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**FROM ABSTRACT DATA MAPPING TO 3D
PHOTOREALISM: UNDERSTANDING EMERGING
INTERSECTIONS IN VISUALISATION PRACTICES AND
TECHNIQUES**

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A word about the weather: depiction and visualisation

Stephen Boyd Davis

Lansdown Centre for Electronic Arts

Middlesex University, UK

‘Finally, a word about the Weather.’ With these words, the BBC Trust began an unusual paragraph in their 2007 report on impartiality (BBC Trust 2007:53). With the advent of a new three-dimensional visualisation of the weather in May 2005 there had been immediate criticism. The images suggested northern Scotland was on the periphery, while south-east England was in the forefront. In its own odd way this controversy touches on an important issue in visualisation and depiction, and on the relationship between those two things. I will return to the weather map at the end of this paper.

The title of the AHRC IT Methods Workshop ‘From Abstract Data Mapping to 3D Photorealism’ could be taken to imply that abstract data mapping (visualisation) and photorealism (an extreme form of depiction) are as far apart as can be, perhaps even that they are opposites. By contrast, this paper explores some aspects they have in common. I suggest that it is productive to think of depiction as a form of visualisation, and to think of it as therefore subject to many of the same design considerations.

It is true that there are some obvious differences between visualisation and depiction as normally understood. Visualisation is generally a form of diagramming which takes quantities and relationships which are not inherently visible and gives them visual form. Depiction instead conveys aspects of an already visible reality or one that can be imagined. Visualisation is generally deliberately designed with a communicative intent, to impart information. The relationship between the message and the receiver is explicitly conceived by the designer: ‘I need to make these parts of my clinical effectiveness diagram more distinct so that users can see both the overall quality and the component judgements that led to it’. This approach has been characterised as one of transformation, where data are transformed by the designer into information (Macdonald-Ross and Waller 2000).

Depiction on the other hand is often seen to be concerned above all with the relation between the thing to be depicted and the depiction. IA Richards characterised it like this: ‘the artist is not as a rule consciously concerned with communication, but with getting the work, the poem or play or statue or painting or whatever it is, “right”, apparently regardless of its communicative efficacy’ (Richards 1928:26). Even where we are not concerned with ‘the artist’ but with the designer – and that designer may belong to any profession, not just to Design with a capital D – there is a tendency to think of depiction as by definition an activity of matching representations to scenes or objects. The argument I develop here is, to borrow the words of EH Gombrich, that depiction is best conceived as *making*, not *matching* (Gombrich 1977:248). This is a pragmatic model with a focus on results – a concern with what a picture does to and for the user or viewer. I suggest we think of depiction operationally and pragmatically. Though the issues to be dealt with here may or may not be of interest epistemologically, I stress those which have a direct practical bearing on how we visualise and how we depict, hoping to influence what we all produce in the future.

The purpose of the picture

To read much of the literature of computer graphics, it may seem that photorealism is *the* goal. It has also become something of a fetish within videogame design. In an exceptionally probing paper,

Durand questioned this objective and suggested that ‘there is more to images than realism alone’ (Durand 2002). What then is depiction and what is it for?

It is useful to divide the answer to this question into two parts: information and affect. Both can be considered in terms of expressivity. I define these terms very crudely. Informational expressivity is the extent to which the viewer of an image knows more as a result of looking at it. Affective expressivity is the extent to which some other response in the viewer is elicited. Both aspects are important in most kinds of designing.

Consider one style of depiction in terms of both information and affect. In 1833 Wheatstone proposed that the mental fusion of the images from the two eyes was the cause of spatial perception and created the stereoscope to demonstrate this; Brewster combined Wheatstone’s invention with photography in 1844, and a mass entertainment phenomenon was created (Gautrand 1998). By the mid 1850s, one version of the stereoscope had sold more than a million in England alone. The ambition of the London Stereoscope Company – ‘no home without a stereoscope’ – was almost fulfilled (Macdonald 1979:50). To see an object depicted stereoscopically generally does not provide any significant information which is not also visible in a monocular view. However it will probably alter the affect: users may have a stronger sense that the object exists in the same space as themselves. In some ways, the stereoscope was a private successor, using a mobile personal technology, to the public spectacle from the 1780s onwards of the Panorama, where also the sense of ‘being there’ was the overriding consideration (Oettermann 1997). In addition to scenes of everyday life, various exotica were available for the stereoscope: ghost pictures, moral tableaux, freaks and oddities, and pornography. This last category is important. It is the ‘sense of the real’ which is the principal objective. I think no one has ever suggested that 3D cinema provides more information than the 2D equivalent: it is sold in affective terms – excitement, engagement, believability. It is true that applications have emerged in which binocularity is combined with motion, such as in virtual environments for aeroplane or oilrig simulators, distance surgery and architectural visualisation. Here the information function is greater, though it is probably still the case that most of the informational benefits come from relative motion rather than stereopsis. I return to the *sense of the real* later in this article, but first deal with the informational aspect.

Depictions as information

In the context of Information Design, Mackinlay (1986:114-6) proposed a strict test of informational expressivity: that representations must ‘encode all the facts in the set and encode only the facts in the set’. I have discussed elsewhere some problems with this model (Boyd Davis 2007); the point to note here is that it presupposes that data pre-exist the design process. Sherlock Holmes claimed that he never theorised in advance of the facts, but his entire mode of working shows how impossible such an approach would be: every discovery within the infinite quantity of potential data results from an informed, experienced, motivated inquiry. The inquiry creates the data, by selecting it from the previously undifferentiated world. If we think of depiction as a form of information design, we can see where the problems of Mackinlay’s rule lie. If, for example, I set myself to draw a scene, what are the data? In one sense, the data comprise everything in the optical array, and nothing else, but, as Gombrich pointed out (1980), the history of picture-making provides few examples of unselective monitoring of the pattern of light on the retina. This history might be the result of incompetence or ignorance, as some commentators have thought, but another explanation lies in the inadequacies, for many purposes, of the photorealistic image.

In a simple sense, a photograph is the depictive embodiment of Mackinlay’s rule. The data is the optical array coming from the scene, and the photograph maps those data into the representation. If we believe Barthes’ assertion that photographs operate without a code (1977:17 *passim*), then even

the perhaps problematic ‘encode’ in Mackinlay’s rule is avoided: it is a matter of simple transmission. So photorealism would seem to be the ideal in Mackinlay’s theoretical terms as well as being a popular goal.

But consider non-photographic forms of depiction such as drawing. Gell (1998:165) compared language and visual art, and suggested that, whereas the ‘d’ in ‘dog’ does not stand for part of a dog, any line which is included in a drawing of a dog does represent some part of the animal – but he is only partly right. It is true that a mark probably appears approximately corresponding to the location of that part of the creature in the observed scene, but the line is not necessarily a delineation of some piece of the scene. The line may also, or instead, function as an *affordance* of visual, or even tactile, experience. It is designed to stimulate a cognitive process in the viewer, rather than simply to transmit data from the scene. Often lines are inscribed onto the surfaces of objects in drawings which have more to do with what it would be like to trace one’s finger across the surface of the object than merely see it. They make a space which is *analogous* to the perceived scene. I have called these traces ‘illicit marks’ simply on the grounds that they are not authorised by any direct counterpart in the scene tonality (Boyd Davis 2002:81). Marr’s model of vision (1982:37) proposed that mental constructs equivalent to outlines are a primary means of segmenting the scene at a basic level, but this does not alter the fact that the lines are post-optical: they are not before the eye. Such techniques in pictures have a long history. Deregowski (1984:42) shows Bushman petroglyphs from South Africa, of ‘ancient but unspecified date’ in which the more distant horn of antelope is clearly drawn as separate from the head of the depicted animals. The illicit gap is there to ‘make’ space, not to match the optical stimulus of the scene.



Figure 1. A photograph in the context of its own subject. (Well, actually, this is a photograph of that photograph...) Part of an artwork by Andrew Kearney at Middlesex University, London, UK. Used with permission.

In the pragmatism of their approach, picture-makers seldom adopt a rigorous logic in their use of illicit marks: the marks are usually combined with optical data in an ad hoc way, which may be driven as much by the ongoing solution of pictorial problems as by any preconceived system. Wollheim refers to the picture-maker building up ‘analogies’ between the medium and the object of representation, seeking an ‘ever more intimate rapport between the two experiences’ (Wollheim 1980:224), and Podro remarks how ‘line connects shape to movement as they can be connected only in drawing. Shape and movement become projected onto each other, so that while making recognition more replete the image takes on a structure which has no equivalent outside depiction.’ (Podro 1998:9).



Figure 2. Pragmatic picture-making. The picture-maker's marks operate in a multitude of relations to the scene. Page from an early nineteenth-century sketchbook (detail). Author's collection.

In **Figure 2**, marks have many functions in a pragmatic evocation of experience. They operate in a multitude of relations to the scene: now delineating the contour of an object, now creating shadow; indicating a surface retreating in depth; caressing the cylindrical shape of the foreground logs; selecting telling details such as the keyhole, hinges and nails of the barn; making a dramatic contrast between the angled stakes and the rectilinear barn wall; evoking the exuberant wildness of the creeping plants in full leaf straggling over the building. Each of these is part of a representational *transformation*, not a transmission of optical data. They make it possible for the picture-maker to 'tell' about the scene graphically not simply to 'show' it. It has been said of technical illustration that the question is not, 'is this what the component looks like? Rather it is: does this collection of graphic marks provide the viewer with the appropriate information to "read" the illustration?' (Richards 2006:103). Richards goes on to argue that the appropriate use of outline (**Figure 3**) is more expressive for his purposes than any simple mapping of tonal and colour values.

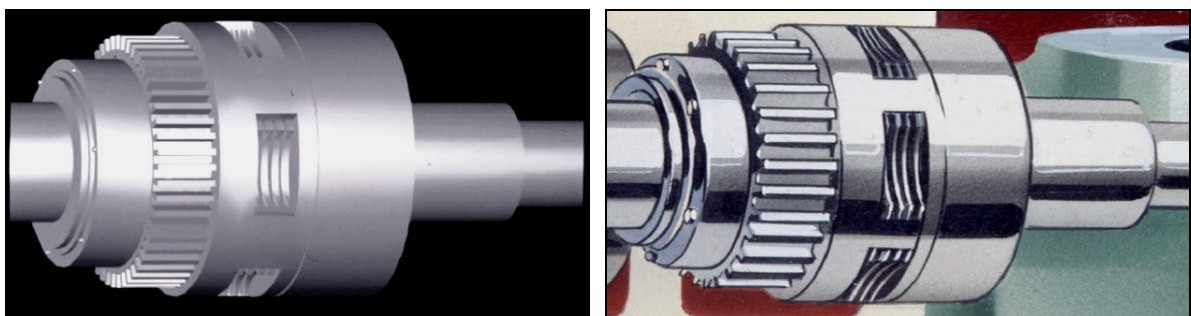


Figure 3. *Left:* a tonal rendering of a machine assembly (Clive Richards, Coventry University). *Right:* an alternative rendering which incorporates variable line weights according to the conventions of technical illustration (Nicolas Bussard, Coventry University). From Richards 2006. Used with permission.

In order to construct a depiction then, the maker engages in a process of active inquiry, selecting, probing, rejecting, interrelating, working with four sets of data:

1. what can be seen

2. what is known (this encompasses both the picture-maker's lifetime of knowledge about the world and more specific information about what the object or scene looks like from other points of view, plus non-visual information concerning touch, weight, etc.)
3. experience of how pictures work (including both conscious and tacit knowledge of shared pictorial culture)
4. the emerging depiction itself.

A photograph has many potential merits, but it satisfies only some of these requirements. There is a limit to how far a photograph can 'tell' rather than simply 'show' because, though the photographer can bring to bear some of the knowledge in requirements 2 and 3, the capacity for selection, omission, attenuation, and augmentation (such as through illicit marks) is limited or in some cases non-existent.

Given that Descartes has been strongly identified with a mechanised model of vision, it is intriguing to find him acknowledging that 'very often the perfection of an image depends on its not resembling the object as much as it might' (Descartes 1954:245). Presumably he was sensitive to the difference between a wholly mechanistic, mimetic mapping of the scene, and one where the artist or draughtsman makes sense of the subject on behalf of the intended viewer. The artist George Stubbs notoriously spent months in the 1750s flaying dead horses layer by layer in order to establish their underlying anatomy, so enhancing the realism of his depictions, and many artists have investigated hidden structures (**Figure 4**) for similar reasons. Their depictions, even when apparently only showing a surface, embody additional knowledge which was not really visible in the simple optical array. Of course, prior knowledge in the hands of the inexperienced picture-maker can be a hazard. Those who are inexperienced in drawing tend to bring too much knowledge of how things 'really are'. This is why they tend to draw the tabletop as the rectangle they know it to be, rather than as the trapezoid that it offers to the eye. They have to unlearn what they know in order to see what is there to be seen.

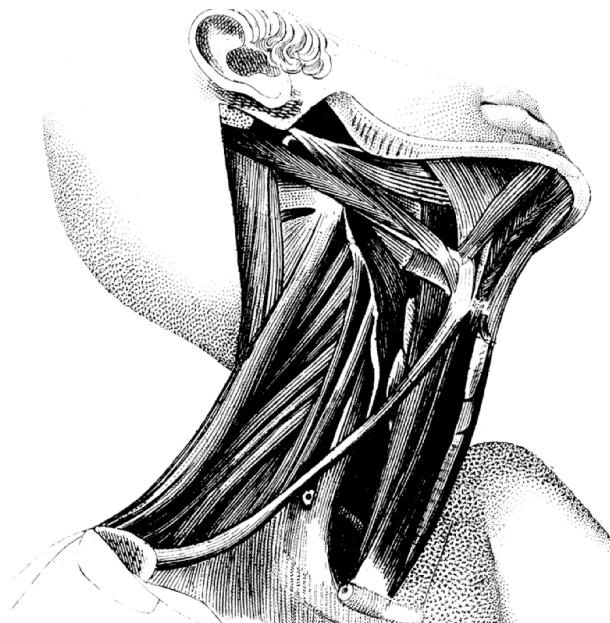


Figure 4. Historically, dissection has been extensively used by artists to acquire knowledge about the underlying workings of the body. From a collection of copyright-free historical engravings of the human body on a CD-ROM accompanying *Images of the Human Body*, Shambhala Agile Rabbit Editions 1999.

Photorealism in the dock

Much has been said to imply that the perspectival depiction inherited from the Renaissance – of which photography is in some ways the apotheosis – is ethically reprehensible. A particular

characteristic of such theories is their tendency to attack any notion of visual realism, offering in its place an entirely relativistic view. There is a tendency also to allege conspiracy. So Crary states that 'The standardisation of visual imagery in the nineteenth century must be seen then not simply as part of new forms of mechanised reproduction but in relation to a broader process of normalisation and subjection of the observer.' (Crary 1990:17). For Harvey 'representations of space and time arise out of the world of social practices but then become a form of regulation of those practices.' (Harvey 1996:212). Lalvani (1996:6) claims that 'linear perspective or artificial perspective is a conventional symbolic ordering of space, operating within a cultural discourse of what constitutes the real'. Jenks (1995:7) claims that 'the overwhelming appeal of such a rigid and intransigent relation between vision and visual field [that is, linear perspective] must surely derive from its strengths in protecting the variety of interests inherent in any social order of signs and images.' This invective of conspiracy seems to ignore the fact that the claim of photography (for example) to be the arbiter of realism arises from popular perception of its special relationship to the visible world, not from oppression. Who is doing the oppressing is seldom made clear. When Virilio (1994:21) claims that 'Considered irrefutable proof of the existence of an objective world, the snapshot was, in fact, the bearer of its own future ruin,' one can only wonder what form this ruin took or is taking.

While there is no reason to go along with these conspiracy theories, it is certainly worth acknowledging two questions when considering the informational expressivity of (photo)realist depiction. Is it actually possible to match optical truth – is a photograph, for instance, true? And what are the limits of usefulness for such images?

Despite the many claims to the contrary, the pictorial geometry of linear perspective – embodied in all conventional photographs – does have the best claim to be considered correct since it is, in Arnheim's words, a tracing of the scene (Arnheim 1956:233). Using a pane of glass and a single fixed viewpoint it is possible to show that this geometry offers a correct fit to our view of the shape of things. The arguments are too complex to review here but an analysis can be found in Boyd Davis 2002:66-74. However, geometry is not the only point at issue, and there are several ways in which every depiction must be forced to choose between rival, and incompatible, claims to truth, simply because depiction can never be equivalent to natural vision. To cite a single example, some depiction, perhaps a photograph, could either be based on the 'truth' that all parts of an image are in focus both in depth and across the visual field, which accords with how we *think* we see, or on the alternative 'truth' that the eye focuses on only a tiny portion of the scene at any one instant, which accords with what the eye can actually do. Pictures are not a simple cross section of space-time (Durand 2002:122).

Some important figures have suggested that a picture represents the retinal image and this has produced considerable confusion. As far back as 1925, Panofsky argued that 'perspectival construction ignores the crucial circumstance that this retinal image [...] is a projection not on a flat but a concave surface' (Panofsky 1925:31). So misled was he by this confusion between the stimulus and the receiving device that he suggested that we see lines as straight because of the conventions of painting and photography. Remarkably, Alberti explicitly stated in 1435 that the operation of the eye itself is of no consequence to an understanding of his pictorial construction (Alpers 1983:53). The potential for confusion continues, as evidenced by Gregory's remark that '*When an artist employs geometrical perspective he does not draw what he sees – he represents his retinal image ... A photograph represents the retinal image – not how the scene appears.*' (Gregory 1998:184 original emphasis). In fact, what a would-be realist image has to resemble is nothing within the eye but the visual rays available from the scene. But the active, moving searching eye 'sees' one thing, while the brain 'sees' another. All early photographers strove to produce perfect focus in the full depth of the

scene, whereas we are now often more satisfied by the ‘realism’ of images which focus on only one part.

Realism as information and not

Why might picture-makers may choose to depart from any goal of straightforward photo-mimesis in the design of pictorial information? If some pictures can at least come close to being ‘right’ as representations of scenes, what purposes do other kinds of pictures serve?

It is clear on looking at depictions from a range of cultures, times and contexts that different ‘realisms’ have been used selectively. For example, the realism of solidity may be achieved through modelling alone without the use of cast shadows. Conversely a coherent, occupiable space can be pictured using cast shadows but where modelling is absent. Peter Greenaway notes the range of realisms which operate simultaneously in Holman Hunt’s *The Hireling Shepherd* of 1851-2 ‘...the sleeping sheep is heavy, the green apples are bitter, the grass in the ditch is wet, the woman’s feet are palpable. With no trouble at all you can walk about the painting like you can walk about a landscape – there is enough evidence to name all the plants’ (Pascoe 1997:34). Here we have the sense of weight associated with ‘objectness’ and modelled solidity (the sheep), the inference of non-visual qualities such as taste (bitter apples), feel (wet grass) and impressibility (palpable feet), occupiability (the landscape that can be walked in) and specific recognition (evidence enough to name the plants).

To a significant extent we can pick and choose between realisms to suit the purpose of the moment. A botanical illustration can allow recognition of a plant without creating any convincing space for the plant to occupy. Examples abound where only some particular realism is invoked.

Computer graphics have often been constructed with a selective approach to realism for reasons of computational efficiency. Sadly, in most of the literature of computer graphics, realism is nevertheless assumed to have some agreed, global definition which need not be specified, though there are exceptions. Usoh et al. (1999) were among the earliest to not only declare their criteria in terms of the response of users but to assess their work against these definitions. Their goal was the development of ‘natural and effective virtual surrogates for user interactions with physical spaces and objects.’ (p359). Creating a virtual space containing an alarming drop or pit to achieve a ‘strikingly compelling virtual experience’ (p363), they assessed the user’s reactions as evidenced by:

- the subject’s awareness of background sounds
- subjects’ reports of similarity to really looking into a pit
- subjects’ sensation of vertigo and willingness to walk over the pit
- whether or not subjects actually traversed or circumnavigated the virtual pit.

This is, unusually, a properly defined sense of realism based principally on the notion of ‘believability’ – in other words a definition based as much on the relation between representation and user as on that between representation and scene. The subjectivity of the experience engendered is acknowledged in their finding that the sense of realism declined in proportion to the subjects’ prior experience of computer gaming (p363). Such recognition that the sense of realism is subject to change over time and to context is very unusual. A complementary approach is taken by work which explicitly deals with the user’s perception of the match between computer graphics and photography (Rademacher et al 2001) avoiding the assumption that this is equivalent to other realisms. Ferwerda (2003), inspired by Hagen’s differentiation of realisms in the geometries of depiction (1986) set out to distinguish three kinds of realism in computer graphics. And Smallman and St John (2005) complained at ‘naïve realism’ which they argued often failed in informational terms. But despite such work there is still a widespread assumption that visual realism needs no definition or analysis and that it is an undifferentiated benefit.

There are many reasons why the closest possible approach to the photo-real may simply not be suited to the task in hand. The representations favoured by architecture, product design, engineering, magazine advertising and many other image-using trades and professions use it as only as one among a range of possible approaches. This is partly because it is not always as expressive in informational terms as the alternatives. Orthographic, axonometric, isometric and hybrid projections may offer benefits such as constant scale or greater clarity about the interrelationship of multiple viewpoints. Photo-mimesis may be suppressed, distorted or subverted in order to convey information more effectively, as with the weighted outlines in Richards' technical illustrations.

Pictures perform a role in both personal and social processes. Sketches, for example, are used for externalisation and reflection as well as communication to others; technical drawings to convey unambiguous instructions; highly pictorial renderings to persuade colleagues, clients or planners. A photo-real image has a character of completeness and non-negotiability (Schofield 1996), and several authors have pointed out the benefits of avoiding such characteristics in some circumstances. When a sketch is considered as an element in a process, it is clear that there are merits to imprecision and tentativeness in depiction. Arnheim (1993) calls sketches 'guiding images' whose role as externalisation facilitates the design process. As long as the guiding image is still developing, the sketch remains tentative, generic, and vague and this vagueness is not a negative quality. The sketch stands for a whole range of possibilities without being wholly committed to any one of them. This is a striking example of the concept of affordance in which the representation is chosen because it is less dictatorial than a more fully worked out picture. Scrivener and Clark (1994:98-9) also suggest that the sketch operates by affording multiple mental images rather than being confined to one, and that the lack of specificity evokes greater imaginative work on the part of the perceiver. This is an argument for the limitation of visual realism in the interests of expressiveness. Their characterisation, like Arnheim's, is essentially an operational one, in which the picture-maker puts down marks which afford interpretations, a process quite different from mechanically mapping the tonal and colour values of the scene. The expressivity of a form of depiction often arises from ways in which it does *not* match vision, even were the latter ever entirely possible.

Panofsky suggested that the 'window' model of perspectival depiction militated against the symbolic (Panofsky 1964:140) and Greenaway also identifies a kind of loss. He complains for example of the harm caused by the move to using size according to the laws of perspective in place of sizing based on semantic significance:

'All those other things that the Renaissance taught us to forget – that Christ is this big [spreads arms] and the apostle is this big [much smaller], which a twelfth century Amiens peasant wouldn't have had a problem with, but subsequent to the Renaissance we all have a problem with because the Renaissance taught us about illusionism and realism and all those other irrelevant phenomena'

Greenaway interviewed in Melia and Woods 1998:30.

For these reasons, Greenaway's own films increasingly rejected the simple pictorial mode of photography, presenting instead, for example in *Prospero's Books*, multimodal configurations of photography, drawing, animation and text, noticeably at odds with the 'realistic' visual practices of mainstream film-makers.

If these are just some of the potential weaknesses of photorealism in terms of information expressivity, we can must ask: what can it do in terms of affect? I suggest that photorealism and other highly mimetic forms actually have most to contribute in this respect – through affect, not information.

Depiction and affect

Affective expressivity concerns a change produced in the user which is not simply one of imparting information but of altering some aspect of the viewer's attitude. As already noted, the expressivity of a depiction often arises from ways in which it does *not* match vision. Nevertheless, realism is often at a premium, and frequently this is associated with the notion of transparency, a transparent representation being one which does not draw attention to its own mediation. It should immediately be noted that, as I suggested above, it does not really matter whether this transparency is 'real' (that is, the image matches natural vision in some way) or the transparency is culturally conditioned (it uses codes which are overlooked because they are shared by both maker and user). The affective benefits of transparent images, which *seem realistic*, have led to a kind of 'pictorial imperative' where depiction is often the form of visual rendering most eagerly adopted. Unfortunately this often means that the analytical decision-making we might expect in other kinds of visualisation is abandoned, because picture-making is thought to be – essentially – simple.

Transparency is the key to the sense of the real in depiction. It is not the match of the depiction to the scene which matters, measured in objective terms, but the perceived naturalness of apprehension. It is defined not so much by the presence of any particular qualities, but the absence of one, namely by the absence of any *apparent* encoding. This creates the impression of a natural, realistic picture.

The transparent image, then, aspires to seem like simply seeing, rather than being overtly presentational. In some cultural groups, such pictorial realism is highly valued; in others, it is deprecated. There is a long tradition of preference among the intelligentsia for images which are ostensibly mediated. This is often accompanied by a preference for content which is difficult of access, which is *not* made effortlessly present to the consumer. Nietzsche (1977:18) remarked that, 'all the more subtle rules of style have their origin here: they hold at arm's length, they create distance, they forbid "admission", understanding...'. A champion of intellectual cinema, scorning popular movies in the early 1930s warned:

There seems to be little doubt that there will be colour. When colour is perfected technically, the film will be an almost perfect copy of reality, almost 'the real thing.' With the perfection of the magnascope, the screen will be made to issue into the auditorium: the audience will be enveloped in the film. The approximation to reality will be still more convincing, the opportunity of imaginative creative work still more improbable, the cheap appeals to participate in a crude and unhealthy experience still more compelling.

Hunter 1932:11

Throughout the twentieth century, it was considered reprehensible in intellectual circles if a work did not demonstrate awareness of its mediation. Ruskin's nineteenth-century fascination with the accurate depiction of the natural world had come to seem irrelevant or naïve. Eisenstein argued that to transmit visual appearance was not sufficient. The visible world required organisation by a stronger principle: 'the dry quadrilateral [ie. the frame of the shot], plunging into the hazards of nature's diffuseness' (Eisenstein 1977:40). The task is 'hewing out a piece of actuality with the axe of the lens' (p41). Among more recent theorists in the intellectual tradition, Bolter has turned his admiration of work which is ostensibly mediated into an assertion that all digital media inevitably 'remediate' other media – that they have no direct address of their own – and a suggestion that all good digital art shares the characteristic of not being transparent (Bolter and Grusin 1999; Bolter and Gromala 2003).

In contrast to this intellectual tradition lies a strong populist preference for illusion. I noted earlier the popular craze for the panorama, seeming to take viewers virtually to another time and place,

which presages realistic special effects in the movies, and popular art-forms generally continue to promote the most direct engagement with what is depicted, rather than any interest in the depictive form as such. However, it is important not to imply that this preference is actually naïve – the audience’s awareness of the interplay between the real and the representation is probably no less subtle than was admiration of the interplay between the painted canvas and the painted subject in former centuries. In fact, surely much of the charm of photorealistic images comes from the simple pleasure of a conjuring trick. We know that the image is not real, and yet it seems to be – a form of magic. Traditionally, the most extreme example of this has been the *trompe l’oeil* painting, such as the seventeenth century work of Cornelius Gijsbrechts. Often our admiration of skill is a strong component of the pleasure, and this continues to be the case even with the computer image. It is ironic that while the pioneers of photography took pains to explain to their public that ‘groups of figures take no longer to obtain than single figures would require, since the camera depicts them all at once, however numerous they may be’ (‘The Pencil of Nature’ by WH Fox Talbot 1844-46, in Frizot 1998:62), computer graphics workers constantly remind the consumer that greater photorealism requires more complex, more subtle and more expensive computing.

The aim of realist computer graphics has been described as being to map a three-dimensional world to a plane surface in a ‘convincing and effective manner’ (Baker 1993:33 emphasis added) and this seems correct. In most cases either the demand is an operational one of effectiveness, in which case the realisms chosen are those which support the practical functions which the pictures serve (as discussed above), or the pictures must merely convince. In the former case complete truth is not required (even if it were achievable) since only those realisms required for the task are called into play, and in the latter case truth is not required at all – it is not necessary that something be true for it to be convincing. This requirement is an affective one, not informational. It is fundamental to the concept of ‘convincingness’ that realism does not reside solely within the artefact. The viewer brings to a picture an awareness of the context in which it is displayed and the technology which was used to make it, and this also leads to many different kinds of ‘being convinced’. When Sontag said (1977:86) that ‘the flat, usually rectangular, images which are photographs make a claim to be true that painting can never make’, the awareness that the medium *is* photography alters the context irrevocably. Barthes claimed (1968) that the ‘reality effect’ (*effet de réel*) arises particularly when irrelevant detail is present – as it is in most photographs – because the inclusion of the irrelevant is like our experience of the world. The role of imputed intention complicates the issue: a photograph and a highly realist non-photographic picture will be interpreted differently. As always, content, context and depiction interact.

A final illustration of the tension between visualisation and depiction is provided by the controversy over the BBC’s redesign of its weather forecasts. The change, on 16 May 2005, epitomises the pictorial imperative, since maps were replaced by a virtual model of the United Kingdom. In the ensuing public argument, several weaknesses of the pictorial mode were alleged. Since a perspectival view requires a viewing position, and the BBC elected to view the nation from the south, Scotland was reduced to a distant blur (a higher viewing angle was later introduced to lessen this effect). Symbols of sun, rain or clouds were replaced by pictorial cloud and rain, which many viewers found less rapidly accessible. Extra-pictorial labelling was replaced by depicted virtual weather. Significantly, the defence of the changes was partly in terms of popular taste: ‘People’s expectations of computer-generated graphics on TV, in films, as well as in video gaming, are much higher now’ the project director at the BBC’s Weather Centre explained. A sentence summed up the perceived advantages for information and affect: ‘[it] makes the topography of the ground look more accurate, and feels like a 3D flying game’ (BBC 2004). But perhaps in fact information had lost out to affect.

A key problem was that moving from a conception of the-weather-as-visualisation to the-weather-as-a-picture meant that the selectivity, judgement, and above all the focus on communicative efficacy which might have been involved in designing a visualisation were abandoned. Effectively the answer was, 'Well if you look at the UK from this end, Scotland *is* very small. That's how pictures are.' Of course no one could conceive of viewing the UK from the Scottish end, as then the whole nation would be the wrong way up: everyone knows that Scotland is at the top of the UK, which I suppose must be some consolation to them.

Closing remarks

I have offered a model of picture-making as pragmatic in two senses. Depiction is a meaning-making activity and a picture is – or rather should be – moulded to its objectives, just as we would expect when devising an abstract visualisation. Here I have concentrated on the static image, but similar arguments can be made concerning the moving image where again expressivity is increased through *mismatch* between the representation and natural vision. Effective picture-making is characterised by pragmatic pictorial decisions in which the elicitation of a response is as important as the matching of an external referent. The marks which constitute even a would-be realist picture are best thought of as stimuli intended by the picture-maker to afford an experience analogous to natural vision, rather than necessarily being a copy of anything. In many cases the informational benefits of a photorealist depiction will be negligible, and such pictures may bring more problems than they solve, yet the hunger for realism (however contentious its definition) will often mean that, for reasons which have nothing to do with information, we choose to use such images. If we do, we need to design them with care, taking nothing for granted. Depiction should be subject to the same decisive, goal-oriented considerations as any visualisation: it is all a matter of design.

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