LIGHT FROM SHADOW

*"Shadow is of the nature of darkness; reflected light (lume) is of the nature of the light source (luce); one
conceals and the other reveals. They are always associated and inseparable from all objects. But shadow
is a more powerful agent than light, for it can impede and entirely deprive bodies of their light, while light
can never entirely expel shadow from a body, that is, from an opaque body."* LEONARDO DA VINCI

In this exhibition we examine the paradox that, although holograms are made entirely by the action of wave- fronts of light, they convey the same impression of shade as well as light that we perceive in the natural world. We do this by focusing on Paula Dawson's hologram, Shadowy Figures(No.18), which juxtaposes three draped figures, rendering in three dimensions reworkings of two-dimensional examples by Giotto, Masaccio and Leonardo da Vinci. These particular historical models have been chosen because they show in a very precise way three different approaches to rendering shadow in the draped figure (they were given a penetrating analysis as such by Michael Baxandall, in his book, Shadows and Enlightenment, (1995)), and have therefore lent themselves particularly well to the investigation of darkness in holographic imaging. The exhibition sets Dawson's new work both in the context of earlier holograms which have made an original and significant use of darkness, and in relation to some pre-holographic images where the technique and meaning of darkness is especially clear. To help understand these contexts we must begin by looking at some of the many interpretations of light and darkness in the western tradition. Let us begin at the beginning.

The Biblical Book of Genesis tells us that in the beginning darkness reigned until, on the first day, God created light and 'saw that it was good' (Gen.I,4). This primary act of creation ensured that light would have a central place in the Divine Order, even before, on the fourth day, the light-giving bodies, sun, moon and stars, were created, bodies which have been given divine status in most non-western cultures and are also prominent in Giotto's Scrovegni Chapel, a home of the Virgin Mary's father, Joachim, one of the subjects of Paula Dawson's hologram, which has also adopted these heavenly bodies from the Chapel decoration.

A reverence for light is deeply embedded in the Christian tradition. The New Testament presents Christ himself as the 'Light of the world' proclaimed by John the Baptist (John 8,12), who also claimed,

'In Him was life, and the life was the light of men. And the light shineth in darkness; and the darkness comprehended it not" (John I,4-5)

Here the negative connotations of darkness are clear.

In Paula Dawson's Types of Darkness,(No. 21), an imaginative re-interpretation of Piero della Francesca's Magdalene in Arezzo Cathedral, the crystal ointment jar, from which Mary Magdalene anointed Christ's feet, has become a generator of light itself. Piero's jar has the form of a pyx, the medieval receptacle of the Host, Christ's body in the form of wafers, ingested by communicants in the course of the Mass, and thus representing the light conveyed by the Saviour to his Faithful. The art-historian Martin Kemp has already pointed to the supreme luminosity of this jar,

'which beautifully demonstrates multiple reflections from the crystal on the illuminated side and diffused radiance within the far side of the liquid, as the light is both caught by its substance and turned back by the inner surface of the container' (1)

Pyxes were often enamelled or encrusted with jewels, but Piero found an even more striking way to convey the light-bearing character of his, which Dawson has amplified in her wonderfully pearly hologram.

Another, late medieval, image of Mary Magdalene suggests that Piero was not alone in thinking that she was a conveyer of light. A miniature in a late thirteenth-century missal in Ghent shows the three Maries arriving at the tomb of Christ, the last of whom, robed in her customary red, but with an unusual red halo, carries a gold ointment-jar with the same pyx-like shape. The notion that red of all colours bore the closest relation to light is an ancient one in the west, and here it qualifies the Magdalene's other role as a scarlet woman (2).

No less ancient is the equation of light and life: Christ himself claimed to be offering 'the light of life'; and his representative on earth, St Peter, present in Shadowy Figures in the form of Masaccio's saint from the baptism episode in the Brancacci Chapel, traditionally wears robes of blue and yellow, colours which we now recognize as the additive complementaries constituting white light (3). Baptism itself, in the early Christian Church, was seen as conferring light, and hence life.(4)

Medieval painters brought light directly into their work by using highly reflective media such as gold or mosaic, or decorating it with precious stones, such as the pearls in Dawson's Types of Darkness. But to Renaissance and Baroque artists such devices seemed too raw and too wayward to serve the new single-point perspective systems, and they devised other, more 'natural' ways of representing light, for example the irregular flames surrounding Goltzius' torches (No.3)or the irregular haloes of Rembrandt (Nos.5,6).

Even in the increasingly secular centuries which saw the beginnings of modernity, light enjoyed a supremely high status as the symbol of Enlightenment itself. One of the most characteristic discoveries of the seventeenth century was Sir Isaac Newton's conclusive proof that colour, which had hitherto been regarded as including an intrinsically dark component, was inherent in light alone, the variable refrangibility of whose rays was responsible for all the colours of the spectrum. The idea that each colour has its own angle of refraction - later identified as a wavelength - is crucial to holography, which depends on coherent laser light of a single wavelength. During their residency at the Royal Observatory in Sussex the holographic artists Michael Wenyon and Susan Gamble (see No.35)made a number of works using Newton's fundamental contribution to modern optics, starting from passages in his Opticks of 1704 (5).

Thus light has invariably been seen as the supreme good; the luminous heavens were the seat of the gods, and those material substances which seemed most to embody light: gold and gemstones, represented the highest values on earth.

THE REALM OF DARKNESS

Not so darkness. Darkness has almost invariably had a bad press. According to a survey among students at a Mexican university in the 1960s, to cite one modern example, black was the colour most readily interpreted in, largely negative, symbolic terms, and, more often than not,of course, it connoted "death" (6). Even the writings of the sixth-century , probably Syrian, monk known as Dionysius the Pseudo-Areopagite (because he was identified with the Greek philosopher converted to Christianity by St Paul at Athens: Acts 17,34), writings which expounded a 'negative theology' of darkness, expressive of the unknown and unknowable nature of God, who in early medieval art was often shrouded in a dark cloud, even these writings also promoted a theology of light; and this was the side of Dionysian thought most influential in the later Middle Ages (7). The seeming paradox of the dark god came to be interpreted more rationally in terms of the phenomenology of vision, as in the blind poet John Milton's lines:
    'Dark with excessive bright thy skirts appear' (Paradise Lost,III, 380)
Milton here adopts the ancient Greek term , lampron (="bright"), but he was also writing at a time in the seventeenth century when subjective optical effects were becoming increasingly fascinating to artists as well as to scientists. To the renewed interest in the negative theology of Pseudo-Dionysius - whose works were printed in a collected edition at Antwerp in 1634 - was added the crucial role of darkness for the investigations of astronomy.
    Johannes Kepler argued at the beginning of the century that darkness was the necessary condition for viewing the heavenly bodies; and the English physician Sir Thomas Browne in the 1650s linked the physical to the metaphysical:
    '...were it not for darkness & the shadow of the earth, the noblest part of the Creation had remained unseen, & the stars in the heaven as invisible as on the fourth day, when they were created above the Horizon, with the sun, or there was not an eye to behold them. The greatest mystery of Religion is expressed by Adumbration...Life itself is but the shadow of death, and souls departed but the shadows of the living...The Sunne it self is but the dark 'simulacrum', & Light but the shadow of God...' (8)
    Yet for artists, and especially for painters, darkness was an essential component of representation. As the eighteenth-century French philosopher Claude-Nicholas Lecat asserted:
    'The art of painting has the same values (nuances) in each colour, of which the principal is always shade (l'ombre), and it is well known that these arts [sic]do nothing but copy the workings of light and shadow in the phenomena of vision' (9).
    Aristotle had proposed that colours themselves were generated by darkness together with light, and owed their particular hues - red, green, etc.- to the proportion of light and darkness in their composition. This classical doctrine was re-inforced in the early modern period by subjective experiments with the newly-developed triangular prism, which, when presented to the eye like a lens, revealed coloured fringes at the junction of light and dark areas in the surface viewed. (10) It is ironic that Newton's experiments with this same optical tool led him to precisely the opposite conclusions about the nature of colour; but a century after Newton the German poet Johann Wolfgang von Goethe returned to these early prismatic experiments and made them the basis of the most authoritative and comprehensive re-statement of the classical view, which, although it was largely rejected by scientists, found a ready reception among artists, especially German artists, well into the twentieth century. The English Romantic painter Turner, who read and annotated Goethe's Theory of Colours, and in 1843 executed a pair of small paintings based on his reading, went so far as to criticise the poet/theorist for having given less prominence to the role of darkness than he, Turner, felt was its due. He did so largely as a result of his experience of printmaking, which had occupied him for most of his career, and where the colours of painting - and he was, of course, a master of colour - had to be translated into a monochrome scale (11). Agostino Carracci's 1582 engraving after a lost painting by Veronese (No.1) is a remarkably early attempt in the same vein to translate a highly coloured image into a vigorous chiaroscuro design.
    It was not, however, only as an indispensible technical resource that darkness came to have such an important place in the repertory of painting and the print. From the mid-seventeenth century critics of art were agreed that the extensive deployment of darkness in what the Italians had already identified as chiaroscuro was what conferred a sense of magic and mystery to visual images. As the French critic Claude Watelet wrote of the Greek painter Nicias - whose work was entirely unknown to him, since none of it had survived, but who was characterised in Antiquity as a master of light and shade (Pliny, Natural History, XXXV, 130-1)- :
    '...it would be necessary to see his works in order to know whether he raised to the level of the ideal chiaroscuro, which artists call the magic of this part of the art [of painting]'(12) .
The magic of chiaroscuro lay very much in the way darkness was distributed over the whole image, whether in the shallow spaces of Caravaggio or in the more mysterious deep spaces of Rembrandt, the supreme master of chiaroscuro, of whom a French Romantic critic wrote,
    'With him the light is only the highest point; but the mysteries of shadow are marvelous; he never made an opaque or muddy (louche) half-tone; everything in his chiaroscuro is warm and transparent' (13).
    The most eloquent tribute to Rembrandt's magic of chiaroscuro is by another painter, Turner, in a lecture of 1811 to the students of the Royal Academy:
    'He threw a mysterious doubt over the meanest piece of Common; nay more, his forms, if they can be called so, are the most objectionable that could be chosen, namely the Three Trees [No.4] and the Mill [Washington, National Gallery], but over each he has thrown that veil of matchless colour, that lucid interval of morning dawn and dewy light on which the Eye dwells so completely enthrall'd, and seeks not for its liberty, but, as it were, thinks it a sacrilege to pierce the mystic shell of colour in search of form' (14).
We must rember that in Turner's day, 'colour' was also used to refer to black-and-white prints, such as the etching of The Three Trees.
    It was a very different sort of Romantic, Francisco Goya, the artist of the late, horrific Black Paintings now in the Prado, who turned his love of Rembrandtesque darkness into a positive expression of ambiguity and - in tune with the Spanish Enlightenment climate of his day - of the fear of ambiguity, in his great etched series of Caprichos (1799). In Capricho 40 (No.12)we know that

the patient is already dead precisely because of the shadowy figures behind the curtain: one a monk who approaches and the other a wife who turns away and covers her face with her hands. But we know this only because in later impressions of the print the etched line is exposed under the worn aquatint (15). And in Capricho 79 (No.13) only we, the spectators, can see the looming shadow which means that the tippling monks are far from being unobserved.

If Goya's shadowy figures and his paradoxical or questioning titles remind us of the feebleness of human knowledge as it was evoked by Plato in his image of the cave (Republic Bk.VII), where humankind can see at most the shadows of reality, Goya's older contemporary Giovanni Battista Piranesi exposed the horrifying mystery of vast, dark, spaces in his series of 'Imaginary Prisons' (Carceri d'Invenzione) (No.11), in which the irrationality of endless staircases, balconies and landings is heightened by the swathes of shadow falling across them. The English poet Samuel Taylor Coleridge recalled these prints to Thomas De Quincy as representing the place where Piranesi sought to escape from the nightmare architecture he had himself created. Coleridge imagined he saw the artist scaling at various points these 'vast Gothic halls...until the unfinished stairs and the hopeless Piranesi are both lost in the upper gloom...'(16)

But Piranesi was not simply the creator of these sublime fantasies. He also applied his mastery of chiaroscuro to the documentation of Roman antiquities where, with an ambition and a flair comparable to that of the modern Roman virtual-reality specialists Infobyte, he succeeded in making the monuments of Ancient Rome vividly present to arm-chair travellers (No.10), but also added an exaggerated scale and a drama of lighting which were wholly personal.

Mystery in Goya and Piranesi is created largely by the darkness of the surrounding spaces, as it is in Paula Dawson's early architectural pieces, and the work of these artists exemplifies the understanding of chiaroscuro as the distribution of light and shade over the whole surface of the image. This is what the leading authority on the history of the concept, Rene Verbraecken, has called the chiaroscuro of the ensemble as opposed to the chiaroscuro of detail (17). But the chiaroscuro of detail has also played a significant role in image-making, and since it gives the appearance of volume to two-dimensional forms, it is particularly interesting in the context of holography, which has more commonly worked with objects close to the picture-plane than with deep space.

DARKNESS AND TRUTH

Caravaggio was among the first painters to focus on strong effects of light and shade to create relief, and this was regarded as his principal claim to notice by the earliest critics. Thus the painter Sebastian Bourdon reported to the French Royal Academy in 1669, half a century after the Italian artist's death:
'Caravaggio is seen to be praised because no painter before him had represented with such truth the shafts of light which, penetrating into dark and shadowy places, and striking the bodies they meet there, produce on these objects great shadows and lights, which make them appear with great force, vigour and an astonishing relief...'(18).
Bourdon, a follower of Poussin, intended no praise; and Caravaggio was indeed much criticised in the seventeenth century for his overwhelming concern for 'truth'. Thus his earliest biographer, Baglione (1642), wrote that the people of Rome were in uproar about the dirty feet and ragged clothing of the pilgrims in the Madonna di Loreto, and a later writer, Bellori (1672) related how the priests at S.Luigi de'Francesi obliged the artist to paint a second version of the St Matthew altarpiece because the first showed the Evangelist's legs crossed and his feet 'indelicately' exposed to the people (19). More directly relevant to our present theme is Bellori's remark that some older - and old-fashioned - painters complained that Caravaggio ' did not know how to get out of the cellar [i.e.out of the dark]', and painted 'all his figures in the same light and on the same plane' (20).

It has long been noticed that Caravaggio tended to crowd his figures into a shallow picture-space, a type of composition that has much in common with early holograms, which have exploited this painter's device - for example in the Vatican Deposition - of suggesting forms in front of the plane of the picture, and hence very close to the spectator. That this kind of intense realism was achieved largely through the skillful manipulation of light and shade was already noticed by early critics of Rubens and the Dutch painter Gabriel Metsu, whose figures seemed to leap out of the picture (21).

These early attacks on Caravaggio for his refusal to idealise foreshadow several of the early criticisms of photography and holography, as incapable of being more than media of record. One of the most influential theorists of the photograph, Roland Barthes, who was far from being hostile to it, nevertheless characterised it in a famous phrase as 'an image without a code'; and he continued until the end of his life to regard it as essentially referential:
'...the realists[including himself] do not take the photograph for a "copy"of reality, but for an emanation of "past reality": a "magic" not an art.' (22)

When holography came to public notice in the 1960s it was often bracketed with photography as concerned with little more than illusion. Thus Umberto Eco opened his 1975 essay, 'Travels in Hyper-Reality' with a description of a small, 360o hologram by Lloyd Cross, Pam and Helen , now in the MIT collection, which he had seen exhibited in New York. The work showed two naked girls touching and kissing and, said Eco, 'even someone who is not a professional voyeur is tempted to circle the cylinder in order to see the girls from behind, in profile, from the other side...' For Eco holography, which 'achieves a full-colour [!] photographic representation that is more than three-dimensional...is now being taken up by artists who formerly might have been photo-realists, and it achieves the most ambitious ambitions of photo-realism.' He concluded that holography could only flourish in the United States: it formed the spearhead of his attack on what he saw as the mindless American obsession with the real,
'where, if a reconstruction is to be credible, it must be absolutely iconic, a perfect likeness, a real copy of the reality being represented.'(23)
Similarly,a few years later, the French academic Jean Baudrillard , in a short essay on holograms, likened them to the double or the clone, as equally futile attempts to create the 'real' (24); and in her 1990 novel, Possession, A.S.Byatt introduced a hologram as a parallel to the dubious illusions of a spiritualist seance.

Such assessments could only refer to a very narrow range of holograms - those perhaps, noted by Byatt, which stand in for

precious objects in museums - and probably none of those in this exhibition. But these largely hostile views do have the virtue of making us ask how the 'reality' of the hologram is achieved, and of encouraging us to investigate the role of darkness in creating that reality. Sometimes it is an abstract 'realism' almost of the order of the scientific diagram.   The requirement of absolute stasis and stability in laser holography is due to the fact that the holographic plate records the interference pattern of two wavefronts of coherent light (from the object beam and the reference beam), and any movement in the object of more than a quarter of a wavelength will be recorded as as lightless and hence black. This has not only allowed the extensive use of the holographic medium for detecting faults in industrial materials, as in Charles Vest's Cylinder with Strain Gage (No.25), but has also enabled artists such as Margaret Benyon, in Tiresias and Counting the Beats (Nos.23,24)to record the blood-flow beneath the surface of her subjects' skin, indicative of emotions. In Sally Weber's Terrain of Venus (No.42), these interference fringes are used to model the volumes of the body as if they were the evidences of movement in geological strata.

One of the more intimate links between darkness and realism in the history of art has been the use of the simple silhouette, a technique in vogue for small portraits from the middle of the eighteenth century, and one which, of course, democratised the profile view which had hitherto been largely the preserve of coins and medals, with their connotations of authority. Rudi Berkhout has given new life to this old convention in his hologram, Awakening (No.37), in which the artist's recumbent black profile is, paradoxically, the only stable element in the design.

In the aesthetic climate of the seventeenth century, where the expectation of idealism was the dominant critical mode of approach to works of visual art, a great critic such as Roger de Piles might well regard the handling of chiaroscuro as subject only to the imagination and taste of the artist. Rembrandt's astonishingly free distribution of large areas of darkness - Sir Joshua Reynolds estimated that on average only one eighth of Rembrandt's picture-surface was light (25)- is a striking example of this principle. But in Reynolds' day, when Enlightenment aesthetics had begun to adopt a distinctly more scientific stance, a French intellectual such as De Saint-Morien might criticise De Piles specifically because 'chiaroscuro is based on "natural" principles [which] cannot at all depend on the imagination' (26). Here we are close to the views of the English Romantic landscape painter John Constable, who devoted a good part of his last years to elaborating what he called 'the Chiar'oscuro of Nature', by collaborating with a brilliant mezzotint engraver, David Lucas, to translate his highly painterly oil-sketches, based on a life-time of outdoor study, into black -and -white prints (Nos.14,15). In the text to the principal collection of these prints, Various Subjects of Landscape Characteristic of English Scenery, Principally intended to Display the Phenomena of the Chiar'oscuro of Nature, Constable argued that the aim of the book was

'to direct attention to the source of one of [landscape's] most efficient principles, the "CHIAR'OSCURO OF NATURE", to mark the influence of light and shadow upon Landscape, not only in its general effect on the whole, and as a means of rendering a proper emphasis on the "parts" in Painting, but also to show its use and power as a medium of expression, so as to note "the day, the hour, the sunshine, and the shade". In some of these subjects of Landscape an attempt has been made to arrest the more abrupt and transient appearances of the CHIAR'OSCURO IN NATURE; to show its effect in the most striking manner, to give "to one brief moment caught from fleeting time" a lasting and sober existence, and to render permanent many of those splendid but evanescent Exhibitions, which are ever occurring in the changes of external Nature.'

The mention of 'expression' in this passage reminds us that Constable was not merely a 'naturalist' but also a feeling and highly imaginative painter; and in the commentary on another plate in this series, Dedham Mill, he noted that it was even, 'little more than an assemblage of material calculated to produce a rich Chiar'oscuro...' (27)

REPRESENTING DARKNESS

It is not surprising that Constable and Lucas should have turned to mezzotint, a technique of engraving which originated in Germany in the seventeenth century, and was especially appropriate for the rendering of darkness, since it worked from dark to light. The metal plate was first covered with a uniform 'tooth', which retained the ink and would print as a black or (occasionally) sepia rectangle. This texture was progressively burnished to create the mid-tones and lights in the design; and in Constable's case it was a process closely supervised by the painter himself. Working in this way would naturally suggest that an acceptable image had been arrived at far lower down the tonal scale than when using the older - and more usual - graphic technique of adding dark marks to the white paper; and the Lucas prints after Constable are remarkable not only for the painterly handling of their models, but also for the extent, depth and resonance of their darks. Although they are probably the first reproductive engravings to imitate the painterly surface as well as the design of their originals, they are, in fact, very far from being reproductions; they are rather translations, with all the freedom that translation implies.

Mezzotint was not the earliest graphic technique to presume that darkness was an integral part of the structure of images. The early historian of Italian art, Giorgio Vasari, drew attention to the practice of making chiaroscuro drawings in pen and with white highlights, among the followers of Giotto; but very few of these have survived (28). This type of drawing , working essentially with three tones: a mid-toned ground, a dark and a highlight, became widely practised in fifteenth-century Florence, notably in the workshop of Andrea Verocchio, where Leonardo da Vinci was a pupil, and made the type of drapery study which forms the basis of part of Dawson's Shadowy Figures. In the early sixteenth century chiaroscuro drawings of this type were imitated in printmaking by the chiaroscuro woodcut (No.2), invented, it seems, in Germany, where hand-coloured woodcuts had already become very popular, but given prominence by the Italian artist Ugo da Carpi who, in his application for a patent in 1516, claimed that his technique was no more than an attempt to imitate such drawings, which were now clearly thought to be worthy of such imitation (29). The chiaroscuro woodcut spread throughout Europe and remained popular at least into the eighteenth century, especially in Venice.

The development of tonally-based graphic media: the chiaroscuro woodcut, the mezzotint, the wonderfully delicate and atmospheric aquatint, developed in the eighteenth century and used to brilliant effect by Goya, all these testify to the growing belief in the modern world that an adequate representation of the visual world must be tonal, not confined to mere outline; and

in this these techniques are the ancestors of the two major nineteenth-century developments in image-making, the lithograph and the photograph. Yet even the linear techniques of the line-engraving and the etching found original ways of suggesting darkness and volume. Hendrick Goltzius' apparently rather smooth and mechanical technique, which conveyed shadow simply by the thickening of the line with deeper cutting, and by an occasional peppering of dots between the lines, was nevertheless a highly original development in its time (No.3) It offers a striking contrast to the free-style etching of Canaletto (No.8), which suggests as much as anything the wandering pen, and is in marked contrast to the regular and repetitive touch in so much of Canaletto's painting. Whereas Goltzius' method is at its most effective with solid volumes, Canaletto's hatching conveys a wonderful sense of the shimmering Italian atmosphere and transparent shadow.

But the most brilliant virtuoso performance in line work is surely The Holy Face by Claude Mellan (No.7) , where, amplifying the technique devised by Goltzius, the whole image, light and dark, is created by varying the thickness of a single line. The prominent inscription at the foot of this image, FORMATUS UNICUS UNA could be read as 'One [line] is shaped into a single [image]'; and what appears to be an afterthought, NON ALTER, as 'No other [one]', and this suggested to the French connoisseur Pierre-Jean Mariette (1694-1774) that this engraving was no more than a vehicle for Mellan to show off his unusual , indeed unique, capacities. But Mariette was writing during the Enlightenment, when, in fact, a fine copy of this engraving was made by one Dudesert (1735) (30); and it remains very doubtful whether in 1649 such a popular and highly-charged icon, whose veneration earned the viewer indulgences in the later Middle Ages (31), could be entirely without religious significance. Mellan was working at a time when Unitarianism, the doctrine that God was a single being , not the Trinity of Father, Son and Holy Ghost of orthodox Christianity, was enjoying a substantial revival. This was, however, mainly in Poland; and it remains that at present we know nothing of Mellan's beliefs. Nevertheless, this is an early modern work where technique - in this case the creation of chiaroscuro entirely by line - may be on an ideological par with the dark mandorlas of the Middle Ages.

The figures by Giotto, Masaccio and Leonardo which form Paula Dawson's new hologram are significant here largely because of their draperies, and the various ways in which these draperies reveal form through the fall of light and the creation of shadow. The Leonardo image is based specifically on a drapery study, of which there are several surviving examples from the workshops of Verocchio, Pollaiuolo and Filippino Lippi in the 1470s and 1480s (32). They were clearly stimulated by the extravagantly bunched and folded draperies of Netherlandish art - Van Eyck, van der Weyden and van der Goes - whose works enjoyed a particular vogue in Florence from the middle of the fifteenth century. Drapery could be manipulated almost at will, and it was thus perhaps the most abstract element in early modern art, in colour as well as in form. One later master of abstract drapery was Giovanni Battista Tiepolo (No.9), whose modelling and shadow in this type of drawing has been well characterised by Michael Baxandall as leading ' a fairly independent life' (33). Even before the Renaissance drapery painting had attracted a good deal of attention in the technical literature of painting, in terms of its capacity to suggest volume, and one of the few formal recipes in medieval painting was concerned with the technique of modelling drapery forms (34). The technical terms incidere, 'to shadow' and matizare, 'to highlight' show how important was the management of shadow even in that period. Thus a chapter on mixing colours added to theDe Diversis Artibus of the early twelfth-century German writer Theophilus, mentions an orange made from the resin called 'dragon's blood' and yellow orpiment, which was to be shaded with black and heightened with lead white (35). Cennino Cennini, the direct descendant of Giotto through his master, Agnolo Gaddi, also devoted many chapters of his Libro dell'Arte to drapery painting, and at one point (ch.lxxi) summarised it by invoking the three-pot method of making a tonal scale in fresco, where the saturated hue served as the darkest tone, and white was added progressively to create two lighter steps. Drapery is thus one of the best indices for assessing the function of darkness in creating volume, a function which has been particularly explored in Shadowy Figures.

THE SPEED OF DARKNESS

Constable's emphasis on fleeting effects in the landscape, encapsulated in his 'chiaroscuro of nature', reminds us that darkness embodies significant elements of time. Light advances and is impenetrable, but darkness is porous and deep; in twilight or even in total darkness we search for the contours of shapes amid all the ambiguities, and this is a slow, and hence more obviously time-bound process. The ancient Greek writer, Plutarch, had already sensed the profound differences in the perception of light and darkness:
'daylight is unitary and simple... [but]the atmosphere of night is a mixture due to the union of various lights and forces'. (36) It was that master of darkness, Rembrandt, who revealed to the early Modernist painter, Wassily Kandinsky, that it did, indeed, create sensations of time. As he wrote in an autobiographical essay of his early experiences of Rembrandt in The Hermitage at St Petersburg:
'Rembrandt moved me deeply. The great divisions of light and dark, the blendings of secondary tones into the larger areas, the way in which these tones melt together in these areas (which from a distance produced the effect of a mighty chord and reminded me immediately of Wagner's trumpets) revealed to me entirely new possibilities, the superhuman power of colour in its own right, and in particular, the intensification of that power achieved by combinations, i.e.contrasts...I sensed fairly unconsciously that Rembrandt's great divisions give his pictures a quality I had never seen until then. I felt that his pictures "last a long time", explaining this to myself by the fact that I had gradually to exhaust first one part, and then the next. Later, I realized this division conjures on the canvas an initially foreign and apparently inaccessible element of painting - time.' (37)
Kandinsky, an experienced amateur 'cellist, was very attracted to musical analogies, but it is especially striking that he reaches here for reminiscences of Wagner's brass. He was, of course, thinking primarily of Rembrandt's paintings, well represented at The Hermitage, and Rembrandt in his later years had a particular liking for resonant reds, the colours which Kandinsky in his 1911 manifesto, On the Spiritual in Art, had likened to the sound of trumpets (38). But he is also thinking of tonal structures, of Rembrandt's mastery of tonal contrasts, and of the merging of one deep tone with another. The rich sound of the musical chord, the simultaneous sounding of several tones, offers a parallel to the complex layering of forms in Rembrandt's shadows, forms

which the eye takes time to search out. We know the high speed of light, but cannot compute the speed of darkness, which must, in any case be considerably slower even than the speed of sound.

Holograms, too, are intrinsically conditioned by time. It is the slight difference between the arrival of the wave-fronts of the object beam and those of the reference beam at the holographic plate, and the slight differences in the time it takes the object beam to reflect from the various saliences of the three-dimensional object (or the computer calculations of three-dimensionality), which create the holographic image. The uncanny stillness of many holographic images is,paradoxically, itself bound by time. And because darkness in holograms is generated by movement, it is an index of that movement, and hence, again, of time. We saw how Margaret Benyon used the traces of the movement in the bloodstream to convey emotion; Charles Vest in Thermal Plume above Heated Wires (No.26) and Paula Dawson in Shrine of the Sacred Heart (No.20) go further, and record eddies of hot air as flame-like plumes of darkness.

Since the hologram, like the photograph, records a moment in past time, it connects us to the past, as Barthes put it, by a sort of umbilical cord. But what distinguishes the large hologram from the photograph, besides its re-creation of deep space, is its capacity to set the viewer more directly into the image, through specular reflection, a device used by Dawson in the original version of To Absent Friends (No.19). It need hardly be stressed that the peculiarly dark atmosphere of deep-space holograms also stimulates a slow inspection by the viewer.

GIOTTO - MASACCIO - LEONARDO: SHADOWY FIGURES

Paula Dawson's hologram Shadowy Figures translates draped figures painted by three Italian Renaissance masters, first into three dimensions, by a Cyrax laser scan of the present writer, draped as these three figures, and then by means of various computer renderings, into the hologram itself. The figures are framed by decorative motifs derived from Giotto's Scrovegni Chapel at Padua, and this is right, since Giotto was the grandfather of Italian Renaissance art, and elaborated the basic framework of narrative technique in painting which was immensely fruitful for his successors in the fifteenth century. Giotto was also the artist who brought to Italian painting the volumetric concerns already explored by sculptors such as the Pisani and Arnolfo di Cambio, who were more readily able to absorb and revive the forms of ancient art, since no examples of ancient painting were known in their time, although there were many surviving fragments of ancient sculpture.

His simple draperies, with their large vertical folds, lit from the front, have an exceptional gravity; and this was a type of lighting especially noticed by Cennino Cennini in his discussion of the lighting of the subjects of wall-paintings in chapels (Libro dell'Arte,ch.ix). After treating side-lighting Cennini speaks of the light which shines on the subject directly opposite the viewer's face, 'or in full glory'; and the term he uses, maesta, or 'majesty' has resonances of a particularly imposing image of the Virgin enthroned and surrounded by angels, much painted in Tuscany in Cennini's day. Here again lighting carries a powerful ideological charge.

It would, however, be rash to take this analogy too far. The episode of the Life of the Virgin from which Giotto's figure of Joachim derives, lies in the top register of scenes in the Scrovegni Chapel. Although looking up at a person, as the Shepherds' dog does in this scene, implies their superiority, it would be fanciful to imagine Joachim - even if he is dignified with a halo - as a major player in the Chapel narrative of the Life of Christ. The scene, although it is placed so high, is painted as if the viewer were on its level, and it is attractive to imagine the spectator illuminating it with his or her own eyes, according to the ancient extramission theory of vision, which is still implicit in Cennini's account of aerial perspective, where distant objects are darker than those close to the spectator, because of the weakening of the light rays from the eyes (ch.lxxxv).

Masaccio's St Peter, on the other hand, follows Cennini's earlier recommendations in ch.ix about directional light, and is lit fom the same side as the altar window in the Brancacci Chapel, behind and slightly above him. Unlike Joachim, who seems to cast light before him, Peter casts shadow, and we are reminded that in another scene of this cycle, his shadow has the power to heal. Although it is placed above the level of the viewer, Masaccio's scene of St Peter baptising is lower than Giotto's Joachim and the Shepherds, and the more localised and more sharply defined shadows of his draperies point more insistently to the controlled directional characteristics of light, which is, perhaps, to be expected in an artist who made some of the earliest experiments in single-point perspective constructions. Like single-point perspective, clearly directional lighting limits the capacity of the viewer to interpret the image freely by moving around it, which is just as well in this case, since St Peter inhabits a rather constricted segment of the altar wall, which gave the original spectators little opportunity for seeing him from several points of view. (Modern tourists are granted more privileged access). Shadow here accentuates a real, but unrealistically constrained, state of affairs.

Giotto's and Masaccio's draperies remained relatively simple, but the lavish complexity of Leonardo's drapery studies signals a new phase in the taxonomy of shadow. It seems more than likely that the problem of doing justice to the deep shadows and half-shadows, soft and hard shadows, and all the many inflections of shadow on lustrous surfaces, such as the silk taffeta represented in the study in the British Museum which lies behind one phase in Shadowy Figures, all this may well have stimulated the campaign of shadow study which was, Leonardo hoped, to issue in a seven-part treatise.

'Shadows', he noted,'appear to me to be of supreme importance in the optics of vision (prospettiva), because without them opaque and solid bodies will be ill defined; that which is contained within their outlines and their boundaries themselves will be ill understood unless they are shown against a background of a different tone from themselves. And therefore in my first proposition concerning shadow I state that every opaque body is surrounded and its whole surface enveloped in shadow and light. And on this proposition I build up the first Book. Besides this, shadows have in themselves various degrees of darkness, because they are caused by the absence of a variable amount of the luminous rays; and these I call primary shadows because they are the first, and inseparable from the object to which they belong. And on this I will found my second Book. From these primary shadows there result certain shaded rays which are diffused through the atmosphere, and these vary in character according to that of the primary shadows whence they are derived. I shall therefore call these shadows derived shadows because they are produced by other shadows; and the third Book will treat of these. Again, these derived shadows, where they are intercepted by

various objects, produce effects as various as the places where they are cast, and of this I will treat in the fourth Book. And since all round the derived shadows, where the derived shadows are intercepted, there is always a space where the light falls and by reflected dispersion is thrown back towards its cause, it meets the original shadow and mingles with it and modifies it somewhat in its nature; and on this I will compose my fifth Book. Besides this, in the sixth Book I will investigate the many and various diversities of reflections of these rays which will modify the original [shadow] with some of the many various colours from the different objects whence these reflected rays are derived. Again, I shall make a seventh division on the various distances that may exist between the spot where they originate, and the various likenesses (similitudini) of colours which they will acquire in falling on an opaque body.'(39)

Shadow for Leonardo was a positive quality; unlike light, it was dense. 'A primary shadow', he wrote,'is that side of a body which cannot be seen by the light; derived shadow is the striking of rays of shadow (razzi ombrosi) (40). He would surely have been very happy with the modern capacity to generate negative light in computer graphics, negative light which has been used to activate shadow in Dawson's version of the draped Leonardo figure.

Besides investigating the varieties of shadow and darkness which result from light or its absence, and the positive power of objects to generate shadow, Leonardo was well aware of the psycho-physiological effects of contrast, where both lights and shadows could appear enhanced in juxtaposition. As he formulated it in the Treatise on Painting put together from his notes by one of his pupils:

'The borders of shadowed bodies look lighter or darker than they are, in the degree that the background on which they border is darker or brighter than the colour of the mass that surrounds them' (41).
The hard triangular lights and shadows in the centre of the British Museum drapery study depend on just this sort of observation.

CONCLUSION

In the developing culture of art-academies in the seventeenth and eighteenth centuries shadow projection and chiaroscuro became standard topics in the teaching curriculum, parallel to the study of perspective (42). The physics of light went its own way; but at the close of the nineteenth century the development of research into radio-activity, infra-red , ultra-violet and X-rays encouraged a French scientist, Gustave Le Bon, to imagine that parts of the non-visible spectrum constituted a type of black light (43). The notion of black light became important to Matisse in the years around 1911, although Le Bon's experimental methods - and his conclusions - turned out to be flawed. But with the recent introduction of negative light into digital imaging ,darkness has again found an important place in the technology of art.

NOTES

1. M.Kemp, 'New Light on Old Theories:Piero's Studies of the Transmission of Light', in M.D.Emiliani & V.Curzi (eds), Piero della Francesca tra Arte e Scienza, (Atti del Convegno Internazionale, Arezzo/Sansepolcro, 8-12 Oct. 1992), p.42.
2. Ghent, Oudheidkundig Museum van de Bijloke, MS 60-1, f.7v. Since all three Maries carry ointment jars - although the other two are less clearly pyx-like- the identity of this Mary as the Magdalene has not been recognized (Barbara Baert in Museum voor Schone Kunsten, Maria Magdalena (Cahier 4, 2002), p.75 (English summary) and No.2. Red became the standard colour for the Magdalene's dress, especially in Italy: a late-fourteenth-century Bolognese Antiphonary.in the Museo Civico Medievale in Bologna (MS 4108) includes an initial depicting the Magdalene in this colour, also with a very pyx-like ointment jar.
3. On the colours of St Peter, M.Lisner, 'Die Gewandfarben der Apostel in Giottos Arenafresken - Farbgebung und Farbikonographie - Mit Notizen zu aelteren Aposteldarstellungen in Florenz, Assisi und Rom', Zeitschrift f. Kunstgeschichte, 53, 1990, pp.309-75; J.Gage, Colour and Meaning: Art, Science and Symbolism, 1999, pp.70-71.
4. J.Gage, Colour and Culture: Practice and Meaning from Antiquity to Abstraction, 1993, p.45. For the ancient Greek notion of light as life, ibid.p.26.
5. See The Fringes of the Shadows of the Knives, 1987, and Newton's Rings, 1987, in Wolverhampton Art Gallery, The Optical Realm: Wenyon & Gamble, Holographic Installations, 1988-1991, 1991, n.p.See also, F.Popper, Art of the Electronic Age, 1993, pp.45-6.
6. G.Ortiz, El Significado de los Colores, Mexico , 1992, pp. 169-70, cf. also p.175.
7. Gage 1993 (note 4 above), pp.60-71, 74.
8. ibid. p.156.
9. C-N. Lecat, Traite des Sensations et des Passions en Generale, et des sens en Particulier, Paris, 1767, pp.367-8, cit. M.Baxandall, Shadows and Enlightenment ,1995, p.156.
10. On these experiments, Gage 1999 (note 3 above) esp. pp.130-132.
11. J.Gage, Colour in Turner: Poetry and Truth, 1969, esp. p.178.
12. C-H. Watelet & P.C.Levesque, Dictionnaire des Arts de Peinture, Sculpture et Gravure, Paris, 1792, IV, p.123, cit. R.Verbraecken, Clair-Obscur: Histoire d'un Mot, 1979, p.51.
13. A.Jal, Salon de 1833, p.13, cit. ibid. p.218.
14. J.Ziff, '"Backgrounds, an Introduction of Architecture and Landscape": a Lecture by J.M.W.Turner', Journal of the Warburg and Courtauld Institutes, XXVI, 1963, p.145.
15. E.A.Sayre in Madrid/Boston/New York, Goya and the Spirit of Enlightenment, 1989, p.106.
16. T. De Quincy, Confessions of an English Opium-Eater, in D.Masson (ed.), Collected Writings of Thomas de Quincy, III, 1896, p.439.
17. Verbraecken 1979 (note 12 above), p.31.

18. cit. ibid, p.178.

19. W. Friedlander, Caravaggio Studies, 1953, pp.232, 235, 240, 248.

20. ibid. pp.239, 248.

21. Verbraecken, 1979 (note 12 above), pp.198, 228.

22. R.Barthes, Camera Lucida: Reflections on Photography, trans. R.Howard, 1981, p.81.

23. U.Eco, Travels in Hyper-Reality, 1986, pp.3-4.

24. J.Baudrillard, Simulacra and Simulation, 1994, pp.105-109. I owe these references to the kindness of Paula Dawson.

25. J.Reynolds, The Literary Works, ed. H.Beechey, , 1852, II, pp.332-3.

26. M.de Saint-Morien, La Perspective Aerienne, Soumise a des Principes Puises dans la Nature; un Nouveau Traite de Clair-Obscur et de Chromatique a l'Usage des Artistes, Paris, 1788, cit. Verbraecken, 1979 (above, note 12), p.39.

27. John Constable's Discourses, ed. R.B.Beckett, 1970, pp.9f., 26.

28. Some good examples in F.Ames-Lewis, Drawing in Early Renaissance Italy, 1981, figs.3, 21.

29. Verbraecken, 1979 (note 12, above), p.73.

30. Paris, Bibliotheque Nationale, L'Oeil d'Or : Claude Mellan, 1988, Nos.106-7.

31. See S.Dackerman (ed.) Painted Prints: the Revelation of Color, Baltimore Museum of Art, 2002, No.18. I owe this reference to the kindness of Phillip Prodger.

32. J.Cadogan, 'Linen drapery studies by Verocchio, Leonardo and Ghirlandaio', Zeitschrift f. Kunstgeschichte, XLIV, 1983.

33. M. Baxandall, 1995 (above, note 9), p.50.

34. E.W.Bulatkin, 'The Spanish word 'Matiz': its origin and semantic evolution in the technical vocabulary of medieval painters', Traditio, X, 1954, pp.461ff. The term 'matiz' was still current in the late sixteenth century (Verbraecken, 1979 (above, note 12), 16.

35. Theophilus, De Diversis Artibus, trans. Hendrie, 1847, p.418.

36. Plutarch, Isis and Osiris, in Diatriba isiaca e dialoghi delfici, Florence, 1962, p.147, cit. Alida Cresti, Nell'Immaginario Cromatico:Simboli e Colori, 1997, p.262.

37.W. Kandinsky, Complete Writings on Art, ed. K.C.Lindsay & P.Vergo, 1982, I, p.366.

38. ibid. pp.162-3.

39. Leonardo da Vinci, Literary Works, ed. J.P.Richter, 1970, I, pp.164-5.

40. ibid. p.169.

41. Leonardo da Vinci, Treatise on Painting [Codex Urbinas Latinus 1270], ed. A.P.McMahon, 1956, I, p.255.

42. See M.Kemp, The Science of Art, 1990; Baxandall 1995 (above, note 9).

43. J.Gage, 'Matisse's Black Light', in Gage 1999 (above Note 3), pp.228-240.

LIST OF WORKS

HISTORICAL WORKS

1.AGOSTINO CARRACCI (Italy 1557-1602) after PAOLO VERONESE (Italy 1528-1602)
The Madonna Protecting Two Members of A Confraternity, 1582
Engraving, 29.9 x 21.9
Coll. Art Gallery of New South Wales, Sydney

2.HENDRICK GOLTZIUS (Netherlands 1558-1616)
Pluto, c.1591
Chiaroscuro Woodcut, from three blocks, 39.2 x 29 cm.
Coll. Art Gallery of New South Wales, Sydney

3.HENDRICK GOLTZIUS (Netherlands 1558-1616)
Christ on the Mount of Olives, 1597
Engraving, 20.2 x 13.4 cm.
Coll. Art Gallery of New South Wales, Sydney

4.REMBRANDT VAN RIJN (Netherlands 1606-1669)
The Three Trees, 1643
Etching with drypoint and burin, 21.6 x 28.3 cm
Coll. Art Gallery of New South Wales, Sydney

5.REMBRANDT VAN RIJN (Netherlands 1606-1669)
Christ with the Sick around him, receiving little Children, c.1643/9
Etching, 56.3 x 80 cm.
Coll. Art Gallery of New South Wales, Sydney

6.REMBRANDT VAN RIJN (Netherlands 1606-1669)
The Agony in the Garden, c.1657
Etching and drypoint, 11.1 x 8.3 cm.

Coll. Art Gallery of New South Wales, Sydney

7.CLAUDE MELLAN (France, active 1648-1688)
The Holy Face, 1649
Engraving, 43 x 31.8 cm.
Coll. Art Gallery of New South Wales, Sydney

8.ANTONIO CANALETTO (Italy 1697-1768)
Le Porte del Dolo c.1744
Etching, 30 x 43 cm.
Coll. Art Gallery of New South Wales, Sydney

9.GIOVANNI BATTISTA TIEPOLO (Italy 1696-1770)
Bearded Man in a Cap and Cloak, c.1750/60
Pen and brown wash, 23.6 x 14.7 cm.
Coll. Art Gallery of New South Wales, Sydney

10. GIOVANNI BATTISTA PIRANESI (Italy 1720 -1778)
Tomb of three Curatii brothers in Albano, 1756
Etching, 56.3 x 80 cm.
From Le Antichita di Albano e di Castel Gandolfo, 1764
Coll. Art Gallery of New South Wales, Sydney

11. GIOVANNI BATTISTA PIRANESI (Italy 1720-1778)
Prison, from Carceri d'Invenzione, 1760
Etching, 71.1 x 53.5 cm.
Coll. Art Gallery of New South wales, Sydney

12. FRANCISCO GOYA Y LUCIENTES (Spain 1746-1828)
"What Sickness will he die of?" (Capricho 40) 1799
Etching and Acquatint, 21.5 x 15.2 cm.
Coll. National Gallery of Victoria, Melbourne

13. FRANCISCO GOYA Y LUCIENTES (Spain 1746-1828)
"Nobody has seen us" (Capricho 79) 1799
Etching and Acquatint, 21.5 x 15.2 cm.
Coll. Art Gallery of New South Wales, Sydney

14. DAVID LUCAS (U.K. 1802-1881) after JOHN CONSTABLE (U.K.1776 - 1837)
Weymouth Bay 1830
Mezzotint 26.5 x 34.2 cm.
Coll. Art Gallery of New South Wales, Sydney

15. DAVID LUCAS (U.K.1802-1881) after JOHN CONSTABLE (U.K.1776-1837)
Heath (Hampstead Heath, Branch Hill Pond),1831
Mezzotint, 28 x 39.2 cm.
Coll. Art Gallery of New South Wales, Sydney

16. SAMUEL PALMER (U.K.1805 - 1881)
The Herdsman's Cottage, 1850
Etching, 14.3 x 11.3 cm.
Coll. Art Gallery of New South Wales, Sydney

17. MAX KLINGER (Germany 1857-1920)
Night, from On Death, 1889
Etching and Aquatint, 27.5 x 27.3 cm.
Coll. National Gallery of Victoria, Melbourne

HOLOGRAPHIC WORKS

18. PAULA DAWSON (Australia)
Shadowy Figures, 2003

Hogel-vector, white-light reflection hologram, 120 x 120 cm.

The subject, a draped figure (Dr John Gage), is shown in a three-channel full-colour image, in which each channel shows a pose from a work by Giotto, Masaccio and Leonardo da Vinci. The hologram is the outcome of Dawson's major Australian Research Council "Discovery"project investigating the use of darkness as an active pictorial element in Italian Renaissance painting, and transposing the specific pictorial devices used by these painters into the three-dimensional space of a synthetic hologram.
Coll. The artist.

19.PAULA DAWSON (Australia)
To Absent Friends (Midnight Fragment), 1989
Laser transmission hologram, 150 x 95 cm.

Bar-room scene in which the holographic reference-beam is modulated by the transparency and opacity of the glass shelves with Christmas snowflakes and miniature liqueur bottles. These cast shadows on to the holographic plate. The recording of the hologram is reflected in the mirror parallel to the plane of the picture.
Coll. Tim Pye

20. PAULA DAWSON (Australia)
Shrine of the Sacred Heart, 1996
Laser transmission hologram (interferogram), 30 x 40 cm.

Two superimposed holograms, one of an ornamental plaster Dome decorated with dark frangipane flowers; the other of a black flame emerging from a cross. The Shrine is on view in the church for which it was commissioned, St Bridget's, Coogee, New South Wales.
Coll. The artist

21. PAULA DAWSON (Australia)
Types of Darkness, 2000
Laser transmission hologram (shadowgram) in three plates, each 10.2 x 12.8 cm.

A series of three images derived from the section of Piero della Francesca's Magdalene (Arezzo, Cathedral) in which a hand activates the materiality of a crystal jar into light energy. The materials used for the subject are a velvet and retroreflective velvet cape, a mosaic made from South Sea pearls and a plaster cast from a living model in the pose of Piero's figure. All three subjects show only a 30 x 40 cm section of the figure with a real hand making a three-dimensional shadowgram.
Coll. The artist

22. MARGARET BENYON (UK)
Hot Air, 1970
Transmission hologram (shadowgram), 20 x 25 cm.

Probably the first hologram to use the darkness produced as a by-product of the holographic process (here the three-dimensional negative shape of the artist's hand) deliberately as a pictorial element in a holographic composition.
Coll. National Gallery of Australia

23. MARGARET BENYON (UK)
Tiresias, 1981
White light transmission hologram, 20 x 25 cm.

Double-exposure portrait of the artist and her technical collaborator John Webster. Dark fringes contour the surfaces of both subjects' faces, their spacing reflecting the rate of movement of blood.
Coll. MIT Museum

24. MARGARET BENYON (UK)
Counting the Beats, 1981
White light transmission hologram, 31.2 x 40.4 cm.

Double portrait of the artist with John Webster. One says "Yes", the other "No".
Coll. MIT Museum

25. CHARLES VEST (USA)
Cylinder with Strain Gage, c.1973-4
Laser transmission hologram 10.2 x 12.8 cm.

The change in pressure inside a vessel shows as contour marks of strain on the vessel walls.
Coll. MIT Museum

26. CHARLES VEST (USA)
Thermal plume above heated wire, c.1973-4
Laser transmission hologram, 10.2 x 12.8

A double exposure of water heated by wires gives rise to a long thin heat plume. This image demonstrates phase shifts in transparent media.
Coll. MIT Museum

29. JERRY MARKS (USA) and SPATIAL IMAGING GROUP at MIT
One particular wave
Rainbow stereogram, 20.4 x 25.5 cm.

A scientific visualisation of a single wavefront of light.
Coll. MIT, Spatial Imaging Group.

30. STEPHEN BENTON (USA)
Aphrodite's Head, 1978
Achromatic white-light transmission hologram, 34.3 x 31.2 cm.

The subject, a marble bust exposed three times, in red, green and blue, appears white, but the edges of the shadows show rainbow colours.
Coll. MIT Museum

31. DAN SCHWEITZER (USA)
Shadowbox, 1978
White light transmission hologram, 33 x 21.5 cm.

The image shows a view of a landscape through a window with the three-dimensional shadow of a hand superimposed.
Coll. Jonathan Ross

32. CARL FREDERIK REUTERSWAERD (SWEDEN)
Gateau Gabor (Smoke without Fire), 1978
Transmission hologram, 52 x 61 cm.

A hologram in honour of the inventor of the medium, Dennis Gabor. The vapour trails from the candles on a real birthday cake appear as dark swirls.
Coll. MIT Museum

33. EDWINA ORR (GB)
Karasansui (test plate) 1979
White light reflection hologram,
Coll. The artist.

27. NILS ABRAMSON (Sweden)
Light focused by a lens (Light in flight), 1982
Transmission hologram, 26 x 21 cm.

A single wavefront of light, captured by the use of the reference beam as a temporal shutter.
Coll. MIT Museum.

28. NILS ABRAMSON (Sweden)
Black Box (Isolation), 2003
White light reflection hologram, 26 x 21 cm.
Coll. Nils Abramson

34. AARON KURZEN (USA)
Unbirthday Cake, 1982
Rotating transmission hologram, 30.5 x 40.5 cm, with three-dimensional cake, 21.6 x 21.6 cm (diameter).
Coll. MIT Museum

35. WENYON AND GAMBLE (GB)
The Logos 1984
Reflection hologram with a shadowgram animated in real time, 50 x 60 cm.
Coll. The artists.

36. DIETER JUNG (GERMANY)
Present Space, 1984
White light transmission hologram, 43.3 x 31.8 cm.
Coll. MIT Museum

37. RUDIE BERKHOUT (USA)
Awakening, 1985,
White light transmission hologram, 30 x 40 cm.
Coll. The artist

38. MELISSA CRENSHAW (Canada)
Safe Place to dream ,1987
White light reflection hologram , 28 x 38.2 cm.
Coll. MIT Museum

39. ANDREW PEPPER (UK)
Series of drawings, A-E, 1987
Five white light reflection shadowgrams, each 25.4 x 20.3 cm.

A cube projects immaterially in space in front of the holographic plate, yet casts a shadow.
Coll. MIT Museum

40. DORIS VILA (USA)
Free-guilt economy with easy roll-over broker, 1991
Three white-light transmission holograms:
A: He said, 50 x 110 cm.
B: Easy roll-over broker, 50 x 85 cm.
C: She said, 50 x 110 cm.

The dark holes made by the objects exposed against a ground- glass screen for the red exposure are sometimes filled, due to gaps occuring in the same place in the blue exposure, etc.
Coll. The artist.

41. EDUARDO KAC (Venezuela)
Adhuc, 1991
Multi-colour stereogram, 30 x 40 cm.

Interference pattern behind letters which congregate to make a word as the viewer moves.
Coll. Jonathan Ross

42. SALLY WEBER (USA)
Terrain 2003
Transmission hologram, 45.7 x 91.4 cm.
Coll. The artist