Chapter Ten

Four-dimensional and multi-dimensional images: diffracting archaeological and computational images

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Once upon a time ancient images were conceived by archaeologists and cultural heritage specialists as stable entities. Stable and reproducible archaeological images were rendered using a variety of different techniques, including water-colour paintings (for example Adela Breton’s depiction of Maya temple murals in the Yucatán peninsula in the 1880s), casting using papier mâché (employed by A.P. Maudsley between 1870-90 to document the Maya monuments of Guatemala), rubbings using wax or tracing paper (once commonly used to transcribe rock art motifs and stone reliefs), the use of transparent polythene overlays (again, commonly used by Scandinavian researchers to transcribe rock art motifs), and of course photography (used for recording a variety of archaeological images, from rock art, architectural features and figurines). In most cases methods of recording were developed to enable archaeological imagery to be accurately rendered to facilitate its interpretation and circulation amongst the archaeological community.

Many techniques for documenting ancient imagery are based on the principle of indexicality: there is a direct indexical relationship between methods of casting, rubbing, or tracing. All of these methods involve physically transcribing images into other media. The same is true of water-colour painting and photography: it was the indexical reproducibility of photographs that Walter Benjamin famously drew to our attention in his essay *The Work of Art in the Age of Mechanical Reproduction* (Benjamin [1955] 1999).

The term ‘documentation’ in relation to recording ancient imagery implies conscious intention, and - based on Katherine Hayles (2017) recognition of the relevance of the cognitive nonconscious - this paper will also question the location of human intentionality in the complex confederacies of technical and digital equipment involved in producing computational images in archaeological contexts.

To discuss this, I will critically address the indexical qualities of archaeological reproductions in order to question the ontological stability of ancient imagery. Here I will employ Karen Barad’s diffractive methodology (Barad 2007; 2014) to consider images in a series of differing ways (see also Barad 2017). I begin by considering the interpretative or semiotic character of images in archaeological analysis; the image in motion presented by anthropological approaches; the digital image as produced in Reflectance Transformation Imaging (RTI). These series of diffractive moments will be used as a means to describe images from the Neolithic period of Britain and Ireland, and in turn consider the ontological character of digital images produced by RTI.

Image 1 – the Archaeological image
Ancient imagery has fascinated archaeologists since the beginning of the discipline. When investigating ancient imagery two major impulses are at work: the impulse to order or catalogue and the impulse to interpret. Of course, these two impulses are linked, and as we shall see, one builds upon the other.

The creation of corpora of ancient imagery has been one of the key early investigative tools undertaken by archaeologists. In a European context, Scandinavian scholars often led the way in this field. Individuals such as Gutorm Gjessing catalogued much of the open-air rock art of Arctic and Northern Norway (Gjessing 1932) and the team of Eva and Per Fett catalogued the open-air rock art of southwest Norway (Fett and Fett 1941). In parallel with this pioneering work, Gustaf Hallström’s *Monumental art of northern Sweden from the Stone Age* (Hallström 1960) brought together in a single volume examples of open-air rock art from across Sweden. For Britain and Ireland, we have similar examples, such as Elizabeth Shee Twohig’s magisterial work *Megalithic Art of Western Europe* (Shee Twohig 1981) which brought together all examples of passage tomb, or megalithic, art across Britain and Ireland and also included France, Portugal and Spain.

One of the effects of these kinds of corpora, illustrated with line drawings and photographs, is that they present a synoptic view of images, enabling the archaeologist to compare between different types (see Jones 2001); they also render images as divorced from their material context (see Jones 2004). As a result, ancient imagery is presented as ‘fixed’ or static as it is detached from its material context of production. This fixing of ancient imagery is a powerful device for the archaeologist: it enables ancient imagery to be circulated in printed form, making it open to comparison at various scales of analysis. In that sense the processes of documentation and publication produces what Bruno Latour has described as ‘immutable mobiles’ (Latour 1987, 215-57). This point in the documentation of archaeological images is also a politically charged moment. As media theorist Sean Cubitt (2017, 152) points out, the abstraction of knowledge in this way enacts a kind of epistemic violence: ‘knowledge has been stripped of its intimate relation to the knower, in order to become tradable information’.

The immutability of ancient imagery, and its conversion into information, enables imagery to be compared. It also has another effect: it allows imagery to be interpreted. Precisely because printed illustrations of ancient imagery could be compared, they were also open to semiotic interpretative analysis; the recognition of difference through comparison is a cornerstone of semiotic analysis. A good example of the way in which interpretative schemes elide with the documentation provided by the printed corpus, is Chris Tilley’s analysis of the rock art site of Nämforsen, northern Sweden (Tilley 1991).

Nämforsen had been exhaustively documented by Gustaf Hallström, and Tilley drew on his account to provide a detailed analysis of the meaning of the rock art motifs. Tilley’s formal semiotic analysis drew on the work of Claude Levi-Strauss (1962). Tilley examined the distribution of motifs on the rocks at Nämforsen, tabulating individual motifs and their combination with other motifs, and notes a series of patterned similarities and differences between motifs of elk and those of boats. Based on these
similarities and differences he builds up a set of oppositions between Clan A associated with the elk, land, nature and the inside, and Clan B associated with the boat, water, culture and the outside (Tilley 1991, 105). This sophisticated analysis arguably set a benchmark for subsequent archaeological approaches to art and imagery (see e.g. Sjöstrand 2010) and became an exemplar of semiotic analyses in archaeology.

The treatment of rock art motifs as semiotic signs helps to crystallize the notion of ancient images as static entities, excised, cut out, or removed from their material context and from the context of their production. Archaeological techniques of documentation had helped to produce images that could be fixed on the printed page. Once ancient images were rendered in this form, so that they could be circulated, reproduced and compared, all that remained for archaeologists was to decode them.

**Images 2- the Anthropological image**

Images flow and move. They are made, circulated, and destroyed or discarded. Anthropologists recognize that images undergo change as they are brought into being and are socially displayed and circulated. However, they also recognize the need to document, and capture the meaning and significance of images in their analyses. Anthropological accounts of non-Western imagery pivot around the question of the dynamism or stasis of imagery, presenting alternating views of the image in motion or the image in stasis.

Motivated by the pioneering work of Claude Levi-Strauss, early generations of anthropologists were also keen to decode the imagery of non-Western cultures. This is particularly the case for researchers interested in the imagery of indigenous Australians, as exemplified by the work of Howard Morphy. Morphy’s account of indigenous Australian graphic representations, *Ancestral Connections* (1991), discusses art and traditional systems of knowledge for the Yolngu people of northeast Arnhem Land, Australia. Based on both Saussure’s and Peirce’s semiotic approaches, Morphy analyses the cultural meaning encoded in both the representational and geometric components of the art (Morphy 1991, 142-80), while his recognition of the multivalency of images enables him to discuss the significance of images in differing contexts. He shows how Yolngu sacred law, or *mardayin*, is one component of a system of ancestral knowledge, or *wangarr*, that is performed and reproduced through paintings. Yolngu art ‘provides a way of socializing people into a meaningful worldview in which certain themes become meaningful, in which certain values are created, and by which certain things can be done’ (Morphy 1991, 293). Morphy emphasizes both the well-defined cultural meanings of individual motifs, while also discussing how those meanings come to have a dynamic cultural effect.

The relationship between symbolic representation and the dynamic materiality of images is especially emphasized in Susanne Küchler’s account of the Malanggan figures of Tikana, New Ireland, Melanesia (Küchler 2002). Malanggan are wooden funerary effigies. The right to carve Malanggan images is tied to rights of ownership over land. Images cover the complex fretwork of the Malanggan figure, and the carving of the figure takes place in secret. The culmination of the ceremony associated with Malanggan is the dramatic revelation of the effigy, followed by the symbolic activation
of its death, by burning, decay or trade (the reason there are so many Malanggan in European museums is that they were deliberately traded with anthropologists, colonial officials and ethnographic art collectors as a way of removing them from circulation). The death of the Malanggan ‘leaves behind a named and remembered image, which is recalled from time to time in states of reverie to re-direct ancestral power to the land of the living. The figure is thus an instance of a polity of images, whose access defines rank, authority and rights to land’ (Küchler 2002, 2). Küchler’s analysis places much less emphasis on the semiotic significance of individual design motifs, and much greater emphasis on the sociological impact and social entanglement of images.

The distinction between semiotic and aesthetic accounts of non-Western imagery and those that pay due attention to the visual impact and social implications of imagery is given its greatest emphasis in Alfred Gell’s major rethink of anthropological art, Art and Agency (Gell 1998). In this account Gell places emphasis on the psychology of visual perception, examining how art comes to captivate the viewer, in a process he describes as the ‘technology of enchantment’ (Gell 1992). His main aim is to examine how art objects come to be social actors: ‘in relevant theoretical respects, art objects are the equivalent of persons, or more precisely, social agents’ (Gell 1998, 7). Drawing on various examples, including Malanggan figures and the artworks of Marcel Duchamp, Gell is at pains to discuss artworks as ‘distributed objects’ examining the relationship between individual artworks and cultural traditions or the ‘oeuvres’ of individual artists. From this he argues that we might view artworks as cognitive processes, the movement of inner durée, as well as the collection of existing objects (Gell 1998, 258). In his formulation of the distributed object Gell highlights the important characteristic of images as processes, in contradistinction to previous accounts, like those of Morphy, which placed much more emphasis on decoding the meaning of individual design motifs as components of artistic traditions.

Anthropological accounts of art and imagery offer the potential to observe images in motion. By examining how images are made, displayed, circulated, and discarded anthropologists necessarily present a much more dynamic picture of images.

**Image 3- the Digital image**

The indexicality of images is now open to question. Images need no longer be indexically linked to real world events or things (Cubitt 2017). Images may be digitized and can be manipulated digitally (Frow 2014). Rather than lamenting the digital manipulation of images on epistemological grounds (see Frow 2014), I instead regard the digitization of images as offering the potential for new avenues of ontological exploration. The implications of this are developed towards the end of this paper.

Techniques of documentation, such as Reflectance transformation Imaging (RTI), were developed by researchers, including Tom Malzbender and Dan Gelb, working in computer vision and 3D graphics at Hewlett-Packard Laboratories, Palo-Alto, California. Polynomial texture mapping (PTM) was developed for the three-dimensional recording of forms for the gaming industry, and latterly archaeology. Polynomial texture mapping is a component of the software underpinning the technique of RTI. Polynomial texture mapping (PTM) is based upon calculation of the Bidirectional Reflectance Distribution
Function (BRDF) which characterizes the colour of a surface as a function of incident light.

RTI images are produced using information from multiple digital photographs of a given subject in which each photograph is taken from a stationary camera. In each photograph produced using this technique light is projected onto the subject from a known direction, producing a series of digital photographic images of the same subject in varying highlights and shadows. Information regarding the lighting from each of these images is mathematically synthesized (using the Bidirectional Reflectance Distribution Function) to generate a mathematical model of the surface of the subject. This allows the RTI image to be interactively manipulated so as to examine its surface under different lighting conditions on the computer screen.

The mathematical characterization of the colour and lighting of surfaces underpins Reflectance Transformation Imaging (RTI), but also lends the images produced in this way with a quality of abstraction. The Bidirectional Reflectance Distribution Function offers images a degree of indexicality – the function links given images to very specific conditions of lighting and colour, while polynomial texture mapping links the image to lighting and texture. This computational data is now manipulable. As we shall see below, this provides the image with a quite different ontological status.

Making a Mark

The *Making a Mark* project analysed the imagery of the Neolithic period of Britain and Ireland (Jones and Díaz-Guardamino 2019). In doing so, it brought together techniques of archaeological documentation with digital imaging and perspectives derived from the anthropology of art. I discuss this below.

The imagery of Neolithic Britain and Ireland (dating from c.4050 cal. BC to c.2300 cal. BCE) ranges from the visually spectacular to the ephemeral. The decorated kerb stones of the great passage tombs of the Boyne valley, Ireland are good examples of the visually spectacular. Kerb stones, such as K1 and K52, positioned at the entrance and rear of the Newgrange passage tomb, are carved with a series of curvilinear and linear motifs, including spirals, lozenges and concentric nested arcs in relief. By contrast, artefacts like the stone plaque from Graig Lwyd, Wales - found discarded at a Neolithic stone axe quarry – are marked with a series of shallow incised lines crosscut by a chevron or zig-zag pattern. These shallow incisions appear to have been repeatedly effaced by peck marks and flaking into the decorated surface. When the plaque was originally excavated, in the early 1920s, these marks were regarded as so ephemeral that prehistorians disputed their validity (Grimes 1939); the ephemerality of these marks is underlined by the attempt to efface them by pecking and flaking during the Neolithic period.

British and Irish Neolithic imagery presents a puzzle for archaeologists. Unlike rock art traditions in other parts of Europe, the designs of the British and Irish Neolithic are not representational (there are few images of elks or boats readily apparent), making traditional semiotic analysis difficult; how can we decode this imagery? The *Making a Mark* project aimed to examine the imagery of Neolithic Britain and Ireland using digital imaging techniques such as Reflectance Transformation Imaging (RTI), structure from
motion photogrammetry (SfM) and low powered digital microscopy. The detailed methodology and archaeological results of this project have been discussed elsewhere (Jones and Díaz-Guardamino 2019), here I will discuss one group of artefacts – the slate plaques of the Isle of Man – as a means of considering how the project allows us to think differently about the ontological character of images.

There are a series of slate plaques from the Isle of Man (situated in the centre of the Irish Sea). The majority of these were discovered during the upgrade of Ronaldsway airport during World War II, these are derived from a Neolithic house. Another plaque, from Ballavarry in the north of the island, was discovered in a Neolithic pit during commercial archaeological work during the 1980s.

As previously argued, following a Neolithic tradition of producing miniature forms of stone tools around the Irish Sea region the artefacts are fashioned in the form of miniature Neolithic stone axes (Jones et al. 2016). The plaques have complex life histories since after they are fashioned they are eventually snapped in two and inscribed with very fine incised lines (it seems likely that incision takes place after the snapping of the plaques as there is no evidence of incisions crossing points of fracture and the only intact plaque is uninscribed). Marking on these artefacts is probably executed with a fine stone or flint implement, though - owing to the fineness of the slate – fingernails are also an effective drawing implement.

Several of the plaques (including Ronaldsway plaques ‘e’ and ‘d’; Jones et al. 2016), were recorded using Reflectance Transformation Imaging (RTI). The best-known artefact is Ronaldsway plaque ‘e’ (Bruce et al. 1947). The obverse side of the plaque is clearly decorated with three registers of lozenge motifs running horizontally across its surface (Figure 10.1: A). The reverse also has a register of parallel zig-zag motifs, and a further register of lozenge motifs below this (Figure 10.1: B). Less well known is Ronaldsway plaque ‘d’ (Bruce et al. 1947). The decoration on this plaque is very difficult to discern with the naked eye. However, using RTI it is possible to tell that the obverse is decorated with a register of widely spaced lozenges, near the base of the artefact (Figure 10.2: A). The reverse, meanwhile, is extensively decorated (Figure 10.2: B). The top of the plaque has a register of widely spaced zigzags. These are obscured beneath grinding striations which are probably the trace of attempts to remove this register of motifs. Below this area of grinding is a register of widely spaced zigzags. Just below that is a register of tightly spaced zigzags, followed by another register of widely spaced zigzags. Finally, near the base, is a register of large widely spaced lozenges or ‘butterfly’ motifs.

The Ballavarry plaque (Garrad 1984) also has a distinctive series of decorations. On the obverse of the plaque there are two horizontal lines making two distinct registers (Figure 10.3: A). Above and below these lines are a series of oblique incisions. At the midway point on the plaque it is possible to see the faint traces of two more evenly spaced horizontal lines. At the centre of these horizontal lines is an incised design resembling a Greek Cross. On the reverse of this plaque an incised zig-zag line bisects a horizontal incised line and forms a register. At the same time the horizontal line bisects
another worn zigzag just below it. Midway down the plaque there is another register of decoration formed by two horizontal lines sandwiching a series of oblique lines.

The detailed description enabled by RTI analysis allows us to visually comprehend the organisation of motifs on these plaques with a greater degree of clarity and we see a notable emphasis on distinct registers of decoration. Much more interesting is the plentiful evidence produced by RTI for the reworking and erasure of motifs. The best evidence for erasure comes from the obverse of the Ballavarry plaque where careful analysis of the top register of motifs – formed of two horizontal lines framing oblique incised lines - reveals that there are short vertical incised lines beneath the oblique lines. Meanwhile, on Ronaldsway plaque ‘d’ a register of zig-zag motifs lies beneath, and is just visible through, a cluster of grinding striations evidently meant to efface the motifs.

RTI analysis offers the potential of a new view of these artefacts. On one level, RTI enables the researcher to clearly view the evidence for imagery, which it had been previously difficult to see, on the surface of these artefacts. More important, RTI analysis enabled us to understand the processes of working on these artefacts. We began to realise that these delicate slate artefacts, and the images incised on their surface, were not fixed entities. They were things in process, images in motion.

We began to understand that the plaques were palimpsests, in the true sense of the word, and in this case, mark making was not a matter of record: marking was a repetitive practice; a continued intra-active engagement between people and materials. In this way, marking was a process of unknowing, a continued grasping towards establishing greater connections between humans, materials, and place. The fine grain of the slate affording not only revision but continued intra-action. These miniature slate plaques from the Isle of Man neatly illustrate one of the key findings of the project: that Neolithic inscribed artefacts were ‘in-process’, and the marks inscribed on the surface of these artefacts were constantly undergoing change and revision. Analysis of artefacts from across Britain and Ireland demonstrated that this is not an unusual example, but part of a widespread set of practices associated not only with artefacts, but also passage tomb art and rock art (Jones and Díaz-Guardamino 2019, 167-80).

Four-dimensional and multi-dimensional images

The Making a Mark project involved a kaleidoscopic combination of methods and techniques: archaeological analysis; an understanding of the anthropology of art; digital imaging techniques. I now want to consider how this project allows us to reenvisage images both archaeologically and computationally.

Archaeologically, the use of digital imaging techniques revealed that Neolithic images were not static, they underwent change. I have argued elsewhere that the reason the abstract and incomplete imagery of the Neolithic presents problems for the archaeologist is that - as heirs to the representational logic of the post-Renaissance era - archaeologists are unaccustomed to analyzing images in process (Jones 2019).

Digital imaging techniques, developed with the archaeological impulse to order, document and reproduce with fidelity were, in the Making a Mark project diffracted
through an anthropological understanding of images in motion (see also Back Danielsson and Jones 2020; Nail 2019). This involved using the manipulable light sources and differing coefficient functions of RTI to not only visualize mark making practices in clarity and detail, but to examine images undergoing change and alteration. As a researcher this led me to reconsider the ontological character of Neolithic images, arguing that during the Neolithic period they were ontological multiplicities (Jones 2019). I now want to diffract my multiple understanding of Neolithic images revealed by RTI back through the RTI process itself to consider in more detail the ontological character of the digital/computational images produced using this method.

One of the characteristics of archaeological modes of documentation are their indexicality. Whether we are discussing casting, tracing or photographic documentation, these methods aim to establish a physical contiguity between the thing documented and the document. In so doing, these methods also aim to establish a temporal index; they fix the documented artefact in both space and time.

In some senses the aims of RTI are similar. The technique was developed to produce accurate images of archaeological artefacts, however the manipulable function of the RTI-image lends the digital image with a quite different set of ontological characteristics. Recall that the Bidirectional Reflectance Distribution Function (BRDF) underpins the RTI-image. The image is therefore a mathematical function. The peculiar qualities of the digital image are highlighted by media theorist Jussi Parikka (2012, 36):

‘...Images are functions in the mathematical realm, made visible for us humans with such historical techniques as raytracing and radiosity – light, the basic ‘substance’ of optics and media cultural phenomena for a long ‘deep time’ of visual culture is itself something that becomes a special case of calculus.’

The RTI-image is a mathematical function which can be manipulated using the light tracking ball and coefficient functions of the RTI-viewer software. The digital image is only loosely indexical: the Bidirectional Reflectance Distribution Function encode specific conditions of lighting and colour and polynomial texture mapping (PTM) links the image to lighting and texture.

Traditional methods of archaeological documentation are concerned with defining the indexicality of the document, fixing the documented artefact in space and time. By contrast, the RTI documentation while offering the superficial appearance of a document operating according to the old familiar laws of indexicality, instead presents an image that can be manipulated, whose modes of lighting only tangentially encode fixed intervals of time. An image ‘out of joint’.

There is an irony here when we consider – in Jussi Parikka’s words- the ‘deep time’ of visual culture. In the Republic, written around 375 BC, Plato imagines humankind as prisoners in a cave only able to determine the existence of reality from the representations of that reality cast as shadows on cave walls. In this early thought-experiment Plato attempts to establish the problematic relationship between form and appearance, reality and representation. For Plato the ultimate mode of establishing the veracity of forms is through mathematical description, a mode of description deployed
by the most noble citizens of his republic (Plato 2007 [1955]). Indeed, one method of highlight-RTI involves positioning an object in a cave-like dome and taking multiple photographs using an array of LED light sources triggered to light the object in sequence. Plato’s cave has now been realised in physical form in the method of highlight-RTI and with the development of digital imaging we have now additionally arrived at the possibility for a mathematical description of images. Though mathematical functions were deployed to produce digital images of the highest fidelity, they also permit the development of a manipulable and mutable image. Plato would have undoubtedly enjoyed the irony: he was fully aware of the slippery and illusory power of images.

Computational imaging enables the image to be re-described both spatially and temporally. Elsewhere I have argued we can imagine archaeological images as four-dimensional: that is images moving through time. Writing with Ing-Marie Back Danielsson (Back Danielsson and Jones 2020), I have termed the four-dimensional image an ‘image-in-the-making’. We imagine images-in-the-making as kinds of practice. Based on Barad’s notion of mattering (Barad 2007), we describe this process as imaging. Barad describes mattering as a process in which reiterative practices co-constitute matter and meaning. In a similar sense imaging is a process of reiterative practice – drawing upon past images and materially constituting new images. Imaging is an ongoing and emergent process, bound up with processes of mark making, of revealing, making relations visible.

We consciously adopted the notion of imaging from the terminology of digital imaging, borrowing the time-based insights revealed by digital technology to understand how images might be considered as existing in time, perpetually in motion (Back Danielsson and Jones 2020). Working with the capacities of the digital image has enabled me to reconsider the importance of time for our understanding of ancient imagery. We now need to recursively readdress the digital (or computational) image. How does the mathematically abstract digital/computational image exist in time and space?

It is evident that digital images composed using RTI software are composites. While individual snapshots produced from this software have the superficial appearance of photographs (Zylinska 2017), these are photographs like no other: they are photographic images composed of everywhere and everywhen; ontological composites (in Sean Cubitt’s terms these are media-generated images utterly abstracted from their originary ecological contexts; Cubitt 2017). This abstraction occurs because the manipulable digital RTI-images from which they are composed encode a series of overlapping indexical moments and spatial viewpoints; in that sense they are indexically multistable.

Using the insights of digital imaging, I characterised ancient imagery as four-dimensional. The notion of four-dimensional images implies images in motion, undergoing processes of revision in which each stage of revision refers to previous stages. Instead, we are perhaps better regarding the abstracted computational image of RTI as multi-dimensional or multi-temporal; multi-temporal computational images
embody a series of differing times simultaneously. The times of four-dimensional images are sequential, whereas the times of multi-temporal images are simultaneous.

The production of the digital image forces us to think differently about images. We can no longer regard images as static entities existing in a fixed place and time. Rather the mathematical abstraction of the digital/computational image allows us to consider images as entirely manipulable and mutable entities that simultaneously encapsulate a host of differing times and places.

**Conclusion – image-assemblages**

I began this paper by arguing that traditional methods of documentation had rendered ancient images as fixed and stable entities. Precisely because ancient imagery was conceived to be fixed, it offered a reliable vehicle for cultural meaning. The ultimate aim of archaeologists was to decode and retrieve meaning from these fixed images from the past. In that sense fixed images possessed meaning which could be accessed by the rational human subject. This vision of images posits that images operate in a human-centred world; interpretable images are therefore focused towards knowledgeable human actors.

The four-dimensional character of images proposed here questions this viewpoint. While four-dimensional images may be interpretable, they are also emergent. As such, they are involved in a multiplicity of relations. While the four-dimensional image is a temporal and changeable image, it is also a material image; one of the key arguments regarding the erasure and revision of marks on Neolithic artefacts, such as the slate plaques from the Isle of Man, is that the revision of marks involved the repetitive re-establishment of relations between people and materials (Jones et. al. 2016; Crellin 2020, 113-4). In this sense, four-dimensional images are no longer the sole purview of the knowledgeable human actor, they instead exist as components of complex assemblages of materials, practices, and people.

Let us now consider the multi-temporal computational image produced using RTI. This computational image further disrupts our notion of images as humanly focused. We don’t necessarily need to invoke the notion of the ‘postimage’ (Hoelzl 2018) here, a vision of a machine-centred monitoring of the digital image, though the digital image produced by RTI is at least partially machinic. Instead, I prefer to return to the notion of imaging as a practice of assemblage formation – a way of making relations and connections visible - to consider the digital image produced by RTI as composed of an assemblage of relations. Media theorist Jussi Parikka (2012, 36) expands on this point for digital images:

‘The image comes out as a mixture of the pixels in the raster – starting from the point 0, 0 at the top left corner – a space that is a space not only of visibility, but of trackability (you are able to identify any minute point with precision), and hence connected to themes of surveillance’

Parikka emphasizes the point that digital images are not only assemblages, they are also composed of genealogical relationships. The assemblages of which they are composed embody previous practices of looking and seeing (Cubitt 2014); they are also mortal
and finite (Cubitt 2017). Given this, we should envisage the digital image produced by RTI as embedded in a network of relations involving mathematical computation, the behaviour of light, the need for the rendering of texture in the gaming industry, the requirement for the retrieval of three dimensional accuracy in archaeology and cultural heritage and the need for reproducibility and transferability of images amongst archaeologists. Each of the components of this assemblage have a long genealogy (for example, the long history of the need for accuracy and fidelity in the rendering of archaeological images). Some of these genealogies are based upon human-centred concerns, others are based on physics, mathematics etc. Critically, our understanding of images is fundamentally altered by our encounter with digital images. Our understanding of the image cross-cuts traditional divisions between humans, things, machines. In that sense, the computational image offers us a view of ‘cognitive image-assemblages’ as a new kind of posthuman knowledge (see also Braidotti 2019, 75-99; Hayles 2017, 115-141). In Katherine Hayles (2017, 115-141) sense these image-assemblages are composed of both cognitive decisions and what she describes as the cognitive nonconscious (the cognitive operations that occur below conscious thought). Cognitive assemblages, in her account, are composed of both the kind of decisions, intentions and operations we typically associate with human cognition working in tandem with the kind of automatic feedback mechanisms associated with machines and other entities not typically regarded as exhibiting ‘conscious thought’. The computational images fabricated by RTI are composed both of human cognitive intentions intra-cut with coefficients formed by mathematical functions, and therefore seem to satisfy Hayles’ definition of a cognitive assemblage. I adopt the term ‘cognitive image-assemblages’ here to emphasize the way in which the intra-action between computational/mathematical functions and human viewers is generative of novel conceptualisations of images.

Computational images are the product of just such complex cognitive image-assemblages and the knowledge and concepts produced from these image-assemblages is emergent rather than fixed (De Landa 2011, 185). The multi-dimensional character of computational images means that the kind of knowledge produced by digital images is multivalent. Digital images are not simply indexical records of past events, they are also interrogative tools that map towards future possibilities and potentials. Not so much the ‘immutable mobiles’ conceived by Latour (1987), but mutable mobiles: simultaneously fixed, transferable and changeable. Computational images produced using RTI not only enable archaeologists to visualize images as static entities, they also allow archaeologists to consider images performatively, enabling them to understand how they shift, change, and mutate. Not only are past temporalities indexically enfolded in the making of digital images produced by RTI, but the exigencies of the image-assemblage enable researchers to unfold images over time, projecting the image into the future. Computational images produced using RTI, while being engineered to quantifying the indexically known, also performatively gesture towards the multi-temporal, multi-indexical unknown.

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This paper was written during in May/June 2020 during the lockdown period imposed by the UK government during the Covid-19 pandemic. Throughout this period posthumanism has never been far from my thoughts as I have reflected on the way a microscopic viral entity had the power to alter modes of sociality and bring economic and political systems into disarray.

One of the few bright points of the lockdown period have been the weekly video conference meetings held by the editorial team: Ian Dawson, Louisa Minkin and Paul Reilly. During these meetings we have not only developed our thinking towards the volume but have creatively developed new understandings of the capabilities of RTI and photogrammetry. I would like to thank the members of the team for helping me to retain a measure of sanity, while keeping my cognitive and creative faculties limber. I would also like to thank Ing-Marie Back Danielsson for continued engagement throughout the Spring/Summer of 2020, and for her help in developing my thoughts around images and imaging, while Paul Reilly, Ian Dawson, Mihaela Brebenel, Jussi Parikka and Jo Turney and the WSA postgraduate seminar group are thanked for helpful comments during the writing and revision of this paper.

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