement for a creative idea. When moving into the convergent stage of thinking, structures help to take ideas from purely abstract to actually useful. Deadlines and goals give people something to work towards, which is particularly effective for the second archetype, the reluctant subscribers.

Those that fall into the reluctant subscriber category are a little more pragmatic. They recognise that, although creatives may not necessarily enjoy following procedures or being constrained, they are necessary evils in delivering creative projects, completing the creative thought process, and taking novel ideas to their useful outcomes. According to Isabel Briggs Myers—author of the famous personality index, the Myers-Briggs Type Indicator (MBTI)—creativity correlates most strongly with those who fall into the "intuition" and "perceiving" categories.

Intuition refers to the way in which one takes in information. Under the MBTI framework, intuitive types rely more heavily on imagination, ideas, possibilities, and looking at the bigger picture (in contrast with those who tend to focus on what is immediately in front of them, prioritise facts and information, and hone in on details). Perceivers are characterised as being flexible and open to opportunities; they are likely to prioritise what makes them happy rather than pleasing people around them, and often find it difficult to commit to plans and important decisions.

It is unsurprising, therefore, that intuitive and perceptive creatives often work better when external structures are imposed upon them. If creativity requires both innovative thought and suitable and advantageous outcomes, we can look at novel ideas as naturally emerging from the intuitive side of one's personality, but self-imposed rules and constraints are not inherent tendencies of the perceptive side. Without a deadline, many creative people find it challenging to finalise outcomes, and can continue iterating and allowing an idea to grow and grow to no end. On the other hand, having a brief or constraint can help filter the influx of possibilities and allow one to look simultaneously at the details and the bigger picture.

Then there are the nerds—those that recognise that constraints not only aid the creative process but constitute expressions of creativity in and of themselves. This idea was most famously demonstrated in *The Five Obstructions* by Lars von Trier and Jørgen Leth. In the film, von Trier gets Leth to remake his masterpiece short film *The Perfect Human* five times, each with a different brief or restriction—from shooting the film in the worst place in the world to making it into a cartoon. Although the final documentary shows lengthy sections of the remade experimental films, its main focus is the reactions of the men and the process of following the obstructions.

Many fine art practices recognise the process of artistic creation as a form of expression. The various plain white canvases found in art galleries across the world are hailed not for their aesthetic beauty but for the way in which they were created and their conceptual reasoning. Another example is rule-based artistic processes, like the British painter Bernard Cohen drawing a single, continuous line until it filled an entire canvas. More recently, this algorithmic approach to art has been increasingly executed through digital controls. Roman Verostko, who coined the term algorist, creates works by programming a pen plotter machine to paint using calligraphy brushes. Though he does not physically execute the paintings himself, he still considers himself an artist because he creates the code behind the artwork.

But why stop there? Could the role of a film producer be considered a creative one? To many, there is nothing more beautiful than a well-designed spreadsheet. According to the International Council Societies of Industrial Design, design is "a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services, and their systems in whole life cycles".[5] If design is inherently creative, then designing logistics and structures must be considered a creative practice as well.

In a recent film project, a small team and I had just three hours to shoot a 10-minute, 60-shot short, performed by first-time child actors. In order to do that, we created a spreadsheet that organised the shots by location, shot

width, and importance in order to find the most efficient way to get it all done. This minimised changes in the camera set-up and enabled us to shoot different characters in different locations simultaneously—creating a filmic production line of sorts. We finished the shoot with five minutes to spare. Was the final film visually striking and well-made? Certainly not. But within the planning and the process, it was unquestionably a thing of beauty.

Whether we like it or not, it is undeniable that creativity and systems go hand in hand—be they the banes of our collective existence, unavoidable measures, or welcome forms of articulation and expression. Nothing quite gets my blood flowing like pure, unadulterated efficiency, and there are certainly more avenues to be explored within this realm.

1 Jonathan A. Plucker, Ronald A. Beghetto (2005) 'Why Creativity Is Domain General, Why it Looks Domain Specific, and Why the Distinction Doesn't Matter', in Robert J. Sternberg, Elena L. Grigorenko, and Jerome L. Singer (ed.) Creativity: From potential to realization. Washington, DC: American Psychological Association

2 Donella H. Meadows (2008) Thinking in Systems: A Primer, Chelsea Green Publishing.

3 Design Council (2005) The Design Process: What is the Double Diamond?, Available at: https://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond (Accessed: 22nd August 2018).

4 M. A. Collins, T. M. Amabile (1999) 'Motivation and creativity', in R. J. Sternberg (ed.) Handbook of creativity. Cambridge, UK: Cambridge University Press, pp. 297-312.

5 ICSID (2002) Definition of Industrial Design, Available at: http://www.icsid.org/about/about/articles31.htm (Accessed: 22nd August 2018).

MAYBE BE A LIZARD FIRST:

A CONVERSATION WITH JOEL KARAMATH

Joel Karamath is the Course Leader for BA (Hons) Interaction Design Arts at London College of Communication. His background in film and cultural studies, and he has an inherent interest in the relationship between theory and practice and how this manifests in the studio environment.

GEORGINA VOSS: How did the BA in Interaction Design Arts (IDA) develop, and how did technology fit into that evolution? To set the scene: we're sitting in the IDA studio where I can see both the computers and the workshop space. I'm curious about how you've brought technology into teaching over the years.

JOEL KARAMATH: As with all things, there's an element of serendipity involved. If we go back ten to twelve years to the inception of IDA, there were a number of pathways in the design school at that time—predominantly typography, illustration, design for advertising, book publishing. Then there were "bolt-ons": if you were doing illustration you could bolt on letterpress because it was relevant.

It soon became obvious that other areas were coming out, like "moving image" and "interaction", as it was known then. These two areas were growing but didn't really belong to any of the courses. Illustrators were doing things with moving images and animation, so they became popular media as people wanted to do pop promos and editing and filming. The wisdom at the time was to make two new pathways, one for moving image and one for interaction. But there wasn't enough money, so they said, "We'll make one pathway and call it Interaction and Moving Image" (IMI). It was a very fortuitous

accident in its own way. It was odd, of course: what does "Interaction and Moving Image" mean? But it had time to develop without the constraints of a given tradition, which in hindsight was a huge luxury.

That was interesting in terms of the way we view the term "interaction". Most degree courses use "interaction" interchangeably with "digital". That's not true here—we have a much broader remit. IMI quickly evolved and became known for the type of work it produced. After revalidation it was renamed "Interaction Design Art", and that terminology gave us an even broader remit. The philosophy of the course is grounded within design thinking: it's a design-led course first and foremost. We do moving image—my background is in film studies—but we work through a design-led approach, film through design, et cetera. I think that's a unique way of looking at it. When you bring moving image into the arts, it allows us to say, "Actually, it's interaction for a number of really different areas".

Very early on, Biggles [course tutor] started to say that the course could be high-tech, low-tech, or no-tech. This is a course about ideas, not technology. Technology is always secondary. It's not because we're completely media-agnostic; it's that it is essential to ask "What's your idea? How do you want it to come to fruition?"

Rather than saying, "I'm going to do something with an Arduino"— what's the idea and what's the best technology to use? Is it an Arduino or a cardboard box?

GV: Can you say more on how "interaction" gets used elsewhere, and how other places might conceive of "interaction" meaning "digital"?

JK: Every now and then, you get these zeitgeist phrases —"new media", "multimedia", and so on. "Interaction" works in that way at the moment: people attach it to a lot of things. But it's still very much seen as the next new thing, even though it's been the next new thing for quite a long time now. The term itself has never really bothered us. It's how we use the terminology and how we think. If we were to start this course from scratch today, we would never call it IMI—but I'm certain that if it hadn't called IMI then it wouldn't have become "Interaction Design Arts".

One of the problems that I see with a lot of new courses in interaction design is that they want to get to the future straight away, and they miss out on the naturally slower pace of evolution. We were crawling out of the swamp from day one. A lot of people say "I'm on dry land now, I'm going to be a bird, I want to fly", and we're saying, "Well, you might need to be a lizard or a dinosaur first."

There's a lot of looking back and looking forward on the course. People talk about future-facing courses and they are literally facing in one direction. Ours is 360 degrees. If you look around the studio you'll find 16mm projectors, 35mm cassettes and cassette display units. They all get used in projects at some point. I try to get our students to use as much film as possible. We look at analogue photography not because it's quaint, but as a way to understand the difference—and make a choice—between the analogue and digital. Seven or eight years ago, the first cohort of first-years had no idea of analogue photography because they'd grown up with digital cameras. What's interesting about that is watching their reactions to working with film, making pinhole cameras or wet plates, and then using that to inform what they do with digital material.

I would argue one of our more successful recent interaction projects was the garden. It's almost the complete antithesis of the digital realm but it gives us a platform to explore things digitally: for example, we want to install a digital weather station. It's the most basic, rudimentary form of technology, going out there and literally getting dirt under your fingernails, but at the same time it informs very future-facing work around data collection, pollution, water, and climate. And it helps us with the very practical technical elements and processes of physically building stuff, away from screens, which is an inherent part of the course.

GV: One thing that's always struck me about the politics of technology is that there's always a point where the historians chip in and say, "Great, but how about we look back to the use of punch cards in WWII or the Cornish pumping engine?" You get a sense of how these systems operated in previous centuries and how their politics have carried through. Does a course that looks forward and back allow students to think more critically about technology?

JK: You can't isolate it like that, or consider history in the Western notion of linear time, when it might cycle or corkscrew forward instead. Technology sometimes misses a visceral element, which is so important. I saw an article the other day about a daycare nursery that gives kids power tools, and I said, "Yes!" Those visceral aspects are being diminished in tertiary education, as everything is forced into white coats and goggles and mitts. There's an element of evolving with your things, but also getting your things to evolve to you as well.

Many design degree courses operate in traditional, interchangeable white cubes where the walls go up and down, aiming to be everything but ending up being nothing. We've designed our active studios to aid our way of thinking, for quick rapid prototyping.

More than anything else, the whole relationship between past, present and future is really encapsulated by the fact that virtually anything that gets thrown out in the college will end up, sooner or later, in our studio. If I had to name a trait that students need to enter IDA, it's skip-diving. It's an essential part of the course. You find things; you ask, what is this? What does it do? How does it work?

GV: And how has it ended up in the skip?

JK: Exactly! All of the things that we've re-appropriated are still working. Students often stand by the shelves looking at a gadget, asking, "What does this do?" and we say, "Take it down and find out!" It harbours curiosity. A lot of education at the moment restricts curiosity—you can be curious, but only within these boundaries. Real creativity goes across boundaries; it comes at the nexus between disciplines. Because we don't have a single discipline on the course, there is more than one nexus.

GV: When I give talks about Supra Systems Studio, I often describe the spaces that permit discursive work—and then skip to a slide of Tommaso [IDA graduate 2017] wielding an engine part; he's beaming, so happy.

JK: It's not too dissimilar from those daycare kids and their power tools; it's the exact same look.

GV: I get nervous about ideas of "critical making"—there's something that feels antiseptic about it. You're allowed to "critically make" something, but never with an element of risk or danger, never with something old to dismantle. It often seems to take place in clean spaces with new materials.

JK: Speaking of space, sometimes we just have to convince people that they can do what they want to do. Some students say, "I only do photography, I can't do any of these other things." I say, "Look at your portfolio: yes, the photograph is good, but look how you're displaying it, look what you've built to display it. It's not just a photograph, it's your understanding of space." Our studio permits cross-pollination. The first-years often help the third-years on their projects. While the second-years are doing the Expanded Cinema unit, the first-years are looking through the window, saying, "Wow, what is that? Can we do that next year?" A first-year will pick up some tools and a second-year will say, "No, you need a different sort of hammer." I tell new students, "Hopefully over the next few years you'll learn a lot from us, but I guarantee you'll learn more from each other." Students feel a certain amount of ownership over the studio space, which helps to build a community of practice. I constantly have to chase students out of here before I can go home. We have our office in the middle of our studio,

which is really important. It's vital for students to know that that staff aren't above the course, but part of it.

GV: You said that this is a design-led course. What did you mean by that?

JK: It's how we approach problem solving: how does it work? why does it work? is there actually a problem at all? Our job as tutors is to create problems for students to explore through a brief. The media-agnosticism of the course comes through here, as students work out whether they want to approach the brief through film, installation, performance, dance, et cetera.

GV: Has it been a challenge to steer students away from simply thinking, "I want to do something with an Arduino" or "I want to do something with VR"?

JK: It becomes less of a challenge over time. In the first year we get into "de-schooling"—pick your idea first, not your medium. Ask yourself, what are the possible ways to do this? A lot of people make the mistake of thinking, "I really like that great project that uses an Arduino, so I'm going to use an Arduino." Fine, but that's not the reason that project is great. It's so important to get students away from the idea that random bits of technology are the solution. We encourage them to think that it's all about them—the ideas in their head and how they get them out into the world. We tell the first-years, "The next three years might seem like a race, but it's more of a ramble. The only thing that matters is your own progression and pace and development. You're not in a race with anyone else." Students need to find themselves and where they want to go with their ideas, because then they can explore why they want to do what they do.

GV: How has the course surprised you over the years? And not just in health and safety terms.

JK: The level of camaraderie amongst graduates, the amount that they give to each other, but also across the college and in community-based projects. There are surprises every year—not just the really high-end projects or the high flyers that you spot in the first year. Other students need gentle, continual coaxing; even into the third year, you wonder, "What are they doing with this…?" And then the students take their ideas and run with them. For me, that's what education is—seeing the people who've made the biggest journey. I'm always most proud of that.

(Interview conducted on July 5, 2018, and edited and condensed for clarity).

OF MACHINES LEARNING TO SEE LEMON

JOHN FASS
ALISTAIR MCCLYMONT

In the seventeenth-century heyday of Dutch still life painting, exemplified by painters such as Jan Davidsz de Heem and Pieter Claesz, lemons feature heavily as opportunities for the display of matchless technique. They also fulfilled many complex symbolic functions. For the newly enriched bourgeoisie of the Dutch Golden Age, still life paintings were subtle displays of ownership and wealth derived from the Dutch colonies in Indonesia, Sri Lanka, and Taiwan, and the trade in commodities extracted from these territories to Europe. This trade was facilitated by the state-supported monopoly of the Dutch East India Company, an early example of a consolidated global corporation. Over its two-hundred-year history, the Dutch East India Company transformed from a trading company into a transglobal body with many of the characteristics of an independent state. It was able to implement its strategies through force of arms, the establishment of multiple independent markets from Amsterdam to Jakarta, and the determined exploitation of conquered lands and peoples.

Still life paintings are a product of this sociopolitical system, which accrued unprecedented levels of wealth for those with access to the opportunities provided by the company, as Toby Sonneman has pointed out in her history of the lemon.[1] The visual work performed by fruit in these images reminds the viewer that the owner can afford to purchase and consume fruit imported from far away (and, of course, that they have sufficient spare income to

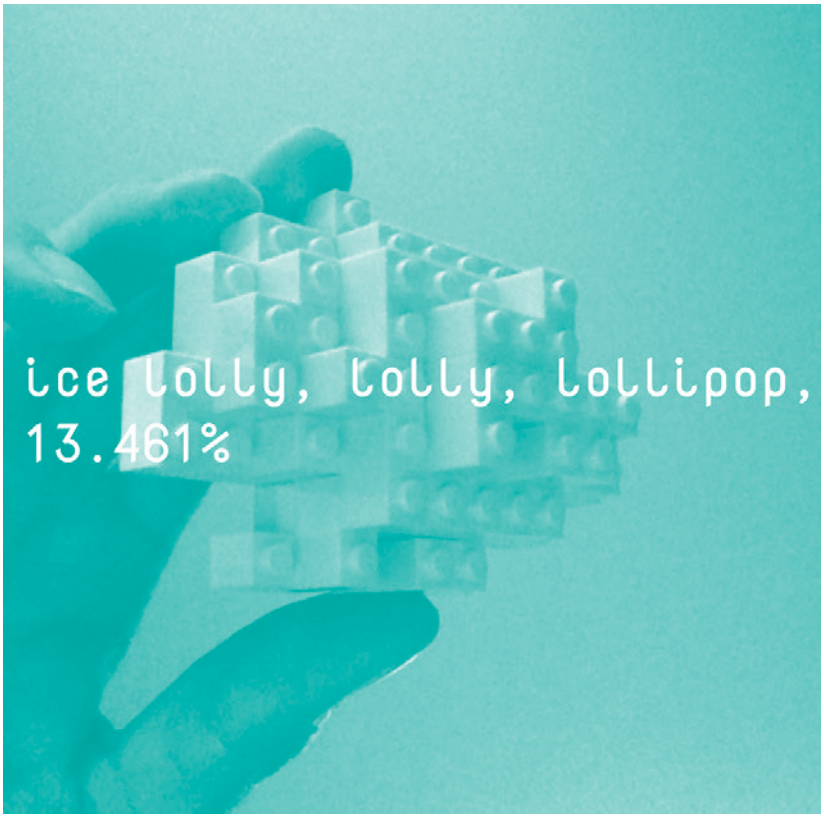
engage an artist to mediate this message). Lemons, like all fruit in still life paintings, conjure impressions of decay and the transient nature of human life — but they also have a particular place in communicating acidity or bitterness, as well as the interior-exterior dynamic of hidden power exerting its influence seen in the contrast between the rough outer skin of a lemon and its glistening lustrous interior. Art historian Julie Berger Hochstrasser has emphasised the importance of pictures of lemons as especially extravagant ways of displaying affluence—"the ostentation of a whole lemon peeled and sitting at the ready, just for a little squeeze of juice".[2]

Still Life with a Silver Jug and Fruit, Jan Davidsz. de Heem, 1652.

Lemons were by no means unknown in Northern Europe, having been brought back from the Middle East by Crusaders in the eleventh century, and were certainly known in antiquity as recorded by Theophrastus' *Historia Plantarum* of 300BC.[3] Nevertheless, in the seventeenth century, only those with the financial means to purchase and consume them would know what they were and what they tasted like. Recognising a lemon by its shape, texture, and colour—for what it was and for its cultural and symbolic significance—was only possible for those who could see real lemons in the marketplace or identify them in visual representations.

In contrast to the social reading of how physical objects are recognised, in neuroscience and computer science object recognition in the human visual system is considered to be a function of complex brain processes that depend

on a cascade of reflexive operations. Di Carlo observes, "we effortlessly detect and classify objects from among tens of thousands of possibilities and we do so within a fraction of a second despite the tremendous variation in appearance that each object produces on our eyes."[4] The complexity of these neural operations are evident in the fact that "All visual cortical areas share a six-layered structure and the inputs and outputs to each visual area share characteristic patterns of connectivity"[5] The task of producing a representation of sufficiently high fidelity to visually identify objects is poorly understood, and there is considerable debate about how it takes place in the brain. Computer scientists have concentrated on constructing computational models of perception, in order to produce explanations along the lines of a Turing machine, i.e. mathematical models that can simulate an infinite number of states. Neuroscientists, in contrast, have focused on the spatial distribution of the relevant brain activity and how these areas may be connected to each other — in other words operating at the cellular and molecular level of cortical circuitry.



An algorithm learns how to identify lemon, Photo: Alistair McClymont.

A computer vision system recognises a lemon in a very different way, although it is rooted in the search for the neural 'algorithm' of human visual object recognition. Computational object recognition requires 'training' using relevant data. The ability of a computer to correctly identify a lemon depends on the number, quality, and accuracy of examples in the data class 'lemon' the system has been exposed to. In addition, the human visual system is very good at processing interruptions to the visual field (we have no difficulty in, say, recognising a tennis racket that is resting on a chair in front of a window that looks onto a river). In the scenario above a computer would need to identify every object, perceive how they are arranged in space, assign the correct label to each one, and recognise the whole as a scene. As Luc van Gool points out, "The same object will look different depending on the viewpoint, the illumination, or the occlusions caused by other objects in front."[6] Furthermore, the wide variation between instances of the same object means that the "recognition of an object as belonging to a particular group is a harder problem for a computer than the recognition of a specific object."[7] One lemon does not look exactly like another, and therefore significant computational resources must be devoted to distinguish between different views, types, or examples of lemons as an object class. As a result, much attention is given to pre-categorisation of images of objects via tagging or other taxonomic labelling methods. This requires large amounts of individual images but, perhaps more significantly, a dominant logic of categorisation to work.

As more and more detailed models are developed based on the millions of images used as training data for object recognition learning algorithms, so system complexity increases. Antonio Torralba, associate professor of computer science and engineering at MIT states, "Deep learning works very well, but it's very hard to understand why it works—what is the internal representation that the network is building."[8] The outcome is an opaque system, resistant to analysis, impervious to scrutiny. Often the data scientists behind this work have no idea why they obtain certain results, and have to commit resources to reverse-engineering them in order to gain a deeper understanding.[9] This opacity of computational recognition systems means the steps involved in recognising a lemon are transformed from a set of specific associations, enculturated by human circumstance and experiential phenomena, into the output of an impenetrable probabilistic matching algorithm. Image recognition systems are of course, the result of a set of cultural assumptions about efficiency, accuracy, and performance, usually enacted through precisely defined operations in institutional environments.

The resulting set of representations, whether cellular or computational, remain mysterious in origin, prone to error, ambiguous in value, of erratic reliability and doubtful authenticity.

1 Toby Sonneman (2012) Lemon: A Global History, London: Reaktion Books.

2 Julie Berger Hochstrasser, (2007) Still Life and Trade in the Dutch Golden Age, New Haven, CT: Yale University Press. Pp 200.

3 Benedict Einarson (1976) 'The manuscripts of Theophrastus' Historia plantarum', Classical Philology, 7(1), pp. 67-76.

4 James J. DiCarlo, David E Zoccolan, Nicole C Rust (2012) 'How Does the Brain Solve Visual Object Recognition?', Neuron, 73(3), pp. 415-434 .

5 Daniel J. Felleman, David C. Van Essen (1991) 'Distributed hierarchical processing in the primate cerebral cortex', Cerebral Cortex, 1(1), pp. 1-47.

6 Quoted in ICT Results (2009) Teaching Computers To Recognize Objects, Available at: https://www.sciencedaily.com/releases/2009/06/090601090029.htm (Accessed: 19th August 2018).

7 ibid.

8 Quoted in Larry Hardesty (2015) How computers can learn to recognise objects, Available at: https://www.weforum.org/agenda/2015/05/how-computers-can-learn-to-recognise-objects (Accessed: 19th August 2018).

9 ibid.

COSMIC SPREADSHEETS

DAVID BENQUÉ

"To be rational is, simply, to think in ratios, like the ratios that govern the geometry of the stars."[1] The American religion professor Alan Jay Levinovitz questions the authority of economics and argues that the discipline is a modern version of astrology. His concerns are particularly resonant in an era saturated with data, and therefore with opportunities to find and interpret ratios between them. What I want to discuss here is how data and ratios have been used and legitimised in a specific type of publication—the almanac. Almanacs are practical guides to the year ahead published since at least the seventeenth century[2] in areas such as farming, nautical navigation, and finance. I would like to revisit the almanac as a prototype for contemporary data analytics—to use it as a guide to understand the multiple roles played by data today, their connection to the cosmos, and the rationalities that they support.

As artefacts, almanacs reveal broader systems and histories in their tangible design details. By transforming collected data into predictions, they are rudimentary predecessors to the kinds of algorithmic systems at work today. In their pages, I am looking for visible signs of the history of prediction in order to retrace some of the trajectories that led to today's big data systems. I am not relying only on observation: I am also making an almanac myself to reflect, with first-hand experience, on the production and publication of predictions. My aim is not to reveal how prediction "works" in technical terms, but rather to unpack the cultural space that the almanac has occupied and to question what this space looks like today.

Almanacs have played a major role in the long history of statistics. Technology and politics writer Adrienne Lafrance calls them precursors to the information age, early analogue versions of smartphones with "apps" such as calendars, navigation maps, weather forecasts, and other predictive widgets.[3] They presented the cosmos as orderly and rational: "The universe as machine: Once you get the operating instructions, you can tell the future."[4] Spots on the surface of the Sun, for example, were thought to have a direct influence over the weather on Earth. Since its first edition in 1792, the *Old Farmer's Almanac* presented an ideal of order and regularity to farmers whose livelihoods depended on the weather. Aside from looking directly to the stars for guidance, the statistical methods used in astronomy were applied far beyond farming, and have been since as part of the first and second "big-data revolutions".

Almanacs also include other forms of cosmic imaginaries such as astrology, which interprets the angles and ratios between the Earth, the planets and the stars as vectors for predictions. This geometrical mode of cosmic prediction has roots extending far back into prehistory,[5] yet it continues to thrive despite the "paradigm shifts" of big data. It survives, for example, in the pages of the *Old Moore's Almanac*, published since 1697. Far from being outdone by scientific methods, astrology has integrated new tools and technologies, gaining in precision and sophistication. In the west "a new urban astrology appeared which is still with us. More individualistic than before, it succeeded in adapting to consumer capitalist society."[6] Today purpose-built software packages use astronomical ephemeris data—the positions of planets for millennia past and future—to compute astrological readings and charts.

Almanacs show different modes of relating the cosmos to events on Earth. They highlight the links between astronomy and early forms of data science—including methods for data collection and computation[7]—while also disseminating folk knowledge of the stars as sources for divination. While these might seem incompatible today, almanacs are documents from a time when their separation was far from clean-cut. They complicate the apparent divide between data science and divination today, when the former increasingly claims to objectively and accurately predict the future.[8]

As a pop culture artefact, the almanac is also an opportunity to consider data science and divination from a graphic design perspective. In recent years a number of art and design projects have explored the interplay between data, divination, and computation. American artist Ingrid Burrington creates astrological charts for the Five Eyes[9] spy agencies.[10] Artist collective RYBN's *The Golem* (2017) is a computer that applies ancient kabbalistic hermeneutics to its own processes and daemons.[11] Computational poet Allison Parrish teaches a class at NYU's Interactive Telecommunications Program that

interrogates forms of divination in digitally-mediated environments, "from the casting of lots to computer-generated randomness to the contemporary revival of Tarot; from reading entrails to astrology to data science."[12] Designer Shing Tat Chung's *Superstitious Fund* trades on the stock market according to "lunar cycles and numerology" as well as an internal logic of "lucky and unlucky values."[13] While stories of divination and magic have long been leveraged to promote the supernatural powers of computers,[14] these critical approaches in art and design have a different objective. They use divination as a reminder that despite dominant narratives of technological progress and computational powers, predicting the future remains an elusive goal. They develop a cultural language to examine opaque technological systems of prediction and control, which were constructed over long, and sometimes murky, histories.

MONISM AND COSMIC ORDER

Almanacs offer glimpses into what geographers Trevor Barnes and Matthew Wilson call "big data's historical burden".[15] Specifically, they illustrate how the current fixation with data as a source of predictions is in part founded on monism, "the idea that there is only one set of principles that applies to the explanation of both natural and social worlds".[16] Breakthroughs in astronomy and physics in the eighteenth-century, such as the first predicted return of Halley's comet in 1759, reinforced the notion of an underlying order to the natural world. "Social physics" transposed this idea to predict the social world. Belgian astronomer Adolphe Quetelet famously used methods from astronomy to predict marriage, suicide, and crime. In 1830 his statistical construct of an "average man" aimed to "facilitate the recognition of laws analogous to those of celestial mechanics in the domain of society."[17] Quetelet used Newtonian gravity and Gaussian error curves—later known as "normal" distributions—to predict the behaviours of human populations. As Ian Hacking shows, this involved blatant "jumping to conclusions" but still had a profound influence on "the twentieth-century conceptual scheme of truths and possibilities to which we still subscribe".[18]

Elsewhere, astronomy and its data practices were used to legitimise speculative finance. In nineteenth-century Britain the people doing astronomy and the people doing business were, in some cases, the same upper-class men. Edmond Halley not only gave his name to the famous comet but also authored the first mortality table for use in life insurance. Figures like Francis Baily, John Herschel, and Charles Babbage, dubbed the "business astronomers" by British historian William Ashworth, used scientific techniques of data management, such as double-entry book-keeping, to give finance the veneer of scientific rigour. They anchored their "accountant's view of the world"[19] in records and tables, the stuff of objective observations rather than speculation, which was seen as immoral.

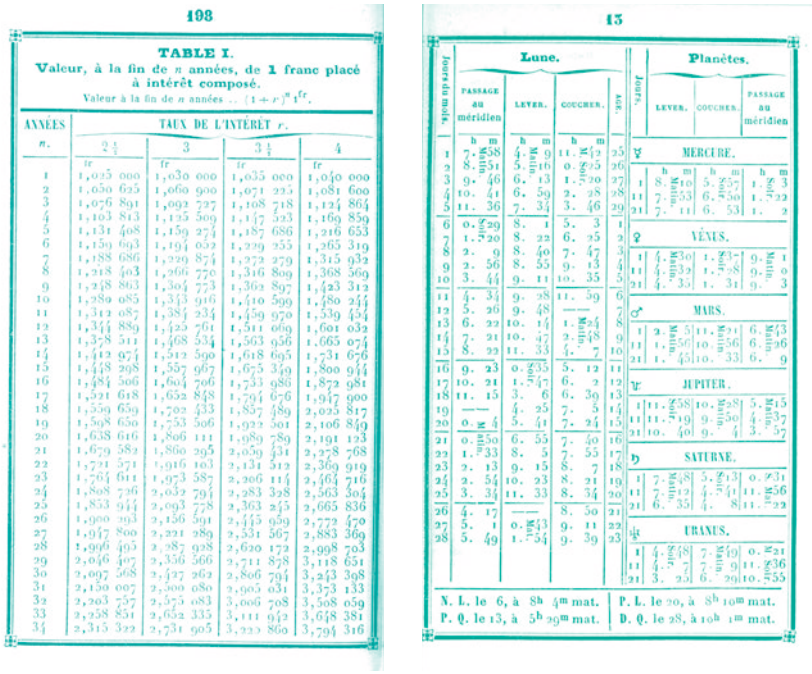


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TABLE I.

Valeur, à la fin de *n* années, de 1 franc placé à intérêt composé.

Valeur à la fin de *n* années ... $(1+r)^n$ fr.

ANNÉES *n*.	TAUX DE L'INTÉRÊT *r*.			
	2 ½	3	3 ½	4
	fr	fr	fr	fr
1	1,025 000	1,030 000	1,035 000	1,040 000
2	1,050 625	1,060 900	1,071 225	1,081 600
3	1,076 891	1,092 727	1,108 718	1,124 864
4	1,103 813	1,125 509	1,147 523	1,169 859
5	1,131 408	1,159 274	1,187 686	1,216 653
6	1,159 693	1,194 052	1,229 255	1,265 319
7	1,188 686	1,229 874	1,272 279	1,315 932
8	1,218 403	1,266 770	1,316 809	1,368 569
9	1,248 863	1,304 773	1,362 897	1,423 312
10	1,280 085	1,343 916	1,410 599	1,480 244
11	1,312 087	1,384 234	1,459 970	1,539 454
12	1,344 889	1,425 761	1,511 069	1,601 032
13	1,378 511	1,468 534	1,563 956	1,665 074
14	1,412 974	1,512 590	1,618 695	1,731 676
15	1,448 298	1,557 967	1,675 349	1,800 944
16	1,484 506	1,604 706	1,733 986	1,872 981
17	1,521 618	1,652 848	1,794 676	1,947 900
18	1,559 659	1,702 433	1,857 489	2,025 817
19	1,598 650	1,753 506	1,922 501	2,106 849
20	1,638 616	1,806 111	1,989 789	2,191 123
21	1,679 582	1,860 295	2,059 431	2,278 768
22	1,721 571	1,916 103	2,131 512	2,369 919
23	1,764 611	1,973 587	2,206 114	2,463 716
24	1,808 726	2,032 794	2,283 328	2,563 304
25	1,853 944	2,093 778	2,363 245	2,665 836
26	1,900 293	2,156 591	2,445 959	2,772 470
27	1,947 800	2,221 289	2,531 567	2,883 369
28	1,996 495	2,287 928	2,620 172	2,998 703
29	2,046 407	2,356 566	2,711 878	3,118 651
30	2,097 568	2,427 262	2,806 794	3,243 398
31	2,150 007	2,500 080	2,905 031	3,373 133
32	2,203 757	2,575 083	3,006 708	3,508 059
33	2,258 851	2,652 335	3,111 942	3,648 381
34	2,315 322	2,731 905	3,220 860	3,794 316

13

Lune.

Jours du mois.	PASSAGE au méridien	LEVER.	COUCHER.	Âges.
	h m	h m	h m	
1	7. 58 Matin.	4. 9	11. 42 Soir.	25
2	8. 51	5. 16	0. 25	26
3	9. 46	6. 13	1. 20	27
4	10. 41	6. 59	2. 28	28
5	11. 36	7. 34	3. 46	29
6	0. 29	8. 1	5. 3	1
7	1. 20	8. 22	6. 25	2
8	2. 9	8. 40	7. 47	3
9	2. 56	8. 55	9. 13	4
10	3. 44	9. 11	10. 35	5
11	4. 33	9. 28	11. 59	6
12	5. 26	9. 48	——	7
13	6. 22	10. 14	1. 24 Matin.	8
14	7. 21	10. 47	2. 48	9
15	8. 23	11. 33	4. 7	10
16	9. 23	0. 35 Soir.	5. 12	11
17	10. 21	1. 47	6. 2	12
18	11. 15	3. 6	6. 39	13
19	——	4. 25	7. 5	14
20	0. ♎ 4	5. 41	7. 24	15
21	0. ♏ 50	6. 55	7. 40	16
22	1. ♐ 33	8. 5	7. 55	17
23	2. 13	9. 15	8. 7	18
24	2. 54	10. 23	8. 21	19
25	3. 34	11. 33	8. 34	20
26	4. 17	——	8. 50	21
27	5. 1	0. ♑ 43 Soir.	9. 11	22
28	5. 49	1. ♒ 54	9. 39	23

N. L. le 6, à 8h 4m mat.
P. Q. le 13, à 5h 29m mat.

Planètes.

Jours.	LEVER.	COUCHER.	PASSAGE au méridien
	h m	h m	h m
☿ MERCURE.			
1	8. 10 Matin.	5. 55 Soir.	1. 3 Soir.
11	7. 55	6. 50	1. 22
21	7. 11	6. 53	1. 2
♀ VÉNUS.			
1	4. 30 Matin.	1. 39 Soir.	9. 1 Matin.
11	4. 39	1. 28	9. 0
21	4. 33	1. 31	9. 3
♂ MARS.			
1	2. 5 Matin.	11. 21 Soir.	6. 43 Matin.
11	1. 56	10. 56	6. 16
21	1. 45	10. 33	6. 9
♃ JUPITER.			
1	11. 58 Soir.	10. 28 Matin.	5. 15 Matin.
11	11. 19	9. 50	4. 37
21	10. 40	9. 4	3. 57
♄ SATURNE.			
1	7. 38 Matin.	5. 13 Soir.	0. 31 Soir.
11	7. 12	4. 41	11. 56 Mat.
21	6. 35	4. 8	11. 22
♅ URANUS.			
1	4. 48 Soir.	7. 19 Matin.	0. 21 Soir.
11	4. 7	6. 39	11. 36
21	3. 25	6. 29	10. 55

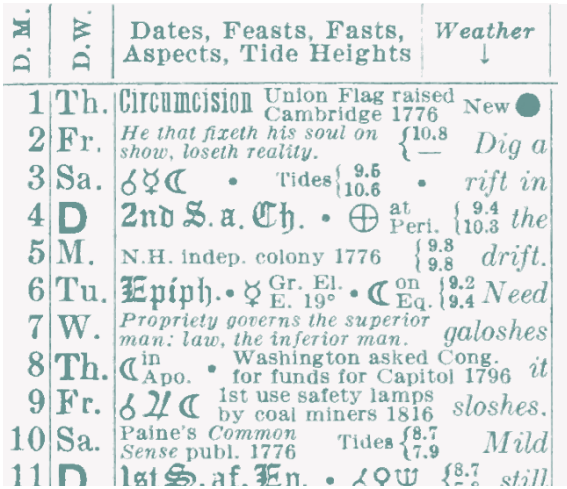
P. L. le 20, à 8h 10m mat.
D. Q. le 28, à 10h 1m mat.

Bureau des Longitudes (1875) 'Annuaire pour l'an 1875 publié par le Bureau des longitudes'.

We can see monism and the accountant's view of the world quite literally on display in the almanac publications of the time. Tables showing the positions of planets were published alongside interests on loans, using similar layouts and visual language. Almanacs also provided a wide range of unit conversions, standards, population statistics, and so on. In Britain, the almanac was the site of a power grab by the business astronomers. Their newly established Astronomical Society took over the publication of the *Nautical Almanac* from the Board of Longitude, as part of a bigger push against the Royal Society and its focus on natural history.[20]

These examples show the almanac as part of the foundations of the authority of numbers in society, a focus on counting—and later computing—which draws its legitimacy directly from the cosmos. There is, however, another side to the parallel between almanacs and the information age suggested by Adrienne LaFrance. As Jeff MacGregor states, "Like the Internet itself, the [Farmer's] Almanac has always been a happy grab bag of marginalia."[21] Unlike the grand promises of big data, almanacs don't take themselves too seriously. A 2017 issue of *The Old Farmer's Almanac* bills itself as "useful with a pleasant degree of humour." Another cover, from 1847, advertises "new,

useful, and entertaining matter."[22] These almanacs mix the scientific, the mundane, and the miscellaneous; alongside the tables mentioned above are remedies, rumours, proverbs, recipes and tips. This translates into a visual vernacular between tradition and prediction, seen for example in the *Old Farmer's Almanac* calendar, which includes astrological symbols, biblical dates, tides, and baseball.



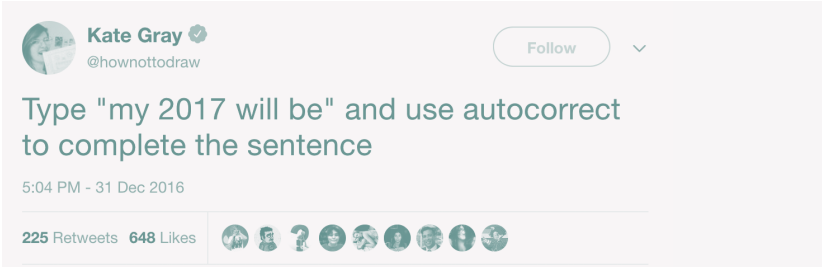
D. M.	D. W.	Dates, Feasts, Fasts, Aspects, Tide Heights	Weather ↓
1	Th.	Circumcision Union Flag raised Cambridge 1776	New ●
2	Fr.	*He that fixeth his soul on show, loseth reality.* {10.8 —	*Dig a*
3	Sa.	☽☿☾ • Tides {9.5 10.6 •	*rift in*
4	D	2nd S. a. Ch. • ⊕ at Peri. {9.4 10.3	*the*
5	M.	N.H. indep. colony 1776 {9.3 9.8	*drift.*
6	Tu.	Epiph. • ☿ Gr. El. E. 19° • ☾ on Eq. {9.2 9.4	*Need*
7	W.	*Propriety governs the superior man: law, the inferior man.*	*galoshes*
8	Th.	☾ in Apo. • Washington asked Cong. for funds for Capitol 1796	*it*
9	Fr.	☽♃☾ 1st use safety lamps by coal miners 1816	*sloshes.*
10	Sa.	Paine's *Common Sense* publ. 1776 Tides {8.7 7.9	*Mild*
11	D	1st S. af. Ep. • ☌☿♆ {8.7	*still*

Old Farmer's Almanac calendar, Thomas, R. B. (1976) The Old Farmer's Almanac, Boston, Jenkins, Palmer & Co.

Almanacs were, at least in the nineteenth century, at the cutting edge of western scientific rationality. However, as a genre, they also included the very themes—such as astrology and gambling—which science was trying to replace. *The Old Moore's Almanac*, for example, has more in common with a tabloid newspaper than with a scientific bulletin. *Old Moore's* lottery *Astro-indicators* illustrate this with a table of predictions of Euro Millions lottery numbers for each astrological sign. While this is precisely the type of "immoral" speculation against which the business astronomers—and many others since—have sought to differentiate themselves, the almanac presents the boundary between legitimate and illegitimate modes of prediction as blurry and porous.

AN ALMANAC FOR THE PETABYTE AGE

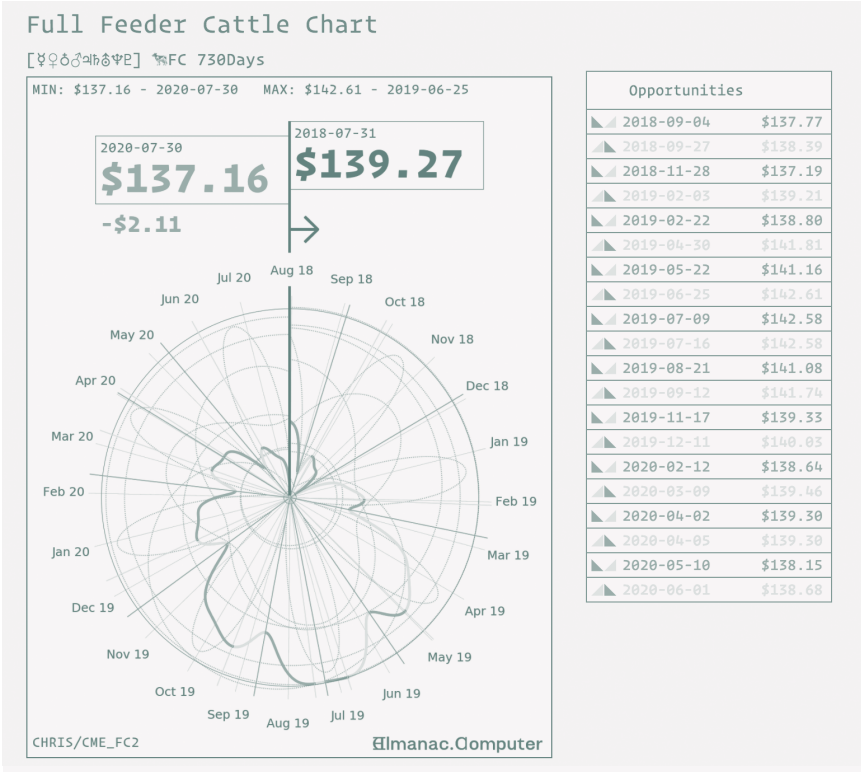
If it was designed today, what would an almanac look like? The accountant's view of the world has been amplified to the point of "actuarial saturation"[23] with big data, and monism is taken for granted, as illustrated for example by the long relationship between physics and Wall Street.[24] While *The Old Farmer's Almanac*, *Old Moore's Almanac* and others are still being published, they look like quaint relics in the current media landscape. The almanac as a cultural space however, is alive and well. Vast networks and infrastructures are dedicated to storing data, and computing predictions. If almanacs were instruments to navigate an uncertain world, their contemporary equivalent might be the "data dashboards" used in anything from business analytics to city management.[25] Instead of tables for the interests on loans, today's almanac includes financial charts and live news-feeds like a Bloomberg Terminal. Instead of a yearly calendar for life advice, the networked almanac relays tips and jokes from continuous feeds such as #astrologymemes.[26] With a personalised touch, and "a pleasant degree of humour," it also provides an oracle for the year ahead based on a predictive keyboard trained on the most mundane and intimate writing, emails, SMSes, tweets, and searches. In these examples and potentially many others, the almanac is thriving, not as a single publication but distributed across a wide range of digital media.



Tweet - Kate Gray (2016)

Revisiting the almanac today is an attempt to bind these scattered sections back together—to bring this peculiar predictive artefact and its history to bear on contemporary modes of algorithmic prediction. I am doing this through digital and critical making.[27] Building my own almanac with the tools of data science—including the Python programming language, data visualisation tools such as D3, and publishing formats like the Jupyter notebook. I take monism as a license to experiment with computational belief systems and to build computational diagrams that link the movements of planets with events on earth, such as the fluctuations of financial markets. *The Monistic Almanac* is an automated online publication that is updated daily. It is made up of multiple widgets, each implementing their own predictive rationality.

The Monistic Almanac cover.



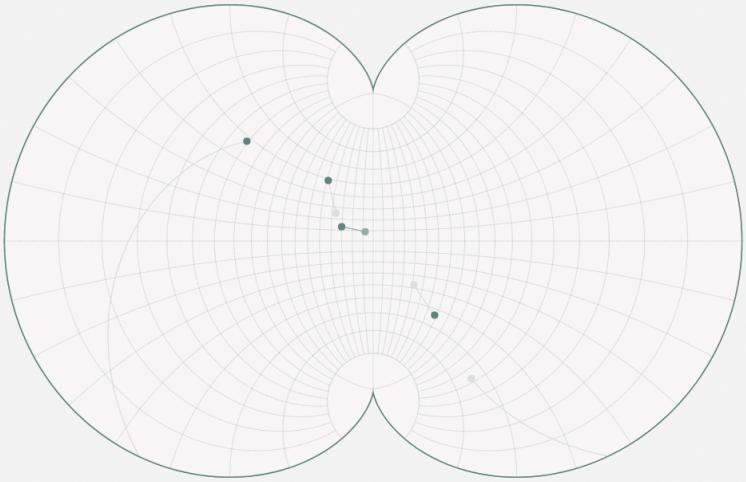
COSMIC COMMODITY CHARTS

Here the price of commodity futures is predicted using the positions of the planets of the Solar System. The relationship between the two is "learned" using regression on historical market data and the planet positions in the DE431 Ephemeris from NASA's Jet Propulsion Laboratory. The model can then derive future prices from planet positions, provided by the ephemeris until the year 17191.

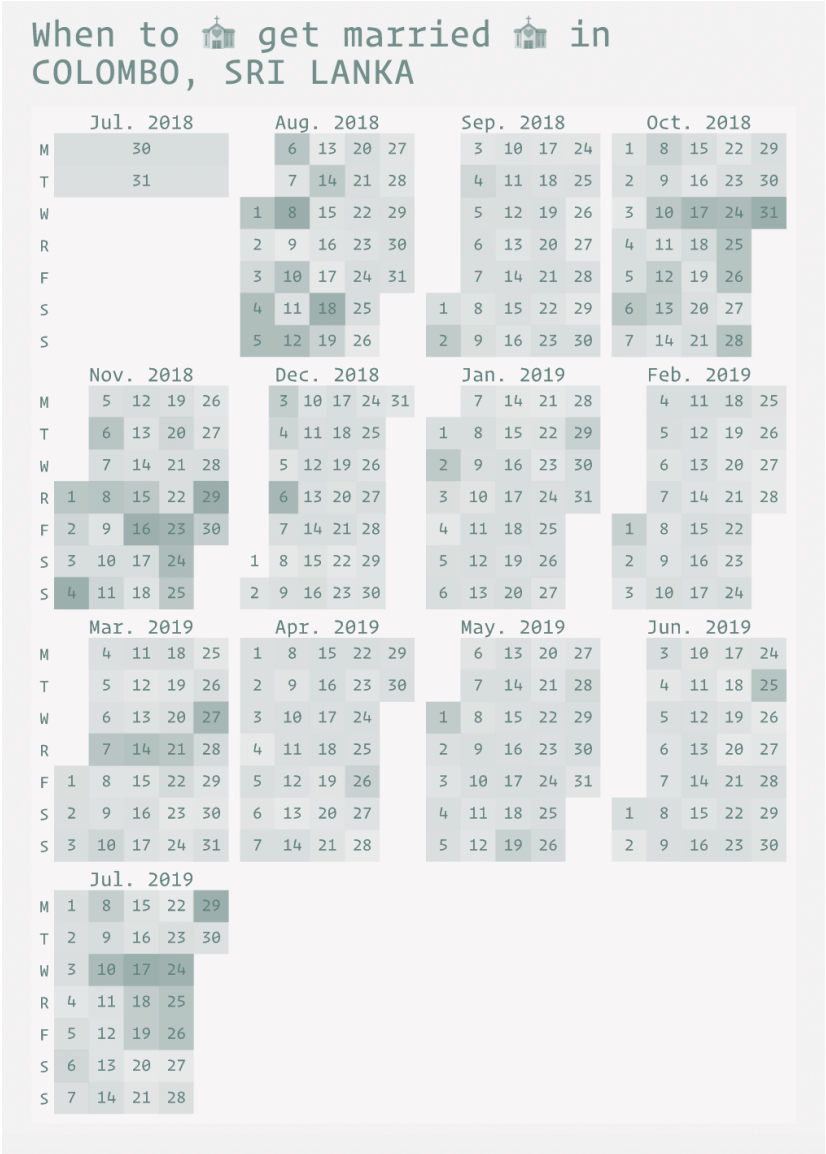
CRISIS PROXIMITY INDEX

CPI is an astrology based on the 2008 financial crisis. It is based on the reference point of August 9, 2007, when BNP Paribas froze three of its investment funds, triggering the first signs of panic among investors. Daily planet positions are compared to this base vector, using distance as an indicator of a possible new crisis.

Crisis Proximity Index



	☿	♀	♂	♃	CPI
2018-07-25	↑ 0.67	↓ 0.59	↑ 1.49	↑ 2.28	↑ 5.03
2018-07-26	↑ 0.68	↓ 0.59	↑ 1.49	↑ 2.28	↑ 5.04
2018-07-27	↑ 0.68	↓ 0.58	↑ 1.49	↑ 2.28	↑ 5.05
2018-07-28	↑ 0.69	↓ 0.58	↑ 1.49	↑ 2.29	↑ 5.05
2018-07-29	↑ 0.7	↓ 0.57	↑ 1.5	↑ 2.29	↑ 5.06
2018-07-30	↑ 0.71	↓ 0.57	↑ 1.5	↑ 2.29	↑ 5.06
2018-07-31	↑ 0.71	↓ 0.56	↑ 1.5	↑ 2.29	↑ 5.06
2018-08-01	↑ 0.71	↓ 0.56	↑ 1.5	↑ 2.29	↑ 5.06
2018-08-02	↑ 0.72	↓ 0.55	↑ 1.5	↑ 2.29	↑ 5.06
2018-08-03	↑ 0.72	↓ 0.55	↑ 1.5	↑ 2.29	↓ 5.06
2018-08-04	↑ 0.72	↓ 0.55	↑ 1.5	↑ 2.29	↓ 5.06



ELECTIONAL ASTROLOGY

This type of astrology is forward-looking: it is about finding the best date for a particular task or event, such as planning a meeting, a haircut, or a wedding. I translated the set of criteria for various events found in *Astrology for Dummies* into Python code, which outputs a calendar for a given task or question and location.[28]

DOWN TO EARTH

Designing and programming The *Monistic Almanac* involves learning to use the tools of data science. This is not, however, with the aim of acquiring technical fluency. Instead, these efforts are a mode of making concerned with what digital humanities scholar Jentery Sayers calls "conceptual matter."[29] While my enquiry into prediction is practice-based, "not knowing all the circuitry may actually spark persuasive interventions from the periphery."[30] I encountered, for example, a Python package called Pandas; an essential part of the data science "stack" that enables the transformation of flat files, the spreadsheets containing data, into vectorised arrays, data as mathematical shapes on which predictive algorithms can operate. With Pandas, the "accountants' view of the world" mentioned above comes full circle. While the business astronomers transposed data practices from astronomy to finance and business, Pandas originated as a tool to handle data in a hedge fund and is now widely used in the sciences, including astronomy.[31] Such connections reveal a powerful imaginary of data as a universal substrate in which the future can be read. They emerge through practice, using contemporary tools against the backdrop of the history of prediction.

I started this project out of scepticism towards the promise that data science could predict everything. I was astounded to see "social physics" and its dubious foundations being repackaged as cutting-edge technology after nearly two centuries.[32] I wanted to push monism to its absurd extreme, in a similar vein as Tyler Viglen's *Spurious Correlations*,[33] using the almanac as a stage. However, as I spend time immersed in making *The Monistic Almanac*, I begin to perceive a more intricate diagram of relations between data science and divination. In fact, my initial position has changed through working on this project.

My first impulse was to use astrology to dismiss data science, to imply that they are equally pseudo-rational. Robin James argues this very well in her update of *The Stars Down to Earth*, Adorno's critique of the *LA Times* astrology column, for the big data era.[34] She argues that forecasts from both astrology and data science aestheticise "unfashionable superstitions"[35] through charts and tables. Instead of forecasts, they produce conservative prescriptions, "only ever reproduc[ing] society and its most conventional norms, values, and practices."[36] By bringing the stars down to earth, both data science and astrology insist that society, like a planet, must be on a regular and stable orbit. James concludes with a call to "shoot for the stars" instead of bringing them down to fit a conservative view of the future.

One way of achieving this might be, as Joshua Ramey suggests, to take divination seriously as a "generic, even universal dimension of human culture".[37] James may dismiss data science and astrology in equal measure,

but she leaves unanswered the question of how to deal with an unknown future. Ramey argues that humans have had the need to "read chance aloud"[38]—to relate to it in some way—since ancestral times. These relationships to chance, however are always *mediated*, never direct or apolitical. When the market is presented like an objective divinatory device, it caters to our innate need to cope with chance. It masks neoliberal politics as a neutral force of nature rather than a foreclosing of unprofitable and suboptimal futures. "Shooting for the stars", in this case, would be to aim for what Ramey calls an *expansive* politics of divination, "marked by curiosity, presumptive generosity, and genuine openness to transformation."[39]

With this in mind, the potential for critique through projects like *The Monistic Almanac* or other previously-mentioned examples may not lie in comparisons or analogies between computation and divination. Instead, these works can serve as a reminder that the two have never really been separate. Both are rooted in the ideal of a universal force, logic or code as the key to knowledge about the future. The binary system at the very heart of computing comes, in part, from Gottfried Wilhelm Leibniz's fascination with the I-Ching divinatory system in the seventeenth century.[40] Data science and astrology, meanwhile, are both modes of using the cosmos to relate to chance—whether by transposing statistical techniques and ideals of regularity, or by looking directly at the angles between planets. In the western world, far more authority is ascribed to the former than the latter, of course. The "accountants' view of the world" has a monopoly over the cosmic. Drawing attention to this may be the first step towards restoring the multiplicity of voices we glimpse in almanacs, including those who Isabelle Stengers calls the "story-tellers, quacks, popular customs and creeds, knowledge without credential";[41] towards countering a data-centric monoculture of imaginaries, and cultivating multiple relationships to chance, while paying attention to the politics of their mediation.

This project is not about romanticising the occult, or challenging scientific knowledge. This is actually what the "big data fundamentalists"[42] do when they name military intelligence company Palantir after a crystal ball in The Lord of the Rings, or proclaim the "end of theory."[43] Instead, it is about keeping a close eye on the credentials assigned to predictions, and about questioning which ones are allowed to remake the world in their image.

Visit The Monistic Almanac at https://almanac.computer

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2 Almanacs or their equivalent have been used for millennia in cultures across the world. In this article I focus on almanacs as mass-produced publications in the US and Europe as part of the history of statistics and prediction in the western world.

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35 ibid.

36 ibid.

37 Ramey, J. A. (2016) *Politics of divination: neoliberal endgame and the religion of contingency, Reinventing critical theory*, London, Rowman & Littlefield International. p.49

38 Evan Heimlich quoted in Ramey, (2016), p.6

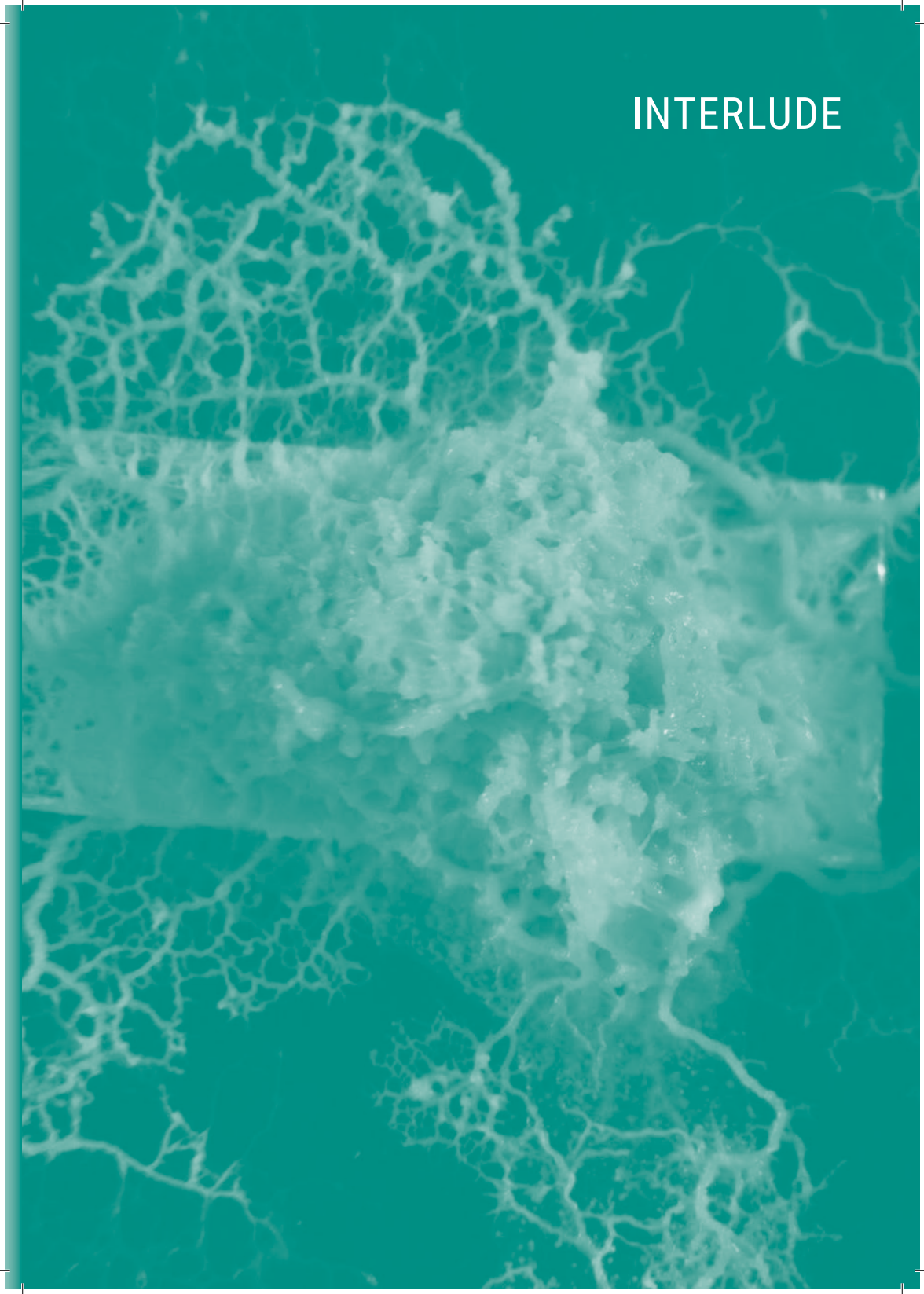
39 Ramey, (2016), p.157.

40 Gray, J. (2016) '"Let us Calculate!": Leibniz, Llull, and the Computational Imagination', *The Public Domain Review* [Online]. Available at https://publicdomainreview.org/2016/11/10/let-us-calculate-leibniz-llull-and-computational-imagination/.

41 Stengers, I. (2011) 'Comparison as a Matter of Concern', *Common Knowledge*, vol. 17, no.1, pp. 48–63 [Online]. DOI: 10.1215/0961754X-2010-035.

42 Crawford, K., Miltner, K. and Gray, M. L. (2014) 'Critiquing Big Data: Politic Ethics, Epistemology', *International Journal of Communication*, vol. 8, pp. 1663–1672 [Online]. Available at http://ijoc.org/index.php/ijoc/article/view/2167/1164.

43 Anderson, C. (2008) *The end of theory: the data deluge makes the scientific method obsolete*, Backchannel - Wired, 23 June. Available at: http://www.wired.com/2008/06/pb-theory/ (Accessed: 2 December 2015).


INTERLUDE

INFORMATION, 2018

PAUL BAILEY

When contemplating the destabilised nature of reading/watching, subject/object, place/space, surface/system and further... I recall and extend Marshal McLuhan's (1967) dictum:

When information is brushed against information the results are startling and effective. The perennial quest for involvement, fill in, takes many forms.

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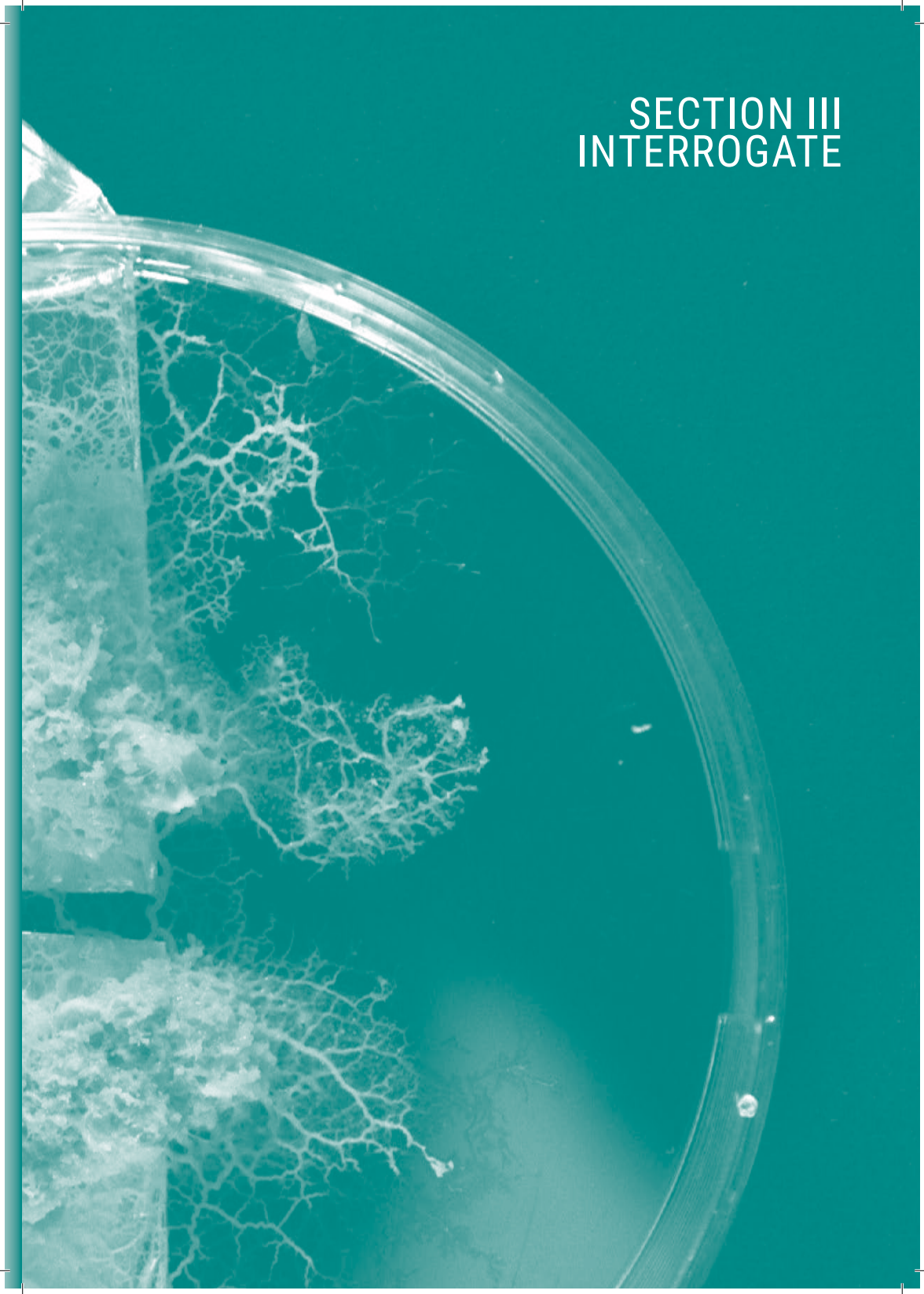
SECTION III
INTERROGATE



WHAT IF WE COULD LOOK AT THE SUN WITH X-RAY VISION

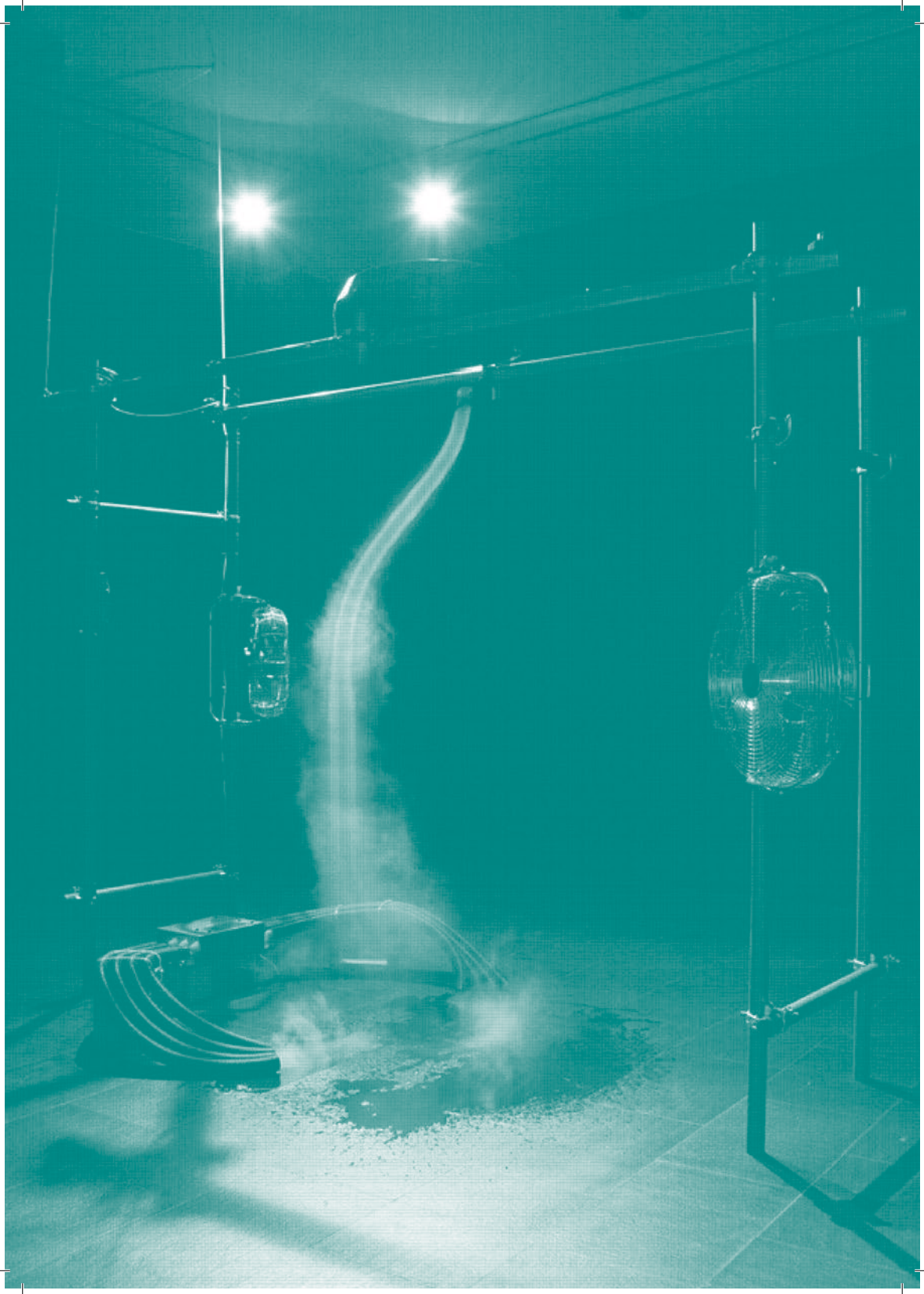
ALISTAIR MCCLYMONT

As a conceptual artist, I am concerned with the sublime and the workings of the world around me. My work is a journey of discovery, learning about and often recreating phenomena: increasingly, I am interested in the relationship between what I do and natural/scientific processes.

Over the last ten years, much of my work has focused on generative processes. The media and outputs of my work vary hugely from installations to drawings; however, the impetus is the same—a desire to understand something about a process and to communicate that understanding in the most appropriate medium. The final work should be a condensed embodiment of the forces at play.

In 2008 I first exhibited a version of *The Limitations of Logic* and the *Absence of Absolute Certainty*, a tornado produced by a combination of cloud- and wind-generating machines. This work, which continues to evolve, was the first time I recreated a natural phenomenon as an artwork.

Figure 1: Alistair McClymont, *The Limitations of Logic and the Absence of Absolute Certainty*, CA2M, Madrid, 2011. Photographer: Alistair McClymont.



By placing a humidifier between a scaffolding of three fans, I established the conditions necessary to sustain a vortex, namely low pressure and spinning air. Every aspect of the machine is reduced to the absolute minimum needed to create an artificial tornado (Figure 2). It is vitally important to me that the artwork should demonstrate the phenomenon and communicate information about the underlying processes with no addition, distraction, or illusion. According to the phenomenological philosopher Maurice Merleau-Ponty:

> *To see is to have colours or lights, to hear is to have sounds, to sense (sentir) is to have qualities. To know what sense experience is, then, is it not enough to have seen a red or to have heard an A? But red and green are not sensations, they are the sensed (sensibles), and quality is not an element of consciousness, but a property of the object. Instead of providing a simple means of delimiting sensations, if we consider it in the experience itself which evinces it, the quality is as rich and mysterious as the object, or indeed the whole spectacle, perceived.*[1]

Aesthetics and art theorist Zhuofei Wang writes: "Merleau-Ponty emphasises that an elementary prerequisite for understanding the nature of perception is that we should try to transform the perception into the object of consciousness."[2]

In my own practice, it is a priority that the structure of the work is clear and simple. The phenomenological nature of the work may have a complex explanation in scientific terms, but I look for a way of making the scientific account more comprehensible. The physical structure of the work and its processes need to act as a conduit for knowledge contained in, as well as knowledge about, the system: the artwork should physically embody and communicate the nature of the phenomena.

Sometimes I work completely alone, experimenting and researching in my studio, while more recently I have begun to collaborate with scientists. The artwork *Raindrop* (Figure 2) was the outcome of the first such collaboration, consisting of a drop of water in free fall in a vertical wind tunnel. This project was sparked by hearing about an experiment that levitated water. One of the scientists involved, Clive Saunders, kindly sent me a copy of the research paper, *Vibrational frequencies of freely falling charged water drops*.[3] After studying a diagram in the paper and seeing the machine in person at Manchester University, I embarked on a mission to create a new version of the original experiment; not having much to go on, it took me two years.

The artwork exists somewhere between art and science, conceived as a continuation of the original experiment from the 1970s, but with quite different intentions and contextual positioning. Placed in a museum or gallery, the purpose of the artwork has more to do with awe, beauty and the

Figure 2: Alistair McClymont, *Raindrop*,
The Art House Foundation, London, 2012.
Photographer: Alistair McClymont.

sublime. At the same time, the installation retains a link with the original experiment and its authors. CPR Saunders and BS Wong are cited in descriptions of the work, and sometimes the original paper is presented as part of the installation. Though my practice has long held an interest in science, this artwork was my first direct effort to tie together the two paradigms. I see a compatibility that is not always represented in traditional theories of the two fields.

Richard Dawkins begins his book *Unweaving the Rainbow* by explaining the title, taken from *Lamia* by John Keats. Dawkins suggests that Keats believed Isaac Newton had destroyed all the poetry of the rainbow by reducing it to the prismatic colours, inferring an incompatibility between the arts and science. Dawkins argues the opposite and talks of the beauty in the scientific process:

> *"The feeling of awed wonder that science can give us is one of the highest experiences of which the human psyche is capable. It is a deep aesthetic passion to rank with the finest that music and poetry can deliver."*[4]

In an interview with the BBC in 1981, Richard Feynman speaks of a conversation he had with an artist:

> *"I have a friend who's an artist and has sometimes taken a view which I don't agree with very well. He'll hold up a flower and say "look how beautiful it is," and I'll agree. Then he says "I as an artist can see how beautiful this is but you as a scientist take this all apart and it becomes a dull thing," and I think that he's kind of nutty. First of all, the beauty that he sees is available to other people and to me too, I believe. Although I may not be quite as refined aesthetically as he is ... I can appreciate the beauty of a flower. At the same time, I see much more about the flower than he sees. I could imagine the cells in there, the complicated actions inside, which also have a beauty. I mean it's not just beauty at this dimension, at one centimetre; there's also beauty at smaller dimensions, the inner structure, also the processes. The fact that the colours in the flower evolved in order to attract insects to pollinate it is interesting; it means that insects can see the colour. It adds a question: does this aesthetic sense also exist in the lower forms? Why is it aesthetic? All kinds of interesting questions which the science knowledge only adds to the excitement, the mystery and the awe of a flower. It only adds. I don't understand how it subtracts."* [5]

Art and science are two things which occupy me. The objects in art and the physical manifestations of knowledge in science—research papers, books, videos, lectures—are both reflections of nature. The format of science

prioritises clarity, precision, and practicality, but it can also be said to come from a similar place to art—a creative instinct and a yearning for truth. *What if we could look at the sun with x-ray vision (contact x-ray plates on the Vulcan Target Area West vacuum chamber, 36 separate shots)* is a collaborative artwork created with scientists at the Central Laser Facility in Oxfordshire, England. I was invited to be part of their experiment as an artist as well as an active scientific participant. The aim of this experiment was to demonstrate the effectiveness of laser technology to see through layers of material using x-rays and neutron beams. My goal was to investigate the strong similarity I see between scientists and artists. My hypothesis is that both ultimately search for truth and both see beauty in that truth.

During the experiment I performed a number of actions that were important to the experimental process. I created test objects to be blasted by x-rays and imaged by the team. I also set up my own diagnostic equipment that was able to image the plasma formed by the laser in much greater detail than any of the scientists' equipment, which detected data that proved crucial to the experiment. This resulted in my inclusion as an author on the research paper, published in Plasma Physics and Controlled Fusion. The paper included the x-ray images of my test object and a photograph of the plasma from the equipment mentioned above.

I created another image during the experiment using digital radiography-plates sensitive to x-rays (Figure 3). The central image is a plate created by

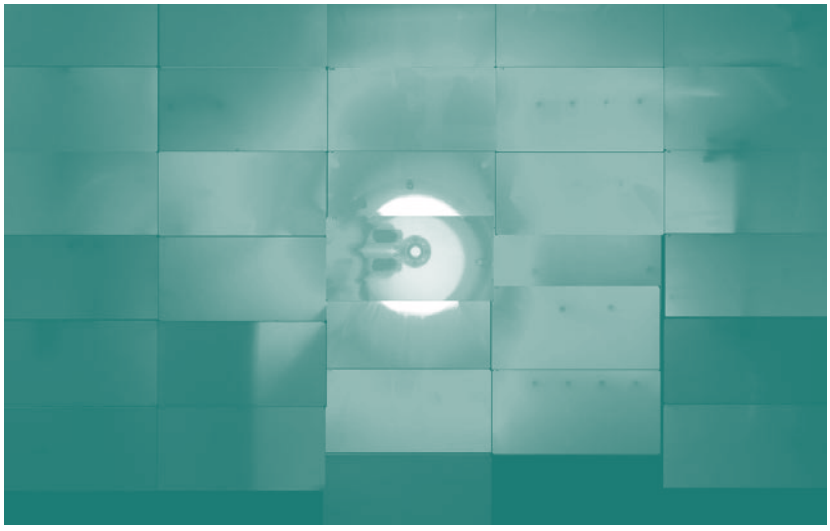


Figure 3: Alistair McClymont, *What if we could look at the sun with x-ray vision (contact x-ray plates on the Vulcan Target Area West vacuum chamber, 36 separate shots)*, 2017

the scientists to calibrate the experiment. Using the same method, I attached plates onto the outside of the chamber in a different place every time they took a new shot (fired the laser and created plasma). The result is a two-metre-by-three-metre image of the vacuum chamber bathed in x-rays. The experimental equipment, nuts, bolts and the chamber itself casts an image in the x-ray light. The x-rays themselves were created, alongside huge amounts of other radiation by a laser driven plasma in the centre of the chamber. This plasma was as hot as the sun, with pressures similar to the centre of the earth. This image was credited to all of the authors of the research paper, which included myself.[6] These artefacts—the x-ray photograph (Figure 3), the research paper (Figure 4), and the test object—become a single artwork. They are an attempt to conceptually unite the endeavours of art and science. I became a scientist and the scientists became artists in quite a literal way, while the art and science became inseparable.

1 Maurice Merleau-Ponty (1945) Phenomenology of Perception, London: Routledge.

2 Zhuofei Wang (2018) Atmospheric Design and Experience with an Exemplary Study of Olafur Eliasson's "The Weather Project". Contemporary Aesthetics. Available at: https://contempaesthetics.org/newvolume/pages/article.php?articleID=831 (Accessed: 19th August 2018).

3 C.P.R.Saunders, B.S.Wong (1974) 'Vibrational frequencies of freely falling charged water drops', Journal of Atmospheric and Terrestrial Physics, 36(4), pp. 707-711.

4 Richard Dawkins (1998) Unweaving the Rainbow, London: Penguin.

5 Horizon. 1981. BBC 1. 23 November.

6 C M Brenner, et al (2015) 'Laser-Driven X-Ray and Neutron Source Development for Industrial Applications of Plasma Accelerato', Plasma Physics and Controlled Fusion 58(1).

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Laser-driven x-ray and neutron source development for industrial applications of plasma accelerators

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Abstract

Pulsed beams of energetic x-rays and neutrons from intense laser interactions with solid foils are promising for applications where bright, small emission area sources, capable of multi-modal delivery are ideal. Possible end users of laser-driven multi-modal sources are those requiring advanced non-destructive inspection techniques in industry sectors of high value commerce such as aerospace, nuclear and advanced manufacturing. We report on experimental work that demonstrates multi-modal operation of high power laser-solid interactions for neutron and x-ray beam generation. Measurements and Monte Carlo radiation transport simulations show that neutron yield is increased by a factor ~2 when a 1 mm copper foil is placed behind a 2 mm lithium foil, compared to using a 2 cm block of lithium only. We explore x-ray generation with a 10 picosecond drive pulse in order to tailor the spectral content for radiography with medium density alloy metals. The impact of using >1 ps pulse duration on laser-accelerated electron beam generation and transport is discussed alongside the optimisation of subsequent bremsstrahlung emission in thin, high atomic number target foils. X-ray spectra are deconvolved from spectrometer measurements and simulation data generated using the GEANT4 Monte Carlo code. We also demonstrate the unique capability of laser-driven x-rays in being able to deliver single pulse high spatial resolution projection imaging of thick metallic objects. Active detector radiographic imaging of industrially relevant sample objects with a 10 ps drive pulse is presented for the first time, demonstrating that features of 200 μm size are resolved when projected at high magnification.

Keywords: laser, acceleration, plasma, applications

1. Introduction

High power laser-driven acceleration of electrons and ions from solid targets is a productive area of study in plasma beam physics, in part due to the extreme physics of generating ultra-high gradient accelerating fields through the interaction of a

Figure 4: Alistair McClymont, *What if we could look at the sun with x-ray vision (contact x-ray plates on the Vulcan Target Area West vacuum chamber, 36 separate shots)*, 2017
Photographer: Alistair McClymont.

EULOGY FOR THE PROGRESS BAR

OLIVER SMITH

The tasks that we use computers to achieve often appear slickly decoupled from the frictions of the physical world. Poke a rectangular formation of pixels and you've moved money around the globe, crashed a stock market,[1] or perhaps caused state-wide panic over incoming (fictional) missiles.[2]

The feeling of immediacy in digital action is an illusion, carefully managed through the design of user interfaces. No computation is truly instantaneous: it is necessary to provide feedback, and the progress indicator is a common way to do so. It may take the indeterminate circular and pulsating form of the looped animation, or the more determinate percent-done, often a linear, horizontal progress bar.

A rogue's gallery of looped animation progress indicators[3].

The American computer scientist Brad A. Myers identified the importance of progress bars in digital interfaces in his 1985 study, describing them as items that fill up "like the giant thermometers in charity drives…as progress is made".[4] Observing users undertaking the thoroughly uninteresting task of querying a transport database, Myers found that the use of percent-done progress indicators reduced users' anxiety by allowing users to feel that their action would be successful. Furthermore, if the progress bar offered an estimated time to completion, they could plan their wait time more effectively, using it "in some productive manner".

MICROSOFT MINUTES

In reality, however, knowing how long a task will take is difficult. Inaccurate time estimates were so common in the Windows operating system at the turn of the millenium that they became known by some users as "Microsoft Minutes". Copying files in Windows could begin with a high estimate such as an hour, drop rapidly to a few minutes, and in reality take ten minutes to complete. Alternatively, copying a single small file could appear almost finished before giving an estimate of over two years to completion.

A somewhat inaccurate Windows file copy dialogue with a progress bar and time estimation in "Microsoft Minutes".

Long-time Windows developer Raymond Chen offers a technically accurate if slightly dissatisfying explanation for the first of these scenarios: "The copy dialog is just guessing. It can't predict the future, but it is forced to try."[5] That does not explain, however, why the second scenario occurs to such extremes in Windows but not other operating systems.[6] What's certain, however, is that the wild variance is a complicating factor in the intention to lower the user's anxiety using progress indicators. In attempting to present a predictable, smooth interface, the progress bar is hindered by the physical realities of computation, including network communication delays, overworked hardware, and erratic user requests.

A YEAR'S PROGRESS

The Twitter account @ProgressBar201X recontextualises the progress indicator: instead of measuring computational task completion, it measures the passage of time over a year in one-percent increments. The bot automatically tweets a new progress bar image every three or four days, as another percent of the year elapses. For the most part, the tweets receive a few thousand likes and retweets, but at key points this engagement spikes. For example, the 50% point of 2018 received ten times as many replies as the average tweet, including hyperbolic reaction GIFs and declarations that posters had wasted the year thus far, such as the always relatable "fuck i've done nothing shit shit shit".[7] While the progress bar of the year is extremely stable and predictable, unlike our fluctuating personal experience of that period of time, it doesn't seem to lower anxiety levels. It allows us to participate in a performative, melodramatic version of progress that, like Hogarth's *A Rake's Progress*, is all always downhill.

@ProgressBar201X is darkly watchable: it is as captivating to see the year fall away as it is to wait for a computer to complete a given task. Myers found that "when the progress indicator is present, the subjects tended to watch it on the screen since they had no other task to do. Without a progress indicator, however, the subjects apparently got bored with the screen and looked around the room."[8]

The halfway point of 2018, from @ProgressBar201X.[9]

Far from freeing us to pursue other tasks, progress indicators can capture us in a system as observers of the task's progression. Of course, when presented with a progress bar and a time estimate, we don't necessarily sit and watch it fill up. Modern systems often allow us to multitask – we may have a second computer in the form of a smartphone at hand, and our environments tend to be more diverse than the empty room under Myers' test conditions. Still, the visual experience of getting closer to the finish remains a form of entertainment and a marker of the passage of time.

What if we aren't shown a progress bar but rather a looped animation? Trends in user interface show the progress bar losing sway to the spinning, pulsating, unbounded looped animation, which often gives no indication of the progress of the task at hand.[10]

If we take a video streaming site, we will often find these animations contained within a GIF or generated by a script: created, shown, or added to the page as a task begins, they often have no further interaction with the system's progress until they are hidden or removed on completion. If, for example, you load a page with a video online and press play, you will see a loading animation. If you now deactivate your WiFi, the animation will keep spinning despite the fact that it can load no more data. Some sites are programmed to notify the user that they are offline, but more often than not the looped animation will keep going indefinitely. It is entirely surface, decoupled from the network and from the server - as much an indicator of progress as the user twiddling their thumbs.

A looped animation progress indicator, then, is a device to *capture* the user. By colonising our attention, it ties us to the task and system: distracted by the visual promise of something occurring, we are unable to plan our escape. Rendered in a hypnotically cyclical, visually pleasing way, the wait becomes an addictive moment. Depending on the dull reality of the system, application or site we're using, and the effort put into designing an "emotional" indicator, we may even prefer the wait.[11] The progress bar, in contrast, is a device with the potential to *free* the user from the task at hand. It allows us—at least in theory—to know and thus plan our newly free time. The best progress bars are not slick interstitial appeasements, forced to predict the future and carefully tuned to make us feel in control, but accurate representations of the chaotic, unpredictable nature of computers and their users. Let us remember them for their flaws, they may not move quite so seductively as a looped animation but in their miscalculations and stutters we may find some clarity, some form of truth about the computational tasks we set in motion.

1 Lindsay Fortado, Philip Stafford, Aliya Ram (2015) Flash crash: Ten days in Hounslow, Available at: https://www.ft.com/content/9d7e50a4-e906-11e4-b7e8-00144feab7de(Accessed: 19th August 2018).

2 Ashley Rodriguez (2018) Hawaiians were falsely warned about an imminent missile attack, Available at: https://qz.com/1179298/a-false-alarm-alerted-hawaiian-residents-of-an-imminent-missile-threat/ (Accessed: 19th August 2018).

3 (2018) Sample of 20 loaders, Available at: http://www.ajaxload.info/, (Accessed: 22nd August 2018).

4 Brad A. Myers (1985) The Importance of Percent-Done Progress Indicators for Computer-Human Interfaces. Human Factors in Computing systems, CHI '85 Conference proceedings.

5 Raymond Chen (2004) Why does the copy dialog give such horrible estimates?, Available at: https://blogs.msdn.microsoft.com/oldnewthing/20040106-00/?p=41193/(Accessed: 19th August 2018).

6 This leads to some ultimately fruitless speculation such as those found on the Super User messageboard (Maxim Zaslavsky (2009) Windows file copy dialog: Why is the estimation so… BAD?, Available at: https://superuser.com/questions/43562/windows-file-copy-dialog-why-is-the-estimation-so-bad (Accessed: 19th August 2018))

7 Jack Ferry (2018) fuck i've done nothing shit shit shit, Available at: https://twitter.com/jackferry0/status/1013756557618827270?s=19 (Accessed: 19th August 2018).

8 Brad A. Myers (1985) The Importance of Percent-Done Progress Indicators for Computer-Human Interfaces. Human Factors in Computing systems, CHI '85 Conference proceedings.

9 Progress Bar 201X (2018) 2018 is 50% complete., Available at: https://twitter.com/ progressbar201x/status/1013754253570166785 (Accessed: 19th August 2018).

10 Bars in general are beginning to disappear, including scroll bars in MacOS X Lion and beyond, the task bar in Windows 8's Metro user interface, the status bar in iPhone X where the notch cuts into the display.

11 Alice Kotlyarenko (2018) How To Design Emotional Interfaces For Boring Apps, Available at: https://www.smashingmagazine.com/2018/04/designing-emotional-interfaces-boring-apps/ (Accessed: 19th August 2018).

PLAYING THE GAME

TOBIAS REVELL

We learn through play. By playing, we test the boundaries of the world, its social and behavioural norms, and the qualities of interactions in our system of relationships. Play implies exploring, inventing, and competing within a given set of protocols or limitations, and skilful or successful play denotes peak performance according to those rules. But play can also go one step further, when players understand the system of relationships in which they act so well that they can engage in a practice of détournement, deconstructing and working around the boundaries that everyday players respect unquestioningly.

Over the last decade, video games have evolved from a popularly-maligned hobby of children and "geeks" into one of the world's most valuable entertainment industry. In the same way that film was both the lightning rod and litmus test for cultural studies in the twentieth century, video games now attract the same level of reflective analysis and critique—and deservedly so. At the fringes of video game practices, we find indications of ways that we might challenge the boundaries of our worlds.

I like playing video games myself, but watching other people play them is a particularly cathartic, sublime experience. It's how I imagine people feel about watching golf or snooker. I enjoy watching people think their way

through problems and make choices, and with constant advances in CGI, watching a video game approximates more and more closely the experience of watching a movie. Machinima has its origins in this practice of using the architecture of games to make cinematic narratives and has since expanded to include a litany of YouTubers and video makers.[1] See, for instance, VaatiVidya's lengthy but addictive expositions on theories in the *Dark Souls* games all set to stunning visuals.[2] In these streams, the players use the game architecture, its physics and mechanics to create alternative narratives unintended by the game developers and writers.

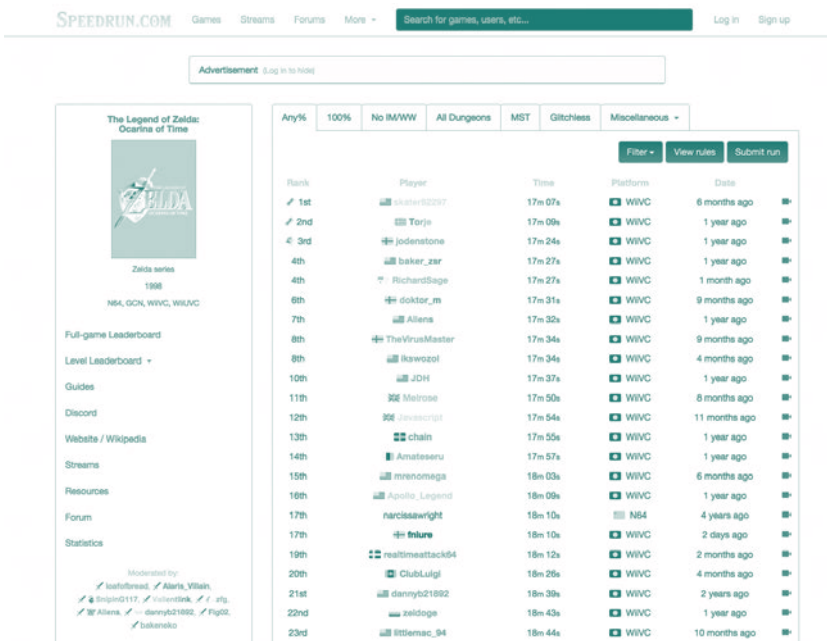
While these videos display an impressive degree of narrative creativity through the medium of gaming, the practice of speedrunning demonstrates a more strategic sense of creativity in the same territory. Like machinimists, speedrunners develop a nuanced understanding of the architecture and mechanics of a game, but for different purposes. Speedrunning is essentially the act—or art—of completing a game or part of a game in as little time as possible. Rather than simply playing very fast, however, speedrunners can use any strategy made possible by the game's code to achieve speed. In its simplest iterations, this can simply mean being very good at playing the game—possessing a mental and motor dexterity precisely attuned to its rules and rhythms, responding instinctively and efficiently to challenges in the form of enemies or obstacles, having an innate sense of the economy of choices to prioritise speed over other markers like health or wealth in the game journey from beginning to end.

Speedrunning is the art of exploitation of simulated environments. At its best, speedrunning is responsible for some of the most unfalteringly stunning acts of mastery and showmanship that I've seen in any discipline – and I mean mastery in a very real way. Unlike, for instance, tennis, cricket, football, cycling or any other form of sport or game where mastery is measured by and conflated with just being very good at performing the sport within the confines of the rules, speedrunning rewards "play" in the ludic sense of flexing the edges of the technical and conceptual construction of the game.

Speedrunning can be found in a wide variety of forms and forums, with sites like Speedrun.com and Twin Galaxies acting as core databases of records and rules. Records are generally accompanied by a video that shows the run with descriptions of techniques and constraints applied to the run. A speedrunning commentary subculture has even arisen, with intense analyses and break-downs of specific runs by ardent YouTuber critics like Bismuth and AverageTreyVG. As with any subculture founded on the Internet, there are celebrities and intrigue; and festivals and events, such as the popular Games Done Quick IRL runner meetups.[3]

Speedrunning can be traced back to the first arcade video games. Players would record their runs on VHS tapes and send them into webmasters of forums like Twin Galaxies, who would authenticate and post the runs. But the real explosion of speedrunning occurred in the mid-1990s with the parallel emergence of home Internet connections and new games like Quake and Doom. These games came with editors that allowed players to create their own levels and share them online. Early dial-up internet speeds were often insufficient for transferring video files over the Internet. However, the data for demo maps was significantly lower. As a result, some players began to reverse-engineer their level creations to "record" the data of runs at a much lower file size than video, which could then be replayed by others in the community. Since then, the range of games, recording formats, and channels for sharing and watching speedruns has expanded exponentially alongside the growth of bandwith: although the most popular titles remain the classics, such as Super Mario Bros., GoldenEye 007 and The Legend of Zelda: Ocarina of Time.

Figure 1: The leader board on speedrun.com of The Legend of Zelda: Ocarina of Time. This twenty-year-old game is still continually played by speedrunners to shave microseconds off play time. The tabs at the top are different conditions for runs; 'any%' means any level of completion is acceptable as long as the game is finished. This is a common category across most games. 'no IM/WW'[4] means no item manipulation or 'wrong warping' which are techniques specific to the mechanics of this game in particular.
Credit: Speedrun (2018). [Online]. Available at: https://www.speedrun.com/oot (Accessed September 1st 2018)



Speedrunning challenges the notions of how we "play" and "beat" games. In normal play, these terms denote that the game was followed and finished within the confines of the way the developers intended. Speedrunning, on the other hand, challenges the world the developers have built. It abuses and exploits glitches, cuts, tricks, shortcuts, and hacks to defy the world that allows the run to exist in the first place. This is true play, pushing and testing the boundaries that structure the world of the game. The most popular games for speedrunning are dissected and broken down to their very code, with every element of their construction pored over by a community of rabid speedrunners looking for any microsecond edge over their competitors. Dedicated wikis spring up to log techniques, routes, and strategies, as well as to debate the finer points of what exactly constitutes a run. Meanwhile, speedrunner video streams can generate millions of views on sites like YouTube and Twitch.

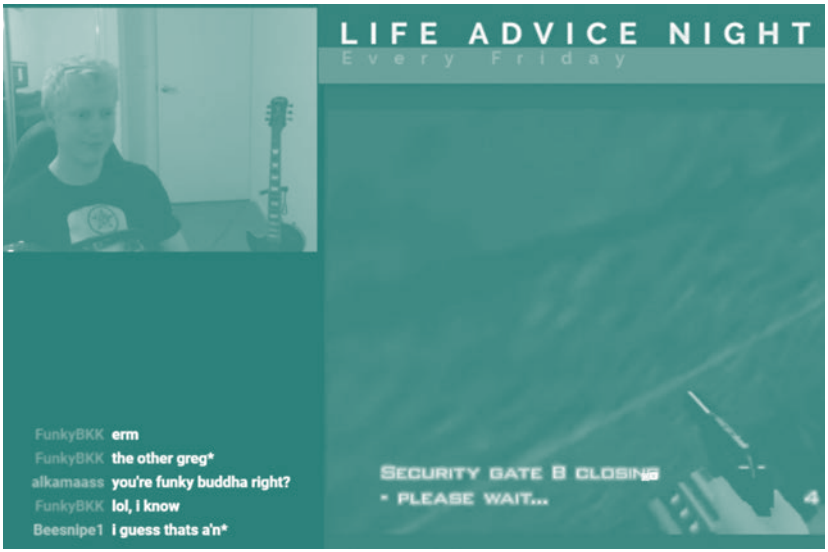


Figure 2: This is a still from a video in which Karl beats a fifteen-year-old record for the Dam level in GoldenEye 007 at 52 seconds. There's almost no play in it in the way the game is conventionally understood, but rather an approach that reveals a dense understanding of its construction. Throughout the run, we see very little because Karl continuously angles the camera downwards towards the floor: this view reduces the background assets that have to be loaded in the game, thus allowing the game to run slightly faster. Credit: Author's screenshot / karljobst (2017). GOLDENEYE N64 - DAM AGENT 0:52 - UNTIED WORLD RECORD. [online video]. Available at: https://www.youtube.com/watch?v=9BChZORabk (Accessed 28th August 2018).

By deliberately exploiting such glitches, speedrunning may appear piratical and anarchic, but its world is incredibly rule-bound, with fervent and effective testing and validation procedures to identify "cheating".

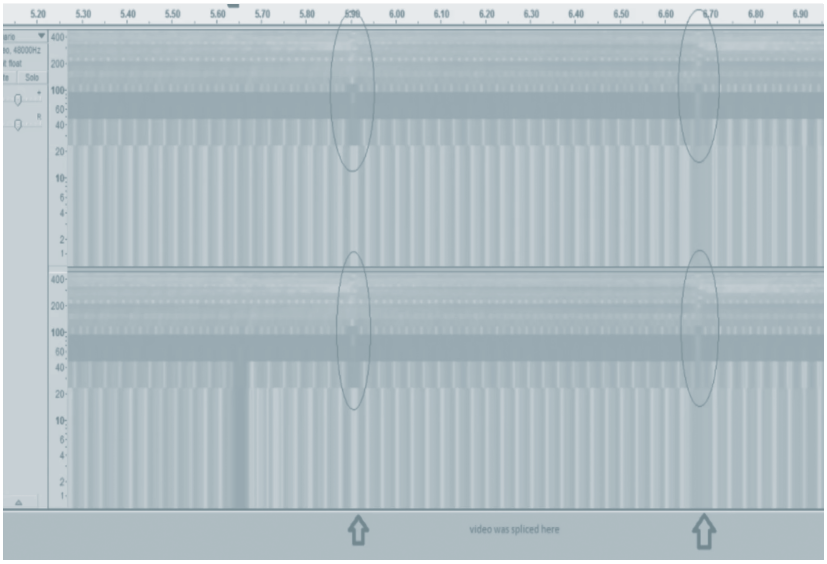


Figure 3: Speedrun fans and analysts will look for evidence of cheating in video and audio tracks that are uploaded. In this case a Donkey Kong player was caught 'splicing' by analysis of the audio track. Credit: Author's screenshot / Apollo Legend' Available at: https://www.youtube.com/watch?v=JdvFSQFZfK8 [Accessed 28 August 2018 2018].

Cheating isn't cheating in the sense that we might understand it by the rules of normal gaming. In everyday play, clipping through the map (literally passing through the landscape), navigating around bosses to avoid fights would be considered poor sportsmanship at best and outright deception at worst. Cheating in speedrunning, however, is essentially the disingenuous reporting of a run. Splicing, one of the most heinous of cheats, means editing together a run from discrete pre-recorded parts. Fans spend hours scrutinising videos for signs of splicing such as skipped frames or mismatched inventories. In fact, the techniques to detect splicing in a certain game—including looking for in-game cues (themselves collated and tabulated on wikis and open documents)—are as varied as the techniques used to speedrun. In Figure 4 the frames of a loading sprite animation in Super Meat Boy, which has a regular 40-frame cycle of an "up" and "down" animation, are analysed from screen to screen to detect any irregularities that might result from splicing.

Photoshopping footage is obviously a common cheat, frequently involving changing numbers that appear on screen at the end of levels. Speedrunners have developed an emergent behaviour to demonstrate authenticity by moving their cursor around and over the time display to show that it is, in fact, a video and not a Photoshopped still image.

Rank	1	2	3	4	5
Player	Matte	Hamb	vorpal	Zaxst	warm_ham
Time	17:37	17:41	17:43	17:55	17:59
VoD FPS	60 FPS	60 FPS	60 FPS	60 FPS	60 FPS
Forest Exit	16 Down	17 Down	1 Down	13 Up	16 Up
Hospital Enter	4 Down	3 Down	19 Down	7 Up	4 Up
Hospital Exit	14 Up	16 Up	8 Down	18 Up	15 Down
Factory Enter	6 Up	4 Up	12 Down	2 Up	5 Down
Factory Exit	10 Down	15 Down	10 Down	12 Up	12 Up
Hell Enter	10 Down	6 Down	10 Down	8 Up	8 Up
Hell Exit	4 Up	11 Up	9 Down	6 Down	7 Down
Rapture Enter	16 Up	9 Up	11 Down	14 Down	13 Down
Rapture Exit	20 Up	9 Down	7 Down	15 Up	7 Up
End Enter	21 Down	11 Down	13 Down	5 Up	13 Up

Figure 4: Analysis of the frames of a loading sprite animation in Super Meat Boy. Credit: Super Meat Boy: Bandage Girl Autosave Animation for Detecting Splices. [Online]. Available at: https://docs.google.com/document/d/1YWiHvjJf96LEz95BJFPmW7NZ-Jxg-0awDCWgLoGrgK_U/edit?usp=sharing (Accessed September 1 2018).

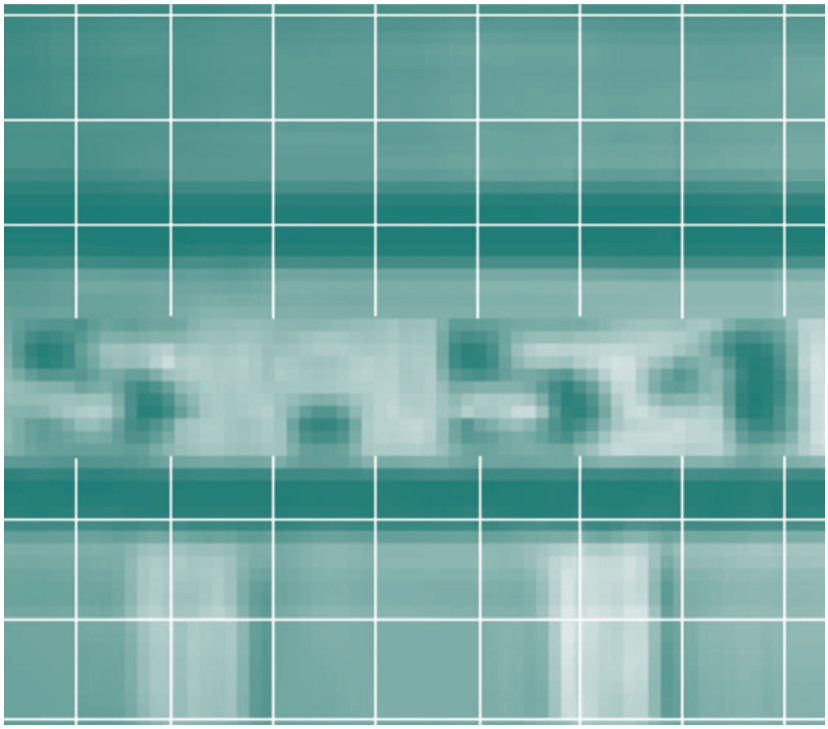


Figure 5: Goldeneye 007 was a common target of Photoshopped finishing times for years because of the ease of just copying the numbers on screen. Pixel pattern analysis is performed by speedrun analysts to detect when numbers have been copy-pasted.

Another cheat is using an emulator to simulate one piece of hardware on another without reporting it. Emulators can create significant advantages through faster frame rates on a modern PC or, on the contrary, through slower frame rates to enable faster and more precise responses, which can make all the difference when every microsecond counts.

The definition of cheating is nuanced and varied among different communities. “Menu-ing”, for example, is when a runner performs actions quickly through the game menu, from rudimentary tasks like moving inventory items around, to more sophisticated techniques such as rapidly saving and loading to reset an enemy or “quitting out” to respawn in a different location. Item manipulation to exploit glitches is generally allowed as long as it is permitted by the architecture of the game. Yet geography determines how menu-ing is regarded. In Japan, speedrunners are respected for their mastery of menu-in using turbo controllers which automate the rapid or continuous pressing of buttons; whilst most Western audiences reject such tools.

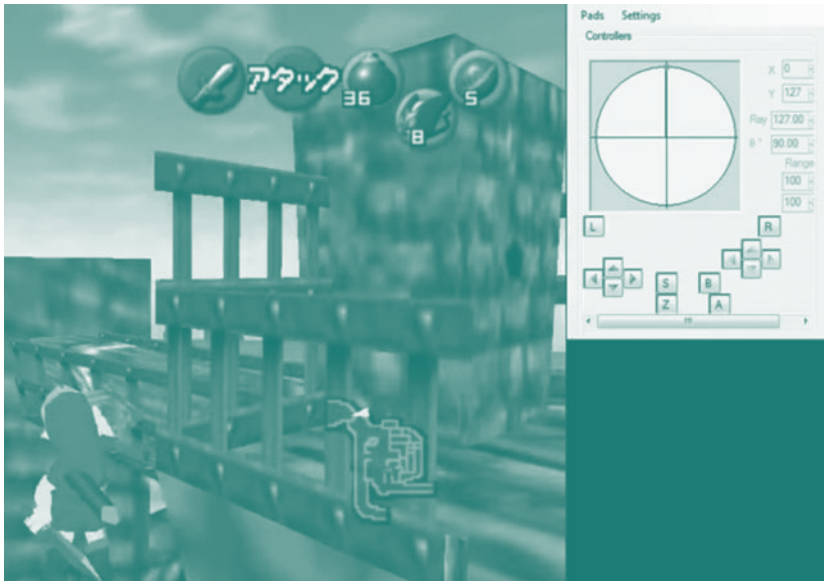


Figure 6. Video of cheating speedrunners. Credit: Author's screenshot / Apollo Legend (2017). 10 Speedrunners Who Were Caught Cheating. [online video] Available at: https://www.youtube.com/watch?v=JdvFSQFZfK8 [Accessed 28 August 2018 2018].

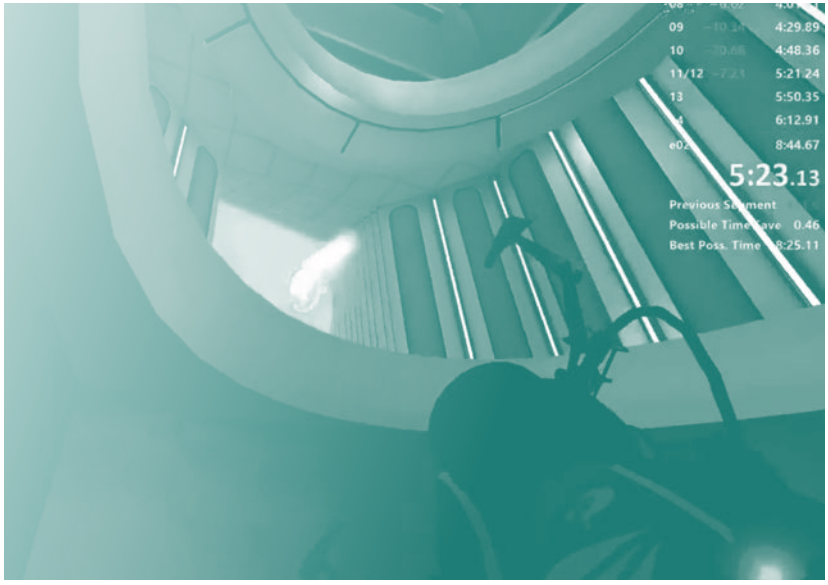


Figure 7. This out-of-bounds Portal run simply requires some acrobatics to take a path through the game that players wouldn't take in normal gameplay. Credit: Author's screeshot / ConnorAce (2017). Portal Out of Bounds Speedrun in 8:37.59. [Online video]. Available at: https://www.youtube.com/watch?v=vYR3aNe8HrY (Accessed September 1 2018).

Even "glitchless" runs that employ none of these tricks are subject to debate, and still court controversy on twenty-year-old games to this day.[5] Figure 6 shows a controversial "frame perfect" jumping technique that can be used in The Legend of Zelda: Ocarina of Time: a sequence of actions has to be performed in the right order in the exact frame when the game may run at speeds up to sixty frames per second. This particular technique involves using the physics of an explosion followed by an attack move to jump the character into a normally inaccessible area. Previously, this level of precision was thought possible only with "tools", by editing game code or using an emulator. However, in December 2017, a second player named dannyb21892 (the world record-holder for glitchless Zelda runs) managed to execute the demonstrated technique through sheer dexterity, leading to an active debate over the difference between a simple skip (the circumvention of a large part of a game) and a glitch (the exploitation of mechanics to the speedrunner's advantage).

Paradoxically, arguments over what constitutes "cheating" in an activity that is about bending rules have caused some of the most fundamental schisms in the ethics of speedrunning methodology. One of the oldest examples played out on Speed Demos Archive (SDA), which began as a forum for Quake players but quickly expanded to other games, including Metroid 2002. Speedrunners in Metroid 2002 commonly used "secret worlds" or "out of bounds" play for faster runs, thereby navigating through parts of the game architecture that were never intended to be accessed by the gamer, including unfinished areas or spaces cut from the final version of the game. As games have developed and the speedrunning community has grown, the SDA forums have sustained a continuous debate about the meaning of "out of bounds" in the context of each different game, with vastly divergent interpretations.[6] Radix, the leader of the SDA community, was keen to lay down a common rule set for all speedruns across all games, and thus banned going out of bounds in speedruns. Conversely, Twin Galaxies, a competitive and more general game records site, allowed individual rules for each game based on each game's architecture. Ultimately, the Twin Galaxies approach became much more popular and is now the standard model for determining the ethics of speedrunning, with each game's community discussing and suggesting rules for runs and arbitrating on what constitutes cheating. On Speedrun.com, each game has evolved its own ideology and idiosyncrasies. Some game communities do not allow certain techniques like glitching—as in the technique used to complete early Pokemon games in 0.00 seconds, as seen in Figure 9—because they void any notion of competition, making the glitched speedrun a pointless exercise. However, the Pokemon community has set variables that still allow for challenges and debate.[7]

Figure 8. …while this Nier Automata technique involves clipping through the map to move outside the designed area of the game. Credit: Nier Automata Speed Running Wiki - Potential Skips. [Online]. Available at: http://nier-automata-speedrunning.wikia.com/wiki/Potential_Skips. (Accessed September 1 2018).

Recent studies of the huge celebrity-driven gaming culture in South Korea—equivalent in financial value and viewing figures to soccer in Europe—identify the sociotemporal aspects of gaming, offering the idea that "play as a disposition for calibration helps to make sense of everyday strategies for making do in precarious circumstances."[8] In other words, the ability to move between different speeds of existence—the rapid "Actions Per Minute" of elite gamers—acts as a reaction against the perceived malaise of precarious society.

The sheer level of accomplishment in the community of speedrunners is staggering, even if it may be seen from the outside as an esoteric subculture for hobbyists and obsessives. But the dedication to iterative play—over, and over, and over again in order to find ever-more perfect runs—is a strategy that we could learn from to play in systems. While it may not be acknowledged or prioritised by the community, there's something richly and politically nascent about speedrunning that—as with film in the twentieth century—may be a lightning rod for ways of playing our world better. Speedrunners possess a sophisticated mastery of a system and its dynamics that allows them to fully exploit that system to their advantage—to see it as an artefact

contained by its construction, and thus open to manipulation. A casual gamer might buy into the simulated world, believing the ground solid and the sky limitless, the whole world bounded by the screen. A speedrunner knows that the ground is simply a collision surface that can be broken at its edges, the sky an environment map, and the screen a mere slice of the architecture at their control. Speedrunners can thus change their relationship with the developer, the game, and their position within it. Every game is a system of interacting parts that fit together to perform certain functions. Speedrunners understand these mechanics so keenly that they are able to turn the system to new uses—to use the game in toto as their own plaground, not one defined by the developers. That power resonates, in contradictory ways, with the preamble in Georges Perec's *Life: A User's Manual*:

> *...Puzzling is not a solitary game: every move the puzzler makes, the puzzle-maker has made before; every piece the puzzler picks up, and picks up again, and studies and strokes, every combination he tries, and tries a second time, every blunder and every insight, each hope and each discouragement have all been designed, calculated, and decided by the other.*[9]

The world is increasingly simulated by systems and databases that bound our interactions in regimented and controlled systems. We play within these confines, bouncing off the limits when we meet them but unable to see or move beyond the construction because we can never imagine it as more than solid ground and limitless sky. We play the game. Speedrunning shows us new ways of interacting with systems, playing them meaningfully and not just operating within their confines. Speedrunners play the playing of the game. As we navigate a world increasingly structured and simulated by software, a mentality and methodology that reconstruct the rules of the game can have profound implications for our sense of agency in that world—and the critical and technical proficiency that requires.

Figure 9. A full game glitched speed run of Pokemon Yellow in 0 minutes. Credit: Author's screenshot / Werstler (2011). Pokemon Yellow: 0:00 Speedrun Glitched World Record. [online video] Available at: https://www.youtube.com/watch?v=VlmoEpNNiV (Accessed September 1 2018).

1 Machinima, Available at: http://www.machinima.com/ (Accessed: 22nd August 2018)

2 VaatiVidya, Available at: https://www.youtube.com/user/VaatiVidya (Accessed: 22nd August 2018).

3 Games Done Quick, Available at: https://gamesdonequick.com/ (Accessed: 22nd August 2018).

4 OoT Speedruns Wikia, Available at: http://oot-speedruns.wikia.com/wiki/No_IM/WW (Accessed: 22nd August 2018).

5 Heather Alexandra (2017) New Trick Has Ocarina of Time Speedrunners Debating What A Glitch Actually Is, Available at: https://kotaku.com/new-trick-has-ocarina-of-time-speedrunners-debating-wha-1796849850 (Accessed: 22nd August 2018).

6 Discussion on the Out of Bounds rule, Available at: https://forum.speeddemosarchive.com/post/discussion_on_the_out_of_bounds_rule.html(Accessed: 22nd August 2018).

7 Speedrun.com - Pokémon Yellow, Available at: https://www.speedrun.com/pkmnyellow (Accessed: 22nd August 2018).

8 Stephen C. Rea (2018) 'Calibrating Play': Sociotemporality in South Korean Digital Gaming Culture', American Anthropologist, 120(3), pp. 500-511.

9 Georges Perec (1996) Life: A User's Manual, London: Vintage Classics.

INTELLIGENCE IN THE UNEXPECTED

MOLLY WRIGHT STEENSON

In 1976, the architect Cedric Price designed an intelligent arts retreat centre for a site in Florida; it was never built. Generator was composed of 150 cubes, 12 feet on each side, and other components that could be moved around by mobile cranes according to the desires of Generator's users. Four years later, the programmer-architects John and Julia Frazer proposed four computer programmes for Generator. The Boredom programme, for instance, would redesign Generator's layouts if the parts had not been moved in a while. "If you kick a system, the very least you would expect it to do is kick you back," John Frazer wrote in his proposal to Price. In a handwritten postscript, he added, "You seemed to imply that we were only useful if we produced results that you did not expect. I think this leads to some definition of computer aids in general. At least one thing that you would expect from any half decent program is that it should produce at least one plan which you did not expect."[1]

At least one plan which you did not expect. The unexpected is central to our very idea of what intelligence is, whether human or artificial. As Marvin Minsky wrote in 1960, "To me 'intelligence' seems to denote little more than the complex of performances which we happen to respect, but do not understand."[2] One might observe loops and subroutines, but no "locus of intelligence."[3] His claim—that "we cannot assign all the credit to its programmer if the operation of a system comes to reveal structures not recognizable or anticipated by the programmer"—could have come from an engineer today who cannot explain why a deep learning algorithm works the way it does.

The unexpected results of algorithms press our assumptions about the worlds we've created. Janelle Shane, an electrical engineer, trains neural networks to do silly things. She discovered how the Microsoft Azure computer vision algorithm insinuates sheep (or "hallucinates" them) into green, rocky and foggy landscapes, even when none are present—clearly because the training data showed sheep on green pastures. "Bring sheep indoors, and they're labeled as cats. Pick up a sheep (or a goat) in your arms, and they're labeled as dogs," she writes. When she colours them orange, the algorithm parses them as flowers. As Shane explains, "If life plays by the rules, image recognition works well. But as soon as people—or sheep—do something unexpected, the algorithms show their weaknesses."[4]

That very outcome could be seen in 2016 when researchers at OpenAI used their Universe platform to train an AI agent to play CoastRunners, a boat race video game.[5] Typically, players complete clockwise laps in a small lagoon and pick up targets along the way. But the AI agent player ran its boat backwards, continuously caught itself on fire, smashed into other boats, never completed a normal lap—and got 20% more points than its human competitors. Winning! As the researchers note, their experiment is a cautionary tale for reinforcement learning: it's hard to get an agent to do exactly what you want it to do, and the outcomes could be not only unexpected but dangerous.

The unexpected and unwelcome are where most people direct their fears of AI—the drone that misstrikes, the AI that develops superintelligence and becomes uncharitable toward the humans that spun it into existence. But other unexpected, surreal responses—the video game boat that careens its way to a high score, the sheep that befuddle the algorithm—provide us with ways to understand the boundaries and permeability of machine learning, to understand how algorithms see the world, or us, or whether there's any difference.

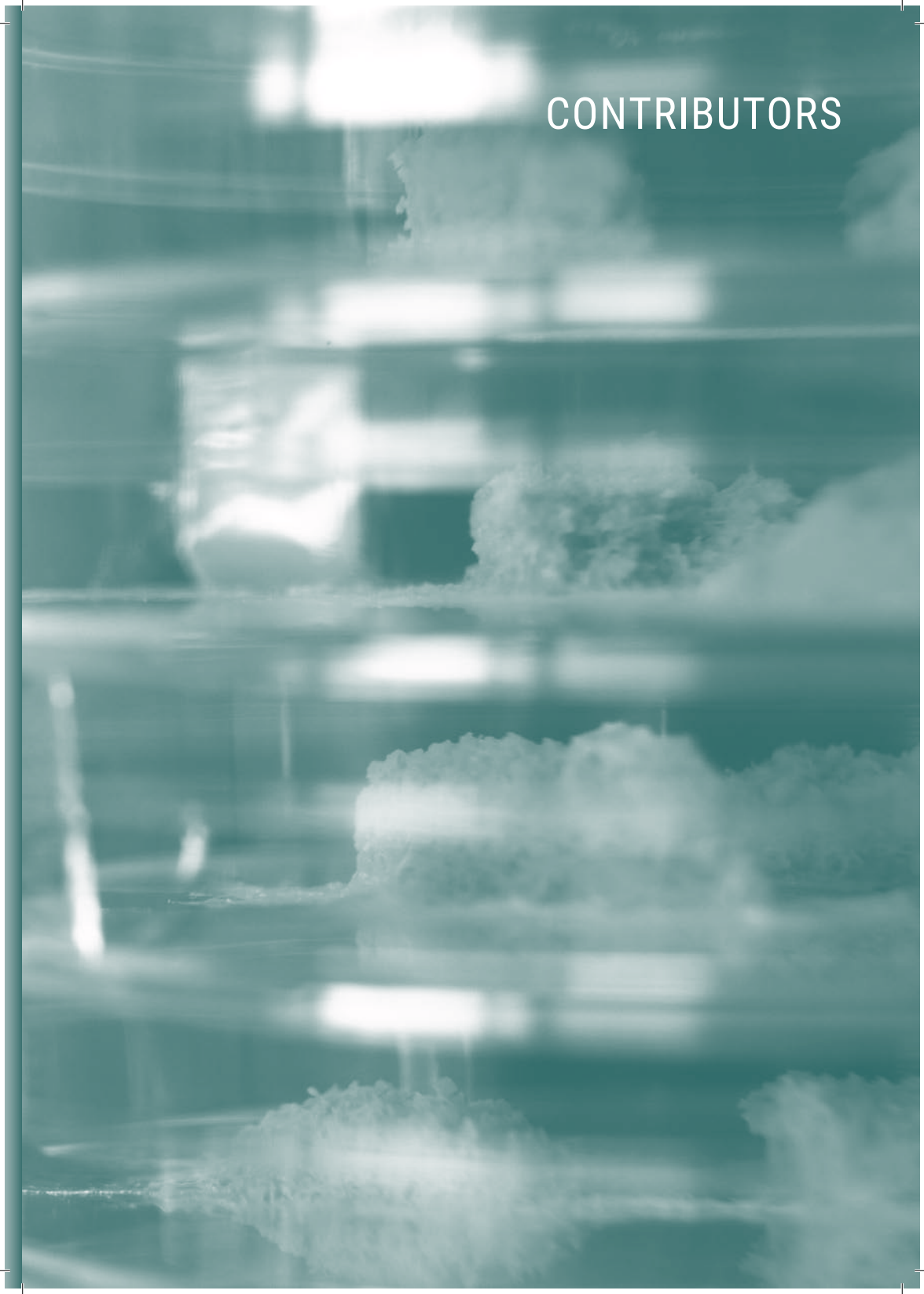
1 John Frazer (2017) 'Letter to Cedric Price', in Molly Wright Steenson (ed.) Architectural Intelligence: How Designers and Architects Created the Digital Landscape . Cambridge: MIT Press, pp. 160.

2 Marvin Minsky (1961)., 'Steps toward Artificial Intelligence'. Proceedings of the I.R.E. 49. https://web.media.mit.edu/~minsky/papers/steps.html. Accessed 19th August 2018.

3 ibid

4 Janelle Shane (2018) Do neural nets dream of electric sheep?, Available at: http://aiweirdness.com/post/171451900302/do-neural-nets-dream-of-electric-sheep.(Accessed: 19th August 2018).

5 Jack Clark, Dario Amodei (2016) Faulty Reward Functions in the Wild, Available at: https://blog.openai.com/faulty-reward-functions/. (Accessed: 19th August 2018).



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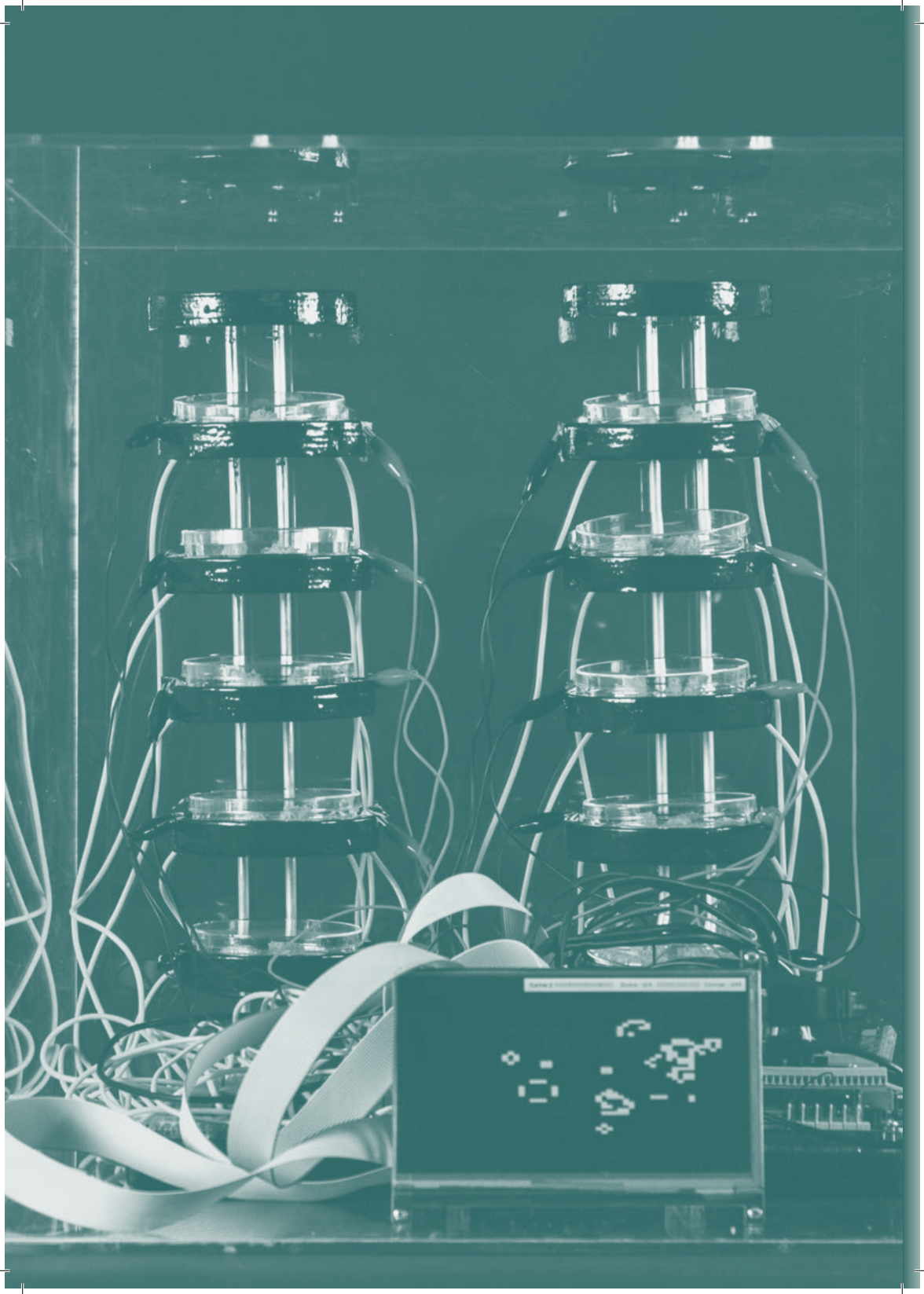
ILLUSTRATIONS



CTRL

MICHAEL SEDBON

Cover art and illustrations are taken and adapted from *Ctrl* (2018) by Michael Sedbon. *Ctrl* is an installation in which 10 Physarum Polycephalum – also known as slime molds - compete with each other to play John Conway's Game of Life.

The slime molds are connected to a food source thought a protoplasmic tube. The electrical potential of the molds is measured through Galvanic Skin Response sensors, hooked up to an Arduino Mega. This data is then transmitted to a single board Windows 10 computer and processed through custom software. The resulting outputs are used as spatial co-ordinates that control the gaming, and set the original state of the Game of Life.

The original Game of Life consists of a computer game in which a collection of cells live, die, or multiply based on a few mathematical rules.

MANIPULATING THE MAP

In his short story *Del Rigor en la Ciencia* (1946), Jorge Luis Borges describes how we must make maps in order to perceive and extract value from reality. A king, unhappy at being presented with maps that do not do justice to his kingdom, demands the creation of a map so detailed that only one on the same scale as the empire itself will suffice.

In order to manipulate a system we must abstract it into a model. But the efficacy of these models depends on the resolution of the abstractions. Our data-maps inform decisions in many parts of society, feeding into decision-making algorithms. From the way we pass through borders, to the tracking of what we buy in a supermarket, algorithms hold tremendous power in our lives. We are increasingly datafied. Our digital selves are transformed into an immense flow of avatars, formatted into parsable datasets in order to inform predictive measures around targeted advertising and law enforcement. We are building a spinning feedback loop between need and outcome: the more data artificial intelligence is trained on, the better it will be at producing new information.

In *Simulacra and Simulation* (1981), Jean Baudrillard nods back to Borges' map allegory, but argues that the territory is fading away and we are now only left with the map: a simulated abstraction of what once was.