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CALCULATED ERROR: GLITCH ART, COMPRESSION ARTEFACTS, AND DIGITAL MATERIALITY

Abstract

This paper proposes a reconsideration of the aesthetic category of 'glitch' and advocates for a more careful theorisation around indexing — in the sense of both locating and naming — errors of a digital kind. Glitches are not as random as they seem: they are ordered and shaped by computational hardware and software, which impose a mathematical rubric on how glitches visually manifest and set ontological and technological constrains on glitch that limit how digital errors can and cannot be made to appear. Most crucially, this paper thinks about how one particular type of glitch — a compression artefact called a macroblock — can often appear as random, erratic, or unpredictable but is, in fact, materially constrained and visually conditioned according to the principles of computing and computer design. At its core, compression aesthetics can shed light on the operations of algorithms, the structures of digital technologies, and the priorities and patterns which occur as a function of algorithmic manipulation. The randomness, unpredictability, or messiness which glitch studies invokes around the glitch is in danger of overlooking the ways that the material architectures and algorithmic protocols structure the digital glitch by organising, constraining, and given form to its appearance.

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> *Bodies and machines are defined by function: as long as they operate correctly, they remain imperceptible.*
> *— Maurice Merleau-Ponty,* Phenomenology of Perception *(239).*

In 2005, Takeshi Murata released a short film called *Monster Movie*. This film showcased a swamp creature emerging from the muck that was noteworthy for its unique visual effects: blocks of mutating pixels that seemed to burst through the monster's body, deconstructing its image into a scattered and murky pixel array. Other glitch art, like David O'Reilly's *Compression Reels* and the net 2.0 aesthetics of cyberpunk art collective PaperRad, were sparked by similar interests in exposing the underlying algorithmic protocols and structuring interfaces of digital media. In the 2000s, glitch style migrated from its origins on niche punk-art message boards and underground websites to become incorporated into commercial music videos for both Kanye West and electro-pop group Chairlift. Directed by Ray Tintori, Chairlift's music video for Evident Utensil used glitch effects to create a visual aesthetic marked by an array of mutating colour blocks that fused the band with their surrounding environment and seemed to rupture the diving line between the environment staged in the video — its content — and the colours on the surface of the screen — its form. Kanye West's *Welcome to Heartbreak* achieved a more fastidiously controlled, choreographed style of glitch art that combined chromakey and green screen techniques to unsettle the grammars of commercial video editing. Starring West and featured singer Kid Cudi, the music video depicted the rappers 'melting' into each one another, alternating recognisable fragments of their faces with sequences of digital skids and bleeds that fractured the representational image and transformed it into an unstable landscape marked by fluctuating glitch effects.

All of these works owe at least one of their particular stylistic effects to the process known as compression hacking. This paper examines how compression hacking works as process of algorithmic manipulation and considers what the artistic practice of compression hacking exposes about the composition of digital images. The key argument is twofold: first, that the particular effects produced by compression hacking are determined by the computational processes and material properties of digital media; second, that the algorithmic functions that are used in compression hacking establish the conditions by which compression artefacts can appear, but that sometimes these compression artefacts remain invisible. Nevertheless, the production of compression artefacts as a result of compression hacking depends not only on certain level of algorithmic functionality, but also on the *matter* of digital technologies: compression artefacts, like all glitch effects, owe their various materialisations to technologies which are not entirely dysfunctional. In other words, malfunction is borne out of function: a digital error depends on the enduring functionality of the systems which give rise it, to make such an error legible as out-of-the-ordinary. One corollary to this argument is that the presence of what appears to be a glitch in a digital image does not always indicate the presence of an underlying technological error — a claim which unsettles the notion of technological troubleshooting and the heuristics underpinning a 'diagnostics' of technological failure.

To these ends, this paper proposes a reconsideration of the aesthetic category of 'glitch' and advocates for a more careful theorisation around indexing — in the sense of both locating and naming — errors of a digital kind. Most crucially, this paper thinks about how glitches — which often appear as random, erratic, or unpredictable

— are materially constrained and visually conditioned according to the principles of computing and computer design. Glitches are not as random as they seem; in fact, they are ordered and shaped by computational hardware and software, which impose a mathematical rubric on how glitches visually manifest and set ontological and technological constrains on glitch that limit how digital errors can and cannot be made to appear.

This paper will emphasise compression *hacking* for a few reasons. The first reason is to draw attention to the human labour and the activity of 'hacking' which generates compression artefacts. It also reinforces that this artistic practice is achieving by playing with the computational logics of compression — compression hacking requires a modicum of computational literacy and is an activity undertaken by someone who understands how to manipulate the information encoded in image or video files. With an emphasis on the 'hacking' of compression hacking, it is clear that this paper will not address compression artefacts or glitches as spontaneously occurring: the epistemic frameworks used to diagnose a digital error in the instance of a glitch's spontaneous occurrence would act as a confounding factor. Simply put, looking at the glitch generally, rather than at glitch *art* specifically, one is forced to contend with other variables pertaining to the origin of a glitch. To think of glitch as a homogenous aesthetic form rather than glitch art as a specific technological practice — or to begin with compression artefacts rather than compression hacking — means grappling with the notion that the glitch appears despite there being no known intervention from an outside agent (e.g. artist, hacker, programmer) who can testify to a glitch's cause or represent a reason for its occurrence.

There is another terminological clarification to make here. Although the term 'datamoshing' operates as an onomatopoetical descriptor which seems to describe the qualities of compression artefacts themselves — e.g. 'moshing' conjuring a pixel-based modularity and squishiness — it does not foreground the technological dimension of this artistic process as clearly as the term *compression hacking* does. 'Datamoshing' elides the role that the artist plays in reformulating the video files to produce visual compression artefacts, and in so doing introduces confounding variables into the discussion that this paper does not have the scope to address. Thinking about how to achieve compression artefacts as a product of compression hacking means that less technologically invasive methods for achieving its stylistic effects — so datamoshing done by applying a photo or video filter through the implementation filters via programs like Photoshop — can be set to one side. Although any file format can be compression hacked, this paper will focus on digital video/moving images for two reasons: because this is the format which has mostly received the attention of compression hackers.

On compression algorithms

The law of information processing upholds that the "fewer states one needs to process a message, the faster and more efficient the system is" (Kane 220). Data compression follows this law by simplifying how data is stored. The purpose of data compression is typically to optimise storage space or increase data transmission rates, and it is often motivated by a desire to save both time and money. Compression algorithms record only the measurable changes in the image data. As a result, only areas of a moving image which describe differential motion or changing luminance values are captured by the compression algorithms (Arcangel).

According to this principle, images with fewer substantial changes from frame to frame are easier to encode. "The whole point of digital image compression," Cory Arcangel writes "is to be able to reconstruct an image without having to send all the data." Lossless compression, as the name might suggest, does not lose any information from the original source during any point of the compression (encoding) or decompression (decoding) process. In his short treatise "On Compression," Arcangel develops a very clear analogy that captures this method of data-optimization in non-technical terms:

> *Let's say we wanted to send this: 'aaaaaaaaaba' and we were going to send it over the phone by voice. As opposed to having to send all the information by reading out each letter one at a time, we could just tell someone '9a's, one b, and one a' and they would know we meant 'a a a a a a a a a b a' and we have saved ourselves a bit of breath. In computer language it means we have stored all the information using less space.*

Digital video files are composed of sequences of different types of frames: 'i-frames' or initial frames — commonly called keyframes — "are full representations of a single frame of a video" (Arcangel). In essence, a keyframe is simply a still image containing all the colour and luminance data of a particular frame and are typically used as reference points by animators. In digital animation as in hand-drawn animation, keyframes are important for determining where and when an animation sequence starts or stops. Predictive, or 'p-frames,' on the other hand, are reference files that inform the video player of changes to the image's compositional arrangement that have occurred since the previous frame (Arcangel). In order to dramatically reduce the amount of data that needs to be stored, what is captured in a compressed video file is only the difference between the initial, or i-frame and the subsequent images, the p-frame, (sometimes called the delta Δ frames for this reason). These later frames contain the image's transform instructions of the initial or keyframe. The illusion of object motion in an image or the appearance that the image itself is moving is determined by relationship between the p frames and the i-frames. If this relationship is thought of as the difference in motion interpellated over time, "subsequent frames could be described as a catalogue of pure differentiality" (Levin). In addition to keyframes and predictive frames, there are also b-frames: these are similar to p-frames but a b-frame references the frame both before and after it. Modifying b-frames leads to more unpredictable results than modifying only the keyframes and predictive frames (Arcangel). In short, compression algorithms control the behaviour of several kinds of frames. When combined, these frames act as a catalogue of movement, and therefore are functions of time — they measure the differences in image data from frame to frame.

Compression hacking creates a new merging reference between the elements of an original image frame and the successive frame. When compression hacking does yield visible compression artefacts, they occur as a direct result of 'playing around' with the relationships between the initial frames and the predictive frame to create digital images characterised by breaks, folds, ruptures, skids, mutations, and pixelated blots. "Macro-blocking, pixelating, checkerboarding, quilting and mosaicking" (Levin) are kinds of compression artefacts. These descriptors capture how these artefacts appear as geometric forms; their behaviours and appearances are visibly linked to organisation of a computational grid arranged by Cartesian coordinates, a point that will important to remember.

Compression artefacts are made visible through the use of lossy compression algorithms, whereby some of the information about an image is 'lost', although it is more accurate to classify the lost information as unnecessary, surplus, or disposable. Lossy compression can occur for a variety of reasons, but it is not bad — in fact, in instances of low bandwidth or limited storage space, lossy compression is desirable. Lossy compression removes or replaces the initial keyframes and/or predictive frames in a video file. It can also cause the "playback image and motion-vector data to distort the resulting moving image with unpredictable results" (Goriunova and Shulgin 91), but it is worth noting that the information lost during the compression process is not always detected by the human eye. Often the loss of information is of no great consequence, but the fact that data is lost during lossy compression means that it is limited in its application: lossy compression techniques applied to text documents, or "any application where all the information must remain intact" (Arcangel) would render the text file unreadable and unable to be restored to its original condition.

Despite the economic, temporal, and logistical advantages offered by lossy compression, images or data which undergo lossy compression are frequently thought of as a downgraded copy of the original image or data file (Brown and Kutty 168). These downgraded versions of an image or data set are optimised for easy storage and retrieval rather than for visual fidelity or clarity. But the central role of visuality in contemporary digital culture means that the aesthetic of lossy compression is often read as one typified by visual blemish or corruption on the surface of the image. These blemishes are read as evidence of a technological error which occurred at some point during the encoding and decoding process of compression, as a sign of the image's technological corruption. However, simply identifying that there are compression artefacts within an image is not sufficient evidence for diagnosing the presence of a technological error within the compression algorithm itself. The algorithmic behaviour of the compression algorithm and the creation of compression artefacts are, necessarily, behaviourally linked—but their behaviour is not identical. In other words, images that appear 'glitched' are not always produced by malfunctioning code. Particularly in the case of compression artefacts using lossy compression, 'corruption' within an image is a matter of artistic perspective. The next section will briefly examine how compression artefacts fit into longer theorisations about the visualisation of technological failure in modern and postmodern culture.

Locating the glitch

As a discipline, glitch studies are a relatively new area of academic research that has nevertheless furnished a prodigious amount of scholarship in recent years. Despite the high volume of cross-disciplinary contributions to glitch studies — from filmmakers, academics, programmers, and para-academic practitioners — very little academic work has directed its focus towards the artistic practice of compression hacking. Perhaps one of the difficulties in charting work on compression hacking is due to the fact that glitch studies is particularly prone to semantic inconsistencies, especially because the scholarship on glitch is often positioned as a history of the present. Keeping pace with the rapid aesthetic transformations ushered in by digital media may pose problems for glitch scholars, whose subject of study may fluctuate as rapidly as the internet and the aesthetic formations it produces. For example, some digital media scholars refer to compression hacking by another name — 'datamoshing'[1] — or simply subsume compression artefacts into larger historical and cultural considerations of the 'glitch' as a general aesthetic category.

While compression hacking can be situated within the domain of glitch as an artistic practice, it also fits into a longer cultural and historical practice of theorising the technological accident. The spectre of error — alien 'glitches' in a system — haunts this long era of the technological, invading everything from the industrial advances in steam locomotion to computer science to drone warfare. Like the character Wintermute in William Gibson's *Neuromancer*, glitches are frequently conceptualised as ghostly forces, malfunctions that interrupt the normal operations of technological systems by seemingly emerging "out of nothing and from nowhere," giving viewers "a fleeting glimpse of an alien intelligence at work" (Vanhanen 46). This theory traces its roots to anxieties that attenuated the industrial and technological shifts demarcating the late Victorian from the Early modern period, which were populated by stories of the technological gothic: "ghosts in the machine" depicted the "threat to the humans subject posed by an autonomous, uncontrollable technology" (Rutsky 125).

Indeed, before 'glitches' came to be known as such, the ubiquity of the unnamed accident was a frequent source of terror for people of the industrial age who struggled to come to grips with the provenance and cause of technological catastrophe. Many industrial technologies did not have monitoring systems, failsafe options, or the emergency stops. As such, industrial machines were constantly threatening to malfunction — one way of treating the factory explosion is not just to read it for its catastrophic effects, but also to see in it a perverse rationality. Machinic explosions may have been one of the few ways that workers were given a glimpse into the structural and operational logic of the machines in their midst. By violently exploding, industrial machines dramatically exposed their interlocking mechanisms — the machinic accident might be understood a spectacle of the machine's operational logic. Error, malfunction, breakdown — these states presuppose a stability, a rationality, and order from which the accident can erupt. From this teleological perspective, the accident acts as a necropsy to dissect the malfunctioning machine — one need only be reminded of 'exploded-view-diagrams' today to consider how the accident testifies not only to the structure and teleology of a machine, but also how "every technology carries its own negativity, which is invented at the same time as technical progress" (Virilo 89).

The concern over an unpredictable or sinister machinic vital force persists today. As visual cultural theorist Carolyn L Kane writes: "computers and algorithmic systems are progressively given authority over human action and experience […] yet we have a dwindling capacity to recognize [sic] this" (219). Viewed from afar, she hypothesises that 'the entire history of modern art could be construed as a glitch and compression of Enlightenment epistemology" (Kane 219). In "Datamoshing as Syntactic Form," Thomas Levin articulates a theory of compression hacking that ties it to anxieties produced by "the miscommunication between sender and receiver". He cites this transcoding error as distinctively cybernetic, operating historically as an aesthetic that "exposes societal paranoia by illustrating dependence on the digital and fear of system failure [and] with the advent of video sharing sites like YouTube […] the glitch aesthetic has evolved into a pop culture artefact" (Levin). Casey Boyle advocates for an art theoretical approach to glitch that embraces it as a generative practice — and not merely as a materialisation of technological failure — because glitches can "render apparent that which is transparent by design" (12). Greg Hainge argues that the glitch foregrounds "how technology always relies on the successful inclusion or integration of failure into its systems" (27). Perspectives like those of Hainge valorise technological failure as necessary to technological function and recuperate the glitch from its negative associations. One ramification of Hainge's view is that the line between something which is 'noise' and something which is 'signal' is not an expression of a technological boundary at all. Instead, 'glitch' is a phenomenon which can call into question the very stability and determinability of the distinction between signal and noise.

Within this larger framework of glitch theorised as an emergent unpredictability in machine function, it is not surprising to see compression hacking described as a practice which brings to the surface of the image the operational failures of digital systems. But compression hacking is not the result of a technological accident. To consider compression artefacts the *result* of accident, or to think of the compression artefact as 'glitched' is to both deny the artistic labour which produces compression hacked images and to misunderstand the relationship between visual and technological malfunction.

Still, it is possible to situate compression hacking in what David M. Berry calls the 'new aesthetic' (NA) a form of "'breakdown' art linked to the conspicuousness of digital technologies" (56). Berry writes:

> *We might conclude that the NA is the cultural eruption of the grammatization [sic] of software logics into everyday life. The NA can be seen as surfacing computational patterns, and in doing so articulates and represents the unseen and little-understood logic of computation, which lies under, over and in the interstices between the modular elements if an increasingly computational society. (57)*

Calculated error

Rather than think of this breakdown in the sense of *dysfunction*, it can be understood in the sense of *take apart*. Although it may seem like metaphorical hair-splicing, reconsidering what is meant by such a breakdown may be a crucial avenue for exploration the aesthetic features of the digital glitch, which reveals itself at the fault-line between *breakdown* as an entropic activity and *break-down* as a structuring principle.

Consider one particular type of compression artefact: the macroblock, as shown in the image above. Macroblocking visually destabilises the representational legibility of a digital image while simultaneously rearranging it into ordered blocks. There are small sections where the outline of an object appears, only to be abruptly cut off by large blocks of colour. Macroblocking can unsettle the ability of a spectator to apprehend an image as representationally legible, even when traces of recognisable objects remain within the image. Macroblocking creates the impression of a carefully controlled digital schizophrenia in a moving image: the shifting location, luminance, and colour of macroblocks combine to create an impression of movement that seems to originate in the screen's pixels. These pixels *seem* to scatter, breakthrough, or penetrate the digital materiality of the screen, moving with regimental precision. Jeff Donaldson describes these kinds of artefacts as "a break from an algorithmic flow [whose] unanticipated appearance is simultaneously frustrating and mesmerizing".

Figure 1: GlitchTVbot (2019). _Image_[Twitter]/ Available at: https://twitter.com/GlitchTVBot/status/1141287271922110464 (Accessed 03 June 2019).

But a macroblock does not actually consist of migrating pixels. A macroblock, occasionally called a 'blocking artefacts,' is a distortion in a compressed image that appears as a collection of pixel blocks. It can occur for a variety of reasons, but what is most important about macroblocking is that it relies on the mathematical principles of compression in image processing and does not feature the motion of pixels themselves. Let's return to Arcangel's vernacular description of compression for a moment:

> *Let's say we wanted to send this: 'aaaaaaaaaba' and we were going to send it over the phone by voice. As opposed to having to send all the information by reading out each letter one at a time, we could just tell someone '9a's, one b, and one a' and they would know we meant 'a a a a a a a a a b a' and we have saved ourselves a bit of breath. In computer language it means we have stored all the information using less space.*

Using a lossless compression algorithm yields no loss of data; whether one reports 'aaaaaaaaaba' or '9a's, one b, and one a', the information remains unchanged. But if the example above used lossy compression, 'aaaaaaaaaba' would be simplified to 'roughly 10 a's'. A similar process, called quantisation, occurs to create macroblocks. Instead of capturing all of the detail in a particular region of an image using a detailed range of values, the compression algorithm encodes only a single value for a particular region. If an image undergoes a great deal of lossy compression, the amount of information that is reduced during the compression process may be significant; in the case of macroblocking, the information the remains after lossy compression may only pertain to the average colour of a collection of pixel blocks, thereby rendering an area that was formerly populated by multiple colours and luminance values into a block of a single colour.

Donaldson's description of the logic of computational failure is of particular significance in understanding how the architecture of digital devices shape the images which they manifest. His remarks are interesting to reproduce here for their emphasis on the pixel as a format which is defined by a specific set of algorithmic architectures and confined by the material makeup and organisation of the computer display:

> *It is a true type of machine art and a crude form of artificial intelligence inasmuch that once an algorithm is let go to run free, due to the architecture of digital systems, a break from routine creates an ordering of its own. The pixel grid of the computer display provides the framework and serves as the canvas for this manifested algorithmic hiccup. It's as if the computer is freed from its normal task and instead displays what it [sic] wants, the architecture of electronics giving shape to sudden random image data. (Donaldson)*

Following Donaldson, let's explore how macroblocks owe their particular appearance to the design and arrangement of the pixel grid. Pixel, which comes from a contraction of the words picture (pic, pix) and "either element or cell […] is basically the smallest element of a discrete and non-continuous dataset […] arranged via an address on a grid location (x,y)" (Baraklianou 305). A pixel is the matter of which digital images are formed and the medium through which an image takes shape. A single pixel's appearance is determined mathematically: electrical signals are converted into a "two-dimensional array of information. A pixel is a register of data that, in combination with other pixels in an array […] is a sample encoded in a long set of binary codes" (Baraklianou 306). Despite the usage of 'pixel' in the colloquial sense, typically used to suggest that they are the atomic components of a digital image which can be decomposed and rearranged, pixels are not building blocks. Furthermore, a single pixel is not mobile — despite the descriptions of swirling, mutating, or bleeding pixels used to characterise the glitch aesthetic, pixels remain fixed, and they are not visible to the unaided human eye. In fact, a pixel is a unit of data that is "fundamentally ambivalent to vision" (Baraklianou 306) tethered to its array, and intimately connected with it surrounding pixels. The pixel is arranged with others like it into a pixel array — always a geometric formation — and the visual qualities of this array depend on the behaviours of pixels which constitute it and surround it; colour and luminance are not determined by the value of a single pixel but are "assigned at a later stage" and depend strongly on the relationships between pixel elements (Baraklianou 306). Whereas the pixel element is anchored to the architecture of the screen and the Cartesian arrangement of the pixel grid, the appearance of a pixel is relational function. In other words, while the pixel is geographically fixed to an (x,y) position on the screen, its "function is based on relational value sets assigned through the matrix of the corresponding elements around it. This enables designation and manipulation of point-by-point values in the image, which renders the image mutable" (Baraklianou 307). Hence, macroblocking appears as the moveable, mutating arrangement of pixels, but the material architectures of the pixel grid and logics of the compression algorithm act as boundaries on this visual chaos and keep the pixels fixed in place. The movement of pixel blocks from one location on the (x.y) plane to another is simply a visual illusion, one which appears due to the way that macroblocking allows a spectator to observe the geometries of the pixel grid as an emergent property of the compressed image.

At its core, compression hacking can shed light on the operations of algorithms, the structures of digital technologies, and the priorities and patterns which occur as a function of algorithmic manipulation. “Machines,” writes Liam Young, “see the world through coded sets of rules. Whether through a camera lens, sensor, or scanner, they search for particular configurations of data, sets of predefined relationships, patterns, and geometries” (125). The characteristics of macroblocking, and by extension other kinds of compression artefacts, can offer clues about the way that computer architectures, such as the pixel array, are structured. The appearance of a compression artefact is constrained by the logics of compression, and by the geometries confining computer hardware, such as the pixel array, to a particular gridded orientation. So while it may seem like pixels are moving in regimental blocks, this is an illusion that is shaped by the material architectures of the pixel grid and the way that the appearance of a pixel array is a product that is relationally determined, mathematically constrained, and materially fixed.

Detecting glitch

In the early 2000s, art collective !Mediengruppe Bitnik released *Download Finished - The Art of Filesharing*. Described by the artists as “an online resource which transforms and re-publishes films from P2P [peer-to-peer] networks and online archives,” *Download Finished* is a part digital performance, part post-structuralist critique of the hidden technological protocols and underlying architectures that give colour, form and shape to digital signal and digital noise (!Mediengruppe Bitnik). Speaking both metaphorically and matter-of-factly, the artists describe the project as an attempt to “make hidden the data structure” of digital technologies visible: the original images and moving images shared across these peer-to-peer networks are run through “a transformation machine,” whose oblique name functions like a black box, with its refusal to confide in the specific technological process of translation that causes a shared file “to dissolve into pixels” (!Mediengruppe Bitnik). The language used to describe *Download Finished* invokes images of technological systems that are impenetrable and unknowable except through the form of their spectacular malfunction. In this way of thinking, the mystifying commands and obfuscating structures that allow computer technologies to work can only be visibly foregrounded through an error in these very commands, a breakdown in these very structures.

Glitch artist Rosa Menkman also believes that glitch art functions to reveal the obfuscated logics of computer processes. She considers her practice a political one because it interrupts the function of computer systems by introducing malfunction into a “highly complex assemblage that is often hard to penetrate and sometimes even completely closed off” (Menkman 12). Menkman’s perspective on glitch art as a radical critique of technological determinism is echoed by critics like Hainge. On Hainge’s formulation, glitching materialises the ‘noise’ that lies dormant or unseen within the operations of digital systems. Some media scholars view glitch art as the latest instantiation of the “aesthetic use of discarded and deleted data (i.e. errors)” (Kane, “Compression Aesthetics”) or as a reaction against the impenetrability of computational systems.

New media scholars like Casey Boyle also adopt this viewpoint. Boyle’s “Questions Concerning Glitch” explicitly expands on the work of Katherine Hayles and Bruno Latour to argue that a responsible rhetorical practice for glitch art would involve understanding "all mediation and any glitches as generative and not as errors to be corrected" (Boyle 12). In *The Wretched of the Screen*, Hito Steyerl champions this feature of the glitch, too, calling them the bruises of images that are "violated, ripped apart, subjected to interrogation, and probing" (5). And as Donaldson writes:

> *The artist's hand no longer dictates the outcome the way it does with conventional fine art. Instead, conditions are created to bring forth something unpredictable, inasmuch as the set parameters are capable of producing.*

Compression hacking aligns with these considerations of the glitch. Compression hacking works to distorts the sleek, seamless look of the digital image and to create an aesthetic that "allows insight beyond the customary, omnipresent […] computer aesthetics" and sheds light on "software's inner structure, whether it's a mechanism of data compression or HTML code" (Galloway 25). To be sure, compression hacking still requires interpretation: it does not reveal the operations of the compression algorithm without some work behalf of the viewer and a modicum of computational literacy. However, compression artefacts like macroblocking can draw attention to the computational conventions by which digital images and rendered visible and by which "digital spaces are organized" (Galloway 25). The glitch is a fissure that allows one to peer into the hidden operations and invisible structures of digital technologies: "Whether its cause is intentional or accidental, a glitch flamboyantly undoes the communications platforms that we, as subjects of digital culture, both rely on and take for granted." (Manon and Temkin)

These theories gesture to an important question that has so far gone explicitly unasked: is macroblocking a glitch? In brief, no. To label this compression artefact a 'glitch' is not a perception, but a judgement. That is, to always read compressed images — or visual indecipherability more generally — as a symptom of technological malfunction is to assign a creative intentionality to the compression algorithm, which is in fact indifferent to the representational clarity of the images it produces. It also supposes that the visual layer of digital images mimics the behaviour of the algorithmic one. But the compression algorithm has no stake in maintaining representational sensibility for its viewers. Compression hacking can give rise to "random image data" (Donaldson) but it can only use the data available to the compression algorithm — and the data can only ever be preserved or lost, never rendered more detailed than its original source. Furthermore, any 'chaos' is bounded by the computational limits of the compression algorithm and the arrangement of the pixel grid. Finally, the appearance of macroblocking relies on the smooth operations of lossy compression; it cannot occur without the successfully completion of the lossy encoding and decoding process that is part of the overall process of compression. The compression algorithm must be functional in order to generate macroblocking effects; if macroblocking were to be considered an error, or as signal of one, then its antecedent would not be the lossy compression algorithm. After all, macroblocks are a product of lossy compression. If anything, the manifestation of macroblocks in an image would testify to the successful completion of lossy completion, not act as an indicator of its failure.

In *The Interface Effect*, Alexander Galloway writes that glitch art "recuperates and even relies on failure to succeed. It is primarily a systemic relation" (25). Likewise, Michel Serres, in his meditation on functional 'alongsidedness' writes, "Systems work because they don't work. Nonfunctionality remains essential for functionality" (in Galloway 25). This perspective, however, does apply to compression artefacts in the narrow case being examined here. Although compression artefacts may give the appearance of being glitched, they still rely on the smooth operations of the compression algorithm for their materialisation. Serre's axiom needs to be modified slightly in this case. As compression hacking demonstrates, sometimes *functionality remains essential for the appearance of non-functionality*. Galloway's observation can be similarly adjusted for compression hacking, which can foreground how images that appear to expose technological failure relies on an underlying technological 'success' for their production. One can amend Galloway: compressed images show how glitch *art imitates failure successfully rather than relying on failure to succeed*. Ultimately, rather than resigning compression artefacts to the domain of glitch and its related nomenclatures, glitch theorists should think seriously about how compression artefacts might depend on precisely the opposite of technological failure for their materialisation.

Conclusion

Digital media are optical and algorithmic in composition: however, the behaviour of these two dimensions does not always correspond. The non-representational character and unpredictable behaviour of compression artefacts trouble a human tendency to collapse the optical and algorithmic dimensions of digital images at the level of the visual: specifically, at the visual interface of digital media, where one can *see what's happening*. Compression hacking produces compressed images which mimic the appearance of technical corruption while not relying on technical corruption at all to produce these visual effects.

Compression artefacts like macroblocks, then, are not materialisations of an underlying technological failure — as the argument goes within glitch studies — but they do visually *simulate* the effects of a technical failure that has not occurred. Compression artefacts indicate that there is a subtle but significant difference between the *visualisation* of a technological error and its *aesthetic simulation*. In a way, compression artefacts are a pastiche of glitch style. By thinking carefully about how compression hacking affects the different strata of a digital image, one can see how the relationship between the algorithmic dimension and the visual dimension of these images are *interdependent* but *not behaviourally identical*. An error in the algorithmic layer does not always manifest at the visual interface; conversely, the appearance of a visual error is not a reliable indicator of a technological malfunction. In other words, the 'glitch' is in need of more careful theorisation: one should not confuse an aesthetic of technological failure with an aetiology of technological malfunction or conflate the visualisation of a technological error with its aesthetic simulation. Finally, it is imperative to keep in mind how much the randomness, unpredictability, or messiness which glitch studies invokes around the glitch is in danger of overlooking the ways that the material architectures and algorithmic protocols structure the digital glitch by organising, constraining, and given form to its appearance.

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Notes

[1] See Brown and Kutty; Schultz-Figueroa; Manon and Temkin; Levin; and Kane "Error." The term 'datamoshing' was coined by internet art collective PaperRad.

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