Low animal spirits

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ABSTRACT

John Maynard Keynes's phrase *Low Animal Spirits* describes a paradox found in human nature that locates a herd-like mentality, as well as unpredictability and uncertainty, at the core of international finance: a model of mass behavioural procedures. *Low Animal Spirits* was a work made in collaboration with Richard Cochrane that took its cue from the oft-mentioned loss of the referent in both language and the economy that was speculated about wildly after the economic collapse of 2007/08. It employs a high-frequency trading (HFT) algorithm written by Cochrane (a former Vice President of Goldman Sachs), and 'deals' in words sourced from global news feeds for virtual 'profit', whilst speculating on their usage. The analysis produces new phenomena in the form of speculative headlines tweeted from the twitterbot *@LowAnimalSpirit*.

As various social productions, including news, are increasingly enmeshed within algorithmic procedures, through their production, distribution and reception, it seemed an apt moment to apply an extreme version of algorithmic operation in the form of HFT to global news production. The Associated Press twitter hack of 2013 that brought about a 1% drop in the financial market in 1 minute was displayed during the exhibition as a polished metal graphic: *Breaking News – Flash Crash*, and generated further investigation into high-speed algorithmic procedures that seemingly conjoin language and the economy. The work developed through procedural experimentation and the following writing traces some of the ideas that came before, after and through the work, often in conversation with others. It is best thought of in terms of a report: a taking stock.

Low Animal Spirits

Most, probably, of our decisions to do something positive, the full consequences of which will be drawn out over many days to come, can only be taken as a result of animal spirits – of a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities … Thus if the animal spirits are dimmed and the spontaneous optimism falters, leaving us to depend on nothing but a mathematical expectation, enterprise will fade and die; – though fears of loss may have a basis no more reasonable than hopes of profit had before.

The General Theory of Employment, Interest, and Money by John Maynard Keynes (1936) (VII chapter 12).

Figure 1. *Low Animal Spirits* by Ami Clarke and Richard Cochrane (2014), and Breaking News – Flash Crash by Ami Clarke (2014).

Notes: The work Low Animal Spirits, and Breaking News – Flash Crash, was kindly supported by the Elephant Trust, Arts Council England 2014, the Hayward Gallery and Museo Del Chopo, Mexico City. The performance of Low Animal Spirits and Error-Correction: an introduction to future diagrams, take (7), was kindly supported by University of Kent, School of Music and Fine Art and the ICA, and Wysing Arts Centre.

Low Animal Spirits was a work made in collaboration with Richard Cochrane that took its cue from the oft-mentioned loss of the referent in both language and the economy that was speculated about wildly after the economic collapse of 2007/08 (Figure 1). It employs a high-frequency trading (HFT) algorithm written by Cochrane who was once a Vice President of Goldman Sachs, and 'deals' in words sourced from global news feeds for virtual

'profit', whilst speculating on their usage. It is driven by real-time data, and scripted as a live onscreen score and audio work with automated readers. The analysis produces new phenomena in the form of speculative headlines tweeted from the twitterbot *@LowAnimalSpirit*. The projected visualisation is a glimpse into the HFT algorithms buying and selling activity with volatility at the centre of these operations. It accesses 994 English Language global news feeds 'live' and acts upon the data as if it were trading in the global market place, analysing words in terms of the potential for a virtual 'profit' to be made. The resulting visualisation displays what is *about* to trend, and likewise, the speculative headline generator tries to anticipate the next headline, based on recent history, and incoming headlines, with the help of a Natural Language Processing algorithm, tweeting from *@LowAnimalSpirit* every two minutes.

The work produced some unexpected results that were made visible and *produced through* the specific visualisation process that we had chosen. During periods of low activity, the HFT algorithm 'sells off' much of it's portfolio, and then 'buys' many new, but small items, as a kind of sifting process. This behaviour change in the algorithm can be seen when many words briefly appear to 'swarm', as can be seen in the installation shot, and the picture below, during the talk at Headstone to Hard Drive, Monument to Folly – Symposia at Central Saint Martins College of Art and Design, London, 2015. It was noted on several occasions that the work is a topology of sorts (Figure 2).
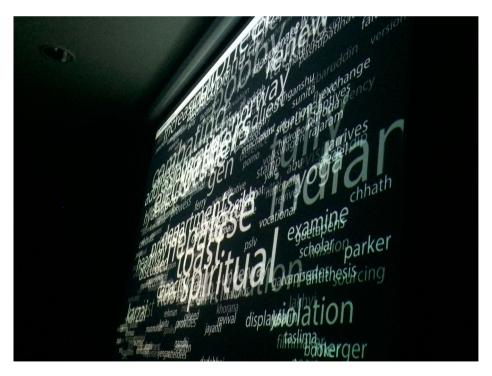

Figure 2. Low Animal Spirits (projected) during the talk by Ami Clarke and Richard Cochrane, at Headstone to Hard Drive, Monument to Folly – Symposium at Central Saint Martins College of Art and Design, London (February 2015).

Low Animal Spirits

Low Animal Spirits was a phrase coined by the economist John Maynard Keynes during the Great Depression of 1929 and almost a hundred years later had cause to be cited[1] again, notably by the governor of the Bank of England Mervyn King in 2012 (King and Flanders, interview 2012). Keynes had spent many years studying probability theory in an attempt to predict future market behaviour and the Great Depression shook his confidence considerably unsettling all his investments, theoretical and otherwise, in ideas of a self-regulating and sustainable market. '*Low animal spirits*' – a mass downturn in confidence – showed a paradox found in human nature that locates a herd-like mentality, as well as unpredictability and uncertainty, at the core of international finance: a model of mass behavioural procedures. The complexities that arose, of the lone individual acting spontaneously within a crowd, conceived through statistical analysis and probability theory, serves to address complex conceptualizations of the individual within new formulations of the crowd. Since the phrase was first coined, the effects of probability theory have increased to an unprecedented scale, and the software/hardware,[2] and infrastructural developments that facilitate these operations, plus political investment in de-regulation and a poorly legislated market place, have developed to the point at which human cognitive powers can no longer keep up. The arena in which these ideas arose is of a time where the very concept of free will came into being during the Enlightenment and as Hayles (1999) notes; an evolving subjectivity that emerged through market relations. Gambling and games of chance, with all the romantic heroism of the autonomous subject pitted against mathematical determinism, drove the quest for ever better odds, whilst the eighteenth century study of celestial mechanics developed complex new mathematical tools for deriving probable outcomes. The term *animal spirits* was drawn from the Latin *spiritus animals* to describe the elusive energy, or spirit, at one point thought of as a fluid, that drives human beings and has associations with Hume's concept of spontaneous motivation.

Celestial Mechanics and Games of Chance[3] (a selective skate through probability)

Probability theory developed through the theory of least squares by Adrien-Marie Legendre and Carl Friedrich Gauss around 1805, and its subsequent application in celestial mechanics 'formulating true statements in advance of experience' (Bender and Marrinan 2010, 161) in the work of John Couch Adams and Urbain Le Verrier. The mathematician Pierre-Simon Laplace at the École Polytechnique, championed the possibility 'to determine the probability of causes lying behind events by working backwards from observations' (Bender and Marrinan 2010, 160) in his 1812 *Théorie analytique des probabilités*. Adolphe Quetelet went on to apply statistical analysis to social data, producing an estimation of the 'average man' in his writing in *Sur l'homme* in 1835. The Scottish physicist James Clerk Maxwell's work on gas molecules continued the work – writing:

> *This method of dealing with groups of atoms, which I may call the statistical method, and which in the present state of our knowledge is the only available method of studying the properties of real bodies, involves an abandonment of strict dynamical principles, and an adoption of the mathematical methods belonging to the theory of probability.*[4] (Bender and Marrinan 2010, 179)

Subsequent work by Ludwig Boltzmann in thermo-dynamics proved Maxwell's theorem on the 'distribution of velocities among particles' (Bender and Marrinan 2010, 181) and led to it becoming known as the Maxwell–Boltzman distribution. Boltzmann went on to develop the H-Theorem leading to Boltzmann's law that abandoned a mechanistic theory of particles in motion 'to embrace a concept of energy states in time' (Bender and Marrinan 2010, 183).

Across several different branches of science, visual perception was overtaken by what Maxwell termed as 'the true logic of this world … the Calculus of Probabilities, which takes account of the magnitude of the probability'. It is significant, he writes, that: 'this branch of math … is generally thought to favour gambling, dicing, and wagering, and therefore highly immoral' (Bender and Marrinan 2010, 178 footnote 79).

Art project at East London train station tweets speculative headlines to affect stock market algorithms. No, really[5]

> *The shape of truth seems to be related to the technical means we use for approaching it.*
> (Bunz 2014, 23)

The focus on news – a social production interwoven with a history of technological innovation, from the era of the printing press to present day hybrid strategies that include both print and digital platforms/distribution – has an underlying requirement with the need for language to be tethered to an instance based on fact and consequently a focus on how truth may be defined.

News production changes significantly with the drift online by traditional news producers,[6] with the increased access to the means of production/distribution via desktop computing and mobile phones with built in cameras, the advent of social media, and online sites dedicated to the aggregation of news. Indicative of a shift from a traditional journalistic model of the 'one to the many' where reputations were hard won over time, to that of productions that come of *a chorus of voices* and a plurality that comes about through citizen journalism, with a shift to a model of 'the many to the many'. The journalist and theorist of technology Mercedes Bunz notes that within the constantly changing landscape of digitalization the durability of facts also comes into question when 'Algorithms are frequently updating the fact, with the outcome that it is being altered endlessly. While the digital fact has never been more accurate, it also has never been less durable' (Bunz 2014, 41). She notes: *it becomes obvious that the digital fact is relating to truth in a new and different way than the fact of the industrial age, for truth and facts aren't the same but share a rather complex relationship newly adjusted by technology.* (Bunz 2014, 41)

Additionally, a recent analysis by York and Stender (2016), focus' on the viral quality and analytics that drive the distribution of news items, on a variety of differing platforms such as buzzfeed, AJ, Vox, The Huffington Post, Business Insider and so on. They highlight the media industries need to find a solid revenue model, writing: 'because media companies rely on advertising to stay afloat, they have an imperative to market their content in a way that reaches the most readers'. The article is presented in such a way that focus' on the 'structures of distribution, the analytical tools and algorithms employed to support the imperatives of social media' (York and Stender 2016). The subsequent

feedback permits media outlets to customise content to users assumed interests, and together *produce* 'clickbaity headlines' through the 'media industry's primary profit motive'.

In relation to these structural phenomena, Chris Anderson writing in Wired (2008) in The End of Theory: The Data Deluge Makes the Scientific Method Obsolete, suggested that: 'models had been superseded by pure data, with disregard of the usual manner of hypothesize, model, test: to say correlation is enough'. The claim made is that 'shear amounts of data are sufficient to furnish statistical algorithms with all they need to know – to find the patterns within the massive clusters of information and hence; correlation supersedes causation'. In 2010 in response to a large data set production by Lev Manovich (How to study 1,000,000 Manga pages? Visualization methods for humanities and media studies) at Tech-TOC: Complex Temporalities in Digital Media, N Katherine Hayles pointed out another tendency: 'You are not mapping cultural objects themselves, you are mapping parameters of these cultural objects – a projected framework' (my notes). Karppi and Crawford also pick up on this distinction in their research in 2015: *With this accumulation of data and the development of new tools to analyze and connect large data sets, we have seen a growing 'data fundamentalism' (Crawford, 2013b), a neo-positivist epistemology in which correlation is sufficient rather than causation, and massive data sets and predictive analytics are taken for objective truth.* (Karppi and Crawford 2015, 77)

The algorithms that facilitate the production, distribution and reception of online news seem to be responsible for making visible certain items over others, responding to a ranking system contributed to through accessing online media, and clearly not all items clicked on are newsworthy. Contra to what increasing quantities of data might propose in terms of better analysis, the structural feedback loops (the predictive analytics of data mining practices leading to machine learning) at work within these systems, typically 'reify and reinforce certain cultural, racial, gendered assumptions and misconceptions, limiting users to a particular stream and thus perspective' (Kay 2014).

What happens when the ranking system becomes a popularity contest, and cannot structurally support within it's operation the reporting of not so popular stories?

Black Monday to black Friday

Of the many contributory factors leading to the financial crisis of 2007/08 and the subsequent slump thereafter, certain key factors are worth noting, such as Nixon's breaking of the Bretton Woods agreements and the loss of the gold standard. Other deregulatory legislation entered into by Reagan (1982 cited in Krugman 2009) and continued during the Clinton administration, the introduction of the Black-Scholes-Merton model, and the increasing reliance on electronic trading from 2000 onwards. Paul Krugman traces the economic crash of 2007/08 directly to Reaganomics – where Reagan broke with long-standing rules of fiscal prudence (Krugman 2009) bringing about the rise of private debt[7] to unprecedented levels. It is important to note that only in combination did the hardware/software, infrastructural developments and the loosening of legislation, bring about an increasing focus on short-term benefits, and the conditions for the perfect financial storm. The build-up of toxic assets that brought about the 2007/08 crisis were only possible in a climate of heavy deregulation, and an ethics that stretched as far as a quick profit.

Scott Patterson, reporter for *The Wall Street Journal* covering financial regulation from Washington D.C., in his article for CNBC in 2010, traces the history leading to HFT back to Black Monday on 19 October 1987, as the Dow Jones Industrial Average lost an unprecedented 22% (Patterson 2010). Mark Carlson of the Board of Governors of the Federal Reserve writes 'The 1987 stock market crash was a shock to the stability of the financial system, not just because of the size of the drop in price, but importantly because market functioning was significantly impaired' (Carlson 2007, 13, 21). Patterson writes that the Nasdaq 'market makers' had left retail investors 'out in the cold' and as a result of this were forced to introduce a system that would automatically give retail investors preference, leading to the introduction of the Small Order Execution System – SOES, trading in 1000 shares or less. New opportunities arose as a result when traders realized there was money to be made from a system that preferenced small orders. Small investing firms, writes Patterson, such as Terra Nova Trading, All-Tech Direct and The Island, took advantage of an increasingly computerized market place in the 1990s and opened up an archipelago of SOES trading rooms, developing electronic communications networks, or ECN's, as a linked system of trading alternative to Nasdaq. After a scandal relating to Nasdaq manipulating trades, the U.S. Securities and Exchange Commission passed the Order Handling Rules mandating that 'bids and offers for stocks on ECNs would be displayed on terminals right beside those of the Nasdaq market makers' (Patterson 2010). The change to decimalization in 2000 meant trading could happen in 'penny-wide increments' with 'a level of complexity easier handled by computers than the human brain' (Patterson 2010), and welcomed in the end of the dominance of Nasdaq and the New York stock exchange. That is, until Getco, and other high-frequency firms were welcomed back into the NYSE as designated market makers, as the NYSE opened up it's own computer data centre in Mahwah, New Jersey 'to cater to high-speed trading firms' (Patterson 2010).

The materiality of the stock exchange

the strategic advantage to a financial company of having a faster system than its competitors is driving a billion-dollar technological arms race. (Johnson et al. 2013)

HFT programs typically trade in small orders, with small increments of profit to be made from each trade. Both 'market-making' – earning 'the spread'; the difference between competitively priced bids and sales, plus 'rebates' (if also executed on by other traders), and trying to avoid 'paying the spread' by trading aggressively, create a flow: 'of individually small but, thanks to the high frequency, collectively significant profits, often with little risk-taking involved' (Arnoldi 2016, 36). Most importantly, every exchange has a 'feed server' sending out information on every change in the order books known as the 'raw' data feed. All trades rely on information gleaned from the raw data feed as well as automated analysis of social media. Donald MacKenzie writes that as there's quite a circulation of staff at HFT firms, their specialist knowledge/strategies also circulate, so the emphasis on speed is amplified. *Originally, the data needed for high-frequency trading travelled almost exclusively via fibre-optic cables, in which signals move at about two-thirds of the speed that light travels in a vacuum and has the bandwidth to transmit the huge volumes of data necessary for todays financial markets.* (MacKenzie 2014, 27–30)

But, MacKenzie writes: ' … now that computers, not humans, are doing the trading, geography matters exquisitely. With any of these technologies – fibre-optic cable, micro-wave, millimetre wave, laser transmission through the atmosphere – the exact route taken is crucial'[8]. MacKenzie recounts how increasingly co-location became a factor, whereby HFT firms and traders were located in the same premises with the exchanges computer servers, to take advantage of latency – milliseconds of difference – by being physically closer to the exchanges 'raw' data feeds. The Chicago Mercantile Exchange, the New York Stock Exchange in Mahwah, New Jersey, Nasdaq in Carteret, BATS in NJ2 in Weehawken, and Direct Edge in NY4, Secaucus, New Jersey and many others, relocated their electronic trading systems to the Aurora to New Jersey geodesic[9] for exactly this reason. As increasingly control is given over to fully automated algorithms, Goldman Sachs moved the last trader out of its four Manhattan trading floors in 2015 (Popper 2012).

Breaking News – Flash Crash

Figure 3. Breaking News–Flash Crash by Ami Clarke (2014). Photo by Tomas Rydin.

Figure 4. Associated Press twitter account hack tweet - screengrab (2013).

Breaking News – Flash Crash[10] – depicted a polished metal graphic of the 1%[11] dip in the market during the 2013 flash crash, with a print-out of the Associated Press twitter account hack tweet, reading: *Breaking: Two Explosions in the White House and Barak Obama is injured* (Figures 3 and 4). The Washington Post, NY magazine, and Andrew Yoskowitz in After Dawn news (as well as many others) reported that:

> *Hackers caused a mini stock market 'flash crash' this afternoon after sending a bogus tweet from a hacked Associated Press (AP) Twitter account. The tweet, read that there were explosions at the White House and President Barack Obama had been injured. The account was quickly shut down, but the damage had been done. U.S. markets, including the Dow Jones and S&P 500 fell 1 percent in one minute before rebounding. White House spokesperson Jay Carney quickly dismissed the story by saying the President was doing just fine. And the Associated Press swiftly suspended all of its Twitter accounts.*

The market recovered particularly quickly in this instance, as there were no other corroborating stories, and the Associated Press were quick to shut down their twitter account. What is clear though, is that those who lost in the downslide with very concrete material effect, did not necessarily recover their losses as the market recovered as a whole. The

entire event lasted 5 minutes (Karppi and Crawford 2015, 74). It is worth noting that this was not due to a broken part, a mis-behaving algo, or a computer running crazily out of control, but precisely because the algorithms operated as designed to do.

A recent N.Y.T.'s article by Nathaniel Popper in February 2016, focussed on Daniel Nadler's 3-year-old company called Kensho, that employs automated software to parse extremely large data-sets, such as the overall growth in American payrolls through analysis of the Bureau of Labor Statistics. In just two minutes, an automated Kensho analysis can supply: 'a brief overview, followed by 13 exhibits predicting the performance of investments based on their past response to similar employment reports' (Popper 2016). A complex operation based on thousands of numbers drawn from dozens of databases that would take a human, days, if not weeks, to complete. These analyses are supplied to trading firms such as Goldman Sachs, who is also the largest investor in the company along with Google and the C.I.A.'s venture-capital arm (Popper 2016). The automated analysis takes over from honed human expertise that would have guided investors how to react, in quickly emerging international events such as flare-ups in the Syrian civil war, taking into consideration previous news events and looking at how markets responded in each case. The problem with the human approach, as Popper, notes, 'was that by the time the results came back, the original trading opportunity was often gone'. The constant amendments to the search terms with little human intervention, is where the sophistication really lies in the software, looking for 'new and unexpected relationships between events and asset prices, allowing it to recommend searches that a user might not have considered'. A sales trader can choose from a series of increasingly narrow criteria – to generate complex studies of a specific time period and a specific set of investments, in a matter of minutes: *The top chart showed that the prices of natural gas and crude oil have underperformed in the weeks after past escalations in the war, while Asian stocks and the United States and Canadian dollar pair has outperformed … we could also see how each event in Syria played out and begin to structure an optimal set of trades based on that history.* (Popper 2016)

In a 2015 analysis of the flash crash event: Social Media, Financial Algorithms and the Hack Crash, Tero Karppi and Kate Crawford draw attention to the Dataminr software that mines Twitter's 'firehose'[12] and delivers what is deemed relevant into the hands of traders.

Dataminr combs through 340 million daily tweets on Twitter and its algorithms quickly seize on abnormal and actionable signals that can be analyzed and confirmed as a relevant event for a client. This could be anything from an assassination or general instability in certain countries to government sanctions, natural disasters or on-the-ground chatter about products or trends. Dataminr uses available Twitter metadata along with other contextual factors such as historical and concurrent data to create a mathematical signature for an event, ultimately deciding on the fly whether an event is valuable for decision-making purposes. […] previous technologies that tried to look at Internet data relied on things like sources and the authority of sources or keyword frequency. Dataminr is very focused on the now and deriving instant value from the flow of tweets online. (Kim 2012 cited in Karppi and Crawford 2015, 79)

Their study reveals several of these software such as RavenPack, Gnip, DataSift and Topsy that clearly focus beyond just text and keywords. Citing journalist Michelle Price in the

Financial News, they write that this sophisticated scoring of the relationships between words in play, can uncover *grades* of expressed 'emotions' and produce more than just a sentiment analysis of Twitter data: 'Through real-time analysis of Twitter data, software packages like Dataminr assess emotion, importance and social meaning in order to "predict the present" and thus transform social media signals into economic information and value'. They suggest that: *digital innovations generally, and software code specifically, are codes also in the sense of being able to shape human conduct. Thus, computer code is seen as performative, in that it creates specific types of social (but not necessarily human) beings (Introna, 2011; Mackenzie and Vurdubakis, 2011) or as governmental (Thrift and French, 2002), because it shapes human conduct.* (Karppi and Crawford 2015, 49). They argue that: *Twitter and social media are becoming more powerful forces, not just because they connect people or generate new modes of participation, but because they are connecting human communicative spaces to automated computational spaces in ways that are affectively contagious and highly volatile.*

The social technology of algorithms

> *a social technology that is massively transforming society, economics and the whole structural premise upon which democracy itself is built.* (Bunz 2014)

Franco Birardi's writing in The Uprising: on Poetry and Finance, informed the beginnings of an idea to apply the algorithmic operation of HFT to news production almost as a challenge to some of the claims made therein. Birardi's writing stems from Guattari's claim that 'capital is a semiotic operator', Baudrillard's writing on the semio-capital boom, and the conceptual frameworks that conjoin language and the economy in the writings of Maurizio Lazzarato (2007) and Christian Marazzi. Birardi's focus on the failings of total concatenation – of everything connected – picks up on ideas emerging with early formulations of networked society, around the same time as de-regulation and the beginnings of neo-liberal ideology. He writes: '… aims to liberate social activity from any regulation except the regulation of money' lead only to 'financial capitalism subjecting social behavior to techno-linguistic governance' (Berardi 2007, 28) and the harshest rule of all: competition.

Karppi and Crawford draw 'thick lines of connection that run between social media spaces, intermediate human and algorithmic actors, and financial markets', inspired by Massumi's writing in 1995 that 'the ability of affect to produce an economic effect more swiftly and surely than economics itself means that affect is itself a real condition, an intrinsic variable of the late-capitalist system, as infrastructural as a factory' (Karppi and Crawford 2015, 81). Twenty years later the collapse of 'structured distinction into intensity, of rules into paradox' (Massumi 1995, 88) could appear to result in a seemingly Baroque Cartesian (Coley and Lockwood 2012; Terranova 2004) synthesis whereby intensity is assimilated into the experience of the quantifiable everyday.

As software such as Kensho, Dataminr, RavenPack, Gnip, DataSift and Topsy, replace human expertise, there seems within this strategy an implicit acknowledgement of the centrality of social productions[13] being enmeshed within the very fabric of finance. The

Associated Press hack analysis by Karppi and Crawford 'underscores the connectedness of the relation between systems of communication and monetary value – systems of humans and algorithms, which are now tightly bound within "microrelational forces of imitative encounters"' (Karppi and Crawford 2015, 87). The scientific report on The Abrupt Rise Of New Machine Ecology Beyond Human Response Time, by Johnson, Zhao, Hunsader, Qi, Johnson, Meng & Tivnan, has begun to explore the behavioural changes that happen as 'society's techno-social systems are becoming ever faster and more computer-orientated', and 'far from simply generating faster versions of existing behaviour ... show that this speed-up can generate a new behavioural regime as humans lose the ability to intervene in real time'.

Philip Ekardt's discussion on speculation in 2014, with the scholar of culture, media, and literature: Joseph Vogl, leads them to noting a similarity in HFT, to that of the fashion trade, as the lifeworld becomes a system for the notation of market trend data and that 'what it demands of us is that we behave today – out of conformism or extravagance – in accordance with tomorrow's trends'. Ekardt says '... so there's no complete presence of fashion; it's always already woven into a differential economy of time in which it is coming, is fading, is plunging into the future and consuming itself in this plunge'.

As an unprecedented[14] reliance on credit brings about what would have once seemed foolhardy levels of debt, financial systems seem increasingly enmeshed in sustaining a market that is purely differential at core – trading for trading's sake – at all costs. I am told (by someone who wishes to remain anonymous) that this scenario is precisely what the Bank of England have been preparing for, and developing further strategies to accommodate to, more readily, in recent years. On the surface, this alters the role of the Bank from *maintaining public confidence through its monetary stability objective* (Bank of England 2016), to a (not altogether) new role of 'market-maker'. Erkardt and Vogl argue that a fundamental change has occurred at a much greater scale: *A social contract based on reciprocity, however fictional it may be, can still be the founding document of a republican society. That's the legacy of political theories since the 18thC. Now there's suddenly a social contract in its stead that's defined by an economy of credit and finance in which the structural insolvency of the system is perpetually compensated for by an ongoing 'futurization' of debt. Societies are held together by debts that no one can pay, by credits that can't be redeemed. All that necessitates a systematic and future-fixated incessant operation of the whole economy.* (Philipp Ekardt 2014)

Further …

Popper writes: One of Nadler's associates, Camacho, working with him on the software Kensho, described going to Nadler's apartment during the first summer of working together:

They watched the science-fiction film "Oblivion," about a world populated by alien-generated human clones, and stayed up talking about the socioeconomic implications of the story. More recently, Nadler invited his engineering team to a dinner at one of Cambridge's nicest

restaurants, Henrietta's Table, for a group conversation about the more distant implications of automation. Nadler said he anticipated some form of strong artificial intelligence, whereby computers in the far future would be smart enough to anticipate our needs and usher in an era of abundance. For the next few decades, though, he predicted a more complicated time – an interregnum in which the computers are not as smart as people but smart enough to do many of the tasks that make us money. (Popper 2016)

The *interregnum* mentioned, whereby the configuration of power is driven only by increasingly extreme strategies of capital accumulation, does not take much imagination to conjure a certain urgency to the present.

I have discussed what legislative possibilities are being considered with someone (who has asked to remain anonymous) working on these concerns for the UK government, and there are seemingly very few options with regards how and what restrictions could curtail such as high-algo spirits. The focus on materiality at the data exchange, with discrepancies in distance from the data feed being evened out with longer cables, is a practice that only goes as far as each individual data centre, and are globally inconsistent. Other ideas of limiting the amount of trades that could be made per second are notoriously difficult to enforce again, globally. The wildest idea of charging a levy per trade, throwing a dollar shaped spanner in the works for HFT, was deemed so preposterous as to never be accepted by traders in the first place. These ideas do not even begin to touch on the complexities that might occur should proceedings actually reach court. Jakob Arnoldi in his survey Computer Algorithms, Market Manipulation and the Institutionalization of HFT, draws on three cases, to show that manipulation can also happen in 'a reverse way, meaning that human traders attempt to make algorithms "make mistakes" by "misleading" them with fairly simple manipulations that would be simply transparent to humans' (Arnoldi 2016, 29). He writes of the complexity of proving 'intent' rather than negligence 'when dealing with actor-networks consisting of, on the human side, programmers, hardware designers, traders, risk managers and, on the non-human side, algos and hardware' (Arnoldi 2016, 45). Further adding that: … *if a trader operating or overseeing an algo used to place orders in a way that constitutes layering, they might not be the person who designed the algorithm. Indeed, the design of the algo might have been a joint collaboration between different people from different firms.* (Arnoldi 2016, 45)

A judicial system that could adequately deal with these complexities would necessarily need to take into consideration the distributed effects of a complex human and non-human actor network. This, of course, doesn't even begin to touch on the inadequacies of a financial system with such distorted priorities, and as such only addresses the symptom and not the cause, but could play a part in forcing new ways of thinking (Figure 5). Differing scales and temporalities simultaneously weave through these operations, with indistinct characteristics of human and non-human engagement, and the trick is how to work within these, whilst staying connected to the particular critiques of feminism, gender and race studies, and the environmental issues paving the way to understanding the most distributed of effects.

Figure 5. Liquidity Symposium – ICA 9th December 2015.

Ami Clarke reading from her ongoing script: '*Error-Correction: an introduction to future diagrams*' with '*Low Animal Spirits*' - a live HFT algorithm trading in world news by Ami Clarke and Richard Cochrane.

'Error-Correction: an introduction to future diagrams (take 7)' is one in a series of experimental takes of an on-going enquiry into diagrams – 'Take 7' focus' on materiality, algorithms, and an evolving subjectivity. It took as it's title an essay written by the founder of Buzzfeed; Jonah Peretti: Capitalism and Schizophrenia: Contemporary Visual Culture and the Acceleration of Identity Formation/Dissolution that he wrote prior to launching the hugely successful online multi-media sharing platform: Buzzfeed in 2006. The company now has a theoretical market value of around $1.5billion. (Matthew, www.fortune.com, 2016).

The script operates as one in a series of takes that reference and include appropriated texts, contemporary commentary; news items, as well as anecdotal evidence, culminating in an interrelated convergence of many interwoven threads, whereby the voice, through language, is constituted 'between someone else's thoughts and the page'. It employs deliberate use of what Alix Rule and David Levine describe as an 'almost pornographic use of language' in their critique of International Art Language – 'On the rise – and the space – of the art-world press release'.

The scripts are developed from theoretical and historical cross-disciplinary research into diagrams, and diagramming, and are an attempt at a 'potential articulation' with regards to current 'conditions' in the world: material, theoretical and philosophical (pertaining to evolving constructs of subjectivity). The title to the on-going work stems from the ideas of the German physician and physicist Herman von Helmholtz, who's research into mathematics of the eye brought him to the conclusion that they were exceptionally prone to error, an approximation at best, that 'operate(s) within the protocols of instruments' – an 'error-correction' of sorts. These ideas led to probability theory and the abstract language of mathematical analysis in celestial mechanics and situated theory as the engine to extend enquiry into domains beyond the human sensorium and beyond visual representation.

The reading performance should be experienced live, and the recording is made available purely as documentation. https://vimeo.com/152330587.

Notes

1. In 2009, the economists Akerlof and Shiller advised that: The proper role of the government, like the proper role of the advice-book parent, is to set the stage. The stage should give full rein to the creativity of capitalism. But it should also countervail the excesses that occur because of our animal spirits (Akerlof and Shiller 2009, 9).

2. 'It's difficult, if not impossible, to draw a clear line between … software and hardware' (Cramer 2005, 121).

3. Further writing traces cryptology and language through mathematics and probability – Markov is of notable interest here through his study of the frequency of vowels in the Russian writer A. S. Pushkin's literary work Eugene Onegin. Markov was the first to

develop a complete theory that took into account the connections between letters, and worked through his research applying the technique developed by Legendre in his 1805 text: *Nouvelles méthodes pour la détermination des orbites des comètes* and Gauss's 1809 text: *Theoria motus corporum coelestium*: the method of least squares (Link 2006, 323/4). Brian Hayes summarises that Markov's methodology went *beyond coin-flipping and dice-rolling (where each event is independent of all others) to chains of linked events (where what happens next depends on the current state of the system).*

4. 'in applying dynamical principles to the motion of immense numbers of atoms, the limitation of our faculties forces us to abandon the attempt to express the exact history of each atom, and to be content with estimating the average condition of a group of atoms large enough to be visible' (Bender and Marrinan 2010, 179).

5. An early review of Low Animal Spirits in which the editors of the art magazine Art Slant 'optimized' the story with a particularly optimised headline – review by Phoebe Stubbs. 30 September 2014 http://www.artslant.com/lon/articles/show/40931

6. In 2007, there were 55,000 full-time journalists at nearly 1400 daily papers; in 2015, there were 32,900, according to a census by the American Society of News Editors and the School of Journalism and Mass Communication at Florida International University. … 105 newspapers closed in 2009 alone – whittled away by the rise of the Internet and decline of display ads, with the migration of classified advertising to Craigslist hitting particularly hard. Between 2000 and 2007, a thousand newspapers lost $5 billion to the free site, according to a 2013 study by Robert Seamans of New York University's Stern School of Business and Feng Zhu of the Harvard Business School (Maharidge 2016).

7. Reagan-era legislative changes essentially ended New Deal restrictions on mortgage lending – restrictions that, in particular, limited the ability of families to buy homes without putting a significant amount of money down (Krugman 2009).

8. There has been speculation that neutrino's could be successfully 'time-encoded and pointed from one financial centre to another, through the earth itself', so with 'neutrino-based buy-and-sell messages via a 10,000 km shortcut through earth; high-velocity traders could handily beat their competitors' (Dorminey 2012).

9. The shortest and hence fastest route between two places (MacKenzie 2014).

10. Exhibition: with *Low Animal Spirits*, September 2014.

11. Wiping out $136.5 billion of the Standard & Poor's 500 Index's value (Karppi and Crawford 2015).

12. Twitter uses the term 'firehose' for complete access to its social media data (Karppi and Crawford 2015).

13. Walter Benjamin: The Author as Producer (1934) – comments on the impatience of 'the speculator waiting for a tip-off' from the newspapers.

14. Almost all finance and exchange relies on credit/indebtedness, but this could be seen as a new phase.

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Notes on contributor

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