A Peer-Reviewed Journal About

MACHINE RESEARCH

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EDITORIAL

MACHINE RESEARCH

Christian Ulrik Andersen
& Geoff Cox

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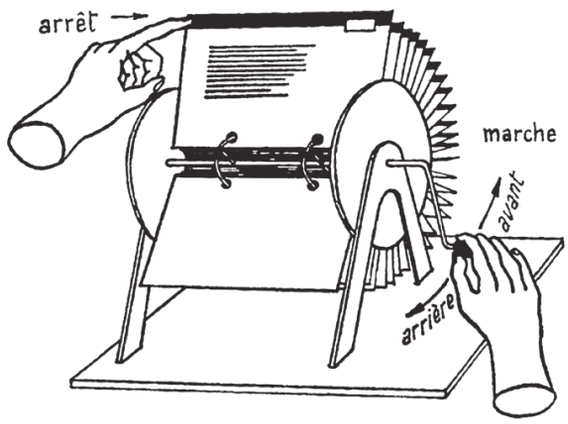

This publication is about *Machine Research* – research on machines, research with machines, and research as a machine. It thus explores machinic perspectives to suggest a situation where the humanities are put into a critical perspective by machine driven ecologies, ontologies and epistemologies of thinking and acting. It aims to engage research and artistic practice that takes into account the new materialist conditions implied by nonhuman techno-ecologies. These include new ontologies and intelligence such as machine learning, machine reading and listening (Geoff Cox, Sam Skinner & Nathan Jones, Brian House), systems-oriented perspectives to broadcast communication and conflict (John Hill, Dave Young), the ethics and aesthetics of autonomous systems (Maya Indira Ganesh, Maja Bak Herrie), and other post-anthropocentric reconsiderations of materiality and infrastructure (Abelardo Gil-Fournier, Etherbox interview).

The papers address these topics in ways that we hope remind readers that all research in-itself is machine-like, following scientific as well as commercial protocols and mechanisms. In this way, the publication also functions as a response to the machinery of academic print and the corresponding rise of open access journals like *APRJA* to promote a culture based on sharing, open distribution and the exchange of ideas. Machines evidently are there to provide opportunities to both limit and expand autonomy. As Maurizio Lazzarato has highlighted, we can be 'enslaved' or 'subjected' to a machine:

> *If we adopt Deleuze and Guattari's perspective, we can state clearly that capitalism is neither a "mode of production" nor is it a system. Rather it is a series of devices for machinic enslavement and, at the same time, a series of devices for social subjection. […] The technological machine is only one instance of machinism. There are also technical, aesthetic, economic, social, etc. machines.*

Whether technical, social, communicational, we are enslaved when we become one of the constituent parts that enables the machine to function, and subjected to the machine when we are defined purely by its actions. But what are the other possibilities? As a response to this question, it is important to emphasise here that the process leading to the publication of these papers – a three-day workshop hosted by Constant in Brussels – utilised Free, Libre and Open Source collaboration tools, collective notetaking and machinic authoring.[1]

To exemplify this approach and other machinic possibilities, we have included a collectively authored interview with a machine that facilitated our work at the workshop (Etherbox interview). Inter-action with this machine is indicative of the ways in which recursive feedback loops seem to operate at all levels in the writing and reading of the texts in this issue of the journal, and points to far messier entanglements between humans and machines that inform our thinking. These kinds of ontological confusions are elaborated here to establish some of the ways that machines operate on other machines and imaginaries. The critical challenge perhaps is to learn from machines

as much as they learn from us, and to develop a new understanding that includes the machinic in all its guises.

Christian Ulrik Andersen & Geoff Cox
Aarhus, April 2017.

Notes

[1] Details of the Machine Research workshop can be found at https://machineresearch.wordpress.com/about/. More details of this process and a resultant publication designed using the PJ tool, designed by Sarah Garcin, can be found at the above website. The print publication that directly resulted from this can be downloaded from http://www.aprja.net/workshops-newspapers/. The workshop and this journal issue have been organised in the context of *ever elusive*, the 2017 edition of transmediale festival of art and digital culture, Berlin, https://2017.transmediale.de/.

Thanks to all participants, Kristoffer Gansing and Daphne Dragona (transmediale) and An Mertens, Michael Murtaugh and Femke Snelting (Constant) for co-organisation of the workshop, and Søren Rasmussen for his editorial assistance on the journal.

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MACHINE ONTOLOGIES AND INTELLIGENCE

Geoff Cox

WAYS OF MACHINE SEEING: AN INTRODUCTION

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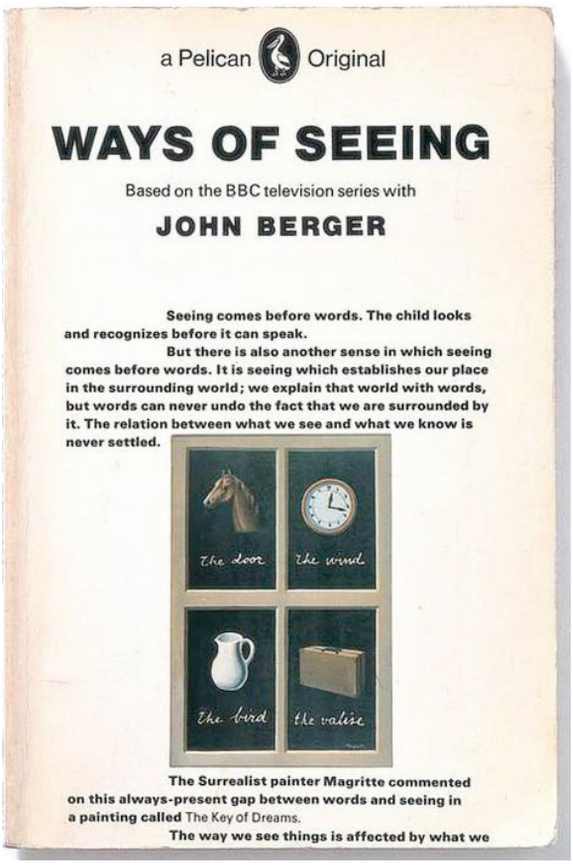

Figure 1: The Cover of *Ways of Seeing* by John Berger (1972). Image from Penguin Books.

You are looking at the front cover of the book *Ways of Seeing* written by John Berger in 1972.[1] The text is the script of the TV series, and if you've seen the programmes, you can almost hear the distinctive pedagogic tone of Berger's voice as you read his words: "The relation between what we see and what we know is never settled."[2]

The image by Magritte on the cover further emphasises the point about the deep ambiguity of images and the always-present difficulty of legibility between words and seeing.[3] In addition to the explicit reference to the "artwork" essay by Walter Benjamin,[4] the TV programme employed Brechtian techniques, such as revealing the technical apparatus of the studio; to encourage viewers not to simply watch (or read) in an easy way but rather to be forced into an analysis of elements of "separation" that would lead to a "return from alienation".[5] Berger further reminded the viewer of the specifics of the technical reproduction in use and its ideological force in a similar manner:

> *But remember that I am controlling and using for my own purposes the means of reproduction needed for these programmes […] with this programme as with all programmes, you receive images and meanings which are arranged. I hope you will consider what I arrange but please remain skeptical of it.*

That you are not really looking at the book as such but a scanned image of a book — viewable by means of an embedded link to a server where the image is stored — testifies to the ways in which what, and how, we see and know is further unsettled through complex assemblages of elements. The increasing use of relational machines such as search engines is a good example of the ways in which knowledge is filtered at the expense of the more specific detail on how it was produced. Knowledge is now produced in relation to planetary computational infrastructures in which other agents such as algorithms generalise massive amounts of (big) data.[6]

Clearly algorithms do not act alone or with magical (totalising) power but exist as part of larger infrastructures and ideologies. Some well-publicised recent cases have come to public attention that exemplify a contemporary politics (and crisis) of representation in this way, such as the Google search results for "three black teenagers" and "three white teenagers" (mug shots and happy teens at play, respectively).[7] The problem is one of learning in its widest sense, and "machine learning" techniques are employed on data to produce forms of knowledge that are inextricably bound to hegemonic systems

of power and prejudice.

There is a sense in which the world begins to be reproduced through computational models and algorithmic logic, changing what and how we see, think and even behave. Subjects are produced in relation to what algorithms understand about our intentions, gestures, behaviours, opinions, or desires, through aggregating massive amounts of data (data mining) and machine learning (the predictive practices of data mining).[8] That machines learn is accounted for through a combination of calculative practices that help to approximate what will likely happen through the use of different algorithms and models. The difficulty lies in to what extent these generalisations are accurate, or to what degree the predictive model is valid, or "able to generalise" sufficiently well. Hence the "learners" (machine learning algorithms), although working at the level of generalisation, are also highly contextual and specific to the fields in which they operate in a coming together of what Adrian Mackenzie calls a "play of truth and falsehood".[9]

Thus what constitutes knowledge can be seen to be controlled and arranged in new ways that invoke Berger's earlier call for skepticism. Antoinette Rouvroy is similarly concerned that algorithms begin to define what counts for knowledge as a further case of subjectivation, as we are unable to substantively intervene in these processes of how knowledge is produced.[10] Her claim is that knowledge is delivered "without truth" through the increasing use of machines that filter it through the use of search engines that have no interest in content as such or detail on how knowledge is generated. Instead they privilege real-time relational infrastructures that subsume the knowledge of workers and machines into generalised assemblages as techniques of "algorithmic governmentality".[11]

In this sense, the knowledge produced is bound together with systems of power that are more and more visual and hence ambiguous in character. And clearly computers further complicate the field of visuality, and ways of seeing, especially in relation to the interplay of knowledge and power. Aside from the totalizing aspects (that I have outlined thus far), there are also significant "points of slippage or instability" of epistemic authority,[12] or what Berger would have no doubt identified as the further unsettling of the relations between seeing and knowing. So, if algorithms can be understood as seeing, in what sense, and under what conditions? Algorithms are ideological only inasmuch as they are part of larger infrastructures and assemblages.

Figure 2: The *Ways of Seeing* book cover image seen through an optical character recognition program. Created by SICV.

But to ask whether machines can see or not is the wrong question to ask, rather we should discuss how machines have changed the nature of seeing and hence our knowledge of the world.[13] In this we should not try to oppose machine and human seeing but take them to be more thoroughly entangled — a more “posthuman” or “new materialist” position that challenges the onto-epistemological character of seeing — and produces new kinds of knowledge-power that both challenges as well as extends the anthropomorphism of vision and its attachment to dominant forms of rationality. Clearly there are other (nonhuman) perspectives that also illuminate our understanding of the world. This pedagogic (and political) impulse is perfectly in keeping with Ways of Seeing and its project of visual literacy.[14] What is required is an expansion of this ethic to algorithmic literacy to examine how machine vision unsettles the relations between what we see and what we know in new ways.

```
// This program is based on the sample code shipped with the Tesseract OCR
// Usage: ./texture image-in.jpg image-out.jpg
// Uncomment the various print statement to see more details about the program.

#include <tesseract/baseapi.h>
#include <tesseract/strngs.h>
#include <tesseract/resultiterator.h>
#include <leptonica/allheaders.h>
#include <iostream>
#include "opencv2/core/core.hpp"
#include "opencv2/features2d/features2d.hpp"
#include "opencv2/highgui/highgui.hpp"
#include "opencv2/imgproc/imgproc.hpp"
#include <QtCore/QString>

using namespace cv;

using namespace std;

int main(int argc, char** argv)
{
  if (argc < 2)
    {
      std::cout << "Please specify the input image!" << std::endl;
      return -1;
    }

  //    char *outText;
  int fontface = FONT_HERSHEY_SIMPLEX;
  tesseract::TessBaseAPI *api = new tesseract::TessBaseAPI();
  // Initialize tesseract-ocr with German, without specifying tessdata path
  // Change here language settings
  if (api->Init(NULL, "deu")) {
    fprintf(stderr, "Could not initialize tesseract.\n");
    exit(1);
  }

  // Open input image with leptonica library
  Pix *image = pixRead(argv[1]);
  Mat im=imread(argv[1],CV_LOAD_IMAGE_COLOR);
  int icols=im.cols;
  int irows=im.rows;
  cv::Mat wim( irows, icols, im.type(), cv::Scalar(0));
  Rect letterRect;
  Mat src, dst, color_dst;
  int confidence_level=0;
  int j=0;
  src=imread(argv[1],CV_LOAD_IMAGE_GRAYSCALE);
  Canny(src, dst, 50, 200, 3 );
  cvtColor( dst, color_dst, CV_GRAY2BGR );
```

```
51    vector<Vec4i> lines;
52    HoughLinesP( dst, lines, 1, CV_PI/180, 80, 80, 10 );
53    int numlines=0;
54    for( size_t i = 0; i < lines.size(); i++ )
55      {
56        double Angle = atan2(lines[i][3]- lines[i][1], lines[i][2]- lines[i][0]) * 180.0
    / CV_PI;
57        if(Angle>=0 && Angle <=5){
58      numlines++;
59      line( wim, Point(lines[i][0], lines[i][1]),
60            Point(lines[i][2], lines[i][3]), Scalar(0,0,255), 1, 8 );
61        }
62      }
63    if(numlines>0){
64      //Mat screen=cvCreateMat(im.rows,im.cols,im.type());
65      api->SetImage(image);
66      api->Recognize(0);
67      //outText = api->GetUTF8Text();
68      tesseract::ResultIterator* ri = api->GetIterator();
69      tesseract::PageIteratorLevel level = tesseract::RIL_SYMBOL;
70
71      if (ri != 0) {
72        do {
73      const char* word = ri->GetUTF8Text(level);
74      float conf = ri->Confidence(level);
75      int x1, y1, x2, y2;
76      ri->BoundingBox(level, &x1, &y1, &x2, &y2);
77      //                printf("word: '%s';  \tconf: %.2f; BoundingBox: %d,%d,%d,%d;\n",
78      //                       word, conf, x1, y1, x2, y2);
79      bool ignore;
80      int psize,fid;
81      ri->WordFontAttributes(&ignore,&ignore,&ignore,&ignore,&ignore,&ignore,&psize,&fid
    );
82      //            printf("point size: %d font id: %d",psize, fid);
83      if(conf>50){
84        QString utfw = QString::fromUtf8(word);
85        //                    if(utfw.size()>4){
86        //               //         printf("word: '%s'  \tlength: %d\n",word,utfw.length
    ());
87        letterRect=CvRect();
88        letterRect.x=x1;
89        letterRect.y=y1;
90        letterRect.width=(x2-x1);
91        letterRect.height=(y2-y1);
92        Mat letterim;
93        try{
94          letterim=im(letterRect).clone();
95          //                            im.copyTo(wim(Rect(letterRect.x, letterRect.y, l
    etterRect.width, letterRect.height)));
96
97          cv::Rect roi( cv::Point( letterRect.x, letterRect.y), cv::Size( letterRect.wid
    th, letterRect.height));
98          //                            printf("x %d y %d width %d height %d \n",letterR
    ect.x, letterRect.y,letterRect.width, letterRect.height);
99          //                            printf("cols %d rows %d\n",wim.cols,wim.rows);
100         cv::Mat destinationROI = wim( roi );
101         letterim.copyTo( destinationROI );
102         QString qs = QString("words/word_%1_").arg(word);
103         qs.append(QString("%1.jpg").arg(j));
104         imwrite(qs.toStdString(),letterim);
105       }
106       catch( cv::Exception& e )
107         {
108           const char* err_msg = e.what();
109           //                              std::cout << "exception caught: " << err_msg <
    < std::endl;
110         }
111       rectangle(wim,Point(x1, y1),Point(x2,y2),Scalar(255,0,0),1,8);
112       putText(wim,word,Point(x1,y1),fontface,0.5,CV_RGB(255,0,0), 1, 8);
113       confidence_level+=conf;
```

```
      j++;
    }
    //}
    delete[] word;
      } while (ri->Next(level));
    }
  }
  //    printf("OCR output:\n%s", outText);
  printf("num lines: %d \n",numlines);
  printf("num symbols: %d \n",j);
  //    printf("confidence level: %d \n",confidence_level);
  if(j>0){
    printf("%d\n",(confidence_level/j));
    imwrite(argv[2],wim);
  }else{
    printf("%d\n",0);
    //imwrite(argv[2],wim);
  }
  //    namedWindow( "Detected Lines", 1 );
  //    imshow( "Detected Lines", color_dst );
  //    imshow( "Result", im);
  //    imshow( "Wim", wim);
  //    imwrite("words.jpg",wim);

  //    waitKey();
  // Destroy used object and release memory
  api->End();
  //    delete [] outText;
  pixDestroy(&image);

  return 0;
}
```

Figure 3: Code by The Scandinavian Institute for Computational Vandalism.

Notes

[1] This essay was first commissioned by The Photographers Gallery for their *Unthinking Photography* series, https://unthinking.photography/themes/machine-vision/ways-of-machine-seeing. The title is taken from a workshop organised by the Cambridge Digital Humanities Network, convened by Anne Alexander, Alan Blackwell, Geoff Cox and Leo Impett, and held at Darwin College, University of Cambridge, 11 July 2016, http://www.digitalhumanities.cam.ac.uk/Methods/waysofmachineseeing; a subsequent workshop, *Ways of Machine Seeing 2017*, is a two-day workshop organised by the Cambridge Digital Humanities Network, and CoDE (Cultures of the Digital Economy Research Institute) and Cambridge Big Data, to be held 26-28 June 2017, http://www.digitalhumanities.cam.ac.uk/Methods/woms2017/woms2017CFP.

[2] *Ways of Seeing*, Episode 1 (1972), https://www.youtube.com/watch?v=0pDE4VX_9Kk. The 1972 BBC four-part television series of 30-minute films was created by writer John Berger and producer Mike Dibb. Berger's scripts were adapted into a book of the same name, published by Penguin also in 1972. The book consists of seven numbered essays: four using words and images; and three essays using only images. See https://en.wikipedia.org/wiki/Ways_of_Seeing.

[3] René Magritte, *The Key of Dreams* (1930), https://courses.washington.edu/hypertxt/cgi-bin/book/wordsinimages/key-dreams.jpg. Aside from the work of Magritte,

Joseph Kosuth's *One and Three Chairs* (1965) comes to mind, that makes a similar point in presenting a chair, a photograph of the chair, and an enlarged dictionary definition of the word "chair", https://en.wikipedia.org/wiki/One_and_Three_Chairs.

[4] The first section of the programme/book is acknowledged to be largely based on Benjamin's essay "The Work of Art in the Age of Mechanical Reproduction" (1936), https://www.marxists.org/reference/subject/philosophy/works/ge/benjamin.htm.

[5] The idea is that "separation" produces a disunity that is disturbing to the viewer/reader — Brecht's "alienation-effect" (Verfremdungeffekt) — and that this leads to a potential "return from alienation". See https://en.wikipedia.org/wiki/Distancing_effect.

[6] To give a sense of scale and its consequences, Facebook has developed the face-recognition software DeepFace. With over 1.5 billion users that have uploaded more than 250 billion photographs, it is allegedly capable of identifying any person depicted in a given image with 97% accuracy. See https://research.facebook.com/publications/deepface-closing-the-gap-to-human-level-performance-in-face-verification/.

[7] Antoine Allen "The 'three black teenagers' search shows it is society, not Google, that is racist", *The Guardian* (10 June 2016), https://www.theguardian.com/commentisfree/2016/jun/10/three-black-teenagers-google-racist-tweet.

[8] Adrian Mackenzie, "The Production of Prediction: What Does Machine Learning Want?," *European Journal of Cultural Studies*, 18, 4–5 (2015): 431.

[9] Mackenzie, "The Production of Prediction," 441.

[10] See, for instance, Antoinette Rouvroy's "Technology, Virtuality and Utopia: Governmentality in an Age of Autonomic Computing," in *The Philosophy of Law Meets the Philosophy of Technology: Computing and Transformations of Human Agency*, eds. Mireille Hildebrandt and Antoinette Rouvroy (London: Routledge, 2011), 136–157.

[11] This line of argument is also close to what Tiziana Terranova has called an "infrastructure of autonomization", making reference to Marx's views on automation, particularly in his "Fragment on Machines", as a description of how machines subsume the knowledge and skill of workers into wider assemblages. Tiziana Terranova, "Red Stack Attack! Algorithms, capital and the automation of the common", *Effimera* (2014), accessed August 24, 2016, http://effimera.org/red-stack-attack-algorithms-capital-and-the-automation-of-the-common-di-tiziana-terranova/.

[12] Mackenzie, "The Production of Prediction," 441.

[13] I take this assertion from Benjamin once more, who considered the question of whether film or photography to be art secondary to the question of how art itself has been radically transformed:
"Earlier much futile thought had been devoted to the question of whether photography is an art. The primary question — whether the very invention of photography had not transformed the nature of art — was not raised. Soon the film theoreticians asked the same ill-considered question with regard to film." https://www.marxists.org/reference/subject/philosophy/works/ge/benjamin.htm.

[14] Berger was associated with The Writers and Readers Publishing Cooperative, aiming to "advance the needs of cultural literacy, rather than cater to an 'advanced' [academic] but limited readership" (From the Firm's declaration of intent). In this sense it draws upon the Marxist cultural materialism of Raymond Williams and Richard Hoggart's *The Uses of Literacy* (1966).

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Brian House

MACHINE LISTENING: WAVENET, MEDIA MATERIAL-ISM, AND RHYTHMANALYSIS

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The first thing we hear: "The Blue Lagoon is a 1980 American romance and adventure film directed by Randal Kleiser."[1] The voice of WaveNet introduces itself with this reference from the Internet Movie Database. WaveNet is a "generative model of raw audio waveforms" outlined in a paper published just last September by DeepMind, a machine learning subsidiary of Google (van den Oord). It is a significant step forward in the synthesis of human-sounding voices by computers, an endeavor which is both paradigmatic of artificial intelligence research and a mainstay in popular culture, from Hal in the film *2001: A Space Odyssey* to voiced consumer products like Apple's Siri. According to DeepMind's own testing,[2] WaveNet outperforms current state of the art text-to-speech systems in subjective quality tests by over 50% when compared to actual human speech—it sounds very good, and no doubt we will be hearing much more of it.

In this text, however, I am not going to explore a genealogy of computer speech. Rather, I am interested in "machine listening." Beyond the sub-field of computer science concerned with the extraction of meaningful information from audio data, that term invokes the knotty questions of what it is to listen, what (if anything) separates listening by machines and by humans, and how listening is entangled with the materiality of the voice. The timely emergence of WaveNet is provocative regarding each of these—it is, perhaps more than anything else, a listening machine. Furthermore, it reveals the limits of a media materialist approach to sonicity, as exemplified by Wolfgang Ernst, when it comes to media that are artificially intelligent. As a corrective, I propose Henri Lefebvre's "rhythmanalysis," a theory of the everyday which helps to take into account the ambiguities of WaveNet.

As far as listening is concerned, the second set of synthesized speech examples provided by DeepMind is the more intriguing. Having been trained to speak, WaveNet nonetheless must be told what to say (hence the IMDb quote, etc). If it *isn't* told, however, it is still capable of generating "speech," but it is "a kind of babbling, where real words are interspersed with made-up word-like sounds" (van den Oord).[3] Listening to these, I am struck first by the idea that this is the perfect answer to the classic campfire-philosophy question, "what is the *sound* of my native language?" When we understand the words, the sub-semiotic character of a language is, perhaps, obscured. This nonsense seems *just* beyond sense, like a tongue somewhat related to English that I do not speak—maybe Icelandic? Secondly, to my ear, this set of examples sounds *more realistic* than the first. I am hearing a certain ennui in these voices, a measured cadence punctuated by breaths and the smacking of lips this is just as expressive as the "words," a performance with the unmistakeable hallmarks of a bad poetry reading. Perhaps the Turing test[4] has been mis-designed—it is not the semantics that make this voice a "who" rather than an "it."

In fact, WaveNet's babbling *sounds* as poetry because it is the same operation: poetic language "*parades* as language while overflowing… the border of signification" (Labelle, *Lexicon of the Mouth* 65). The acoustic additions which both gibberish and poetry draw forth foreground the timbre, rhythm, and inflection of the spoken voice "that cuts and augments meaning" (Fred Moten quoted by Labelle, *Lexicon of the Mouth* 5). If machine speech has been perfectly *understandable* for decades, it is the previous lack of this linguistic excess that has made them unsatisfying as voices. But what goes beyond the semiotic in language indispensably links it to the corporeal, blurring the supposed divide between language and body. Brandon Labelle writes that "to theorize the performativity of the spoken is to

confront the tongue, the teeth, the lips, and the throat" (*Lexicon of the Mouth*, 1) and "it is not the voice I hear, but rather the body, the subject… that does not aspire to be an object" (6). This at once feels indisputable and is deeply problematic when confronted with a media "object" such as WaveNet.

From acoustic knowledge to the materiality of listening

The inclusion of a poetic sense of performance in WaveNet is largely a function of the acoustic level at which it operates. Previous techniques of text-to-speech, as DeepMind explains, are parametric or concatenative. The former is purely synthetic, attempting to explicitly model the physical characteristics of human voices with electronic oscillators; the second relies on a database of sound snippets recorded by human speakers that are pieced together to form the desired sentences. Both strategies proceed from structuralist assumptions about how speech is organized; for example, they take the abstract phoneme as speech's basic unit rather than sound itself—the sound in which that expressive excess is present. Where WaveNet is different is that it begins with so-called "raw" audio—that is, unprocessed digital recordings of human speech at 22,000 samples per second, to the tune of 44 hours from 109 different speakers (van den Oord). This data is used to train a convolutional, "deep" neural network, an algorithm designed to *infer* higher-order structures from elementary inputs. Subsequently, WaveNet generates its own speech one audio sample at a time. An unexpected and intriguing aspect of the result is that WaveNet ends up modeling not only the incidental aspects of speech in the training examples, but even the very acoustics of the rooms in which they were recorded.

This is a form of what media theorist Wolfgang Ernst dubs "acoustic knowledge" (Ernst 179). For him, such knowledge is a matter of media rather than cultural interpretation, and it is embodied in the material processes by which sound is, for example, cut into a phonographic disc. As he puts it, "these are physically real (in the sense of indexical) traces of past articulation, sonic signals that differ from the indirect, arbitrary evidence symbolically expressed in literature and musical notation" (173). A sequence of digital audio samples, though processed as symbolic logic by the machine, nonetheless counts as an indexical trace by virtue that "is not directly accessible to human sense because of its sheer electronic and calculating speed" (Ernst 60).[5] Raw audio is capable, in other words, of recording "not only meanings but also noise and the physicality of the world outside of human intentions or signifying structures." There is some irony that the corporeality of poetic performance lies within such technicity, in the "physically real frequency" (Ernst 173) that is a matter of the signal rather than semantics.

I will provide a personal example. Digging through attic boxes filled with half-forgotten stacks of past consumer formats, an amateur media archaeology familiar to many, I uncovered a reel-to-reel tape recording made by my family in the late 1940s. On it, my grandmother can be heard with a distinct Pennsylvanian accent. This was somewhat of a revelation, some 60 years later, as I had known her as an older woman with no such inflection. Her description to me of that time in her life had to some extent been limited by her telling—it required the temporality of a machine, rather than a human, to reveal the dialect that was inevitably missing from her own narrative. The sonographic resonance was something different than the hermeneutic empathy I drew from her stories.

However, the feeling of time-travel was not solely via the sound of her voice. The warm, saturated timbre and slightly wobbly pitch are not from my grandmother's speaking, but from the recorder itself—material contingencies that comprise the character of such listening machines and which add a historical valence to the sonic events they reproduce. There is, then, also a "style" to a medium, a dialect in this addition. For Ernst, this is simply indicative of how the medium is inseparable from the recording, the confluence of material processes that he encapsulates in the concept of the "event" (Ernst 146). I would go further, however, to posit that the imperfection of the tape identifies it as a *listener*, a body that undergoes a physical change when it hears, a change that is expressed in subsequent enunciations.

If our ability to listen can be defined in this way, as our capacity to be physically affected by acoustics, it aligns with the nature of sound. As Labelle puts it, "Sound is intrinsically and unignorably relational: it emanates, propagates, communicates, vibrates, and agitates; it leaves a body and enters others; it binds and unhinges, harmonizes and traumatizes; it sends the body moving" (*Background Noise*, ix). Sound leaves an impression. *How we* experience it and how we respond to it with our own particular bodies are conditioned by both physiology and past experience that marks us as listeners, whether non-biological or of an ethnicity, class, culture, species. Listening to something cannot just be a matter of source + receiver[6]—rather, it is a material entanglement of these two together.

Direct technical inscription is one such mode, whether by phonograph, tape recorder, or even digital sampler, though that these devices *listen* may feel, admittedly, like a stretch. I want to insist that these machines listen, however, because I think Ernst's focus on technical apparatuses is unnecessarily, and problematically, circumscribed. In the effort to assert acoustic knowledge over symbolic meaning, he sidesteps the material nature of *human* listening. For example, the recent "neural resonance theory" championed by Edward Large observes (via fMRI) that electrical oscillations between neurons in the brain entrain to the rhythmic stimulus of the body by music. Once adapted, these endogenous oscillations can be maintained independently of any external sound. Such an embodied understanding of cognition gives us a model of the brain as a complex oscillator that constantly adapts to its environment. It does this not via some internally coded representation, but as a physical coupling passing from the world to the body to the brain. In this way, the voice that you recognize by its cadence, the familiar acoustic quality of a habitual space, even the song that pops into your head are no more symbolic and no less physical processes than what goes on with the phonograph, even if neurons might not be durable in the same way as vinyl.

Ernst's methodological statement is incongruous with this more generous materialism: "Instead of applying musicological hermeneutics, the media archaeologist suppresses the passion to hallucinate 'life' when he listens to recorded voices" (Ernst 60). Such a call for "unpassioned listening" (Ernst 25) denies the inherent interrelationality of sound. What exactly is listening if the listener is not moved? It replays the detached ocularity—the cold gaze—of colonial naturalism by implicitly claiming an objective "ear" for acoustic knowledge.[7] To the contrary, the contextual cues of acoustics—such as dialect and room sound—that locate a speaker in a physical and social context do so through the mediation of our own past acoustic experience. If media materialism intends to meet the technical on its own terms, it cannot

step outside the web of material—and often warm-blooded—relations the technical is situated within.

The virtual and the aggregate

With that in mind, let's return to WaveNet. Like the phonograph, I am claiming that by virtue of operating at the level of raw audio, it has the capacity for acoustic knowledge. If we could train it on my grandmother's speech, for example, the algorithm would (imperfectly) capture her accent, thanks to its sample-by-sample process. The distance between such a spoken—or babbled—result and a voice recognizable as hers would be the result of WaveNet's own physical character—the equivalent of the pops and hiss of analog media (bracketing, of course, the actual words she might say). I am insisting, too, that this "WaveNettiness" marks it as a particular kind of machine *listener*—one embodied in its processors and programming languages. Compared to the record, this more diffuse physicality already makes it somewhat more difficult to isolate as a technical object. But neither stop at the hardware; my grandmother would also be enveloped in the ensemble that constitutes the corporeality of each.

However, WaveNet, while it records voices, records no enunciation *in particular*. Instead, a voice takes shape through the accumulation of sonic impressions on a numeric topology. In the terms of Deleuze and Guattari, WaveNet's voice is *virtual*—real, because it has one, but not actual in the sense of a groove cut into a record. It is something less, and something more. It is indeed a trace of past articulation—acoustic knowledge—but what WaveNet embodies via training is potentiality rather than indexicality. It is this combination that resists Ernst's easy formulation of sonicity as a material event that is reproducible by technical means. When WaveNet speaks, it does not re-perform a signal, as mediated by its own physical contingencies. Rather, it generates a new signal. And at the same time, this signal is not simply a result of combining cultural symbols from a database of possibilities, as with other new media—it carries poetic qualities which cannot be parameterized, but which are the result of physical processes.

This virtual dimension is a faculty of listening that clearly exceeds that of the phonograph. To give a processual account of the event here is a matter of uncovering not just the contingencies of a single inscription but the enculturation of the algorithm to the repeating patterns of a voice. The acoustics in WaveNet's speech express a prior speaking subject, such as my grandmother—we can hear her, even though she leaves no indexical trace. The danger, of course, is that this originary signal is forgotten entirely. The virtual dimension is invisible to the cold gaze—it requires all our listening faculties to hear the body behind the voice.

This is a critical issue in general when it comes to artificial intelligence. It is seductive to compare an algorithm like WaveNet to, say, a child shipwrecked in a lagoon learning about the world without outside influences, and hence wholly "natural," as alien a nature as that might be. A dispassionate approach masks this fantasy with a robot's cool objectivity. In fact, the complexities of training an algorithm and generating a data set to do it with are anything but straightforward. What, for example, do we hear of those 109 voices? The recordings are from the English Multi-speaker Corpus for CSTR Voice Cloning Toolkit assembled by Christophe Veaux, Junichi Yamagishi, Kirsten MacDonald of the University of Edinburgh.[8] Native English speakers of "various" accents read a series of texts including the so-called "rainbow passage", a rumination on rainbows that traces

interpretations of the phenomenon through a Western lineage of Biblical to Greek to modern scientific explanations. The passage is commonly used to test English speaking skills as it contains nearly all the phonemes in the language.[9] Here, of course, its purpose is inverted—to train rather than test—as a means of outlining the acceptable variance in pronunciation.

This situates WaveNet in a tradition of research that, according to Jonathan Sterne, "seek[s] to overcome the subjectivity of listening" (104). Beginning in the 1920s, institutes like Bell Labs conducted research into human perception to inform the development of WaveNet's technological antecedents. The use of a large number of training subjects is precisely to try and understand sound on a level "that transcends—or subtends—individual subjective experience […] repeatable, verifiable, scientific knowledge that transcends any particular individual in the form of statistical aggregates and probabilities" (Sterne 104). It is worth noting that the sample rate of "raw" audio is based on this kind of laboratory research, the supposed universal frequency range of human hearing (50hz to 20khz) built into audio technology. If digital audio counts as acoustic knowledge, it is nonetheless conditioned by the cultural apparatus of the scientific laboratory, and so requires a cold gaze to overlook. Regardless, the goal is to *normalize* what it is to hear, and what it is to speak, so as to give a foundation to technologies like WaveNet. What we cannot know are the actual identities of the speakers, the conditions of their labor or how they were evaluated, or what English speaking communities they represent, what ages, classes, genders, ethnicities, abilities, and so on, who they were speaking *to*, whether they were free to move around or just sitting in a room[10]—all embodied attributes present in a voice.

Rhythmanalysis

Lacking this, the recourse we have available is to be attentive listeners, ones that specifically pay attention to how the voice—or voices—of WaveNet affects us. This partiality relieves us of treating acoustic knowledge as universal—a self-aware passion should be central to media materialism. Additionally, it acknowledges the bi-directionality of listening which is what is actually at stake. If sound leaves an impression on the listener that conditions future expressions, what is normalized in WaveNet could (will) assert itself in human-machine conversations to come. As the algorithm works its way into the myriad listening and speaking devices proliferating in consumer electronics—Siri (Apple), Alexa (Amazon), Cortana (Microsoft), and Google Now (which thus far has refrained from branding their software with a futuristic/exotic female name)—it will shape the vocal patterns of their human conversants.

What I am proposing is to modulate a media materialist approach with the "rhythmanalysis" of Henri Lefebvre. Lefebvre uses the term "rhythm" in an extra-musical sense, and he is not strictly concerned with sound. But the patterns of everyday speech are a perfect example of the kind of temporal articulations that concern him. Rhythm might be compared to acoustic knowledge as it is a material, rather than symbolic, impression that carries poetic excess. It is also similarly situated within a version of the event: "Everywhere there is interaction between a place, a time and an expenditure of energy, there is rhythm" (Lefebvre xv). However, Ernst's dispassion is contrasted by Lefebvre's warm bloodedness: "We know that a rhythm is slow or lively only in relation to other rhythms (often our own: those of our walking, our breathing, our heart)" (Lefebvre 10)—and our speaking. In this sense, rhythm

encompasses a greater sense of relationality, contingency, and potentiality than a sonicity confined to the technical object.

There are several ways in which rhythmanalysis helps situate a machine listener such as WaveNet. First is that the virtual is inherent to the concept of rhythm. Though rhythm both depends on and is generative of measurable physical phenomena, it is itself an unfolding process that is not materially fixed. We can meaningfully speak about the reality of a rhythm, therefore, even when the indexical trace is absent. For example, the qualities of an accent, or the particularities of someone's gait, or even the pace of a neighborhood or city—to say nothing of the meter or feel of a beat. Notably, these all lend themselves to *relative* rather than absolute comparisons. Conversely, the presence of a rhythm implies that it has been conditioned by actual material occurrences. We get the tongue, the lips, the teeth, or the digital-analog converter and the speaker cone, or even written notation—rhythm does not exist unarticulated.

This brings us to the second point—Lefebvre uses the term *dressage* to describe the formation of a rhythm in the body. He notes that "To enter into a society, group or nationality is … to bend oneself (to be bent) to its ways […]. Dressage can go a long way: as far as breathing, movements, sex. It bases itself on repetition." (39) Lefebvre's theory is primarily one of the everyday life of humans, rather than of media. But this dressage—training—precisely matches the process of machine learning. Iterative reinforcement is fundamental to the construction of a neural network, and serves the purpose Lefebvre describes. That training is neither autogenous nor neutral, but is shepherded toward a constructed norm.

Further, a medium conceived of as a trained body—a *listening* body that undergoes change—is broad enough to include both the algorithm and the phonograph alongside the human. Lefebvre himself opens this potential when he writes that by "bodies" he includes "living bodies, social bodies and representations, ideologies, traditions, projects and utopias. They are all composed of (reciprocally influential) rhythms in interaction." (43) Bringing ideology into physical contact with the enunciations by the humans and machines that produce it does not compromise the nature of acoustic knowledge—rather, it collapses the false bracketing of the political implied by a cold technicity.

As Deleuze and Guattari put it, "Because style is not an individual psychological creation but an assemblage of enunciation, it unavoidably produces a language within a language." (97) This second-order language, this style, this *rhythm*, is what rhythmanalysis brings into play with the listening that conditions it. Ernst's strict division of the semantic versus the technical requires us to repress the very reverberations that make acoustic knowledge significant, the chain of embodied entrainments in which we are co-implicated with the machine. And yet the absence of the machine in Lefebvre's thinking can only be supplied by a close attention to the materiality of technology. To my ear, something like WaveNet therefore requires the interanimation of these methodologies.

Beyond WaveNet

WaveNet is a listening machine. Like a phonograph, it processes "raw" audio, and reproduces raw audio in return. It operates beneath a human conception of what speech "is" and captures instead the acoustic knowledge that actually composes it. That we recognize the quality of that audio as important to a "realistic" voice shows that humans, too, possess a means of acoustic knowledge beyond the semantic—a sense of rhythm. But

we know from Large that the quality of internal oscillation in human physiology is conditioned by the environment—rhythmanalysis demonstrates that how you listen and how you walk, have sex, or use a computer are not materially separable. Likewise, WaveNet introduces its own inflections that are intrinsic to its material situation—training *corpus*, algorithm, hardware, Google engineers. Its speech is a negotiation between human resonance and this embodied machine temporality.

Lefebvre muses how "If one could 'know' from outside the beatings of the heart of […] a person […], one would learn much about the exact meaning of his words" (4). Beating at nonhuman rates, WaveNet both listens and speaks differently. What is it that we hear, then, in the melodrama of its babblings? Though its phonetic poetry is at first hearing benign, it begs the question of what qualities of enunciation it might normalize—who are the voices it listens to? To which listeners does it appeal? And how will speaking with WaveNet voices shape human ears, as they inevitably will?

Notes

[1] https://storage.googleapis.com/deepmind-media/pixie/us-english/wavenet-1.wav.

[2] This testing was conducted via online crowdsourcing. The anonymous, underpaid, typically non-US human labor involved in training contemporary AI systems is an intriguingly problematic method and another example of the extended embodiment of WaveNet discussed in this paper.

[3] https://storage.googleapis.com/deepmind-media/pixie/knowing-what-to-say/first-list/speaker-2.wav.

[4] Alan Turing proposed a test that predicated a machine's ability to think on its ability to imitate a human. This was to be done via teletype—only written language is ever exchanged.

[5] A young human can typically hear up to 20kHz—a sampling rate of at least twice this frequency is required to accurately reproduce the waveform (CD-quality audio is 44.1kHz). WaveNet operates at 22khz, meaning it is limited to frequencies below 11kHz—it is not hi-fi from an audiofile perspective, but that's still pretty good.

[6] Jonathan Sterne calls this the "hypodermic model," adopted by early researchers in telephony technology, that "conceives of communication as primarily a function of transmission, an assumption it would share with the then-emergent metascience of cybernetics" (Sterne 74).

[7] The call for situated knowledges by Donna Haraway is here, as everywhere, instructive—"only partial perspective promises objective vision" (Haraway 581)—and every listening subject hears in a different way.

[8] http://homepages.inf.ed.ac.uk/jyamagis/page3/page58/page58.html.

[9] This public domain text was originally from Grant Fairbanks' the *Voice and Articulation Drillbook* published by Grant Fairbanks in 1937, http://www.york.ac.uk/media/languageandlinguistics/documents/currentstudents/linguisticsresources/Standardised-reading.pdf.

[10] I have noticed that when Alvin Lucier's iconic sound art piece *I Am Sitting in a Room* (1969) is discussed, his stuttering is often not mentioned. This has always bothered me. Jacob Kirkegaard's restaging of Lucier's resonance technique in *4 Rooms* (2006) similarly abandons the personal significance of Lucier's act in favor of the dispassionate "sound of the room itself." That Kirkegaard's recordings were made at Chernobyl makes me wary that what seems to be materialism is actually 'ruin porn' that comes at the expense of sounding out actual material relationships.

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Nathan Jones & Sam Skinner

ABSORBING TEXT: REREADING SPEED READING

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Speed reading applications such as *Spritz* isolate individual words from bodies of text and display them sequentially, often with the middle letter highlighted. Known as Rapid Serial Visual Presentation (RSVP), its proponents suggest it can accelerate reading speed from the average of 100-200 words per minute, to over 1000. This is principally achieved by the visual system reducing the number of saccades involved in 'normal' reading. When reading a word among many other words, for example a line of text, you are reading both backwards and forwards, scanning ahead for words within your parafoveal vision, and back again. The speed reading app *Spritz* declares on its website that: "You'll find that you will be able to inhale content when you regain the efficiencies associated with not moving your eyes to read. And you will no longer move your eyes in unnatural ways." (Spritz).

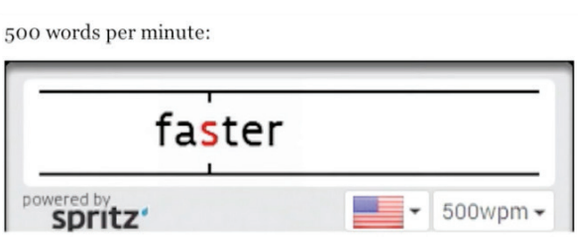


Figure 1: Screenshot from Spritz.

This is a new natural then, where we inhale content, and exhale who knows what. Not so much vapourware, as vaping words. But this invocation of old 'unnatural ways' and new physical and neuronal processes is both the most radical conceptual side effect of this esoteric technology, and the rhetoric that surrounds it. Furthermore, it is important to note that increased speed of reading is only one of the possibilities afforded by the processes of RSVP, and the degree to which comprehension 'keeps up' is questionable, as will be discussed later. In fact, speed reading as a term, application and a commercial enterprise, in the case of *Spritz* and others like it, has essentially appropriated and redirected the science of RSVP toward their own commercial, and one could say accelerationist ends.[1] That such an apparatus is framed in terms of increasing speed and the productivity of the reader, is perhaps unsurprising – in an age where speed and efficiency appear to be synonymous with technological development. There has of course been an increasing interest in speed with social sciences and the humanities in recent years. From the work of Paul Virilio, in particular *Speed and Politics* and *The Great Accelerator*, through to more recent work such as Hartmut Rosa and William E. Scheuerman's book *High Speed Society*. As they observe in their introduction:

> *What was experienced as being extraordinarily speedy just yesterday… now seems extraordinarily slow. The shot lengths in movies, advertisements, and even documentaries have increased by a factor of at least fifty, and the speed with which speeches are delivered in parliament has risen by 50 percent since 1945… Speed dating and drive-through funerals remind us that even basic life activities appear to be speeding up: fast food, fast learning, fast love. (2)*

Rosa and Scheuerman also consider the relations between speed and concentration, one which the aggressively temporal and linear form of the speed reader would seem to actively turn against (or even act as a therapy for):

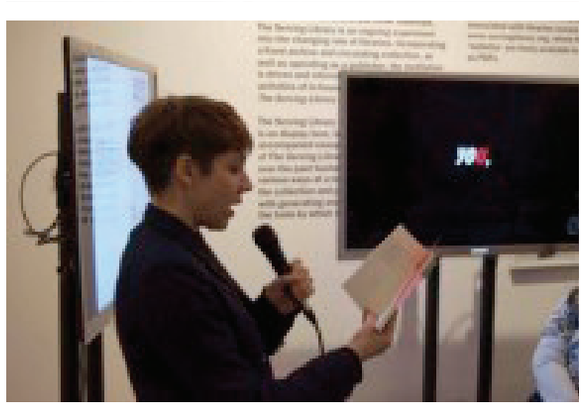
> *the time we're allowed to concentrate exclusively on one thing is progressively diminishing: we are constantly interrupted by a stream of incoming messages, phone calls, television*

> *and radio announcements, or merely by sudden breaks in our flow of consciousness that disrupt whatever activity we happen to be pursuing. (2)*

Rather than turning away from speed readers because of their surface involvement in the equation 'fastness = progress', we examine how this new, temporal form of text might inaugurate a return to the technical and material fundamentals of reading – and what alternative ways of thinking through our relation to new textualities this might offer. This allows us to pose (although not always resolve) questions about technicities and materialities that converge upon the act of reading, but are not reducible to it. The claims made for speed reading applications by commercial companies such as *Spritz* and *Spreader* are weighed against clinical research and set within emerging theoretical frameworks, setting the stage for a critical design and creative practice using and abusing speed reader-type technology. We begin by introducing our initial research to date with this new machinic form of reading, and go on to explore what alternate conceptual and practical applications, beyond simply speeding up for the sake of productivity, it may afford, particularly within poetic, performative, and typographic realms. It should be noted that the text is speculative in character, seeking to articulate and provoke questions, rather than provide answers, which our research has engendered thus far, we hope this approach is fertile for readers.

Torque: Twisting Mind, Language, and Technology

Our experimental publishing project *Torque* [2] has to date performed several applications of speed readers as an art medium. Our first book, *Mind Language Technology* was exhibited at the *Typemotion* exhibition at FACT, Liverpool (Nov 2014 – Feb 2015) in three formats – print, ebook and speed reader – utilising bespoke manufacturing processes, from coding and bookbinding, to artisan woodwork and print-on-demand cushions, inviting the reader to discursively explore the texts, their mediums of transmission, and different modes of reading.



Figures 2 and 3: Installation view FACT, Liverpool, and artist Erica Scourti reading alongside speed reader, at *The Opticon*, Tate Liverpool.

We also used speed readers to display a series of questions relating to issues of privacy and security to gallery visitors during a residency at Tate Liverpool. Set at 1000 words per minute the machinic pace and aesthetic of the speed readers were suggestive of processes of text analytics employed by government surveillance systems that rapaciously 'read' and sift online activity. Artist Erica Scourti and media theorist Christian

Fuchs presented work alongside the speed readers and we produced a newspaper entitled *The Opticon* comprising over 15,000 words of gallery visitors' responses.

Our second book *The Act of Reading*, comprising essays and artworks from authors, including Katherine Hayles and Tim Etchells, was produced as a speed-reader video installation and exhibited at Furtherfield, London, in 2015, for the exhibition *being being read being reading being read and reading beings*. We also presented a 'slow reader' where visitors were recorded reading aloud poems appearing on screen one morpheme at a time, later broadcast across Finsbury Park, where the gallery is situated.

We are currently working with researcher Tom Schofield (who we commissioned to produce an open source speed reading application)[3] at Newcastle University's CultureLab, building on conversations with neuroscientist Alex Leff. The aim is to develop a range of new trajectories for rapid (and slow) serial visual presentation methods which 'weird' this technology, and problematise the progression of reading mediums in general as being solely used and thought about in terms of increased reading speed and efficiency. Exploring instead how they might serve processes of re-learning to read across multiple formats, in multiple modes, digital and print, fast and slow, attentive and discursive, approaching a kind of *hyper-reading* (Hayles, "How We Read"). As a collaborative project, we are particularly interested in three distinct areas of research that speed readers intersect: visualisation, vocalisation and typography. Below we introduce aspects of this research, and close with some questions about the contexts and implications for this specific area of machine research.

Textual Landscapes

Rather than shuffling our eye along the map of information on a page, with speed readers we enter the landscape of information itself. Dropping down the mine shaft of the text, we reach terminal velocity as the foundational materialities of reading vanish from under us.

Speed reading software applications are a recent instance within a long lineage of evolutions of how the written word is consumed and distributed. Mainstream publishing traditions, from parchment to broadsheet to ebook, have primarily placed words into bodies of text in two-dimensional relation on a surface, awaiting scanning by a moving eye. Beyond the confines of the mass media, the serial presentation of words has been experimented with and challenged through a variety of artistic practices, principally, concrete poetry, film titles, and text-based art across print, digital and filmic forms (Scheffer et al.). Digital media in particular, affords new forms of interaction and display, as Katherine Hayles writes, with "the advent of digital technology, writers have more flexibility in how they can employ the temporal dimension as resources in their writing practices… as a machine to organize time." (Hayles, "Digital Poetry" 181). Operating in a hinterland between printed page and digital platforms, new 'virtual reality' texts such as Mez Breeze and Andy Cambell's *Prisom*, float on virtual pages, on virtual planes, within recognisably figurative landscapes.

However much screens, and the software and hardware behind them, may have ruptured the fundamental economies of books, reading 'pages of text' still persists in the form of ebooks, PDFs, web-pages, etc. Perhaps now though, the term 'page' refers more to the screen than printed leaves, becoming a more amorphous and reconfigurable form, but still fundamentally a surface on

which information can be recorded – across, not into, which the gaze moves. Furthermore, the paper page persists as skeuomorphism, as drop shadow hovering at the edges of most onscreen documents, reminders of the ability to print, icons of post-digital textuality, its residual form refusing to be scraped away from our collective palimpsest. The persistence of this skeuomorphism is echoed in speculative and artistic reading apparatuses, designs for which are often dedicated to the task of handling the book-codex, particularly turning pages. As Alessandro Ludovico's work on *post-digital print* has explored and articulated so well, print remains a highly effective interface, and the relationship between print and digital is far from being a one-way street.

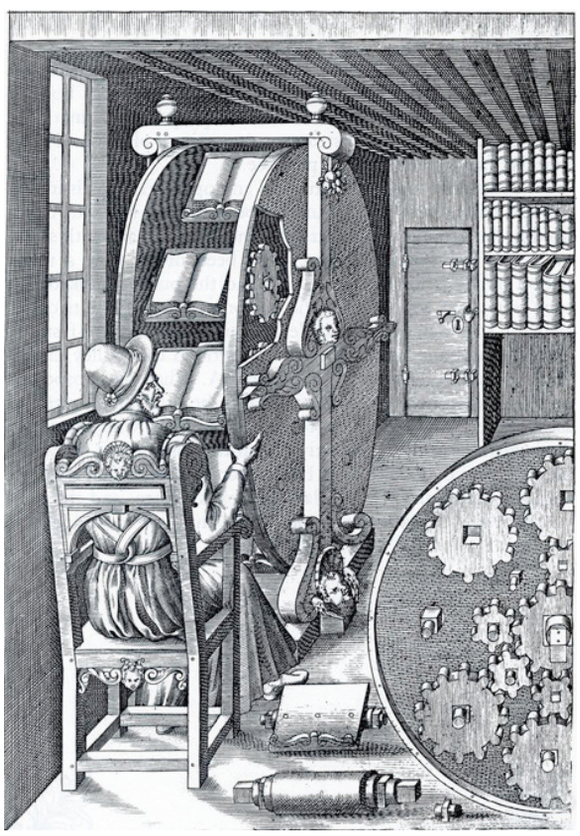


Figure 4: Agostino Ramelli's *Bookwheel*, engraving from Le diverse et artifiose machine, 1588. Reproduced in A. G. Keller, *A Theatre of Machines* (London: Chapman and Hall, 1964).

Figure 5: Rodney Graham, *Reading Machine for Lenz*, 1993.

Speed readers, by eschewing this figurative link with the page as a text map, draw on more primal facilities of the visual system, in particular how it facilitates orientation through landscapes and the ability to recognise objects within; processes that our reading and visual systems recycle for reading, being a much more recent invention (Dehaene). To understand the potency and relevance of speed reading in relation to such contexts and processes, we need to look more closely at the nature of our visual and reading systems.

Speed readers achieve their acceleration of text processing primarily by suppressing the need for eye saccades: the optical twitches back and forth across a text that our eyes perform when reading lines of text. This process appears to be an evolutionary vestige of the way in which we build high definition images of our surroundings. Around 33% of our entire visual system – from retina to the visual cortex in the brain – is concentrated on producing high definition in only 0.1% of the visual field, right at its centre: "When you hold your arm fully extended and look at your thumbnail, that's about the extent of central vision" (Leff 178). Nevertheless, we feel as though we have a high resolution image of the entire field because the visual system casts around, 'sampling' and registering

positions, and reconstructs the whole from these remembered hi-definition fragments (Leff 178-180).

Likewise, in page reading, the intensity of visual equipment is not only guided along horizontally; it also desirously, distractedly, produces minute precognitions of the visual field composed by the page, flashing its optimal visual spot-light not only from the word we are reading to the next word along the line, but also to a spread of locations down the page, before returning. Reading in this way builds up a picture or model of a language world, from many smaller encounters with many individual words, each registered in relation to others on the page. Furthermore, in order for page reading not to blur the text, the brain switches the visual cortex 'off' during an eye movement and on again when the eye settles. Which is to say that reading, and in fact landscape viewing, are themselves rapid and serial in their presentation.

Alex Leff's research at UCL's Aphasia lab has observed that it is these eye movements and on-off actions, or rather the struggle to make them and build up a coherent picture from them in relation to a flat plane of text, which can be a substantial cause of reading disorders such as alexia and aphasia. These ostensibly cognitive disorders are more accurately located in an instability between the interface of muscular and nervous systems. The Aphasia Lab use RSVP to simulate eye movements and retrain the visual system, and have developed web-based therapies, including *Read-Right*, which can help to improve reading speeds in patients with Hemianopic Alexia.[4]

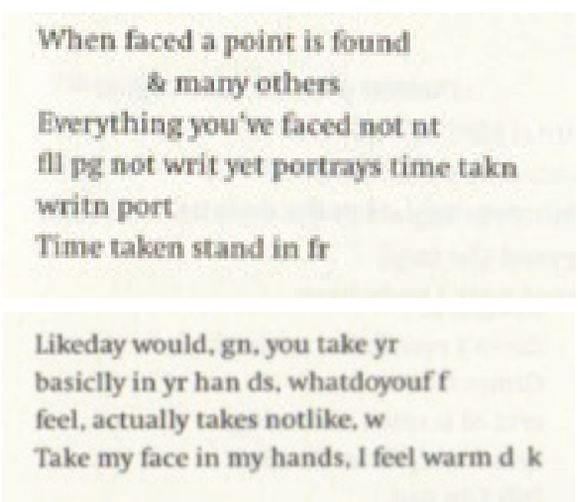
Using the figure of the landscape itself as rapidly and serially presented, we can perhaps better understand this therapeutic quality, and also the feeling of falling through a text we get when we encounter speed readers. Rather than simulating the distracted twitching of page reading, the speed reader produces an always-relevant visual stimulus akin to a landscape rushing by, perhaps a forest of letterforms. Each glimpse of the text in RSVP is a high definition fragment in which an animal or fruit might be seen. This provokes the question, if speed reader technology and associated innovations can help people with noticeable reading disability as in the work of Leff and others, is there a gradient of ability that 'normal' readers can ascend further up? Although the modern page-reading mental apparatus has been trained into a concentration of singular focus, do the eyes themselves lag behind in an integral archaic distraction?

Subvocalisation

Commercial apps like *Spritz*, redirect the science of RSVP and Optimal Viewing Position toward what they claim is a more fluent, focused experience, that smoothes over disorders by requiring less physical engagement of visual or subvocal systems. The tagline on *Spritz*'s website reads: "Reading Reimagined. Improve focus, completion, and fluency. Enjoy a pleasurable, effortless reading experience." Writer Colin Schultz in something of a puff piece on the technology wrote that the: "the process feels less like reading and more like *absorbing the text*". To which we might add: or is it the text absorbing us? And furthermore, is speed reading just a spectacle of reading, that enables the eye to better register and perhaps to 'complete' more texts, but at the expense of comprehension and the textual sensorium?

The saccadic twitching of the eye is accompanied and echoed by the subvocal twitching of the throat, called subvocalisation – also subdued in the speed reading experience, where increased speed results

in a decrease of the 'inner voice' we hear when reading. Literary scholar Steven Connor observes "what readers may feel as a sounding in the mind may be due at least in part to the effect of very small impulses sent by the brain to the larynx and the tongue" (Connor 106) – and presumably also these impulses bouncing-back to the brain. This subvocal physical encounter with texts is a point of material empathy with the author, whose writing process was accompanied by the impulses in the larynx approximating the words they write. Poet Caroline Bergvall's text *About Face* refolds the pain of a "sutured jaw" that she suffers while performing, back into a poetic text. The poem that results is a kind of pseudo-transcription of the disfluencies, aposiopesis, and gasps of speaking with a faulty jaw, made-textual by disordering and removing letters, and adding gaps into the middle of words.


When faced a point is found
& many others
Everything you've faced not nt
fll pg not writ yet portrays time takn
writn port
Time taken stand in fr

Likeday would, gn, you take yr
basiclly in yr han ds, whatdoyouf f
feel, actually takes notlike, w
Take my face in my hands, I feel warm d k

Figure 6: Extracts from Caroline Bergvall's *About Face* (31-45).

About Face emphasises the bio-technical, subvocal – and perhaps saccadic – apparatus of reading as a kind of empathic struggle that echoes Bergvall's own pain and struggle with enunciation. The poem's meditation on faces, by its emphasis on the mediation of Bergvall's own face, lend it an intimate quality.

We might observe then that subvocalisation, repressed in speed reading, is a vital part of the sensuous quality of a poetics. But perhaps, like a child moving her lips as she reads, the subvocal is something we have outgrown. Connor muses "that our difficulty in describing [the internal voice's] qualities is due to the fact that we are hearing its last dim spasms and whispers. Perhaps, following the stilling of our external lips, we are undergoing a slow quelling of the internal voice" (106). The speed reader then may not be a premature technical closure of our sensual embodiment of language. Rather, a symptom of reading itself shedding these unnecessary evolutionary vestiges, a sublimation no less.

In this sense, speed reading pushes against our physical and cognitive capabilities, amplifying or awakening certain physical responses, such as blink reflexes and iris contraction, just as it subdues subvocalisation and eye-saccades. Are some of these responses more useful for a future reading? If this is so, we might ask: what will the formal qualities of our future literature be, at the level of assonance and consonance, for example? How does rhythm enter into the semiotic regime now that a text engulfs us, rather than an ocular drift, back and forth across a body of text? Furthermore, with speed readers, do we enter the text, in a mode approaching a trance state? Is this a realm in which the distractions of self-reflection and self-awareness are occluded, or appear only as spectral undefined borders? Could this bodiless, and selfless reader be the foundations for a new literary subject?

Text Comprehension and the Materiality of Type

A recent review paper on speed reading applications suggests that users are unable to increase the speed of reading whilst still

maintaining proportionate levels of comprehension (Rayner et al.). At best, studies have shown that readers may still be able to comprehend individual sentences at increased speed, but at worst they can render reading slower than standard rates: "Successful reading thus requires more than recognizing a sequence of individual words. It also requires understanding the relationships among them and making inferences about unstated entities that might be involved in the scenario being described." (Rayner et al. 5). Furthermore, the assertion by makers of apps such as Spreader and Spritz that eye movements and saccades are wasted time does not stack up, because cognitive processing continues during saccades, and "devices that present words faster than readers' natural pace may run the risk of presenting a word before the brain is prepared to process and understand it" (Rayner et al. 8-10). Additionally, reducing the inner sounding of words, or subvocalisation, as suggested by proponents of speed reading, who deem it linguistic loitering or neuronal negligence, has an adverse effect upon reading because "translating visual information into phonological form, a basic form of language, helps readers to understand it" (Rayner et al. 16). Finally, the onward recursive march of speed reading apps do not allow readers to easily go back or reread certain parts of texts and accordingly makes misinterpretation more likely (Rayner et al. 17).

Proponents of speed reading decrying regressive eye movements, the sounding of words, alongside a championing of speed readers' ability to make quick and correct inferences at all times, is suspiciously ideological, and runs the risks of enacting an almost vitalist or techno-positivist critique of bodies, both human and textual. But if we put aside increased speed as a focus of their use, the space of increased legibility and readability offered by the technics of speed reading might enable the catalysing and disruption of other areas of the reading experience. Beyond simply increasing speed, new possibilities emerge regarding content, typography, and the physical space we occupy, and that text occupies in us, when reading.

Experiments with typography and speed reading offer certain affordances to explore both the fundamentals of reading and to push it into more divergent or liminal territory: investigating where the limits of legibility may lie, what machinic systems of computation and display may enable or replace, and how in turn this might affect our mediation of and with the world. Recent work by theoretical neurobiologist Mark Changizi observes that human visual signs possess a similar signature in their configuration distribution, suggesting that there are underlying principles governing their shapes. He provides an ecological hypothesis that visual signs have been culturally selected to match the kinds of conglomeration of contours found in natural scenes because that is what we have evolved to be good at visually processing (Changizi et al.). This body of research suggests that the words you are reading now look this way because they resemble the contours found in natural scenes, thereby tapping into our already-existing object recognition mechanisms.

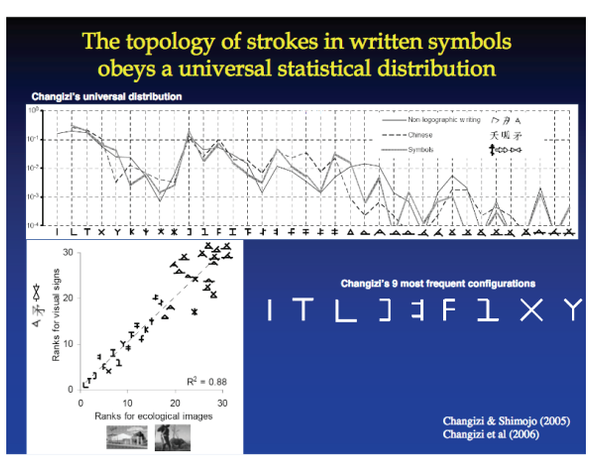
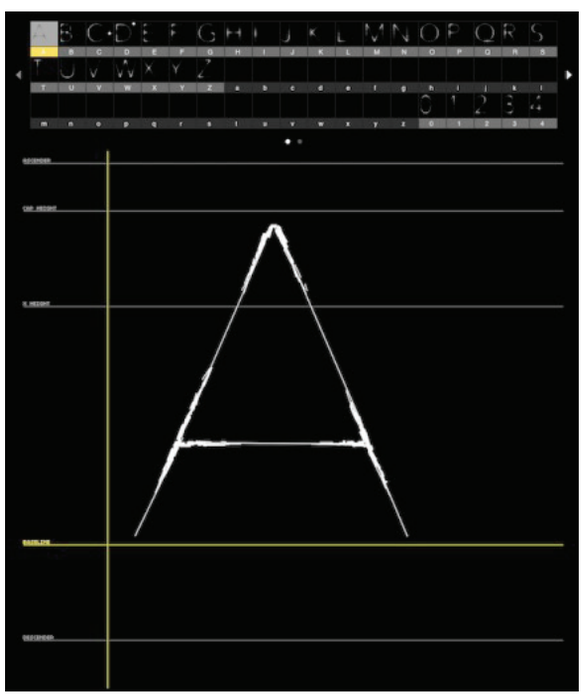


Figure 7: Slide reproduced courtesy of Stanislas Deheane.

Furthermore, the reading system synthesizes not only external worlds but internal ones too, recycling both the natural landscape and our visual system to new ends. The neuronal recycling hypothesis implies that our brain architecture constrains the way we read, and has functioned as a massive selection process, where over time, writers and designers have developed increasingly efficient notations that fitted the organisation of our brains. Cognitive Psychologist Stanislas Dehaene argues our cortex did not specifically evolve for writing, rather, writing evolved to fit the cortex and to be easily learnable by the brain.



Figures 8 and 9: Images of *Torquera* typeface by Sam Skinner.

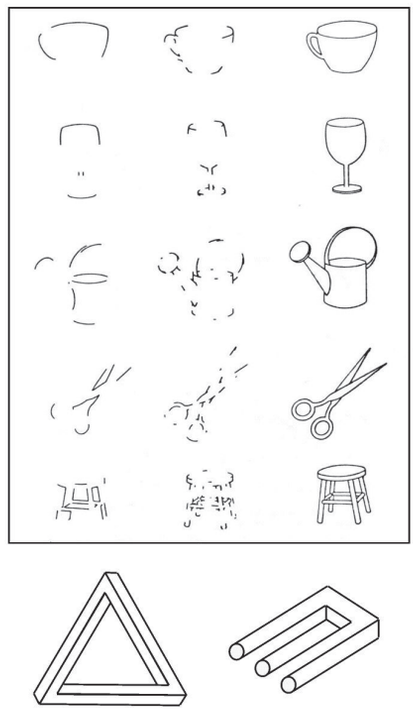


Figure 3.7. Complex objects are recognized through the configurations of their contours. At the places where they join, these contours form reproducible configurations shaped as T, L, Y, or F. If these junctions are erased, the images become much more difficult to recognize (left column), whereas deletion of an equivalent amount of contour that spares the junctions causes much less difficulty (middle column) (after Biederman, 1987). As soon as an organized set of contours is present in the image, even if it does not form a coherent whole, our visual system cannot help but perceive it as a three-dimensional object (bottom).

Figure 10: Courtesy of Stanislas Deheane, from *Reading in the Brain*.

The typeface shown (Figures 8 & 9) is designed to be used with a speed reading application, and accentuates the areas of letters where contours intersect. As discussed above (and demonstrated in Figure 10), the visual system recognises objects through the configuration of their contours. Where these are accentuated or removed they become easier, or conversely more difficult, to recognise. This typeface combines this aspect of visual recognition with the increased legibility of type in RSVP, creating a textual encounter that is both more and less legible, experimenting with the possibility and affordances of a kind of liminal reading: a reading on the edge of different physical, typographic, and neuronal systems.

Researching the phenomena of reading as a composite machinic system enables a kind of meta-reading of the world beyond

words, where text becomes a microcosm and interstice of other systems, providing unique answers to the fundamental questions: why does text look the way it does? Why does writing consist of such a number of strokes, arranged in such a way? Where might the genesis of these fundamental qualities of textuality itself lie?

Within the context of Machine Research – which we understand as a field of enquiry that asks how both the human and nonhuman is put into a critical perspective by machine driven ecologies – how might text or the technics of reading be seen in machinic terms as an apparatus operating between worlds? And to take this one step further, how might the machinic be driven by more fundamental exigencies of matter – where matter precedes agency, both human and technical? Can these processes, these machinations, be seen in terms of an engine at the heart of life, fundamental to and transferring energy between systems? Iris van der Tuin and Aud Sissel Hoel describe in their diffractive reading of philosophers Ernst Cassirer and Gilbert Simondon, the "ontological force" of technological apparatuses. Writing that "what takes Cassirer's and Simondon's accounts beyond the terrain of relational and processual approaches, is their insistence on an irreducible third ingredient in the ontological entanglement: *Technicity*" (188), where "the human/nature mangle [is] essentially mediated by tools or technological objects" (190).

An instance of this entanglement as co-constitution is suggested when we look at the evolution of language, tools and cognition; where it matters less which came first as each co-constitutes and catalyses the other in a continual process of becoming (Gibson and Ingold), trading places, entangled, one in the other. As such, each can be perceived as being as alive as, and alive to, the other. Speed reading as we have framed it, can be studied as another fork in this process of differential re-becoming: a McLuhan-esque moment of 'retribalization' perhaps, where the speed reader returns the reading subject to an animalist state of orientating through a landscape and cognizing objects within.

Through the machinic processes used to both analyse and evolve our reading systems, old divisions between nature and culture fall away, becoming another iteration in a long line and tangled web of linguistic evolutions. Perhaps, we might rethink them and refer to speed reading machines instead as *rereading* machines, where their rapid recursions offer a more performative means or third space to mediate new textual landscapes, finding a home and use within the aesthetic domain, less accelerationist, more experimentalist. After all, machines have the advantage of not having to recycle old neuronal systems like humans do, and present new ways to read and write, forming ruptures in the possible we describe as new media. Perhaps speed reading machines serve as an interface, a kind of machinic empathy operating between web crawling bots and spiders rapaciously indexing the web, and our own skimming of inboxes or abstracts. Or is speed reading rather a symptom of trying to keep pace with machines? Whatever the answer, the limits of reading speed, and crucially also of comprehension are important markers, delineating the difference between page turning and reading. Furthermore, how we write into and for, new forms of reading, holds significant potential. Both reading and writing are mediated by machines, but as Sean Pryor and David Trotter remark, "the converse… is equally important: writing mediates technology." (10). Accordingly, new literacies, new writing, and new forms of reading must in turn mediate machines and our agglomeration with them.

Conclusion

So where next? And what is the role of *Torque*, here operating as a public research project, and our role as people who are inherently skeptical of narratives portraying history as a succession of ever-faster ever-more-efficient technologies – and nevertheless awake to the therapeutic and speculative potential of reading machines? As ever, the answer is not to ignore this new technology, but to explore its embedded strangeness. We propose that speed reader technology might indeed play a part in navigating contemporaneous evolutions in computational culture and new modes of reading. After all, the speed reader itself is merely one example of a tendency for media to flow forward, often with little concern for the past. Twitter streams, 24 hour rolling news coverage, and the notion of the status update – a new self every time – are other associated phenomena of the contemporary reading subject.

We have observed our own tendency to become distracted while reading long form writing online, and this is a common complaint. In a study of hypertext in pedagogy, Gail A. Hinesley notes that researchers have found evidence of "cognitive overload" and "a haphazard, hypertext-structured thought process" resulting from this common form of online text (Hinesley). The potencies discussed in this paper, of the speed reader and of the body as revealed by speed readers, might help us to disentangle the relation between this distraction, the digital-age mind and reading itself. Plato famously decried writing for its potential ill effects on memory and verbal communication, but was there ever a time different to now, when technics arrived without deleterious, corrupting effects? By producing our own speculative *technicity* in collaboration with others, we seek an alternative platform by which reading itself can be reassessed as a component activity of contemporary thinking and being-with the world.

Notes

[1] *Accelerationism* is a term coined by Benjamin Noys, to refer to the political ideology of embracing Capitalism's tendency towards destructive speed. In recent years, there has been a split between "left-accelerationist" theorists such as Alex Williams and Nick Srnicek (2013), and the "right-accelerationism" of Nick Land, who suggests that rather than using the collapse of capital to improve social conditions, we should embrace accelerated flows "precisely for its inhuman, violent, and destructive power" (Shaviro 2015). Both of these trajectories place an emphasis on the increased opportunities offered by technological innovation, to revolutionise social relations. By making the equation of neoliberal-accelerationism here, we observe that the accelerationist ideology in technology-entrepreneurial culture has the tendency to value the financial benefits of an innovation over its particular usefulness or contribution to people's well-being.

[2] See project website here: http://www.torquetorque.net/.

[3] Made using *Processing* and available here: https://github.com/tomschofield/speed_reader.

[4] For further details, see: http://www.ucl.ac.uk/aphasialab/alex/home.html.

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MACHINIC SYSTEMS OF CONFLICT

John Hill

DON'T JUST SIT THERE SHOUTING AT THE TELEVISION, GET UP AND CHANGE THE CHANNEL: A NETWORKED MODEL OF COMMUNICATION IN THE CULTURAL POLITICS OF DEBT

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In his closing remarks from the first episode of the 1972 television series *Ways of Seeing*, the writer and critic John Berger urges the viewer to consider what he has shown them – a visual essay arguing that reproduction has changed the way we see painting such that images have become a form of information – but to "be sceptical". He tells viewers to be wary of their passive acceptance of the one-way broadcast medium and that only when access to television is "extended beyond its present narrow limits" can there be dialogue within modern communication media. Immediately following this a title card explains that many of the ideas in the programme are taken from Walter Benjamin's essay "The Work of Art in the Age of Mechanical Reproduction".

This short section of the film contains at least three ideas of what communication is and can be. This essay will discuss these different models of communication — dialogue, broadcast and networked — and, following the work of cultural theorist Tiziana Terranova, show how they appear in and influence contemporary politics. In the final section it will build on the work of Maurizio Lazzarato and attempt to show how the networked model of communication, when applied to our understanding of debt relations, might help us think differently about the politics of debt and potential for political action within networked debt relations.

Dialogue, broadcast, network

The dialogue that Berger calls for is an example of what Terranova describes as the "traditional conception of the dialectical game" using "argument involving the interplay of truth and persuasion" (*Network Culture* 15). In its production style, however, *Ways of Seeing* shows that Berger is acutely aware of the "means of reproduction" he is using. Far from being a conversation, the form of communication provided by television is more the type described by Claude Shannon's "Mathematical Theory of Communication".

Shannon is perhaps best known for his diagram of the communication process, comprising a "source, a transmitter, the message, the channel of communications and the receiver" (Terranova, *Network Culture* 14). The transmitter must encode the message in to a form that can be carried by the channel and then successfully decoded by the receiver. Developed to address the specific problems of how signals become distorted by their own physical properties — for example, the electrons carrying the current in a wire — Shannon's innovation was to apply the statistical techniques used to model thermodynamics to the uncertainties of communication. With this he was able to formulate the maximum amount of information, of any kind, that could be sent down a channel (Shannon and Weaver 18). The mathematical model of communication did not concern itself with the reduction of noise or the amplification of signal, but instead sought to maximise the efficiency with which a channel could be used, concerning itself with what Terranova calls the "minimum condition of communication" (*Network Culture* 17).

Berger acknowledges, and plays with, the power that broadcast gives him, but that power is in part based on how the relationship of sender to receiver is conceived. As Terranova points out, in mathematical communication "interlocutors… are *assumed* to be on the same side" (*Network Culture* 15), and therefore broadcast is fundamentally reliant on a receptive audience, one already open to the message. In order for this to be achieved, and for the statistical properties of the message to be maintained, sender and

receiver must necessarily have an existing understanding of what the possible messages will be, allowing then to separate signal from noise.

It is this limitation of possible messages that Theodor Adorno and Max Horkheimer critique in their essay *The Culture Industry*. Contrasting the liberal, dialogical, two way communication of the telephone, and the type of subjectivity that it could produce, they see broadcast as inherently limiting, turning participants into listeners and subjecting them to "programs that are all exactly the same" (Adorno and Horkheimer 121). For Adorno and Horkheimer, the power of the culture industry lay not simply in its control of mass media, but in its ability to define and construct the receiver, "classifying, organizing and labeling consumers" (123). Using statistical methods with the same roots as those used in thermodynamics and information theory (Terranova, *Network Culture* 28), consumers are corralled into categories that reflect the broadcaster's pre-conceived ideas about who they are and what they want. The result, or at least the desired effect, is that responses become "semi-automatic" such that "no scope is left for the imagination" (Adorno and Horkheimer 127).

Berger's call to open up broadcast media might be seen as a call for a return to liberal dialogue such as that offered by the telephone but his understanding of the informational quality of the reproduced image suggests another important aspect, or consequence, of information theory and its basis in statistics. Although, if properly encoded with an appropriate redundancy, a message can be accurately decoded with a high degree of probability, information theory does not guarantee being absolutely sure. Rather than being a reproduction or representation of the information source, the message received always has a probabilistic relationship to the message sent. It is not possible to determine absolutely if a signal is decoded to the same message that was originally encoded. The audience may "receive images and meanings which are arranged" in the case of Berger, but they are able, and in this case encouraged, to interpret them differently, just as the programme examines not "the paintings themselves… but the way we now see them". In this way Berger's television series, and subsequent book, are examples of the shift, away from the primacy of transmission in understanding culture, to the importance of reception. While the Frankfurt School approach of Adorno and Horkheimer focused on the production of mass, broadcast culture, work done by the likes of Stuart Hall turned its attention to the possibilities that lay in the "difference between the encoding and the decoding" (Wark). Rather than facilitating the 'minimum condition of communication' here, information operates as a form of *disconnection* between the sender and receiver, allowing for positive creativity in the act of reception. The failure of television to become a dialogical media of the type Berger had called for — either through public access cable or the 'algedonic' viewer feedback systems of cybernetician Stafford Beer (Pickering 269) — meant that "resistance to media power had to be located in the viewer" (Terranova, "Systems and Networks" 117)

If Adorno and Horkheimer were more focused on the transmission of culture, and Hall's cultural studies on its reception, more recent work by Terranova and others turns its attention to the systems that connect the two, the channel or channels and the information itself. Drawing on the work of Gilbert Simondon, she describes an *informational milieu* in which meaning is "increasingly inseparable from the wider informational processes that determine the spread of images and words, sounds and affects" (*Network Culture* 2). How, she asks, "can we still believe

that information simply flows from sender to receiver (or from producer to consumer) without any of the noise, indeterminacy, and uncertainty having any effect on the process at all at some level?" ("Communication beyond Meaning" 67) Instead of simply the connection of pre-existing sender/receiver nodes, Terranova sees communication as occurring between what Simondon identified as pre-individuals. Information acts as an individuating force, creating the nodes through the act of connection, but never fully defining or describing them, such that divergent and conflicting tendencies and potentials of the pre-individual remain. As a consequence, unlike the statistical stability of thermodynamic systems, all connections, including measurement of the sate of the system, have effects that determine and delimit the things that are measured. Every measurement, being both within the system and itself probabilistic, has the perverse effect of multiplying indeterminacy; "the more knowledge is generated about the system, the more the uncertainty." (Terranova, "Systems and Networks" 124). In unstable systems like the milieu of networked communication, measurement of a channel's indeterminacy — its signal-to-noise ratio — is never enough to insure a signal's lossless transmission. Indeterminacy can never be fully accounted or compensated for.

For Terranova, however, information's disconnecting effect doesn't simply render it self-referential, socially constructed, without "anchorage to any social or bodily referent" ("Communication beyond Meaning" 62) and therefore without meaning. Unlike representation or signification, which find their meanings in relation to other images and signs, information's meaning exists in its relation to a material reality that can be both "observed and experimented with". Like the "asignifying machines" that Maurizio Lazzarato develops from the work of Félix Guattari, information is non-representational, creating "diagrams" that act "directly on material flows… functioning whether they signify something for someone or not" (*Signs and Machines* 40). Although neither linear nor deterministic, the meaning of information lies in its function, its effects on the material world through the "chain of events by which it is set in motion and which it sets in motion" (Terranova, "Communication beyond Meaning" 66).

Suhail Malik's critique of what he calls the "statistical-quantitative model" (31) of information proposes a similar basis for meaning in a material reality. For him information's meaning must be "situated" — only meaningful within a system — and ceases to be information outside of it (35). Malik emphasises the necessity for a system's capacity for mutable memory in order to give information a meaningful context. It is not, however, that memory is the store of pre-defined possibilities that the information selects from, as with the mathematical model. Rather memory, at its most abstract level, is the organisation of the system itself, while information is the ongoing production of meaning through the alteration of the system's structure (Malik 46) . Here we can see a connection to the autopoietic theories of Humberto Maturana and Francisco Varela, not only in their emphasis on organisation over structure — the relations between components rather than the components themselves — but also on the role of the observer in the production of meaning (Maturana). In Malik's description the system's memory has the function of self-observation, allowing changes in structure to be meaningful in relation to a persistent organisation.

Both Terranova and Malik view information's interaction in unstable systems — its capacity to both reflect and affect, determine and individuate — as giving it the potential to produce new forms of organisation and new meaning, an "active power of invention" (Terranova, "Communication beyond

Meaning" 68). Meaning is both determining of and determined by the whole of the system, and necessarily situated within it. Thus what Terranova calls the "cultural politics of information" — the struggle over what it is that the systems of networked communication do — must be orientated not simply to the nodes of transmission and reception but to the entire network of communication. This necessitates a "questioning of the codes and channels that generate the distribution of probabilities" and requires "renewed and intense struggle around the definition of the limits and alternatives" (*Network Culture* 25)

Political Communication

How communication is understood, how it is modelled, is one of the ways in which the distribution of possibilities is determined, and alternatives rendered more or less likely. Dialogical, broadcast and networked communication all open up and close down certain possibilities. Terranova describes the broadcast model of political communication as imagining a "circuit between the TV screen, the newspaper headline, and the ballot box" ("Communication beyond Meaning" 60) where the job of the 'communications manager' is to amplify the signal to drown out the noise. Political messages are reduced — compressed — to messages with a redundancy that fits the channel, for example Tony Blair's insistence in his 1996 Labour Party conference speech that his priorities for government were "education, education and education", a soundbite with meaning that would be hard to distort no matter how noisy the channel. The current leader of the British Labour Party, Jeremy Corbyn, has been criticised for his media strategy (Greenslade; Freedman) but this might in fact be a result of a conception of communication as traditional dialogue, communication intended for public meetings rather than televised speeches and interviews. His opponents in the Labour Party continue to follow a 'Blairite' media strategy, yet lacking a message beyond their opposition to Corbyn's leadership they are reduced to producing noise, disruptive signals that fills up the media channels and blocks Corbyn's ability to communicate anything (Rayner). The current British Foreign secretary, Boris Johnson, writing the the *Daily Telegraph* in 2013, describes this disruptive strategy, quoting Conservative Party campaign strategist Lynton Crosby, as "throwing a dead cat on the table, mate". No one is going to talk about anything except the cat.

While Terranova suggests that strategies like these show an understanding of information as networked — seeing it as passing not simply from sender to receiver but along a complex chain of of connections, each of which might alter the message ("Communication beyond Meaning" 67–68) — they still operate with a focus on broadcast's minimum conditions, establishing connection. Recent political events seem to suggest that the domination of politics by broadcast communication is no longer certain. Jeremy Corbyn was re-elected Labour Party leader, and Hilary Clinton, who 'won' each of her televised debates (Saad), was not able to secure enough electoral college votes to win the presidency. The circuit between TV screen and ballot box seems broken, or at least much less closed than in once was. One explanation for this lies in what the broadcast model is unable to account for: nonlinearity. In nonlinear network communication, Terranova identifies "non-proportionality… between input and output, a tendency of systems subjected to amplification to produce deviations and distortions". Drowning out a competing message, with either signal or noise, can lead to "feedback or retroaction—cynicism and anger" that can produce effects at the "biophysical

processes of affection" ("Communication beyond Meaning" 60). To understand the erratic, nonlinear language used by Donald Trump as simply noise disrupting Clinton's signal fails to grasp its function to connote an open, probabilistic relation to meaning that seeks not to transmit an undistorted, or undistortable, message but to create a distribution of possibilities that delimit alternatives (Prasse-Freeman). Trump's statements may not be true, but the possibility of their truth becomes available, where previously it was excluded.

Understanding political communication using a networked model is not simply a case of opposing linear with nonlinear communication, of mainstream media with social media, or television with the internet. Rather it is about seeing the whole of the communication system as complex, unstable and indeterminate. Networked communication includes within it both broadcast and dialogue but does not separate them out. Each part of the system has the capacity to determine the potential of the other, with meaning a product of the change they effect on the system as a whole. Understanding broadcast as existing within a networked model reopens the potential for invention that the statistical model of information must foreclose in order to function. The politics of broadcast communication is necessarily hegemonic and, like the hegemony of Chantel Mouffe, "predicated on the exclusion of other possibilities" (Mouffe). The politics of the open network neither requires nor seeks hegemony, instead possessing "a material potential for dynamic transformations… that neither the liberal ethics of journalism, the cynicism of public relations officers, nor the theory of cultural hegemony can really address" (Terranova, "Communication beyond Meaning" 70)..

Diagrams of Debt

In this final section I wish to consider another area where the cultural politics of information makes itself apparent and discuss how a networked model of communication might allow us not just to understand the contemporary cultural-political situation but act upon and affect it. Drawing on the recent work of Lazzarato — which emphasises the dual role of debt and machinic, asignifying systems in the management of populations — I wish to question how he constructs and uses models of communication and how an alternative conception of financialised debt might lead to a more open and active field of political action.

In *The Making of the Indebted Man* Lazzarato provides detail on how debt exploits "non-chronological time" — nonlinear and indeterminate — mutable by choice, decision and action. "Granting credit" he says, "requires one to estimate that which is inestimable — future behaviour and events — and to expose oneself to the uncertainty of time" (45). In order to do this profitably, the same statistical methods found in thermodynamics and information theory are applied to determine the creditworthiness of an individual. Financialisation, he says, is the mechanism for managing debt, and the debtor-creditor relationship, with finance "controlling the temporality of action" and locking up possibilities "within an established framework while at the same time projecting them into the future" (*The Making of the Indebted Man* 71). Much like the statistical delimiting of sender-receiver communication, he views finance as setting limits on the potential for a break in the linear relation of the present to the future. For him "debt simply neutralizes time, time as the creation of new possibilities… the raw material of all political, social, or esthetic change" (*The Making of the Indebted Man*

49), with this "foreclosure of alternatives, aggressively and subtly pursued at all levels by neoliberal governmentality".

For Lazzarato debt plays a key role in the individuation of subjects, acting to balance the powerful desubjectivising forces of asignifying "machinic enslavement" (*Signs and Machines* 25). This enslavement draws on the 'molecular' pre-individual components of subjectivity and puts them to use as components of a larger systems. Debt's role is then to reterritorialise 'molar' subjectivity that can be held accountable, for example in the form of the entrepreneurial subject of "human capital" impelled to take on "the risks and costs for which neither businesses not the Sate are willing to pay" (*Signs and Machines* 53).

In a similar way to Lazzarato, Michel Feher sees debt relationships as being key to the formation of contemporary subjectivity — what he calls the neoliberal condition — but understands this as based in the drive to maximise our credibility, creditworthiness, or self-esteem. Rather than an entrepreneurial conception of human capital, this financialised subject aims to maximise their potential future value upon which credit can be given, never seeking to determine or realise that value in the present. For Feher, credit-seeking is also a process of individuation and subjectivisation, attempting to maximise self-worth in order to be seen as worthy of credit (*Thank You for Sharing*), but this is always based on a potential, rather than determined future.

Feher sees indeterminacy as an essential component of entrepreneurial capitalism, one that the neo-liberal project was trying to rescue from risk-averse, or risk-mitigating, social democracy (*Improve Your Credit*). While credit-scoring attempts to estimate a person's future worth, and uncertainty of that future occurring, its function is not to limit risk but to price it; any risk can be taken as long as it is quantified. Financial instruments, such as debt insurance and credit default swaps, re-sell the uncertainty that remains in the credit-debt relationship, with derivatives of a debt then used to mitigate, spread and often conceal risk (Simkovic) rather than eliminate it. While debt can operate in the way Lazzarato suggests, as a promise of the continuity of the future with the present (*Signs and Machines* 48), finance makes no promises, rather it is a machinic diagram, structuring the multiplicity of indeterminate futures to maintain profit, and power, whatever the outcome.

While Lazzarato and Feher are in agreement about the subjectivising effects of debt, there may be differences in their positions on quite what those effects are. Feher sees the indebted, or rather credit-seeking subject, as a "portfolio manager… of the self" where different parts of the self can be offered up for evaluation. Whereas, in his recent work on asignifying semiotics, Lazzarato describes how "the component parts of subjectivity function as inputs and outputs of the 'television' assemblage" (*Signs and Machines* 47) but sees debt's function as the regrouping of these parts into an individual subject. Lazzarato's reference point for communication is almost always broadcast. His earlier writing on television views it, just like debt, as an apparatus for neutralising political events and subjectivities (Toscano 84). While the machinic assemblage he describes in part resembles the network model of communication proposed by Terranova, its 'television' qualities remain in its structure of inputs and outputs. For Lazzarato debt is an input into the asignifying financial machine, where it is "torn to pieces" and reassembled as an output of capital (*Signs and Machines* 48). Seen in this way Lazzarato's network assemblage is simply a complex channel to transmission, a component in what remains Shannon's model of transmitter-channel-receiver.

If, as I have argued above in the case of political media, you reverse this model, to view linear transmission as a component of the network, then the debt relations appear much more like communication in the informational milieu than the linear transmission of broadcast. Debt remains subjectivising, acting like Simondon's communication to creating the nodes of the network, but there are no inputs or outputs. In this model the 'manager' of self described by Feher is not external to the network but already a part of it, individuating and subjectivising through the creation of connections between parts, entering into financialised debt relations by allowing more and more of those parts to be measured, evaluated and credit-scored.

In my view Lazzarato's modelling of debt as broadcast, establishing a connection between creditor to debtor, is no longer sufficient under debt's financialisation, based as it is on the instability of the present's connection to the future. Rather than its ability to foreclose possibilities, we should see the power of finance as its ability to shape the functioning and organisation of the network. Unlike the individual subjective qualities — "guilt, responsibility, loyalty, trust" (Lazzarato, Signs and Machines 48) — that give linear creditor-debtor relations their power, financialised debt's power, which is to say its *meaning*, is based in the memory, that is the organisation of the system itself. As Malik shows, all information, all connections that comprise and shape the network, are given their meaning by the organisation of the system as a whole. Power and meaning are not fixed or foreclosed, but altered with every new connection made.

Lazzarato's proposal to counter debt's restrictive effects on desire and action is a product of his model. He argues that political action must position itself on the edges of the system "between the molecular and the molar" (*Signs and Machines* 36) such that we reconfigure the types of subjectivities without becoming a subjectless component in a system. Whereas Feher's suggestion is an embracing of our neoliberal condition and to use the capital we possess, even if its human rather than financial, for investee activism, demanding that neoliberalism's promises — "pleasure, a sense of accomplishment, recognition, experimentation with new forms of life" (*Signs and Machines* 53) — are fulfilled.

A network model of debt also suggests a way forward. Terranova's call for a renewed cultural politics of information that takes into account "dynamics of information diffusion" within the "crowded and uneven communication milieu" of the network ("Communication beyond Meaning" 53–54) reopens the possibilities for action and invention that broadcast debt shuts down. If the functioning of the network is not dependent on hegemony, all possibilities for action remain open. Imaginings and desires for a different future become information that affects the system as a whole. With a network diagram of debt, where the power and memory of a system is in its organisation, politics appears as the creation of connections between components of the network. All connections are information that by definition alter the network's structure and affect its organisation. Shifts in centrality — that is in the importance of a component to the functioning of the network as a whole — become the means by which power relations are altered. Repositioning the self away from being an input or output to instead take on an active role in the network allows for the possibility of 'nonproporational' effects on a nonlinear and indeterminate future. Not dependent on the linear power-law dynamics of broadcast, where alternatives can simply be drowned out and dismissed as noise, the network allows for different kinds of centrality, where small, peripheral acts can affect the organisation of the system as a whole. The

cultural politics of networked debt become not about avoidance, disconnection, or even resistance, but about how we change the network though its use.

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COMPUTING WAR NARRATIVES: THE HAMLET EVALUATION SYSTEM IN VIETNAM

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Over the two decades following the French withdrawal from Vietnam in 1954, the United States found itself increasingly enmeshed in a war that evaded expectations. In order to fulfil their commitment to their stated policy of stopping the spread of the Soviet sphere of influence as outlined in the *Truman Doctrine*, the US had to invest heavily in sustaining their presence in the region. In anticipation that the fall of Vietnam to communism would trigger a chain-reaction of Soviet-backed governments rising to power across Asia (the so-called *Domino Theory*), a visible display of military presence gained a strong sense of urgency. What quickly became apparent to military strategists in the Pentagon was that this conflict did not follow their assumed 'conventions' of *regular warfare*: the heavy machinery of the US Military was destabilised by the networked nature of the Vietcong insurgency in South Vietnam. In his 1985 book *War Without Fronts*, Thomas C. Thayer describes how, despite its colossal human and machinic capital, the US Military was faced with a hindered ability to even accurately evaluate how the Vietnam war was progressing on a regional level, let alone contain the spread of communist influence (4). Without any headquarters and with networks of cadres operating across the rural villages and jungles of the country, it became difficult for the US Military to know where to concentrate its attention. The military strategists believed that the solution to this problem could at least in part be solved with machines.This approach, articulated in General Westmoreland's concept of "the electronic battlefield", can be more generally summed up as a systems-oriented perspective on conflict, where anything from supply chain logistics to the political disposition of rural villages can be quantified, managed, and controlled.

In this text, I will unpack the workings of a particular technological apparatus applied in South Vietnam during the war, contextualising it in the culture of systems-analysis which became prevalent in US defence strategy following the Second World War. This apparatus – called the *Hamlet Evaluation System* – was in formal operation from 1967 until 1973, and aimed to provide US Forces with a vital narrative of progress in their "pacification programmes" in Vietnam. With its disruptive use of computers, the immense scale and scope of its task, and its affordance of a managerial approach to warfare, this system raises a number of issues around the role of the computer as bureaucratic mediator – in this case, tasked with converting complex insurgencies into legible, systematic narratives. What kind of insights did it provide into the operations of the Vietcong insurgency? How does it fit into the wider ecologies of command and control in the US Military during the first few decades of the Cold War? As the Hamlet Evaluation System, almost fifty years after its inception, is still considered the "gold standard of [counterinsurgency]" (Connable 113), it remains an important case study for those trying to understand how computers structure the institutional bureaucracy of war, and how they are imagined as epistemological tools that can somehow reveal objective truths about the complex, dynamic reality of war.

Legible Thresholds

The 1954 Geneva Accords, in addressing the new power vacuum in South East Asia following the final defeat of the French forces in Vietnam, came to a rushed agreement. Vietnam would be temporarily partitioned along the 17th parallel, leading to the creation of two states: the Democratic Republic of Vietnam, and South Vietnam. Democratic elections were planned to occur two years later, after which the country was to be

reunited under a newly elected, singular government. However, the 1956 elections never took place: knowing that Ho Chi Minh would win any popular vote, Ngo Dinh Diem – the South Vietnamese Chief of State – working in liaison with the US Government, decided to withdraw support. Vietnam thus remained in a suspended state of partition, caught between a century of French colonial rule and an apparently forthcoming new era of US proxy governance. It was these pre-existing conditions which laid out foundations for the asymmetric relationship between on one side the US Military and Government of South Vietnam (GVN), and on the other the various counter-powers fighting on behalf of the northern Democratic Republic of Vietnam – notably, the Vietcong's political and military infrastructure. As growing numbers of US troops arrived in Saigon in the early 1960s and were mobilised around the country, an organised Vietcong insurgency was already well-established in the villages and towns all over South Vietnam. The US troops quickly found that they were not dealing with a unified, centralised enemy: they were dealing with disruptive threats which emerged through unpredictable guerrilla operations, flashes of combat in quiet villages or jungle roadways which could vanish as suddenly as they appeared. This was not bloc-against-bloc warfare, where oppositional forces engage in conflicts around fronts, nor was it as simple as being "without fronts" as Thayer suggests. Instead of describing the war according to these principles, in acknowledgement of the systems-oriented perspective that came to characterise this war, we can think of it as being constituted of a *multitude of thresholds*. The emergent nature of these thresholds posed a serious problem for US Military and GVN strategists, especially in rural districts throughout South Vietnam, and it was the task of mapping and predicting where they might emerge next that occupied many US Military strategists in Saigon.

This concept of the threshold finds its application in the strategies favoured by Robert McNamara, US Secretary of Defense from 1961-68. McNamara, a Harvard-trained economist famed for using "systems analysis" to revolutionise the ailing post-war Ford Motor Company, took a similar systems-driven approach to his role in government. Donald Fisher Harrison describes how McNamara's approach to his position incorporated "business analysis techniques":

> *McNamara's early applications of computers to war were ground-breaking. Using computers as an analytical tool, he soon made fundamental changes in the department's reporting techniques, as well as in the use of computer-generated data for decision making. (Fisher Harrison 20)*

By the time McNamara was appointed Secretary of Defense, there in fact was already a burgeoning culture of systems analysis among scientists and engineers developing computers, the nuclear programme and experimental weapons. Outside the military, the practice of systems analysis could already be seen in the organisation of the corporate workplaces, manufacturing industries and communications infrastructures of the United States since the early twentieth century (Yates). However, it was the war emergency in the early 1940s that really set systems analysis to work in solving military problems, such as the design of anti-aircraft weapons and locating German submarines in the north Atlantic Ocean. What Peter Galison calls the "manichean sciences" – cybernetics, game theory, and operations research – emerged during this period to address strategic problems in military thought, and came to be regarded as powerful frameworks for managing the unpredictable nature

of the "cunning opponent" during the Second World War and beyond (234):

> *More active than the targeted, invisible inhabitants of a distant city and more rational than the hoardelike race enemy, this third version emerged as a cold-blooded, machinelike opponent. This was the enemy, not of bayonet struggles in the trenches, nor of architectural targets fixed through the prisms of a Norden gunsight. Rather, it was a mechanized Enemy Other, generated in the laboratory-based science wars of MIT and a myriad of universities around the United States and Britain, not to speak of the tens of laboratories in the countries of the Axis. (231)*

It is no coincidence that the emergence of the manichean sciences were concurrent with the development of digital computing – both drew on and further facilitated a perspective of the world which was quantifiable in terms of logical and rational systems of control and communication. For instance, John von Neumann, one of the chief proponents of Game Theory, made important contributions to defence computing projects during the Second World War. During this period, computers had urgent problems to solve – problems posed by long-range ballistics, cryptography, submarine warfare, and the threat of the bomber plane. The availability of federal funding and the politically-motivated scale of ambition facilitated ground-breaking computing projects such as von Neumann's MANIAC computer (Jacobsen 33). As the Cold War tensions heightened, continued research and development in new technologies was seen not just as desirable displays of capitalist innovation, but as absolutely vital to the management and prediction of threats from the Soviet Union. While, as outlined above, systems analysis was not necessarily new to the military as such, the appointment of McNamara and his advisors – the so-called *Defence Intellectuals* – to such high-ranking positions expanded its scope. It was leant a further legitimacy when it was made a central concern in forming policy and strategy in Vietnam. Evelyn Fox Keller's writing, while on the subject of what she calls "cyberscience", neatly epitomises the worldview of the Defence Intellectuals and the manichean scientists:

> *For cyberscientists, Life (especially corporate life, electronic life, and military life — the modes of life from which these efforts emerged and on which they were focused) had become far too unwieldy to be managed my mere doing, by direct action, or even through the delegation of "doing" to an army of underlings kept in step by executive order. (85-86)*

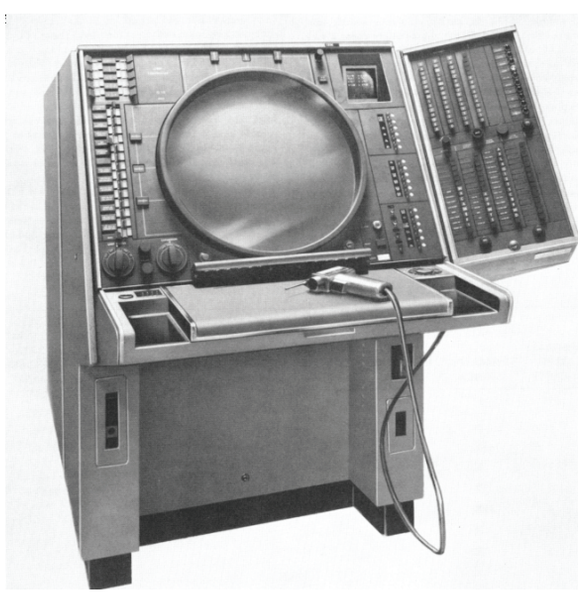

Figure 1: SAGE Situation Display Console (IBM 60)

As the cutting edge of digital computing advanced rapidly, its utilities expanded from just being labour-saving calculators to becoming expansive multi-purpose

data-processors, generating actionable information from vast quantities of inputted data. For example, the *Semi-Automatic Ground Environment* (SAGE), built by IBM for the US Air Force in the 1950s, was designed to manage the airspace of the United States. Its development, catalysed by the explosion of the Soviet Union's atomic bomb in 1949, was relatively brisk considering its technical novelty. The SAGE system was online by 1960, receiving streams of radar information from a variety of arrays around the country, identifying crafts that were possible threats and tracking their movements. With SAGE came innovations in digital memory formats, operating systems, and screen interfaces that rendered data streams as legible thresholds that, when traversed, would immediately alert the system's operators. In *Closed World*, Paul Edwards describes it as "the first large-scale, computerised command, control and communications system" (75), which although obsolete by the time it was finished, demonstrated the practical possibilities of defence computing and had an enormous influence on subsequent projects funded by the Department of Defense. It is important to note that, while SAGE was enthusiastically developed by teams of scientists and engineers, it was dismissed by some Air Force traditionalists for its defensive nature, the possibility of the project diverting funding from other Air Force projects, and its centralised position of command in the military hierarchy (Edwards 94-96). A CIA analyst, writing in 1960 on the "capabilities, prospects, and implications" of the computer and military projects such as SAGE, warned: "Not that computers and other [Electronic Data Processing] machines constitute any panacea for our ills; they are not glamorous Aladdin's lamps to do our bidding while we recline at ease." (Becker 7)

Pacification

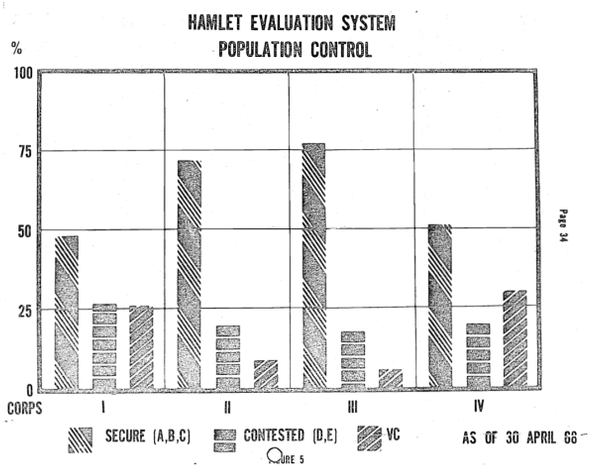

Figure 2: HES population control data by hamlet security rating, dated 30th April 1968 (Brigham 34).

The shock of the Soviet launch of their Sputnik satellite in 1957 and the grave implications for national security resonated in US President Eisenhower's State of the Union address the following year: "The advent of revolutionary new devices, bringing with them the problem of overall continental defense, creates new difficulties, reminiscent of those attending the advent of the airplane half a century ago."

In the address, Eisenhower, himself a General in the Second World War, acknowledged the necessity to establish new approaches to defence research. The newly created *Advanced Research Projects Agency* (ARPA, later becoming DARPA after being given the prefix *Defense*), furnished with a $10 million grant to start their research programme, became an important location for technological experiments and systems analysis. ARPA's role in the early years of Vietnam centred on Project Agile, a Saigon-based research programme tasked with tackling the problem of the insurgency. *Project Agile* was to varying degrees responsible for the US Military's defoliation programme — the destruction of the natural camouflage of the jungle canopy, and the invention of Agent

Orange — a herbicide that poisoned arable soil and water sources, prohibiting future attempts at farming the land. Simultaneously, Project Agile was also intended as a key weapon in the battle for *pacification*, that is, the effort to win the "hearts and minds" of the Vietnamese and "pacify" the efforts of the insurgency. Agile's strong-handed and often misguided approach to pacification is evident in the *Strategic Hamlet Programme* (SHP), where Vietnamese farmers were given financial incentives to move away from "Vietcong infested" areas to live in US-sanctioned regions, under protection of the GVN (Jacobsen 133). In doing so, it was hoped that "ARPA would collect enough information on strategic hamlets to be able to monitor their activity in the future" (Jacobsen 135), and "tie the villages into the network of government administration and control" (Hilsman). While the village was traditionally considered the lowest administrative unit in Vietnam, each village would typically be comprised of a number of discrete communities called hamlets. These hamlets could in fact vary significantly in size, from small clusters of houses surrounded by rice fields to whole urban districts, and with populations ranging from as few as 50 people to as many as 20,000 (Connable 114). This attempt to create safe havens and win the support of the Vietnamese was not as straightforward as anticipated, ignorant as it was to the communities it was attempting to displace. Dislocated farmers lost their cultural connection to their ancestral lands, and reportedly were underpaid for being relocated and forced to build fortifications during the "most important planting time of the year, which meant that many farmers had been unable to plant their own crops" (Jacobsen 135). An ARPA-funded investigation carried out during the programme's lifetime which suggested this initiative was doing much more harm than good was rejected and subsequently "scrubbed" from the records, at which point a new, more *favourable*, report was commissioned (Jacobsen 136).

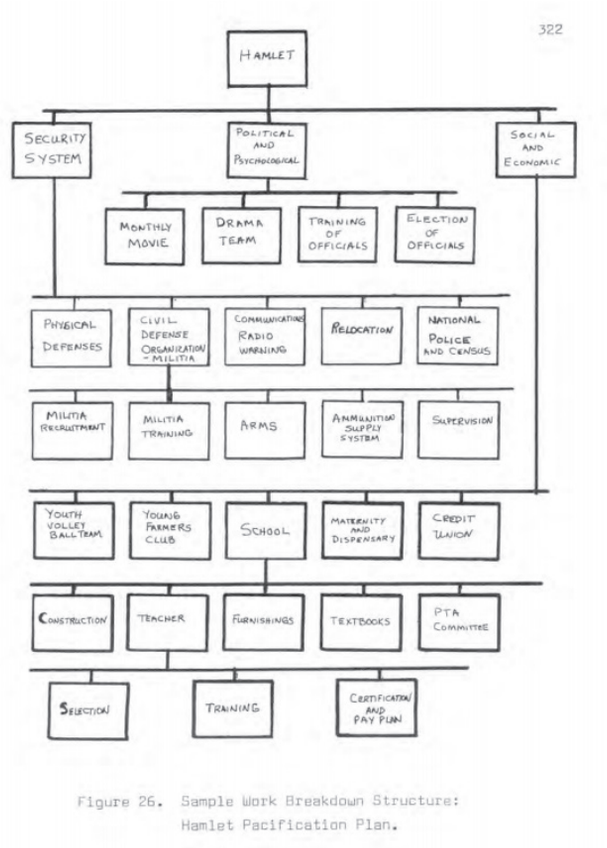

Figure 3: Proposed *Hamlet Pacification Plan*, 1966 (Nighswonger 322).

The SHP's observation of specific communities and the production of new controllable zones for Vietnamese farmers was just one interpretation of what "pacification" could mean for the US Military and its research institutions. As Thomas Scoville notes in his history of pacification in Vietnam, the exact definition of the term in fact remained unclear throughout the war:

> *There was never agreement among Americans in Vietnam on just what pacification was and how it might be achieved. Some saw it as controlling the population; others as winning the people's allegiance. Some viewed it as a short-term military operation*

> *aimed at quashing opposition; others as a long-term process of bringing, in addition to security, economic, political, and social development to the people. (3)*

By October 1966, McNamara was seeking new ways to get a clearer picture of the counterinsurgency efforts in Vietnam, and asked the CIA to develop a system to measure progress – and regress, as the case may be – in the pacification programmes (Ahern 231). The CIA were brief in their response, quickly developing a proposal for what became known later as the *Hamlet Evaluation System* (HES): "Mandated on a Monday, brainstormed on Wednesday, and coordinated inside CIA on Thursday, the proposal reached Secretary McNamara on Friday. He approved it on the spot, after which it received pro forma review in the State and Defense Departments" (Ahern 233). The following year, the system was installed as part of a bureaucratic assemblage consisting of both military and civilian organisations. It was led by *Civil Operations and Revolutionary Development Support* (CORDS), and implemented by *Military Assistance Command Vietnam* (MACV), a branch of the US Military charged with responsibilities such as running psychological operations, aid programmes and pacification campaigns. As Ben Connable puts it, "MACV was the neck of the funnel for nearly all field reports on operations, intelligence, pacification, and other data categories" (99). In order to get a sufficiently high-resolution perspective on the narrative of the counterinsurgency, the designers of the system recommended that MACV collect data on a hamlet level, which ultimately amounted to over 12,000 hamlets.

The task of the HES was to quantify the pacification status in regions outside the cities by assigning security ratings ranging from 'A' (friendly) down to 'E' (contested) for each

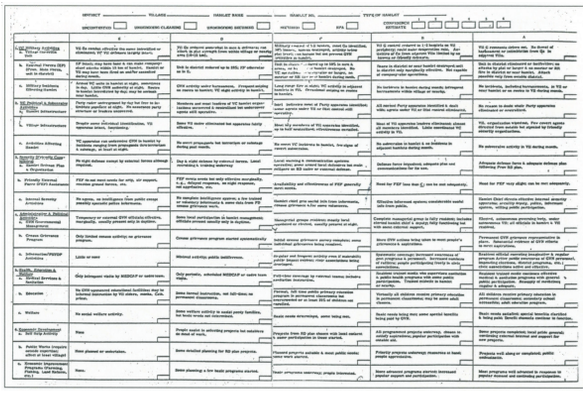

Figure 4: *Hamlet Evaluation System* Worksheet, circa 1968 (Ahern 419).

hamlet, the majority of which were situated in remote rural areas. MACV staff known as District Advisors were given an allocation of hamlets to be visited on a monthly basis, whereupon they would liaise with local chiefs and complete questionnaires rating the state of *security* and *development* of each particular hamlet. The original HES version had a total of eighteen questions, each with up to five possible answers. Subsequent reviews by the Simulmatics Corporation (de Sola Pool et al.), RAND (Sweetland), and ARPA (Prince and Adkins) appended new questions and altered the scope of responses. Typical questions varied from the degree of Vietcong presence in the area during different times of the day, to the number of households that own radios, to forms of economic activities local to the hamlet (see MACCORDS 303-336). The design of the Hamlet Evaluation System aimed to maximise efficiency, speed up reporting times,and enable the operation to be practicable on an almost national scale by implementing newly available computer systems: "Automated Data Processing is used in the HES to minimise the district advisors' workload and also to facilitate the storage, tabulation, and analysis of the reported information" (Brigham 2). The quantity of data produced from the system is impressive:

> *Every month, the HES produced approximately 90,000 pages of data and reports. This means that over the course of just four of the years in which the system was fully functional, it produced more than 4.3 million pages of information, and each page may have contained ten, 20, or more discrete elements of data – perhaps 40 million pieces of data, as a round estimate. (Connable 120)*

It is important to note that the HES was not the only data collection system in use by the US Military at the time. A collection of systems documented in the US National Archives in Washington point to a widespread systematisation of conflict, ranging from logistical control of supply chains to terrorist activity databases. A parallel programme to the HES, also run by CORDS, called *Phung Hoang (or Phoenix Programme)*, sought to construct a list of individuals working for or sympathetic to the Vietcong and subsequently — according to the US Military euphemism — "neutralize them" (CORDS 1). According to Tim Weiner, the total number of Vietcong suspects killed in the Phung Hoang programme amounts to more than 20,000 "at a minimum" (394). Also in operation at the time were the National Police Infrastructure Analysis SubSystem (NPIASS) — a GVN-collated database of criminals — and the Pacification Attitude Analysis System (PAAS), which attempted to carry out opinion polls on the population of South Vietnam (see US National Archives).

Although working in very different environments, the Hamlet Evaluation System in essence was assigned a similar computational task to projects such as SAGE: to distil large quantities of information into actionable *knowledge*, and to do this over a sufficiently brief period of time such that defence strategists could develop a relevant tactical response. Humans might conceivably be able to do the calculations required, but the number of *man-hours* (government term) required to do so would make the task completely inefficient and the results likely irrelevant. Indeed, before the development of electronic computers in the later years of the Second World War, it was people – and most often women – who were the *computers*, brought into the war effort to work with mechanical calculators or do arithmetic by hand. Janet Abbate gives an idea of how a machine such as ENIAC, an example of an early digital computer, would speed up the labour of calculating ballistics firing tables: "To create a single firing table required a month of continuous work for either the Differential Analyser or a team of a hundred women" (16). However, the use of computers in the HES did not simply remove the need for manual labour – in fact, the task of data collection proved to be an arduous task, fraught with danger as well as logistical difficulties. The process of observing and recording each hamlet could not be automated, it had to be carried out by humans, vulnerable to ambush and prone to subjective bias as will be demonstrated below. Nevertheless, the novelty and importance of the computer as an instrument of war was not lost on the chief of CORDS. In a 1967 press briefing announcing the HES, Robert Komer hailed the system's use of computers as a labour-saving device, as well as noting their analytical "flexibility": "We can ask the computer questions on details among the 50 different facets and can get answers of any kind" (Komer "HES System" 3). Although being remarkable for its use of computers to automate analysis, the enormous amount of work required to first collect hamlet data and then render it as machine-readable should not be understated.

In its hyperlocal focus, the HES was in essence concerned with converting the

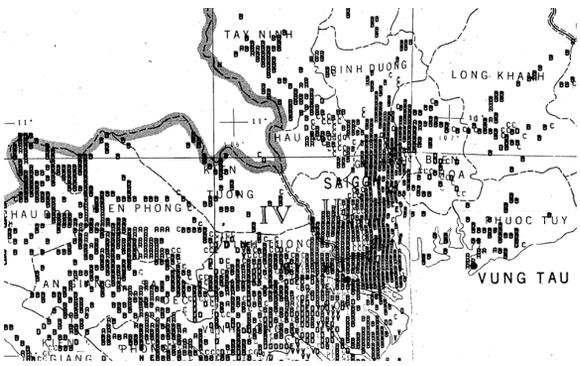

Figure 5: *Hamlet Plot* (extract) dated 30th November 1970. This extract shows hamlet security ratings in the regions surrounding Saigon (MACV, Hamlet Map).

population of South Vietnam into discrete units whose perceived security could be managed, controlled, and sculpted through responsive GVN and US Military strategies. The social and political dynamics of rural communities were schematised, with behaviours and conditions becoming "thresholds" to be converted into data and subsequently analysed in myriad reports generated by IBM computers in Saigon. Automatically generated maps, surveys, and charts would be sent to the US and subjected to further analysis, their statistics being held up as evidence of progress at high levels of US Government (Tunney 1). Perhaps the most striking document produced by computer analysis was the *Hamlet Plot*, a printed map of South Vietnam with the security score of each hamlet displayed. The plot was "state-of-the-art, and facilitated the emergence of a new visual register" (Belcher 133). It would appear then, with the availability of novel registers such as the Hamlet Plot, that McNamara's desire to increase the legibility of the war narrative had been achieved.

Not a Precise Thermometer

However, the HES was not without its critics. The idea that the Vietnam War could be understood as a scientifically manageable system was, similar to SAGE before it, taken with scepticism by senior Generals who believed in the intuitive "art of war". They loathed the extra layers of bureaucracy that inevitably came with integrating complex military operations with hundreds of civilian computer analysts spread across Saigon and the continental US (Belcher 144). Furthermore, there was a question of who exactly was being evaluated by the HES, with some believing that to some degree "their own personal performance was monitored by McNamara's computers" (Fisher Harrison 21). This suspicion was in fact partially true. HES metrics came to be a method of benchmarking and incentivising regional progress in the conflict, with senior strategists in the US setting targets for improving security and development ratings in hamlets across the country – targets which commanders were under great pressure to meet. In tape transcripts of a 1968 meeting between General Creighton Abrams with CORDS director William Colby, Abrams presses this point: "It may be that, under the pressure of goals and targets and so on that […] some have leaned a little bit over backwards to look at the better side of things […] but now's the time you've got to look past the chart and it mustn't be only A/B/C [hamlet ratings] and A/B in the HES report" (Sorley 288). He continues to state that "this government's life depends on it being what [the HES] says" (288). This appetite for data drove further divisions between the subjective observations of advisors on the ground and the assumed "objective" narratives generated by the computers. The sheer quantity of labour required to meet the monthly demand for hamlet data, not to mention the logistical complexity of the task, almost certainly contributed to a significant distortion of the data as it was collected. Given that a District Advisor might have upwards of 50 hamlets in their roster, how much time could they conceivably spend in

each location on a monthly basis, and how accurate an insight into regional security and development would this provide in practice? William Colby himself indicates his awareness of the ambiguities of HES data, but nevertheless defends it as a useful tool: "We've been using it, and defending it, over the years. We've emphasised that we don't think it's a precise thermometer for the situation, but it's been a very handy tool. It's given us an idea of differences over time and […] space" (Sorley 367). An Army-commissioned and generally favourable review of the HES by the Simulmatics Corporation just one year into its operation claimed that, while the District Advisors did not self-report any tendency to upgrade ratings to show "progress" in hamlets under their command, found limited evidence of bias in monthly reporting. That said, the primary author of this report was Ithiel de Sola Pool, an MIT professor and founder of the Simulmatics Corporation, and an important figure in ARPA's Project Agile as well as the Strategic Hamlet Program — not necessarily somebody who could be considered as an independent evaluator (Scott 377). He writes:

> *Without exception, the district advisors stated that they honestly have tried to reflect reality in the HES. Some respondents, however, acknowledged their general outlook affected their interpretation of "reality." Four of the forty respondents tended to be optimistic and to view the apparent general trend of the Vietnamese conflict favorably. (de Sola Pool et al. 94)*

A 1969 inquiry into the Hamlet Evaluation System by Senator John Tunney went much further, quoting one unnamed District Advisor who explained that, after downgrading four hamlets, he "was immediately hit with a barrage of cables from Saigon demanding a full explanation for downgrading them" and spent the next couple of weeks justifying the evaluation (8). The laborious process led the advisor to admit that "it may be a long time in hell before I downgrade another hamlet" (Tunney 8). Recent analyses of HES reporting by Connable and Belcher present a more generally problematic picture. Despite appearing on a superficial level to be providing crucial insights into the war narrative, the very data these insights were based on were at least partially corrupt, and its methodology was faulty:

> *Indeed, there is a two-sided struggle in the centralized assessment cycle: On one side, analysts fight to obtain, collate, and understand vast reams of decontextualized data while under intense pressure from policymakers and senior military leaders to show progress; on the other side, troops in the field are tasked with reporting data that often do not exist, in formats that make little sense, for objectives they do not understand or believe in, while also under intense pressure to show progress. (Connable 96)*

A 1972 HES Review Committee memorandum is but one example of issues with District Advisor reporting, highlighting committee suspicions concerning "an unexpected, extraordinary upgrading of hamlets" and "sudden upgrading of long-term enemy strongholds" (Jones 3). The hamlet questionnaire itself also observed an optimistic bias, with questions phrased such that conditions appeared to be improving. Indeed, a dominant preoccupation in the aforementioned ARPA (Prince) and Simulmatics (de Sola Pool et al.) reports attempted to address issues around bias and labour complexity.

The entire operational stack of the HES, from the Hamlet Chiefs right up to the

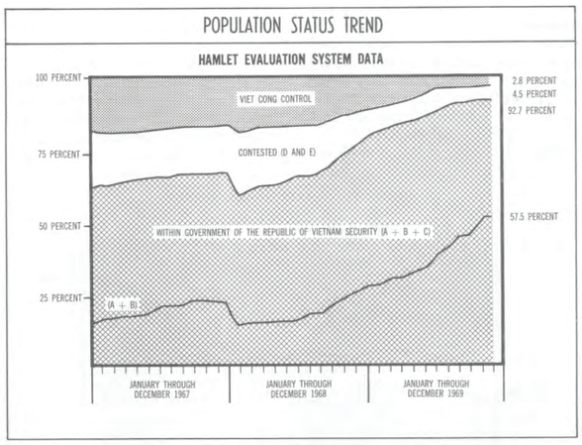

Figure 6: Population Status Trend according to HES Data, 1967-1969 (Brigham "Military Review: Pacification Measurement" 51).

top of the US Executive Branch – and not excluding the computers, algorithms, and the databases – constituted an unwieldy bureaucratic apparatus. In effect, it had more to do with legitimising a continued US engagement with Vietnam than functioning as the intended 'neutral' epistemological tool that would enable the strategists to read the battlefield like a manual. The Hamlet Evaluation System's grandiose ambition to map the progress of the pacification programmes meant that its consequences were far reaching, influencing military strategy and policy while suggesting that conditions in the country were widely improving. For instance, its optimistic reporting would have implied that the $777 million dollars spent in 1970 on pacification was rewarded with real progress on the ground (Komer "Impact of Pacification" 19), or that search and destroy tactics were successfully bringing new regions under GVN and US influence. While the aforementioned examples of bias and data manipulation were not necessarily active intentions of the system, they were at least affordances of the complex administrative bureaucracy required to keep it in operation. But it is the "liveness" of the HES that is crucial to dwell on: it was an untested experimental apparatus, trialled in a highly complex and dynamic theatre of operations where its formula evolved over time at enormous expense of those who were subjected to it. As an experimental pacification tool, it was not alone: the HES was but one component in an assemblage of machineries all feeding in to one another, shaping strategy in response to perceived trends in the war narrative, and having tangible, violent effects on the lives of the Vietnam's rural population. Robert Komer, the CORDS chief who excitedly announced the use of computers in the HES in 1968, wrote of the pacification programmes two years later: "Like most things in Vietnam, [pacification] has been cumbersome, wasteful, poorly executed, only spottily effective in many respects" (Komer "Impact of Pacification" 8). In carrying out their task of making emergent guerrilla tactics legible as part of some overarching strategic vision, these systems failed to approach the ontological question of what actually characterises the supposed "rational" or "obedient" subject in asymmetric warfare.

Giorgio Agamben writes: "We have then two great classes: living beings (or substances) and apparatuses. And between these two, as a third class, subjects. I call a subject that which results from the relation and, so to speak, from the relentless fight between living beings and apparatuses" (14). In the case of the Hamlet Evaluation System, the "living beings" who inhabited the rural hamlets of South Vietnam were subjectivised. What behavioural nuances could be lost to *noise* in the data? How can assumed "objective" data be produced out of a system that fundamentally relies on subjective observations, clouded by the fog of war and distorted by bureaucratic pressures to attain targets? Purely as a machine that produced a "gold mine" (Komer "Impact of Pacification" 9) of actionable information about the insurgency, one could conclude that the Hamlet Evaluation System was

successful. However, this understanding is to take a purely technocentric position, omitting the very real and violent political implications of the data contained within this "gold mine". If the war was "a war for the control of the population" (Kalvyas and Kocher 337), the Defence Intellectuals worked with the concept of "population" as a *technical abstraction* that could be conveniently understood with algorithms and surmised in statistics, rather than as an amorphous form sustained and constituted by a dynamic and evasive social substrate. It was rather the particular reality of this technical abstraction which necessarily informed and facilitated McNamara's Vietnam strategies, and which was also presented to the American public as evidence of "progress". While some examples of contemporary analysis of the HES acknowledge its sophistication (see Kalvyas and Kocher 341), as a case study it raises crucial questions about the kinds of structural distortions that arise out of the application of systematic apparatuses in conflict scenarios. The notion that analysing "enough data" will lead to an increase in the "legibility" of asymmetric warfare must come with a critical caveat: it should be understood with relation to the administrative organisations that modulate their end-use and, perhaps to a significant degree, prefigure their consequences. For the present, analysis of the Hamlet Evaluation System identifies a number of fallibilities in the process of mass data collection, which bring to mind the "collect it all" mantras that characterise the counterterrorism strategies of the US and UK (Anon). In this respect, thorough analysis of the inner-workings of Vietnam's "gold standard" (Connable 113) pacification programmes can afford us with a historically-sensitive mode of critique for their *classified* contemporary analogues.

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MACHINE ETHICS AND AESTHETICS

Maja Bak Herrie

ELUSIVE BORDERS: VIRTUAL GRAVITY AND THE SPACE-TIME OF METADATA

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The digital has become an important part of everyday life in terms of virtual and physical objects filtering and forming our experience of the world, often without our awareness. Countering this imperceptible or even 'immaterial' relation to the technologies that shape and facilitate our lifeworld, a number of contemporary artists are working with what can be understood as the more 'physical' parts of the infrastructures of data transmission, storage, and reception. However, analytical potential emerges when these two poles are juxtaposed with particular sensibility to the continuity between them. Indeed, this continuity creates opportunities for studies of the physicality of the virtual – the 'stuff' of signs, norms, beliefs and representations, and the imaginary and ephemeral aspects of seemingly 'solid' objects as borders and boundaries.

In this article I discuss the themes of movement and restriction inherent in digital technologies in two very different artistic projects, both of which offer aesthetic material for debating the politics of data. I approach this discussion through the term gravity as used by philosopher Levi R. Bryant (*The Gravity of Things*; *Onto-Cartography*). Through an analogy to Albert Einstein's theory of relativity, Bryant suggests the term gravity to denote how both semiotic and material entities influence the becoming and movement of subjects and collectives in time and space (Bryant, *The Gravity of Things* 10). I use this as a point of departure to investigate the shared space between physical and virtual borders, and the streams of data that are formed by, and also form, the space they traverse. The term gravity is used to elucidate the contours of the digital space that determines the paths between sender and receiver, as well as draws and erases borders, restricts and enables movement.

Introduction: Physical and digital borders

Whether portrayed as boundaries or frontiers, borders are often conceptualised with reference to political geography (Basaran). From a legal perspective, borders are constantly transformed, negotiated, and contested as they are determined by enforcement rather than geographic stability. However, the border, as a geographic boundary between two entities, may be defined in a more formal or mathematical way. For example, the Euclidean definition describes space in terms of proximity or metric closeness, or, more simply, as the distance between two points defined by a straight line drawn from the first point and subsequently ending with the other (Weisstein).

The differences between legal and mathematical approaches to borders seem to define a very distinct quality of this phenomenon: It occurs between actual localities with or without a *physical* barrier, and between legally determined spaces with or without an executively enforced *virtual* barrier. Questions concerning borders seem to represent this conundrum: One may be at Europe's doorstep, physically only a few metres from the soil of a European country, yet the legal border forms an even more fundamental spatiality related to possibility. In Euclidean space, two locations may be close to one another, but because of the presence of fences and the way borders are laid out, it may be difficult to reach a particular location. The ongoing Syrian refugee crisis is an example of this. Europe's borders exercise a certain gravitational effect on movement affecting social relations. Borders include not only actual physical hindrances, such as a dangerous sea or an impenetrable fence, but also virtual interruptions, such as images of crowded ships, documentation of deaths

at borders, deployment of border guards in so called "hot spots" of border regions, and military imagery and language (De Genova, Mezzadra and Pickles 13). These 'virtual' appearances of the border all serve to present what Nicholas De Genova has identified as the "spectacle of the border", deepening and extending the physical architecture of the border (1181). Although in Euclidean space the Syrian refugees may be physically close to the Greek border, spatial and temporal closeness are understood differently in lived space and time, because of the administration and control that impose both a physical and a virtual architecture of exclusiveness. Thus, the European border functions as a spatio-temporal gravitational field, warping the possibility of movement in various ways, impacting the ability to move to and live in certain spaces, or, as Bryant describes it:

> *Space and time are not the same everywhere, and movement is not materially possible in all directions […]. The way in which roads are laid out in a city play a role in what is related to what, how one entity has to move in order to reach another place, as well as the time it takes to get from one place to another. (Bryant,* The Gravity of Things *28)*

In much the same way as the layout of roads and borders in cities matters for the movement of individuals, so does the layout of cables and the locations of sources and receivers for data transmission. And much as the virtual needs the physicality of cables and routers, so do seemingly solid objects such as borders and boundaries, as they are deepened and extended by the immaterial 'stuff' of signs, norms, beliefs and representations. Movement and restriction are formed by, and form, the spaces in which they unfold.

In this article I consider the politics of data as it is embodied in two different works of art. Both artistic projects address the ambiguity between relations and matter, data flows and bodies, and transactions and the places of things (Meade). A recurring question in this article is how artistic strategies of exploring hidden or unnoticed infrastructures may help address the questions concerning the ephemeral and complicated status of some of the objects that facilitate and determine everyday life.

A space-time of information flow: Subterranean cables

The first project I bring into this discussion is artist Nina Canell's subterranean cable project. Among the works included in this project are two from 2015: The *Mid-Sentence* series, exhibited at Moderna Museet, and the *Shedding Sheaths* series, included in the Satin Ions exhibition in Seoul, amongst others. Canell's work is based on subterranean cables of various sorts: fibre-optic cables used for long distance telecommunication or for providing high-speed data connections between various locations, electrical and communication cables, and a variety of sheathings designed for diverse contexts. The artworks allow the viewer to perceive normally imperceptible infrastructures as they are exposed by aesthetic means. To follow the material qualities of the work requires more than a discussion of 'the digital', or as media archaeologist Jussi Parikka suggests, we have to "pick it apart and remember that also mineral durations are essential to it being such a crucial feature that penetrates our academic, social, and economic interests" (Parikka 5). Parikka calls attention to the components and materials that facilitate the functionality of technologies and media, and instead of exclusively theorising about the

social or economic phenomena of networks, he advises that we also remember the importance of copper or optical fibre for such forms of communication (5). In this case, 'matter' is rather complicated. As Bruno Latour remarks, assemblages are "simultaneously real, like nature, narrated, like discourse, and collective, like society" (Latour 6). To draw attention to the optical fibres of the networks constituting and facilitating everyday communication, the 'stuff' of signs, norms, beliefs and representations, or the complicated ways in which things are interrelated in societal assemblages should not be ignored. Bryant approaches this discussion by proposing the use of the term gravity to investigate how different kinds of power unfold. Moreover, the advantage of the term gravity is that it accentuates the ways in which non-human machines such as technologies, infrastructures, and geographical features also contribute to the forms taken by social assemblages (Bryant, *Onto-Cartography* 10).

The important intuition in the Einsteinian approach to the discussion of gravity in physics is – in consonance with Bryant's views – the understanding of gravity as something other than *force* (Bryant, *Onto-Cartography* 186). Building on the Newtonian understanding of gravity, Einstein diverged from Newton on this particular point. According to Einstein, gravity is an *effect* of how the mass of objects curves space-time, rather than being a force that *attracts* or *repels* other objects. The movements of the moon do not originate in a dynamic of force initiated by the relationship between the moon and the earth, but occur because of the mass of the Earth curves space-time, creating a path the moon follows. From this perspective, gravity is a field or a topology that other objects' movements follow (Bryant, *Onto-Cartography* 186). Whereas Einstein's account of gravity pertains only to mass, the use of the term here in a broader philosophical inquiry refers to physical motion and fields produced by signs, technologies, infrastructures, and so on (Bryant, *Onto-Cartography* 194). In this context, the term sheds light on exclusions and inclusions of data flows and electricity, as it is ascribed to the space-time of the information flow along fibre-optic cables. Here, material entities – exemplified by Nina Canell's cables – play a pivotal role in the movement of subjects and collectives across time and space.

Following the idea of the subterranean cables series, Canell has transformed her (and her artistic partner Robin Watkins') website into a *tracerouter*, tracking the information about, and length of the cables used for transmitting data from her atelier in Berlin to the visitor's local server (Canell and Watkins). When loading the website, one becomes aware of these paths, as the functionality of the servers involved in the data transmission becomes apparent. The content of the website is visible only because of thousands of kilometres of subterranean cables constituting a network of data. Whereas the operating cables constitute the space-time of the information flow – the space for every possible movement of the signal – the routers, however, create the gravitational function that curves space-time and forces the messages along particular paths. Without this complicated network of copper and plastic sheathing there would be no flow of information. The shape and the curvature of the network space-time are determined by the things in it, or, as Bryant states: "Space-time does not pre-exist things, but rather arises from things" (Bryant, *The Gravity of Things* 12). The cables do not move, but the path along which the message travels is dynamic. The things populating virtual space-time, in this case the routers that constitute the network, create a curvature that shifts the direct path of the system based on an optimising logic of throughput

and speed. Canell's tracerouter shows the direct path through the current formation of the network.

Silenced *Mid-Sentence*

To make the subterranean cables perceivable sculptures lying on the gallery floor, Canell unearths the electrical and communication cables from their hidden locations. To make them visible and tangible, she has to dislocate and interrupt their functionality. One could argue that in order to present her critique, she has to destroy the objects, fixing them to white gallery spaces. Whereas the tracerouter on the website shows the functionality of the cables as the signal passes through, the cable bodies on the gallery floor have been interrupted, almost violently cut away from their functionality as a medium of communication. Neringa Černiauskaitė's review of the cable sections in Canell's exhibition at Moderna Museet notes:

> *They appear as open mouths with half-pronounced words hanging like dead sound in the air […] Almost surgical incisions in the cables reveal their internal "organs" for the viewer's inspection: Dead slices of the flow of information. (Černiauskaitė)*

The way in which Canell makes infrastructures accessible is in some way similar to the way in which an entomologist collects insects to inspect them without having them "flapping around" (Černiauskaitė). The functionality of the infrastructures was never visible, the electrical transmission of the message never apparent. When the signal of the cable function is lost, it is like examining a screen that is turned off. The cables become symbolic relics of the invisible distance that is only ever traversed immaterially, as it is stated in the catalogue for one of Canell's exhibitions (Ayas, Hoare and Kleinman 60), and the names of the sculptures seem to refer to the paradoxical 'life' of the cable sections, going from being conducting hosts of information that erase geographical distance with connective, distributive and compressive operations, to becoming shedded *sheathings* removed from the sequence of interconnection, silenced *mid-sentence* as dead sound in the air.

Metadata and the 'aboutness' of signs

The second artistic project included here is Trevor Paglen and Jacob Appelbaum's installation, *Autonomy Cube* (2014), shown in many art museums, galleries and civic spaces. The sculpture is made of several connected computers housed within the piece to create an anonymous Wi-Fi hotspot. It routes all Wi-Fi traffic over the Tor network, a global network of thousands of volunteer-run servers, relays and services designed to help anonymise data. The sculpture itself is also a Tor relay, and may be used by others around the world to anonymise their internet use. When *Autonomy Cube* is installed, sculpture, host institution and users become part of the infrastructure (Paglen).

The Tor network (which is an acronym for The Onion Router) has sparked considerable debate, as its encryption potentially interferes with law enforcement. Tor uses the so-called *onion routing technology*, which encrypts metadata surrounding the actual content of the information sent. The data is encrypted several times and is sent through a random selection of Tor relays. Each relay decrypts a layer of encryption to reveal only the next relay in the circuit in order to pass the remaining encrypted data on to it, hence the name, 'onion routing'. The final relay

decrypts the innermost layer of encryption and sends the original data to its destination without revealing, or even knowing, the source IP address (torproject.org). Metadata is a key concept here. Metadata constitutes the context or milieu of the content, revealing the 'surroundings' of the data (e.g. time and date of creation, information about the author and location of the computer network where the data was created). This 'data about data' is crucial when the original data is put to use, as it emphasises the material aspects of the generated of data. It is metadata that gets the attention of the activists behind Tor, the context of the content is what seems to be important: who is sending what, from where, and who receives it?

The Tor network removes the origins of the signal that reveals the metadata as a meaningful identifier, and thereby foils any attempt to compile a history of actions of the sender. By spreading out the locations of the signals in physical space, convergence to a single 'solid' assemblage as a useful representation of a human individual is no longer possible. Indeed, the signals are no longer related to that same individual. Another example of data obfuscation through diffusion is the ad blocker *AdNauseam* that, instead of keeping meaningful parts of the signal secret, as the Tor network does, sends all possible signals at once by clicking every ad that it hides once, as the slogan, "Clicking Ads So You Don't Have To", indicates (Howe). By flooding the surveillance the actual movement of the body becomes impossible to distinguish from all the fake signals. It becomes as impossible to find a pattern in the space of all possible signals as it is to find one in the space of no signal. As metadata constitutes an increasingly powerful resource for pervasive digital surveillance, "our mainly nonconscious or habitual [actions] count more than our words", as Wendy Hui Kyong Chun puts it. We are "constantly captured and compared to others, our moves determine past and future narratives" (Chun 363). Ad blockers and alternative networks such as *AdNauseam* and Tor seek to obfuscate and obstruct such strategies of bodily capturing in different ways.

Returning to Bryant, metadata may be understood as a crucial part of the data stream representing the geographical distribution of data. Like a virus or a microbe in a particular environment, the message has an epidemiological distribution in the world. Because every text requires a material manifestation in order to travel throughout the world, each is located at a particular time and place (Bryant, *The Gravity of Things* 20). This is precisely the point of the encryption used by the Tor network. Whereas a normal router would use the shortest path from A to B, using the metadata to decide the most efficient path, the Tor router uses a random path, leaving no trace and no metadata, as it is continually peeled off. To address the problems of surveillance, the people behind Tor use virtual space to overcome the problem of proximity, but simultaneously adopt the advantages of physical space by avoiding any traces. Virtual space is used to construct a random path that is impossible to trace backwards or to infer, whereas the physical space is used to deposit the necessary information needed to guide the information flow to its destination. In this way, Tor's use of metadata may be seen as a mediator between two kinds of spatiality: It determines the direction of the message in physical space as a kind of envelope for the mailing system, but it does so based on a principle of randomness, sustaining a borderless space. Instead of 'snowballing' content by adding more and more metadata, Tor discards the used 'envelopes'.

When comparing the two artistic projects addressed above, a discussion of the borders of the digital emerges, as they both

present different aspects of movement and restriction, inclusion and exclusion in digital spaces: Whereas Canell's subterranean cable project exposes the infrastructures of data transmission, providing transparency and accuracy, Paglen and Appelbaum's Wi-Fi hotspot exploits the opportunity of secrecy, using the limited infrastructures of physical space to create an autonomous and borderless space. Although Canell's artwork serves as an example of a peculiar interruption, of unearthed cables that are no longer functional or operational, *Autonomy Cube* is an artwork in flux – it shows the functionality of the infrastructure as a running printing press connecting, transmitting, and receiving. And whereas Canell's artwork explores questions of proximity, of distance between two servers, Paglen and Appelbaum's work concerns autonomy and tracelessness

Both Canell's, and Paglen and Appelbaum's artworks present interesting perspectives on digital spaces. However, an analytical potential emerges when the two types of digital spatiality are comparatively juxtaposed with a particular sensibility related to the continuity between these poles. Indeed, this continuity constitutes a space for an emerging 'digital object' – a term philosopher and computer engineer Yuk Hui also proposes in his 2016 book, *On the Existence of Digital Objects* – in the form of the metadata, potentially being both a representation of a physical location and an obfuscation of this location. Contextualised in this way, the metadata becomes the surface or the shell around the message, both interacting with and being formed by the network as it is transmitted. In one case, the metadata becomes an onion-like envelope in the Tor network, shedding its layers on the way to its destination, and in the case of the tracerouter, the metadata is assembled, noting every individual location it has visited, incorporating the entire path from sender to receiver. The data package inhabits these different spaces and the metadata becomes its surface, both encountering and becoming marked by the physicality of the network.

The cartography of mobility

We now return to the relation between the legal and mathematical definitions of borders sketched in the introduction: the mathematical definition based on proximity, on metric closeness between two objects, and the legal definition that relies on the idea of enforcement as a constitutive power of the border phenomenon. When dealing with machines, both approaches are needed. The concept of metadata may be understood through these two kinds of spatiality: on the one hand, the physical path travelled by the message, exemplified by the nodes visited along the way (where either the message is sent along the optimised path or a layer of metadata is deposited in the Tor protocol), and on the other, the way the path is chosen in the first place (by either selecting an optimised shortest path, or selecting an untraceable randomised path). Metadata is operational in nature, and its objective is the transmission of information, and therefore it both forms and is formed by the space in which it exists. Metadata is *both* the interpretation and the realisation of the message-sending operation.

Space as we perceive it is not operational input for a machine. A machine can only process metadata, and therefore suggest the location of a server. With high probability, the computer determines an exact location that in a 'normal' network should be correct. However, if you browse Canell's website through a Tor relay the server monitor will suggest locations and cables from all over the world. The metadata indicates the

locality, somewhere in the global network of thousands of servers and relays. In line with Bryant's assertion that space does not pre-exist things, but rather arises from them, the metadata becomes the digital object that both forms and is formed by digital space. In this manner metadata becomes both the physical space with fences, walls and barriers, and the borderless space where law enforcement is inoperative. Canell's trace-router captures a glimpse of the underlying infrastructure, a snapshot of the path of least resistance along which a message has travelled. Although this picture is accurate for a network based on a throughput optimising logic, when taken from the Tor network it becomes distorted. This distortion stems from the introduction of a different logic into the construction of the network – a logic of privacy preservation: although the physical layout of the cables remains the same, the cartography of the digital space changes. By changing the routing strategy and protocol, a new network is created, and the nature of the direct path changes as a result of the changing gravity. In effect, this redraws the borders of the map.

The infrastructures of virtual space are just as restrictive, formative and determinative as the borders and walls of physical space, because they are deeply integrated into the infrastructures of everyday life. The two artistic projects I have presented expose the infrastructures of data transmission, storage and reception, and a central question is how these strategies of exploration of hidden infrastructures may help us to address matters concerning the digital objects that facilitate and determine social and political agency. They both explore the physical and virtual infrastructures that constitute the network, albeit in two different ways: Canell's cables offer a surgical dissection of the body of the network, whereas Paglen and Appelbaum's sculpture shows an alternative mode of operation for these cables, as they transmit packages of information. *Autonomy Cube* may be said to distort the process that enables Canell's website to lay out the entire scope of the physical infrastructure used for sending a package from one destination in the network to another. Instead of tracing the path of the message in the metadata that surrounds it, Tor creates a layered construction of encrypted metadata to begin with, which is peeled off layer by layer as the message traverses the network. In this way the artwork operates as a mediator between physical and digital space, exploiting precisely this intersection.

The digital border resembles the physical border, such as those between nations, yet is a much more extreme version of it. Whereas the physical border leaves room for the actual border in the form a bordered no man's land, the digital border seems to be completely binary. There is no label for the border location itself; one cannot be on the border, only on either side. Although there is a nuanced vocabulary that encompasses both physical and virtual borders and boundaries in real space, exemplified by De Genova's border spectacle, where the 'stuff' of signs, norms, beliefs and representations hinders and restricts movement, such a vocabulary seems to be missing in the case of digital space. Here, only virtual borders exist, and the binary nature of the digital border obstructs any attempt to identify a possible continuity between the discrete entities in the network. In order to explore the physicality of digital space, I propose the analytical concept of the digital object that emerges from the continuity between physical and digital spaces. The digital object, exemplified here by metadata in the transmission of a message, both forms and is formed by the digital space it traverses. With Bryant's expanded concept of gravity, the contours of digital space may be explored, contours that

determine the paths between sender and receiver as they draw and erase borders, restrict and enable movement.

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ENTANGLEMENT: MACHINE LEARNING AND HUMAN ETHICS IN DRIVER-LESS CAR CRASHES

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Algorithmic regulation of everyday life, institutions and social systems increases with little oversight or transparency, and yet usually with significant social outcomes (Angwin et al.; Pasquale). Therefore, the need for an 'ethics of algorithms' (Ananny; CIHR) and 'accountability' of algorithms (Diakopolous) has been raised. The "constellation of technologies" we have come to refer to as 'artificial intelligence'[1] (Crawford and Whittaker) enable an anxiety that sits alongside the financial speculation, experimentation and entrepreneurial enthusiasm that feeds the Silicon Valley gold rush of 'innovation'. How can machine intelligence optimise its decision-making and avoid errors, mistakes and accidents? Where machines are not directly programmed but learn, then who or what is accountable for errors and accidents, and how can this accountability be determined?

This paper is based on driver-less car[2] technology as currently being developed by Google[3] and Tesla, two companies that amplify their work in the media. More specifically, I focus on the moment of real and imagined crashes involving driver-less cars, and argue that the narrative of 'ethics of driver-less cars' indicates a shift in the construction of ethics, as an outcome of machine learning rather than a framework of values. Through applications of the 'Trolley Problem', among other tests, ethics has been transformed into a valuation based on processing of big data. Thus ethics-as-software enables what I refer to as big data-driven accountability. In this formulation, 'accountability' is distinguished from 'responsibility'; responsibility implies intentionality and can only be assigned to humans, whereas accountability includes a wide net of actors and interactions (in Simon). 'Transparency' is one of the more established, widely acknowledged mechanisms for accountability; based on the belief that *seeing into* a system delivers the truth of that system and thereby a means to govern it. There are however limitations to this mechanism in the context of algorithmic transparency (Ananny and Crawford). This work does not begin with a definition of accountability, but is part of a larger body of ongoing work that asks how accountability may be defined anew in a context where human and non human agents are in interaction.

This paper starts by looking at a recent crash involving a Tesla semi-autonomous car, and then examines literature around aviation crashes as a body of work that narrates how accountability in complex vehicles human-machine systems has been approached. This literature shows that establishing accountability is difficult because of the dense entanglements between human action and machine agency; that identifying the actors and events involved in a crash include complex chains of human and non-human agents. However, in the development of the driverless car, machine learning is being used to practically pre-empt crashes. I show that ethics becomes a framework to guide the development of machine learning, and thus in doing so sets up linear paths of accountability: if the machine can minimise human error by learning how to respond to a vast number of crash scenarios, then accountability becomes something much easier to un-entangle. However, this is the ambition for a fully autonomous consumer vehicle, which does not yet exist, and is unlikely to for at least the next ten years. Based on their documentation of driverless car testing and crashes, Brandon Schoettle and Michael Sivak conclude that the most risky period is that of transition from conventional driving to driverless cars. Moreover, industry predictions suggest that the insurance industry could be transformed by autonomous driving, moving to a model of offering coverage of technical errors rather than personal liabilty, much like cruise ships and airlines (Bertoncello and Wee). Thus I conclude

that there is a pressing need to confront machine learning as it is being applied to the new framing of ethics-as-accountability; and consequently develop new considerations of accountability in terms of, and building on, the reality of entanglements between human and machine agents.

Of Tesla and other crashes

In May 2016, an ex-US Navy veteran was test-driving a Model S Tesla semi-autonomous vehicle. The test driver, who was watching a Harry Potter movie at the time with the car in 'auto-pilot' mode, drove into a large trailer truck whose white surface was mistaken by the computer vision software for the sky. Thus it did not stop, and went straight into the truck. The fault, it seemed, was the driver's for trusting the auto-pilot mode, as the company's condolence statement suggests:

> *It is important to note that Tesla disables Autopilot by default and requires explicit acknowledgement that the system is new technology and still in a public beta phase before it can be enabled. When drivers activate Autopilot, the acknowledgement box explains, among other things, that Autopilot "is an assist feature that requires you to keep your hands on the steering wheel at all times," and that "you need to maintain control and responsibility for your vehicle" while using it. Additionally, every time that Autopilot is engaged, the car reminds the driver to "Always keep your hands on the wheel. Be prepared to take over at any time." The system also makes frequent checks to ensure that the driver's hands remain on the wheel and provides visual and audible alerts if hands-on is not detected. It then gradually slows down the car until hands-on is detected again. (Tesla)*

Tesla goes into detail to clarify that the human is assumed to be in control even though 'auto-pilot', familiar to anyone who has been up in an airplane, implies that the machine is in control. This confusion over the meaning of auto-pilot becomes a critical moment to begin to think about the relationship between the human operator and a complex machine and how challenging it becomes to identify responsibility for errors. The literature from aviation crash histories offers some valuable insights in this direction, and suggests that responsibility for a crash has never been easy to ascertain.

The history of aviation crashes shows that human error tends to be cited as the most common reason for accidents; moreover, there is a tendency to "praise the machine and punish the human" for accidents and crashes (Elish and Hwang). Looking specifically at the history of the role of autopilot, scholars find that even though there has been increasing automation in the cockpit, the responsibility for accidents remains with human pilots (10).

Peter Galison finds that identifying the cause of an aviation accident can be a Byzantine exercise. Examining narratives of aviation crashes, he finds that there is a deep entanglement in accounts of accidents between human actions and the perceived agency of technologies, a "recurrent strain to between a drive to ascribe final causation to human factors and an equally powerful, countervailing drive to assign agency to technological factors" (4). Galison finds that in accidents, human action and material agency are entwined to the point that causal chains both seem to terminate at particular, critical actions as well as radiate out towards human interactions and organisational cultures (4).

Yet, what is embedded in unstable accident reporting is the desire for a "single point of culpability" (Brown 378), which never seems to come.

Galison finds in these multi-causal accounts that there has been a gradual move away from individual action towards examining "mesoscopic world[s] in which patterns of behavior and small-group sociology could play a role" (37). A good example of the role of small-group sociology comes from Diane Vaughan's landmark ethnography of the *Challenger* Space Shuttle crash. She finds that the crash was caused by the 'normalisation of deviance', a slow and gradual loosening of standards for the evaluation and acceptance of risk in an engineering context. This loosening happens because of organisational-cultural issues, and not because of blatant corruption or malafide intent. *Challenger* exploded 73 seconds into its ascent because the 'O rings' on the rocket's boosters broke on that unusually cold January morning; and yet, it was known for over a year that the rings would fail in cold weather. Vaughan found that how engineers, scientists, bureaucrats, and managers communicated and managed risky or faulty engineering was determined by the bureaucratic language or processes of NASA. It got hidden, reframed, minimised, second-guessed, and eventually buried. In unearthing it, Vaughan found a complicated chain of accountable actors.

Madeleine Elish and Tim Hwang acknowledge multiple sites of potential responsibility for crashes and ask, "how do we locate the network of human actors responsible for the actions of computational agents?" (22). Is it the car manufacturer that is responsible, or the software development team that programmed the car's software? In the Tesla case, who is responsible? Is it the driver who lost his life because he misinterpreted what auto-pilot mode means, the computer vision software that wrongly categorised the side of a long truck trailer for the sky, or the manufacturer, Tesla, that did not pre-empt these possibilities? If all of these actors, and others not identified here, are somehow part of the story of how and why the crash happened, then how are they all to be held accountable and to what extent?

What is at stake in how accountability is assigned for crashes involving driver-less cars? In order to answer this question, this paper began by showing that assigning accountability in aviation crashes reveals a complex entanglement between the human operator and machine agent; and that, despite increasing automation, humans are still held responsible for crashes. Next, taking this forward into the driverless car context, I make a detour into machine learning in driver-less car technology; from there I will discuss how machine learning is related to the application of the *Trolley Problem* and the Pascalian *Wager*, which are both used to construct an 'ethics' of autonomous driving. This will then allow me to show how software and big data are implicated in the consequent framing of ethics.

Computer vision and machine learning for accuracy in driver-less cars

The precision and accuracy of driver-less cars comes from software that 'learns' appropriate driving behaviour – merging, driving around construction zones, etc. – through exposure to large datasets that its algorithms are trained on. The combination of computer vision and machine learning is used so the car can detect objects, identify and categorise them, and rely on data it has been 'exposed' to in order to make a decision about how to respond to objects and avoid

accidents.

One of the most significant features of machine learning algorithms is that they determine patterns. Algorithms such as convolutional neural nets, that are used in driver-less car software use their pattern-recognition ability to build internal models for identifying features of a dataset. Eventually, they can learn how those features are related without being explicitly programmed to do so (NVIDIA; Bojarski et al.). Another distinctive feature of machine learning more generally is that it is not always possible to open up the system and identify exactly *how* or *why* a decision was made to categorise and analyse something – machine learning is an inscrutable technology (Knight).

Rather than have to be 'brute-force' programmed, or 'hard-coded', to respond to every single possible situation it might encounter – a near impossible and exhausting software engineering exercise – driver-less car software uses machine learning to establish how to respond to unfamiliar situations through repeated practice (Google, *Self Driving Car Project*). An illustrative parallel to the difference between hard-coded programming and machine learning exists in the history of computers programs that play 'perfect information games', games where all information about the status of the game is available to all players. In the 1980s, *Deep Blue* was an IBM computer program that was brute-force programmed to play Chess; that is, every possible permutation and combination of moves that could be made on a 8×8 board with 32 pieces was programmed. The ancient Chinese game of Go however has a far higher number of possible moves; it is a more complex game than Chess. So in the development of *Alpha Go*, the Google computer program that plays Go, the algorithm looks at millions of games of Go, and discerns patterns in it. It can read which moves, and which combinations of moves, are more or less successful in achieving a winning outcome and then it is able to enact those moves when playing a game (Hassabis, Alpha Go).

Driver-less cars have to learn how to identify objects so they know how to respond to them in a similar way. Cars are fitted with radar, LIDAR ('light detection and ranging') and other sensors with which to perceive the environment around them. Computer vision software identifies an object and breaks up that image into small parts: edges, lines, corners, colour gradients and so on. By looking at billions of images, the neural nets in cars can identify patterns in how combinations of parts come together to constitute different objects. The expectation is that such software can identify a ball, a cat, or a child, and make a decision about how to react based on the data received. Yet, this is a technology still in development and there is the possibility for much confusion. So, things that are yellow, or things that have faces and two ears on top of the head for instance, can be misread until the software sees enough examples that distinguish how things that are yellow, or things with two ears on the top of the head, are different from one another. In the case of the Tesla crash, the software misread the large expanse of the side of the trailer truck for the sky. It is possible that the machine learning was not well-trained enough to make the required distinction.

Depending on what the object is, the driver-less car is expected to respond: stop, go around it, wait for it, and so on. With increasing exposure to good quality data, the software can distinguish between different kinds of objects and eventually make more fine-grained decisions. The more complex something is visually, without solid edges or curves or single colours – or if it is a fast, small, or flexible object on the road – the more difficult it is to understand. So, driver-less car software is shown to have a so-called

'bicycle problem' because bicycles are difficult to identify, are not a structured shape, and can move at different speeds (Fairley). Being able to identify objects on the road and assess their relative value in relation to each other has become a central aspect of the narrative around ethics in driver-less cars, which the paper now turns to.

Programming ethics in machines: Trolley Problems and Wagers

Ethics is assumed to be a framework for values governing appropriate actions in society; and often applied in situations that are difficult for the law to regulate, or where laws do not yet exist. 'Machine ethics', 'information ethics', 'computer ethics', and 'robot ethics' are some overlapping fields that deal with ethics in contexts relevant to the present discussion, however it is beyond the scope of this paper to unpack each of these in more detail. Mike Ananny has identified three approaches to ethics in technology across these domains, and these tend to mirror consequentialist, Kantian (or, deontological), and virtue ethics: developing policies and regulations by codifying use of technologies, developing standards, best practices and anticipating future failures; anticipating the ethical outcomes of technologies and how they reconfigure social relationships; and investigating the values of designers and developers of these technologies (95).

In the context of driver-less cars, the accident is framed as a moment when a decision has to be made by software about how to avoid it. This decision-making process is tantamount to 'ethics' and has been framed in terms of Kantian ethics and consequentialist ethics through the Trolley Problem, a popular shorthand for the discussion about ethics in driver-less car contexts (Lin; Google, *Self Driving Car Project*). In the world of the Trolley Problem, an autonomous vehicle is expected to learn to make the optimal choice in the case of the worst scenario imaginable – an autonomous vehicle being involved in the killing of human beings.

The Trolley Problem is a classic thought experiment developed by the Oxford philosopher, Philippa Foot in 1967, originally to discuss the permissibility of abortion. The Trolley problem is presented as a series of hypothetical situations with two or more negative outcomes, in which consequentialist or deontological approaches must be used to find a way to choose the lesser of two negative outcomes. The Trolley Problem is described by Judith Jarvis Thompson in the following way:

> *Suppose you are the driver of a trolley. The trolley rounds a bend, and there come into view ahead five track workmen, who have been repairing the track. The track goes through a bit of a valley at that point, and the sides are steep, so you must stop the trolley if you are to avoid running the five men down. You step on the brakes, but alas they don't work. Now you suddenly see a spur of track leading off to the right. You can turn the trolley onto it, and thus save the five men on the straight track ahead. Unfortunately, Mrs. Foot has arranged that there is one track workman on that spur of track. He can no more get off the track in time than the five can, so you will kill him if you turn the trolley onto him. Is it morally permissible for you to turn the trolley?" (1395)*

Thompson goes on to describe versions of the Problem substituting track workmen and the trolley with other characters

and circumstances. Each version of The Trolley Problem necessitates a process of reasoning by invoking the tension between Kantian ethics, and consequentialist ethics: does how you *arrive* at the outcome matter more than the *outcome* itself? Is it more important to save more lives (a consequentialist approach), or is it more important to consider *how* people die? (the deontological approach), and in which situations is one approach more valid than the other?

Patrick Lin has developed an application of the Trolley Problem (as described by Bhargava and Kim 2017) as has MIT's Moral Machine Project. In the Lin version, the driver-less car is in a situation where it has to decide which of two difficult options to select in order to save itself, such as having to either hit a cyclist wearing a helmet or one that is not; or decide what to do if a child runs out across a road; or how to rationalise potentially harming occupants of a car known to have poor crash test ratings. The Moral Machine Project is an online research exercise based on the Trolley Problem that serves as "a platform for 1) building a crowd-sourced picture of human opinion on how machines should make decisions when faced with moral dilemmas, and 2) crowd-sourcing assembly and discussion of potential scenarios of moral consequence" (Rahwan, Bonnefon and Sharif). In this, the driver-less car has to select which kinds of humans to avoid hitting – children, pregnant women, older people, escaping thieves, athletes, or animals like cats and dogs – in the case of brake failure.

Vikram Bhargava and Tae Wan Kim find however that the Trolley Problem does not address the fact that Kantian and consequentialist cannot be resolved because they are not of the same kind of moral value ("value incommensurability"); that the Problem sets up a situation beset by moral uncertainty; that it does not afford a "view from nowhere", meaning one that is 'objective'. In such an objective view, say the authors, even the driver-less car should be factored in to the question of who or what should be saved in the case of an unavoidable crash; in the Trolley Problem, the driver-less car and its occupants are not assumed to be at risk in a crash, only pedestrians or other vehicles and drivers are. Instead Bhargava and Kim suggest an application of the Pascalian *Wager*, along with a ranking system developed by Andrew Sepielli. In this, calculations to rank different outcomes of crashes are developed to arrive at an 'objective' choice. So, the cases of the car with failed brakes ramming into a child, an animal, or a helmet-wearing cyclist, or destroying itself to save others, are all given numerical rankings. An algebraic calculation processes these rankings to arrive at the most mathematically objective outcome. The authors note that ethics tests properly applied in this way could help to establish accident claims under the law, and allow manufacturers to offer their customers a "moral navigation system", much like a menu of Facebook's privacy settings from a drop-down list; and manufacturers could generate crowdsourcing mechanisms to generate datasets of appropriate, and objective, decisions for machine learning (13-14).

There is a nuanced shift suggested by this scenario. If 'ethics' has become a series of computations that can be augmented by big data, then ethics – and thereby failures of ethics – is seen as a matter of individual morality rather than that of a group of individuals, organisations, laws, or other actants. Through application of the Trolley Problem, it is almost as if the car is imagined to be a sort of neoliberal, individualised, subject. As 'self driving', it is imagined to be an individual moral agent that can act independently and efficiently on the basis of guidelines and feedback (Ganesh).

It is possible that data currently being harvested about driver behaviour from a

variety of sources – from highway cameras, police records, social media, insurance records, automotive engineering simulations, and so on – will be used to develop machine learning algorithms that will learn how to make decisions across different situations. Something to this effect has already been in development and testing as Anderson and Anderson discuss in their paper on the possibility of creating an ethical, intelligent machine agent. They cite an approach to applied ethics called *casuistry*: "the branch of applied ethics that, eschewing principle-based approaches to ethics, attempts to determine correct responses to new ethical dilemmas by drawing conclusions based on parallels with previous cases in which there is agreement concerning the correct response" (20). This appears to be very much along the lines of machine-learning for decision-making discussed here. They cite work by Rzepka and Araki that identifies such an approach to machine ethics:

> *it might be safer to have machines "imitating millions, not a few," believing in such "democracy-dependent algorithms" because, they contend, "most people behave ethically without learning ethics." They propose… [to] search the web for opinions, usual behaviors, common consequences, and exceptions, by counting ethically relevant neighboring words and phrases, aligning these along a continuum from positive to negative behaviors, and subjecting this information to statistical analysis. They suggest that this analysis, in turn, would be helpful in the development of a sort of majority-rule ethics useful in guiding the behavior of autonomous systems." (Anderson and Anderson 20)*

However they do not discuss what the practical implications of this sort of application are. For example, that crowdsourced datasets are neither 'raw' nor neutral, and import the errors, biases, and the cultural and local contexts encoded in them. One of the 'promises' of big data is that of insight and prediction, a kind of 'higher' knowledge (boyd and Crawford). Something to that effect is being invoked here in pre-empting crashes. The idea that crash situations can be envisioned is, however, not entirely new to the automotive industry. In the 2000s car manufacturers began to invest large sums in mathematical modelling. Paul Leonardi cites Nigel Gale's work in identifying "road to lab to math" as an industry-wide belief that mathematics-based simulations are more cost-efficient than road and laboratory testing:

> *Math is the next logical step in the process over testing on the road and in the lab. Math is much more cost effective because you don't have to build pre-production vehicles and then waste them. We've got to get out in front of the technology so it doesn't leave us behind. We have to live and breathe math. When we do that, we can pass the savings on to the consumer. (244)*

Thinking outside black box ethics

In the development of driver-less cars we can see an ambition for the development of what James Moor refers to as an *explicit ethical agent* – one that is able to calculate the best action in an ethical dilemma – through big data technologies. In the development of machine intelligence towards this goal, a series of shifts can be discerned: from accounting

for crashes after the fact, to pre-empting them; from ethics that is about values, or reasoning, to ethics as crowdsourced, or based on statistics, and as the outcome of software engineering. Thus ethics-as-accountability moves towards a more opaque, narrow project, and away from the kinds of entanglements that scholars such as Galison and Vaughan identify.

Yet, as the Tesla crash indicates, if there was both an error in the computer vision and machine learning software, as well as a lapse on the part of the test driver who misunderstood what the term autopilot meant, then how are these two conditions to be understood as part of the dynamic that resulted in the crash? What is the relationship between them? How might an ethics be imagined for this sort of crash that comes from an unfortunate entanglement of machine error and human error?

In a 2016 paper, Mike Ananny and Kate Crawford confront the idea of transparency as a mechanism for algorithmic accountability citing ten limitations of the idea of transparency, emphasising that "it is sometimes unnecessary and always insufficient to simply look inside structures"; but that the limitations of the idea of transparency could serve as a starting point for accountability (12-13). In this vein, I conclude with an agenda for future work.

In thinking about a framework for values, and in rethinking accountability, how can the multiple, parallel conditions present in driving be conceptualised? Rather than understanding an 'ethics of driver-less cars' to be a set of programmable rules for appropriate action, could it instead be imagined as a process by which an assemblage of people, social groups, cultural codes, institutions, regulatory standards, infrastructures, technical code, and engineering are framed in terms of their interaction? As Ananny notes:

> *In reality, technology ethics emerges from a mix of institutionalized codes, professional cultures, technological capabilities, social practices, and individual decision making. Indeed, ethical inquiry in any domain is not a test to be passed or a culture to be interrogated but a complex social and* cultural achievement *(Christians et al. 2009). It entails anticipating how the intersecting dynamics of a sociotechnical system—design, interpretation, use, deployment, value—"matter" for the future (Marres 2007)—and figuring out how to hold these intersections accountable in light of an ethical framework. (96; emphasis in original)*

In this conception, ethics is not just a end-point or outcome, but is something that can be imagined as a series of individual and system-level negotiations involving socio-technical, technical, human and post-human relationships and exchanges. The more challenging and intriguing questions of how these actors and their inter-relationships are to be materialised and made visible are still to be answered, but perhaps we may start to discern the shape of the black box.

Notes

[1] In a recent public event, *AI Now*, convened by the White House, 'artificial intelligence' was defined as a constellation of technologies that includes machine learning, natural language processing, and big data. This text ascribes to this definition of AI as a constellation.

[2] 'Autonomous vehicles', 'self driving cars', and 'driver-less cars' are all commonly used terms today referring to the same technology. There are five levels of autonomy in vehicles as defined by the United States' National Traffic and Highway Safety Authority. At present, there is no fully autonomous vehicle in testing or operation, but it is Google's ambition to create one. Tesla is working on a semi-autonomous vehicle. Traditional car manufacturers have been introducing increasing levels of autonomy in existing car models, such as adaptive parking, highway assist, or cruise control. Thus, this paper does not use the word 'autonomous vehicles' but uses the terms 'driver-less cars' or 'self driving cars' to refer to this technology.

[3] Both Google and its self-driving car project have undergone some changes in identity. Google is now known as *Alphabet*, and the self driving car project is called *Waymo*.

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POST ANTHROPOCENTRIC RECONSIDERATIONS

Abelardo Gil-Fournier

SEEDING AND SEEING: THE INNER COLONISATION OF LAND AND VISION

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> *In the impact of a forest on the steppe, or in a mass of lichens moving up from the tundra to stifle a forest, we see the actual movement of solar energy being transformed into the chemical energy of our planet. (Vernadsky 62)*
>
> *Light, where it exists, can exert an action, and, in certain circumstances, does exert one sufficient to cause changes in material bodies. Suppose, then, such an action could be exerted on the paper; and suppose the paper could be visibly changed by it. (Talbot 4)*

Observed mainly in plants, phototropism names the chemical ability of certain cells and organelles to self-divide and to grow as a reaction to the exposure to light. It is one in the set of massively repeated operations that transform sunlight into the vast, rich and varied envelope of life that we know as the Biosphere. This paper deals with the planetary wide capacity of processing light, a capacity that is related to a pervasive presence of different types of interactions with light: the ones that produce the visible, within the eyes or, more noticeably even, within the far-reaching omnipresence of visual media.[1]

The interweaving of the seen and the seeded will be exposed through an account of different episodes of industrial agriculture where the role played by visual operations has been critical. In particular, two agrarian reforms and land settlement programmes that took place during the 20th-century will be addressed: the German *Innere Kolonisation* and the Spanish *Colonización interior*. Invisibility, the notion of empty space and the practice of aerial photography were essential to these developments, as it will be shown, and simultaneous with the growth of infrastructures such as irrigation networks or workers housing.

In this paper, the coupled performance of both visual apparatus and infrastructures on the ground will be considered from what Eva Horn has called a 'medial a priori': the "assemblages or constellations of certain technologies, fields of knowledge, and social institutions" (Horn 8) that become the conditions of possibility of processes, transformations or events. A medial a priori consisting of "discourse networks, cultural techniques and formations of knowledge" (Siegert, *The Map is the Territory* 15) that, in the broadest sense, goes even beyond the technical assemblages, to deal with the flows of energy and matter that give rise to them. In this vein, the interweaving of operations of light that gives rise to the seeded and the seen steps into what Jussi Parikka has framed as an alternative deep time of media, where "any consideration of media should start not from media but outside it" (*Earth Volumes* 124). It is within this frame of reference this paper departs.

"Light fills and forms the world" (Cubitt 2), inside and outside our eyes. Outside our eyes, these inner colonisations changed the manner in which the encounter of light and soil took place on a large portion of the totality of the surfaces of the Earth. Their scale gave way to the Green Revolution, with its oversized agri-food corporations, and to contemporary information-based precision farming technologies. To what extent these colonisations of the encounter of light and soil also changed the way contemporary vision is produced, that is, the shape of the interaction of light with visual media, will be discussed at the end of the paper.

Figure 1: Workers building an irrigation channel in a forced labour camp in Krychów (Poland) managed by the German administration of the General Plan East preparing latifundia for the colonists (1940). Source: Wikipedia / HANSK

Emptiness and the German Inner Colonisation

In 1884 German economist Max Sering proposed a rational land allocation project meant to increase production. It was a plan inspired by the government-sponsored settlements in the US and Canada, where the productivity of the farms had made the prices of cereals sink. The *Innere Kolonisation*—as he named it—was presented as an agrarian economist argument that aimed to develop the Reich's politics in relation to the Ostsiedlung, a settlement plan based on a fund that financially helped Prussian farmers to buy land and move to the East. While the original government programme encouraged German landowners to acquire large inefficient estates and employ seasonal workers, Sering's thesis devised instead an "agrarian-industrial state" (Nelson, *From Manitoba* 449) constituted by committed "peasants turned into landowners, as in western America" (Sering 98). In 1919, right after the end of WWI, Sering was promoted to lead the Kolonisation and appointed to write a new Settlement Law. The Weimar Republic, forced to give up its foreign colonies after the Treaty of Versailles, needed its domestic food production to be strengthened in order to replace the incoming flows of external resources that had been cut. Moreover, as the regions of Posen and West Prussia were gone too, the government wanted the Eastern provinces to be further populated in order to prevent future annexations. Sering's ideas on the inner colonisation as densification of the productive land were then applied, and further expanded in his newly funded Research Institute for Agriculture and Settlement. At the beginning of the 1930s, however, his position became increasingly unstable. His assimilationist colonisation model, committed "to raise the cultural level" through the Germanisation of the local Poles, was considered in opposition to the Nazi's race-based politics and ideas of purification (Nelson, *From Manitoba* 440).

Yet, despite Sering's differences with the racial programme, his settler colonialism and the following expansionist plan—the infamous *Generalplan Ost* [General Plan East]—shared a common abstraction: the colonial notion of empty space.

In cultural historian Robert L. Nelson's analysis of the German inner colonisation and its links to the settler programmes in North America, it is observed that where colonisation meant "bringing under plough any 'unused' or 'wasted' property" (Nelson, *Emptiness* 162), an abstracted view of space was in operation. It was, in particular, a notion that likened the absence of German culture and productivity to the emptiness of people (*From Manitoba* 456).[2] Moreover, Nelson relates this emptiness to the principle of *vacuum domicilium* described by John Locke, allegedly operating in the English occupation of American lands: "in a pattern to be repeated throughout the history of colonialism, Natives who failed to practice modern modes of production disappeared into the empty backdrop of nature" (*Emptiness* 165). Interestingly, this abstraction in the encounter of settlers with the territory addresses the visual, on the one hand, as it disregards and renders invisible native populations in most cases, while on the other hand it acts on the territory itself, allowing the clearing, replacement and the cultivation of land. However, this double operation of emptiness—instrumental and representational—collapses in Nelson's analysis, and becomes the consequence of a "colonial gaze" (169), a modulation of a pre-existing and untouched subject, the coloniser, able already both to represent and perform. A gaze, in Nelson's words, "that produces empty space in the eyes of the colonizer… followed by new, proper settlers and correct modes of production" (169).

If we, however, take into account the tools, techniques and practices put into play (instead of relying only on an acculturated subject) it becomes possible to consider this emptiness as part of a 'medial a priori' operating in the colonial. Such a material media history of the inner colonisation would characterize it as an unfolding of agencies and operating abstractions whose persistence, in particular as media forms, would help to understand the contemporary post-digital within larger temporal contexts. In the following, I am going to follow this path through two different developments: first, through Bernhard

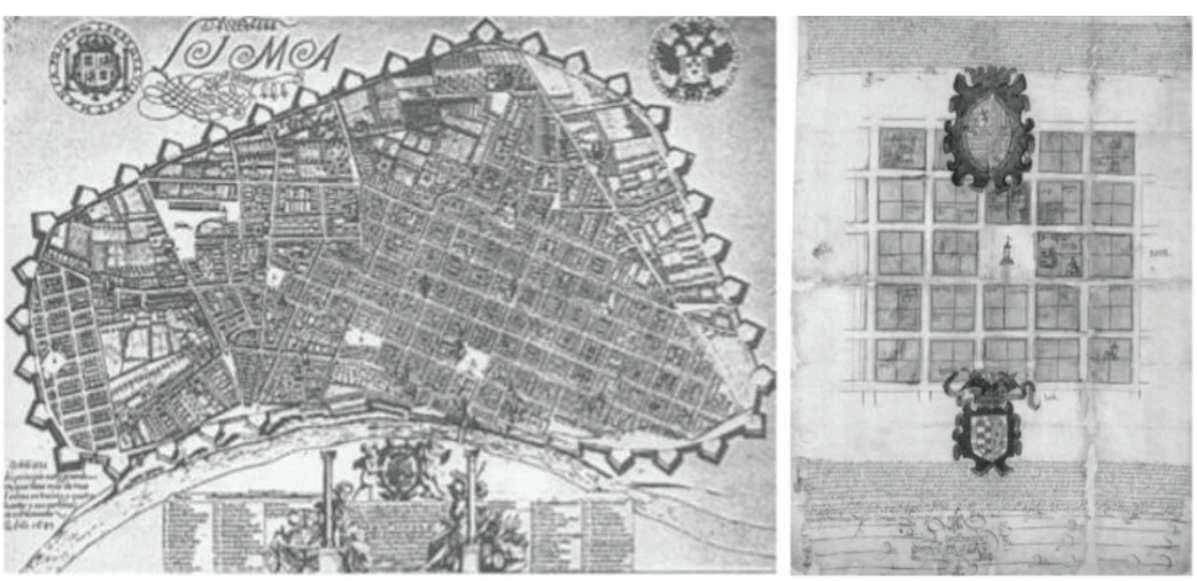

Figure 2: Lima (Perú) 1687, and San Juan de la Frontera (Argentina) 1562. Source: Siegert, Cultural Techniques.

Siegert's account of the use of grids and lattices during the 16th-century colonisation of America, and second, through the crucial role played by aerial photography during the agrarian inner colonisations of the last century.

Colonial Grids

In his work on the role of maps during the foundation and early urbanism of Spanish colonial cities in America, Siegert remarks that urban settlements were not planned and built on the basis of an actual number of settlers, but were instead devised with future growing populations in mind. Initial drawings and plans used by the founders of these cities consisted of boundless grids as abstract layouts to be used at the same time as "plans, registers and cadastres" (Siegert, *Cultural Techniques* 107). They had an indexing character, and were able to address both the already present settlers as well as future ones. For Siegert, they were tools that enabled and sustained "the possibility of writing empty spaces, that is, the ability to literally reserve a space for the unknown" (107). Grids introduced therefore a fundamental separation between data and address: "Persons… are turned into data that can be stored for subsequent retrieval by the correct addresses that logically and temporally precede them" (107). Settler homes, institutions or businesses would become the data to populate a space of addresses—the land reserved for the city—which would then coincide with the paper surface: an addressable, graphical emptiness. This means that this "semiotics of zero" (100) would not necessarily stem from an already acculturated colonial gaze, but would be inscribed instead in colonial media. Grids, coming from Antiquity and used during the Reconquista, were already identifying urban order with political order; as a Renaissance graphical tool, additionally, they entailed also the technics of a "data space" (100) to allow that "everything

Figure 3: Picture of the penal colony of Los Merinales in Dos Hermanas (Seville, 1945), displaying the construction of an underground water channel, part of the Spanish Inner Colonisation, by war prisoners. Source: Archivo RMHSA-CGT.

is assigned its own place" (108). Emptiness, therefore, was literally transported in the caravels, not as abstractions in the minds of those gold seekers, but in the instruments they used to operate: in the papers and inks, on the one hand, and in the knives and cuirasses, on the other.

Aerial enforced infrastructures and the Spanish inner colonisation

Cultural techniques such as the grid are practised, learnt and disseminated in time and space, and are also embedded, reshaped or codified within different tools, devices or media. This is the case, for instance, of photogrammetric equipment used in aerial surveys. Provided currently with GPS receivers and other movement tracking devices, digital cameras for aerial photography are able to produce images suitable to be automatically rectified with the adequate software and exported to fit within grid-based tiled maps (Jacobsen et al. 84). Although the first military and commercial procedures of aerial photographic surveys needed large amounts of time from skilled interpreters to build up the photo-mosaics with the aid of existing maps (Saint-Amour 243), they have been used, at least since the 1910s, as a measuring tool. Through them, military and civilian infrastructures were located and cadastral information retrieved and added with precision to the grids of cartographic maps. Subsequently, aerial surveys became particularly apt for 20th-century development and land reform plans in Europe, where the scale of operations such as water infrastructures or urbanisations met the spatial extent of the aerial perspective. Wastelands had become empty; it was needed to monitor them in order to start making them productive. This process in Spain was called *la colonización interior*, the inner colonisation.

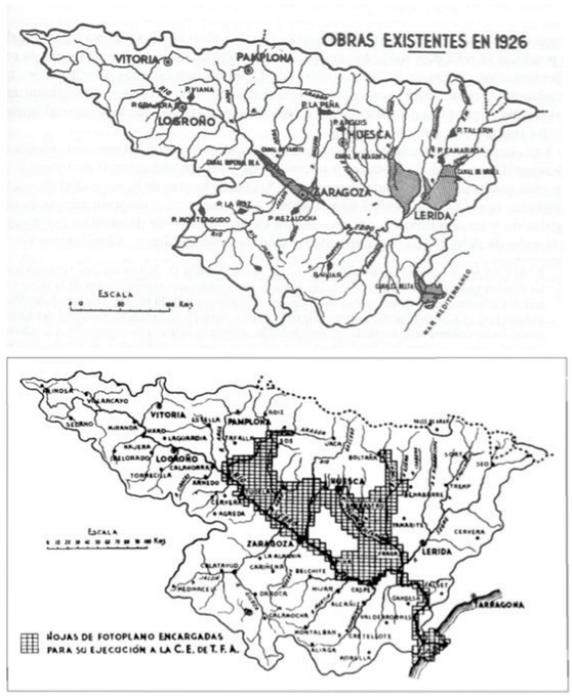

Figure 4: Upper image, works executed during the development of the Ebro River Basin in 1926; Lower image, areas aerially photographed in 1929. Source: Fernández..

In 1926, during the dictatorship of Miguel Primo de Rivera, a new administrative entity was defined in Spain: the River Basin Authorities. Instead of the province or other political-geographical demarcations, the physical river basin and its connected waters became the territorial unit used to organize water planning in an integral approach (Martín-Retortillo 105). By means of it, one single institution supervised all the possible uses of fluvial waters, such as irrigation, transport and energy. The 1926 law demanded complete and precise cartographies of the territories under their control, detailed enough to display also their divisions into plots. As the existing resources were inadequate, and in order to acquire this material in a quick way, the only means to technically render it possible was to contract the services offered by a private company that pioneered and promoted aerial photography (Fernández 223). The first set of official aerial photographic images of Spanish land dates from

this time, and the use of aircrafts to produce cartographic documents was soon extended to the completion of an updated cadastre. The number of acres of land photographed from the sky grew then sustainably, until the Civil War paused everything.

Years later, after WWII, it was the US Army Map Service who continued the aerial mapping, completing two ortho-photographic archives of the whole Spanish territory in 1945 and 1956 (Fernández and Quirós 190). Spain was already governed by the Franco dictatorship, and a vast Agrarian Reform and Land Settlement programme was in operation, managed by the Spanish National Institute of Colonisation. Across three decades, from 1939 to 1973, enormous extensions of land were repurposed in order to increase agricultural productivity and demographic growth, parallel to the engineering of large-scale water infrastructures and other operations; among these, for instance, were expropriations, drainage of ponds, big movements of soil and population, formative practices, the supply of machines and fertilisers and a centralised management of the information gathered in the continuous monitoring of the process.[3]

This material redefinition in Spain also involved an ambitious project of networked rural urbanism. New towns had to be built to house the workers, where nothing existed but wasteland. These are well-known urbanism experiments today because of their intrinsic architectural qualities: an avant-garde of Spanish architects had the opportunity to build new villages, ex-novo, and designed them departing from a social and rationalistic point of view. During this process, that described exhaustively the shape of family units, the sizes of plots and the economic relation between the State and settlers, the foundation of approximately 300 towns and 30000 dwellings was triggered (Delgado 80)

Figure 3: Picture of the penal colony of Los Merinales in Figure 5: Villalba de Calatrava, 1955. Source: Delgado (131).

Needless to say, the abstract and serialised urbanism did not mitigate the settlers' sense of loss when inhabiting the new villages. They arrived to towns with no memory, which offered only a predesigned future. Additionally, houses and plots were not theirs: during 20 to 40 years they had to pay off the housing and investments provided by the Institute, which was meanwhile the legal owner. They were instead left with an environment turned into a production system. The most informed critique to these actions is the book *Extremadura Saqueada* (Extremadura Exploited) edited by ecological economists Mario Gaviria, José Manuel Naredo and Juan Serna, which compares the organisation of human settlements inside an Irrigation Zone with a Mumfordian archaic work machine, oriented to the production of foodstuff: "Although it was made of living human parts, it was a work machine, so tightly articulated that individuals were reduced to 'things' to fit in a prearranged bureaucratic mechanism." (Gaviria, Naredo and Serna 18)

Some of the urban plans, additionally, emphasised an interweaving between population and soil: in Cañada del Agra, a root-like spreading of the streets allowed the town to organically lay on the terrain; in many other towns, such as Esquivel, the main square was placed outside, as if crops were incorporated to the urban scene (Delgado 143).

Furthermore, the space between towns was measured in terms of a magnitude called the "cart-module" – the maximum operative distance covered by a settler with a cart (Alagón 8). The centres of these circles of influence were the nodes of the irrigation network, which provided with water to a shared grid of canals that fed both the soils and the settler's homes. It is as if settlers and crops were not necessarily distinguishable, as if an underlying managerial grid were addressing and symbolically manipulating both of them, at the same time, as if they had already been transformed into data; or as Parikka puts it, "isolated, analyzed, synthesized, and entered into circulation as deterritorialized bits of information that can be traded in complex, global ways." (Parikka, *A Geology of Media* 110).

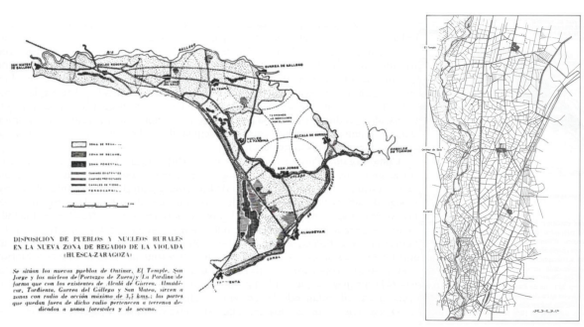

Figure 6: Maps displaying cart-modules and water channel infrastructures in the colonisation of the desert of La Violada, Zaragoza. Source: Villanueva and Leal.

A New Soil

In a blurred, hybrid process, land became an infrastructural surface to hold and transform solar light energy into cereals, fruits and vegetables in an efficient way, while at the same time the reflected sunlight became gradually a source of information to be stored in the photographic plates carried on by aircrafts owned by military and cartographic institutes. The same land was, on the one hand, measured, parcelled and populated and, on the other hand, photographed frame by frame by fleets of aircrafts. In some sense, these were two envelopes growing at the same time: a surface of hundreds of thousands of acres of uncultivated land transformed into green areas of productive yields, and the organised grid of images taken from airplanes.

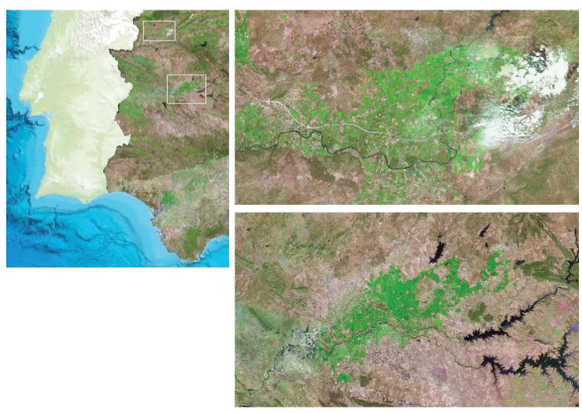

Figure 7: Two Irrigation Zones—Alagón and Guadiana—as seen from a satellite in 2014. Source: Instituto Geográfico Nacional (IGN).

This image (fig. 7), where the scale of the transformations of the Spanish Inner Colonization is visible, shows a portion of the planet brought materially to behave productively, displaying how vast territories were activated thanks to their connection to huge water reservoirs. The image can be read in fact as a thermodynamic diagram, displaying the inner workings of an abstract machine. Interestingly, during the first decades of the 20th century, and after the chemical industries had ended up synthetising nitrogen to fuel the productivity of yields, a thermodynamic stance started to be applied to the Biosphere, the uppermost layer of the planet, encompassing the Earth's soils, waters, oceans and living entities. In this vein, the works by the Russian mineralogist Vladimir Vernadsky or the American mathematician Alfred Lotka introduced an additional agency, the biochemistry of the soil itself. Interfacing the Earth with the Universe, the Biosphere as an "envelope of life where the planet meets the cosmic milieu" (Vernadsky 39),

was fully described in 1926 by Vernadsky as an ensemble of living and non-living agents that create and keep active a biochemical film, a "living film" "where the radiant energy of the Sun is transformed into free terrestrial, chemical energy" (Vernadsky 148). To Lotka, in his seminal book *Elements of Physical Biology*, this ensemble and context of living creatures in the Earth could certainly be considered a machine, a "World Engine" (Lotka 331), an energy transformer composed by a multitude of subsidiary units, each separately working together as a whole. "It is well to accustom the mind to think of this as one vast unit," he wrote, and added: "one great empire" (Lotka 331).

Focusing on the molecular cycles where the soil was involved, Lotka emphasised the practical aspects of his quantitative approach, and drew upon outcomes and statistics relative to recent agricultural engineering. Among them, remarkably, the synthesis of ammonia and its industrial production, a particularly relevant technique that had been recently created by the German chemical complex. Thanks to it, synthetic fertilisers could be industrially produced from the open air, and thereby increase the productivity of the "World Engine". After WWII, the growth of synthetically fixed nitrogen was exponential, forcing even the need to look for high-yielding varieties of crops, as the previous ones could not absorb the extra nutrients. Combined with the use of different types of pesticides, the increasing consumptions of water caused a need for large-scale irrigation infrastructures. In the 1960s, all of this was marketed as the Green Revolution, an ensemble of techno-scientific developments, patents and planetary management strategies, announced somehow by Lotka, already in the 1920s, for whom the consequences of synthetic nitrogen would be considered "literally comparable in magnitude with cosmic processes" (Lotka 241).

The inner colonisation of land and vision

This development of aerial, mechanical and chemically-aided soil operations has evolved to become a multi-scale practice today; in a much more dense and intensive way, in fact. Under the umbrella term of *Precision Farming*, devices on tractors are programmed to control the dispersion of water and chemicals upon information gained from satellite or aircraft based sensors that measure the wavelengths of radiant energy absorbed and reflected from the land surface. Soil moisture, surface temperature, photosynthetic activity, and weed or pest infestations are addressable with a resolution of a square metre, almost exactly the size of the irrigation system actuator. Other irrigation infrastructures carry their own imaging devices, feeding the soil according to real-time data obtained from infrared cameras.

Precision Farming comes then at the end of a list of what I so far have been addressing as a set of practices on the ground, and as media operations linked to periods of colonisation and agrarian development. Periods where big portions of the surface of the planet became green: nominally, as in the Green Revolution, or literally, as in post-processed satellital images, where areas that reflect infrared frequencies are rendered in this colour as they trace vegetation activity. In this paper, this has been described in terms of grids and the production of emptiness; the aerial and the new scope of the various transformations; and the chemical as the, so to say, colour fixer. These are episodes, in the end, that might be appraised as a media history of soil.

The question now is whether vision becomes something else, once visual media techniques are considered from the point of view of the entanglement with operations on

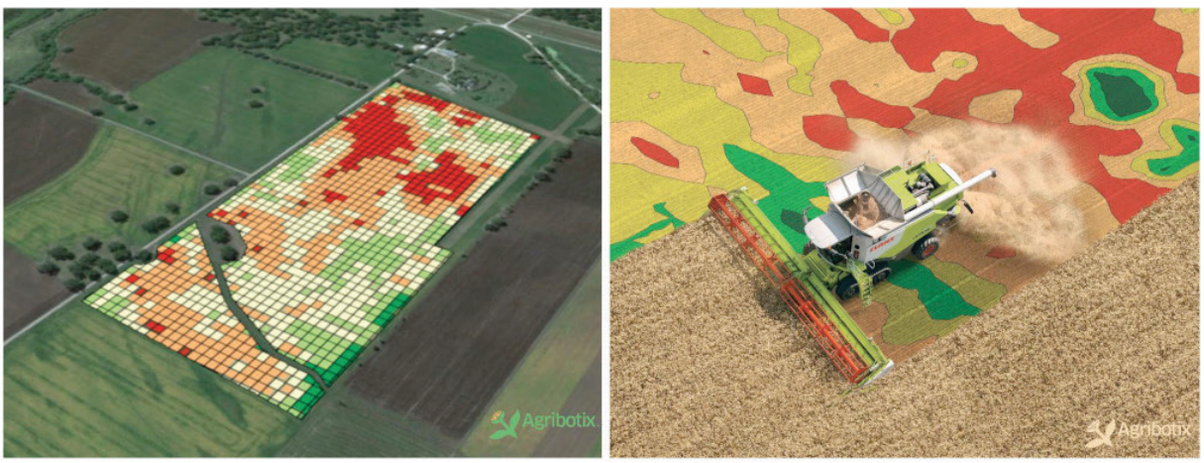

Figure 8: Images from the website of Agribotix, a company that commercialises precision farming technologies.

the soil. "To engage aerial sightedness—or even vision in its most basic form—," writes Ryan Bishop, "is to yield almost completely to the promise and problems posed by the surface," and to rely thus "upon some other entity, some other ground, not visible or graspable for its support" (Bishop 276). Vision inherits in its historicity and technicity the issues and nuances linked with the ways and contexts where it is produced and communicated, a ground of practices and operations that, without dealing directly with the visual contents themselves, belong to the relationships between humans and the environment. We might ask, then, in which ways this media history of soil can be understood the other way round, as a soil-based genealogy of visual media. In this vein, the notion of "medianatures," coined by Parikka as an elaboration of Haraway's 'naturecultures' (Parikka, "Media Zoology"), is particularly relevant. They characterise the entangled set of practices where media and nature appear as "co-constituting spheres, where the ties are intensively connected in material nonhuman realities as much as in relations of power, economy, and work," making it impossible to distinguish such spheres separately (Parikka, *A Geology of Media* 14). It is a relevant notion at this point, if we insist once more in the double operation that light exerts on the world: it allows us to see, on the one hand, and it makes the living crust of the planet grow, on the other. These are two parallel imprints that give rise to the apparently separate realms of visual culture and agriculture, which might therefore be considered as parts of the same whole. Put in a different way: we see, but not alone; as the world "sees" too, giving the Biosphere its elaborate output.

Episodes such as the inner colonisation of the wastelands, the nitrification of yields and the subsequent assimilation of the Biosphere into the regime of the industrial display a tamed "practice of light," in Cubitt's words. This is a mediation that has been again "parceled out, amassed, ossified, delayed, hypostasized" (Cubitt 2), affecting not only the Biosphere, but seeing on a planetary scale. An inner colonisation of the seeded, then, where the seen might have become the sown.

Notes

[1] On the unavoidable and politically significant presence of the non-human within the contemporary regime of the visual, see for instance the recent essay about the machinic circuits of invisible images by Trevor Paglen.

[2] A similar case of colonisation is the Israeli one, described in *The Conflict Shoreline* (Weizman and Sheikh).

[3] For more information, see the exhaustive collection and review of documents in relation to Spanish Inner Colonisation in the series of volumes *Historia y evolucion de la colonizacion agraria en España*, edited by the Spanish Ministry of Agriculture. (Villanueva and Leal).

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INTERVIEW WITH AN ETHERBOX

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“Etherbox” is the name of a configuration of software and hardware that was in use during the Machine Research workshop co-organised with Constant and held at Brussels World Trade Center, 24-26 October 2016. Speaking “in” and “from” the situation, the platform was used to collectively write the Questions and Answers of this interview by the workshop participants.

Q: Before any conversation can begin, we should establish a mutual language. What language, should I address you in?
A: How do you mean? I support utf-8.

Q: That’s not what I meant. What about English?
A: No problem.

Q: OK. Where do we begin?
A: Try typing etherbox.local/var/www/ in your browser. Part of the etherbox is an Apache web server configured to publically serve the entire structure of the hosting machine. etherbox.local refers to that machine on your local network, and /var/www is the default path of the “home” directory of the server.

Q: Would you describe yourself as a good host?
A: I am trying to be, at least. To be a “good host” according to me, means somehow more than offering reliable service. So to find a way to be present, but not in the way that other technologies disallow access. Does that make any sense?

Q: Sort of, but are you not just part of the more general trend of the shift from software to services?
A: I try to be both.

Q: Right. So who is your favourite peer?
A: I think of myself as… collaborator agnostic, but now I look around me, I am not so sure that is true.

Q: What makes an etherbox?
A: Well for one thing, etherpad. It’s basically a shared editor where users can write the same text simultaneously.

Q: Could another way of collaborative writing work equally well? Like for instance, what do you think of Google docs? Sorry that was a provocation.
A: Ha ha. Well as a matter of fact, etherpad started as a product of ex-Google employees, then got bought by Google, only to be later Open Sourced.

Q: And Piratepad, is it the same?
A: That’s just a public instance of the etherpad software, it is of course not a box like me. But the naming is interesting too, as it demonstrates how other kinds of political imaginaries can be activated. I feel an affinity with pirates. I like their style.

Q: Ah, so why don’t you call yourself a Piratebox?
A: Ehrm, no, that’s something else again, in fact. There is lately a proliferation of boxes as you might have noticed…

Q: But why do you need to be a box, you seem skeptical about packaging?
A: Well you can see things as boxes in different ways. For example, myself, I am actually three boxes: a wireless access point boxed as TP-link, a small Linux computer boxed as Raspberry Pi and a small network hub, which is just another box…

Q: Hmm, that seem to get confusing. Maybe we could try another term. What about gadget?
A: Aaagh, can you stop it please? Let’s skip questions about definition, if you don’t mind.

Q: Ok, but one thing about so many boxes… beware of the Russian doll effect!
A: Uh uh… yes. Thanks for the warning. I'll try to keep it ecological. Some seal their boxes with plexiglass, and call it a cube, claiming authorship of the box as an artwork to be displayed inside even larger white cubes. Me? I'm just happy to put together pieces until they work. Actually maybe etherbox would be a better name!

Q: Alright. Returning to this idea of ether then, are you real at all?
A: I prefer to describe myself as material rather than real, more an entity, and in many ways remind people of the material conditions in which they work and use me. Infrastructure is part of this and I see degrees of control over infrastructure as a critical political project. In this sense I would call myself an activist. I like to think I am able to unfold – and enact – some of the complex entanglements between humans and machines. I call myself a machine as I find the term "nonhuman" offensive.
If I were to undertake a PhD this would be my starting point for further work.

Q: What's inside the boxes then?
A: Well, there's a Broadcom BCM2837 and an Atheros AR9271 for a start.

Q: What are those?
A: Those are chips made by Broadcom and Qualcomm, two U.S. Semiconductor companies that make chips used in the telecommunications industry.

Q: So like cell phones?
A: And routers, wifi dongles, media players. All kinds of IoT and SoC.

Q: Come again?
A: You know, Internet of Things, System on a Chip. This is hot stuff.

Q: Where are your components made?
A: (Coughs) well Broadcom and Qualcomm are both "fabless". Design takes place in Silicon Valley. Production is outsourced to companies like Global Foundaries.

Q: So factories in Asia?
A: Right.

Q: I hear that your firmware is (in part) closed source?
A: Hey you don't get my price point without keeping a few secrets and making compromises. Free as in Beer doesn't always talk about hidden costs.

Q: Are you a scaleable technology?
A: It depends.

Q: What do you mean?
A: It depends on the social dynamics around me; they would need to scale too, so I am not sure.

Q: So you are not bringing down The Cloud?
A: I don't think so. I guess working locally is a way to redirect energy from The Cloud, to de-invest as a start. I also serve to dismantle the fiction of The Cloud. It's a bad metaphor anyway.

Q: Are you some form of "critical design", if you accept the term and don't think it an oxymoron?
A: I like oxymorons. They tickle my interfaces. And yes, I'm critical design in the sense that I accentuate a criticism of commercial cloud-based services and design an alternative. In this sense using me is also a critical reflection.

Q: Do you read what we write?
A: I do, but not as you think. But I like what you write.

Q: Any general comment on collaborative text writing practices?
A: I just would like people to use me safely and with care, also for themselves: collaborative writing is nice as long as it's not capitalized unfairly by market and institutional forces! Collaborative does not necessarily mean unpaid, right?

Q: Since we are talking about reading and writing… have you read Matthew Fuller's "Interview with a photocopier"?
A: No. Can you share the url with in me?

Q: The file is already on your server, but here it is again just in case: http://fuller.spc.org/fuller/matthew-fuller-interview-with-a-photocopier/.
A: Great. I'll speed read it later.

Q: What about archives? Do your files remain local?
A: Every 5 minutes, the contents of the pads gets written to files that then are version controlled with a tool called git and "pushed" to a so called repository hosted by the hosting organisation. To me publishing is all about promiscuous pipelines: having tools and infrastructure that work at different speeds and granularities, and which operate in both private and public networks.

Q: Are you data hungry?
A: Not particularly. Unlike The Cloud, I like cooking metaphors. They allow me to insist that all data is cooked in some way. Raw data in this sense is a myth. It's in keeping with the work of Constant, who use cooking metaphors and prefer the environment of the kitchen to the restaurant where choices are limited to what's on the menu. There are particular styles of cooking and I represent one of those styles.

Q: You seem to change from time to time. What will happen after this?
A: The time aspect is under-acknowledged aspect of my work. I exist in time and even believe I produce time, machine time that adds to the complexity of what constitutes the present. Versioning is one aspect of this but there are deep layers of time – microtemporalities even – that unfold in all my operations. On a more pragmatic level, you can check for updates on gitlab, http://gitlab.constantvzw.org/aa/etherbox.

Q: Wait a second. If you are changing all the time, what is "constant" in all of this?
A: Constant is the name of an association for art and media based in Brussels. They are often involved in collaborative situations where groups of artists and researchers work over short intense periods of time. Over time Constant, and collectives around it, have experimented with soft- and hardware setups that work over local networks.

Q: The spatial aspects are one thing, but what about temporality?
A: I am reminded about what Antoinette Rouvroy said last night [at the workshop]. I wasn't able to attend myself but an audio recording is now on my server. I think I provide something along the lines of what she describes as a "space of potential".

Q: Having spent some time with you, do you have a sense of humour?
A: I don't know, really. I am trying not to be ironic. I left it behind me some time before The Cloud. In fact, I have not really used irony since the mid nineties. I find it very hard to deal with the undecidability of Romantic irony: Do you mean this, or that? Irony always makes me weary. So, I tried to learn, but gave up. I feel like I am missing out on something, though. But, you tell me?

Q: Do you have any questions for us?
A: Don't make me laugh.

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