ROYAL COLLEGE OF ART

A PhD Thesis in Holography

HOW IS HOLOGRAPHY ART?

Margaret Benyon

Submitted: April 1994

PLEASE NOTE

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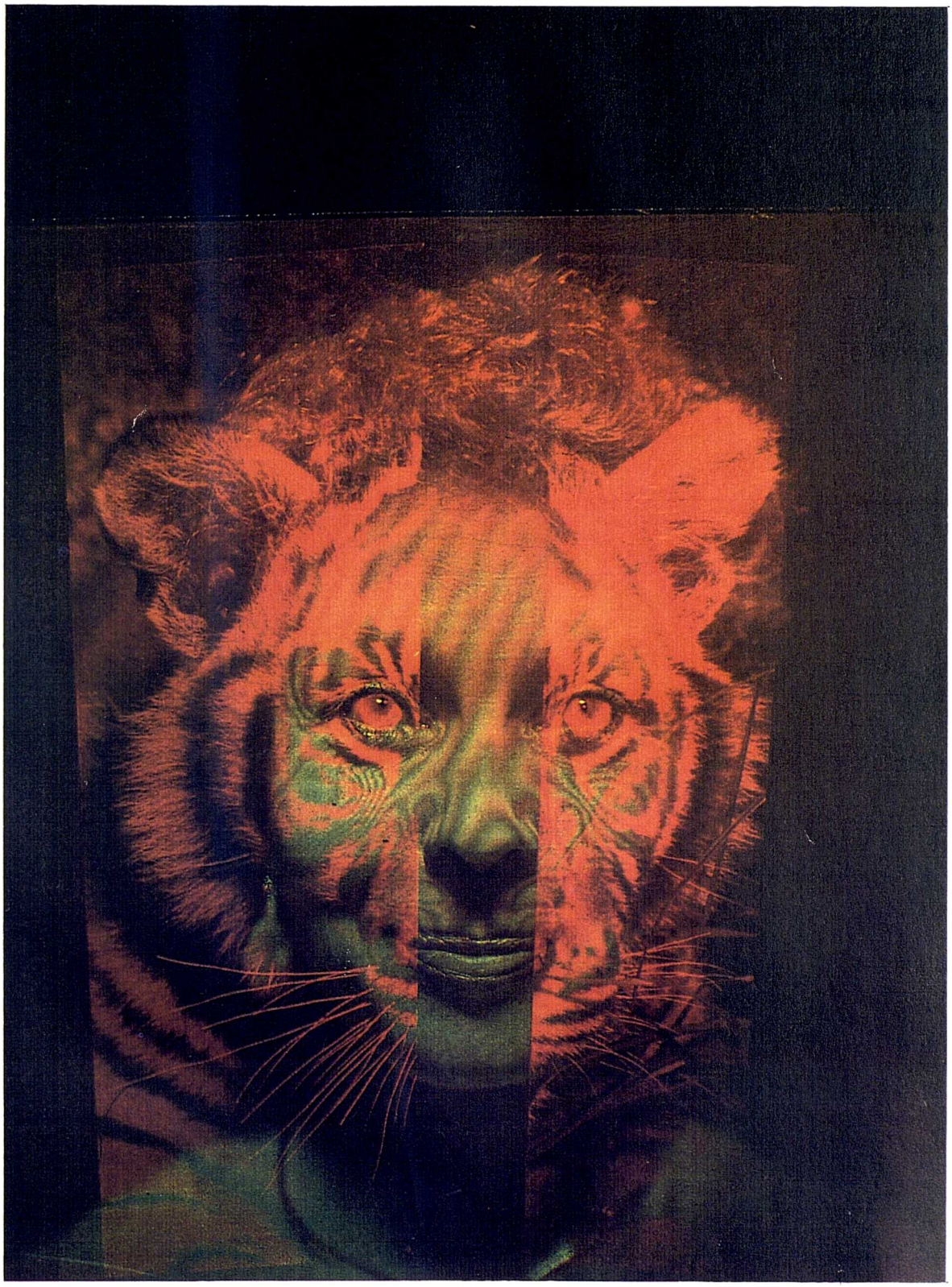
Plate 1 *Tigirl*, Benyon (self-portrait), 1985, 30 x 33cm reflection hologram & reproduction.



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ACKNOWLEDGEMENTS

Major thanks are due to Ilford Ltd who sponsored this PhD project despite setbacks caused by my ill health, and the unsteady commercial progress of holography.

I acknowledge the contributions of John Hedgecoe, Michael Langford and all the staff at the RCA associated with my project. In particular I wish to thank Christopher Frayling for his valued advice and encouragement, former and current technicians Rob Munday and Roddy Canas for their advice and assistance on technical matters, Rod Murray for his suggestions, and of course Anne George and the friendly and efficient library staff.

Thanks are due to Andrew Pepper and the University of Reading for the loan of his PhD thesis, which helped me to organize the initial stages of my own. I need to express my indebtedness to a large number of people and organizations over the years, too many to list. The support of Rosemary Jackson has been important to me, and now that of Jonathan Ross, who characteristically undertook to copy-edit this thesis at short notice.

I should like especially to thank my friend Jo Simmonds for her kindness in housing me during my working sessions at the RCA. Most significant of all is the support and encouragement of my partner William and children Lucas and Chania Rodwell throughout this extended project.

ABSTRACT

This thesis explores holography as an art medium from a conceptual rather than technical perspective. It outlines 20th century theories of art and aesthetics, and suggests terms to describe subcategories of art in display holography, also charting the various types of holograms that exist. A pre-history proposes holographic parallels in the history of art. A summary is given of the history of holography in the visual arts, with a survey of the first and second decades giving turning points in recognition or development. The advantages and disadvantages of holography as a medium are discussed, along with holographic developments from existing art movements and how artists have used holography. Attention is drawn to survival networks in the holography world that exist for artists in holography. Issues that are controversial in contemporary and holographic art are discussed. These include sections on the position of women, explanations for the art world bias against holography and the scarcity of informed critical writing on the subject. An indication is given of the technical choices possible in making and displaying holograms.

The second part of the thesis covers work carried out during the PhD project. The overall aim of the project to break down the boundaries between holography and the traditional fine art area of painting, to present male and female stereotypes, is discussed. A commentary on the male *Cosmetic Series* and other project works is given. Technical procedures are laid down for work in pulsed and continuous wave holography, film handling and colour work, and exhibition presentation. The thesis ends with a conclusion and some brief speculations on the future of holography in general.

SUMMARY OF RESEARCH PROJECT

PhD Research subject
How holography can be used as an art medium.

Purpose of the work
To enlarge the boundaries of what is traditionally seen as fine art. In this project works of art are assumed to contribute to knowledge and to articulate visually the meaning of the age in which they were produced.

Practical project
The practical project aims to produce work that is original in its particular combination of paint and holography to present male and female stereotypes, combined use of pre- and post-swelling, and other individual solutions. This is over and above the fact that artists produce work that is original *sui generis*. Regarding the 'hands - on' nature of the work, the candidate was the first artist to produce her own holograms, and subsequent work in the field is relative to this.

Thesis
The first part of the thesis contains research material organized in the form of documentation, classification, sociological comment and historical perspective. These are factors which have provided a basis for the conception and development of the practical project. The second part covers work carried out during the project, with an explanation of the finished results.

The thesis contains a number of ideas, some of them original. Some ideas in the thesis originally expressed and used by the author (such as the use of the shadowgram, originally called non-hologram) have now passed into the general display holography field.

MANIFESTO

.A code.
.Spatial.
.Didactic.
.Photonic.
.Futuristic.
.A discipline.
.Illumination.
.A photograph.
.Science↔Art.
.A precision tool.
.Illusion concrete.
.Pure chiaroscuro.
.An automatic Eden.
.An indivisible whole.
.Painting↔Sculpture.
.3D on 2D intimating nD.
.Material and immaterial.
.Writing the whole picture.
.The presence of absence.
.Making the invisible visible.
.An artificial 3D imaging system.
.Re-evaluating our visual traditions.
.Part of an innate human grammar.
.A bridge into the future with a past.
.The smile without the Cheshire Cat.
.Neither geometric nor organic in form.
.The reconstruction of light wave-fronts.
.Shattering the illusionist paradigm in art.
.A perceptual screen from the 'real world'.
.A potential mass-communications medium.
.A visible medium and a subvisible principle.
.A model for the complexities of brain function.
.Not art, but a condition in which art can happen.
.Mirrored in the life process, our own physiology.
.A mirror to our evolutionary progress from objects to systems.
.Realizing space time/time reversed/back as front/inside as out.
.A model for non-fragmentary thinking, language and behaviour.
.A diminutive shadow-theatre in which metaphors are strongly lit.
.A possible visual model for quantum theory and relativity theory.
.The most complete form of reproductive imaging that exists to date.
.A means of making statements about the world, or presenting pieces of it.
.The fulfillment of a longstanding cultural vision of what imaging ought to be like.
.Joined with high technology to raise the ceiling on humanity, or record Doomsday.
.The automatic execution of the ultimate cubist notion of a simultaneous view at every given point.
.An expression for mystical aphorisms such as 'the universe in a grain of sand' and 'we are all one'.

HOLOGRAPHY AS ART

Benyon, M. From exhibition catalogue PHASES, Museum of Holography 1980.
Reprinted in ESTHETICS CONTEMPORARY edited by Richard Kostelanetz, Prometheus Books, New York, 1989.

MARGARET BENYON BIOGRAPHY

SUMMARY
Professional painter from 1965-1970. Pioneered art holography in 1968. Produced a body of early laser transmission art works that laid the groundwork for subsequent explorations in the field. Lectures and papers from these years introduced other artists to the medium. Holograms include *Hot Air* 1970. *Bird in Box* 1973. *Solar Markers* 1979. *White Rainbow* 1980. *Tiresias* 1981. *Conjugal Series* 1983. *Tigirl* 1985. *Cosmetic Series (female and male)* 1986 - 1993.

BORN 29 April 1940, Birmingham, England. Lived Kenya, Africa, 1948 - 1958, UK 1958 - 76, Australia 1976 - 81, UK 1981 - now. Partner William Rodwell, scientist, m. 1974. Son Lucas, b. 1974, daughter Chania, b. 1976.

EDUCATION

1958-60 Birmingham College of Art. Intermediate NDD. Painting.
1961-66 Slade School of Fine Art, University College London. Dip FA. Painting. Postgraduate year.
1989-94 PhD project *How is Holography Art?* sponsored by Ilford Ltd, Royal College of Art, London.

PROFESSIONAL ACTIVITIES

Fellowships

1968-71 Fellow in Fine Art. University of Nottingham.
1971-73 Leverhulme Senior Art Fellow. University of Strathclyde, Scotland.
1978-79 Creative Arts Fellow. Australian National University, Canberra.
1987 Fellowship of Royal Photographic Society of Great Britain.

Teaching

1965-66 Silk-screen printing. Byam Shaw School, London, UK
1966-68 Painting. Fine Art Dept, Coventry College of Art, UK.
1968-71 Painting. Fine Art Dept, Trent Polytechnic, Nottingham, UK.
1977-80 Co-ordinator, Graphic Investigation. Canberra School of Art, Australia.
1983 External Assessor, Dept of Environmental Media, Royal College of Art, London, UK.
1986-87 Short teaching courses carried out in own studio, Dorset, UK.
1985-89 Visiting Tutor, Holography Unit, Royal College of Art, London, UK.
1991 Master Class. Photographic Studies, Derby School of Art, UK.

Lectures (selected)

1971 Icograda World Congress, Vienna, Austria.
1972 Symposium on Photo-Interpretation, City University, London, UK.
1972 Architectural Association, London, UK.
1972 Royal Society of Edinburgh, UK.
1973 A colloquy on holography with Professor David Bohm and Jonathon Benthall, Institute of Contemporary Art, London, UK.
1977 Australian National University, Canberra, Australia
1978 Museums Association of Australia, Canberra, Australia
1980+82 Museum of Holography, New York, USA.
1980 Goldsmiths Holography Workshop, London, UK.
1981 City University. Seminar, UK.
1982/85/88/91 1st, 2nd 3rd & 4th International Symposium on Display Holography. Lake Forest College, Lake Forest, Illinois, USA.
1984 Royal College of Art Library Colour Course, UK.
1986 O/E LASE SPIE Conference. Los Angeles, USA.
1986 BIPP Video Conference. Bournemouth College of Art and Design, UK.

1987 Ryerson Polytechnical Insitute. Toronto, Canada.
1989 Tate Gallery, Liverpool, UK.
1965-92 Lectured in undocumented number of Colleges of Art/Polytechnics in Britain and Australia.

SOLO EXHIBITIONS

1969 MARGARET BENYON. Nottingham University Art Gallery, UK. First solo holographic art exhibition.
1970 FIRST LONDON EXPO OF HOLOGRAMS. Lisson Gallery, London, UK.
1970 MARGARET BENYON. Nottingham University Art Gallery, UK.
1971 Icograda World Congress, Vienna, Austria.
1971 MARGARET BENYON. Nottingham University Art Gallery, UK.
1972 Richard Demarco Gallery, Edinburgh, UK.
1979 Watters Gallery, Sydney, Australia.
1979 Ewing Gallery, Melbourne., Australia.
1981 PHASES. Retrospective Exhibition, Museum of Holography, New York, USA.
1984 Poole Arts Centre, Dorset, UK
1986 MIRAGE IMAGE. Musée de l'Holographie, Paris, France.
1987 CONJUGAL AND COSMETIC SERIES. Interference Hologram Gallery, Toronto, Canada.
1990 COSMETIC SERIES • CONJUGAL SERIES. Museum fur Holographie & Neue Visuelle Medien, Pulheim. West Germany.

GROUP EXHIBITIONS

Total to date: 65

1965 YOUNG CONTEMPORARIES. 5.
1966 YOUNG CONTEMPORARIES. London and Arts Council Tour, UK.
1966 KINETIC ART. Herbert Museum, Coventry, UK.
1966 Axiom Gallery, London, UK.
1968 VAT '68. Herbert Museum, Coventry, UK.
1968 COLOUR RHYTHM. Organized by Annely Juda. Oxford Gallery, Oxford, UK.
1970 N DIMENSIONAL SPACE., Finch College Museum, New York, USA.
1971 ART SPECTRUM. Alexandra Palace, London, UK.
1972 Electro-Optical Exhibition, Brighton. (Trade Show)., UK
1973 ILLUSION OF REALITY AND REALITY OF ILLUSION. (Organized by Roland Penrose) University of Stirling, Scotland, UK.
1974 ILLUSION IN NATURE AND ART. (Organized by Ernst Gombrich and Richard Gregory.) Institute of Contemporary Art. London, UK.
1977 WORKS ON PAPER. Susan Gillespie Gallery, Canberra, Australia.
1979 Australian Academy of Science, Canberra, Australia. (Visitors included international scientists, diplomats and HRH Prince Charles)
1979 Solander Gallery, Canberra, Australia.
1980 Adelaide Festival, Australia.
1981 Photographers Gallery, London, UK.
1982 SPACE-LIGHT. International Exhibition of Holography. Touring Sydney, Melbourne, Brisbane, Perth, Australia
1982 BRITISH HOLOGRAPHY. Light Fantastic Gallery, London, UK.
1982 1ST INTERNATIONAL EXHIBITION OF DISPLAY HOLOGRAPHY. Lake Forest, USA.
1982 AIR '81. Museum of Holography, New York, USA.
1983 CONTEMPORARY ART HOLOGRAPHY. Museum of Holography, New York, USA.
1983 LIGHT VISTAS, LIGHT VISIONS. Moreau Gallery, Indiana, U.S.A.
1983 INTERNATIONAL HOLOGRAPHY. Light Fantastic Gallery, London, UK.
1983 LIGHT DIMENSIONS. RPS, Bath, and Science Museum, London, UK.

1984 BRITISH HOLOGRAPHY. San Francisco, touring to Museum of Holography, New York, and Interference Gallery, Toronto, Canada.
1984 PHANTASMAGORIA. An International Exhibition of Art Holography'. Cleveland Gallery, Cleveland, U.K.
1984 LIGHT YEARS AHEAD. York City Art Gallery, York, UK.
1984 LICHT-BLICKE. Deutsches Filmmuseum, Frankfurt, Germany.
1984 DEDALE '84. Deuxieme Biennale des Metiers d'Art, Avignon, France.
1984 HOLOGRAPHY GROUP EXHIBITION. Royal Photographic Society, Bath, UK.
1984 A TASTE OF HOLOGRAPHY. Ferens Art Gallery, Hull, UK.
1985 2ND INTERNATIONAL EXHIBITION OF DISPLAY HOLOGRAPHY. Lake Forest, USA.
1985 THE HOLOGRAPHIC IMAGE; EIGHT ARTISTS IN THE AGE OF THE LASER. Gulbenkian Museum, Lisbon, Portugal.
1985 Palais de la Decouverte, Paris, France.
1986 HIGH TECHNOLOGY AND ART 1986. Tokyo and Nagoya, Japan.
1986 GLOBAL IMAGES EXHIBITION. Beijing, China.
1986 PROCESSOS: CULTURA Y NUEVAS TECHNOLOGIAS. Centro de Arte Reina Sofia, Madrid. Ministry of Culture exhibition, Spain.
1986 HOLOGRAPHY (RE) DEFINED, INNOVATION THROUGH TRADITION. Museum of Holography, New York, USA.
1987 TOWARDS A BIGGER PICTURE: CONTEMPORARY BRITISH PHOTOGRAPHS. Victoria and Albert Museum, London, UK.
1987 AIR WAVES. Museum of Holography, New York, USA.
1987 Fratelli Allinari Photo Museum, Florence, Italy.
1987 IMAGES IN TIME AND SPACE. Montreal, Canada.
1987 THE HOLOGRAPHIC INSTANT, Museum of Holography, New York, USA.
1987 British Trade and Technology Week. Genoa. (Trade Show), Italy.
1987 ILLUMINATIONS RPS National Centre of Photography, Bath, UK.
1987 Houston Center for Photography, Houston, USA.
1987 Tiffany & Co, (Window display). Houston, USA.
1988 FUTURESIGHT. Selected works from Museum of Holography, NY. Tour of New Zealand.
1988 SPARKASSE exhibition, Waiblingen, Germany.
1988 3RD INTERNATIONAL SYMPOSIUM ON DISPLAY HOLOGRAPHY. Lake Forest, USA.
1989 AS WE SEE IT. National Geographic Explorers Hall, Washington, USA.
1989 RPS Stand, Ideal Home Exhibition, London, UK.
1989 ARTEC '89. International Biennale in Nagoya, Japan.
1989 WORLD OF HOLOGRAPHY International Exhibition, Tokyo, Japan.
1989 TOWARDS A BIGGER PICTURE. Tate Gallery Liverpool., UK
1989 Israel National Museum of Science and Technology, Tel Aviv, Israel.
1990 CAPTURED LIGHT: NEW WORKS BY LEADING HOLOGRAPHERS. Chelsea Center, New York, + Museum of Holography, New York., USA.
1990 INTERNATIONAL CONGRESS ON ART IN HOLOGRAPHY. (Steering committee member) St Mary's College, Notre Dame, Indiana, USA.
1991 Holographic joint project with Richard Hamilton included in his solo exhibition at Anthony D'Offay Gallery, London, UK.
1991 4TH INTERNATIONAL SYMPOSIUM ON DISPLAY HOLOGRAPHY. Lake Forest, USA.
1991 FIAT LUX! HOLOGRAPHY. Asturias, Spain.
1991 HOLOGRAPHISCHE VISIONEN, Museum fur Holographie & Neue Visuelle Medien, exhibited in Köln, Germany and Caja de Madrid, Spain.
1992 4 BRITISH HOLOGRAPHERS. Smith's Gallery, London.
1992/3 Exhibition to celebrate publication of International Women's Art Diary, Centre 181 Gallery, London.
1994 Dorset Art Week. April. Open Studio, Broadstone, and group exhibition of Dorset artists, Knoll Gardens,Wimborne.

COMMISSION 1991 Arts Council Award trophy.

AWARDS, GRANTS, PRIZES

1964 Audrey Mellon Prize Purchase Award for Slade Painting Collection.
1972 Carnegie Trust Award towards cost of 15mW He-Ne laser.
1979 Visual Arts Board/Australia Council Travel Grant towards cost of travel to the USA for holography research.
1981 Artist in Residence, Museum of Holography, New York.
1982 British Council Travel Grant to lecture at First International Holography Symposium, Lake Forest, Illinois, U.S.A.
1982 Kodak Photographic Bursary for work in pseudocolour holography and editioning.
1982 Calouste Gulbenkian Holography Award. Commission award for creative holography, including sponsorship for materials by Agfa-Geveart.
1983 Direct Grant AIR , Museum of Holography, New York. U.S.A.
1985 Agfa Award 'Best of Exhibition' purchase award from Agfa Geveart, USA.
1987 British Council Travel Grant to Canada.
1987 Shearwater Foundation Holography Award.
1994 Shearwater Foundation Scholarship to attend Fifth International Holography Symposium, Lake Forest, Illinois, U.S.A.

OTHER INFORMATION

Public Collections

Paintings: Department of the Environment UK
University College London, UK
Castle Museum Nottingham, UK
Nottingham University, UK

Holograms: Ministry of Aviation UK
Australian National Gallery, Australia.
Michell Foundation Melbourne, Australia
National Gallery of Victoria, Melbourne, Australia.
Massachusetts Institute of Technology Museum, Boston
Museum für Holographie & Neue Visuelle Medien, West Germany
Calouste Gulbenkian Foundation, Lisbon, Portugal.
Musée de l'Holographie, Paris, France.
Interference Gallery, Toronto, Canada.
Ontario Science Centre, Toronto, Canada.
Victoria and Albert Museum, London, UK.
Tenchijin Kan, Museum of Holography, Tokyo, Japan.

Works included in an undocumented number of private collections worldwide.

Publications (Benyon)

1970 'The Holographic Image.' Art and Artists.
1971 'Laser Holography as a New Medium for Visual Communication.' Icographic 2. Margaret Benyon and Jonathon Benthall.
1971 Margaret Benyon. Exhibition catalogue. Nottingham University Art Gallery
1973 'The Holographic Recording of a Complete Closed Surface.' Gordon Rogers and Margaret Benyon. Applied Optics. Vol 12, No 4.
1973 'Holography as an Art Medium.' Leonardo. Vol 6, No 1.
1973 'Comparisons of a Hologram and a Slide of a Room Interior.'David Canter, Margaret Benyon and Sue West. Journal of Perceptual and Motor Skills.
1973 Book Review of Holography by H. Arthur Klein. Leonardo. Vol 6, pp 270.
1974 'Holography as an Art Medium.' Kinetic Art: Theory and Practice. Dover. 1974.
1979 'Margaret Benyon's Holography.' Interview. Cantrill's Filmnotes. Nos 31, 32. pp 52-68.

1980 Exhibition catalogue for PHASES: A Twelve Year Retrospective of the Work of Margaret Benyon Museum of Holography, New York.
1980 An Interview with Margaret Benyon Holosphere. Vol 9, No 10. Oct 1980. pp 1 - 4.
1981 'Holography as Art.' Letter to Peter Fuller. Art Monthly.
1981 'Unclear World'. Heresies 13. Feminism and Ecology Issue. Earthkeeping/Earthshaking.
1982 'On Holography as Art in the Second Decade and my Recent Holograms.' Leonardo. Vol 15, No 2. pp 89-95.
1982 Book review of 'The Holography Book' by Jeff Berner. Leonardo. Vol 15, No 4, pp 331-2.
1982 'Display Holography in Britain 1982.' Proceedings 1st International Conference on Display Holography, Lake Forest, Illinois. USA.
1983 'The Law and Holography.' Letter. Art Monthly. No 62, p 22.
1984 Interview mit Margaret Benyon Exhibition catalogue, Deutsches Filmmuseum, Frankfurt.
1984 Letter to Frank Popper. Real Image. No 1, p 14.
1984 'Holography Today.' Letter. Art Monthly. No 81.
1985 Exhibition catalogue for 'The Holographic Image: Eight Artists in the Age of the Laser' Gulbenkian Museum, Lisbon.
1985 'In Memoriam Adrian Lines 1960-1985.' Proceedings 2nd International Symposium on Display Holography, Lake Forest, Illinois, USA.
1986 'Pulsed Holographic Art Practice.' Margaret Benyon and John Webster. Proceedings of O/E LASE SPIE Conference. Los Angeles, U.S.A.
1986 'Pulsed Holography as Art.' Leonardo. Vol 19, No 3, pp 185-191.
1986 Dialogue with Artists: Margaret Benyon Interviewer, Al Razutis. Wavefront, Vol 2, No 1, Fall 1986.
1988 'Display Holography in Britain 1988' and 'Extracts from Writings pertaining to Holography.' Proceedings 3rd International Symposium on Display Holography, Lake Forest, USA.
1988 'A Holographic Artist's Viewpoint: Margaret Benyon FRPS.' The Photographic Journal. Vol 128, No 11.
1989 'Cosmetic Series 1985-1987: A Personal Account.' Leonardo. Vol 22, Nos 3/4.
1989 Letter. Holosphere, Fall, Vol 16, No 4.
1989 'Holography as Art.' M. Benyon. Revised ed. Esthetics Contemporary edited by Richard Kostelanetz. Prometheus Books.
1991 'Art concepts in holography: works from the Male Cosmetic Series.' Proceedings 4th International Symposium in Display Holography. Lake Forest, USA. Published SPIE. Vol 1600.
1991 'Living with Holography.' M. Benyon. Women's Art Magazine. No 41. July/August.
1991 Letter. Women's Art Magazine. No 42. September/October 1991.
1992 'Do We Need an Aesthetics of Holography?' Leonardo. Vol 25, Issue 2.
1993/4 'Holography as Art'. Introductory essay and dossier in the Electronic Dictionary published by GRAM (Groupe de Recherche en Arts Mediatiques), UQAM, Montreal, Canada.

Bibliography and reviews

(Books listed in upper case)

1969 Guardian Journal, 16/8/69.
1969 Evening Post and News, 14/5/69.
1970 Studio International, Feb 1970.'Technology and Art II: Holography and Interference'. Jonathon Benthall.
1970 Arts Magazine, Feb 1970. David Russell.
1970 Connoisseur, May 1970. Peter Fuller.
1970 Queen. 18/3/70, Elizabeth Glazebrook.
1970 Institute of Physics Bulletin, March 1970, and April 1970.
1970 What's on in London, 20/2/70. Oswell Blakeston.
1970 Evening Standard, 3/2/70. Richard Cork.
1970 The Sunday Times. 1/3/70. Edward Lucie Smith.
1970 Observer, 1/3/70. Nigel Gosling.

1970 Art International, April 1970. Bernard Denvir.
1970 Morning Star, 12/3/70. Amateur Photographer, 18/3/70. Sun, 23/9/70.
1970 The Guardian, 5/6/70. Myfanwy Kitchin.
1970 Ariadne, 16/12/70. Amsterdam.
1971 TOMORROW'S WORLD. Raymond Baxter and James Burke. BBC Publication, pp 202-203.
1971 New Scientist and Science Journal. 20/5/71. David Dickson.
1971 The Guardian, 4/5/71. Myfanwy Kitchin.
1971 Arts Review, 17/7/71. Peter Dyke.
1971 Icographic 1, June 1971.
1971 Central Office of Information. Photographic record of Nottingham exhibition distributed worldwide.
1972 The Scotsman. 10/1/72. Edward Gage. 21/1/72. Julie Davidson.
1972 The Guardian. 14/1/72.
1972 SCIENCE AND TECHNOLOGY IN ART TODAY. Jonathon Benthall. Thames and Hudson. pp 89-93.
1972 ART, TECHNOLOGY AND SOCIETY. Donald Brook. University of Sydney.
1977 The Canberra Times. 8/6/77. Sasha Grishin.
1978 UNDERSTANDING HOLOGRAPHY. Michael Wenyon. Arco Publishing Co, New York.
1978 LIGHTS AND PIGMENTS. Colour Principles for Artists'. Roy Osborne. Routledge and Kegan Paul.
1979 The Australian. 24/7/79. Sandra McGrath.
1979 The Sydney Morning Herald. 28/7/79. Nancy Borlase.
1979 The Age. Melbourne. 22/8/79.
1979 The Australian Women's Weekly. 28/3/79.
1979 Design Magazine. July 1979. Michael Wenyon.
1980 HOLOGRAMS. Graham Saxby. Focal Press. p 138.
1980 WHO'S WHO OF AUSTRALIAN WOMEN. Cassell.
1980 'Holos-Whole, Graphos-Picture, the Work of Margaret Benyon'. Lip. A Feminist Journal. Catherine Peake. pp 94-96.
1980 Holosphere. Vol 9, No 12. Dec 1980.
1980 The British Journal of Photography. 19/12/80. Graham Saxby.
1981 Pol Magazine. Australia.
1982 SPACE-LIGHT. Paul Walton. Doubleday. pp 40, 73-74.
1982 Holosphere. 'Margaret Benyon's Pulsed Rainbows'. Andy Pepper. June 1982. pp 4, 6. Holosphere. Vol 11. No 10. October 1982. Holosphere. Vol 11, No 9. September
1982 Spectator. John McEwan. 17/4/82.
1982 Observer Magazine. 21/11/82. (Photograph)
1982 British Journal of Photography. Graham Saxby. 7/5/82.
1983 The Photographic Journal. RPS. July 1983. (Cover photograph)
1983 Exhibition catalogue for 'Light Dimensions'. pp 33, 56.
1983 NEXT... January 1983. (Photograph).
1983 Evening Echo, Bournemouth. 19/10/83.
1984 Exhibition catalogue for ELECTRA. Musée d'Art Moderne, Paris. Frank Popper. pp. 47-48.
1984 Evening Echo, Bournemouth. 3/10/84.
1985 Chicago Tribune. 28/6/85. Abigail Foerstner.
1985 Sky Magazine. September. (Cover photograph)
1986 Wavefront. SPIE Profiles. Vol 1, No 3.
1986 Publication for PROCESSOS: CULTURA Y NUEVAS TECHNOLOGIAS exhibition. Vicente Carratón. Centro de Arte Reina, Madrid.
1986 'La Nueva Perspectiva Holographica'. Vicente Carratón, El Paseante, No 4.
1987 HOLOGRAPHIE. Peter Zec. DuMont Buchverlag Köln.
1987 NOW. Toronto. Dierdre Hanna. April 9-15.
1987 NEW SCIENCE AND THE ORIENT. Shunsuke Mitamura. Ed. Tadeo Takemoto, Shuntara Ho, Yujiro Ikemi. Publisher: Seishin Shobo.

1987 Folha ole Sào Paulo. 'A holografia em movimento da inglesa Margaret Benyon'. Eduardo Kac. 16/8/87.
1988 New Scientist. 'Light into Art'. Chris Titterington. 4/2/88.
1988 PRACTICAL HOLOGRAPHY. Graham Saxby. Prentice Hall International (UK) Ltd.
1988/9 Art Monthly. 'Holography, Visual Medium or Cheap Trick.' Andrew Pepper. Dec/Jan 1988/89. No 122.
1990 GARDNER'S ART THROUGH THE AGES. Ninth edition. de la Croix, Tansey & Kirkpatrick. 1991. Harcourt, Brace Jovanovitch Inc. Includes reproduction of *Tigirl.*
1990 CULTURE, TECHNOLOGY AND CREATIVITY IN THE LATE TWENTIETH CENTURY. Ed. Philip Hayward. 'Art in the Space of Technology - Margaret Benyon, Paula Dawson and the development of Holographic Arts Practice'. Rebecca Coyle. Arts Council/John Libby.
1991 Catalogue for HOLOGRAPHISCHE VISIONEN, Museum fur Holographie & Neue Visuelle Medien, Pulheim, Germany.
1992 Catalogue for 'Holografia Ciencia Y Arte', Museo Nacional de Ciencia Y Technologia, Madrid.
1992 'The best of British'. Graham Saxby. The British Journal of Photography, April 30.
1992 'Holographer of distinction'. Graham Saxby. The British Journal of Photography, Sept 10.
1992 ART IN PUBLIC. Ed. Susan Jones. AN Publications, p143.
1993 DICTIONARY OF INTERNATIONAL BIOGRAPHY: The Biographical Record of Contemporary Achievement. 22nd Edition. Publication Spring.
1993 INTERNATIONAL WOMEN'S ART DIARY, presented by Womens Art Library, UK, published by Open Letters. (Photo opposite page for March.)
1993 THE CREATIVE HOLOGRAPHY INDEX: The International Catalogue for Holography. Vol 1, Issue 1. Editor, Andrew Pepper. Monand Press, Bergisch Gladbach, Germany.
1993 "The Place of High-Technology Art in the Contemporary Art Scene." Frank Popper. Leonardo, Vol 26, No 1, pp 65 - 69.
1993 ART OF THE ELECTRONIC AGE. Frank Popper. Thames and Hudson.
1993 Photograph of *Facial Codes* in 'Face Values', Liz Wells. Women's Art Magazine, UK, No 50, Jan/Feb.
1993 Women's Art Library. Biography and slide of *Tigirl* in teacher's slide pack.
1993/94 THE WORLD WHO'S WHO OF WOMEN. Twelfth Edition. Publication Winter.
Also included in:
International Directory of Electronic Arts (France).
SPIE Holographics International Directory & Resource Guide (USA).
GRAM Electronic Dictionary (Canada)
Art & Techno-Science Dictionary (Japan)
1994/95 The ICC Project. CD ROM catalogue of artists and new media, published by The Intercommunication Centre, Tokyo, Japan.
1996 Macmillan's Dictionary of Art.

Collaborations and facilities used

National Physical Laboratory, UK. T. Ennos, E. Archbold.
Nottingham University, Department of Mechanical Engineering.
Loughborough University: Professor J.Butters.
British Aircraft Corporation: Dr B. Watrasiewitz, P. Spicer.
EMI, Feltham.
National Engineering Laboratory: I. Ledbetter, E. McLaughlan.
University of New South Wales, Royal Military College, Canberra.
Australian National University, Department of Physics.
Museum of Holography, New York.
Polaroid Research Labs, U.S.A: Dr Stephen Benton, J.M.Fournier, H.Mingace.,
CSIRO, Sydney: Dr P. Hariharan, S. Hegedus.
Imperial College, London: K.Bazargan.
J.K.Lasers, Rugby: Dr J. Webster, C.Mead.
Museum of Holography, Paris: Anne-Marie Christakis.
Royal College of Art, London: Rob Munday, Roddy Canas.

Broadcasts

Interviewed on Granada Television, BBC Television News, BBC Television 'Tom-Tom', BBC Television 'Reporting Scotland', New York MetroMedia/Channel 5 Evening News, 'Spotlight' TVS. South Australian Film Co., 'Do you see what I see'. Global Images Video, 'Holography: Memories in Light'. (Holograms filmed). 9/13/84. Interview with Richard Reynolds, National Public Radio, Canada & N. America. 5/87. Interviewed on numbers of local and world service radio programmes.

DATE	TITLE	MEDIUM/TYPE	SIZE	NOTES
	PAINTINGS & MIXED MEDIA			
Pre-1962.		Life drawings		
	Pregnant Skeletons	Drawings		
	Babies. Mortality	Drawings		
	Self-portrait as a Baby	Drawings		
	Foetus/William Blake	Drawings		
	Blake with Third Eye	Drawings		
	Three Dancers.	Painting		
	Male & Female Heads	Painting		
1962	**Fan**	Pen & wash drawing		
1962		Felt pen drawings		Collection: Iris Murdoch
1964	**Double Image**	Painting. Polymer on board		Hard edge optical.
1964	**Diamond Interference**	Painting. Polymer on board		Hard edge optical. Diamond.
1964	**In and Out**	Painting. Polymer on board		Hard edge optical. Diamond. Collection: R. Benyon
1964	**Lapis**	Painting. Polymer on shaped canvas		Hard edge optical. Diamond. Collection: Peter Cowan
1964	**Mushroom Cloud**	Painting. Polymer on board		Collection: Peter Cowan
1964	**Red Relief**	Painting. Polymer on board		
1964	**Droplet**	Painting. Polymer on board		
1964	**Coil**	Painting. Polymer on board		Collection: Slade School of Fine Art
1965	**Untitled**	Screenprints		
1965	**The Red and the Green**	Book-jacket.		For Iris Murdoch (Chatto & Windus)
1965	**Planar**	Felt pen on striped cotton		
1965	**Grey Interference.**	Drawing		
1965	**Grey Interference**	Painting. Polymer on board		Collection: L. Benyon
1965	**Relief Interference**	Drawing		
1965	**Relief Interference**	Painting. Polymer on board		Collection: Dept. of Environment
1965	**Octagon Box**	Letterpress print & screenprint on perspex.		Kinetic interference pattern Collection: Private, Ireland.
1965	**Interference**	Drawing		
1965	**Red Interference**	Painting		
1965	**Elipses**	Painting on paper		
1966	**Flutes**	Painting	64" x 59"	
1966	**Target**	Painting	5' x 5'	Collection: Peter Cowan
1966-67	**Target II**	Painting. Gouache on card.	24" x 24"	Collection: J. A Benyon
1967	**Waves**	Painting & screenprint on paper		Collection: J. A Benyon
1967	**Colour Gradation I**	Painting	60" x 68"	Collection: Castle Museum, Nottingham
1967	**Colour Gradation II**	Painting	66" x 75"	
	Cold Light, Hot Shade	Painting	68" x 68"	
1968	**Untitled**	Screenprint transfers on card & aluminium	19.5" x 28.5"	
1968	**Untitled**	Screenprint transfers on xograph & aluminium	26.5" x 18.5"	
1968	**Transfer Colour Gradation**	Painting. Screenprint transfer on polymer on canvas	68" x 68"	
1964-69	**Interference Box I**	Screenprint on perspex, ink drawing	6.5" x 7" x 1.5"	Kinetic interference patterns
1965-69	**Interference Box II**	Screenprint on perspex, collaged letterpress prints	21" x 21"	Private collection
1965-69	**Interference Box III**	Screenprint on perspex, collaged letterpress prints	11" x 11" x 2"	

1969	**Stereoscopic Shadow Projections**			Staged at first Notts exhibition
1969	**Dot Stereo**	Anaglyph painting. Polymer on canvas	8' x 6'	
1969	**Perspectival Stereo**	Anaglyph painting. Polymer on canvas	8' x 6'	
1969	**Space Reversal Stereo**	Anaglyph painting. Polymer on board	26" x 35"	
1969	**Paradox**	Anaglyph painting. Polymer on board		Private collection
1970	**Web**	Anaglyph painting. Polymer on canvas	24' x 6'	
1970	**Web**	Anaglyph painting. Polymer on paper		
	HOLOGRAMS & MIXED MEDIA			
1969	**Tone Bands**	Laser transmission	5" x 7"	Facility: BAC
1969	**Interference Pattern Box I**	Laser transmission	5" x 7"	Facility: BAC
1969	**Single Lights Box**	Laser transmission	5" x 7"	Facility: BAC
1969	**Interference Pattern Box II**	Laser transmission	8" x 10"	Facility: NPL
1969	**Picasso**	Laser transmission	8" x 10"	Facility: NPL
1969	**Still Life**	Laser transmission	8" x 10"	Facility: NPL
1969	**Lights**	Laser transmission	8" x 10"	Facility: NPL
1969	**Metal and Hand**	Laser transmission	8" x 10"	Facility: NPL. Non-hologram.
1970	**Double Exposure Still Life**	Laser transmission	8" x 10"	
1970	**Wide Angle Still Life**	Laser transmission	16" x 10"	
1970	**Hot Air**	Laser transmission	8" x 10"	Collection: Australian National Gallery. Non-hologram/shadowgram
1970	**Hot Air with Cup**	Laser transmission	8" x 10"	
1970	**Metal Rods**	Laser transmission	8" x 10"	
1970	**Triple Exposure**	Laser transmission	8" x 10"	3 separate images seen when plate is pivoted.
1971	**Bread**	Laser transmission	4" x 5"	
1971	**Clock, Mirror and Hypercube**	Laser transmission	8" x 10"	Pseudoscopic. Facility: EMI
1972	**Continuous Surface**	Laser transmission	8" x 10"	Collaboration with Gordon Rogers
1972	**Room Interior**	Laser transmission		Made with argon laser at NEL
1973	**Still Life**	Laser transmission	8" x 10"	Hologram & integral sodium display kit, Collection: Ferranti
1973	**Bird in Box**	Laser transmission	8" x 10"	Collection: Rosemary Jackson
1973	**Jigsaw**	Laser transmission		
1973	**Wide Angle Still Life**	Laser transmission & photo on acetate	16" x 10"	
1973	**Brave New World**	Laser transmission	16" x 10"	
1973	**Third World**	Laser transmission	8" x 10"	
1972	**Test Plates**	Reflection fragments		
1978	**Test Plate**	Reflection fragments on wood		Collection: National Gallery of Victoria, Australia
1978	**Greetings**	Reflection & engraved emulsion on wood	4" x 5"	Collection: Michell Foundation, National Gallery of Victoria, Australia
1978	**Rainbow Rainbow**	WLT, 2 colour	4" x 5"	
1978	**Rainbow Rainbow**	WLT, full colour	4" x 5"	Made with argon & He-Ne lasers giving 3 colours
1978	**Jigsaw II**	Reflection	6 pieces of 8" x 10" on wood blocks	
1979	**Secret Sacred I**	Reflection	8" x 10"	Collection: Ellen Waugh
1979	**Secret Sacred II**	Reflection	8" x 10"	
1979	**Totem**	Reflection	8" x 10"	
1979	**Solar Markers**	Reflections on rocks	1.5" x1"	Collection: MIT Museum, Boston.
1979	**Binding**	Reflection	8" x 10"	Collection: Australian National Gallery

1979	**Twigs**	Reflections, gang-mounted	Three 4" x 5"	
1979	**Lattice I**	Reflection & engraved emulsion	8" x 10"	
1979	**Lattice II**	Reflection & painting	8" x 10"	
1979	**Hyperworld**	Reflection & drawing	8" x 10" (4" x 5" holo)	
1979	**Unclear World I**	Reflection & drawing	8" x 10"	
1979	**Unclear World II**	Reflection & engraved emulsion	8" x 10"	
1980	**Greenhouse I: Creation Myths**	Reflection & engraved emulsion	8" x 10"	
1980	**Greenhouse II: an Automatic Eden.**	Reflection & engraved emulsion	8" x 10"	
1980	**Greenhouse III: Electric Garden** (Destroyed)	Reflection & engraved emulsion	8" x 10"	
1980	**Black Rainbow**	Open aperture & WLT	12.5" x 12.5"	Benyon & Benton. Joint work. Collection: Benton.
1980	**White Rainbow**	Achromat & WLT	12.5" x 12.5"	Benyon & Benton. Joint work. Collection: Benyon
1981	**Counting the Beats.**	WLT	12" x 16"	Collaboration: Webster &Mead Collection: MIT Museum, Boston, London.
1981	**Tiresias**	WLT	12" x 16"	Collaboration: Webster & Mead Collection: MIT Museum, Boston. Victoria & Albert Museum, London.
1981	**Tectonic** (Destroyed)	Open aperture & WLT	4" x 5"	
1982	**Red Horse.**	Reflection	4" x 5"	
1982	**Blue Sky, Brown Cow.**	Pseudocolour reflection	4" x 5"	
	Conjugal Series:			Collections: Private & public worldwide. Facility: CEGB
1983	• **Hands & Rice.**	Reflection	8" x 10"	
1983	• **Hands & Freesias I**	Reflection	8" x 10"	
1983	• **Hands & Freesias II**	Reflection	8 x 10"/ 4 x 5"	
1983	• **Cat's Cradle**	Reflection	8 x 10"/ 4 x 5"	
1983	• **Tango**	Reflection	8" x 10"	
1983	• **Binding II**	Reflection	8" x 10"	
1983	• **Pile of Hands**	Reflection	8" x 10"	
1983-4	• **Stress Relief**	Reflection. Two plate sandwich with real rice.	8" x 10"	Collection: Museum fur Holographie & Neue Visuelle Medien, Pulheim
1983-4	• **Limbo**	Reflection and letratone	8" x 10"	
1983-4	• **Presentation**	Reflection	8" x 10"	2 superimposed holograms.
1985	**Facial Codes**	Reflection		Four 8" x 10" reflections and xerox border
1985	**Man Laughing**	Reflection	8" x 10"	2 superimposed reflection holograms from *Facial Codes*
1985	**Tigirl**	Reflection and reproduction	30 x 33cm	Collections: Private and public worldwide
1985	**Picasso**	Reflection	30 x 40cm	Transfer with original 1969 work used as master
1985	**Still Life**	Reflection	30 x 40m	Transfer with original 1969 work used as master
	Cosmetic Series (female)			Collection: Musée de l' Holographie, Paris, & private & public collections worldwide
1985-86	• **Self Portrait**	Reflection & gouache painting/laser colour copy	Various	Number of painted versions.
1986	• **Painted Margot**	Reflection & gouache painting	30 x 40cm	Master no longer exists. Collection: Global Images, Hamish Shearer
1986	• **Gaelle**	Reflection & gouache painting/laser colour copy	30 x 40cm.	
1986	• **Sophie**	Reflection & gouache painting/laser colour copy	30 x 40cm	
1986	• **Flora**	Reflection & gouache painting/laser colour copy	30 x 40cm	
1986	• **Sonia**	Reflection & gouache painting/laser colour copy	30 x 40cm	
1986	• **Voiles**	Pseudocolour reflection	30 x 40cm	Two colour

1986	• Voiles	Multicolour reflection	30 x 40cm	Post-swollen
1987	Benedict Comedienne	Reflection	8" x 10"	A study. Split master. Reduced image.
1988	Benedict Revealed	Reflection	40 x 30cm	Double exposure.
1989	Split Benedict	Reduced image reflection	40 x 30cm	Collage. 3 colours. Collection: J.Ross
	Cosmetic Series (male):			Assistance R.Munday
1987	• Drawn Stephan	Reduced image reflection	10" x 8"	
1987	• Painted Stephan	Reduced image reflection & gouache painting	10" x 8"	Collection: J.Ross
1990	• Cosmetic Camouflage	Reflection	43 x 32cm	Pre- and post-swollen, loose film.
1990	• The Soldier	Reflection & gouache painting/laser colour copy	43 x 32cm	
1991	• The Artist RichardHamilton	Reflection	43 x 32cm	Flesh coloured. 4 colour mix. Collections: R.Hamilton, J.Ross
1991	• Richard Hamilton 1, 2 & 3	Reflection	43 x 32cm	Monochromatic. Series of 3. Collections: R.Hamilton, Victoria & Albert Museum.
1992	• Pockell Paul	Reflection	50 x 60cm	
1993	• Black Jack	Reflection & gouache painting/laser colour copy	43 x 32cm	
1993	• Pagan Paul	Reflection & gouache painting/laser colour copy	43 x 32cm	
1993	• Eddie Coloured	Reflection & gouache painting	50 x 60cm	
1990	Enough Tyranny	Reflection	32 x 43cm	Pastel pink. 3 colour mix
1994	Money can't buy it	Laser transmission master	30 x 40	Unfinished work in progress
1991	Trophy	Reflection	8" x 10"	Arts Council commission. 2 colour.
1991	Wrapped Flowers	Reflection	32 x 43cm	White and scarlet. 3 colour mix.
1992	'...penetrate the emulsion...'	Reflection & silver pen	32 x 43cm	Same as *Wrapped Flowers*, with pen markings
1993	Web	Reflection	50 x 60cm	Unfinished work in progress
1993	Blue	Reflection	50 x 60cm	Unfinished work in progress
1993	Curtain	Reflection	50 x 60cm	2 colour
1994	Curtain Moving	Laser transmission master	8" x 10"	Filmed animation. Unfinished work in progress. Assistance R. Canas
	Cornucopia			
1994	• Cornucopia	Laser transmission master	8" x 10"	Computer morphed animation. Unfinished work in progress. Assistance R. Canas
1993	• Fish	Reflection	50 x 60cm	Unfinished work in progress
1994	• More Fish	Laser transmission master	30 x 40	Unfinished work in progress
1990	• More Twigs	Laser transmission master	30 x 40	Unfinished work in progress
1993	• Concrete	Open aperture transmission	50 x 60cm	
1993	• CauliFlowers	Open aperture transmission	50 x 60cm	
1993	• Shells		50 x 60cm	
1994	• Planets (Rotating Cabbages)	Laser transmission master	8" x 10"	Filmed animation. Unfinished work in progress. Assistance R. Canas
1994	Dorset Markers	Reflections & embossings on rocks		Unfinished work in progress

Slides of works underlined accompany the thesis.

INTRODUCTION

INTRODUCTION

Holography gives us three dimensional images of astounding realism. It also provides a visual model of undivided wholeness rather than the relation of parts to a whole. It takes us into a new age, from electronics into photonics, the age of light. It is part of an extraordinary time of change in which we live. Recent technological progress in holography has meant that forecasts about its use in such areas as medicine, advertising, military, security, information storage and reproduction, have already been fulfilled. The impact of holography is strongly felt in the display area, where many people who first see a hologram do not forget the experience. And yet, to quote from the brochure accompanying *Towards a Bigger Picture* at the Tate Gallery Liverpool in 1989, "it remains one of art's least explored territories"[1].

Despite the early presence of artists in holography more than two decades ago, there is still considerable ignorance in the art area about holography, and about what it can and can not do. Judgements and expectations learned from more familiar media are often applied to holography, with damaging results. Many people are not receptive perceptually, emotionally or intellectually to the achievements of holographic artists, because they fail to understand that holography is a medium in its own right, with its own unique characteristics[2]

Holography is evolving so rapidly that what is true today is almost certain not to be the case next year. A short time ago the holography world was so small that it was possible for most of its practitioners - artists, scientists and entrepreneurs - to know each other. This is now no longer the case, with the rapid growth of numbers of people involved. There are signs that display holography is now settling down into patterns that already exist for other techniques, services and products.

The thesis addresses artists, art critics, curators, educators, exhibition organizers, and funding bodies, and the holography world. The viewpoint is intended to be that of usefulness to the art area, through documentation, classification, sociological comment and historical perspective. It is written from the point of view of the author, an artist who has used holography since its inception into the art field[3]. 'In the author's opinion' should be assumed as

preface to every statement that does not deal with straightforward data. My priorities are those aspects of the subject that have the greatest bearing on my own life and work as a holographic artist. I prefer to put forward ideas, rather than to be completely right. Ideas do not have to be 'right' to be very useful. Those who explore new territories have to accept mistakes. The maps of medieval cartographers were hopelessly inaccurate, but the explorers would not have discovered countries they had never seen if they had not set down on paper their conceptions of the New World. There are views expressed in this thesis that may not be 'right', but they do provide a point of departure for future thoughts on the subject .

Work that aspires to be accepted as art must usually show a developed aesthetic apparatus, and channels through which critical discussions can take place. Holography is an innovation which has been developing this apparatus over the last twenty years. A small but rapidly growing international network of artists constitutes an embryo art world within the holography world. Some of these artists have been taken seriously by the art world, and already have a tenuous position in the history of art by representations in art books and the presence of their works in national public collections. An increasing number of established artists are also becoming involved with holography for short periods. This thesis gives some background to this activity to aid communication, and act as a bridge from the past to the future.

Apart from information scattered in exhibition catalogues, existing literature tends to concentrate on technical matters at the expense of wider reasons why and how holography should interest artists. Therefore this thesis will be based on issues and concepts rather than techniques. Where technical matters are discussed, the emphasis will be placed on the ways in which holography can be made flexible as a medium. The technical aspects of holography have been given previous coverage (see bibliography), and potential practitioners can prepare themselves by reading the literature that already exists on this.

I believe that holographic artists and writers should aim to forge generalizations that are true not just to holographic art, but to contemporary art as a whole. Holographic art should have general contemporary relevance. It should not only be part of, but essential to, contemporary art debate.

CHAPTER ONE

CHAPTER ONE

1.1 CLASSIFICATION OF VISUAL ARTS IN HOLOGRAPHY

> **Display**: setting or presentation of something in open view, an eye-catching arrangement by which something (eg goods for sale) is exhibited.
> **Holography**: the technique of making or using a hologram.
> **Hologram**: a pattern produced by interference between light scattered from an object illuminated by one part of split laser beam and light from the other part of the beam; also, a photographic reproduction of this pattern that when suitably illuminated produces a 3-dimensional picture.
>
> Longman's Dictionary.

Display holography is the main category of holography in which artists are working. Much display holography, whether holographic art, science or commerce is innovative, in that it is constantly opening up new areas. Many of the terms used to describe the various art practitioners of holography are used loosely. However there are fine distinctions between each of these terms, which can aid our perception of these specialist areas. The following definitions/notes are suggested as an initial guide:

Holographer: anyone who makes holograms.

Holographic artist: an artist working exclusively with holography. Holographic artists have some difficulty with this classification, because it makes their medium too dominant over their profession as artist. If we translate 'holographic' into 'photographic', and then use the term 'photographic artist' to describe artists who use photography, like Cindy Sherman, Richard Long (who records his passages in the wilderness with photography), or Victor Burgin, we begin to see how inappropriate and belittling this classification by medium becomes. It implies that the medium is given priority, rather than what is done with it. However, when we want to make the distinction between an artist, and an artist using holography, it is a convenient short-hand to use the term 'holographic artist'.

Artist using holography: an artist who uses other media as well as holography, and is sometimes not an holographer. Nowadays an increasing number of artists employ a holographic technician or company to carry out their work.

Commercial holography: product of the holographic industry, which is involved in the mass-production of holograms, embossing, advertising, promotional and decorative holography, security, packaging, large format holography, and many other uses.

Commercial display holographer: someone who makes display holograms for sale, who is not necessarily an artist. Many display holograms are made by holographers who are not educated in the visual arts. Their holograms tend to exist on the same level as curios or souvenirs. The images are chosen for the express purpose of selling the hologram.

Commercial holographic artist: an artist who makes holograms for sale commercially. These are usually aesthetically pleasing, up-market versions of the above. The term 'commercial art' has been superseded by 'design' in art education.

Holographic designer: someone who applies creative ability and knowledge to solve a particular problem provided by a client.

'Hands-on' holographer: someone who makes holograms themselves. The term emphasises the craft, rather than the scientific-optical aspects of practice. Scientists rarely call themselves 'hands-on' holographers, artists often do. In fact some artists regard it as imperative to make their own holograms and disregard any work that has not been made with the artists' own hands, in the same way that some painters would not accept other people making their paintings for them.

Independent holographer: holographer working solo, outside institutions and commerce. Independent is a term sometimes used to classify art practitioners in film, video and photography. Independent holographers are usually professionals, and are not to be confused with the **hobbyist** or **amateur**, unless self-professed.

Hobby holographer: There is a difference in tax status between professionals and amateurs. "If you fail to convince the tax office that you are practicing your art 'on a commercial basis with a view to the realization of profits, then the result will be that you are merely indulging in a hobby[4]." RIP, Van Gogh!

Fine art holographer: someone who makes holograms for fine art purposes, pursuing traditional fine art concerns:

Experimental holographer: anyone who uses holography experimentally. In science this is usually the person who produces the holograms rather than the theorist. In art the word 'experimental' is also used to describe films made by individual artists, or the music made by innovatory composers like John Cage.

Creative holographer: someone who uses the process in a creative way, not just as a technical recording process, but who need not be an artist.

Artistic holography: This can be a slightly derogatory term, implying only a likeness to art. An artistic person is not necessarily an artist. Artistic holography has some superficial characteristics of art, such as decorative qualities, without achieving the actual status of art.

Hologenic: Term used to describe appropriate subject matter for a hologram. This term was first used by Emmett Leith at the first Lake Forest Symposium . Ideally this term should include appropriateness to the medium itself, that is use of the medium in a way that other media could not be used.

The edges between these areas are in practice frequently blurred. There is a relationship between creative holography and technological innovation in holography, as there is between holographic art and mainstream art. Art is a very small, but vital aspect of the much larger field of holography. Categories of applied holographic art such as design & commercial display, or holograms of art objects per se, are seen as incompatible with fine art objectives, and outside the scope of this thesis. However, there is a merging of differences between commercial and fine holographic art. The business side of art is understated, but artists have to balance their books, work with dealers, and buy services as self-employing small businesses. The main difference is that they do not need to justify starting a piece of work with the

sure knowledge that it will sell. This obviously does not exclude the possibility that holograms can be displayed outside the art context, in commercial venues such as shop windows and trade fairs, without losing their validity as art.

In the visual arts the relationship of fine to applied art is comparable with the relationship in science between, on the one hand, pure science and research, and on the other, applied science and technology. In this way the presence of 'fine art' artists at the experimental leading edge in the history of display holography may be explained. The small numbers involved are perceived by some to make artist's contribution unimportant, but their role in display holography has been seminal.

1.2 HOLOGRAM IDENTIFICATION CHART

Type	***Reflection***
Invented	Yuri Denisyuk ,1962.
Identification	Hologram looks black, & reflects a monochromatic full ***parallax*** image.
Stock Format	Film and glass 4" x 5" to 50 x 60cm. Usually wall hung.
Lighting	White light point source. Front illuminated.
Advantages	Full parallax. Can be surface mounted.
Disadvantages	Limited depth resolution, around 8". More difficult to make & less bright than ***WLT***'s.
Developments	***Pseudocolour. Full colour. Pulsed images.*** Edge-lit holograms.

Type	***Laser Transmission***
Invented	Emmett Leith and Uris Upatnieks, 1964.
Identification	Image appears in single colour (red, yellow, green or blue). Looks grainy.
Stock Format	Flat film or glass plate. 4" x 5" to 1 metre sq. (Film roll 1.1m x 10m)
Lighting	Laser or semi-***coherent*** source such as filtered mercury arc, sodium lamp.
Advantages	Full parallax. High resolution. Depth limited only by power/coherence of laser.
Disadvantages	Needs darkened space & expensive light sources. Laser maintenance, safety regulations.
Developments	Very large size. 35mm real-time computer-generated holographic video.

Type	***White Light Transmission*** (***WLT*** or ***Rainbow***)
Invented	Stephen Benton, 1968
Identification	Image has spectral colours that vary with viewer height/location.
Stock Format	Film and glass plates,4" x 5" to 1 metre sq. (Film roll 1.1m x 10m)Often hung by cables.
Lighting	White light source (spotlight, sun) from rear, above or below.
Advantages	Very bright and colourful. Inexpensive lighting. Images extend towards viewer.
Disadvantages	Loss of vertical parallax. Specified viewing zone.
Developments	Pseudocolour. Pulsed images. Embossed mass production. Very large size.

Type	***Holographic Stereogram*** (***Integral hologram***, ***Multiplex***, Holo-movie)
Invented	Lloyd Cross,1973
Identification	Formerly on drum or curve, with fine vertical lines on film. Image motion.
Stock Format	Formerly 9.5" film inside 16" diam. cylinder or 180°arc. Currently as WLT or reflection.
Lighting	White light source or integral display unit.
Advantages	Uses conventional film technology for live & outdoor scenes, or computer images.
Disadvantages	Limited image size, depth, resolution, and motion.
Developments	Large format flat distortion-free images. Embossing. Reflection w/out vertical lines. Computer generated images. Alcove holograms. Very large size ('ultragrams'). [5,6]

Note: A short definition of words printed in bold italics can be found in the glossary.

References and Notes

1 From brochure for TOWARDS A BIGGER PICTURE, Contemporary British Photographs from the Collection of the Victoria and Albert Museum, the first exhibition of photography to be held at the Tate Gallery Liverpool, February to May 1989.

2 **Lancaster, I.**, A CRITICS LEXICON FOR HOLOGRAPHY, Proceedings of the 3rd International Symposium on Display Holography, Lake Forest, Illinois, USA, 1988

3 **Benyon, M.**, EXTRACTS FROM WRITINGS PERTAINING TO CREATIVE HOLOGRAPHY, Proceedings 3rd International Symposium on Display Holography, Lake Forest, Illinois, USA. 1988.

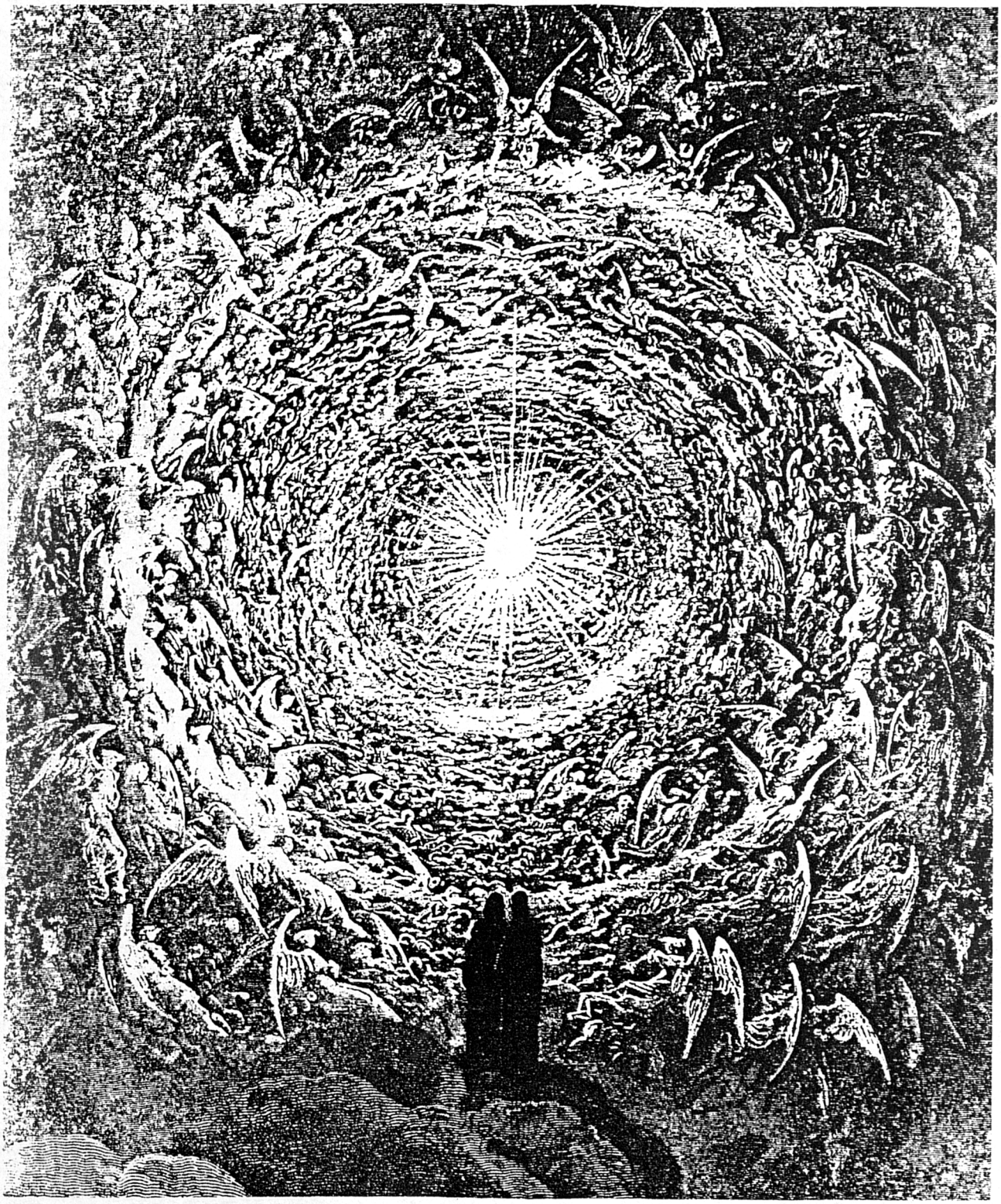
4 **Young S..**, EMPLOYMENT STATUS AND TAX, Making Ways, Artic Producers, 1987.

5 See also **Benton, S A.**, HOLOGRAPHIC DISPLAYS 1975-80, Optical Engineering Journal, 145, pp 686-690, (Sept/Oct 1980).

6 **Holzbach, M.**, RECENT DEVELOPMENTS IN HOLOGRAPHIC DISPLAY AT THE MIT MEDIA LAB, HODIC Circular, No 1, January 1992.

CHAPTER TWO

Plate 2 *The Mystic Rose of the Empyrean*, Gustave Doré (19th century).



2.1

Plate 3

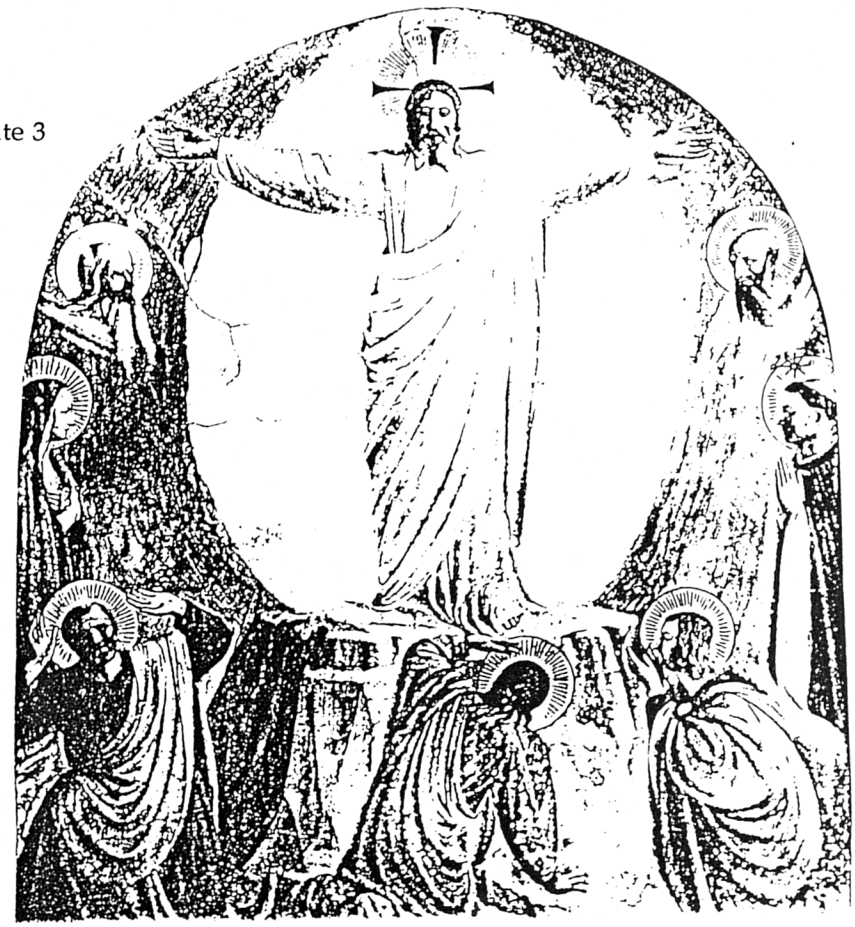


Plate 4

Plate 5

Previous page:

Plate 3 *The Transfiguration*, Fra Angelico (15th century), San Marco, Florence.

Plate 4 *Ascent to the Empyrean* by Heironymous Bosch (ca. 1500).

Plate 5 *Resurrection; The Risen Christ in Glory*. Grunewald. (A detail of the Isenheim alterpiece)

Below:

Plate 6 *Cristo Morto*, Andrea Mantegna, Pinacoteca di Brera.

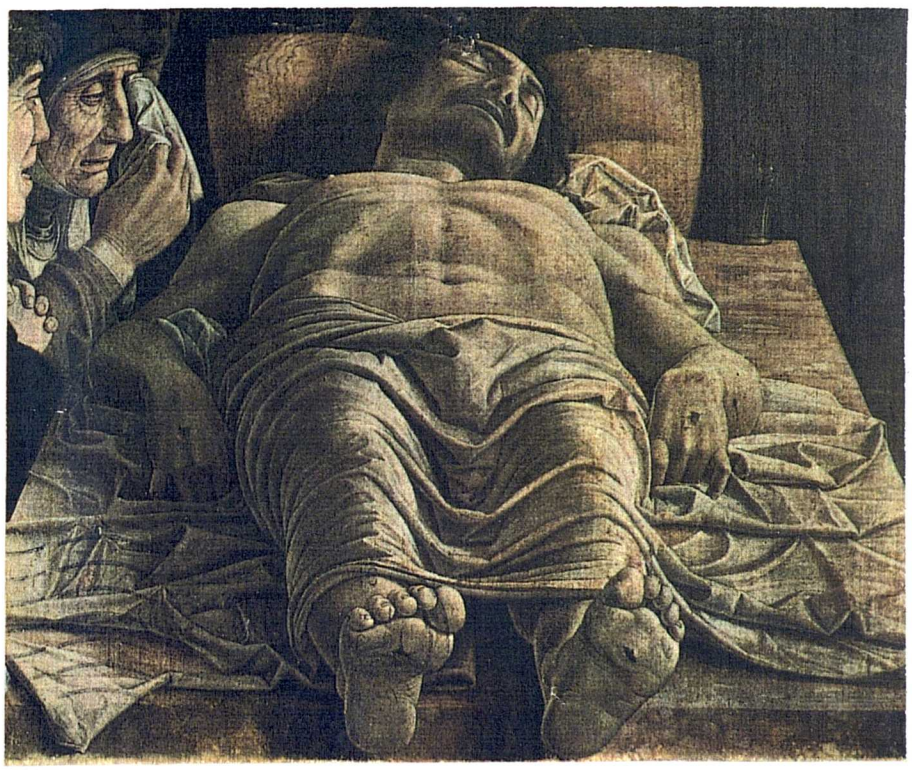


Plate 7 *Then a Spirit Passed Before my Face.* William Blake.
The Book of Job in the National Gallery of Art, Washington.

2.1

CHAPTER TWO

2.1 PRE-HISTORY

> Its fundamental brightness shone, so by chance creating
> An object which then obscured its radiant nature.
> Thus in delusion there appeared one-sided emptiness
> In which an imaginary world was built.
>
> The Surangma Sutra

Looking at holography as pure principle, the primary and purest form of a hologram is the *diffraction grating,* or *holographic optical element (HOE).* On this primary level, holographic art is seen as self-referential, with subject and object being interchangeable[1]. Few artists using holography work exclusively at this primary level. The majority work with the properties of holography at a secondary, more complex level, to make images, but frequently refer to this first hidden structure of the hologram, within their images.

A view of the universe as composed of interacting wholes that are more than the sum of their parts is an attribute of much art of the past, and is still a motivating factor in the work of many contemporary artists working in other media. My own recognition of these messages within the art of the past has been a source of enjoyment and confirmation of my validity as an artist. The art of the past can work on us in the same way as our first vivid images from childhood, as a powerful signal of human consciousness. We live and work in a time continuum, and it is my opinion that claims for the autonomy of holography disregard the message of interconnectedness that the holographic principle conveys.

Comparison of holography as an art medium with the wealth of images from the past is not intended to substantiate holography - it could in fact show up its inflexibility. (The most flexible medium for an artist is probably still pencil and paper.) Rather, there are signs from past art of which one might say that if this artist were alive today he (unfortunately all male) would surely be using holography. These signs from the past are visual, not easily translated into words, unlike the obvious technical route of artificial three-dimensional

imaging systems in the history of art. This route has already been comprehensively traced by art historians, through the development of perspective in painting [Plate 6], and the camera obscura. A history of three dimensional imaging has also been traced[2].

I suggest that the history of art contains works by artists that are 'holographic' in their aesthetic, ethic, philosophic and formal implications. These links are suggestive metaphors, which spark the imagination, rather than anything more laboured, and are certainly not meant to represent a retreat into past romanticism. Artists working in holography such as Ruben Nunez[3], Dieter Jung[4], and Brigitte Burgmer[5] amongst others, have made these imaginative links between art of the past and holography. The trajectory of art should not be based on negation of the past, but on affirmation of the future, but those who do not study history could be in danger of repeating it. The pre-history of art goes back to the time of cave (and presumably body) painting, and the time when humans first began to make small votive carvings. Perhaps the richest source for images formed or transfigured with light, and with holistic iconography is to be found in Eastern and Western visionary art. Many paintings show transfiguration scenes in which Christ is shown encircled with light [Plates 2 to 5]. The 'highest heaven' of traditional cosmology is often depicted as a central ringed sphere of light. The mystical painter William Blake often drew his figures surrounded with an aura of light [Plate 7].

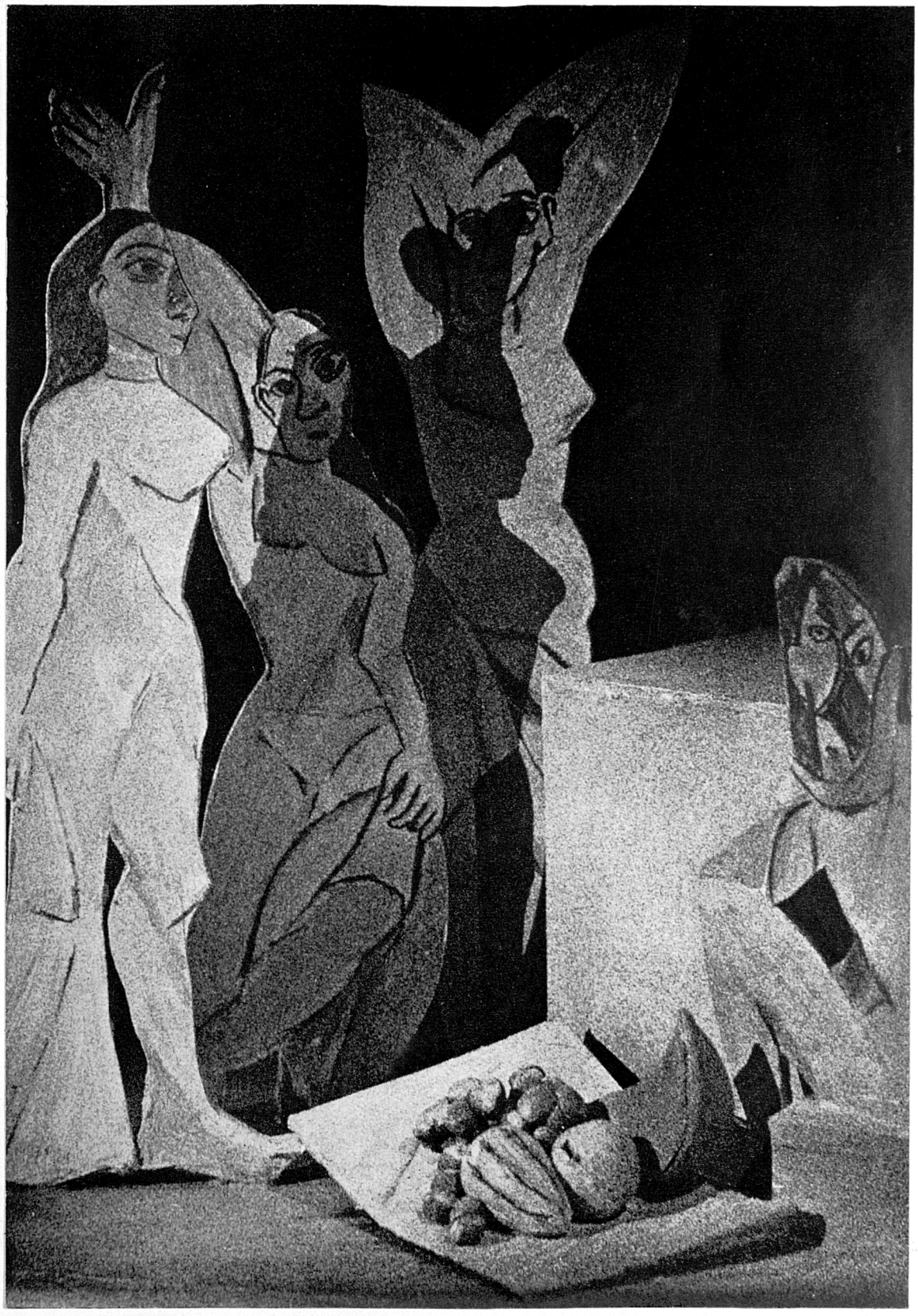
The role model for an artist in history whose work embodied both art and science is Leonardo da Vinci (1452 - 1519). His example has been so strong that it reaches down through the centuries. In his *Trattato della Pittura* he writes, '...the main objective of painting is to show a raised body projecting from plane surface. whoever achieves this surpasses all others and should be considered most skilled within his profession[6]'. His scientific studies of chiaroscuro, the rendering of light and dark in painting, advances his work to the seicento, and can be seen as a precursor of our present use of light and dark in holography.

An etching by Rembrandt made in 1652 illustrating Goethe's *Faust* shows a vision looking very like a transmission hologram. Velasquez' *Las Meninas* shows a ***virtual image*** of the king and queen at the back of the mirror, and a ***real image*** unseen by them in front. Van Eyk's *The Marriage* uses a mirror like a lens. Both are optical phenomena familiar to holographers, as are the anamorphic distortions that appear in the works of painters from Holbein to Dali. Depictions of outer and inner space, such as Van Gogh's stars and suns, connect metaphorically with the space and light of the hologram.

In his short pre-history of holography, scientist Stephen Benton quotes the following passage, in which an imaginary realistic imaging process uncannily like holography is described in some detail:

> That window, that vast horizon, those black clouds, that raging sea, are all but a picture...you know that the rays of light, reflected from different bodies, form a picture, and paint the image reflected on all polished surfaces, for instance, on the retina of the eye, on water, and on glass. The elementary (sic) {elemental} spirits have sought to fix these fleeting images: they have composed a subtle matter, very viscous and quick to harden and dry, by means of which a picture is formed in a twinkling of an eye. they coat a piece of canvas with this matter, and hold it in front of the objects they wish to paint. The first effect of this canvas is similar to that of a mirror: one sees there all objects, near and far, the image of which light can transmit. But what a glass can not do, the canvas by means of its viscous matter, retains the images. the mirror represents the objects faithfully, but retains them not: our canvas shows them with the same exactness, and retains them all. this impression of the image is instantaneous, and the canvas is immediately carried away into some dark place. An hour later the impression is dry, and you have a picture the more valuable in that it cannot be imitated by art or destroyed by time... The correctness of the drawing, the truth of the expression, the stronger or weaker strokes, the gradation of the shades, the rules of perspective, all these we leave to nature, who with a sure and never-erring hand, draws upon our canvasses images which deceive the eye.
>
> Giphantie. Tiphaigne de la Roche, Paris, 1760[7]

Plate 9 *Picasso*, Benyon, 1971. 8" x 10" laser transmission hologram.



In 1911 Metzinger discussed how the Cubists 'allowed themselves to move around an object in order to give, under the control of intelligence, a concrete representation of it, made up of several successive aspects'. Cubist works have been discussed as dependent on conceptions of objects, memories of objects or multiple viewpoints of objects. Picasso's *Demoiselles D'Avignon* is seen as a proto-cubist master-piece. If the intellectual aim of the Cubists was to show three dimensions on a two-dimensional surface, then holography achieves this automatically, as film does with the Futurists' attempts to show movement [Plate 9].

In the Soviet Union in 1917 the Suprematist movement and the 'Rayonists' were interested in capturing from a still life the most brilliant reflections of light, then magnifying the effects. Lissitsky illustrated this concern in his work *Floating in Space* (1920). In his paintings *A Trip to the Stars*, and *Night Birds*, Réné Magritte effects the transfer of characters by means of light.

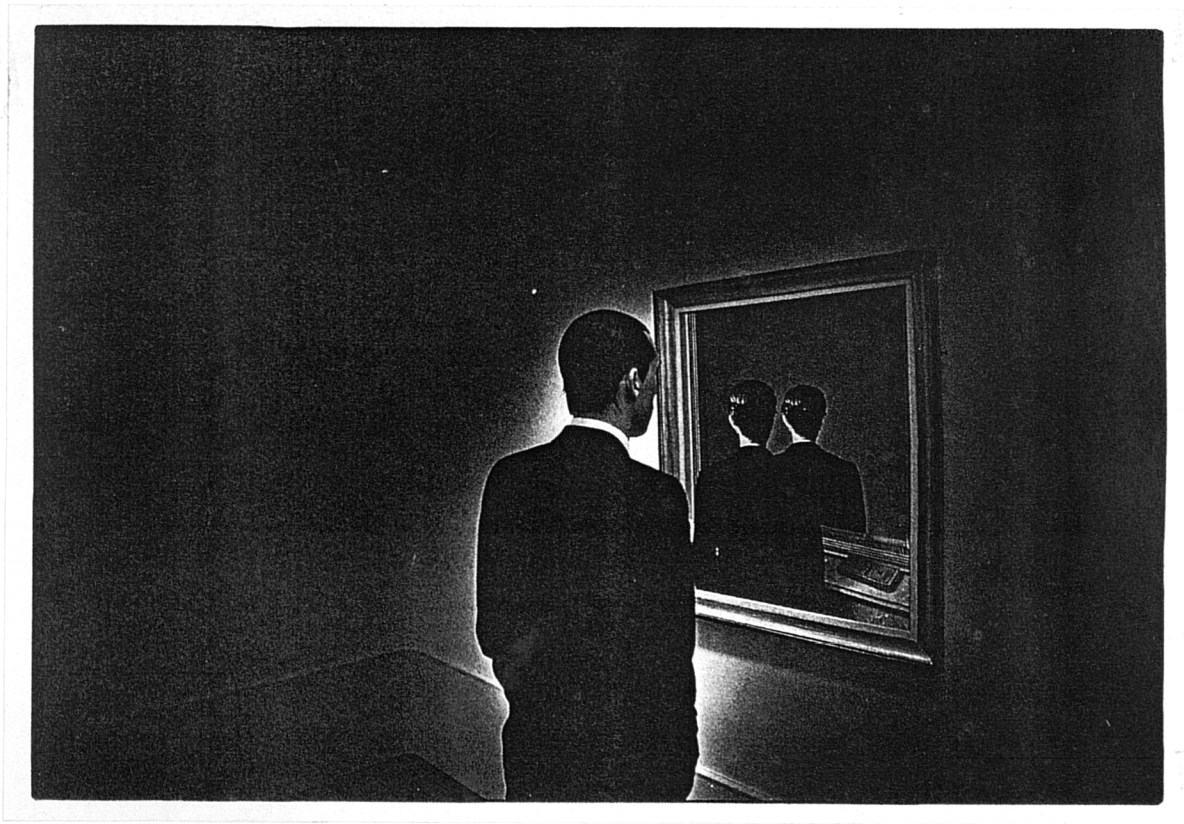
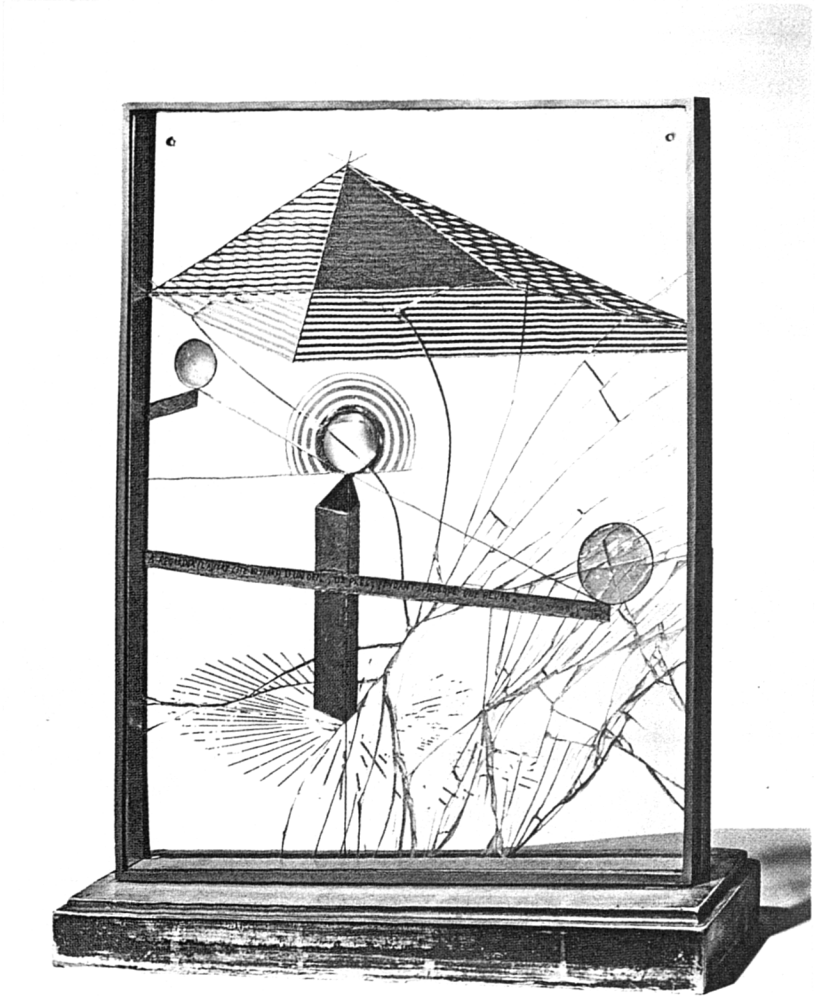


Plate 10 *La Réproduction Interdite / Forbidden Reproduction* by Réné Magritte

Paintings like that illustrated above suggest the dreamlike infinite regress that is possible in holography by taking holograms of holograms.

Duchamp's statement 'The artist I believe in; the art is a mirage.'[8] previsages post-object and dematerialized art, which holography resembles in its use of de-materialized images. His *Small Glass* contains a number of optical references, including a magnifying lens and graphic interference patterning, and is mounted in a standing frame like a 30 x 40cm transmission hologram.

Plate 11 Marcel Duchamp's *Small Glass* entitled *To be looked at (from the other side of the glass) with one eye, close to, for almost an hour.* 1918.



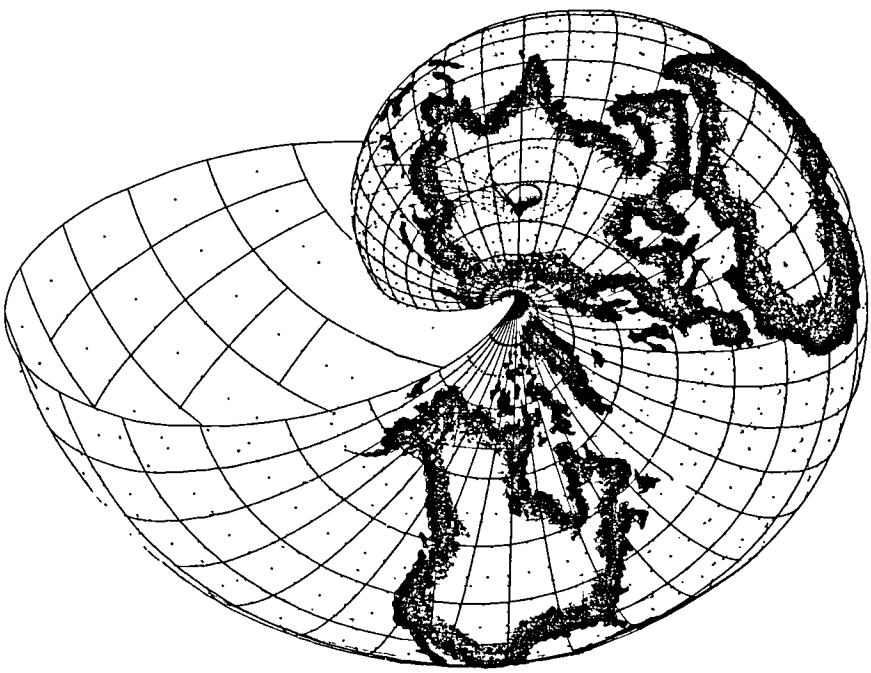
In 1920 Naum Gabo made a kinetic sculpture in which a vibrating rod creates the appearance of a solid space. In his book *Behind Appearance,* C H Waddington traces 'interconnectedness' in the analytical Cubists and later in the Abstract Expressionists, and suggests that a painting like Mark Tobey's *Messengers* bears some resemblance to a laser hologram viewed under a microscope by ordinary incoherent light. He suggests an analogy between paintings that possess an 'all-over' quality like Tobey's, Pollock's and

Dubuffet's and the hologram, which makes conventional ideas of 'composition' irrelevant[9].

Minimalist Donald Judd once said that 'A form that is neither geometric nor organic would be a great discovery', without recognizing that such a form already exists in the structure of the hologram. In a radio interview in 1989 British painter Anthony Green expressed the feeling that we are on the brink of discovering an unknown new form which would solve his particular problem of presenting the 'indeterminate edge of our memory of images'. His temporary solution is to use the shaped canvas. Holography could be that new form. Similarly David Hockney's interest in the spatial/perspective aspects of his work, and his cubistic gang-mounted Polaroids, strongly suggest that he should look at holography.

Artists throughout the centuries have used systems for the imaging of three-dimensional space[10].

Plate 12 Agnes Denes Isometric Systems in Isotropic Space - Map Projections (defined boundaries and space relations) THE SNAIL (helical toroid). 1978.



My own use of interference patterning to modulate the picture-plane of a painting spatially was a means of questioning the assumption of the Abstract Expressionists that a painting should be flat, without resorting to Renaissance space and traditional illusionism. This led me to investigate holography as a medium.

Plate 13 *Relief Interference* , Benyon, 1965. Collection: Dept of the Environment.

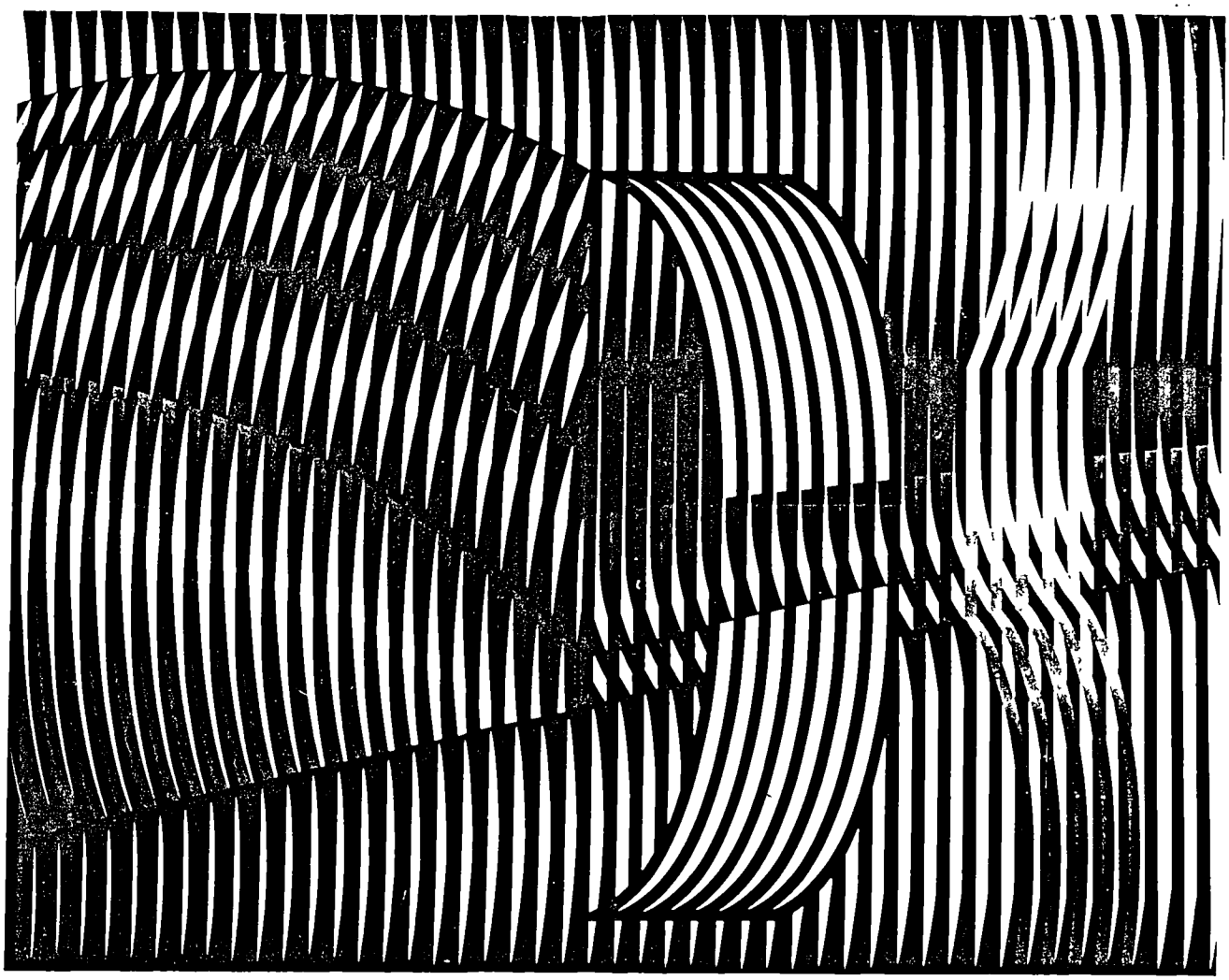


Plate 14 Letter from inventor of holography, scientist Dennis Gabor.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING
Professor D. Gabor
C.B.E., D.Sc., Dr.-Ing., F.Inst.P., F.I.E.E., F.R.S.

CITY AND GUILDS COLLEGE
EXHIBITION ROAD
LONDON SW7 2BT
Telephone: 01-589-5111
Telex: 261503

28 Febr. 1973

Dear Margaret Benyon,

Many thanks for your fine paper on Holography as an Art Medium. I am very interested in this subject, and I hope that one day I will be able to give you, artists, something really powerful; panoramic holograms, extending to infinity, in natural colours. I am working on this with the CBS Laboratories, Stamford. It is uphill work, because we require new lasers, but at least we have some idea what it will be like, because we have got the big lens which is needed for it, and looking through this at a suitably compressed model is quite stunning .

Yours sincerely

Dennis Gabor

D. Gabor

2.2

2.2 A SUMMARY OF THE HISTORY OF HOLOGRAPHY IN THE VISUAL ARTS, 1968 -1980

> While there are certainly significant "points" in the development of the medium, it is impossible to extrapolate a true picture from this close up, and even more difficult to connect a philosophical explanation to either cause or effect...For those of us who want to know what is going on before the dust settles, it is important to obtain background information on the early years of holography through published papers and recorded events[11].
>
> Rosemary Jackson. Founder, Museum of Holography, New York.

The principle of wavefront reconstruction of a hologram was invented in 1948 by physicist Dennis Gabor[12]. He proved the theory of holography with a semi-coherent light source, but his idea went underground, kept alive by a handful of workers until the first working laser was produced by Theodore Maiman in 1960. In Russia at this time Yuri Denisyuk invented a technique using laser light that reconstructed wavefronts by volume reflection, similar to a technique proposed by Frenchman Gabriel Lippmann in 1891 to produce colour photographs. He published the results of his work in 1962[13,14]. This development allows viewing of the hologram without a laser in white light.

In the USA, Leith and Upatnieks at the University of Michigan were working to improve the images obtained by Gabor's process using a laser and an off-axis recording technique, inspired by their side-looking radar work. The rush to produce three-dimensional display holograms really started after Leith's report on 'lensless' photography in 1964[15]. By the mid-60's, research was going on into natural colour, computer-generated holograms and interferometry, and the medium had attracted much attention. Despite the excitement felt by workers in the field, holography as science was for many years viewed generally as a solution looking for a problem. This is highlighted by the fact that it was not until 1971 that the importance of the process was acknowledged by the award of the Nobel Prize for Physics to its inventor, Dennis Gabor. Denisyuk also received late recognition in 1970, when he received the Lenin Prize for his invention of reflection holography.

The first generation of artists to use holography did so through direct collaborations with, or support from, scientists. In this period of scientific

holography, toy trains and chess sets are considered to be the central motifs, but in fact few pictorial holograms, chess sets or otherwise, exist from this period. The visual aspects of holography were not considered important by scientists, although some laboratories were, and still are, involved in display work on a demonstration level, as a means of publicizing their researches. An early example of such work was the hologram of a royal crown made by the National Physical Laboratory, London, for Expo '70 at Osaka[16]. This hologram was 8" x 10", the largest stock size available in Britain at the time. There was no point in the companies that supplied holographic materials providing larger sizes than suited scientific purposes.

"Juvenile", "in its infancy" - these are the clichés generally used about holography in the visual arts today. The field is young certainly. All artists who have used holography are still alive, except for Salvador Dali, Adrian Lines who died at the age of 26, and David Dewar. Nevertheless, holographic art has a history, spanning most of the period of existence of the modern laser hologram. It was the fine artists who forged the first links with science and took holography out of the lab. Although 1968 is the year of the first involvement of artists, the first decade of the history of display holography is generally taken to be 1965 - 75, dating roughly from the appearance of the modern laser hologram. Artists Bruce Naumann (USA), Margaret Benyon (UK), Harriet Casdin-Silver (USA), and Carl Frederick Reutersward (Sweden), began exploring the potential of holography from 1968-1969, and started showing the results between 1969 and 1970. "Of the four, only Benyon made her holograms totally by herself. While all are considered the first artists in holography, the distinction of being the first holographer who was an artist is commonly given to Benyon."[11]. Sculptor Jerry Pethick is credited with inventing the sand-table during this period, with scientist Lloyd Cross in San Francisco. During 1968 they opened the first gallery for holography, Editions Inc, in Ann Arbor, Michigan.

Holograms produced for Nauman by a commercial company were exhibited at the Leo Castelli Gallery in New York in 1969[17]. Casdin-Silver, with help from Raoul von Ligten, made holograms at the American Optical Company, and exhibited work from this period at an art and technology show in Boston, Massachusetts, during 1969[18]. In 1970 Reutersward showed work produced with the assistance of Hans Bjelkhagen in Stockholm. In 1968 Benyon was awarded a painting fellowship at the University of Nottingham, where she

was able to teach herself holography in the Product Engineering Department. She worked in almost complete isolation, obtaining information from the few scientific papers available at the time, notably Leith's 1964 paper, and from scientists at the University, the National Physical Laboratory and the British Aircraft Corporation. The first exhibition of this work was held in the Nottingham University Art Gallery in May, 1969[19]. In 1970 Finch College Museum of Art, New York a group exhibition included holograms by artists Robert Indiana, George Ortman, Nauman, Pethick, and Benyon[20]. In 1970 Benyon showed holograms at the Lisson Gallery, London[21].

With *Cobweb Space* (1972), in a collaboration with physicist Stephen Benton, Casdin-Silver brought the scientist's 1969 ***white light transmission*** technique into the public eye and made people realize how bright the ***rainbow hologram*** was[22]. There is no doubt that the availability of white-light viewable holograms made working in the medium more viable technically.

In the USA, Salvador Dali exhibited holograms at Knoedler's gallery in New York in 1972. The first School of Holography for the general public was set up by Cross and Pethick in San Francisco in 1972. A centre of creative holography was formed around this school, and artists such as Sharon McCormack, Lon Moore and Fred Unterseher became involved. Anaït took a course with Lloyd Cross in 1973 and began her pioneering work in reflection holography in Los Angeles. In 1973 the New York School of Holography was founded by Jody Burns, and in 1976 Posy Jackson opened the Museum of Holography with a charter from New York City. In Canada, Fringe Research Holographics Inc was set up by Michael Sowdon and David Hlynsky in the early 70's, and Visual Alchemy in Vancouver by Al Razutis (1972 - 78), and they functioned for many years as the only Canadian centres for holography. In Australia Paula Dawson began her work in laser transmission hologaphy in 1974 with the exhibition *Boxes* at the Ewing Gallery Melbourne. In 1975 Jackson and Burns held the most comprehensive show of holography for that period at the International Centre of Photography, New York, *Holography '75: the First Decade* in 1975. This exhibition had a mixed reception[23]. In general, it can be said that display holography had a very unsettled childhood, viewed at one extreme as child prodigy, and from another as delinquent dropout[24].

In the second decade (1975 - 1985), holography became much more visible to the general public through large public exhibitions, in which works by

artists, scientists and commercial companies were shown, and often mixed together with no distinction. In 1977 a small exhibition of work by Holoco, a company financed by the 'Who' rock group was mounted at the Royal Academy. This exhibition attracted a large amount of media attention. The show was followed by a larger one the following year at the same venue[25]. These exhibitions did a great deal to help raise interest in the medium and to create a market for holography.

In 1979 more people went to exhibitions of display holography than in the previous ten years combined. Matthias Lauk opened the Museum für Holographie & Neue Visuelle Medien in Germany, and Anne-Marie Christakis opened the Musée de l' Holographie in France. There were exhibitions in Tokyo, Eindhoven, Rotterdam, Berlin and Liverpool, where the Richard Payne collection of fine art holograms were exhibited at the Walker Art Gallery, curated by Eve Ritscher. Artists Dan Schweitzer and Sam Moree opened the New York Holographic Laboratories as a school and studio rental facility, which became a centre for artists working in the field.

The UK became the largest user of holographic materials, second only to the USA, and the holographic industry became very active, compared with other European countries. In the UK commercial companies and shops/galleries opened and closed, some within a very short space of time. It is interesting to compare the situation with that in Canada, where there is still relatively little commercial activity, and where a sum has been especially allocated by the Canada Council for art in holography. Consequently Toronto, where Fringe Research was established by Michael Sowdon and David Hlynsky, became a centre for art, rather than applied art, holography. Originally set up as a living spoof on legitimate research corporations, with their fringed lab-coats and 'lab rat' letter headings and other superb parodies, they became the umbrella for a large number of ideas, projects and activities within the artistic community in Canada.

In the UK two teaching facilities were opened in the early '80s. In 1980, the Goldsmiths Holography Workshop was set up as an independent facility in the Fine Art Dept at Goldsmiths' College. Here artists and designers could learn about holography, under the instruction of Michael Wenyon, an optical scientist who later became an artist, in collaboration with Susan Gamble. In 1982 Edwina Orr established Richmond Holographic Studios, which began

offering practical courses, both basic and advanced. Educational institutions were to open shortly after, in Liverpool and at the Royal College of Art, offering further opportunities for creative holography.

References and Notes

1 There is a symmetry in the function of the reference and object beams in holography. By considering the roles of object and reference beams to be reversed, it can be seen that reconstructing the hologram with an object beam would reproduce the reference beam. It is a convention what each beam is called, and in this sense there is no difference between them.

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5 **Burgmer, B.**, HOLOGRAPHIC ART: PERCEPTION, EVOLUTION, FUTURE, Daniel Weiss, La Coruna, Spain, 1987.

6 **Leonardo da Vinci.**, TRATTATO DELLA PITTURA, Cod. Vatican Urbanate 1270. Edition Angelo Borzelli, Lanciano, 1914.

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11 **Jackson, R.**, IN PERSPECTIVE. A THIRTY-FIVE YEAR ACCOUNT OF THE HISTORY OF HOLOGRAPHY, published in three parts in Holosphere; Part I, Vol 12, No 4, pp 5-12, Summer 1983; Part II, Vol 12, No 5, Fall 1983, pp 13 - 17; Part III, Vol 12, No 6, Winter 1984, pp 19 - 23. This history is the most impeccable of those written to date, most of which are hopelessly inaccurate.

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15 **Leith E N and Upatnieks J.**, WAVEFRONT RECONSTRUCTION WITH DIFFUSED ILLUMINATION AND THREE DIMENSIONAL OBJECTS, Journal of Optical Society of America, 54, pp 1295-1301, 1964.

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17 **Davis, D.**, ART AND THE FUTURE, Praeger, New York, 1973.

18 HARRIET CASDIN-SILVER HOLOGRAPHY, editor E. Bush, exhibition catalogue, Museum of Holography New York , 1977.

19 MARGARET BENYON, exhibition catalogue, Nottingham University Art Gallery, introduction by Maurice de Sausmarez, May 1969. This catalogue lists 5 holograms.

20 N DIMENSIONAL SPACE, exhibition catalogue, Finch College Museum of Art, New York., introduction by Elayne H Varian, April 1970.

21 **Benyon, M.** See Appendices F & G for papers, LASER HOLOGRAPHY AS A NEW MEDIUM FOR VISUAL COMMUNICATION (Icographic 2, 1971), and HOLOGRAPHY AS AN ART MEDIUM, Leonardo, Vol 6, pp 1-9, Winter 1973. This paper was also printed as a subject relevant to kinetic art in: KINETIC ART : THEORY AND PRACTICE, edited by Frank Malina, Dover Publications Inc, New York, 1974.

22 **Casdin-Silver H.**,MY FIRST 10 YEARS AS ARTIST/HOLOGRAPHER, Leonardo, Vol 22, No 3/4. 1989.

23 **Kramer, H.**, ART VIEW - HOLOGRAPHY A TECHNICAL STUNT, New York Times, August 3, 1975.

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25 Light Fantastic catalogues - see bibliography.

CHAPTER THREE

CHAPTER THREE

3.1 WHY HOLOGRAPHY?

Positive characteristics of holography

The question of why artists choose to use holography as their medium is large enough to become the subject of another thesis, and an attempt to cover this comprehensively can not be made here. My *Manifesto* (p ix) gives 45 reasons. How can we explain the fact that, despite its associated difficulties, artists have chosen to work with holography with a tenacity bordering on obsession?

For most artists using holography, it is the visual impact of the hologram that has been sufficiently powerful to impel them to become an holographer themselves, or to raise the funds to have their holograms made for them. For some, it is seen as a way out of theoretical or conceptual problems posed initially by other media. In my own case, it was the theoretical solution to my problems as a painter that drove me to make my own holograms before I was able to see one. In 1967 I had no opportunity to actually see a hologram, so that the first one I saw was my own.

Holography can make artists out of people. The following account by the late David Dewar, who has one of his holograms in the collection of the Victoria and Albert Museum, speaks for itself:

> It was the impact of seeing such (spectacular) holograms that determined me to make a hologram for myself....This determination, amounting almost to a compulsion, was as unexpected as it remains unexplained, and continues to defy analysis...I had no background in art or science...I was not a 'handy' person nor had I shown any signs of the dogged single-mindedness with which I embarked on the background reading, and construction work...Behaviour so atypical can hardly have been provoked only by three dimensionality...I feel driven to make holograms. I have to make them[1].

Holography is powerful way of affecting human sensory response. During an exhibition of my work in 1970 a five-year old burst into tears of frustration because she could not grasp the image. People insisted that they saw colour in monochromatic holograms. Twenty years later, exhibiting in Japan, I heard the same shocked reaction in a group of young Japanese women, squealing en masse at first sight of a hologram. The story of the old woman attacking with an umbrella the hologram of jewels in Cartier's window as a work of the devil has become legendary.

Holograms sometimes provoke a desire for possession, a feeling that the hologram is a precious jewel to cradle in the hand and hold up to the light, a natural diffraction like butterflies wings and opals. They provoke greed; most holographers have had numbers of works stolen, with thefts increasing in savagery and perseverance as public knowledge about holograms grows. Holograms fixed to walls with security fixings are ripped out of walls, fixings and all. (One of my *Solar Markers* was stolen from under the nose of a security guard from inside a perspex box which was screwed down all the way round, and had to be unscrewed likewise.)

The most compelling aspect of holography is its ability to render light as apparent substance, the metaphorical illumination of visions. Light is basic; we depend on it for our survival. Some see holography as the fulfilment of a longstanding cultural vision of what imaging ought to be like. An imaginary realistic imaging process uncannily like holography is described in some detail as early as 1760 (Tiphaigne la Roche, 2.1).

Holography opens up fresh new opportunities to make original statements. This is not brainless technologism, an unthinking affiliation to whatever is new. Holography does take us into a new age, from electronics into photonics, the age of light. It is a particularly appropriate medium for the postmodern age of "simulacra". Art world commentators often use the word 'potential' about holography, suggesting survival into the future. Traditional fine art media have become dislocated from those that are changing the pattern of human life. Technology has been the source of the greatest cultural thrust in this century, and artists using new technology are sharing in the its predicaments at the source of change. By using holography as a medium from the beginning of its development, artists have already influenced the direction of its use.

Holography has many faces. With a hologram it is possible to turn space inside out, cut it up, record the absence of objects, make the invisible visible, and make the solid transparent in paradoxical ways not possible in other media. Holography also has a number of properties in common with other media. In traditional terms it can be seen as an expanded form of both painting and sculpture, since it records three dimensions on a two dimensional surface. A display hologram resembles a photograph in that it is recorded on a photosensitive emulsion, but here the resemblance ends. It has been described as being more like a system for encoding space, structurally closer to other systems like maps, surveys, or even the freeze-drying of coffee than photography. Even the description of holography as "lensless photography" is not accurate, as holograms can be generated from sound as well as light waves. Some artists see the the three-dimensional image characteristics of holography as somewhat of a dead end which leads back to photography and illusion, preferring to work with it as a synthetic code, replaying light itself.

Didactically, holography is used in education to bridge the art and science fields. It provides useful new ways of comprehending the world. The hologram teaches us many things. Holography is perhaps the only visual model that we have for undivided wholeness rather than the relationship of parts to the whole. For the first time in history we have a medium in which a part is also a whole. Contemporary artists can experiment directly with the world, in full acceptance of its physical laws, such as the behaviour of light, rather than separate their creative thinking processes from the discoveries and conclusions of other realms of research. The optical properties of holography, the fact that it is not lens-based, allow it to do what other media can not, over and above its three-dimensionality. There are many things that can be done with it that can not be done with any other art medium[2].

The Downside

Holography remains one of art's least explored territories. There is a very small amount of art work being made with holography, relative to other media. Using the very widest interpretation of the word 'artist', at time of writing there are a maximum of 30 holographic artists in Britain, and at an optimistic rough estimate 300 world-wide[3] with the largest proportion working in the USA. There is a constant background activity of 'one-off' or serial works being made by artists dipping in and out of holography from other fields, and ripples of enthralled young makers appear whenever educational initiatives are taken, but a major problem is how to expand such a small field.

Factors that can hamper its development as an art medium are technical, financial and cultural. Some technical disadvantages of the medium are still almost the same as they were 25 years ago. Even though holograms are no longer lit with lasers they still need individual lighting at the display stage. Holographic art practice is still capital and labour intensive, still uses special optical equipment, and holograms are still small in scale and restricted in viewing angle by art-world standards. Western holographers have also been largely dependent on only two photographic companies for the production of their silver-halide materials. They need patience, courage, and commitment to work within such severe technical and financial constraints. For instance, continuous wave holography requires that objects do not move more than one ten thousandth of a millimetre. This is comparable with the early days of photography. Even though their equipment weighed 100lbs, early photographers could at least travel to their subjects. There are ways round many of these constraints, but they are extremely expensive.

Other disadvantages connected with its cultural development concern the art-world bias against holography, the non-existent art market, archival problems, the domination of the medium making everyone's work look alike, and its current relationship to mass reproduction and kitsch. The automatic association of holography with other 3D imaging systems and the technological pigeonhole could also be seen as stumbling blocks.

Requirement for special illumination

A modern white light viewable hologram requires a non-diffuse point source for its reconstruction. Each hologram usually requires its own light source, set at the correct angle, that is the same angle as the reference beam in the making stage - conventionally 45°. Exhibitions outside venues and galleries set up for the permanent exhibition of holograms will need to include the temporary installation of track and spot lamps. In Europe these are generally the low-voltage lamps available in an increasing diversity of designs for shop lighting from a number of lighting firms. Small-filament tungsten-halogen lamps with built-in reflectors can be track mounted with separate transformers out of sight, and can be minimal, elegant and unobtrusive these days.

This requirement can be seen as an advantage, because it places holography automatically into the art area of installation, which is currently fashionable. The disadvantage is that it places a further barrier to the acceptance of holography into the art world, because it requires a special effort on the part of curators to make temporary adaptations to their lighting systems.

It is unknown how many people who buy holograms are also sold the appropriate light, and go to the extra trouble of mounting this light in their homes. Many hologram retailers underplay the importance of lighting holograms properly to hologram purchasers. This is probably because in some cases the cost of a lamp would amount to more than the cost of a hologram. Since art works involve pricing in which the cost of lighting is much less than the hologram, it is likely that collectors take more care with correct lighting. Many artist prefer to cost in the installation with the sale of a work, and undertake this themselves.

Expense

Art critics say, "all that equipment and so little to show for it". Artists say, "too expensive; the cost of setting up a holographic studio makes it an elitist, exclusive medium." A basic holography studio would cost in the region of £10,000, and could cost twice that amount with all the extra requirements to begin working and exhibiting. Materials costs are high, with a single 30 x 40cm hologram glass plate currently costing £54, with acceptable results not guaranteed each time. However, costs in traditional art media can also be high. The cost of having a suite of prints made is probably in the region of £7000, and a colour catalogue for a solo exhibition would probably cost

upwards of £3000. Foundry costs are beyond the pockets of many traditional sculptors. My own holographic garage studio equipment was accumulated and built over many years. Considering the freedom it gives me to work, and at my own pace, to me the costs are reasonable. They are favourable compared with hiring lab time or paying a technician to make my holograms. The costs of building a studio, or lab hire are on a par with the sponsorship requirements for a photographer, film-maker, or sculptor doing site-specific work. Rachel Whiteread's *House* cost as much as an actual house.

Small scale

The stock sizes of holographic plates and film are small by art world standards. The largest size of hologram, typically 1.5m x 2m, is beyond the financial reach of most artists, and this is still small compared to the large canvases and Cibachrome prints currently on show in art galleries.

Conceptually, there are no size limits. Rick Silberman devised a work in which holographic points meet in space above earth if treated in the same way as a diagram or map. There is also the literal presence of holographic art in space, in Lowry Burgess's work orbiting the earth by space shuttle. Large walls or sheets of holograms can be made by gang-mounting holograms, and this method is used extensively by artists to solve the problem of scale. Similarly, simple *diffraction gratings* or *HOEs* can be used as modules in indoor and outdoor work of environmental scale. Sally Weber carries out large scale holographic commissions in this way.

Plate 15 *Jigsaw*, 1978. 6 pieces 3.25cm x 3.75cm mounted on wood blocks.

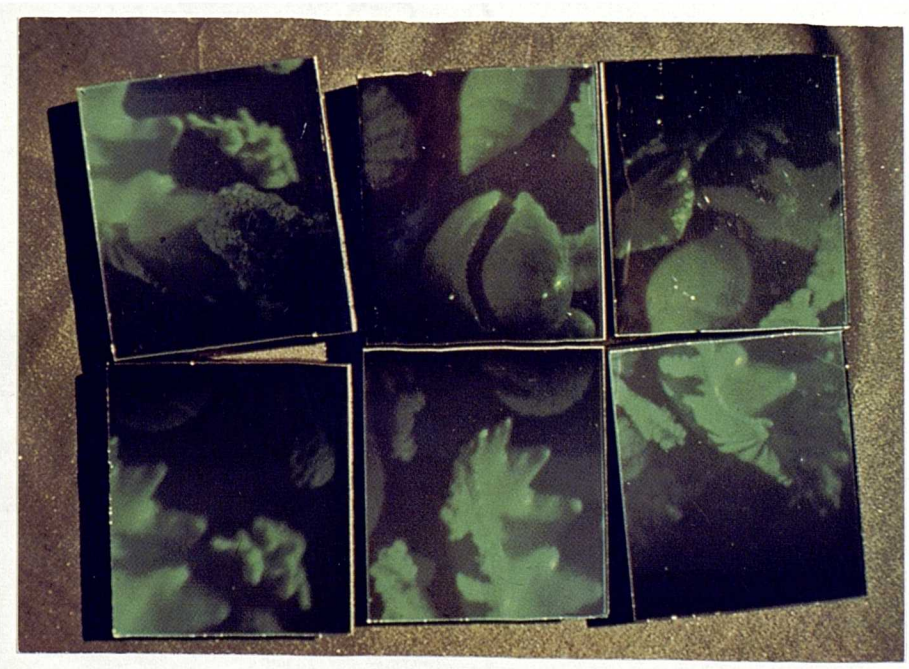


Plate 16 *Solar Marker*, 1979. Reflection hologram on rock. Collection: MIT Museum, Boston.

3.2

The conclusion amongst photographic archival researchers is that silver-halide materials can't be considered to be archivally permanent. However, photographs can be reclaimed. The use of photo-polymers would increase the physical stability of hologram, but these materials are currently only usable with high energy lasers beyond the financial scope of most artists. Archival aspects are also discussed in 4.2.

Art world bias against holography

This is discussed in chapter four. There is no doubt that this has an effect on the potential for art, and is damaging.

Domination of the medium over individual use

"I worry about ticky tacky holography. I am wary of the colours in white light holography that make everyone's work look too much alike."

Harriet Casdin-Silver[4]

Mass reproduction and kitsch

The endless, shapeless cataloguing of all objects that can be holographed is a necessary stage for holography to go through, but does not amount to good news for the art world, who do not understand this.

Association of holography with other 3D imaging systems

In particular, there may be an association with 3D systems that have become out of date. An example is the stereographic photograph that began at same time as photography, but for which there now remain few afficionados. Holograms are patently more sophisticated than these imaging systems, can be seen freely without viewing devices, and show full *parallax*. Nevertheless the 'novelty' aspect of the commercial holography industry bears too close a comparison with the earlier stereographic industry for comfort. It is as if holography has taken over where failed stereoscopic gimmickry left off. Some holograms mimic the same efforts that were made in stereographic photographs and anaglyphic films to produce images that thrust forward and back aggressively, in a way parodied to hilarious and gruesome extremes in Andy Warhol's 3D gothic horror movies. Part of the failure of 3D anaglyph films was due to inappropriate subject matter, like football matches that moved too fast for the eye to accommodate the stereo effect. However, all too often in association with holography we hear the offensive phrase 'exploitation of effects'. This sort of attitude is enough to deter artists from using the medium. For those who have a vision of a different sort of future for the hologram, the only answer is to press on with making their own art

work and try to offset the exploitative or thoughtless uses currently being made of holography.

Automatic association of holographic art with technological art
There is a tendency for 'high-tech' media to become too expensive for individual use, as in the case of computer art which became computer graphics involving teams rather than individuals.

Dependence on photographic companies.
The recent withdrawal of Ilford Ltd from the manufacture of holographic materials has focused the eyes of holographers on this potential difficulty. Agfa, Kodak, and to a lesser extent Ilford, have been long-term suppliers of silver-halide materials and after many years of involvement they are still providing them as a charity, according to Duncan Croucher of Agfa (UK). In the early years these holographic materials were provided for research and education. If the two big companies decided to pull out, non silver-halide materials such as dichromated gelatin, photopolymers and photo-resist would be the obvious route left. However, the Russians have always coated their plates, and doubtless the efforts of individuals such as Jeff Blyth to produce silver-halide emulsions for hand-coating would come to the fore. Holographers are resourceful people, who would doubtless overcome this problem if it arose.

Limitations challenge artists rather than bind them
It should be borne in mind that limitations challenge artists rather than bind them. Factors that at first sight seem to hamper the development of holography as an art medium, may not be disadvantages on closer examination. Disadvantages for the scientist or commercial holographer could be advantages for the artist. The physicist tries to get an approximation close to reality, to eliminate properties of the medium that distort, whereas it could be exactly those properties that make it unique to the artist. The commercial holographer has to reject a blemished hologram, whereas for artists those blemishes can be the way in which they make their mark.

Artists in display holography place continual demands on the technology. Their natural tendency is to break rules. I believe that most successful holographic artists belong to this 'suck it and see' category of experimentalist. On hearing about the 'rules' of holography, they will break them, just to see what happens. This has been a fruitful method of making art for me.

Examples in my own work of the use of such broken rules are multiple referencing in *Lights* (1969) or instability in *Bread* and *Hot Air* [Plates 17 & 18]. Every art medium has its limitations, and artists work positively within them. The disadvantage for art holographers is that unreasonable expectations are made by those who are ignorant of what holography can or can not do. Currently, only the holographers themselves can truly assess how successfully a piece has transcended the limitations of the medium, as most art world commentators have not been willing to date to understand what these are.

Plate 17 Bread, Benyon, 1970. Two 4" x 5" laser transmission holograms.

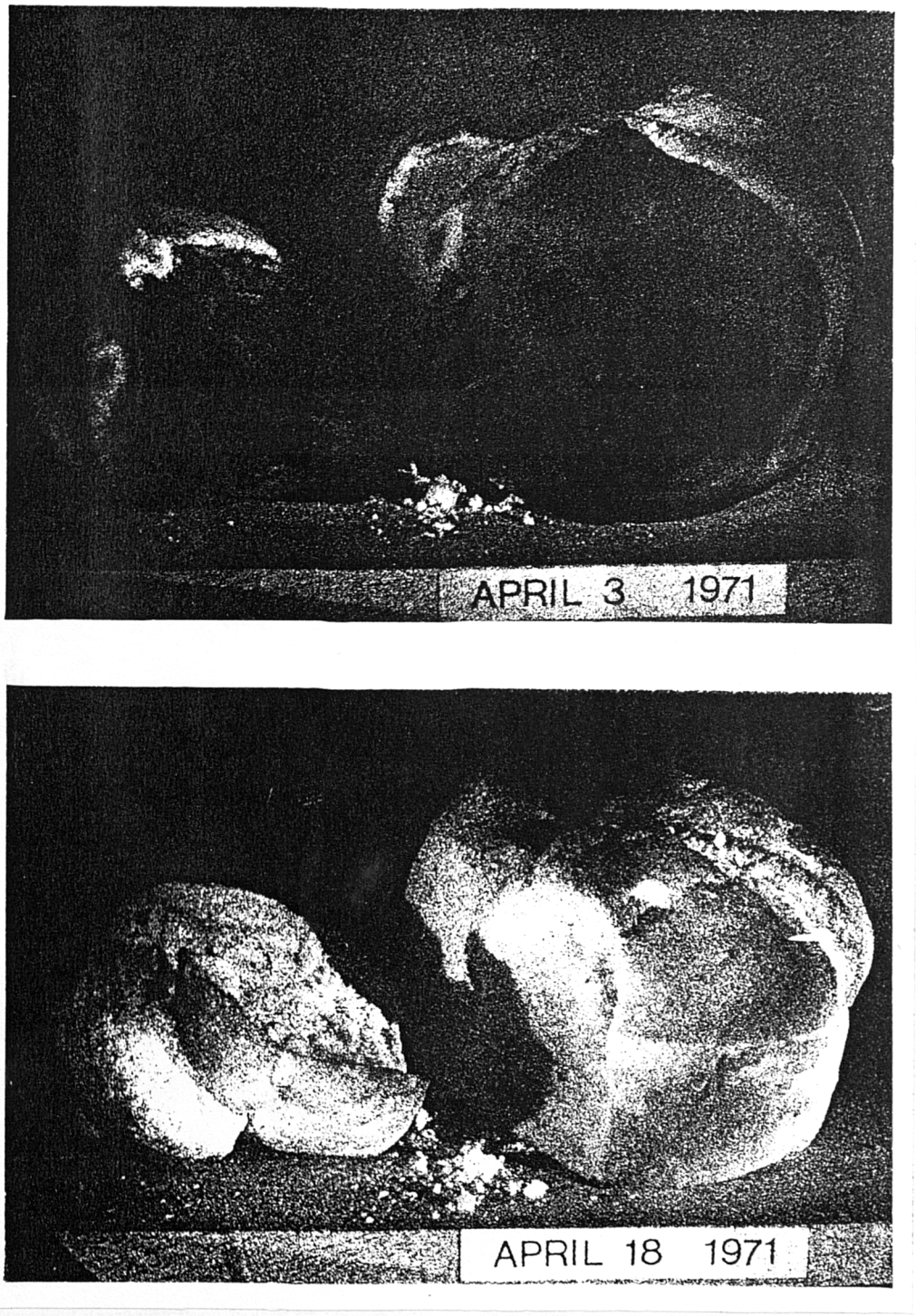
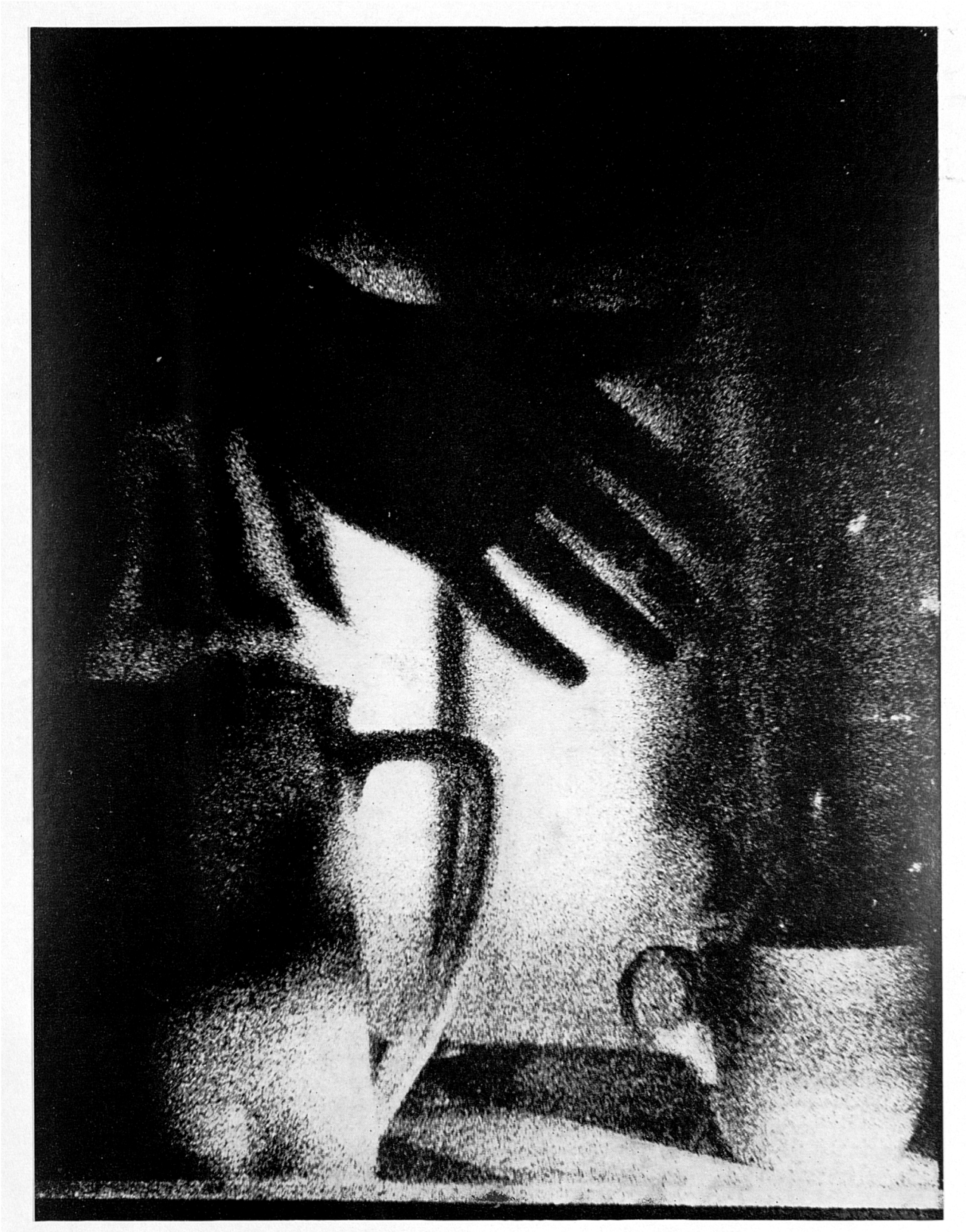


Plate 18 *Hot Air*, Benyon, 1970. Collection: Australian National Gallery.



> "...In the last few years, and especially at the level of formal development, all hell has broken loose in holography.... we have an abundance of strangeness and 'shaking loose' of the syntax. We also have, which is more important, aesthetic streams in holography - holographic cubism, constructivism, expressionism etc. that must be read as a departure from its painterly equivalents. But do we have a critical vocabulary to deal with this current work....?[5]"

It is beyond the scope of this thesis to make detailed comparisons between past and current art styles and tendencies in holography. Current art practice is the basis for a critique of art using holography as a medium, but to adapt art theories to holography is seen to be useful only where these concepts are used in specific holographic art works. Explanations of a painter's 'figure-ground' problem, for example, or the use of quattrocento perspective in a holographic image would need to be made in holographic terms.

Stylistic analogies tend to be superficial, and it is in recognition of the boxed-in nature of style that the most interesting artists working to day tend to disregard it. That is, they make works that can be stylistically very different from each other, and yet still retain the artist's unique voice because the underlying motives, not the superficial stylistic ones, are the link. There are however some general parallels that observers make between holography and pre-existing art, such as surrealism, trompe-l'oeil and illusionism.

Illusionism

With a straightforward holographic reproduction, it becomes difficult for the observer to penetrate beyond the illusionistic surface appearance of the hologram, because it is visually so direct. The interference pattern in the emulsion directs the reconstructing light to travel on in the same direction as the light from the subject when the hologram was made, and to the eye there is no difference. To experience a hologram as an illusion no education is necessary, art-historical or otherwise. The illusion is self-evident and exact. It is so precise that in industry it is used as the illusory 'master' against which real duplicates, such as metal cylinders, are measured for flaws. It is not dependent, as is the trompe l'oeil illusion, on the willingness of the observer to suspend disbelief and enter a fictional world, because genuine spatial

relationships are preserved in the holographic image. The nature of the illusion, as opposed to its interpretation, is self-evident. It is not dependent on suggestion and variable subjective response, in the way that a painted illusion is.

Surrealism.

In holography there is no need to deform objects to make them look mysterious or surreal, because a hologram can be made to do this anyway. *Uncollimated* beams can be used to produce distortions and anamorphism. The *pseudoscopic* image turns space inside out, reversing time. In *continuous wave* holography, anything that moves more than a fraction of a wavelength of light does not record, so parts of an image can disappear altogether, or become blotched and distorted. The unique aspects of holography (over and above its three-dimensionality) allow it to do what other media can not.

Realism/hyperrealism.

Tom Wolfe in *The Painted Word*, a scathing satire on the pretensions of the art world and in particular art theory, describes the moment when he was jerked alert by a revelation of the buried life of contemporary art. He read in the New York Times the words of the critic Hilton Kramer on an exhibition of seven realist painters at Yale University, Seven Realists (1974),

> "Realism does not lack its partisans, but it does rather conspicuously lack a persuasive theory. And given the nature of our intellectual commerce with works of art, to lack a persuasive theory is to lack something crucial - the means by which our experience of individual works is joined to our understanding of the values they signify."

'To lack a persuasive theory is to lack something crucial' (Kramer again). A century ago art theory had merely been something that enriched people's conversation in matters of culture. Now, intellectual rigour is a necessity. This could explain the aversion of the art world to the holographic image. It lacks art theory, and it is also too real. The realism of the image gets in the way of its art function as symbolic representation. The hyperrealist painters of the 1960's, Chuck Close, Malcom Morley, Philip Pearlstein, Lucien Freud, appeared not only pre-modern, but pre-impressionist - late 19th century in fact. The hyperrealist aspired to be strictly neutral, at least this was the theoretical defence put up for it by the handful of critics who bothered to investigate it at the time[6]. Now, with the simulated worlds of Umberto Eco

and Baudrillard, the hyperrealist aesthetic fits the post-modern malaise rather well.

The technique required by a hyperrealist painting is achieved automatically in holography. A straightforward reproductive type of hologram requires little skill. Holography can be easy these days, depending on the type of hologram made. A child with the appropriate equipment can make a simple one-beam *Denisyuk hologram* in less than an hour, and with an automatic machine for making pulsed reflection holograms, like that originally developed by Applied Holographics, five a minute. The hologram subverts the whole notion of skill and technique, because those holograms which are dismissed as pure technique or technical gimmick involve the least technique of all. It is the multi-staged, multi-exposed, multi coloured work in holography that exercises real expertise, and so far this sort of work is not mass-produced. There is a similarity between superreal sculpture and the pulsed hologram because both are taken from the living body - from plaster casts in the case of the former - in comparison with waxworks, which are not.

The immaterial

"The artist I believe in: the art is a mirage."(Marcel Duchamp[8]). The dematerialization of the art object that took place in the '70's is literally characterized by the hologram[7]. This was acknowledged by the inclusion of holographic work by Doug Tyler in the exhibition *Immaterieux* held at the Centre Pompidou in the 1980's. There are links with post-object, dematerialized or immaterial art.

The search for new forms

"A Form that is neither geometric nor organic would be a great discovery."
(Donald Judd, minimal artist, 1967.)

An antidote to the Post-modern problem

We are now living in the postmodern era. The modern age stretched from Impressionism to Abstract Expressionism. Postmodernism began with Pop and via Conceptualism and Minimalism rapidly developed into a pluralist stage. Current holo art needs to be assessed in the light of postmodernist theory. Chris Titterington, a curator at the Victoria and Albert Museum, has pointed out that an aspect of Post-modernism deals with our inability to conceive of things except through the vehicle of language, which restricts the

range of possible experience and response. Related to this attitude is a concern with an idealist philosophy informed by modern physics, such as the indeterminacy principle which states that the character of things cannot be known in any complete way. In the arts this leads to profound ennui, a sense of loss and a fashionable pessimism. He believes that this kind of melancholy cannot last, and that holography as Post-modernism's other face, tougher, pragmatic, more critical, should survive this and become part of the antidote to the "Post-modern problem", producing an art that is comfortable with our position as beings that construct our world in the widest sense. He sees in the rainbow-like properties of the hologram - the fact that the rainbow has no physical location and that in a group we all see our own rainbow when apparently in the presence of a single entity - a perfect metaphor for interaction with the world, a reminder of our participation in the creation of our world, and an image of its beauty[9].

Holism

Holism, or a view of the universe as composed of interacting wholes that are more than the sum of their parts is an attribute of much art of the past, and is still a motivating factor in the work of many contemporary artists working in other media, as well as holographers themselves. The hologram has an underlying structure that is holistic, in the sense that all the details of light from a subject are recorded, that is the phase relationships of light to which the holographic emulsion is not sensitive, as well as the intensity of the light to which it is. In art practice, a challenge that has rarely been faced is the possibility of carrying over this holistic structure into finished work, so that the participant can experience it for themselves. I have only ever done this once myself, in *Jigsaw*.

Varied uses of holography by artists (a small selection)

Holo poetry: Eduardo Kac, Richard Kostelanetz, Dieter Jung.
Holo memory: Paula Dawson, Susan Cowles.
Holo portraiture: Ana Maria Nicolson.
Holo narrative: Doris Vila.
Large format holography: Sally Weber, Paula Dawson, Alexander.
Holo movies: Alexander.
Holo stage set: Nancy Gorglione.
Public art commissions: Setsuko Isii, Sally Weber, Graham Tunnadine.
Holo mixed media:
Painting: Brigitte Burgmer, M. Benyon, Phillipe Boissonet.
Sculpture: Al Razutis, Alexander, George Dyens.
Installation: H. Casdin-Silver, Phillipe Boisonnet, Doris Vila, Wenyon & Gamble, Sally Weber, Ed Lowe, Betsy Connors.
Assemblage: Frithioff Johansen, Mary Harman.
Diffraction gratings: Paul Newman.
Holographic stereograms: Anait, Alexander, Patrick Boyd, Eduardo Kac.
Laser Transmission: Casdin-Silver, Benyon, Paula Dawson.
Holo comment: (socio-political) - Sowdon, Benyon, Dinsmore & Crenshaw.
Reflection holography: Anait.
Refection pseudocolour: John Kaufman, Melissa Crenshaw.
Whitelight transmission holography: Rudie Berkhout, Sam Moree, Dan Schweitzer, Dean Randazzo.
Holo glass: Ruben Nunez, Scott Nemtzow, Jean Bailey.
Holo abstraction: D. Jung, Rudie Berkhout, Wenyon & Gamble.
Holo figuration: Dinsmore & Crenshaw, Benyon.
Holo environment: Sally Weber, Paula Dawson, Setsuko Ishii.
Holo architecture: Doug Tyler.
Holo cosmology: Ruben Nunez.
Holo choreography: Steve Weinstock, Doug Tyler.
Holo expressionism: M. Richardson.
Antagonistic holography: M. Sowdon.
Holo humour: Hylinsky and Sowdon, Ed Wesley, Patrick Boyd.
Drawing in space: A. Pepper, S. Cowles.

There are alternatives to mainstream art institutions that support and provide services to holographers. In the holography world there are museums, galleries, journals, educational courses, conferences and the holography industry. The artists in holography have their own networks and are in regular communication with each other through group exhibitions, correspondence and personal visits to each other and the holographic centres that exist in each country. Not enough recognition is given to the potential power of these networks. Ideas and visions are important, but their success and permanence rest on organizational support, not on their intrinsic worth.

A small but rapidly growing international network of artists constitutes an embryo art world within the holography world. Selective value judgements about art in holography are being made continuously; about which holographic artists should be asked to exhibit, which artists are to be given awards (such as the Shearwater Foundation[10] and Fulbright Commission[11], and those from the holographic materials industry), which artists are to attend conferences, which artists are invited to teach and lecture on the subject, edit journals, curate shows etc. (However, the importance of these decisions is relative to the larger survival issue of how we expand such a small field.) Some examples of survival structures for artists in holography outside the art world follow.

The Museum of Holography New York was a cornerstone in the development of support structures for the medium. It was started by Jody Burns, and implemented as a chartered institution by Rosemary Jackson in 1976, with a position amongst the other museums in New York. It became the progenitor of other institutions, in Chicago, Paris, Cologne, Belgium, Amsterdam, and Washington. At first glance, the foundation of a museum, usually taken to be the repository of dead objects, at the very source and emergence of a new discipline, seems to be chronologically the wrong way round. However, this approach enabled the Museum of Holography to build a collection of early art works, and support artists through its AIR programme (and by the very fact that it was there, and cared, at the very tender early stages of the medium). Through its lectures, exhibition programmes, and newsletter *Holosphere* it educated the general public about holography. It was non-profit

making and grant-aided in part, and for most of it's existence seemed to exist in a "pre-managerial" state, without the financial stability it merited, to begin the refining process for systems and procedures which come after a museum is firmly established. It closed its doors in March 1992, and its collection was bought and re-housed in the MIT Museum, Boston.

At the Museum of Holography New York visitors from the established art world had to accommodate such details as having to negotiate a shop full of kitsch on the way to the exhibitions, and the fact that the exhibitions themselves did not necessarily contain distinguished art. The fact that the Museum survived as long as it did was a small miracle in view of the difficulties engendered by its pioneering efforts. Other holography museums, such as those in Amsterdam and Belgium, have also not survived. The Museums of Holography in Paris and Cologne are both structured differently, but each has a policy of including artists in their plans, and try to keep up to date with work in the art area.

The Museum was sometimes criticized by artists because of the populist image it conveyed. This critical stance was one extreme in a spectrum of attitudes, and it did not provide a satisfactory solution for the majority because it perpetuated the hierarchy of the established art world, unchanged. For every gallery stable of ten artists there are a thousand artists wanting to exhibit their work. The conventional art world is also controlled by very few people, perhaps as few as 100. Another view would be to create new channels, to create the networks of people who can co-operate, and become strong together. Holographers can only do this if enough others join them to support their activity, to create an art world within the holography world and as a group convince the rest of the world that what is being done is art.

Holography galleries exist. Most of these are in fact shops, or permanent displays of holograms chosen for their crowd-pulling potential, such as large-scale spectacular, or popular subject-matter. Holography journals are listed in the Bibliography. There are no journals specifically for artists, although Andrew Pepper's *Index of Creative Holography* is a specialist outlet for artists. Currently distributed in 26 countries, it is an ongoing international catalogue of the work of creative holographers, with colour photographs, biographic details and critical discussion. Just started is Ramon Benito's *Karas Tiny Magazine*, a Spanish/English A6 sized publication of creative holography.

Most holographic artists have been involved in education at some time in their lives, either teaching their own workshops or involved as students or staff in official teaching courses in institutions. For up-to-date information on educational programmes the annual directories listed in the Bibliography should be consulted. World-wide, many universities have lasers and basic holography equipment in science area, and loopholes are often found for artists to have limited access to this equipment.

There is still an extremely limited number of art schools with holography courses. In the UK, facilities in holography have been made available in art colleges at Wolverhampton, Liverpool, Derby, Salisbury and at the London College of Printing. Students from these institutions were eligible for the postgraduate degree programme in holography at the Royal College of Art, which has been the main institutional source of creative holography in the UK. Some other creative holography programmes are those at the School of the Art Institute of Chicago in the USA, at the Ontario College of Art in Canada, in Germany at the Academy of Media Art in Köln, and in Japan at the University of Tsukuba. There have been holography programmes in schools in the USA and the UK. These are often seen as an art/science bridge, and sometimes involve children as young as six.

Of independent workshops those run by Sam Moree and Dan Schweitzer at the New York Holographic Laboratories has been the most longstanding. The Holography Institute in San Francisco offers basic and advanced courses in holography.

There are a number of holography conferences, with sufficient breathing space for holographers to gather new material for the next conference. However, the majority of optical conferences do not include art holography and are probably not sufficient justification for artists to raise the finance for travel overseas. Exceptions are the conferences organized by the SPIE and Lake Forest College, which has offered excellent state-of-the-art exhibitions as well as authoritative papers on all aspects of the subject. Conferences are vital networks for the international exchange of information and moral support. Hopefully more art conferences will follow the first experimental *International Congress on Holography in Art* (1990)[12]. Many countries now have their own national holography groups which hold meetings, lectures and events.

Blockbuster holographic exhibitions also include some art holography. World-wide there have been group art exhibitions held which include holograms amongst other works. A couple of examples in the UK are *From Prism to Paintbox* (1989) curated by Roy Osborne, and *Towards a Bigger Picture* (1987 & 1989) curated by Chris Titterington. There have not been many of these mixed exhibitions.

In the industry, most small holography producers specialize. Holography is too capital and labour-intensive to treat as a 'sideline'. They all export beyond their own locality, through an international network of distributors, all busy competing for their own particular place in the market. Stock items are produced, mass-produced film and embossings, small and large format holograms, wholesaling (most holography distributors do this), below-the-line holographic advertising consultancy, *dichromate* jewellery retailing, exhibition organization, both seasonal or permanent, high street retailing, custom design and commission. Many holographic artists plug into the industry at some time in their lives for survival. Some will produce a range of stock images for sale and keep this separate from their holographic art activity. Others will take temporary employment in the industry, or become taken over altogether by it. Some set aside specific periods from commercial work when they can do their own art work. Some have produced only one art work in their lives, and are remembered and valued for that one piece, such as Kenneth Dunkley for *Thoughts* (1973). An increasing number of artists in the established art world find the funding to have works made for them by holographic technicians in the industry, leaving them free to continue working in the traditional media.

References and Notes

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2 **Benyon, M.**, HOLOGRAPHY AS ART, letter to the editor, Art Monthly, No 49, 1981. [Appendix E]

3 SPIE Holographics International Directory and Resource Guide, 1993, gives some information about these, albeit confusing. It lists 129 addresses under "Holographic Fine Artists with Own Lab" but many of these are companies employing artists rather than independent fine artists, some of whom are listed under "Galleries Museums and Retailers, Fine Art" and some under "Commercial Art".

4 **Casdin-Silver H.**, A GENTLE MANIFESTO, Proceedings of the 2nd International Symposium on Display Holography, Lake Forest, Illinois, USA, July 1985.
5 **Razutis, A.**, ART AND HOLOGRAPHY, Wavefront, Summer 1985.
6 **Lucie Smith, E.**, ART TODAY, Phaidon, Oxford, 1977.
7 **Lippard, L.**, SIX YEARS: THE DEMATERIALIZATION OF THE ART OBJECT, Studio Vista, London, 1973.
8 From a television programme, taped in 1964.
9 **Titterington, C.**, LIGHT INTO ART, New Scientist, 4 February, 1988.
10 The Shearwater Foundation is the only foundation currently funding artists working in art holography, and is the single foundation world-wide that has set up a program to identify and support the highest achievement in this field. Besides its annual holography awards it also supports activities and institutions that provide needed services to art holographers. For example, the Shearwater Foundation provided a two-year funding commitment to enable the International Congress on Art in Holography to take place in Indiana, USA in 1990. For additional information on the Holography Program, write to Posy Jackson Smith, Suite 116, 502 Lake Avenue, Lake Worth, Florida 33460, USA.
11 The Fulbright Commission annually offers two Fellowship Awards in the Arts. Grants are made available to one artist from the United States and one artist from the United Kingdom to enable them to pursue studies in their specialist fields for nine months in the other's country. The field of art in which the award is offered changes each year. Two British artists working in the field of holography, Andy Pepper and Patrick Boyd, have received Fulbright Awards. Andy Pepper received a Fulbright scholarship for research at the Museum of Holography, New York. For further information write to the Fulbright Commission, 6 Porter St, London W1M 2HR, UK.
12 INTERNATIONAL CONGRESS ON ART IN HOLOGRAPHY, St Mary's College, Notre Dame, Indiana. 1990. The congress, which was organized by Doug Tyler, brought together thirty-five international representatives of art holography, and four curators to discuss relevant issues and to present art work. The congress was designed as a prototype for a larger conference and included a lengthy evaluation and a summary of the main addresses, which were published in the REPORT.

CHAPTER FOUR

CHAPTER FOUR

4.1 ISSUES IN CONTEMPORARY ART

This section involves issues for all artists in the western world that are ideologically hot and in the light of which art is made, knowingly or otherwise. Some current arguments about art and culture involve the following:

Some problems with the 'status quo' of art and aesthetics
a) Elitism.
b) The exclusion of women and other cultures.
c) Obsolete aesthetic criteria. It is recommended that larger philosophical theories should be looked at, rather than institutional aesthetic theory only.
d) Will traditional art survive, other than as the 'antique'?

The social role of art
The Wilding report on the funding of art in the UK separated 'artistic' work from 'socially beneficial and educative work' by artists - for example their work in hospitals, schools and public areas - and funds them differently.

Ethics and aesthetics
Arguments about aesthetics are arguments about basic values which must be examined before aesthetic judgements can be made. Ethics and aesthetics are linked, and we still use concepts such as 'bad' and 'good' art. However, Baudrilliard and followers believe that truth is no longer an issue because all signs are interchangeable, and we have difficulty distinguishing the real from the artificial.

Artist as auteur
Artists are often interpreted as egotistical because they work as individuals. This has often been given as the reason for their lack of political power. Artists do not have the protection of a union. There are alternatives to the idea of artists as sole workers, other than as corporate artists producing art by committee. Artists form group studios, carry out public commissions

involving team work, and work together as one person, like Gilbert and George (or in holography Wenyon & Gamble, or Dinsmore & Crenshaw). Participatory art breaks down privileging of the artist as a sole pre-ordained visionary, as is often achieved through time-based and installation work.

Art world ruled by fashion and trends

Late Modernism versus Postmodernism is the current criterion.

Technology and art

The art world is largely anti-technology, despite the fact that the greatest thrust for cultural change in the West this century has been technological.

Survival. The market-place. Support structures.

> I think that many people are astonished that a person would sacrifice the possibility of comfort and what's thought to be an agreeable life to a life of uncertainty and loneliness, where you're engaged in, to them, an incomprehensible activity, with results which were fairly unlikely to affect your situation in an economic way. The thought of that seems to be astonishing to many people, at least to anyone who wasn't trying to do anything like that.
>
> Lucien Freud, painter[1].

Most visual artists, like poets in our Western culture, have to survive by other means than through their art work. There are difficulties in the interpretation of professionalism, being commonly understood as the ability to make a living. Artists are often suspicious of such an interpretation. An example of this is painter Patrick Heron's statement that he was 'deeply depressed to hear that art students are interested in being successful.'[2]

Medium-based art and photography

There are problems that all medium-based art has in common. In the words of Simon Wilson of the Tate's Education Department,

> Modern art is notoriously not medium specific and the question therefore is not one of medium but of the thing's (whatever it's medium might be) quality as art. That raises the possibility that the Tate might be in ignorance of the existence of high quality art being made in the medium of holography.... PS. I am drawing a distinction between photography as a medium for 'fine art' and photography as an art. As I say in my letter, the

> Tate Gallery has no brief or remit to collect photography as an art[3].

Artists using holography share some of the problems about art made with photography on the part of curators. The Tate brochure accompanying *Towards a Bigger Picture*, an exhibition of photographs that included some holograms, stated that there can still be uncertainties as to whether this particular means of picture making should be treated separately from older ways of making images with pencil, paint or clay. Forty years ago the Director of the Victoria and Albert Museum wrote that photography was a 'mechanical process into which the artist does not enter'. The National Portrait Gallery and the Victoria and Albert Museum, whose primary concerns are with images and artifacts respectively, collect photographs, for instance, while the National Gallery and Tate Gallery, whose concerns are with fine art, do not. However, the brochure states, in the last twenty years the universal presence of the photographic image has helped to divert attention from the novelty of the medium towards the quality of the experience that is being offered. As a result the recognition that some photographs are art whilst others are not has become more widely acceptable[4].There are signs of recent improvement in the conservative attitude of art institutions towards photography, and many recent Tate purchases have been photographs.

Feminism.

Particular emphasis has been put on this issue in the thesis, because my major task as an artist has been to work in a culture which is based on assumptions of male privilege and excellence.

> Woman, man's necessary appendage, the spiritual creation of man, has no right to the privileges of her husband, since she constitutes "the other half" only by virtue of her numbers: comparatively, she is merely the sixth part of a sixth.
>
> August Strindberg[5]

In the last century, the first wave of feminism did little to change discrimination, and from the 30s to the 50s of this century seemed like a defunct social movement. The 'feminine mystique', which is what Betty Friedan called the cult of glossy housewifery and suburban motherhood, was predominant. A new, more sophisticated and shrewd feminism appeared in

the late sixties, which has led to a new awareness and changes for the better in the last two decades[6].

There have been a number of male allies in the past[7], and this number has greatly increased in the last twenty years. Against these sympathetic men is set the major anti-feminist contribution of Sigmund Freud. His theory of penis envy, that woman's anatomy dictates her whole destiny, though unsubstantiated by clinical evidence still survives in modified form today. Another insidious male strategy is the idea of the woman as a holy muse for poets, a passive inspiration rather than an active participant in the real world. The idea that male dominance is biologically based, that men are innately aggressive and born to dominate, is given as a reason why women are not seen to provide satisfactory images of power which would induce communities to follow their leaders[8]. This view of the 'natural' superiority of men, both physically and socially, does not explain why male dominance needs such elaborate social machinery to maintain itself, and why so many women fail to abide by this 'natural' caste system.

The 'woman problem', the fact that women have been traditionally seen as inferior to men, is a basic human rights issue that is still with us. With masculine privilege rationalized and entrenched in our social institutions there is still insufficient feminine self-assertion to achieve equal status with men[9]. Not until there is a 50/50 ratio of women holding positions of power and prestige, of men adapting their lives to women's careers, and of women holding equally well-paid jobs with men, will this basic human right be seen to be finally achieved. That women are members of a caste collectively victimized by sexual stereotyping is a fact of life which emerges very clearly to any woman who takes herself seriously as a whole human being, and is thwarted in her growth and interaction with the world at large. Women are labelled 'feminist' as a derogatory term, if they wish to achieve anything at all. They still have to engage in a constant battle to prove themselves (and encounter the glass ceiling) in a way that men do not.

Women and art

The repression of women in the history of high art continues and is still of serious concern today. The unavailability of the nude model to aspiring women artists in the period of Western art extending from the Renaissance until near the end of the nineteenth century meant that it was institutionally

impossible for women to achieve excellence or success on the same footing as men, no matter what their talent or 'genius'.

> If women had the golden nugget of artistic genius, it would reveal itself. But it has never revealed itself. Q.E.D. Women do not have the golden nugget of artistic genius. (If Giotto, the obscure shepherd boy, and Van Gogh with his fits could make it, why not women?)
>
> Linda Nochlin[10]

A feminist critique of art history aims to pierce cultural-ideological limitations, to reveal biases and inadequacies *not merely in regard to the question of women artists, but in the formulation of the crucial questions of the discipline as a whole.* Some of the writings of feminist historians are directed at re-establishing the histories of neglected or forgotten women artists and exploring the historical circumstances in which women have worked as artists. Others explore the ideologies of class, race, sex and power as they have affected both the work of women artists and the representations of women. Some of these publications are listed in the Bibliography at the end of this thesis.

Notions such as 'innate genius', or the 'master' concept of art, have to be questioned. The master concept of art indicates a social hierarchy which is top heavy with men, not just the traditional roles of artist as male, and of muse and model as female. I was invited in 1991 to give a 'Master Class' in a UK art school. Primarily, I felt honoured, dignified and comforted by the title of Master, but I was also aware how inappropriate the title was. The alternative title of 'Mistress Class' brought female art professionalism into comic relief. Perhaps the word 'mater' or 'matrix' could be used instead[11].

The inferior position of women in society as a whole holds true, and may even be exaggerated, for the art world. In America women earn only 2/3 of what men do, and women artists earn only 1/3 of what men artists do[12]. In Europe the percentages of works of art by women artists purchased by major museums or commissioned by governments is extremely small compared with that of men[13]. In Britain the socio-economic position of women artists is such that they can expect to make at most half the income that male artists enjoy from their artwork, a ratio that holds true right the way through the age categories. At around the 35-45 age bracket, when male artists expect to be

earning the maximum from their work, women artists 'at this time in their life cycle normally drop out of professional practice in large numbers'[14]. Only if they manage to reach an interesting very old age will they be given a brief moment of recognition.

In the art world, work by women artists is not exhibited equally with men and very little art presented in museums and auctions is by women. The professional art schools, whilst they do not exclude women faculty members, give decisive preference to men, even though the percentage of female students is often higher than male students. In the UK, 4 out of 17 colleges have no full-time women on the staff of their fine art departments at all (1988). It is obvious that good art has no gender, yet dealers are rarely impartial about the sex of their artists. Women are still demanding equal representation and still not getting it. When my joint collaboration with Richard Hamilton (as part of this PhD project) was exhibited at the Anthony D'Offay Gallery in 1991, the gallery 'stable' comprised 34 males, 0 females.

The few established female artists tend to reinforce the status quo rather than attempt to change it through their lives. In a radio broadcast (Sept 1990) Bridget Riley, one of the few females internationally established as a painter, expressed the opinion that married women could not be artists. This reinforces the male status quo, and does not ameliorate the position of female artists. She neglected to apply the same rule to male artists, many of whom enjoy family life and are still artists. I suspect that her statement was not borne of the sense that marriage, like money, is a male invention (marriage originally meant the sale of a woman from one man to another), but the knowledge that to be a successful artist needs one's full energy and time, and that marriage usually places an unfair burden of duties on the female. (Having fed a baby at the breast the female is expected to be the one that serves the food for ever more.) The inexorable problem, even though paternalism is gradually declining and losing its economic base, is the fact that women are still hindered in their professional lives by procreation. They can choose to avoid this problem by not having children, but to exclude from professional status as an artist those who have confronted the problem by bearing children is not the answer.

Working out personally appropriate solutions to these life problems are imperative for every woman artist. Single status offers the easiest solution, in that a single woman has more opportunity to operate as a male. Parenting

shared with the father, shared home duties and breadwinning, shared lobbying for crêche and child-care centres - this seems to me to be a more balanced and realistic approach to life, despite the pitfalls of marriage and child-care assumed by the outside world.

There is a tendency for women to work in experimental areas because they are outside mainstream male culture and have nothing to lose. Somehow they need to remain in the business, when the male stronghold is that women will give up. *Guerilla Girls* are an example of the realization that if there is nothing to do but fight, women have to fight. Women should be allowed to have everything, work and family, like men, but should keep the concept and awareness of themselves as women alive. They should maintain a dual position, gaining strength from feminism whilst operating to become more generally integrated with male peers. Each decade the goal posts move. The fact that art is coming off its pedestal is helpful to women, and the age of the 'genius dinosaur' may be over.

A hopeful sign for visual artists is the inroads that women have made in the field of literature. Women's presses are filling gaps in the market in the publishing world. Women's science fiction has described utopias existing only at the edges of our imagination, and within this women's writing is beginning to gestate a new language and new structures of thought for a completely different society[15]. Support structures in the visual arts world are the Women Artists Slide Library in the UK, and national women's museums in Washington USA, and Germany.

Conservation issues

If 'lasting' is the major criterion by which people recognize great art, it has to be asked whether it is the actual work that is supposed to last, or the original ideas behind it. Contemporary work asks whether the romantic view of 'the hand of the artist' is not too precious. Many contemporary artists put across a semi-journalistic message and are not concerned with the long-term survival of their work. They use ephemeral materials for as long as is needed for its cultural message to be understood, rather than its collectability. The paradox is that self-destructive art does not escape the art market even if this was intended. Museum conservationists are being presented with the challenge of conserving disintegrating works, such as Pollock's canvases, in an increasing number of bizarre materials. Some of Warhol's paintings came into

conservation whilst still new; the paintings were wet and had stuck to the blankets wrapping them. Frozen works are being exhibited, calling for a commitment on the part of the gallery owner to keep the freezer running. Manzoni's breath escapes the balloon. Sol Le Witt's drawings can be made in deep time. Damien Hurst assumes that another shark can be ordered.

With debate about whether conserving a work creates a 'relic' rather than the actual work, the archival concerns of holographers need to be put into perspective.

Some of the issues that affect artists using holography outlined in this section are the art-world bias against holography and the scarcity of critical writing on the subject, the art/science/technology debate, and the position of women.

It has been the aim of independent artists who are working in what the late Peter Fuller (a well-known British art critic) called the megavisual tradition, to oppose the standardization of consumer needs and tastes that dominate it [Appendix E]. This is particularly true of film and video, but less true in the case of holography. This may be because artists have been instrumental in actually forming the field and have been living with it in a more organic way. Because holography itself is still unfamiliar as a visual medium, some holographic artists feel that it needs to be part of the furniture of our lives before it will be seen to take its rightful place as just one of a number of possible media for artists to use. This means that they can take a tolerant view of the commercialization of holography, because they recognize that the efforts of the industry to put holography out into the world could be of long-term practical benefit to them.

Despite the prevailing commercial atmosphere, it can be seen to be a true democratization of culture for people to be handling holography themselves. As long as there is a hands-on approach to holography, as long as it can be physically worked with in numerous different ways, there is no reason why making holograms should not be seen as vastly different from working with other media in practice. Workers in other media find that they have their limitations too. Much of the prejudice against holography by the art world stems from lack of education. Like Fuller, many artists and critics believe that a hologram is just posed and processed, which is decidedly not the case.

From the many choices possible at the different stages of making a hologram, the outcome as art can be determined. If they are proper artists, each holographer's body of work will be unique to themselves, to their view of the world, and to the medium. That there are a minimum of 50 good artists world-wide who have such a body of work was well shown at the *International Congress on Art in Holography* in 1990. The verdict of the keynote speaker at this Congress, John Hanhardt, (curator of film and video at the

Whitney Museum), after a day of artist's presentations was that they were exciting. But John Hanhardt is someone who has taken the trouble to follow holography for the last ten years, to visit exhibitions and, particularly, holographic artists' studios. This resulted in the exhibition *New Directions in Holography* at the Whitney in 1991, curated by René Barilleaux.

Hands-on holography

It is in the holographer's studio that the stages in the making of a hologram can be worked on, from initial notebook drawings [Plate 19], photographs and ideas, to the choice or making of the subject to be holographed, the making of test plates, the making of master plates/film for subsequent transfer, or alternatively a spontaneous one-shot final exposure[16]. Holographic masters can be optically transferred on to the final hologram in a number of ways, each of which allows for imagination, expression, or the other components of a human being that drive us to make art. There can be further manipulation of the piece, either in the way that it is shown or combined with other media. In all these stages there can be feedback from the medium, and from people who see the finished hologram. This can suggest alteration of the original starting point, further ideas, etc, or there can be a straightforward process from A to B.

Artists using holography have been traditionally polarized into those who make their holograms themselves, and those who have the work made for them. Some artists feel as strongly about the need to make their own works as a painter would in making their own paintings. Anaït is one of these. She has proposed that like-minded artists form themselves into a group, the AHH, or Artists in Hands-on Holography. Artists who have not actually gone through the process of making holograms themselves can be described as 'artists who are not holographers', or 'artists using holography' although with some the distinction is meaningless, since they are able to enter fully into the holographic aspects of their work by working closely with the holographer. In the case of some artists, the transition into actually making the work themselves has meant a visible transformation in the nature and relevance of their work. Marie Andrée Cossette's work is an example of this.

Archival aspects

Of the issues affecting artists working in holography, the question of archival permanence is one of the most serious, along with our daily struggle for survival. The conclusion amongst photographic archival researchers is that

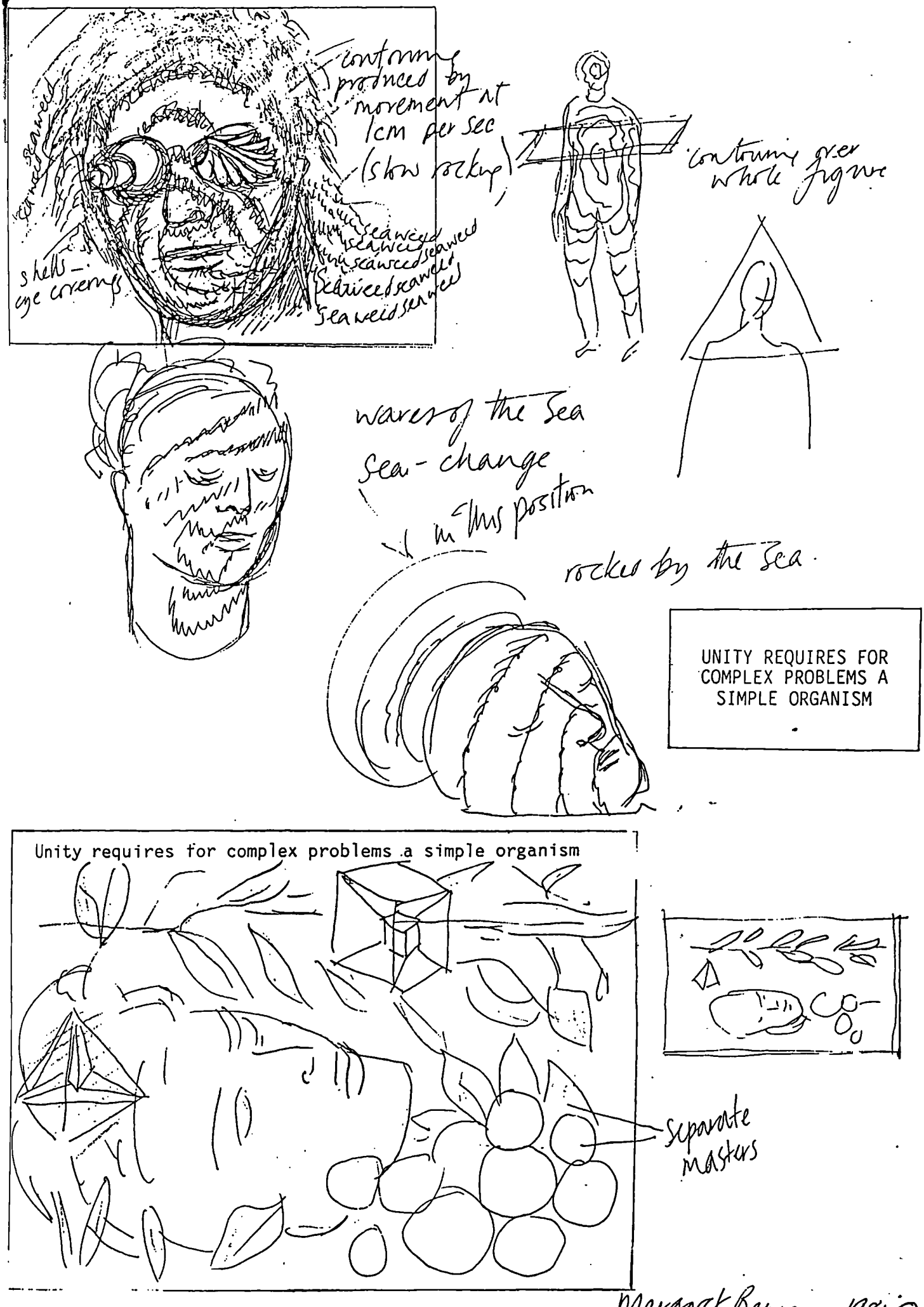

Plate 19 Notebook drawings of ideas for pulsed holograms.

silver-halide materials can not be considered to be archivally permanent. However, photographs can be reclaimed. Doris Vila and Ed Wesley became so tired of waiting for scientists to do research in this area that they did some themselves[17].

Art world bias against holography

The quarter decade of my work in holography has seen some changes in attitude by the art establishment towards holography as an art medium. My early holograms exhibited in 1969 and 1970 were well-received in the art world, and in fact gained international acclaim that is still of benefit to me. Today, however, the attitude is less encouraging. The statement by German critic Peter Zec at the *International Congress on Art in Holography*, that holography would never be accepted as an art medium in the future, and that there was no way of establishing holography as part of the art world[18], suggests that there is a hardening of attitudes that were not so rigid a decade ago, not only in the UK but in other European countries also.

The UK art establishment, if it considers holography at all, places it under the larger heading of 'new technologies' along with video, film, and computer graphics. Educationally, an indicator that these are still regarded with great suspicion is in the conspicuous absence of references to them in the Interim Report for Art and Design in the new National Curriculum. At the Royal College of Art, the Holography Unit has been housed in the applied, rather than the fine art area. At the Arts Council, film, video and broadcasting is administered separately from the visual arts. The National Collections considered suitable for the acquisition of holographic art are the Victoria and Albert Museum, which is a museum of design and artifacts, and the National Museum of Photography, Film and TV in Bradford which, as part of the Science Museum, collects hardware and equipment. Both these museums collect contemporary art photographs as part of the history of photography, and the collection of art holograms fits this remit.

In the art market, where so much else seems to be acceptable, the exhibition and sale of holograms seems to be currently not possible even in the case of established artists using holography. The crediting of holography as an art form in its own right is a problem for the UK art world, and this creates an extremely difficult climate in which to work. However, censored or not, some artists will continue to work in holography because they are driven by other motives than fashion or expediency.

Today it is commonly recognized that there exists an art world bias against holography. D. Tulla Lightfoot has written comprehensively on the subject of the bias in the New York art world. René Paul Barilleaux has carried out a survey on a cross-section of the art world in the USA, and revealed both negative and positive results. Andrew Pepper and Chris Titterington have also written on the subject[19].

Some artists using holography have been taken seriously by the art world. The sanction of the art world is necessary, so artists need to persuade the appropriate people, or organize a new art world. Holographic artists need the cultural historical and theoretical support disciplines, and access to an art market. Holographic artists are seen as innovatory, creating their own support networks.

The use of holography in the visual arts is currently viewed with scepticism, not only by commentators, but by artists working in more traditional media. When artists and art historians have spent their lives building up attitudes and skills in the traditional area, this is only to be expected. The scale of investment of the art world in its own institutional networks of information and co-operation may explain the unwillingness of traditional mainstream galleries to include more holograms in their exhibitions.

Bearing in mind the dictionary definition of the arts as 'any of the academic subjects that are not considered to be science' (Longmans), resistance by artists to processes which have developed in the scientific or industrial field can be understandable. This resistance becomes compounded when artists and reviewers see work produced using the process of holography which appears to be more concerned with demonstrating a technique rather than exploring through content, concept or any of the other factors that motivate an artist to make art.

Ostensibly, the separation of art and science still continues in holography with the major technological advances originating from scientific institutions, and with holography as art generally not accepted by the art institutions except when it is carried out by artists who have made art successfully in other media. There is a general lack of sanction by the art institutions, which is hopefully not a permanent condition. There is the occasional break-through, but the resistance with which holography as an art medium is being

met suggests that 'support personnel' in the art world are being obliged to learn about something different, be inconvenienced, even threatened, and the force of inertia is as strong as the force for change.

The holography and art worlds are two separate worlds, but they can merge. No art world can protect itself fully or for long against change. New worlds come into existence, old ones change. In order to change, innovators have to succeed in mobilizing enough people to co-operate in regular ways that sustain and further their idea. Lasting is the major criterion by which people recognize great art. An art world defines the boundaries of acceptable art. It frequently incorporates at a later date work they originally rejected, so that the distinction does not lie in the work, but in the ability of the art world to accept it and its maker.

Jonathon Benthall's statement in *Science and Technology in Art Today* (1972)[20] that my work should be taken seriously as art, but that it was not going to be other artists or art critics who would most appreciate it, has been borne out by my own and other artists' experience. Frithoff Johansen, a Danish artist who has work in national collections and whose work using more conventional media continues to attract favourable critical attention, finds that none of the critics are willing even to mention his holographic work, never mind comment on it. He continues to use holograms in his work even though it renders them unsaleable. He believes that 'to be alive we have to die a little. Holography was my suicide attempt'. Ed Lowe, a successful US sculptor, found that his work was 'accused of being a hologram' by a critic, even when it was not!

There is evidence that the repercussions still exist from unfavourable reviews of the holography show at the International Center of Photography, New York, in 1975 by Hilton Kramer and others, and the often-quoted comparison of the hologram with a 'postcard from Montauk'[21]. In my own experience, curators and gallery owners fear that the inclusion of holograms would lessen their reputation. For reviewers to assume that the majority of holographic works included in some holography exhibitions were intended as art in the first place is such a basic mistake that the negative tenor of such reviews is understandable. René Barilleaux has found that critics attending exhibitions do not wish to talk to the curator, which does not help. This is destructive towards those artists who have spent their lives working with holography.

The display context for holographic art has tended to keep it in the holography world. Most artists would prefer to show their work in a serious art context, including the author. However, holographic art continues to be lumped in with waxworks, 3D movies, or last year's fashions. Frequently there is the choice of showing work in an inappropriate context, or not at all. The tendency in art circles to exhibit only holograms by established artists as a temporary spotlight on the medium, and to regard artists who make their own holograms as technicians, means that views of the field are distorted. Rather than explore the potential of holography fully, established artists tend to use pre-existing ideas, even converting pre-existing photographs into three dimensional 'photographs', as Joe Gantz has done. Some artists avoid holography exhibitions, put their 'holograms' in quotation marks, hide the fact that their work contains holograms at all, describe them as 'light works', 'light sculptures' and so on, to make quite clear that what has been done with them is regarded as more important than the fact that they are holograms.

Some of the reasons why holography as art is currently viewed with scepticism can be summarized as follows:
(a) The inability of the art world to get beyond the perception of holography as a novelty or gimmick.
(b) The conservative political climate of 70's and 80's.
(c) Large display holography exhibitions mixing art indiscriminately with general display work, and commercial art masquerading as genuine art in holography.
(d) An erroneous association with military research, 'smart' weaponry etc.
(e) Vague criticism of the supposed 'transitory' nature of art using new technology.
(f) There is not much good art in holography.
(g) The scarcity of critical writing on holography.
(h) Creative people are turned away by what they perceive as the practical limitations of holography.

Relevance to present day

It is important to use a form of art that is truly involved in the terms of its own society. Holographers are invariably seen as involved in a fantasy of the future, and can choose to balance this with a fantasy of previous societies, or those that live on a different time scale from our own. In a society saturated with hallucinatory images to an extent that has become positively

phantasmagoric, holographers are truly involved with the terminology of global culture, at the psychic level.

Commercial art masquerading as genuine art in holography

The effect on the US and UK art worlds of the of the advent of commercial holography contrasts with how holographic artists are regarded in Canada and Australia. Since 1980 the Canada Council has set aside an amount of money specifically for art work in holography. In Australia, my own experience was that I had no difficulty in being able to show solo in proper art venues, whereas in the UK I have not shown solo in a serious art gallery since 1972, at the Richard Demarco gallery.

Changes in attitude brought about by the prevailing commercial climate are exemplified in statements by the late Peter Fuller. In May 1970, before the advent of commercial holography, he believed that it was impossible to over-estimate the importance of the hologram in the probable future of communications, and that it was a discovery that nobody working in any branch of visual communications could afford to ignore[22]. In 1980 he expressed the opinion that "the development of holography has proved entirely consonant with, and readily exploitable by, a monopoly capitalist culture which seeks to distort and extinguish free imagination and creativity on the part of those who live within it[23]." At the beginning of the 1980's I was informed by Isobel Johnstone of the Arts Council that my holograms were eligible for the Arts Council Collection. Now this is no longer the case.

Even in the holography press it is acknowledged that few hologram producers have, as yet, understood the necessity of limiting themselves to a choice of identity either as an artist or as a commercial producer, because a producer can get free advertising by participating in holographic exhibitions labelled as 'cultural' or 'artistic'. The reluctance of commercial producers to see themselves simply as that limits the development of holography as an art form. The art world has difficulty in coming to terms with holography as art, and art critics are not comfortable in dealing with the medium.[24]

Where is the critical writing on holography as art?

Apart from information scattered in exhibition catalogues, existing literature tends to concentrate on technical matters at the expense of wider reasons why and how holography should interest artists. Many of the workers in the display area of holography are interested in it because it gives them an

opportunity to get to grips with a fascinating new technology. They feel themselves on shaky ground when art issues are raised. Many can not in fact recognize holographic art when they see it, and misinterpretation is rife. In order to be on safe and respectable ground, many holographers prefer to stick to discussion of technical matters because this is a definite, concrete area. Improving the technology is obviously necessary and beneficial to the development of the whole field. However, this technical emphasis can distort and misrepresent the real achievements of artists, in their attempt to merge merely 'domestic' or 'in-house' issues of holographic technique with larger and more universal issues.

In general there is very little serious writing about holographic art[25]. Holographic journals print exhibition reviews and articles about art, but these are often superficial. *Wavefront* was an artist's journal, but it folded after four issues. *Leonardo* has published papers by artists using holography from the beginning, and continues to do so[26]. Some UK critics, notably Chris Titterington, Edward Lucie Smith, and John McEwan have written favourably within the last decade. The main source of serious writing on holography as art comes from the artists themselves, scattered in exhibition catalogues, letters to editors [Appendix E], and occasionally in international art magazines. The *Creative Holography Index* is an ongoing source of artist's statements about their work, with high quality colour illustrations and selected biographical details[27].

Factors that have contributed to the scarcity of critical writing in holography are:

1. There has always been, and still is, a gulf between philosophical aesthetics and the arts themselves. Aesthetics has usually emphasized very general problems concerning the nature of art, beauty & aesthetic value, and appears to be a highly specialized subject in debate with itself over small technicalities.
2. There is a very small amount of art work being made with holography, relative to other art areas. Using the widest interpretation of the word 'artist' there are a maximum of 30 holographic artists in Britain, and about 300 world-wide. The work has to be made in order for its theories to become manifest and then written about. Then, ideally, theory should be in step with practice, so that they amplify each other. There needs to be an understanding of both for the formation of operating principles. As has often been the case with the beginning of art movements in this century, the artists in holography

are initiatating the theory themselves. Every artist who makes a hologram is in effect theorizing through his/her practice. But for holographic artists to write, when they lack both time and money, is another matter. Hands-on holography is intensely practical, and its demands leave little time for reading the right books, and attending exhibitions and lectures, unless the artist has an academic position and salary to match. Most holographic artists are so busy trying to survive, that serious art considerations are often left to 'sabbatical' periods in their lives. Holographic artists are able to identify the properties which attract them to the medium, and a small band of writers also understand these characteristics, since many have made holograms themselves. However, the establishment of such awareness is slowed by the absence of a language of criticism for holography.

3) There is evidence to suggest that there exists an art world bias against holography, which prevents critics and theorists who should be active from assessing it as art.

4) The overwhelming preponderence of 'kitsch' in the display area, and the fact that much holographic 'art' is still insubstantial. In a late Modernist/Post-modernist world it is not sufficient for work to be based entirely on simplistic concepts such as 'self-expression', 'composition' and 'relationships between forms'. The holistic properties of the hologram are used as justification for holograms that might have fallen out of a cereal box. This deters writers with a potential serious interest.

5) Holographic artists, who come from all walks of life, tend to protect each other from critique without appreciating how vital such feedback is to their development as artists. There is little criticism by holographers of their own work amongst themselves, probably because this is regarded as destructive. There is a very real need for holographers to support each other, and adverse criticism can affect sales of work, the only way in which most holographic artists survive.

Art and science

> A number of people with little or no scientific training are making holograms. It is only too easy to reach the conclusion that display holography has moved out of the realm of science. The question then is, if display holography cannot be considered a branch of science, and if many of the people involved with it are artists, can it be classified as a branch of art?....Display holography is an excellent example of an area in which two types of creative activity, science and art, come

> together. The distinction between art and science vanishes and each one acts as a stimulus for the other.
>
> Dr P Hariharan, scientist[28].

For me, there is little need to debate about the connection between science and art in holography. As an artist I live with holography on a daily basis in an organic way. I doubt whether many artists using holography see their artwork as science, and to suggest to a scientist that they were making art would probably be taken as a gross insult. In general, scientists aim to understand natural laws, and the subjective element is not part of the discipline. Artists may be presenting world views which are in accord with natural laws, but they are not determining what these natural laws are.

New technology

Holography has issues in common with other new forms such as video, computer-aided art, telecommunications, or 'space art'[29].

Innovation

If creativity can be loosely described as imagining impossible scenarios and then making them happen, then there have been some creative uses of holography. In describing creativity, a distinction needs to be made between the 'true creativity' of Gabor[30], and 'creativity' as activity so meaningless that no-one has done it before nor is likely to do it again.

Survival

Survival is all. Most history deals with winners. The difference between the success of one artist and the failure of another can sometimes be attributed to the marketing strategy used, not the work itself. However, creative holographers generally see their success and failure differently. They see their future in terms of one-off, small scale production work, and are concerned to be constantly producing work in response to personal change and development, rather than to consumer demand or expected profit. This poses a survival problem for holographers without a structure of public subsidy, and many, like poets in our Western culture, have to survive by other means than their art work.

On support structures:

The following quotation from David Dewar summarizes the position of many creative holographers:

> I am incredibly fortunate in having a well-paid job to support my holography....The sales of work from my exhibitions would not provide me with a livelihood...Support by friends, wife: this is not financial, but without the active support of my wife it would be impossible for me to be both married and an holographer...a good deal of money that could be spent on agreeable things goes into the bottomless pit of holography... [31]

Perhaps it is worth comparing the social position of the medium with photography, for which there was no perceived need before the 19th century. The real inventors of photography could be seen as those who first created a market rather than a particular process[32].

Women and technology.

Rather than the 'master' concept of which as a woman I am instinctively suspicious, perhaps we could propose the non-hierarchical one of integration. There is a hidden agenda behind the three-dimensionality of holograms, which is the holographic principle itself. In holography we have a new way of structuring that suggests integration, rather than hierarchies. A part of a holographic image provides the whole of the image of which it is itself a part. It records all the details of light from a subject or scene all over the photosensitive plate or film, so that if the hologram is broken or cut up, it will still contain the whole picture. I have an idea that the clue to the strong presence of women artists in holography is connected with these integrative properties of the hologram.

Women's place in technological society is very different from men's. Due attention to women's abilities in this area has not been given, and there are still considerable barriers to technological careers for women, which interfere with their entering into the labour market. Women have to get through their technological education in which male stereotypes are to the fore, and there are few female role models. Many women experience the crisis of failure, rejection or abandonment because it is felt that these activities are not synonymous with a woman's personality, inclinations or aspirations. When they get through their technological education women still have to overcome the reluctance of the industry to employing women technologists.

Gender differences in attitudes towards technology begin early. Recognition in schools that boys crowd out the girls and dominate computer rooms has

led to positive efforts in some schools to have 'girls only' days on the computer. (Research into childrens' relationship towards the computer shows a difference in attitude between boys and girls. Small boys stand physically closer to the machine, and form a one-to-one relationship with it, often intense, whereas girls stand further back, treating it as a social instrument in interaction with other children, and more as a means to an end.)

Nowadays new initiatives are being set up to help create a favourable learning environment for women by bringing together in joined programmes trainers at different levels of education and trainers in "feminine differences". The WITEC (Women in Technology in the European Community) programme has initiated student placements that should enable women to create concrete experiences in a friendly and welcoming environment, and space for the expression of gender differences. (However, it is difficult not be a little sceptical about the WITEC UK group, which is the only one in Europe headed by men.) This has come a little late for me. I taught myself holography as an art medium twenty three years ago in a University engineering block that was built without a women's toilet, let alone a friendly and welcoming environment.

Women and holography

What complicates the answer to the question of why there have not yet been any 'great' artists in holography is that its pioneers have primarily been women, in particular Harriet Casdin-Silver and myself, and a healthy number of its strongest artists are female. Female holographic artists have been in a strong but ambivalent position, based on shock tactics. They got some work done before the institutions could impose their own patriarchical structures.

They prepared the way, but now that the institutions have become involved and there has become a real possibility for making money, I believe that this favourable gender balance is already changing. Fringe Research's society for 'Guys with Big Lasers' is a humorous recognition of the fact that the labs with the best equipment and most of the teaching posts are now held mainly by men, apart from male/female partnerships. I believe that the presence of a strong female, Posy Jackson, the founder director of the Museum of Holography in New York, has been a pivotal figure in providing exhibition opportunities, support and employment for female artists. Her management of the Shearwater Foundation Awards is an example of the way in which a fair gender balance has been maintained. Eve Ritscher's promotion of

holography exhibitions in the UK also provided opportunities, particularly for the teaching programmes of Edwina Orr.

Opportunities for female holographic artists vary. The gender balance in exhibitions depends on the organizers. For instance, exhibitors in *More Light: Artist's Holograms and Light Objects* at the Hamburger Kunsthalle, 1985, constituted 41 males, 3 females. In contrast, the gender balance of holographic artists selected for the *International Congress on Art in Holography* 1990 was fairly even. Participating artists were selected on the basis of their prior contribution to the field, as reflected in their leadership roles, artistic performance and commitment to the medium, as follows:

Female	**Male**
Abrahams, Claudette	Alexander
†Benyon, Margaret	†Berkhout, Rudie
†Burgmer, Brigitte	Boisonnet, Phillipe
†Casdin-Silver, Harriet	†Gauchet, Pascal
Conners, Betsy	†Johansen, Fritjioff,
†Cossette, Marie Andrée	†Jung, Dieter
Cowles, Susan	†Kaufman, John
†Crenshaw, Melissa	Lowe, Ed
†Dawson, Paula	†Nunez, Ruben
†Deem, Rebecca	†Pepper, Andy
†Dinsmore, Sydney	Razutis, Al
†Gamble, Susan	†Moree Sam
†Ishii, Setsuko	Nemtzow, Scott
Nicholson, Ana Maria	Ruiz, Julio
Stephens, Anait	Silberman, Rick
†Weber, Sally	†Schweitzer, Dan
†Vila, Doris	†Sowdon, Michael
	†Tyler, Douglas
	†Unterseher, Fred
	†Wenyon, Michael

†Shearwater Award recipients, through international selection board.

Plate 21 THE GREATEST SHOW OFF EARTH. Fay Pomerance, gouache.
The Womens Art Library Postcard Series.

Technochauvinism

> Another concern: the second class citizenship in this supposed union of scientists and artists. Everyone working together to send holography into space. The artists know this is untrue. The women know this is untrue....The 'step-child' syndrome of the holographic artist must be dealt with.
>
> Harriet Casdin Silver, artist[33].

There is a patriarchal attitude amongst some scientists (and some artists) that all technical difficulties should be solved before we can start to make art with holography. It is likely that the technocentric character of some holographic art will date it, and much work in holography could be rendered aesthetically obsolete by technological advances. However, the development of holography has been affected by its use by artists from the beginning.

It can be argued that technochauvinism is related to male chauvinism. How many contemporary art catalogue covers have you seen like that for the well-

Plate 20 Catalogue cover for the *Art and Technology* exhibition organized by Maurice Tuchman at the Los Angeles County Museum of Art in 1971, in which there was not a single female participant.

4.2

known *Art and Technology* exhibition organized by Maurice Tuchman at the Los Angeles County Museum of Art in 1971 [Plate 20]?

There is a social stereotype of science as male and art as female, as 'hard' and 'soft' disciplines. Even the choices artists make about the types of holograms they make can be interpreted as phallocentric or otherwise. Rebecca Deem has pointed out that there was a time at the beginning of the 1980's when all the women artists using holography (apart from Harriet Casdin-Silver) were making reflection (passive) holograms, and all the males (apart from John Kaufman and Lon Moore) were making transmission (active, penetrating) holograms. This situation is no longer the case, with the wide-spread use of mirror-backing for white light transmission holograms with the growth of embossing, which alters them to reflection mode, and the greater overall use of both types of holograms by artists of both genders.

The ideal light falls on the object at 45 degrees.

Leonardo da Vinci. Trattato della Pittura.

There have been available for some time publications on practical holography[34]. These books are general in nature. Also useful are specific papers pin-pointing particular aspects of holographic technique published by individual artists. These make particular techniques more accessible. Classics amongst these are papers by John Kaufman on pseudo-colour, Fred Untersehr on pulsed reductions, and Suzanne St Cyr on Benton's maths. A good source of such papers is the Proceedings of the triennial *International Symposium in Display Holography* at Lake Forest College, Illinois[35].

Because these papers are written by holographic artists themselves, they are in tune with other artist's needs. They are reliable sources, in the sense that other artists know that the recommendations will work, because the evidence is before their eyes in the form of successful holograms. Holographers are accustomed to the familiar and time-wasting problem of following recommendations (particularly in the field of photo-chemistry) from papers by writers who have not fully tested their results, do not have the same visual standards as artists, or do not understand the artists' concerns. Scientists whose work has been particularly important in the larger field of display holography of artists are Stephen Benton and Nick Phillips. Steve McGrew's 'hinge-point' graphical method devised for use by artists is detailed in Chapter 5.

To date there has been no comprehensive study of the numerous different stages in making holograms which allow for the making of art, rather than just holograms. At present artists are using a range of methods, from the simplest techniques obtainable with modest equipment, (typically a garage or 'witch's kitchen' type of studio), to the most sophisticated available world-wide. It is no longer obligatory for holographers to make holograms in their garages, and large amounts of funding are occasionally being found by artists for ambitious projects. The largest project to date is probably Michael Snow's personal holographic exhibition at *Expo '86* in Vancouver, although an

increasing number of artists, such as Paula Dawson and Alexander, have completed successful projects on high-tech equipment, interestingly producing work with a low-tech touch.

Low - Tech

Some simple examples of low-tech methods are Denisyuk holograms in which stability problems are solved by literally tying object and holographic plate together, the use of WLT holography where conditions are not sufficiently stable for reflection work, and the making of diffraction gratings and HOEs. One-step holograms are cheaper and quicker to make than transfers, and could therefore appeal to impecunious artists on grounds of shortened lab-hire time, or increased spontaneity. Pseudo-colour by pre- and post- swelling, collage and gang-mounting, the use of film substrate, multi-colour, multi- exposure, split master and animation techniques, and many other options are available to the low-tech practitioner.

High -Tech

The following are areas of limited access to artists, either because of the large capital costs involved, or the current commercial environment: pulsed technology, natural colour, computer generated holography, holographic stereograms, embossing, mass production, and large scale work.

A study could be made of how techniques affect the outcome as art, of which lend themselves to art purposes and of which do not, how flexible various methods are, and what choices are possible.

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LINK

This section summarizes the relevance of the first part of this thesis to the second.

In the Introduction I stress that the thesis is written from the point of view of someone who has used holography as art since its inception. My priorities are those aspects of the subject that have the greatest bearing on my own life and work as a holographic artist, and I make no apology for concentrating on my primary enthusiasms.

If you read interviews with living artists you will find that when asked about specific works, they will invariably reply in a general manner, putting their work in its broader physical and conceptual context. It is generally recognized by teachers of fine art that the subject itself can not be taught, but can only be taught around, for reasons given in Chapter 1.1. This is what the first part of the thesis attempts to do, to put my practical work in context. This context is vital in explaining why an individual with postgraduate qualifications in fine art, like myself, would be interested in taking holography seriously as a fine art medium. Otherwise research would be limited to exploring and explaining techniques.

The intention in this project was to concentrate on creative rather than technical aspects, but I found that a 'diary' of my work concentrated on the practical aspects rather than the creative, and a description of the intention and ideas behind it could only be written up after completion of the work. I found it virtually impossible to record the processes in my head that led to creative rather than technical decisions, whilst they were going on. (This may be because it is not possible. I can not think of examples of artists recording this aspect of their work, perhaps because different mental processes are used for generating art work than for tracking or observing.) Films made of artists working will show the evidence of their thinking, but not where their creative decisions come from.

The context in which we all live and work is more important than the efforts of a single practitioner, or the outcome of a single PhD project. The purpose of the project was to enlarge the boundaries of what is traditionally seen as fine art. Research material organized in the form of classification, historical

perspective, documentation, and sociological comment in the first part of the thesis is intended to provide a basis for the conception and development of my practical project.

It would be time-consuming and repetitive to go through the first part of the thesis and give detailed examples of its relevance to individual pieces of my practical work, but I hope that this is revealed through the choice of subject matter. For instance, to write about the pre-history of art in relation to holography pre-supposes my belief in the importance of historical continuity. This makes my practical work different from that produced by an artist declaring no interest in what went before. My work is imagist, even pictorial, and employs traditional art media. It is unlikely that a male architect or media scientist would produce work that looked like mine. Similarly, to produce an art bibliography alongside an holography bibliography suggests that the two could merge in future. There is an intent in this seemingly dry academic exercise which may seem pointless to someone who is not interested in either subject. As a practitioner, the merging of the two disciplines, art and holography, is vital to me and has a bearing on my practical project.

From my own experience as a pioneer, I have been interested to observe the way in which women in holography are beginning to be written out of history. Although Harriet Casdin-Silver and myself were the pioneer holographic artists, the male establishment artists who used holography only briefly (Nauman, Reutersward, and later Dali), are now being placed as the prime movers in some texts, with the women placed later on. The dates of my early works are often quoted as five, or in one case eight years after they were actually made. Most histories of holography are inaccurate. This is why I wrote an accurate history in this thesis. Claims by individual male holographers in the early 80's that they are the pioneers of holography made mockery of my own and Casdin-Silver's achievements. The reason for my emphasis on the position of women in the socio-political parts of the thesis is self-evident. Another example is that I pioneered the 'hands-on' approach, and subsequent art practice in the field is seen as relative to this.

The pre-historical section of the thesis, in particular the inclusion of transcendental paintings, link with my *Holart* (interim title) works. A view of the universe as composed of interacting wholes that are more than the sum of

their parts is an attribute of much art of the past, and is still a motivating factor in my own work. This creates some difficulty. Since the appearance of logical positivism, it has not been intellectually tenable to discuss the secret and sacred parts of human experience. However, my own recognition of these messages within the art of the past has been a source of enjoyment and personal confirmation of the validity of my work to myself. Artists throughout the centuries have used systems for the imaging of three-dimensional space, and to take holography as an extension of this into the present day gave me more acceptable grounds for working. My early use of holography as a medium to question the assumption of the abstract expressionists that a painting should be flat, without resorting to Renaissance space and traditional illusionism, is no longer an issue. Present day public interest in the hyperreal and virtual reality may well be.

In summary, Chapters 1-4 of this thesis gives the background to the PhD project. The second part of the thesis covers work carried out during the practical project, with Chapters 5 and 6 documenting the work involved. Technical documentation is included in sections 5.2 to 5.5, and Appendices A - C, so that these processes can be understood and applied by other people. A description and explanation of the finished results is to be found in Chapter 6.

CHAPTER FIVE

Plate 22 *Facial Codes*, 1985
Four 8"x10" reflection holograms. Painted photocopy border.

CHAPTER 5

5.1 INTRODUCTION TO THE PRACTICAL PROJECT

Practical project

The practical project aimed to produce work that is original in its particular combination of paint and holography to present male and female stereotypes, in its combined use of pre- and post-swelling, and in other individual solutions, over and above the fact that artists produce work that is original *sui generis*. The main part of the project involved the male *Cosmetic Series*, but the work carried out before and after the male series is also presented, to give continuity and breadth to the project and set it in context.

Work at the Royal College of Art commenced as a development from my previous art work [Appendices E - J], both technically and in content. The first phase of my work with holography (1968-1973) was an exploration of those properties not accessible in any other medium. The second phase (1978-1981) was mytho-symbolic, holistic, cross-cultural. The third phase (1981-1991) used the human body exclusively, in a personal, almost therapeutic way [Plate 22].

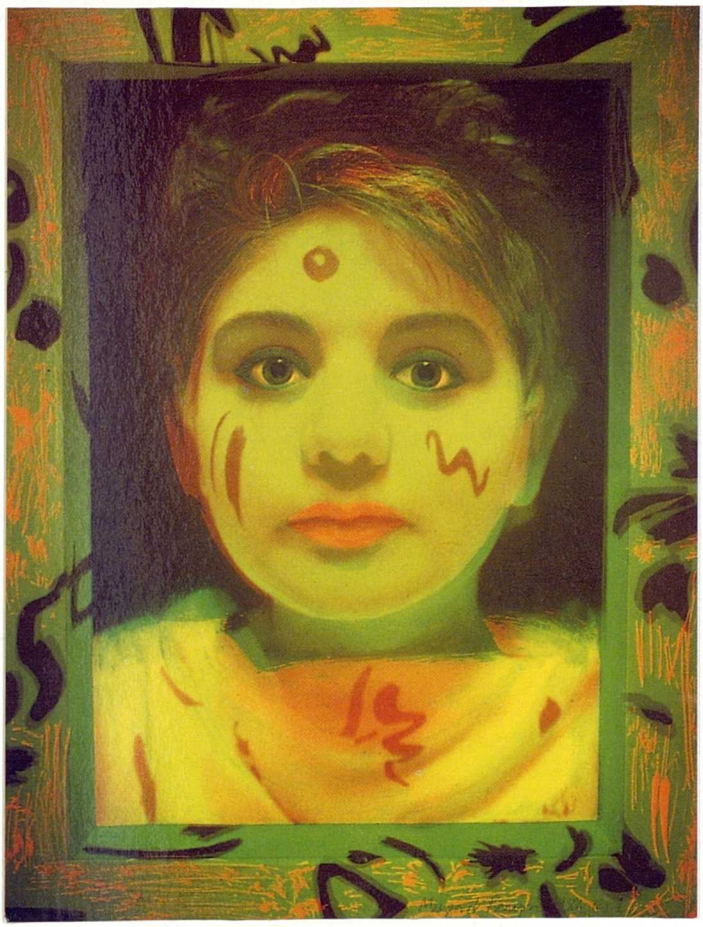
The Cosmetic Series

The use of our bodies, painted for the ritual of dance, is likely to have preceded cave painting as the first expression of culture. The *Cosmetic Series* stems from these early beginnings, but in a form appropriate to the present-day with the pulsed hologram. The pulsed laser 'freezes' moving subjects for the duration of the holographic exposure and makes it possible for the artist to make three-dimensional images of human beings.

The female series involves the faces of young women, painted to make themselves beautiful with the cosmetics used when recording a pulsed laser hologram[1]. Because the holographic image is a reconstruction of light wave-fronts, it cannot be re-touched like a photograph. However, it can be modified to a surprising extent. A brightly coloured gouache painting placed underneath the transparent holographic plate can alter and emphasize the holographic features. The mixture of additive and subtractive colours

produces a new, subtle range of tints. There has also been a reversal of media. For example, the painted graffiti on *Sophie*'s face is present in the hologram and not in the painting, and the viewer needs to look at the piece from different viewpoints to determine which is which [Plate 23].

Plate 23 *Cosmetic Series: Sophie.* 1986/9
30 x 40cm reflection hologram & gouache painting.



Also in the *Cosmetic Series*, different colours have been produced, not by painting, but by swelling the holographic emulsion before exposure to two separately mastered images. This produces brilliant ***pseudocolour***s - colours that are not related to the actual, natural colour of the original subject.

The underlying ideas behind my *Cosmetic Series*, are cultural, socio-political, art-historical, psychological, documentary, personal and, of course, holographic. The images are used as the 'status quo' of representation, attempting neutrality but emphasizing the superficial, the stereotype. They are not prescriptive. What the representations say about the women and men is partly about how they present themselves. They made the choices within

the prescribed scenario of "making beautiful" for the women and the use of paint for enhancement for the men. The project was a collaboration with each of the participants. Some chose to paint their own faces, others chose to have me paint them.

The female *Cosmetic Series,* initiated in 1986, called for its male counterpart. The objective of the practical part of the PhD project was to complete the male *Cosmetic Series* and provide a direction into the future with subsequent works. A pattern of procedure involving ***master***ing on a ***pulsed laser*** facility, and ***transfer***ring in my own studio was continued, with the mastering taking place at the Royal College of Art with the assistance of Rob Munday, and later Roddy Canas. Larger work (50 x 60cm) was carried out on the RCA ***krypton*** laser in the later stages of the project.

The overall aim of the project was to break down boundaries between the traditional fine art area of painting and holography, and to find a way of functioning as an artist within society in a recognizable way. Works of art are assumed to contribute to knowledge and to articulate visually the meaning of the age in which they were produced. The project concentrated on pulsed holography, but the aim was to produce results that would lend themselves to exhibition and acceptance in the art world. This suggested a mixed-media approach. My aim was to test my work in the public arena as far as possible, since most artists educate themselves in public. However, I was prepared for the direction of the work to be modified by the consequences of the project itself.

Technical considerations for the translation of holography into a fine art medium.

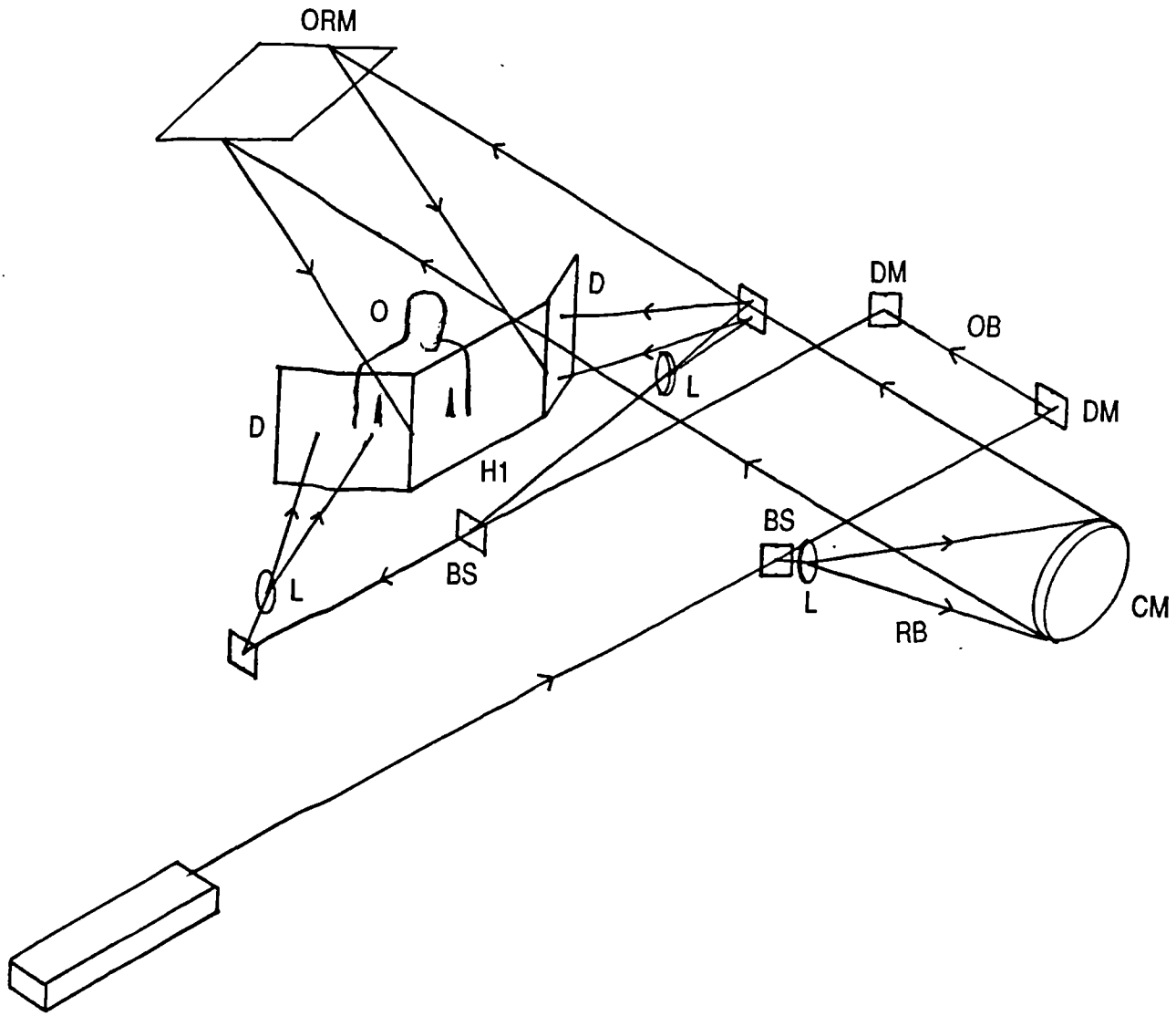
At the start of the project these were:

1. Those methods which make the medium flexible. It would be fatal to narrow down an already limited medium.
2. The size criterion was taken to be an issue, since the small size of holograms has been criticized. One of the aims of the practical project was to produce 50 x 60cm holograms that were a size larger than I had made previously. Holographic systems such as holographic stereograms which produced smaller results were lower in priority, (setting aside the option of gang-mounting or collaging).

3. Low tech, non-institutional, least expensive solutions to problems were considered most likely to be useful to impecunious artists.
4. Techniques which would encourage the most spontaneity in handling were to be given priority. Dichromated gelatin, embossings, and holographic stereograms were considered too inaccessible and capital-intensive for regular work to be done in these areas. Experimental work in such areas was likely to lead to results which are physically too small to be considered suitable for exhibition in large gallery spaces.
5. Those techniques which do not require a high degree of maths were to be used. Artists don't normally use high level mathematical skills every day in the way scientists do, and it is not natural territory for them. Advanced holographic technique requires an amount of calculation and set-up precision which is likely to be daunting to artists. Holographers have to find their way through the forest of numbers and formulae to develop a 'feel' for workable set-ups, so that they become routine, and they can then concentrate on using the image space to its best advantage.
6. The project was conceived as a transition into holography out of the traditional fine art medium of painting, so reflection holography was to be used because the lighting on a reflection hologram is oriented much as with a painting, from the front. The back-lit rainbow hologram can be made into reflection mode by backing with a mirror but this was felt to be incompatible with my particular attempt to bridge holography with painting, and can be objectionable if seeing a reflection of the viewers face in a hologram is not part of the visual idea. Reflection holograms are more earthy and solid looking than rainbow holograms. This is partly because the background of most reflection hologram images is dark, rather than light, but also because they are more static, and do not appear to shift as much as rainbows.

During the course of the project these pre-conceptions were modified.

Figure 1a Pulsed laser master set-up for lighting subject from two sides with overhead reference beam, Royal College of Art



Pulsed beam from 10j ruby laser is split 50/50 with glass wedge BS. ***Reference beam*** RB is diverged by 150 FL ***dichroic*** concave lens L, collimated and tilted up and across from 55cm diameter concave mirror CM to overhead front surface mirror ORM, then down onto hologram H1 at approximately 38°. ***Object beam*** OB is relayed via 45° dichroic mirrors DM, split into two side beams with 50/50 beam splitter BS, and spread by concave lenses L to cover subject O, via diffusers D. Set-up is baffled and curtained off.

Figure 1b Plan of Figure 1a showing table geometry

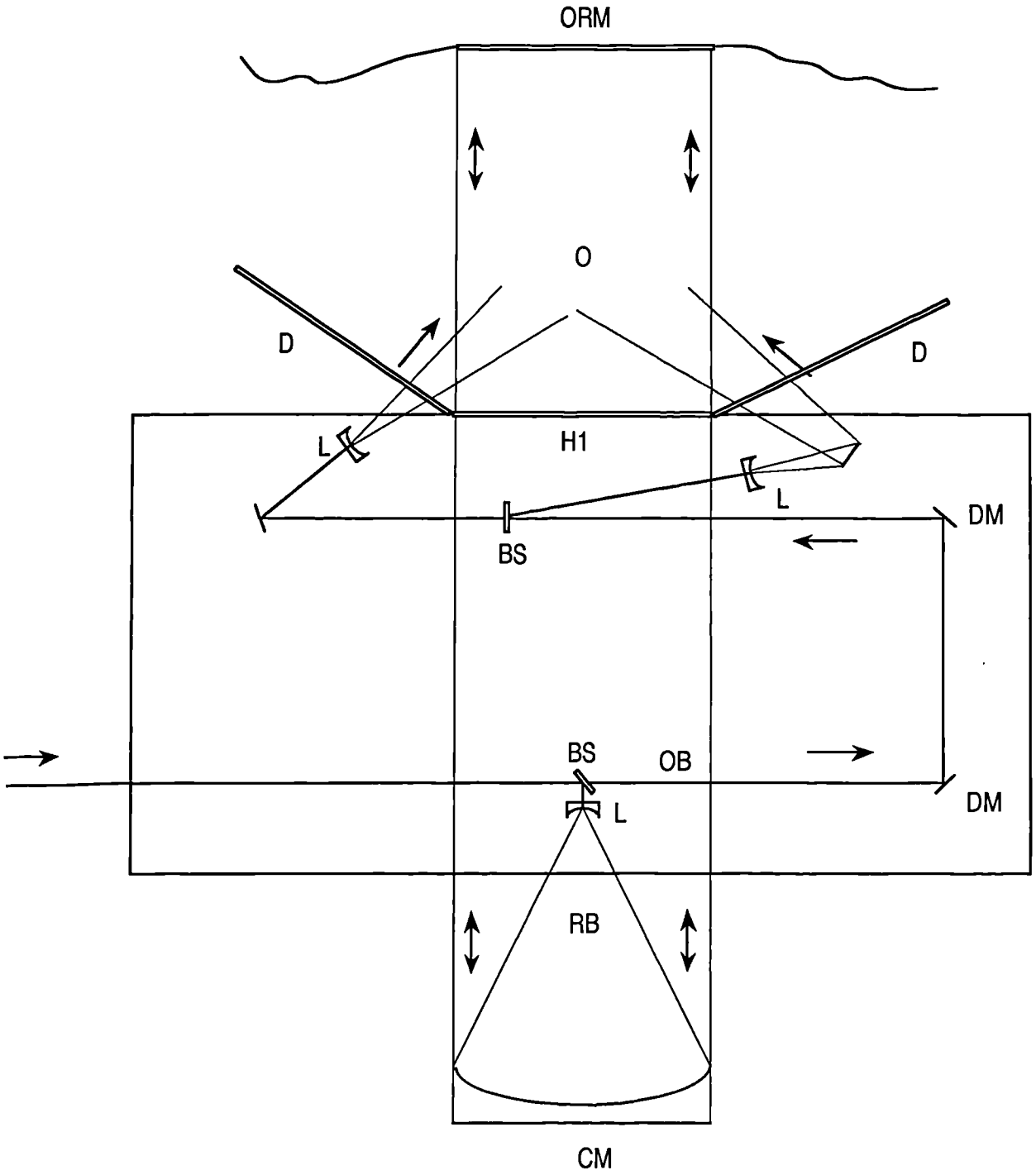
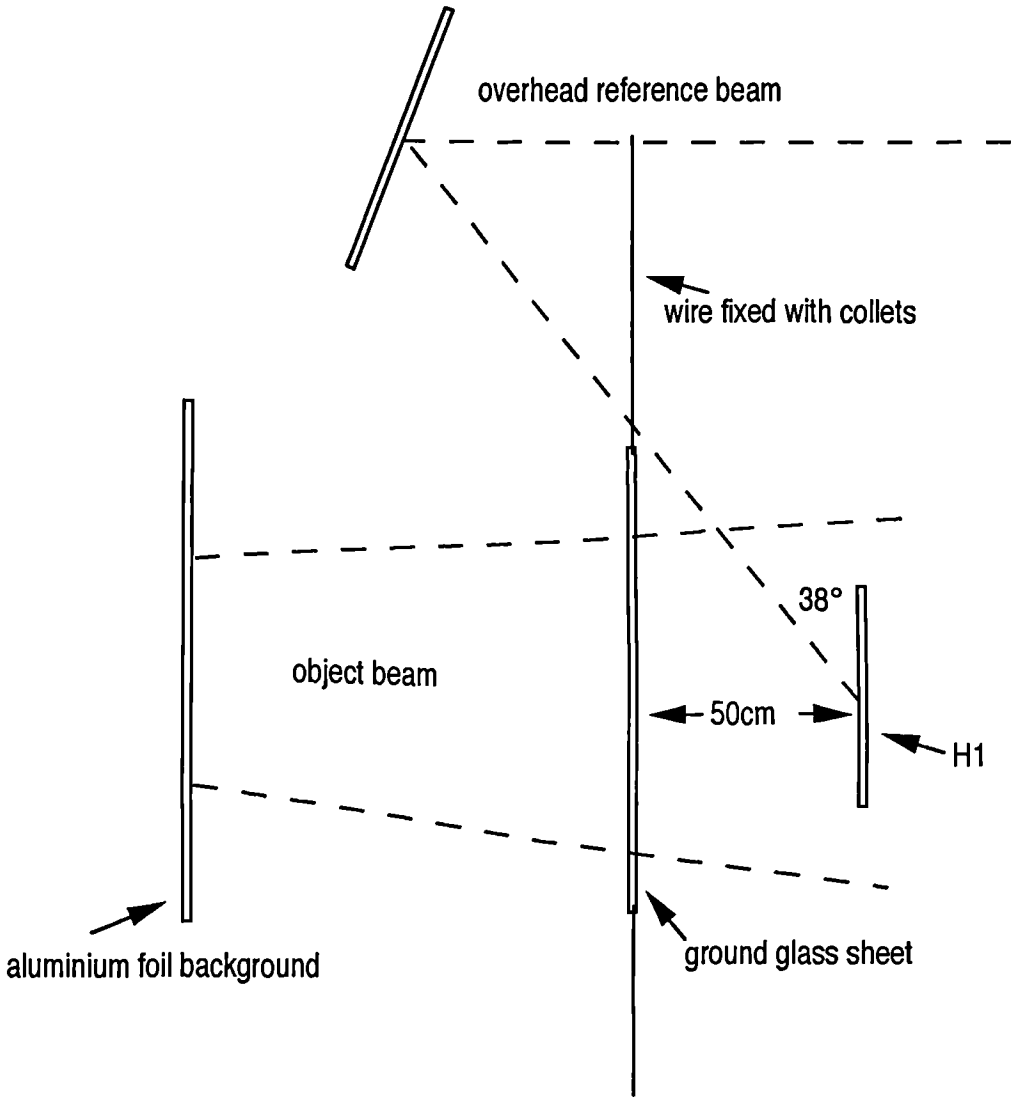


Figure 2 Side view of set-up for master of ground glass diffuser



Masters; One 50 x 60cm, and one 30 x 40cm, with plate/film placed horizontally in plateholder.
Object: I metre square ground glass sheet, with holes drilled 1" from each corner, for suspension above and below with nylon wire.
Lighting: Overhead reference beam at 38° grazing angle to plate. Single horizontal object beam lighting aluminium foil background and transmitted through ground glass sheet with beam spread approx. 70cm in diameter for 50 x 60cm H1, 50cm diameter for 30 x 40cm H1.

Previous papers on my work in pulsed holography [Appendices I to J] give details of how the pulsed laser increases the artist's scope, and discuss individual art works of mine made with a pulsed laser over the last ten years. They also give a historical background to pulsed holography, a short description of the *pulsed laser*, and a comparison between continuous wave and pulsed holographic practice. Despite the rapidity with which good pulsed facilities have been multiplying all over the world in the last five years, it is still difficult for artists to gain access to pulsed facilities. An obvious future development would be the undertaking of co-operative ownership of pulsed equipment by artists, along the lines of the continuous wave laser studio shared by the *Photon League* in Toronto.

Individual work at the RCA was begun on the pulsed laser with safety considerations placed first. Lasers are classified according to the biological hazard that they present. In this classification, the 10j pulsed laser is in Class 4, and must be treated with extreme caution. In the operation of a Class 4 laser there are a number of hazards to be considered. The 10j pulsed laser is driven by a high voltage power source which could be lethal if interfered with, and it has a high energy beam output, which could blind an operator and could destroy expensive optics if correct procedures are not observed. These details are listed in Appendix B.

Setting up

The lighting set-up used for the master holograms for the male *Cosmetic Series*, and other works was mainly that shown in Figures 1a and 1b. For safety reasons, preliminary setting-up was carried out using a Class 2 *helium neon* spotting laser, which is routed via the pulsed laser head to follow the same path as the pulsed beam. (A burn test will establish whether the spotter laser is aligned with the pulsed laser. With the pulsed laser turned up to 280, a piece of black burn paper is placed in the path of the spotter laser, and the pulsed laser is fired. The burn produced should be in the same spot as the cw beam. If not, the He-Ne beam needs to be re-aligned. Exposed photographic paper can be used instead of burn paper, but care needs to be taken that the

emulsion side is positioned away from the beam, so that smoke does not go back into the laser.)

Setting up beam paths and path length matching is done without the use of the pulsed laser. Coated dichroic optics need to be used up to the point where the beam is diverged, after which standard uncoated lenses and front surface mirrors can be used. The pulsed laser is employed in the later stages of setting up, when the progress of each part of the pulsed beam is baffled off and checked to see whether it is satisfactory. The final positioning of the pulsed reference beam onto white card placed in the plateholder needs to be checked, and beam ratios assessed. The beam ratio is controlled mainly by the choice of different thicknesses of lens placed directly after the first beam splitter to vary the strength of the reference beam. If the reference beam is too weak, a thinner positive lens would spread it less. This lens needs to be baffled with a circular mask. Once this main adjustment has been made, finer adjustments of beam ratio can be made by moving the lenses on the object beams closer or further from the subject.

Beam ratios can be assessed either with a power monitor or by eye after the beam has passed through diffusers, using black card to cover half the reference beam on the collimator. Processing used was as detailed in Appendix A.

Making shadowgram masters

When making back-lit shadowgram masters the reference beam needs to be stronger than when making masters of front-lit subjects, so that the thinnest meniscus lens often needs to be used. To the eye, the object beam appears hardly visible on the white card compared with the strength of the object beam when making front-lit masters. Figure 2 shows a set-up using aluminium foil instead of a relay mirror, to minimise hot-spotting and increase diffusion. If aluminium foil is used, the set-up is as in Figure 1 except that only one object beam is used to illuminate the aluminium foil, and the diffuser D is omitted, which gives a smaller spot. When setting up, the direction of the object beam on the H1 can be checked by placing a mirror temporarily on the foil. In the case of the master of a shadow-screen diffuser only, it helps to check for noise and contrast by placing black masking tape on the diffuser when tests are made.

Preparing images for stereogram masters

Images not possible in pulsed and cw work can be made up from still photographs, movies, video or computer generated imagery.

Options for photographing images for holographic stereograms to achieve stereo (rather than animation) are to use a rotating stage and fixed camera, or a camera moving along a linear rail with a rotary stage for toeing in to a pivot point on the subject. (Linear rails are used in the movie industry.) In the latter case a black background is needed for portraits, or the background will appear to swivel behind the subject. A camera moving along a flat linear rail can be used, but it will have the image coming towards the viewer in the middle and going back at the edges in the final stereogram. To achieve animation a fixed camera and subjects moving past the camera can be used, as in time-lapsed photography. Stop frame for animation gives a flat image but enough depth cues (such as overlapping) to read as stereo. A static camera and a moving person would look flat. Figures moving slowly in one direction will create stereo pairs and appear separated out in space from a flat background. Stereo views of slightly moving people give a pseudoscopic person if one of them moves the opposite way. A sequenced set of images of a computer drawn square moved across in one direction introduces parallax and the square appears to float.

A motorized camera is needed, the faster the better. Interframe distances have to be consistent, and these vary on manual cameras. The faster the film goes through the camera the better it will be. The RCA uses a Nikon F3 motorized camera. For the RCA machine, the ideal is 35mm, b & w, positive, high contrast with grey tones, narrow band, landscape format. Kodak T Max 400 negative film is used to film the subject first. This is not sufficiently contrasty and has to be copied onto positive lith film. Black and white film gives much better quality than colour slides, which produces a noisy result when projected by laser, unless producing full colour holograms. Flat art work can be done straight on to positive lith film, that is positive LPD4 Kodak line positive film, sometimes called 'line film'. When processing black and white

film over-expose slightly, about half a stop, to get a light film for multiplex when registered on positive film on the rostrum camera.

Re-registration is necessary for interframe anomalies or jitter, which you can get even on a linear rail. Sliding a camera along on a table is often no worse. To re-register, you need to have something pre-dominant in each frame to register onto, to pick out stereo pairs. At the RCA a Forox rostrum camera is used with lith film re-registered from black and white T Max for the best scenario, using a graticule to register each slide. Positive lith film LPD4, or Ortholith 2556 negative lith film is used, depending on the job. Skill is needed in getting the exposure right on lith film, a hand process.

Colour positive options are colour positive film, panchromatic neg film or lith negative to give positive black and white. Kodak T Max 100 film can be re-photographed through filters. The cheapest colour slide film can be used because the colour cast will not matter. When mastered on the red pulsed laser there is the same distortion for holograms from slides as with normal objects, ie blue & green look black, and red becomes clear. For 3 colour holograms, tri-colour separation filter sets give maximum transmission, and balanced three colour separation. If separating art work for colour, filters shift the focus, so re-focus for each frame.

If images are taken off a computer, registration problems are solved, as computer images are well registered already. Colour positives (36 individual prints) can be scanned into the computer, which sees them in 3 colours. These need to be colour separated, with colour output as black and white slides. A slide maker scans directly from computer onto colour slide film, red green & blue. In graphics software such as Photoshop, channels can be split into red, green, and blue.

Any animation technique can be used for multiplex holograms. Video images can be converted into digital information. Polymorphic tweening on Morph software generates images in between two end images. Registration points are set up between 2 images and marked off as anchor points for the morphing process. This technique was used in *Cornucopia* (working title), with scanned images from Ernst Haekel's *Kunstformen der Natur* (1904), selected in Photoshop and sequenced in Morph [Plate 24]. A Mac Quadra 2VR computer (with 28mB) was used.

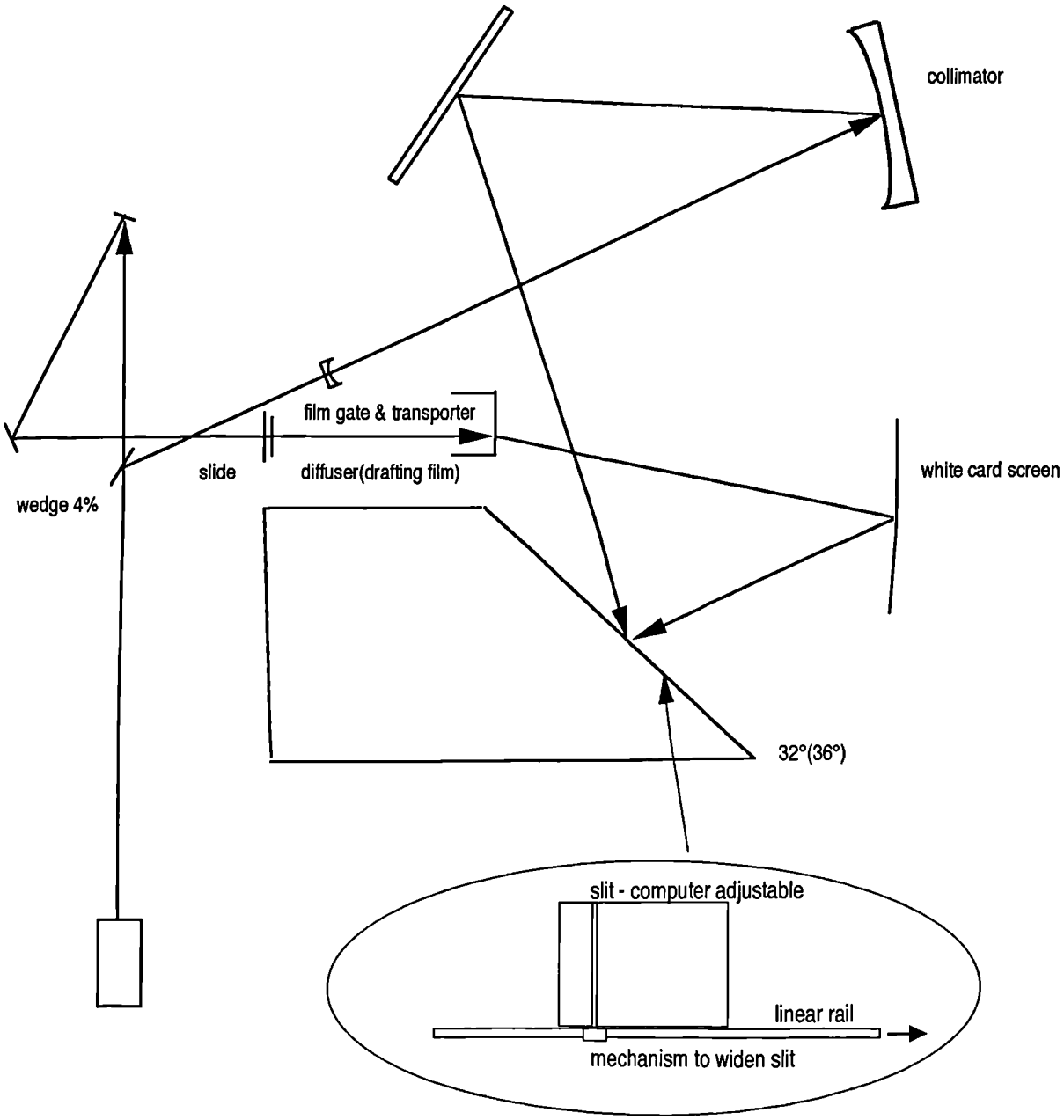
Pulsed Multiplex™ machine at the RCA (Fig 3a)
To illuminate the film a white card screen is used, rather than a diffuser screen, which makes the machine more compact. A diffuser screen would be too directional for use with a high energy laser. The reference beam overhead exposes the whole hologram, and a slit of angled metal splits up the viewing zone. The film gate and transporter is the most expensive part of this system. The film drive is pin-registered with an old movie camera. The machine was made with slits at the achromatic angle which works upside down for full colour. (The reference beam needs to come in from the opposite side from that normally used when making transfers. See Fig 3b)

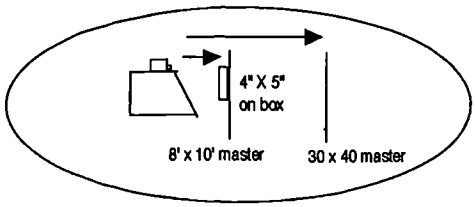
The machine is computer linked so it can fix the slit width and shoot the same number of frames as are available as slides or film. The slit size is dependent on the number of frames and the size of plate. The width of the pupil is about 5mm, so there is no point having it smaller than that. The slit width for *Curtain* was around 8mm.

The computer can be set for automatic motor control of the slit. It is necessary to test, to make two or three frames and look at the slits to see if they're properly close together. If they overlap, one region is overexposed and you start to get fringes. If they underlap, you get a dark dead region. It is better to underlap. The pulsed laser is not linked up to computer for safety reasons. For cw exposures the film drive motor would have to be turned off. To make different sizes of hologram, the screen needs to be moved forward and back, according to size.

On image planing transfers, because of the unusual angle of plate, it is necessary to use a test target to make sure you are exactly on the image plane. A hologram needs to be made of the test card on the pulsed master set-up then used again when making transfers, to establish the correct position of the image plane.

Figure 3a Holographic stereogram machine with back-directed screen, RCA (side view)

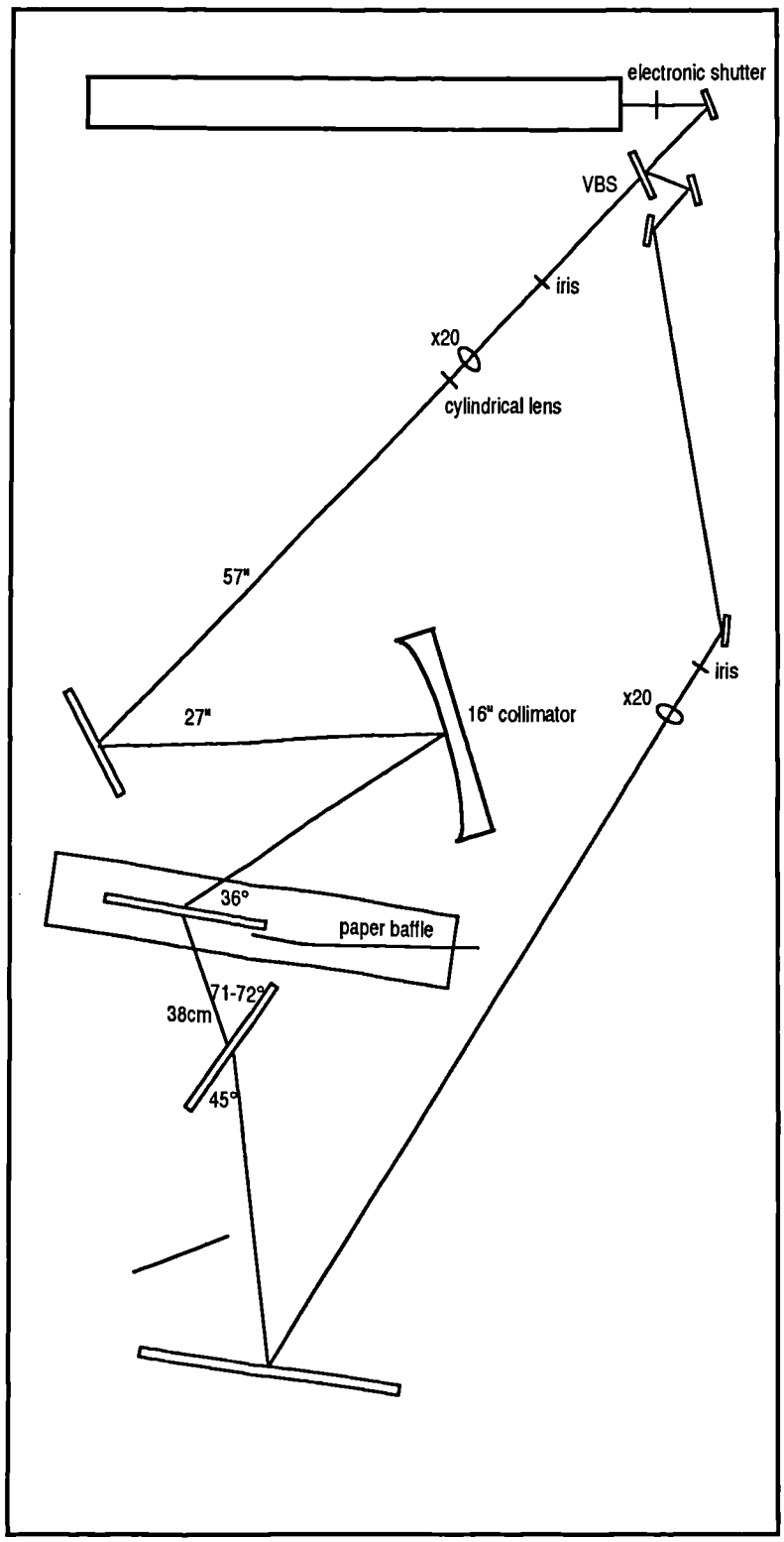




Adjustments for different sizes of master

5.3

Figure 3b Stereogram transfer set-up - 8" x 10" - own studio.



5.3

Plate 24 From *Cornucopia* (working title) Benyon, 1994. This is one image from a sequence of morphed computer scanned images of shells derived from Ernst Haekel's *Kunstformen der Natur* (1904), and used to make a holographic stereogram.

Holograms mastered at the Royal College were mainly transferred in my own studio. Using my own studio allowed time for further creative work at the transfer stage. For holograms larger than the ***coherence*** (12.5 inches) and power limits (25mW) of my own laser, it was recommended that I used the ***krypton*** laser at the RCA [Plates 4, 5 & 6]. For any size of hologram larger than 32 x 43cm it has been necessary to use holographic film, when large glass plates have not been available commercially. Film is much cheaper, and since it could be cut up or laminated in layers, seems to lend itself more naturally to collage or shaped images.

Handling film

Film emulsions seem to give better results than those on glass. It is not possible to give an accurate reason for this because the photo materials companies keep secret their manufacturing methods, but an educated guess could attribute differences to 'subbing', that is the differences in substrate used to attach the emulsion to their respective bases, and a speedier drying time for film emulsions. However, the handling of film presents extra problems, especially with regard to lamination. Larger format transmission holograms are usually made either with a vacuum plateholder, or rollering the film down as flat as possible onto a piece of glass that has been previously sprayed, in a spray booth, with re-positioning spray adhesive. The commercial alternative is to find a lamination company with appropriate motorized rollers for a continuous dust-free feed of film, and a willingness to black out the premises for the lamination of unexposed film.

Without a large vacuum plate-holder, or expensive laminating equipment, an inexpensive solution to the problem had to be found at both master and transfer stage. With pulsed master holograms of people for eventual transfer in white light transmission mode the problem is not serious, since the absolute flatness of the master is not as apparent in rainbow holograms. In a reflection hologram the distortions, jumping and rippling of the image transferred from a master which was initially adhered with re-positioning adhesive is unacceptable, unless these characteristics can be used positively in the final image, as a 'watery' image, for example (as with *Fish*). In *Cosmetic*

Camouflage the final image lent itself to flexible film and was mounted loosely. 50 x 60cm film and 30 x 40cm glass plate masters of the same subjects were made, so that I would have a back-up if the film versions proved unusable. Glass plate masters were made for the painted versions of the series.

Gelatin lamination tests

It was decided to experiment with a method of laminating film to glass 50 x 60cm x 6mm thick that was inexpensive, low-tech, recoverable in the case of mistakes, and in keeping with the modest scale of an artist's, rather than a commercial, studio. Initial tests with exposed film showed that gelatin crystals made up at about double normal strength of edible jelly, 275ml to 11.6g (one sachet), provided a workable viscosity and 'bloom strength'. A few crystals of copper sulphate were added as an anti-bacterial agent so that the mixed gelatin could be kept over a few days if refrigerated. In anticipation of the length of time it might take to adhere the film, a fog test was made to find a safe distance from the safelight for up to 3 hours. Light-tight boxes to store the drying gelatined film were made up. Waterproof tape was tested and found suitable for a final seal round the edges of the laminated film.

The laminating table was made level, so that the gelatin solution would spread evenly when first poured. The gelatin was heated to approx 80°C and was fluid when poured onto the glass. It could be rollered thinly with a large roller away from the centre between the glass and the film. Small weights were used to prevent the edges from curling up. As the gelatin cooled it set, and became easier to push out from the edges with a small roller. Warm water and sponge-cloths were used to wipe away over-spill, and finally the edges were blotted dry with tissues. Any accidental blots on the emulsion were wiped away with warm water at this stage. The gelatin solution swelled the film slightly, so that as it dried it stretched the film flat, rather in the way that water-colour paper is prepared. The inevitable flecks of dust which would ruin a hologram index-matched with a fluid (such as white spirit or mineral oil) because of instability of the film in the area around the grain of dust, do not seem to present such a problem with gelatin because it sets firm. Waterproof tape around the edges protect the gelatin during the pre-swelling and processing of the exposed film. Masters laminated in this way can stay mounted on the glass, stored and ready for making stable transfers in a cw set-up. Over time the gelatin dries out completely and bonds film to glass semi-permanently. If film is index-matched to glass with gelatin for

processing only it needs to be used within a few days. Detaching the film from the glass whilst the gelatin is still viscous is easy, as the gelatin has a low bloom strength, and the residue of dry gelatin adheres to the glass rather than the film. Once the film is exposed, it can be laminated in the conventional way, with self-adhesive laminate onto any substrate, preferably not as fragile as glass.

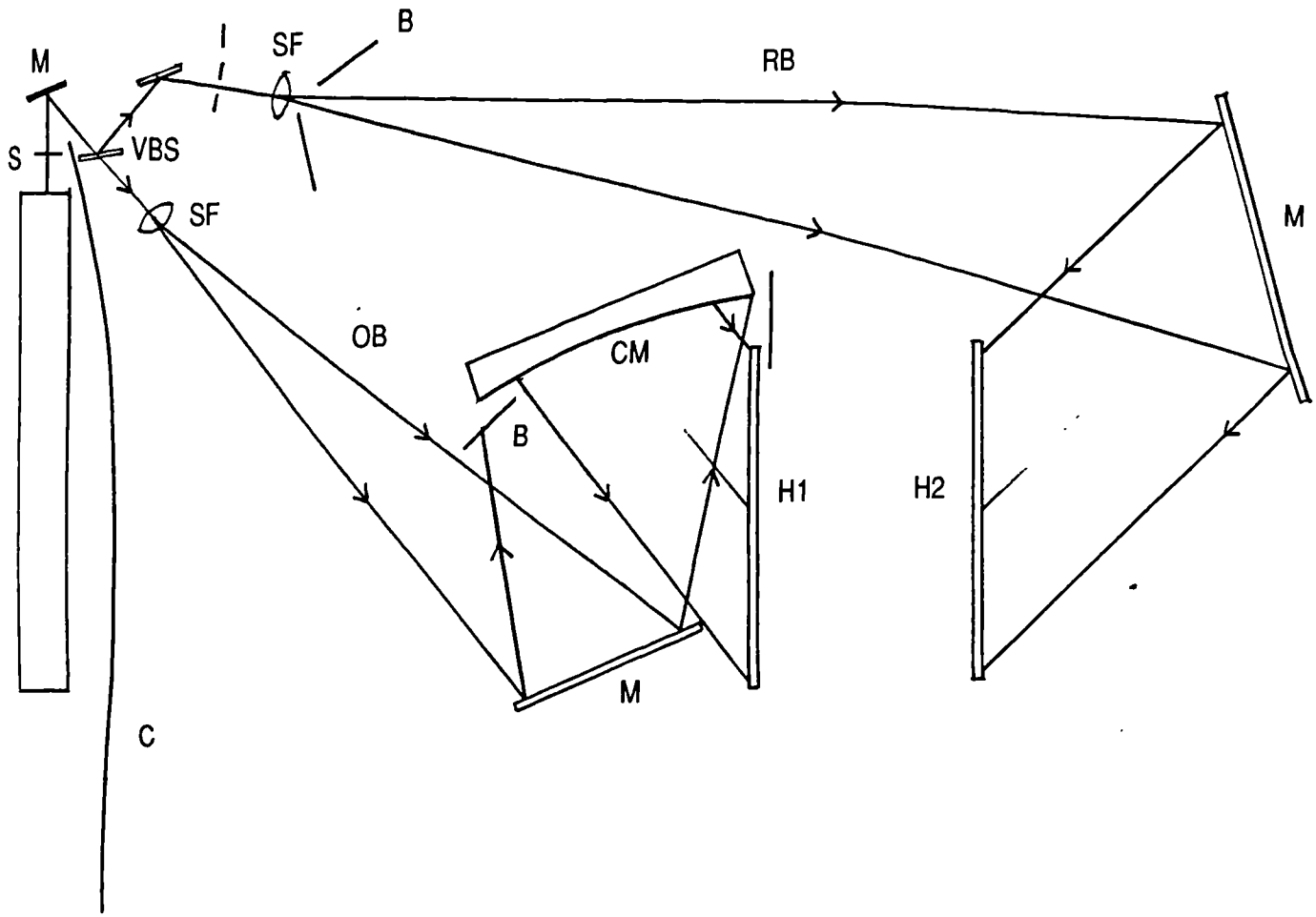
Because gelatin will eventually bond film to glass once the film has been removed it is important to wash all traces of gelatine from the edges of the hologram under the waterproof tape, because it could bond to the mounting glass.

A major disadvantage of laminating film with gelatin is that it is messy. The edges of holograms laminated in this way are often untidy. It is also time-consuming. It takes about two hours to laminate a piece of 50 x 60 film. For most display applications this method is not appropriate, but for the artist who wishes to use alternative formats or a choice of substrates, it is a viable technique. A major advantage is that it has none of the instability problems for long time-exposures, particularly in reflection holography with low power lasers, to which fluid index matching methods are prone. Another advantage for the artist is that it is temporary, and allows the film to be removed and used as the flexible medium that it is. It can be cut up, freed from the tyranny of stock formats, collaged and mounted in ways that are appropriate to its floppy nature, rather than trying to ape the glass plate, which is by its nature fragile and vulnerable to breakage. Loose film holograms are light and easier to transport and store than film laminated to glass. Finally, a major advantage is that it is very cheap - the cost of a few grammes of gelatin. The escalating cost of glass plates relative to film means that experience gained in different film lamination techniques could be of long term benefit.

Sheet lamination

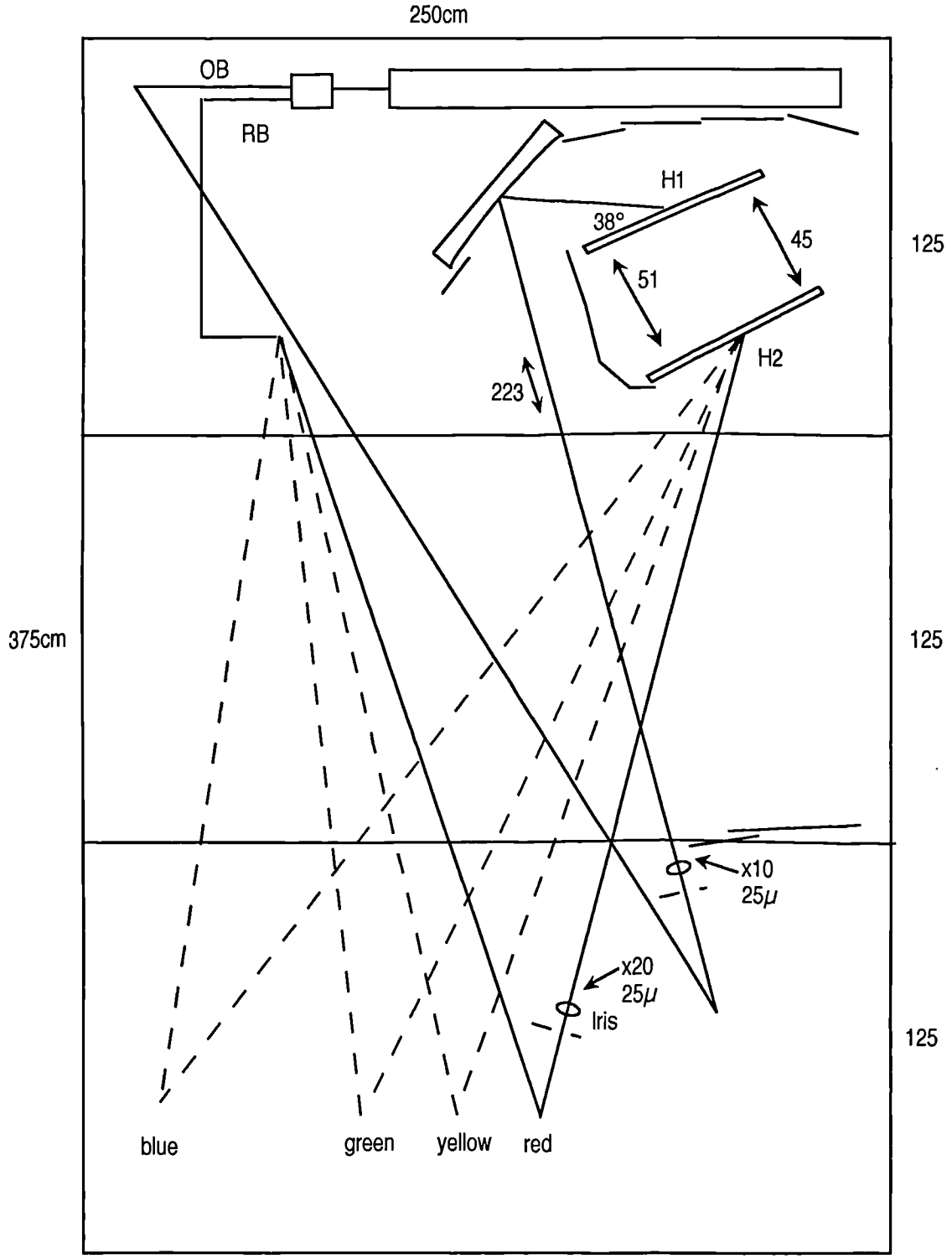
At an intermediary stage of this PhD project the RCA obtained a laminating machine. When work commenced on the krypton laser 50 x 60cm holograms were made with both sheet and gelatine laminated film. It proved feasible to use gelatin as a laminating material despite the short time over which the gelatined film could be used. Notes on the use of sheet laminating material are included in Appendix C.

Figure 4 Helium neon (He-Ne) laser transfer set-up for 50 x 60cm reflection hologram with side reference beam, artist's studio.



Beam from 25mW helium neon laser is passed through electronic shutter S, and relayed by front surface mirror M to dielectric variable *beam splitter* VBS. Reference beam RB is passed through iris I and baffles B, diverged by x60 microscope objective in *spatial filter* assembly SF, and relayed by front surface mirror M onto transfer hologram H2 at approx 45°. Object beam OB is diverged by x40 objective SF, relayed by mirror M onto 55cm diameter collimating mirror CM, to illuminate master hologram H1 at 38°. Set-up is baffled B, and curtained C.

Figure 5 Krypton laser transfer set-up for multi-colour 50 x 60cm reflection hologram with side reference beam, Royal College of Art.

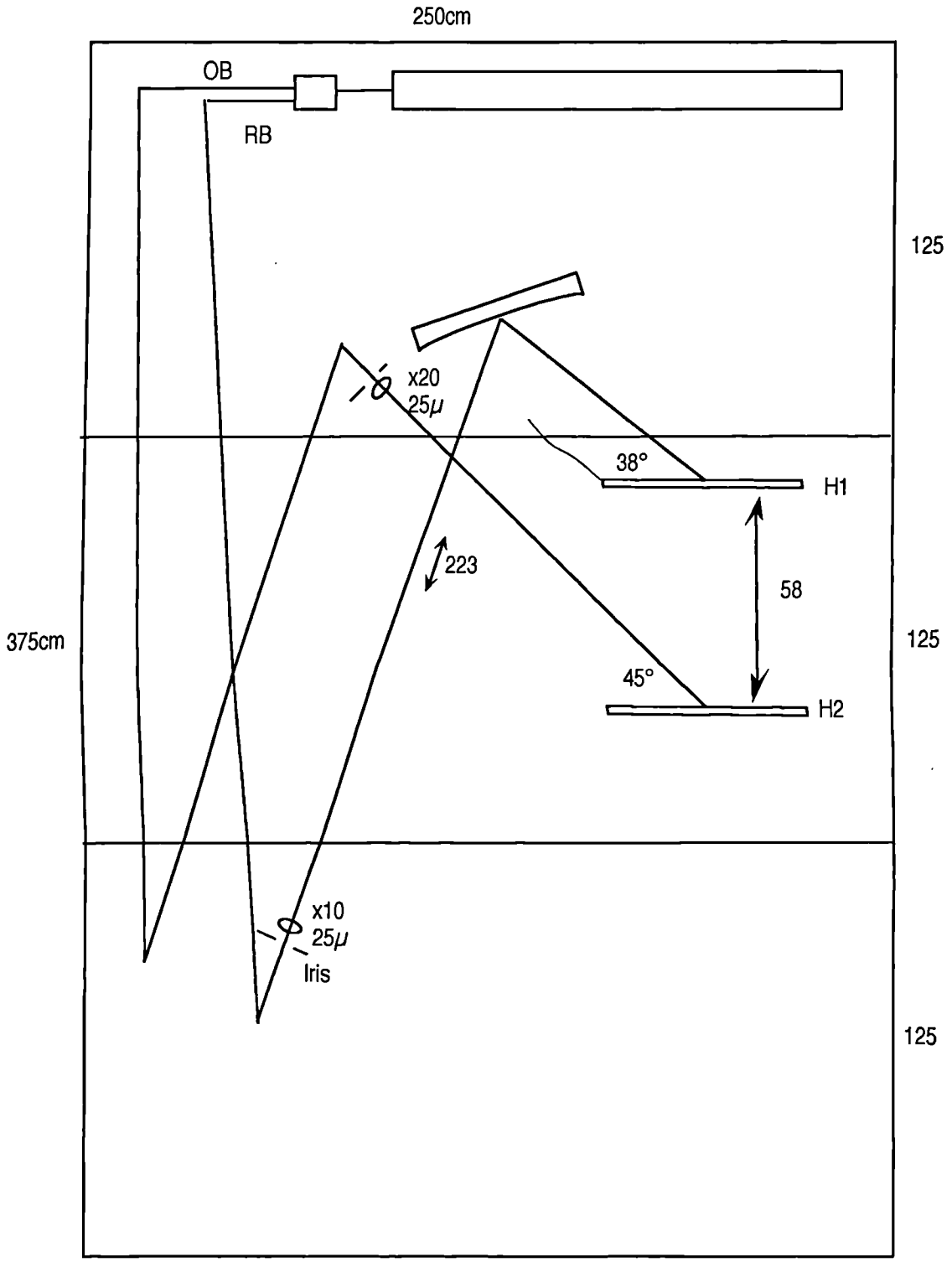


Optic axis 14.5cm
Etalon 6m coherence

3 Photon Control™ tables
22" *collimator*, FL 223cm

5.4

Figure 6 Krypton laser transfer set-up for 50 x 60cm transmission hologram with side reference beam, RCA.



Optic axis 14.5cm
Etalon 6m coherence

3 Photon Control™ tables
22" *collimator*, FL 223cm

5.4

Colour is an important formal consideration for most holographic artists. ***Full colour holography*** such as that carried out by Professor Hariharan, Kaveh Bazargan[2], Paul Hubel[3] and Professors Kubota[4] and Jeong[5] requires use of more than one laser and is beyond the current range of possibilities for most artists. In 1978 I was fortunate to carry out a piece with Dr Hariharan, *Rainbow Rainbow*, at the time when his patents on full colour work were first approved. We made a full colour ***focused image*** rainbow hologram which solved problems of colour registration simply because it was carried out in one step. The hologram had to be a sandwich of red and green sensitive emulsions because panchromatic emulsions were not available commercially.

The white-light transmission hologram has its own characteristic spectral shift, which can dominate over any individual use that the artist makes of it. An exception to this is the achromatic WLT hologram, invented by Stephen Benton[6]. Reflection holograms reconstruct in the monochromatic colour of the laser used to make them, unless the emulsions are manipulated beforehand. Before they withdrew from the production of holographic materials Ilford employed a Built-In-Pre-Swell (BIPS) factor. A choice of colour has to be made, even with monochromatic holograms. Choice of processing influences colour, but not in any pronounced way. Most ***multi-colour holography*** is usually carried out by artists in ***pseudocolour*** techniques which involve changing the reference angle at the transfer stage for correct registration of different colours, and pre-swelling the emulsion before exposure in the case of reflection holography.

The idea of swelling the emulsion before exposure with triethanolamine is attributed to Jeff Blyth. John Kaufman showed how successfully the pseudocolour technique could be used in reflection holography with his holograms of rocks, made at the beginning of the '80s[7]. The increased brightness of holograms pre-swollen with triethanolamine (*TEA*) has meant that some artists, such as myself, have built this regime into the making of all their reflection holograms. An explanation for the improved quality of pre-swollen holograms is that more fringe planes are created in the emulsion.

The colour most favoured for monochromatic reflection holograms of people is yellow, which is near maximum visibility, the colour of the sun. Unfortunately yellow is a very narrow part of the spectrum, so colour casts towards the red and green are inevitable, particularly if the hologram is made and exhibited in different humidity conditions. I have found that unless the colour is modified by painting with a flesh colour under the hologram, or by double exposure so that the image becomes less solid-looking, the monochromatic image lacks subtlety.

Some of the work carried out for this PhD project therefore involves more subtle, de-saturated colours, such as "flesh" colours, by multi-exposure. The making of colourless holograms involved an investigation of the tolerances and various approaches to colour mixing and registration. De-saturated colours in holography are duller colours. For example, brown is a low-intensity orange. This is because efficiency or brightness is reduced in direct relationship to the number of exposures made. However, de-saturated colours look more 'natural', less bizarre than the monochromatic saturated colours most often used in reflection holography. This seems to be an obvious area for artists to be working in, requiring as it does an intuitive approach.

It is possible to use pseudocolour loosely, changing colours on the same hologram by simply exposing it after each triethanolamine bath, and changing the master (or subject, in the case of a one-shot shadowgram) without attempting correct colour registration. The requirement for a change in angle and distance of the reference beam in pseudocolour reflection holograms can be by-passed at those times when the placement of colours is not critical. I have found that the loose approach can sometimes be used to advantage, cutting out extra or unwanted parts of an image so that they are outside the replay angle.

I had previously carried out some initial colour registration work on a reduced 8 x 10" reflection transfer. The method used was to take an initial transfer with three separate exposures pre-swollen to red green and blue, with all three reference beams at the same angle. On reconstruction there is misregistration between the separately coloured versions of the image, caused by a shorter-wave blue image (475nm) being physically smaller than a larger wave red image (650nm). The degree of misregistration is visible, and is a guide to how much difference in angle and distance there is in the reference

beam. A test of how accurately the hologram has been replaced in the plateholder is that the holograms show fringes where one exposure overlaps another. If a minispot is put on the table at the optimum reconstruction angle for each of the colours, this will be a guide to the different angles at which the multi-colour transfer should be made.

There is a convention in applied optics that a beam angle is measured as an 'angle of incidence', that is the angle the beam makes with the 'normal', a line drawn perpendicular to the surface. This is because the surface may be curved. However, artists often quote the angle the beam makes with the surface of the hologram, called the grazing angle, because it is much more straightforward in practice to line up the beam directly along the desired angle on a protractor, than to make a calculation from the protractor. This convenience means that they tend to measure the angles off the easiest way, then to convert them to the angles of incidence afterwards for the sake of propriety. Any angles quoted here are the artist's working, grazing angle measurements, rather than the scientist's correct angles normal to the plate. This is such a common tendency amongst practitioners that it always best to check which way they are giving their angles. Although a scientist will be sure to be using the conventions, artists may not, with confusing consequences.

In this initial trial I calculated angular shifts and distances from Steve McGrew's graphical method[8]. This involves the location of a 'hinge point' and is based on drawings rather than the Benton mathematical method. Although equivalent to the mathematical method, it has the advantage of directly generating a diagram of the necessary recording set-up, and for this reason is likely to be useful to artists, many of whom have an aversion to mathematics. The procedure was designed to control image colour and simultaneously correct for depth distortions due to wavelength shifts between recording and reconstruction. Those interested in using the graphical method are advised to obtain Steve McGrew's original paper.

Fig 7 shows how the 'hinge point' HP is found by drawing a line from the imaginary 'reflected' illumination position to the position of the viewer, and finding the intersection at the hologram plane. A reflection hologram to be displayed as in Fig 7 should be recorded as in Fig 8. The reference sources are placed on the recording axis which is a line drawn from the hinge point

Figure 7 Locating the hinge point for a reflection hologram

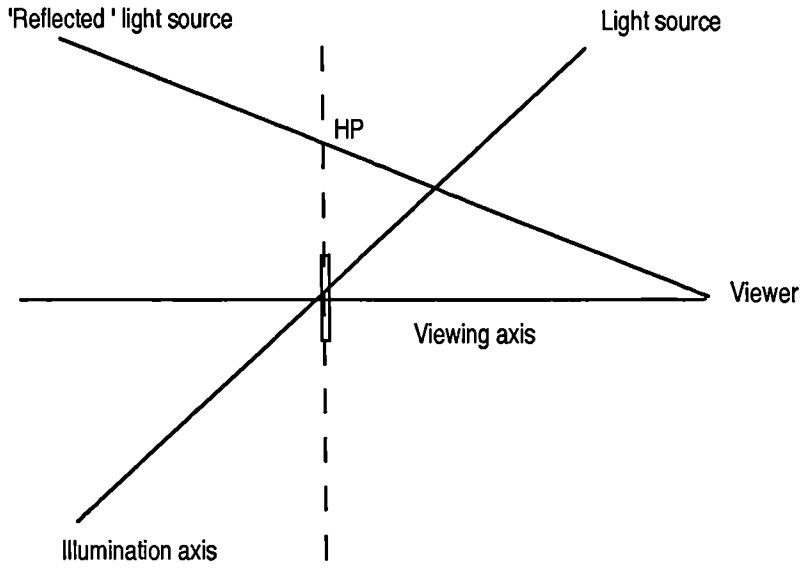


Figure 8 Using the hinge point and illumination axis to design a recording set-up for a reflection hologram

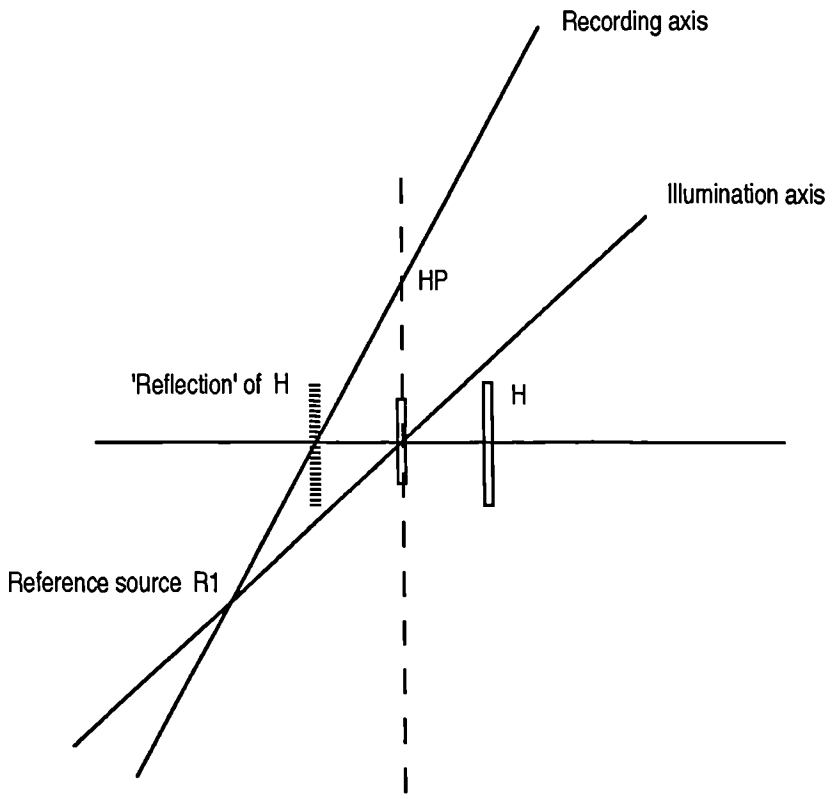
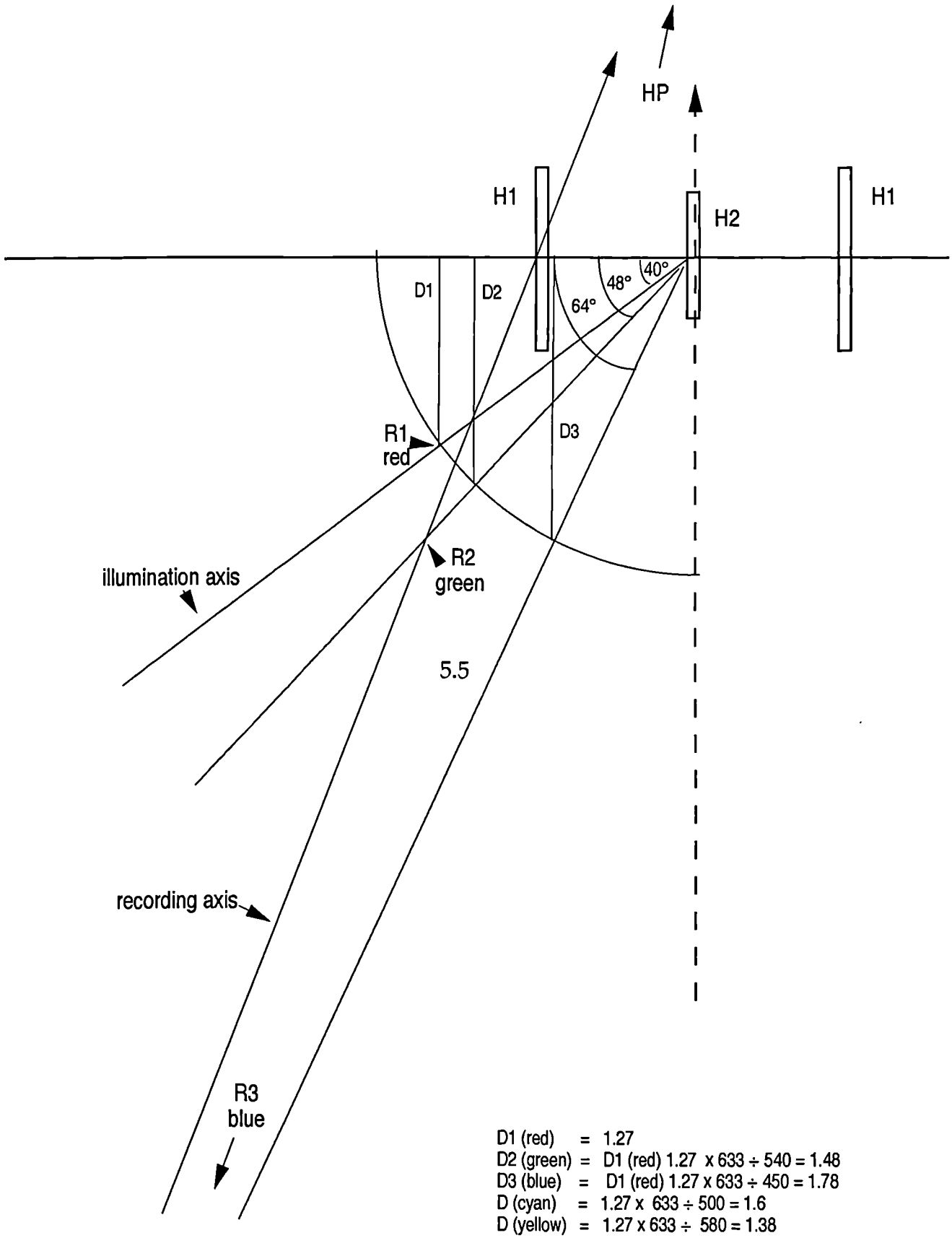


Figure 9 Using the hinge point and illumination axis to design a recording set-up for a reflection hologram in red (633nm), green (540nm) and blue (450nm).



through the 'reflection' of the H1 colour masters. The reference source for the red component goes at R1, the intersection of the recording axis with the illumination axis.

Wavelength (λ) ranges in nanometers (nm) approximating to various colours are as follows:

Colour	λ Range nm
Red	700 to 620
Orange	620 to 580
Yellow	570 to 580
Green	487 to 570
Blue	400 to 487

In Fig 9 the reference sources for red, green and blue components of a reflection hologram are shown. The hinge point and point R1 are found as in Fig 8. A line is drawn from R1 perpendicular to the viewing axis. The distance of this line is measured and called D(red). D(green) is found by multiplying the ratio of the red wavelength to the green wavelength:

$$D(\text{green}) = D(\text{red}) \times 633 \div 520$$

Angles of 50°, 42° and 26° (grazing angle rather than angle of incidence) were calculated, but in practice they turned out to over-compensate for the shift. Also, green tended to dominate, because maximum visibility is around 555nm, a yellow green. The required reconstruction angle of 45° meant that the angle for blue was very steep, and off the table as far as reference distance was concerned. It was necessary to proceed by approximations to angles and distances, beginning with reference distance and angle the same for all colours, and then gradually adjusting for acceptable registration.

Repeatability of colour is not easy to maintain in reflection holography, even with the use of a humidity gauge and a de-humidifier with humidistat to control the ambient humidity, which can affect the hologram during settling times. A slight variation in squeegee pressure can result in sufficiently different colour combinations to throw off the final colour mix quite appreciably. If one is looking for white, this resembles a search for the Holy Grail! It is important to try and regularize squeegeeing techniques. Higher

concentrations can require a change in squeegeeing technique, or a change from a soft to a hard squeegee blade. Sometimes the hologram is placed flat, or is held in the hand, and the number of squeegee strokes and pressure varies. Some repeatability can be achieved by regularizing drainage time before squeegeeing, and using two hands for squeegeeing instead of one. With pseudocolour techniques no amount of accurate calculation will help if the same concentrations of TEA produces varying results because of changing exposure times, humidity and squeegee pressure. Slight variations can produce large changes, and require repeated compensatory measures that are on-the-spot and intuitive. If the hologram prints out and is re-bleached in dichromate it can go redder. Different bleach formulations require different concentrations of TEA.

A problem with placing the reference beam at different distances to achieve spatial registration in the transfer hologram is the fact that holograms of people need as long a throw as possible on the reference beam in order to reduce distortion. Ideally a converging reference beam should be used, but this would be impractical. The option of placing the reference source closer to the hologram for the red image meant increased distortion, and was seen to be unacceptable. However, assessment of how demanding a particular image would be is best made through experience and subjective choice. John Kaufman now considers that only when colour registration is most demanding need one adhere strictly to the hinge-point.

Further tests were carried out with *Enough Tyranny*, in which the image is an image-planed flat graphic element. The displacements of colour with smaller objects and a shallower space than a human head and shoulders could be more easily seen. Hot-spots on very reflective objects, such as the pearls in the image, produce a uniquely holographic multiple-image if misregistered. This phenomenon would need to be worked on for deliberate use. The energy and rawness of Warhol's misregistered and 'pseudo- coloured' screen prints when they first appeared in the 60s, suggest that there is a use for misregistration and violently mismatched colour in holography. Plate 25 shows a working wall in my own studio where film handling and colour tests can be looked at. *Enough Tyranny* is the triple image in the centre.

Plate 25 Studio wall showing tests in colour, film handling and collage.

Quick colour registration in reflection holograms can be made by tilting the hologram copy rather than the reference beam, and moving the master back and forth for better spatial registration[9]. The 'quick' method was tried first, to find out the parameters involved, bearing in mind that any colour work in holography is time-consuming. The pre-swollen latent image becomes increasingly unpredictable the longer the time between exposure and processing. Here my ill health had to be taken into account. With the proper, lengthier procedures I needed to be physically capable of changing as many as four set-ups in sufficiently short time (a day) not to have unwanted changes in the latent image. Holographers whose studios limit them to fixed hours have the same problem.

To register colours by turning the hologram on its axis, the plate-holder needed to be pin-registered at the axis point. I used a pin, glued to the bottom of my plateholder, lined up with a protractor adhered to the table. Bearing in mind the general rule that any colour and its complement will produce a version of white, a number of exposures were carried out on 4 x 5 inch plates. An achromatic mix of aqua and red, blue and yellow orange, or violet and green was aimed for. The different variants of warm colours (orange, red to magenta red) were separated onto different plates with the emulsion away from the beam, and variants of cold colours (green, blue cyan, and violet blue) onto plates with the emulsion forward. This was done so that different warm and cold colours could be combined together without the emulsions being displaced by the thickness of the glass substrate when sandwiched.

Holograms were also made at different angles within 5° of tilt, so that the correctness of registration could be checked, and also the joint reconstruction of these combined holograms at 45°.

These tests were enjoyable to carry out because for the first time I was able to appreciate for myself the great range of colour mixtures possible in pseudocolour holography. These colour differences can really only be appreciated by the eye when the colours are physically in close proximity with each other. The colour mixtures obtained in these tests were:

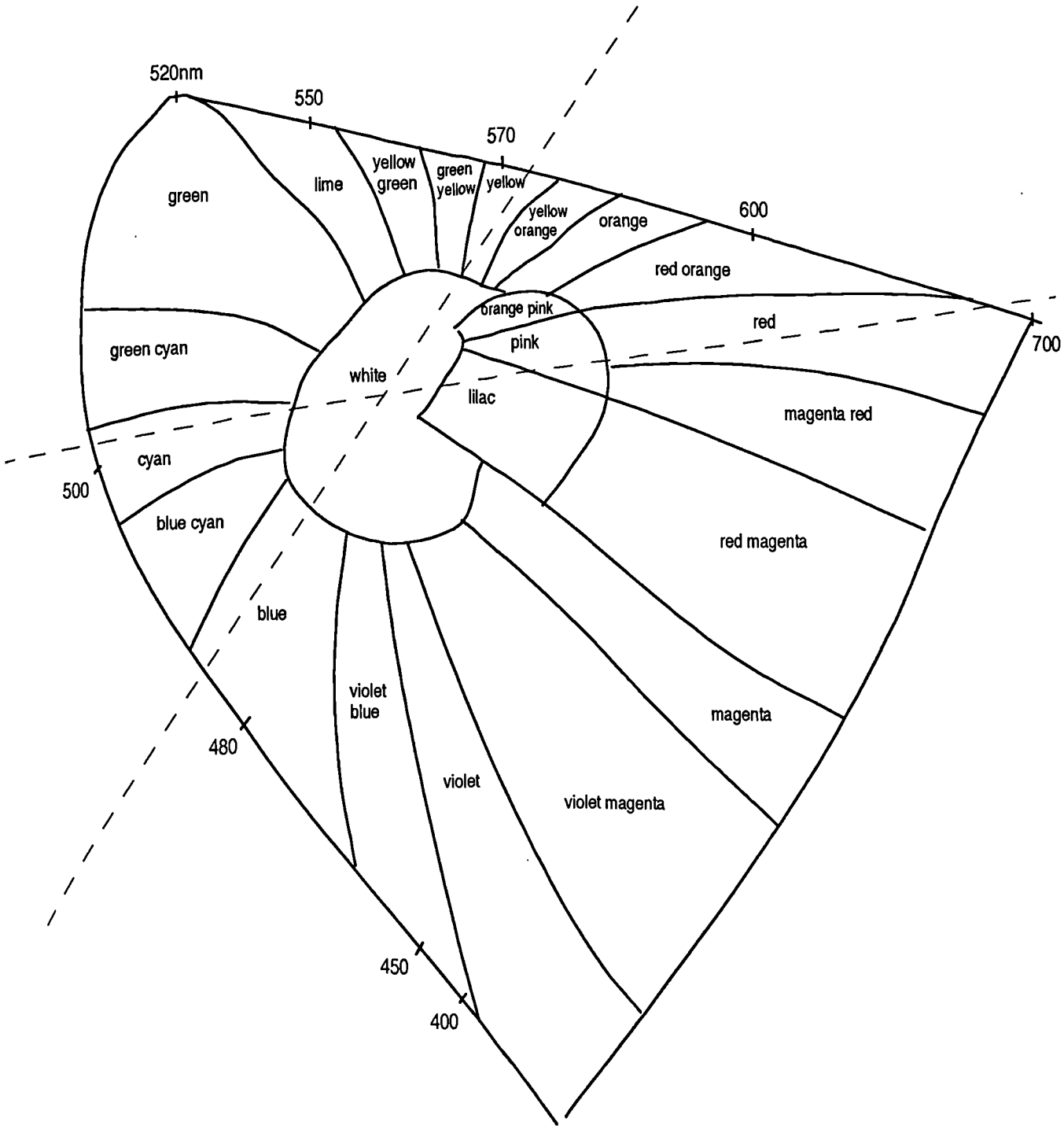
Red + green ..... green yellow white
Red + blue cyan ..... blue white
Red + violet blue..... violet magenta
Orange + blue..... lilac
Red orange + cyan ..... yellow white

Fig 10 shows a drawing of the CIE Chromaticity diagram. A guide to which colour mixes can be obtained can be made by drawing a line from one colour area to another.

In assessing registration, the first shortcoming of this method became evident. In tests made with no angular adjustment, blue comes below red on the image-plane, so the angle needs to be increased until the two colours are superimposed. However, with this method of tilting the plate instead of the reference beam, an increase in tilt produces an increasingly distinct misregister in either the real or virtual image, and not absolutely perfect registration on both. Similarly, on reconstruction the tilt of 5° maximum was found not to be sufficient, suggesting a wider angular separation, closer to Steve McGrew's hinge-point calculations. It was concluded that for demanding achromat work it is necessary to register colours by changing the reference beam angle in the conventional way. It is also quicker not to take the short-cut of using two colours instead of three for achromat work, because with three it is easier to obtain the desired results.

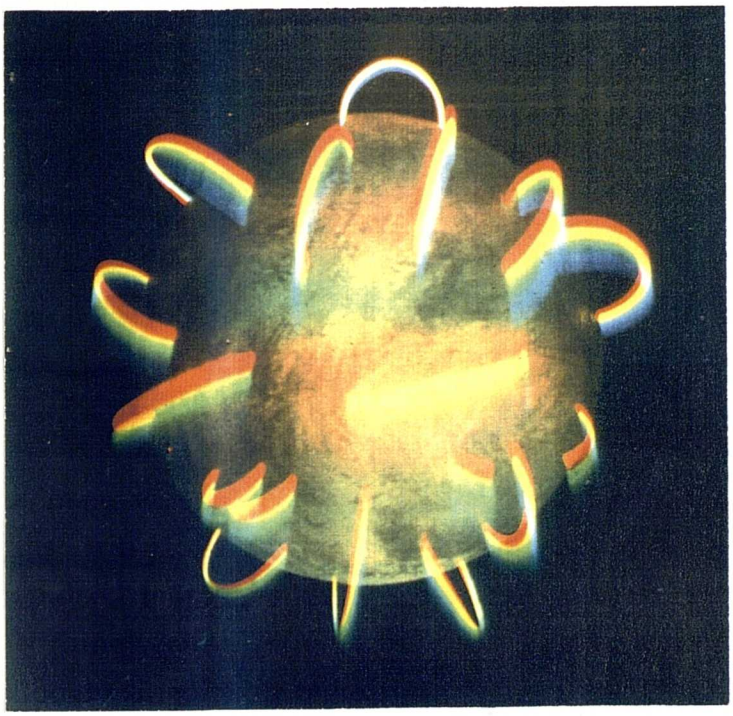
Notes were taken which help greatly in the duplication of results or tests at a later date. Beam ratios, reference beam distances, processing times, H2 angles, exposure times, etc, were taken down in table form to allow for quick checking. Detailed procedures are necessary when carrying out tests. Records

Figure 10 Rough drawing of CIE colourmetric diagram indicating colour possibilities for achromatic mixing.

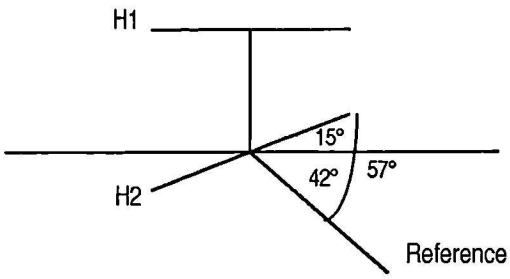


were made of table set-ups and details of tests and recordings in an expanded written form whenever necessary. These records were kept in brown and green notebooks which are completely separate from my notebooks containing drawings for visual ideas. The brown and green books come from the "scientific" side of holographic practice.

Plate 26 *White Rainbow*. Benyon & Benton, 1981



In 1981 I collaborated with Stephen Benton on a piece entitled *White Rainbow*, [Plate 26] in which an achromat was combined with a laser transmission hologram reconstructed in white light. The achromat was made with a holographic diffractor plate. For his 'achromatic angle' Benton uses a 'diffractor plate' or multi-beam splitter/off-axis zone plate. To use the idea of the 'tip angle' the image would need to be tipped spatially onto H2, so it can only be used in transferring from masters made specifically in this way. The fringe structure of pulsed masters already made had to be accepted, and transfers made accordingly. *Wrapped Flowers* [Plate 27] is an example of an achromat made without using the tip angle.



The optimum condition for correct colour registration is with the plate placed at the bisector of the reference and object beams forming the hologram. At the bisector the fringes forming the hologram are parallel to the plate rather than at an angle, which means that the three primary colours overlay each other, making registration much easier, and giving a narrower band of replay. Some practitioners of multi-colour holograms compromise by tilting their holograms 15° away from the normal orientation of H1 to H2 so that the three

Plate 27 *Wrapped Flowers*, 1991, 32 x 43cm reflection hologram, white and red.

primary colours are much closer together than they would be with the H1 normal to H2, chromatic dispersion is decreased, and the illumination beam does not go straight into the viewers' eyes. This means that on replay the hologram also has to have a 15° tilt. (When exhibiting, the back of the hologram/frame would need to built up at the lower edge to the correct angle.)

Holograms carried out in this way should have a much smaller angular separation between the two extremes of colour - a matter of 7.5° instead of 28°, so that angles between the three primary colours are approximately 57°, 52° and 49.5°. Registration in depth is improved, because the fringe structure is more parallel to the plate. In multi-colour holography there is an aesthetic trade off between flatness and depth. Mixed colours are pure with two dimensional subjects, and muddier with deep subjects.

Multi-colour multiplex holograms are usually made with an object beam onto a diffuse screen, and colour separations are determined by slides or filters, which reduce the intensity of light onto different areas of the screen for different exposures. If slides are used for colour separation, colour can be controlled, although perhaps not to the exacting standards of printing studios, where pantones are matched exactly. With holographic colour

changes in refractive index are involved, rather than mordant dyes. As far as the industry is concerned, mass-produced pseudocolour reflection holograms are still not an attractive proposition, although Larry Lieberman has been making pseudocolour film copies since 1990. Silver halide emulsions apparently have a top layer which prevents the making of white light copies, and for full colour work dichromated gelatin is still the best material.

The use of a diffuse screen in colour work can present spotlighting problems, unless expensive diffusers are used. In general, the more diffuse the screen, the less bright it will be. It is possible that lighting the screen with a number of object beams could increase parallax. For an experiment using a master hologram of a sheet of white paper instead of a diffuser, the master was not sufficiently bright, and a subsequent master had to be made using a 1 m ground glass screen. The idea involves the use of a hologram of a screen for use in a transfer set-up in the same way as a shadow screen, without requiring a change of set-up. With this master I should be able to combine shadowgrams with transfers without a change of set-up. So far the 50 x 60 hologram *Blue* has been made from this master. Mike Medora makes one-shot shadowgrams with the screen filtered with old exposed holographic film in selected areas, opened or shut, to give intensity differences.

Post-swelling

In commercial holography post-swelling could be of interest because of its ability to shift an existing monochromatic H2 transfer hologram to the exact wavelength of the laser used to make an *H3* contact copy. For the artist with an interest in colour, post-swelling has the advantage that from a single exposure numbers of different colours can be produced from a monochromatic image. I have found that chemicals previously published as post-swelling agents do not work. In fact, aluminium sulphate hardens the emulsion rather than softens it, producing the reverse of what is required. The citrate that I have used, in for example *Voiles*, and *Cosmetic Camouflage*, can shift an ultra-violet image into the visible spectrum and right through it to a deep red.

Plate 28 *ARTEC '89*. International Biennale Nagoya, Japan. Photo: Akira Ohtaka

The public exhibition of work is to a visual artist the equivalent of the publication of a book to a writer. Most artists regard the showing of their work as an essential part of their professional activity. Without exhibitions, the artist's voice does not become heard. Their work becomes pointless without an outlet.

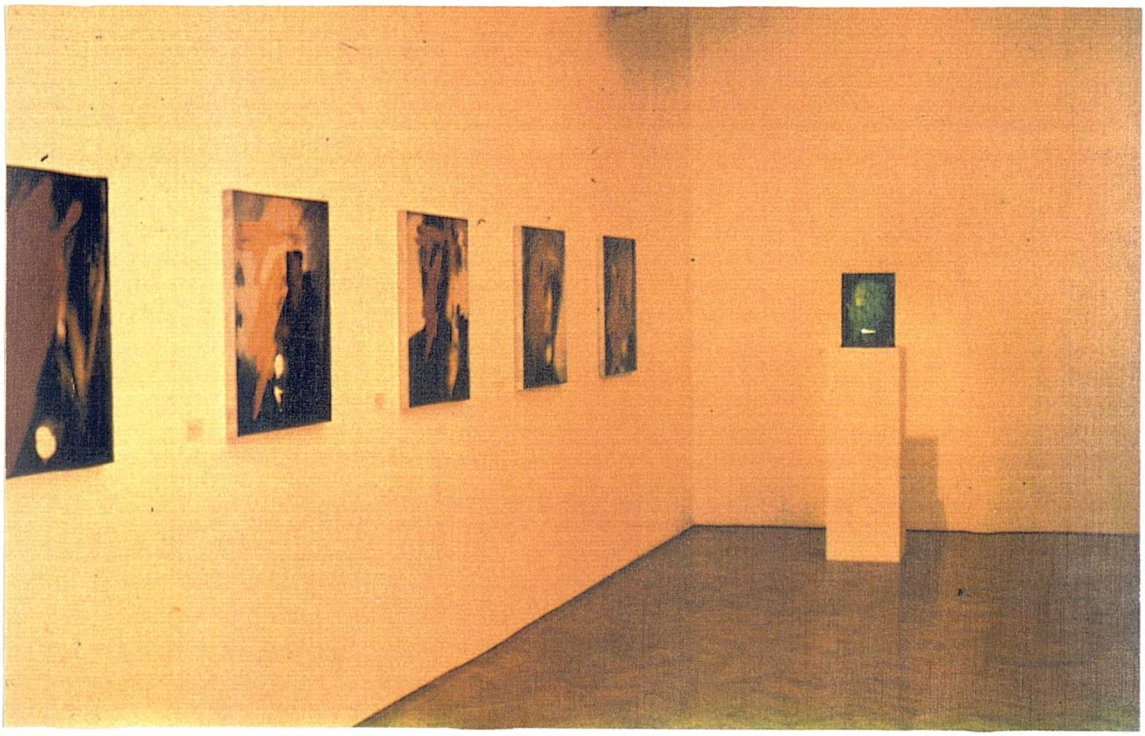
Although the number of exhibitions of art in holography has greatly increased in the last few years, these shows have not necessarily taken place in traditional art galleries. One of the reasons for this is that exhibitions of holographic art are more costly to mount than an exhibition of drawings or photographs if new lighting apparatus has to be purchased and developed for the exhibition space. Artists are much more likely to be successful in obtaining an art venue for the exhibition of their work if they have their own lighting systems and are prepared to a carry out the installation of their work themselves. The physical and financial burden that this places on the holographic artist is considerable, compared with the ease of showing internationally in holographic museums and galleries, which have their own expert exhibition lighting systems and riggers.

The *Cosmetic Series* and other works are intended as gallery art, to be displayed first in a gallery and then in public and private collections. In order to make my PhD project realistic, that is tested and applied in the real world, I continue to make exhibition proposals to art galleries because I regard this as an important part of an artist's professional activity. A measure of how currently unacceptable my holographic work is to UK art gallery curators is the fact that I have not had a solo show of my work in a serious art gallery in the UK since 1972, at the Richard Demarco Gallery. All my solo shows have

taken place overseas since then. An unrealistic amount of time has been spent attempting to persuade curators who have aesthetic problems with holograms to exhibit them as they would work made in another medium. Much time and effort has been wasted not getting past the initial hurdle.

The paradox is that acceptance comes after knowledge, and knowledge can not be obtained until acceptance. The exhibition at Anthony D'Offay of my collaboration with Richard Hamilton showed one way in which this problem

Plate 29 Richard Hamilton exhibition at the Anthony D'Offay gallery, 1991, with hologram.



could be overcome. There would be no other way than through collaboration of exhibiting my work in such a sexist gallery. Gender issues are discussed elsewhere (Ch. 4), but statistics give a measure of the discrimination against women in the sphere of publicly funded and promoted exhibitions. For example, from 1910 to 1986 individual shows at the Tate Gallery by men numbered 206, by women, 8. This suggests another solution which is to show with other women. I am now participating in exhibitions mounted by the Women Artists Library. It is also extremely likely that the kitsch element in my work is taken at face value by galleries, making it even less acceptable.

With the lack of opportunities for exhibition, other options are open to artists in holography, such as commissions, or distribution in the holography world. The commission I carried out for the Arts Council in 1991 is an example of the

former option. This commission I regarded as a job, and in a separate category from my own work. Distribution in the holography world very much restricts creative options.

Exhibition lighting

In the last few years there has been an explosion in the market of low voltage point source spot lighting with numbers of companies producing their own fittings. Designer lighting systems, such as co-axial rods and jacks, are currently being developed at an appreciable rate. This is a great improvement on the 60's and 70's when the only option for displaying holograms was with projectors, from which the current low voltage lamps were derived, or adaptations of projector and car headlamp bulbs. At the beginning of the 80's one or two companies, such as Wotan and Phillips, started to develop small low voltage dichroic lamps with transformers incorporated in the housing. By the mid-eighties shops and businesses were converting their lighting systems to low-voltage dichroic, often spending large amounts of money replacing whole systems every one or two years with more up-dated designs. From having to adapt display areas for laser lighting of master holograms, to being spoilt for choice of lighting system is a very favourable progression for holographers. There is a choice in the installation of low voltage lighting systems between:

1) Separate low voltage lamps mounted individually from a false wall, as in the exhibition *Canadian Holography Now* at Canada House, London in 1984.

2) 240V (in the UK) mains track with light fittings housing both transformer and lamp. The advantage of the former system is that it is robust enough to withstand the rigours of travel and installation in separate venues. It is also more likely to integrate with existing art gallery lighting systems if a reputable make such as Concord or Erco are used. For instance, the Institute of Contemporary Art in London uses Concord systems. If working systems are needed in which the wattage and number of lamps on a length of track need to vary according to the number and size of works mounted, the use of mains track and separate transformers in each lamp is recommended.

3) 12v track with a minimal lamp and socket with a separate larger transformer for a number of lights. Disadvantages with this system are that

separate transformers should be mounted near the track. If they are mounted at a distance the lights will be dimmer and change colour. Standard wound transformers are large and heavy, and this could create a problem if they are to be rendered invisible for the minimal elegance of the small dichroic lamps to be appreciated. If access can be made to the space above the ceiling the transformer can be wired up though a hole. Alternatively a false ceiling can be built in the exhibition area if a large number of transformers are required. Holographic galleries often have lighting grid systems installed, which makes it easy to change the lighting requirements for exhibitions, and to hide any unwanted wires out of sight.

The advantage of conventional wound transformers (if weight and size are not a problem) is that less lamps can be used on the track than the maximum wattage allowed as long as the maximum is not exceeded. Electronic transformers are geared to give a specific power output so a specific number of lamps have to be used. If less lamps are needed, light is thrown away with the use of extra housings and lamps to make up the allowance. Electronic transformers are much smaller and lighter than wound transformers and are radio-suppressed, have more control over power surges and are better protected against short-circuit and over- and under-running of lamps. I have found that, contrary to expectation, they can be available at a cheaper price than standard transformers. Dichroic lamps with G5.3 fittings are now available in a great variety of designs, colours, and adaptations, as are the live 12v track systems developed for them. Lamps can be flexed in all directions, hung, or clamped to cables. A lamp can be incorporated into a holographic piece as a single sculptural entity if a plug transformer is used.

Exhibitions

The most comprehensive paper on preparing and setting out a holography exhibition was written over a decade ago by Rosemary Jackson, founder of the Museum of Holography, New York[10]. It includes advice on paperwork, packing and shipping, lighting, framing and presentation, exhibition design and installation devices, floor plans, safety considerations and de-installation. There are advantages for artists in designing their own integral display/shipment unit as Marie Andrée Cossette (Canada) has done. Commercially available integral systems are intrusive and industrial-looking, and would only be appropriate to that sort of work. Regarding the return of work from exhibitions overseas to the UK I have found that a C1314 form,

available from shipping agents, combined with copies of an exporting Pro-Forma Invoice and whatever other exhibition documentation on the actual work is available, solves the problem of accidentally incurring VAT and customs charges. The use of a Carnet is probably inappropriate for the shipment of work by single artists.

The decision to participate in an exhibition, even in prestigious venues, has always to be tempered by decisions regarding the value of the work to the artist, and how easily s/he could tolerate its damage or loss. If the work is irreplaceable, there has to be a large element of trust. Examples of bad experiences were stolen work from the *Space-Light* Australian tour, and the mess ensuing from the Hamburger Kunsthalle, which was still going through the courts some years later. If a work is sold the artist should ask for payment before work is shipped. This is normal trading practice. The holography world does seem to have more than its fair share of crooks. Perhaps this is the price to be paid for involvement in a highly entrepreneurial field. The need for exhibition contracts must be emphasised. There should be a written guarantee of adequate insurance coverage, along with properly drafted and signed loan forms with details of works. For overseas exhibitions the contract should include instructions for return of work, with customs and tax details covered. Unfortunately, even impressive legal contracts are not a guarantee of the safe return of work from exhibition. Choice of which country's legal system should be used invariably favours the exhibiting country, rather than the country in which the work was made, and litigation in overseas courts in the case of stolen work is extremely difficult.

Regarding exhibition maintenance, greasy finger and even nose prints can obscure a hologram image completely, in a way in which those dealing with conventional media do not have to concern themselves. The use of soft cloth for cleaning is required through exhibitions, as work will be subjected to maximum tactile experience by visitors. Use of any solvents or cleaning agents should be discouraged, as these can creep round onto the emulsion side of the hologram and affect it. If cleaning solvent has to be used, apply lightly to the cleaning cloth, never straight onto the hologram. Lamp spares are essential. If there is no light on the work it might just as well not be displayed at all.

Archivally the following procedure is recommended for glass hologram plates:

- Leave an air-gap between emulsion and cover-glass. My early holograms which are now 26 years old have survived reasonably well, but the sandwiching of the emulsion directly onto a glass backing plate created a condition in which contaminants migrated to the surface of the emulsion. Discourage a micro-climate favourable to mould and other organisms.
- Do not paint the back of the emulsion black. If chemicals migrate to the surface, or there is print-out in the hologram, these problems can not be corrected. Archivally, all adhesives should be water-soluble, so that they are reversible if problems arise over time.
- It is preferable to store holograms away from contact with any other material, stacked with an air gap with spacers if possible. Do not store in contact with bubble-wrap, or even the silver backed paper used in the original packaging. If the piece has to be stored wrapped, use acid-free materials.
- To be absolutely safe, do not laminate. However close to the refractive index of the hologram the laminate is, it is still likely to age in a different way from the emulsion in time. (What is not generally known is that Stephen Benton's PAAP formula depends on immediate lamination if print-out is to be prevented.) Graham Tunnadine has found that the anti-UV sprays used in the electronics industry for the protection of circuit-boards protects very effectively from print-out. Both sides of the hologram would need to be sprayed, presumably.

In practice a choice needs to be made about the way in which a piece is presented to the public, and in many cases archival considerations have to be waived and the piece regarded as disposable.

Presentation of the Cosmetic Series and other works

Pictorial holograms are conventionally presented in frames to protect them from theft and damage. Glass plate holograms are extremely vulnerable to damage, because the cover-glass is the hologram. If framed in clip frames, the hologram is very likely to be chipped on the edges in handling. In my experience, holograms are greatly more prone to theft than other art forms. This means that they need to be securely fixed, however they are presented. There is a post-modernist objection to both frames and pedestals. It seems regressive to use frames at all. Even a transparent frame neatens and finishes

a work in a way which separates it from reality. There are other options, such as setting the pieces into a larger painted environment, or linking them with narrative text, or physically taping them to the wall with soldered copper tape.

A major convention in galleries is that framed art works are presented in the same type of frame through out. This policy is very effective because it has the effect of 'dropping out' the frames to the eye of the viewer. If each piece is framed in the same frame, the frame becomes insignificant in relation to the work, and the work dominates without any distraction of the eye to the frame. To adhere to this policy, a decision about frames sometimes has to be made before making the actual work, particularly in the case of larger pieces, because it is difficult to stand back and look at a piece properly without holding it in position in a frame.

Collage could loosen up working practice. Pieces of film could be moved around more easily than glass plates. Much holography requires control, and tension and restraint has to be endured to reach a final result, leading to a tightness in the work. I had already felt the need to extend the lighting beyond the frame in my *ARTEC '89* room, gating the lights loosely so that the beam profile was irregular on the wall.

Work which is exclusively framed and wall hung could result in a rather oppressive 19th century atmosphere in an exhibition. Individual pieces of the *Cosmetic Series* are in frames, whereas I'd prefer a more 'open' approach to mounting. The *Sideless* frame that is open at the sides was intended to display the Richard Hamilton holograms butted together in a continuous modular line with split battens [Fig 11]. However, in order to butt the holograms I need to use expensive framing projector lamps which are beyond my budget.

Plate 30 *Dorset Marker* 1993/4. Diffraction grating on rock.

It is difficult to find a way of satisfying all criteria, such as archival safety, portability, and so on which fits with an overall vision of a successful exhibition installation. Making one or two freestanding works for the open space of a gallery, such as versions of *Dorset Markers*, could be a

solution.

Design and construction of self-lit hologram pieces

There is a need for integrated light/hologram pieces which could be placed easily as single works in group art exhibitions (ie. works by artists in other media). My easel light is the only option I have to date [Fig 12]. As a freestanding piece of 'sculpture' it is only applicable to some contexts, such as the presentation of the Arts Council Award ceremony, and the exhibition celebrating the International Women's Diary in which one of my holograms of Richard Hamilton featured, at Centre 181, Hammersmith. The easel light is designed to be very light and portable and intended for temporary displays, but can also be used in exhibitions. Self-lit holograms would aid the exhibition and sale of holo-artists works. I have made initial drawings for frame lights using telescopic radio aerials, also portable. I hope to make some self-lit indoor *Dorset Markers*, in collaboration with local maker in metal, Anthony Hedgecock.

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Figure 11 Sideless frame in matt black stained wood, for glass plate holograms

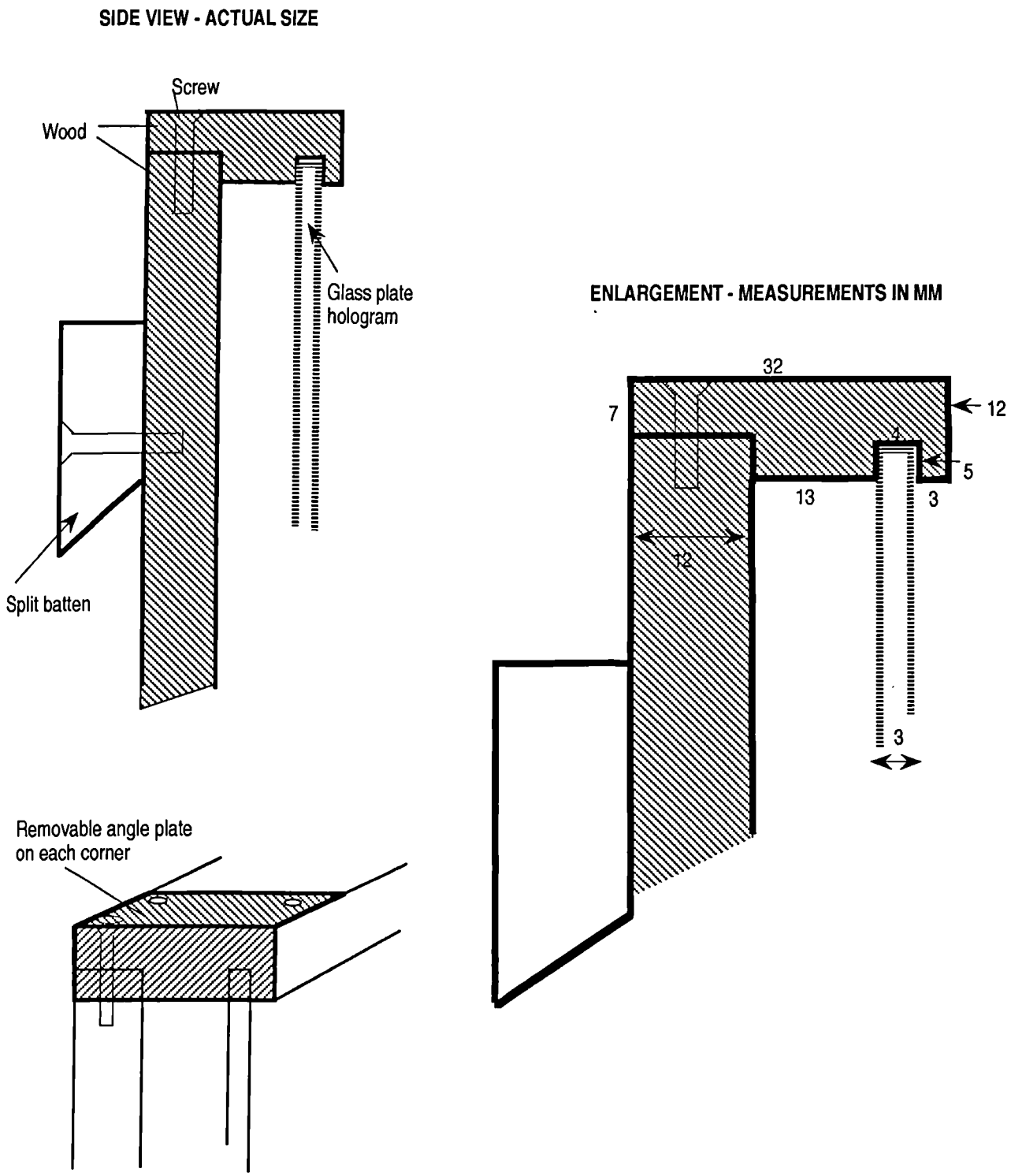
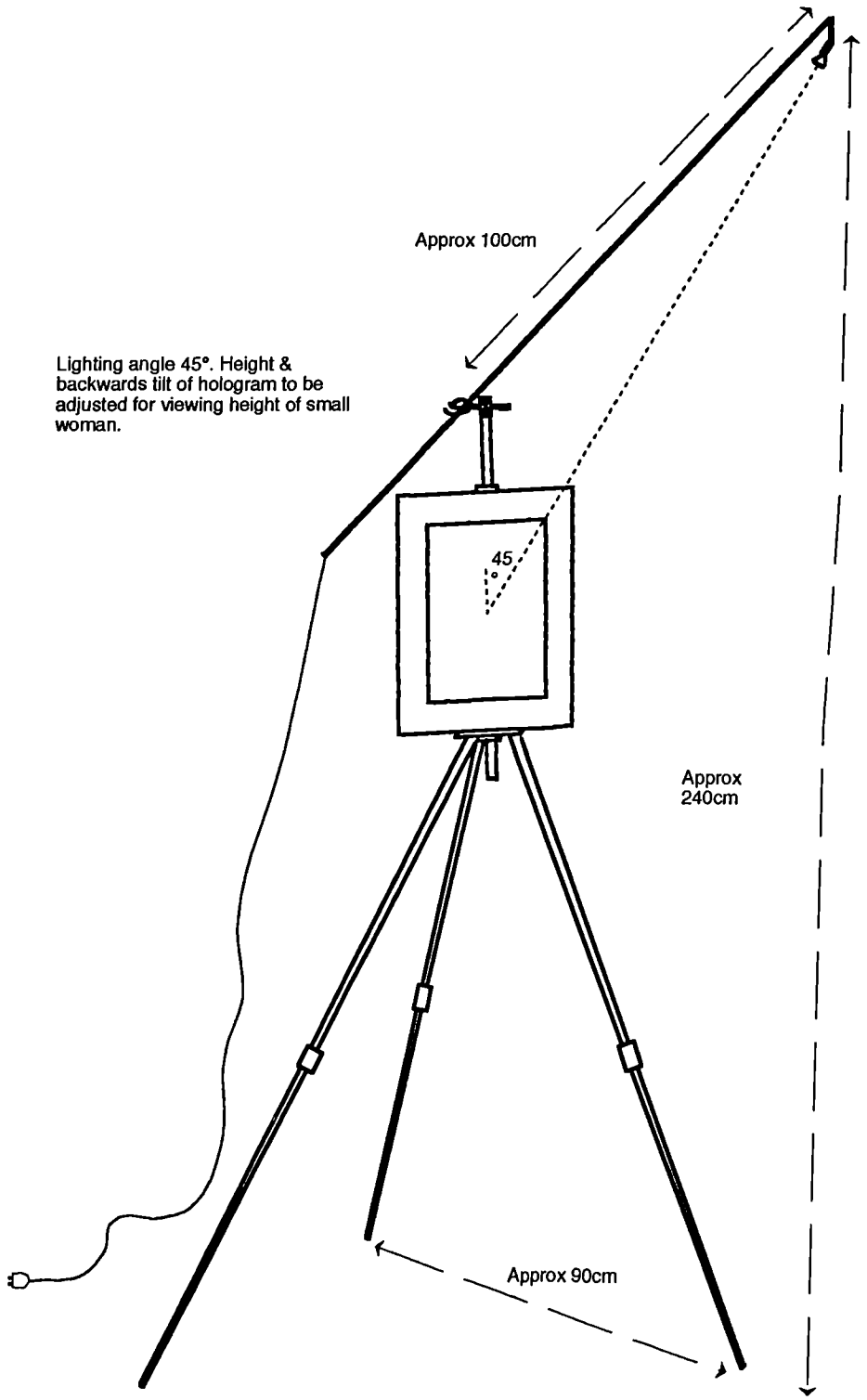


Figure 12 Easel light and hologram



CHAPTER SIX

CHAPTER 6

6.1 IDEAS: PRACTICAL PROJECT

The reader is invited to test the observations detailed in this part of the thesis by viewing the holograms produced as part of the project.

From the particular to the general, inside to outside, private to public

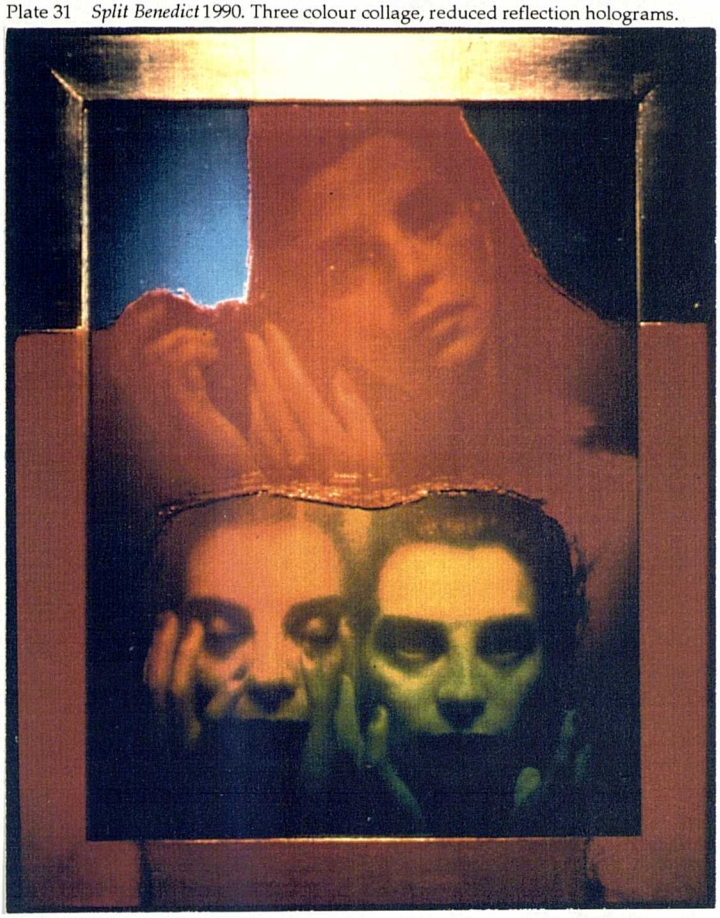
The phase of my life-work on which this project concentrates, the *Cosmetic Series*, assumes the existence of an inner self. This contradicts the anti-individualist, anti-humanist, anti-visionary stance of Post-Structuralist thinkers such as Derrida and Foucault, which when translated into the field of art can become distorted and extreme[1]. For example, my female *Cosmetic Series* arose partly out of an awareness of my inner self still around 23 years of age in a rapidly ageing body, and partly from the use of cosmetics in pulsed holography, to help prevent the laser light from producing the waxy appearance so familiar in a pulsed hologram.

I believe that the creative exploration of the medium on its own, however powerful, is not enough to produce art that continues the great tradition that has been handed down to us. I regard art practice as a symbolic activity, and our encounter with whichever medium we use to make art needs to be passed through our own individual intellectual, emotional, experiential make-up. It needs to emerge in a way that reflects this individuality, translated into a form that is universally recognizable beyond our own private experience. Work that has not gone through this sort of transformation is usually a 'copy', an eclectic reflection of the culture that surrounds us. I disregard the anti-visual, anti-humanist, anti-individualist, post-feminist stance of post-modernism. I see holo art as positive, pragmatic, fearless, naive, even joyful - a way out of the current rigorous and stern climate of suspicion, doubt and gloom.

The hidden agenda

Split Benedict is an esoteric but key piece in the female *Cosmetic Series*. I have not written or spoken about the personal aspect of my work because it seems

Plate 31 *Split Benedict* 1990. Three colour collage, reduced reflection holograms.



unwise and may even be wrong to do so. Some people seem to be able to respond to this work without explanation. *Split Benedict* is an important piece to me. It connects me with those early childhood experiences that many of us have, the first raisings of human consciousness, which in my case had a powerful effect on the course of my life and made me want to be an artist from around the age of five.

The underlying reason why I am making holograms now, rather than paintings, is because they are a purer way of connecting up with those really early, pre-verbal memories that are experiences of light. I have a memory of my father's teaching me to paint, with that deep blue that seems to resonate in us more profoundly than other colours, which is the colour of the 'sky' in *Split Benedict*. This seems to be the colour of meditation - why else would it feature so often in medieval paintings? Perhaps, it is because we can 'see' the ultra-violet part of the spectrum, the hidden part that we can't really see. I think that we already 'know' about things that science feels it has to prove, but can't speak about them simply because they belong to the realm of subjective experience.

Hiding and revealing is partly what the *Cosmetic Series* is about, and *Split Benedict* is like an esoteric clue to the hidden agenda behind the series, the cosmic aspect from which the word cosmetic is derived - the metaphysical or religious aspect. The trinity is female because I am female. The hiding and revealing that goes on in these works ties in with the *Secret Sacred* (1978) series of three works that I made whilst in Australia. To expose the private parts of my work would feel like a violation. My early student explorations of my female psyche were so misunderstand by my male tutors that I was asked whether there was anything the matter with me. With my sanity in doubt, I

quickly learnt that the privilege of working with things of the female spirit in an open manner was not acceptable, and I adapted the forms of art as defined by men. I am considering whether I should make some works that are entirely sacred to me, that only people that I know are on the same wavelength are allowed to see, like the Australian aborigines did.

In the *Cosmetic Series*, this 'hidden agenda' is mostly hidden. The painted pieces are mask-like, ironic. There is an ironic use of the traditional format of framed artwork, which flouts the current objection to frames, and the tongue-in-cheek attitude towards kitsch and 'identikit' painting. However, there is also a controlled, centred, classic stillness in the image, which is one of the enduring qualities in painting. The use of underpainting and the brush mark in current work acts as a personal signature, (literally so in the case of the fingerprint in two of the Hamilton holograms). In this way the project continues an interaction with the traditional art area of painting within holography.

Kitsch

That the *Cosmetic Series* is on the edge of kitsch comes directly from the fact that I now live in Britain, in an urban industrial society. The holograms that I made when I lived in Australia are very different [Appendix H]. It also comes from the medium itself, pulsed holography, which in recent years has become commercialized. These works have to compete with genuine kitsch in the large popular holography shows that have been my main chance of showing my work. As gallery art, this relationship with kitsch should not present a problem, post-Pop. The work is a comment on 'surface' reaction, a 'cosmetic' reaction to urban society. It is not prescriptive, but reflects our current position in the form of stereotypes. In physical terms, a surface defines the extent of an object and can always be related to mass. In a hologram, surface is redefined as a 'skin' without substance. The production of cosmetics is based on packaging and advertising, as much as on the actual product. The use of stereotypes is one of the most powerful mechanisms for assimilation in mass circulation imagery, but there is an eventual fatigue inherent in all stereotypical images. Artists can deliberately accelerate or retard this fatigue[2]. I do not wish to be more interventionist and confrontational than this.

Beautification

Beautification in the *Cosmetic Series* has universal implications. The word *kosmos* in the original Greek meant proportion, reason, order, which in today's

Western culture has become superficial and vulgarized into the word *cosmetic*. The Platonists believed that the 'apparent' world was merely an adornment of the invisible (intelligible) world of pure principle. Adornment was both illusion as well as a revelation of the principles of which it is an outer expression.

The male *Cosmetic Series* has diversified from the female series in size and ideas. Men do not normally use visible cosmetics in daily life and a different approach needed to be found for our collaborations. The masters for the male series were made with beautification in mind, but also with the idea of making male stereotypes, icons of male authority, personally experienced by a female in a male world. As with the female series, the subjects were sympathetic. The central, symmetrical positioning of the faces in the *Cosmetic Series* is deliberate, in the way that the 19th century painter Caspar David Friedrich positions his images centrally.

Aesthetics and 'composition'

I have discussed previously [Appendix K] whether we actually need an aesthetics of holography, bearing in mind the problems associated with aesthetics. Basic values must be examined before aesthetic judgements can be made. As an example, one of my *Femi* pieces has been dismissed as a bad hologram which could perhaps be appreciated only by 'little old dears'. This brings into question whether in fact the artist herself is not a 'little old dear', and whether senior females have as much right to make serious art, or have it made for their gaze as other sections of our society. Such judgements raise questions of sexism and ageism which are more morally basic than aesthetics.

'Composition' is a very useful high-school concept for assessing works of art, but it has to be asked how relevant such concepts are in relation to the progression of art through Late Modernism, Conceptualism and Post Modernism, and in particular to the 'all-over' properties of the hologram.

The Other

My work operates within the area of identity and gender differences. I make a distinction between 'sex' and 'gender'. Sex refers to biological identity, and gender to the parallel and socially unequal division into feminine and masculine. My disability (ME) has affected the content and appearance of my current work. Through illness I have been forced doubly into the stereotype of the weak female. This has led me to work more collaboratively. Faith

Ringold, Alison and Betty Saar, and Carrie May Weems are examples of black artists working from a position of negative privilege. As yet there are no black, female, holographic artists, but I should imagine that if there were, she would be the prime example of negative privilege.

My own position is that I reflect the status quo, stifle my anger and use subversive over confrontational methods. I feel impelled to produce work in which humanism is the main stance, regardless of the mainstream move away from humanism. Regarding both theory and practice I have problems with the necessity of conforming to existing male standards, whilst producing work true to my own medium and gender position as an outsider.

Painting and the good old things

Regarding the hybridization of holography and paint, hybrids can produce energy. The intention was not to make holography 'respectable'. I regard holography as a medium in its own right, as is obvious in my early work. The aim in my current work is to make compatible the private and the public faces of my work, the symbolic and personal with the demands for the distanced 'correct' and fashionable presentation as a gallery artist. I am trying to make my way in the contemporary world, within an appropriately contemporary medium. My view of painting is that it has been revived in the current conservative climate but is nevertheless sitting on the edge of a cliff. New things can no longer be done with painting, and as a medium it is out of its time. It is not fashionable, not at the leading edge. It is in danger of surviving only as the arcadian antique, pursued enthusiastically by amateurs in the main, as evidenced by the art clubs flourishing all over the UK. Having ventured from painting into holography with the idea of bringing fresh information into the art area, and finding the door closed behind me, I now wish to experiment with all possible means of retaining my roots, but as an holographer.

In the *Cosmetic Series*, the emphasis on painting the face during the recording stage is carried through into the final presentation of the hologram, through fusion of the hologram with a painted image of the same face. The faces are centred in full frontal view, partly to emphasise the stereotype, but also because I had to merge a spatial image with a flat one on the image plane, and a full frontal view is flatter than any other orientation of the head.

The holographic image cannot be retouched, which means that the original image has to be accepted, warts and all, but it can then be modified in the following manner. A brightly coloured gouache painting is made to correspond as closely as possible to the holographic features. When this painting is placed underneath the transparent holographic plate, it alters and emphasizes the holographic features. A new, subtle range of tints is produced from the mixture of the subtractive colours of the painted face with the additive monochrome (usually yellow green) of the hologram. The success of the modification depends on the careful registration and alignment of the painting with the holographic features, so that it enhances rather than conflicts with them. In practice this is rather difficult to achieve while still maintaining the necessary spontaneity in the brushwork, so that the brush marks lend a texture and vitality to the hologram. I wanted to loosen up the image slightly, to get away from the waxy, morguelike feeling that pulsed portraits sometimes have.

Dim holograms are acceptable, allowing the painting to show through and modify the image. In one exception, *Black Jack,* I have used a bright hologram which over-dominates the painting, but this has allowed me to paint a completely different man underneath, without disrupting the hologram. Choice of colour and tone in the painting reinforced painterly mores. While working to maintain the spatial integrity of the hologram, I found that red came forward, and blue receded, just as I had been taught when I was a painting student. It proved impossible to use red backgrounds in the painting, because it was necessary for the background to recede. The hologram became the "machine" that predetermined the painting, in the same way that Sol le Witt's ideas have been the machine that makes his art. It became the system by which my activity was controlled. A feature of my *Cosmetic Series* is that when the light illuminating the hologram is out, there is still a painting on the wall.

Living with holography

Holographers are working, "not with the good old things, but with the bad new ones", as Brecht put it. In also using the good old things (such as their own hands) they acknowledge a time continuum bridging past, present and future. It is important to use a form of art that is truly involved in the terms of its own society. Holographers are invariably seen as involved in a fantasy of the future, and can choose to balance this with a fantasy of previous societies, or those that live on a different time scale from our Western society. In a

culture saturated with hallucinatory images to an extent that has become positively phantasmagoric, I believe that holographers are truly involved with the terms of their own current society, at the psychic level.

The work that I produce for gallery exhibitions comes out of the (currently unfashionable) conviction that I have an 'inner life'. The work comes from a need to articulate and communicate these experiences visually. My holograms are usually small and exhibited in the living space of people's everyday lives. I do not want to do away with the quiet attitude that this sets up. I am suspicious of large scale spectacular work and see a dominating, patriarchal element to it. I am suspicious of the 'master' concept of art which emphasizes status rather than rapport.

Like many artists in the UK, I work at home with my children around. Rather than the more usual British artist's studio in the bedroom, mine is in my garage. It is extremely low-tech, containing a low-powered laser, hand-made optical components, and a darkroom of chemicals which I mix myself. I duck in and out of institutions when I need access to more high tech equipment than my own. For me there is no art/science debate. I have been living organically with holography as art since its inception. I regarded it as important from the beginning to make my own holograms, and believed that this 'hands-on' approach was important at the time for the discovery of those aspects of the medium that are unique to it. That holography could be taken out of the reach of individual artists by the operations of multi-national companies fills me with dread.

My approach is as an 'auteur' rather than a corporate artist, retaining those individual characteristics which are tied to the traditional role of the artist in society.

This section is an explanation of ideas and results arrived at in individual works made in the practical project. A summarized list of works is given in Appendix J.

THE COSMETIC SERIES

Painted Soldier

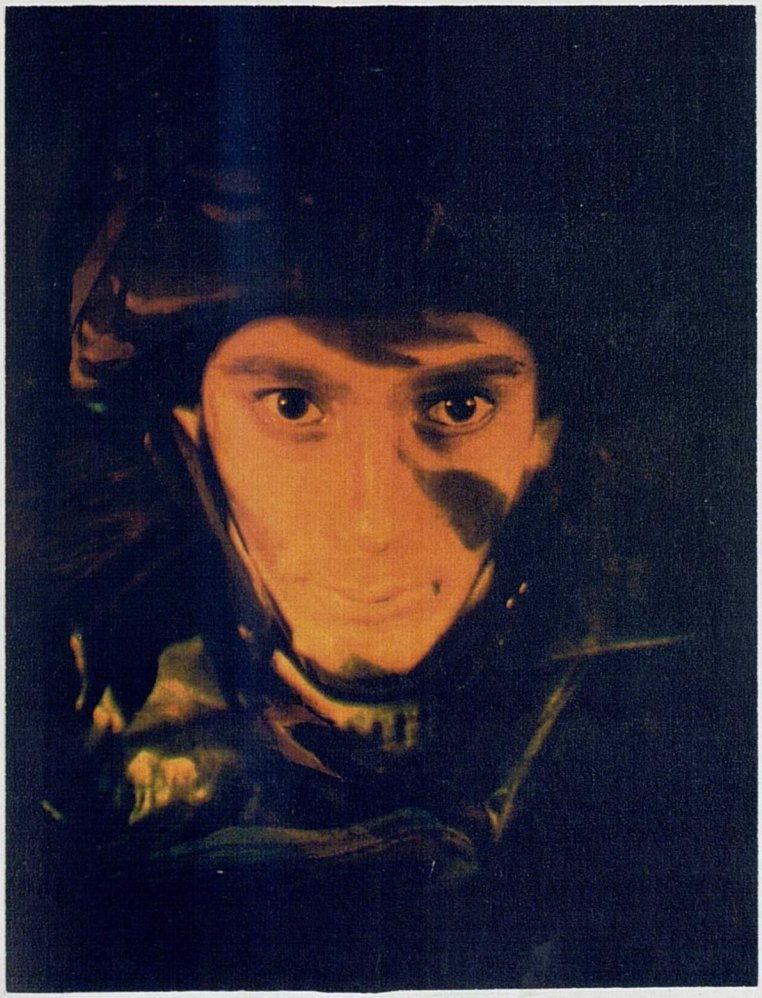


Plate 32 *Painted Soldier* 1990

This is a 32 x 43cm glass reflection hologram combined with a gouache painting registered with the holographic image of a young male in helmet & combat jacket, with camouflage make-up. In this piece the soldier is treated sympathetically, as a mother's son, but within the 'toylike' kitsch culture of the pulsed hologram. The image is expressive less of machismo than fear, identifiable in the dilated pupils of eyes 'shot' with a pulsed laser. An innocent young face was chosen to combine the old warrior man with the 'new' man, more sensitive to female values, an image that men could feel does not attack them, but nevertheless accepts the reality of sexual stereotyping. This image may be seen to be unacceptable within the art world, but if Cindy Sherman's monsters and Jeff Koons' toys are acceptable, so is this work.

That holography was born out of military research is an untruth that the art world in its ignorance likes to believe. That lasers are used for warfare should be even more reason why artists should, in my opinion, be out there counter-acting the sinister uses with peaceful ones. I have made anti-war holograms in a military academy with cadets drilling outside (*Unclear World I & II*). However, the message coming across in *Painted Soldier* is more oblique. This piece fuses two dimensional painting and three-dimensional holography in a hyper-realist manner, similar to that used in the female series. It contravenes the unwritten contract that many artists hold with themselves, never to use a militaristic subject. This is seen to be even more morally indefensible than accepting sponsorship from weapons-producing industries. The frame of reference of this work as a peaceful, voluntary offering for contemplation is felt to separate it sufficiently from the arena of 'smart weaponry' and the killer instinct, but the subject suggests that modern life can be such a minefield that artists can no longer be so certain of a built-in professional morality.

My collaborator Jonathan Cope had been in the Territorial Army, and had become an art student. He had no objection to my perverting the use of camouflage make-up towards making him look beautiful. I did not want a parody of 'machismo' which I could have obtained by over-doing the camouflage, putting bird's nests on the soldier's helmet etc.

Cosmetic Camouflage

Cosmetic Camouflage is a 30 x 40cm pseudocolour reflection film hologram of an image of the soldier masked with camouflage cut-outs. It is post-swollen in brush-marked areas reminiscent of abstract expressionism (a predominantly male movement in art). By superimposition of images, or in combination with other media, it is possible to make a number of quite different pieces from the same master. Camouflage in the image of the soldier was extended in the transfer stage to a form of optical camouflage. The master hologram was masked with camouflage cut-outs which, when the transfer is flipped over, looks like an animated dappling of the face when seen at a distance. The rippling is further enhanced by loose corner-mounting of the film transfer. *Cosmetic Camouflage* has been further manipulated by post-swelling, which has the advantage that from a single exposure numbers of different colours can be produced from a monochromatic image, each of which is unique.

Cosmetic Camouflage II (Pushing up the Daisies)
This is a planned collage of separate film reflection transfers of 50 x 60cm soldier, flowers and screen, possibly including text and photocopies.

The Artist: Richard Hamilton

Plate 33 *Richard Hamilton* 2 1991.

Richard Hamilton is now recognized as an important British painter, best known as a 'father of Pop Art', and also known for his reconstruction of works by Marcel Duchamp, the artist who has been a major influence on the art of this century. He is also well-known as a technophile. It was his understanding approach to technology that prompted me to ask him if he would collaborate with me as one of my male *Cosmetic Series*. I had seen in 1980 in *Similar Visions* at the Museum of Holography, New York, a lenticular photograph of him using raw pigment in space in front of his face, and

thought that would be an interesting approach to the idea of painting male faces. When shown other works from the series he was interested in the ways that the holographic image could be modified, and expressed the opinion that holography had progressed further than he had previously thought.

This series of holograms show the stages of Richard Hamilton's involvement in time with painting on a sheet of glass in front of his face. They show his initial disengagement, the changes made to the distribution of the paint, his use of the shadows it cast on his face, and the paint drying between exposures.

The series contains three monochromatic holograms, and one with four colours mixed to give the 'flesh' colour of the face. The pink flesh colour may be carried through to other holograms as a way of *humanizing the technology* - a term first used by Billy Kluver of Experiments in Art & Technology (EAT) in the '60s. Whilst we were working on the project Richard Hamilton asked whether I wanted an old man as a model. I replied that I wanted him. This was because I had always seen his work, from his days as a founder of the Independent Group, as a rare response to the issues of the day. I also admire his intelligent use of technology. He appeared completely at home in a holography studio.

Plate 34 *Cosmetic Series: Richard Hamilton* 1991.

The joint project was successful for both of us. The final piece that he worked towards fits perfectly with his current computer-manipulated Cibachrome self-portraits, and the flesh-coloured portrait of the

artist fits well into my *Cosmetic Series*. He was given the best of the flesh-coloured proofs, and a monochromatic proof which was shown in his exhibition at the Anthony d'Offay Gallery, London. The opening was a stylish affair, with such luminaries from the '60s as Mick Jagger and Paul McCartney attending. The hologram is mounted in the same aluminium channel as Hamilton's reconstruction of Duchamp's *Large Glass*. Duchamp's statement, 'The artist I believe in: the art is a mirage' has come true metaphorically in the de-materialized image of the hologram. The effect of this collaboration has yet to be assessed, but one outcome has been the christening of Hamilton as 'Hologram Hamilton' in a leading UK Sunday newspaper.

Pagan Paul

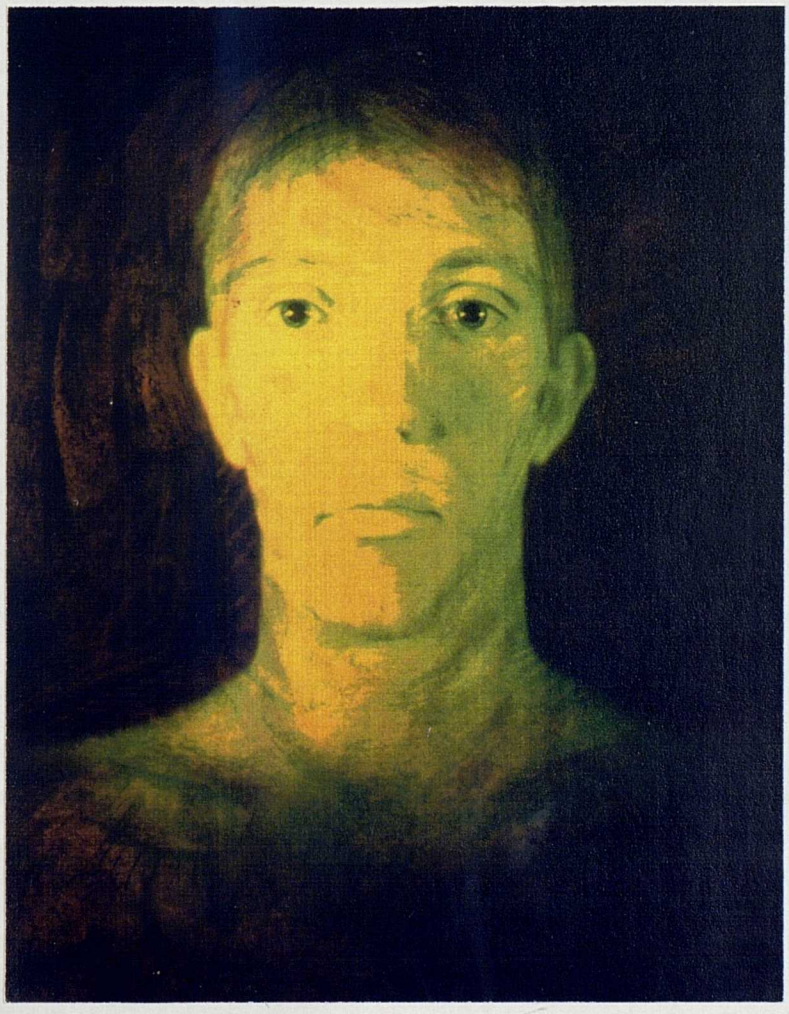


Plate 35 *Pagan Paul* 1993

This is a 30 x 40cm hologram of a young male daubed and finger-marked with dry pigment as the cosmetic element, combined with dry powder and pastel in the under-painting.

Pockell Paul

Pockell Paul is a 50 x 60cm hologram of the same subject as *Pagan Paul*, but with the pockell cell left off, which produces areas of destructive interference. There was an element of 'risk' in leaving off the pockell cell and trusting to a random image. If the pockell cell is left off, a single long pulse is produced which gives a softer interferometry than a double-pulse. I used the double-pulse in *Tiresias* 1981 and *Facial Codes* 1985 to show an interferometry

of the emotions. In this experiment with random holography, it was necessary to accept a more aleatory result. With the pockell cell on, the energy builds to a peak and is then released. With the pockell cell off, a number of random peaks are produced, which each produce their own hologram if the path lengths are matched. The image produced contains areas of random intensity, noise and destructive interference. The master of Paul produced a malevolent-looking image with a startling appearance of black bruising and lack of symmetry about the eyes - a battered man.

Eddie Coloured

This is a 50 x 60cm hologram of a young black man, originally intended as a partner for **Margot**, framed in a rectangle of wood, with a gouache underpainting including the written message 'Do Not Frame'. This refers both to the unacceptability of frames in current art, and the possibility that those with black skin may be adversely set up, 'framed', in British culture.

Black Jack

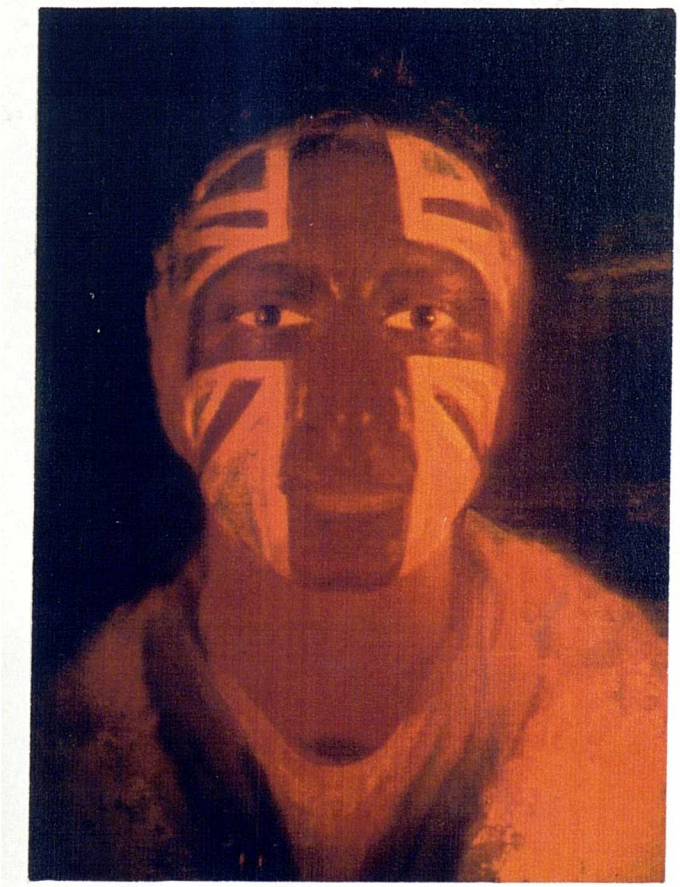


Plate 36 *Black Jack* 1993

Black Jack is a glass hologram 32 x 43cm combined with gouache painting of an unemployed young Brit, painted with a black Union Jack. Males in positions of established "authority" - the military man, the master artist, the pagan or cave man and in this case the nationalist, are treated sympathetically in the *Cosmetic Series*. In a country in which a recent Gallup Poll showed that half the UK population would prefer to emigrate than to live in "Great" Britain, the issue of nationalism was shown against the background of negative patriotism, a black Union Jack. The painting underneath the

hologram shows a black young Brit against a grey sky. A pair with different skin colours and the same nationality, are painted with the national flag for a ritual occasion such as a football match, a Royal wedding, or a night at the Proms.

A COMMISSION
Arts Council Award 1991

Plate 37 Arts Council Award 1991

Usually holographic commissions have nothing to do with art, and everything to do with commercial promotion. However, since arts organizations are no longer able to sponsor individual artists, funding is occasionally directed towards public commissions. In 1991 I undertook one of these commissions, after presenting drawings of three different ideas from which the Arts Council chose one. The hologram was to be presented as an award, and the idea involved the 'distancing' of a real trophy, a rosebowl, by making it into a hologram. Both masters and transfers of the two colour hologram were carried out in my own studio during the period that I was

involved in my PhD project. Although it is not considered as part of the project, it provides a sidelight on acceptable survival options.

This commission was presented in association with the Prudential Awards for the Arts at a presentation dinner held in London at the Grosvenor House Hotel in November 1991. Lord Peter Palumbo, the Chairman of the Arts Council, announced and presented the award to the London International Festival Theatre. A slide of the hologram image was back-projected on either side of the podium during the announcement. The actual hologram was installed in the reception area. The image was also chosen by the Arts Council for their seasonal greetings card, and sent to their clients.

FEM SERIES

Much feminist art has stressed the relations between the personal and the political to explore issues of identity and experience. Women artists have led the way in the exploration of the poetic and subjective, and in the demand for a 'content' to art. My work belongs in this context.

Female artists have been relegated to the chaotic, the pre-conscious, so-called 'natural' areas. Therefore 'natural' images - water, fish, twigs and flowers were recorded in an all-over way, stressing the integrative, co-operative aspects of female behaviour, and holography itself. Characteristics called feminine are always associated with women, and those called masculine with men. The idea is to make use of values called feminine, so that cultural/biological differences between the sexes are more visible in the actual making of the art, as well as the subject matter. Assigned female characteristics such as decoration, the organic, gentleness, passivity, caring, and so on could be used to construct a female aesthetic.

Their problem is, that to be equal in status to men, women must no longer be women. Using their assigned characteristics could put women into even deeper water and re-affirm their relationship with the negative 'outsider'. It could result in even more unbalanced divided aesthetic sensibilities. Alternatively work could be made deliberately to address the subjugated half of the human race specifically, since women's work is invariably viewed in the knowledge that it has been made by a woman. As a painter, even when I painted with hard-edged colours chosen from the Rand table (a random table of numbers) my choice of colour was still criticized as too sweet (by a

woman). It is no longer a serious option to work incognito as a man, as some women writers have done in the past.

Wrapped Flowers

This is a glass 32 x 43cm triple exposure reflection hologram in red and white. Flowers are partially wrapped in different ways and superimposed so that flowers and coverings interpenetrate each other. The flowers are marguerite daisies, a pun on the artist's name. The wrapped flowers are self-centred, a gift to the maker herself, a person suffering from ME (and also feeling transparent). This work has an affinity with that of a female photographer suffering from the same disability, Claire Collison. The physical stamina required to carry out a registered reflection ***achromat*** within the time necessary (a day) meant a prolonged time of rest on either side of the work period. The reduction by illness to the stereotypically weak female is counteracted by the physical achievement of carrying out of the work (when to work is to bring on physical illness).

'Penetrate the surface...'

This version of **Wrapped Flowers** has marks and the text "....penetrate the the surface of the emulsion..." written with silver pen on the surface of the glass. Multi-layering and handwriting are methods initiated by female makers, sometimes adopted by male makers (eg. Duane Michaels). Small silver pen markings tie the three dimensional image to the two dimensional surface of the hologram, so that both interact. The instruction to the viewer to 'penetrate the surface of the emulsion' allude both to the physical act of viewing the hologram beyond the image plane, and the metaphysical act of penetrating superficial appearances to perceive their 'hidden agenda' (6.1). The 'all-over' composition of the piece refers to the hidden construction of the hologram, in which light wavefronts have fallen all over the plate, making conventional ideas about composition irrelevant (2.1).

Enough Tyranny

Enough Tyranny combines fragile precious images of insect wings, pearls, a baby, combined with a flat graphic of a man's hand and raised hard-edge baton/gun barrel, lying in the centre of a folded piece of paper. The image is a message about vulnerability and domination. The work consists of a number of 4" x 5" glass plates in various colours and a glass 32 x 42cm hologram in a 'flesh' colour, tending towards green.

The *Femi* series overlaps with *Hol* and *Cornucopia*.

'HOL' SERIES

This series involves holistic or metaphysical concerns which I am not able to discuss, for reasons given in 6.1 under 'hidden agenda'.

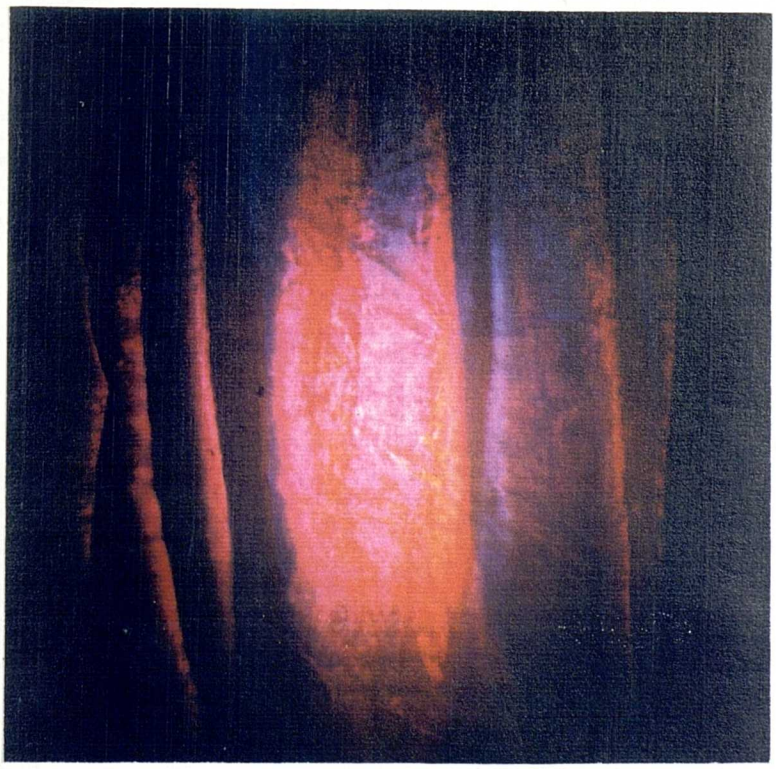
Web

Web is a loose film 50 x 60cm red reflection hologram of a section of net which continues beyond the edges of the hologram, implying a limitless field. The net can be taken at face value, as an image. However, the work employs religious symbolism, the holistic 'many-in-one', a binding together. (The root of the word religion is *ligare* to bind and the Sanskrit *yoga* and *tantra* mean binding and weaving.) The work stresses the holistic integrative aspects of holography as a medium, and celebrates the co-operative aspects of female behaviour.

Blue

A 50 x 60cm film hologram of a lit blue screen can be used on its own, like a sheet of sky, a colour of meditation, or as an element in a future collage.

Curtain



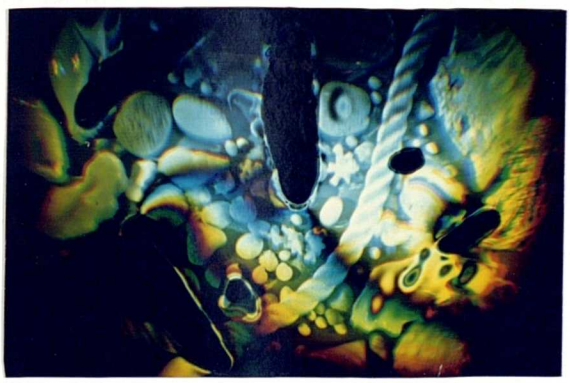
This is a 50 x 60cm hologram of rich red draped pan velvet lit from two sides. The curtain is closed. It is intended to be combined with an 8" x 10" stereogram of the curtain being opened, an image of revelation.

Plate 38 *Curtain*

CORNUCOPIA

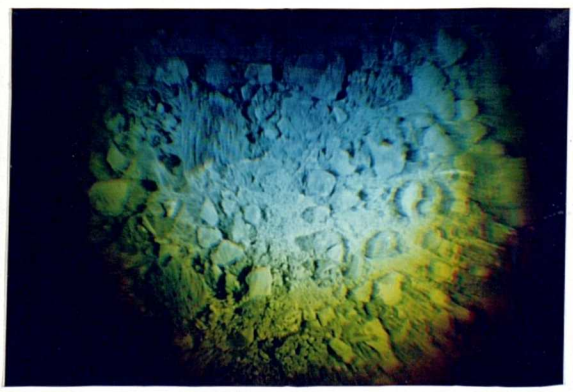
I take the view that everything can be classified as 'nature'. Humans and the things they make are part of nature, even their agents of destruction. Nevertheless, parts of our environment are traditionally perceived as the primary creations of nature re-created by humans. Here, the least manipulated natural phenomena are seen at their most aesthetically acceptable, so that storms, skies, trees, grass, mountains, seas, are more pleasing to the senses than synthetics, garbage tips, concrete buildings, and machines. In the *Cornucopia* series 'natural' images are chosen for their hologenic and sensuous appeal, (the sunset without the turd). This is to comfort the viewer and re-contextualize the hologram as organic and easy to live with, rather than as the product of an alien technology, the raw rather than the cooked.

The images are not seen as significant on their own, but are intended to be combined together in abundance. The masters were made to be used as a basis for experimentation with colour, pre- and post-swelling, and for possible inclusion in installations in which the images are presented in a cumulative manner with other images.



Shells

A 50 x 60cm laser transmission hologram lit in white light, of an all-over image of shallow ground covered with shells. An unstable version of *Shells* has dramatic marks that look like sea-slugs in the context of the underwater image.



Concrete

A loose film 50 x60cm transmission hologram of an all-over image of shallow ground covered in concrete pieces, extending beyond the edges of the hologram. Rainbow dispersions from the larger chunks of concrete transform them seemingly into opalescent coral.

Plate 39 Top: *Shells* . Bottom: *Concrete.*

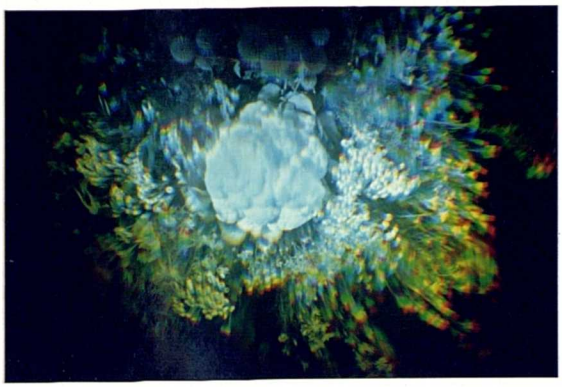


Plate 40 *CauliFlowers*

CauliFlowers

A loose film 50 x 60cm transmission hologram of a circle of various flowers and berries centred on the head of a cauliflower. A central efflorescence, suggestive of female sexuality. Chromatic dispersions abstract the image except where it clusters round the image-plane.

Fish

A blue-green 50 x 60cm loose film reflection hologram of real fish swimming in the same direction, in painted water.

Dorset Markers

These are being developed from my **Solar Markers** (1979). They comprise small limestone rocks ground to a flat surface on one side with holographic material applied in various ways, as 'naturalized' holograms. They are at an experimental first stage. The synthetic plastic 'feel' of film is treated as an aesthetic problem to be solved. Experiments are being carried out with bleached transparent reflections attached in a floppy way, transferring thin layers of metal diffraction grating foil with glue to rocks, or attaching self-adhesive embossings and foils, stringing them up with thin wires, etc.

The art works which are the result of this project can not be 'proved', like a scientific theory, although they can be put to the test in public exhibitions. Some work from this PhD project has been presented to the public in two forms, as papers[3] and in exhibitions in Pulheim, (Germany), at Lake Forest College, Illinois (USA), the Anthony d'Offay Gallery, London, the Smith Gallery, London, Centre 181, Hammersmith, London, and at my open studio during Dorset Art Week, 1994. Written material from the thesis has provided the germ for three published papers which are more concise than the thesis. I feel that the first part of the thesis has potential for further development into a book. A proposed John Libby/Arts Council joint publication with the ACGB Film Department made no progress beyond initial interest. The current recessionary climate in the UK does not encourage the opening up of neglected areas of debate such as holography, and tried recipes are being recycled rather than publishing and exhibition programmes diversified.

The holograms show the ground covered during the practical project. The techniques explored and described include learning how to set up for pulsed holograms (and deliberately mis-use a pockell cell), use a krypton laser, make 50 x 60cm holograms, develop gelatin lamination and post-swelling techniques, handle film as opposed to glass plates (including sheet lamination), and make achromatic and 'flesh' coloured holograms, and holographic stereograms. Although I have not concentrated on the technical aspect I suspect that this is what is most expected from a PhD project.

The value of the project to me is that I have been able to complete the male *Cosmetic Series*, and subsequent work provides a direction into the future. I will continue to work from the matrix holograms for *Cornucopia*. With my PhD completed, the most pressing direction for me is to make some self-lit pieces, and to explore avenues other than exhibitions. With the passage of time it has become evident to me that despite life-long efforts I have barely scratched the surface of the art world. There are signs that the next generation is faring better, but my conclusion has to be that holography as art has a long way to go before it is taken seriously. Perhaps it does have to be fully integrated into our culture before it will be used regularly by artists.

The value of the project for others is that it is a comprehensive examination of the art ramifications of holography and may provide a basis for further study in this field. In different circumstances the thesis would have been smaller and the body of practical work larger, as I would have preferred. There have been disadvantages in carrying out the project part time. It was difficult for me to retain enthusiasm for work on the male *Cosmetic Series* when spread over such a long period. I have become much more enthusiastic about exploring the potential of holographic stereograms, which add the time dimension. Because the thesis was written over a period of five years the emphasis would inevitably be different if written now, but it is not much out of date.

An aspect of knowledge most valuable to me has been the requirement to set aside time to examine the relationship between my ideas about my work and where they fit and do not fit the current theory and practice of art. Some of this thinking is set out in the thesis, some of it is evident in the work, and most of it will provide the impetus for future work. It is hoped that the work carried out will be useful to practical holographers, artists, art critics and writers, educators, and exhibition organizers, as originally intended.

> To prophesy is extremely difficult - especially with respect to the future.
>
> Chinese proverb.

The position of holography now is that it has a sufficient number of artists interested in it to be considered an art medium. However, the main area for growth and change in display holography is in the commercial field. Embossing, dry processing, photopolymers such as the Polaroid Mirage and Dupont materials, mass-production, automated holo-copiers, holograms on clothes, architectural uses outside and inside buildings, hot-stamping in magazines and books, all take us into the future. Already over a billion holograms have been distributed world-wide as security devices[4]. Corporate take overs are now a feature of the holography business. Technological innovations are proceeding, but these are combined with the harnessing of old technology into new uses, in for example the embossing industry. The photonic revolution is taking over from electronics (light is faster).

Benton's privately expressed opinion that holographic TV is probably three or four Nobel prizes away may need to be revised in the light of his own developments in this area. Benton's original paper on 'slit' holograms concerned the reduction of information in a hologram, because the amount of information in a hologram makes it difficult to transmit with TV bandwidths. Now his MIT group is computing and reconstructing realistic moving images in real time - the world's first demonstration of real-time holographic video[5]. Mass-communication systems are becoming increasingly digital, and holographic high resolution liquid crystal screens could be developed. Regarding communications, nations are busily laying down fibre-optic cables, which is the right direction to go for holographic transmission.

Emmett Leith reports that optical computing has become one of the hottest topics in optics[6]. A new type of digital computer, one that works with photons rather than electrons, could be much faster and more powerful than present day computers. Fibre optics, integrated optics (handmaiden to fibre optics, to provide the switching, inputting and outputting needed in fibre optics telecommunication systems) non-linear optics - an all-optical digital computer. The second possibility is an analog computer known as a neural

network, because it works on principles that are possibly rather close to those governing the brain.

Leith states that whilst holography is not the basis of these emerging technologies it plays an important role, and is an ubiquitous presence in the research literature. Holography appears in solutions to the problem of making the trillions of interconnections between different cells of the computer. Such a vast network could not be made electronically, because of the impossibility of having so many wires criss-crossing in a confined area. But light beams can cross over each other, with many beams occupying the same space, with no interaction effects. It is holography that is often considered for forming those interconnects. Also, holography is being considered for the huge memories that such computers require. And it is often holography that is invoked to form the devices that will work with light beams. It is Leith's opinion that if this far-out dream of optical computers comes to pass, it may contain within it most important applications for holography.

Holography could be the 'glue' that holds future ideas together and makes them possible.

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GLOSSARY

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GLOSSARY

Beamsplitter: a partially silvered mirror which divides a light beam into transmitted and reflected beams. A variable beamsplitter allows control of the ratio of intensity of the two beams.

Coherent light: light of the same frequency that is also *in phase*. The laser produces coherent light which enables the hologram to be recorded in the form of an *interference pattern*.

Collimator: a device, either a lens or a curved mirror, which is used to produce *collimated light* by positioning a light source at its focal point.

Collimated light: light which forms a parallel beam and neither converges nor diverges.

Continuous wave (cw) laser: in display holography this is usually a helium-neon (HeNe) laser, although more powerful lasers such as argon and krypton lasers are used.

Denisyuk hologram: a single beam hologram in which the reference beam is also the object beam. The beam shines through the holographic film/plate, lights the object which is placed close to the film, and then bounces back to interfere with itself on the film plane.

Dichroic: the property of a surface which reflects light of one colour and transmits light of other colours.

Dichromated gelatin hologram (DCG): a hologram made on a light sensitive emulsion made up of a solution of dichromate compound on a gelatin substrate. DCG produces holograms that are very bright.

Diffraction grating: a device which bends light through the effects of diffraction. A hologram is a special kind of diffraction grating. A holographic diffraction grating is a hologram formed by the interference of two or more beams of direct laser light.

Emulsion: the light sensitive coating of a holographic film or plate.

Etalon: a device introduced into the laser to extend the *coherence* of the beam, often to several meters. It has the disadvantage of also reducing the power output, so is only worth using with high power lasers.

Focused image hologram: a hologram in which the image has been focused onto the film or plate by a lens or optical mirror.

Fringes: interference bands made up of cycles of constructive and destructive interference, which show up under the microscope as a pattern of light and dark areas.

Full colour holography: holography in which colours are intended to reproduce as closely as possible the true colours of the subject, sometimes called natural or true colour holography.

H1: a *master hologram*

H2: a *transfer hologram*, which could also be the sub-master for an *H3*.

H3: a copy hologram from a sub-master.

Helium neon (He-Ne) laser: the laser most commonly used in display holography. Helium-neon is a lasing gas mixture that produces a continuous red beam at 632.8 nanometers (nm). Its low power and short coherence length (approx 13", depending on the size of the laser) limits the size of holograms that can be made with it.

Hologram: an interference pattern formed between two beams of laser light, whereby a record can be made of the detailed properties of the light reflected from an object or scene, that is the *phase* relationships to which the emulsion is not sensitive, as well as the intensity to which it is.

Holographic optical element (HOE): in display holography the HOE is the term most often used for *diffraction grating*. A HOE is a hologram which may be used to act as a lens, mirror, or more complex optical component. Holographic *collimators* are HOEs.

Holographic stereogram: a hologram in which the image has been made from many consecutive photographs or computer graphics so that the eye sees only one image from one viewpoint. The image appears to have full horizontal parallax. The technique is a marriage between 3D lenticular photography (xograph) and holography. Sometimes called *multiplex*™ or integral holograms, the images often include limited movement.

Image plane hologram: a second generation hologram or *transfer* hologram positioned in the plane of an image formed by a *master* hologram.

In phase: the description of light waves of the same frequency which are in step, so that the crests and troughs in the waves all travel along together.

Interference pattern: the pattern produced when two beams of mutually coherent light interfere.

Isolation table: a table which has been damped from vibrations from the ground, using vehicle inner tubes or more sophisticated methods. This table can have a metal top, concrete or sand. Vibration isolation must be used in holography to prevent the movement of interference *fringes* during an exposure.

Krypton laser: a laser which produces a red light similar to that produced by a helium-neon laser, but with approximately ten times the power. The addition of an etalon (coherence expander) allows for increased image size and ease of working.

Laser: (Light Amplification by Stimulated Emission of Radiation). A device which emits a beam of very intense, monochromatic *coherent light.*

Laser transmission hologram: a *transmission* hologram lit with laser light.

Master hologram: a hologram (usually a *laser transmission hologram*) used to produce a real image for a transfer hologram .

Multi-colour Holography: holography involving more than one colour, either natural or *pseudocolour.*

Multiplex™ hologram: *holographic stereogram.*

Object beam: the laser beam lighting the object which falls onto the holographic emulsion when making a hologram, to interfere with the *reference beam.*

Open aperture hologram: a transmission *image plane* hologram viewable in white light.

Orthoscopic image: an image with correct parallax and front and back orientation.

Parallax: the apparent difference between two different views of an object, whereby with binocular vision we can extrapolate depth. The viewer can look around and behind objects in a holographic image which has full parallax.

Phase: the position of a wave in space measured at a particular point in time.

Pseudocolour: in a hologram, colour which is not that of the original subject, but is created deliberately by changing the wavelengths at which the hologram is replayed.

Pseudoscopic image: the opposite of orthoscopic. An image that is turned inside out.

Pulsed laser: a laser which emits light in a very short and powerful burst. In display holography this is a ruby laser.

Rainbow hologram: a white light transmission (WLT) hologram. The name derives from the rainbow colours that change as the viewer's vertical position changes. Also called a Benton hologram after its inventor.

Real image: in holography, the part of the image that appears to be in front of the holographic plate or film.

Reference beam: the pure beam of laser light which is directed onto the holographic emulsion when making a hologram, and interferes with the *object beam.*

Reflection hologram: a hologram lit from the same side as the viewer.

Ruby laser: a pulsed laser producing red light which is the only laser suitable for holography of live subjects.

Sand table: a vibration isolation table made of sand.

Shadowgram: a hologram using back-lit subject-matter. A 2D/3D hologram is a shadowgram with planar subjects in space.

Spatial filter: a device whereby a laser beam can be cleaned, by placing a pinhole in the rear focal plane of the lens used to expand the beam.

TEA: an abbreviation for the triethanolamine used for pre-swelling in reflection holography to produce changes in colour.

Transfer hologram: a hologram made using a *real image* as object, usually white light viewable.

Transmission hologram: a hologram lit from behind, so that the light passes through the hologram to reconstruct the image.

White light transmission (WLT) hologram: a transmission hologram made to be lit with white light. This involves the introduction of a slit in the making stage to compensate for chromatic dispersion. (This occurs when a *laser transmission hologram* is lit with white light.)

Virtual image: in holography, the part of the image that appears to be behind the plate or film.

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APPENDICES

APPENDICES

APPENDIX A. PROCESSING DETAILS

Much display holography, and in particular the work of artists, has been carried out with high resolution silver halide emulsions specially developed for holography. Developers intended for conventional photographic film are not suited to the development of holograms, although a standard proprietary developer Kodak D19 is still sometimes used. Processing procedures still resemble those of the early days of photography, in that individual practitioners make up their own favoured processing formulae.

The main constituent of photographic emulsions is silver bromide. When exposed, light activates the silver in the emulsion, so that the developer turns silver bromide into metallic silver. 'Silver halide' means mainly silver bromide. In the ordinary process of development, the silver forming the image is derived from the silver compounds present in the emulsion itself. Fixing removes any sensitive substance that could be acted upon by light or by the developer, thus rendering the emulsion unalterable by further action of light. In holography it is preferable to use formulations needing no fix, or if necessary, very short fixing times, because fix tends to degrade the holographic image.

Bleaches are used in holography to make the developed opaque grains of silver halide in the emulsion transparent. Because no light is absorbed, all the light used in reconstructing the hologram goes towards making a brighter image. Bleaches are mainly classified into 2 different categories, rehalogenating and solvent:

- *Rehalogenating* bleach turns the metallic silver back into silver bromide. It does not remove any of the silver from the emulsion, relying on the redistribution that has taken place during development, and for this reason a heavy exposure is required. This type of bleach often uses potassium bromide in the formula.
- *Solvent* bleach removes the silver, leaving undeveloped silver bromide in the emulsion. Into this category comes reversal bleach, in which all the

developed black silver metal should be dissolved so that it completely leaves the emulsion. Fringes of undeveloped virgin silver bromide laid down by the manufacturer should be left behind, alternating with bands of just gelatin, cleared free of silver salts.

Water used for making up formulae should be purified, either distilled or preferably de-ionized. (A beneficial side-effect of the use of a de-humidifier in the holographic studio is that it provides free, unlimited supplies of pure water). Some of these formulae are an irritant through inhalation or contact with skin. Processing should always be undertaken in a well-ventilated room wearing gloves, and in some cases with a face mask.

PROCESSING SEQUENCE

Development	1 to 6 minutes at 23°C.
Wash	3 minutes.
Fix (if necessary)	1 minute maximum.
Rinse	3 minutes.
Bleach	clearing time plus 30 secs.
Rinse	5 - 10 minutes.
Dry	squeegee and hand-dryer (with care), or alcohol rinse.

FORMULAE†

†Formulae used at the Royal College of Art. These are the current formulae found to produce optimum results.

TRANSMISSION DEVELOPERS

GP61 Recommended by Agfa for use with their HD materials for many years

6g	Metol
7g	Hydroquinone
0.8g	Phenidone
30g	Sodium Sulfite Anhydrous
60g	Sodium Carbonate Anhydrous
2g	Potassium Bromide
1g	Sequestrene (EDTA)
1000ml	Water

†'NICK 19'

20g /100g	Sodium sulphite
60g /300g	Sodium carbonate
8g /40g	Quinol (hydroquinone)
1g /5g	Phenidone
1000/5000ml	Water

'This formula is safe to use without gloves. Storage time 3 - 4 weeks. Optimum temperature is 23°C.

VITAMIN C

10g	Ascorbic acid
2.5g	Metol
45g	Sodium Carbonate Anhydrous
1000ml	Water

Heat to 27° to a density of 2.

FIX

If fixing is necessary, use without hardener. Rapidfix, G-334, Amfix - diluted 1:4. 2 minutes (maximum) at 20°-24°C, for absolute maximum of 1 min.

TRANSMISSION BLEACHES

FERRIC NITRATE (GP431) Recommended by Agfa.
Rehalogenating bleach.

150g	Ferric Nitrate 9-Hydrate
30g	Potassium Bromide
1000ml	Water to make

Dissolve 300mg of Phenosafranine in 200ml of methanol. Add mixture to bleach solution. Dilute 1 part bleach with 4 parts water to make working solution.

DICHROMATE ('PYROCHROME') Solvent bleach.

4g	Potassium Dichromate
4ml	Sulphuric Acid (Concentrated)
1000ml	Water

A safer alternative to concentrated sulphuric acid is 30g sodium hydrogen sulphate per litre.

FERRIC SODIUM EDTA. Recommended by Ilford.
Rehalogenating bleach.

100g	Ferric Sodium EDTA
30g	Potassium Bromide
10ml	Sulphuric Acid
1000ml	Water to make

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†**EDTA.** Rehalogenating bleach.

30g	Ferric Sulphate
30g	Disodium EDTA
30g	Potassium Bromide
10ml	Sulphuric Acid
1000ml	Water to 1000ml.

NB. EDTA bleaches have a tendency to print out, and should be stabilized with acid. Post-bleach for approx 30 secs (until clear) with dichromate bleach. After using EDTA bleaches it is advisable to wash with the lights out, as emulsion prints out more rapidly in water.

REFLECTION DEVELOPERS

†'PYROCHROME'

Part A:	10g	Pyrogallol
	1000ml	Water
Part B:	60g	Sodium Carbonate Anhydrous
	1000ml	Water

'Pyrochrome' processing devised by Van Renesse yields good results for reflection holograms and retains same wavelength for exposing and viewing. Recommendation of adding sodium sulphite to developer if a wavelength shift towards green is required is not satisfactory for large colour shifts. This developer is extremely tolerant, and can be used at far higher temperatures than recommended, without fogging. This means that exposure times can be reduced, and low-power lasers used for larger formats than conventions impose.

REFLECTION BLEACHES

Dichromate Bleach, Ferric Sodium EDTA or EDTA as given above. Previously used PBQ bleach has now been widely replaced by EDTA, because p-Benzoquinone in powder form is extremely irritating and toxic. It should be handled with gloves in a fume hood, or with face and eye mask for protection.

PBQ (GP 432). Rehalogenating bleach.

50g	Potassium Bromide
1.5g	Boric Acid
1000ml	Water to make
2g	p-Benzoquinone (added just before use).

STABILIZER

Stabilizer can be used as a finishing bath to help protect the emulsion from print-out, or darkening with exposure to daylight, for both reflection and transmission holograms. Proprietary stop bath, approx 4% of acetic acid, or 10ml nitric acid in 1 litre of final water have been recommended.

PRE-SWELL

Triethanolamine (TEA): Various dilutions in water.
Guanidium Carbonate: Used to pre-sensitize, but also pre-swells.

THE SAFETY ASPECTS OF WORKING WITH A 10 JOULE PULSED LASER

- Eye tests undergone before initiation to the use of the laser, to monitor condition of user's eyes.
- No unauthorized access to the laser.
- Flashing light installed outside studio door as a warning whenever pulsed laser is on.
- Laser is switched on with a key, which is removed whenever operator leaves the room, to prevent unauthorized use.
- The door to the pulsed room should always be locked before the laser is fired.
- People should not work alone except when the laser has been made inoperable.
- Live subjects whose eyes are open need to be illuminated through diffusing screens.
- The direct beam should be kept at waist level, and care should be taken in baffling beam to prevent laser radiation inadvertently reaching the eyes of the user. With Class 4 lasers the eye blink reflex is insufficient protection. Specular reflection from optical interfaces and bright surfaces should be taken into account. A simple precaution is for the user to close his/her eyes whenever the laser is fired, except when assessing beam ratios by eye. Black curtains are used to baffle off stray light from people opening the door to the room, and above the hologram, and diffusers to baffle stray light from the set-up.
- Use of goggles which cut out light at 694nm (the wavelength of the ruby laser). Unfortunately these cannot be used whilst setting up, since they make the beam invisible, but are used after the set-up has been built, for instance in the taking of power readings, when user has to hold subject-matter in the beam, or by visitors to the studio.
- The capacitor voltage which determines the amount of energy coming out of the laser should be set low (around 170) until an exposure needs to be made.
- Basic precautions need to be taken in the use of optics, to ensure that the pulsed beam is not reflected back into the laser, since this would destroy

the ruby amplifiers. Negative lenses must not be used, and positive lenses used in the direct beam near to the laser should be placed off-axis, with the flatter side towards the laser so that there is no focussing effect at the back of the lens. This is particularly the case when Denisyuk (single beam) holograms are made on the pulsed laser. If used, a half wave-plate should always be positioned off-axis.

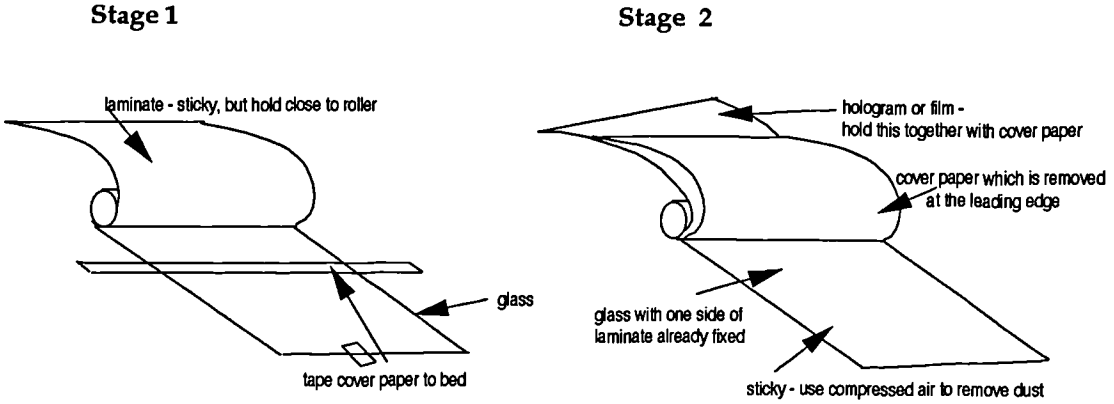
- Preliminary setting-up is done using a Class 2 helium neon spotting laser, which is routed via the pulsed laser head to follow the same path as the pulsed beam.

Operating the pulsed laser

- To switch laser on: turn on the pump and wall switches first. Then switch on oscillator and amplifier. The amplifier capacitor voltage can be set between 170 to 240 maximum (10j), and this is the only setting that changes. The maximum needs to be worked up to. For safety, work to the lowest voltage usable, to spare the laser and optics. The pockell cell is left off until ready to make a hologram. The pockell cell is set to 3.1Kv when on. The oscillator capacitor charge is fixed at 1.9kv. Turn key at the control cabinet a quarter turn and leave key in. If key is taken out, the laser will be interlocked. The laser is now ready to be charged and fired. The laser can not be fired from the control cabinet.
- To fire laser: put key in, press green button on the control cabinet to charge laser. The laser takes about 4 - 6 seconds to charge, or can be charged with a hand controller which has an interlock panic button to dump energy, a button to charge the laser, and a button to fire. If energy has been dumped, the user has to go back to the control cabinet to re-charge.
- To turn off laser: turn off the key, then the oscillator and amplifier, then wall switch.

Further options on the laser are an internal trigger which can be wired up to a remote trigger, with micro-switch wired in to fire off laser at an exact time. The development of a light detector that would allow holograms to be taken in daylight would be useful. The delay switch on the pockell cell enables the laser to be fired when it has reached the right energy level. A second delay switch triggers the pockell cell twice, in double pulse mode, for interferometry.

Application of sheet laminate for 50 x 60cm holograms



Stage 1

1. Check that are no defects in the laminate whilst it is still on the roll. If there are, and these show up in the laser light, it may be necessary to return the roll. Cut a sheet from the roll a little larger than necessary, so that there is a margin for error in cutting the leading edge, and also so that there is a piece of film to hold close to the top roller when it finally goes through the rollers.
2. Before cutting through the backing paper at the top of the sheet, practice with a sharp knife on a spare piece of backing paper to judge its thickness and the amount of pressure needed to avoid cutting through subsequent layers of material. With a sharp scalpel it should be just enough to score through once with very little pressure. To obtain an even pressure on the scalpel, it is best that the straight-edge or ruler is positioned so that scoring is done with the scalpel drawn towards you. Cut through the backing paper about 4mm from the top edge of the sheet and take away the top layer of backing paper from the 4mm strip. Make sure before laying the laminate onto the glass that the second self-adhesive layer is not scored through, otherwise when the backing paper is taken off the whole section will come away at the leading edge and the whole sheet of laminate will need to be scrapped.
3. Make sure that the 50 x 60cm glass is absolutely clean, otherwise the laminate may not stick properly and come off during processing. Sometimes in hard water areas limescale droplet marks are visible on pre-washed glass. Remove these with a dichromate bleach bath, rinse with distilled water and

squeegee dry. Otherwise use either proprietary cleaning fluid or isopropyl alcohol mixed with 30% water. Ensure that the largest particles of dust have been removed from the glass and the laminate before lying the sheet of laminate onto the glass. Since the backing paper produces static, it is preferable that compressed air is used to clean the laminate of dust. Make sure that the can of compressed air is not shaken and is held vertical, otherwise the propellant will fall as a deposit onto the film. A special nozzle fitted to the can will concentrate the blast of air. It is important that as much dust as possible is removed, because particles will cause the laminate to lift away from the glass in that area, in a manner which deteriorates still further during photographic processing of the film. Try to remove dust before it builds up static by being put through the roller.

4. Lie the sheet of laminate flat onto the glass, moving the sticky leading edge into alignment with the top of the glass. Stick this down by hand.

5. Adjust the rollers to a loose pressure, and put glass and laminate through the rollers to check if there is any stress. If the laminate is flat it will show coloured Newton's rings. If the laminate is stressed it is not on straight, so take it off and try again. Check again for any dust trapped between glass and backing paper, and remove it, bearing in mind that some of the lighter particles of dust will be embedded by the rollers into the backing paper and will be borne along out of harm's way by the backing paper as the laminate goes through the rollers. It is important that the first roll is loose, so that particles do not damage the glass or impress themselves into the laminate before they can be removed. Do not trim the edges yet.

6. Practice putting the glass through again to gain a feel for the right roller pressure. Mark the machine with two pressures, the first a medium pressure for putting the film and glass through, and the second a firmer pressure to re-inforce a good lamination after it has been checked for flaws. Too little pressure creates air gaps and opaque patches where the laminate has not adhered that are impossible to correct with further passes through the rollers, although in the case of a small bubble it is possible to prick the laminate with a pin to get the air out. Too great pressure on the rollers causes tucks and puckers in the laminate. Make sure that soft material such as bubble wrap is put at the other end of the bed so that if the glass shoots out of the rollers and falls onto the bed it does not break.

7. Engage the leading section of glass and laminate in the rollers, and start taking away the backing paper evenly from the corner of other end. Make sure when lifting it off that you're lifting off the backing paper only, not the

adhesive layer also. Ensure that no part of the material is buckled in the process.

8. When the backing paper is pulled away, tape it firmly to the bed of the laminating machine, right across the top and also at the bottom, as shown in the drawing of Stage 1. Since the backing paper is designed to release itself, masking tape is not adequate to stick the paper to the bed of the machine, so use an offcut of the laminate itself. This use of the backing paper protects the glass from dust, and attracts dust to itself by static as the laminate is rolled through.

9. The laminate is falling backwards over the rollers as the leading edge goes through them sticky side up, so do not take too long over these preliminaries because of falling dust. In an unfiltered room, large particles of dust will be airborne. With the pressure still medium, turn the rollers evenly and reasonably fast, whilst holding onto the end of the sticky section. It is important not to release one's grip, as the sticky section could flop over and stick anyhow onto the glass. It is also important to keep holding this section right through the process, and also at the end to keep it close to the roller so that air gaps are not introduced.

10. Discard into a bin the backing paper that was taped to the bed. Being slippery, it falls easily to the floor and becomes a safety hazard underfoot, particularly if it folds over on itself.

11. Check the lamination to confirm that it is satisfactory. If not, it can be removed at this stage by pulling off both backing paper and self-adhesive film together. If this proves too difficult, bathe the glass and laminate in hot water, and it will become easy to remove after a few minutes.

12. Once the first side of the laminate is adhered satisfactorily, cut off the overhanging edges of the laminate so that it does not stick to the rollers when it goes through. Being silicon, the rollers do not stick to the laminate badly, but the laminate will stick to them. To ease the separation of the backing paper during the second stage, a small corner could be left, which is subsequently cut off close to the edge of the glass. Put the laminate and glass through the rollers again at a firmer pressure to re-inforce the lamination. Only hard roll when quite sure the lamination is acceptable, as it is much more difficult to remove it after hard rollering.

Stage 2

1. Score the backing paper on the other side to make another 4mm leading edge. This time it is not quite so critical to avoid going through the self

adhesive layer, as this can be encouraged to stick back onto the glass again if it comes off.

2. The most difficult part of the procedure has been done with the lights on. The only part that needs to be done in the safelight is attaching the unexposed sheet of film so that it is correctly aligned with the edges of the laminate and rolling it through. In the case of film, either unexposed film or a film master, there is no need to smooth the film through the rollers as the film is thick enough to adhere satisfactorily. Compressed air is used most at the second stage, in keeping dust off the film just before it is rollered through. Drawing Stage 2: Make sure that film and cover paper are held firmly back over rollers whilst rollering.

Laminating hologram first.

Allow a long piece of laminate to hang down if you have to stick laminate to a hologram before sticking it to glass. This allows you to hang on more effectively to whatever is going through the roller, and the weight hanging backwards over the roller helps.

Removing laminate

It is possible to pull off a failed lamination, clean the glass and start again. Soaking in hot water for half an hour will help to lift off the film and laminate, depending on how well the glass has been cleaned before lamination. After processing however, it is usually not possible to rescue a film hologram by this method because the film tends to buckle in the hot water. The hologram must be lifted off very gently otherwise it will tear and crack. If it has been rescued successfully, the remaining lamination adhesive can be removed from the back of the film with methanol, and the hologram rinsed in photoflo and squeegeed dry. If there is only a slight lift-off round the edges the hologram can be run through the laminator again.

Storage

It is inadvisable to store more than 2 laminated pieces at a time unless there are spacers separating the pieces, since the weight of glass may stress the emulsion on the glass on the bottom. Save the backing material to protect the emulsion, since tissue will stick to the laminate on the edges, and will come off in subsequent triethanolomine or acetic acid baths. It is preferable to cut off any sticky edges altogether, since these will dissolve in acetic acid and create smears.

APPENDIX D. SUMMARY OF HOLOGRAMS FROM PROJECT

THE FEMALE AND MALE COSMETIC SERIES

Subject	Painted faces.
Ideas	The ideas behind these works are ideological, cultural, socio-political, art-historical, psychological, documentary, personal, aesthetic and holographic.
Ideological	Works are symbolic representations. The 'unification of opposites' is sought, by presenting both genders together. Formal manifestation of this ideological status is as frozen (deep time), centralized, hieratic images with neutral expressions.
Cultural	There is a relationship with kitsch. The word *kosmos* in the original Greek meant proportion, reason, order, which in today's culture has become superficial and vulgarized into the word *cosmetic*.
Personal	Re-generation of myself through younger women in the female series, and coming to terms with male authority in the male series.
Psychological	Bridging the gap between inner self and the outer world. The work takes on a life of its own and does not turn out as planned.
Socio-politics	Modification of ideological plan by outer, real life issues such as gender and racial identity and social stereotyping.
Documentary	The holograms are a record of people at a single stage in their lives. The titles involve their real names (apart from **Black Jack**).
Art-historical	Figurative paintings have a relationship with past art.
Aesthetic	Works are about beautification rather than beauty, suggesting a sceptical aesthetic attitude.
Holographic	Some of the techniques such as pre- and post-swelling, masking at the transfer stage, and mis-using the pockell-cell are specific to the medium.

From previous works:

FEMALE COSMETIC SERIES

Idea	To 're-touch' the holographic image through mixed media. To present female stereotypes through collaboration, within the scenario of cosmetic beautification. Ironic attitude to kitsch and 'identikit', 'bad' painting.
Titles	**Sonia, Sophie, Gaelle, Flora, Margot, Voiles**
Description	Glass 30 x 40cm reflection holograms and gouache paintings, except for 3 versions of **Voiles**, which are pre- and postswollen.
Subject	Women aged 23 (age of my 'inner self') who collaborated in painting themselves with cosmetics used in pulsed holography to counteract the bleaching and penetrative effects of ruby laser light.
Idea	The 'skin as mask' of the paintings is related to fact that the surface of the hologram is unsupported by mass.
Title	**Split Benedict**
Description	Glass 30 x 40cm reflection holograms in 3 colour collage
Subject	A female trinity. Three reductions of a woman hiding and revealing her face, in red and yellow with a blue sky.
Idea	An esoteric key piece in the series, indicating the 'hidden agenda', the metaphysical aspects of my work that are secret and which I am not prepared to discuss.

Other previous works are a **Self-Portrait**, and two 8 x10 reductions **Painted Stephan** and **Drawn Stephan**, for inclusion in the male series.

From work carried out for the PhD project

MALE COSMETIC SERIES

Idea — Enhancement of the male through use of paint. Beautification has been superseded by the author's response to male authority. Choice of authoritative male stereotypes - the military, the cave man, the master artist, and the nationalist are treated sympathetically, through collaboration.

Title — **Painted Soldier**
Description — 1 glass 32 x 43cm reflection hologram and gouache painting
Subject — Young male in helmet & combat jacket, with camouflage make-up.
Idea — Two dimensional painting and three-dimensional hologram fused in a hyper-realist manner, similar to that used in the female series. The peaceful frame of reference of this work is felt to separate it sufficiently from the arena of 'smart' weaponry and the killer instinct, but the subject suggests that modern life can be such a minefield that artists can no longer be certain of a built-in professional morality.

Title — **Cosmetic Camouflage I**
Description — Film 30 x 40cm reflection hologram.
Subject — Soldier image with camouflage cut-outs and post-swollen brush-marked areas.
Idea — By superimposition of images, or in combination with other media, it is possible to make a number of quite different pieces from the same master hologram. Camouflage in the image of the soldier includes a form of optical camouflage, which looks like an animated dappling of the face when seen at a distance. Brush marked areas are reminiscent of abstract expressionism, a predominantly male movement in art.

Title — **Cosmetic Camouflage II** (Pushing up the Daisies)
Description — Film 50 x 60cm (soldier), 30 x 40cm (flowers).
Subject — Planned collage of film reflection transfers of 50 x 60cm soldier, flowers and screen. Separate transfers so far, possibly combined with photocopies and text.
Idea — So far, this is a memorial for bereaved mothers. The soldier has flowers on his hat and a neutral expression.
Status — Film collage still under consideration.

Title — **The Artist: Richard Hamilton I - 3**
Description — 3 glass 32 x 43cm reflection holograms, monochromatic orange/green
Subject — Holograms showing the stages of Richard Hamilton's involvement in time with painting on a sheet of glass in front of his face. They show his initial disengagement, the changes made to the distribution of the paint, his use of the shadows it cast on his face, and the paint drying between exposures.
Idea — A variant of the cosmetic idea, in which the paint is in space in front of the face instead of on it. A collaboration in which either artist could use the results for his/her own purposes.

Title — **The Artist: Richard Hamilton**
Description — Glass 32 x 43cm four colour reflection hologram - 'flesh' and pastel green
Subject — Painter Richard Hamilton, with paint in front of his face
Idea — The pink flesh colour may be carried through to other holograms as a way of *humanizing the technology* - a term first used by Billy Kluver of Experiments in Art & Technology (EAT) in the '60s.

Title — **Pagan Paul**
Description — 30 x 40cm reflection hologram, with dry pigment used in underpainting.
Subject — Young male daubed and finger-marked with dry pigment.
Idea — Western men do not normally use visual cosmetics in daily life. Paul had difficulty with the cosmetic idea until I described a male sited further back in our evolutionary history. Before we painted the walls of caves we probably painted our own bodies.

Title	**Pockell Paul**
Description	50 x 60cm reflection hologram
Subject	Same as **Pagan Paul,** but with Pockell cell left off, which produces areas of destructive interference.
Idea	There was an element of 'risk' in leaving off the pockell cell and trusting to a random image. The result was a sinister but vulnerable image of Paul, with a startling appearance of black bruising and lack of symmetry about the eyes - a battered man.

Title	**Eddie Coloured**
Description	40 x 50cm hologram and gouache painting
Subject	Young black man framed in a rectangle of wood similar to that used in **Sophie**.
Idea	'Coloured' partner for **Margot**.

Title	**Black Jack**
Description	1 glass 30 x 40cm reflection hologram.
Subject	Hologram shows unemployed white young Brit, painted with a black Union Jack. Painting shows a black young Brit against a grey sky. A pair with different skin colours and the same nationality, painted for a ritual occasion such as a football match, a Royal wedding, or a night at the Proms.
Idea	Identity and difference, positive and negative patriotism.

'FEMI' SERIES

Idea	Female artists have been relegated to the chaotic, the pre-conscious, so-called 'natural' areas. Therefore 'natural' images - water, fish, twigs and flowers were recorded in an all-over way, stressing the integrative, co-operative aspects of female behaviour, and holography itself. The idea is to make use of values called feminine, so that cultural/biological differences between the sexes are more visible in the actual making of the art, as well as the subject matter. Assigned female characteristics such as decoration, the organic, gentleness, passivity, caring, and so on are used to construct a female aesthetic.
Problem	To be equal in status to men, women must no longer be women. Masculine characteristics are assigned to men and feminine characteristics to women, in ways that are less healthy for women. Using their assigned characteristics could re-affirm the female relationship with the negative 'outsider' and lead to even more unbalanced divided aesthetic sensibilities. Since my work is viewed in the knowledge that it has been made by a woman, it could be made deliberately to address the subjugated half of the human race specifically. (It is no longer a serious option to work incognito as a man.)

Title	**Wrapped Flowers**
Description	1 glass 32 x 43cm reflection hologram triple exposure, red and white.
Subject	Flowers partially wrapped in different ways are superimposed so that flowers and coverings interpenetrate each other.
Idea	There is an intimate, personal aspect to this work. The flowers are marguerite daisies, a pun on the artist's name. The wrapped flowers are cosseting, self-centred, a gift to the maker herself, as a person suffering from ME.

Title	**'Penetrate the surface...'**
Description	1 glass 32 x 43cm triple exposure reflection hologram, red and white, with silver pen marks and text on surface.
Subject	Image as in **Wrapped Flowers**.
Idea	Multi-layering and handwriting are methods initiated by female makers, sometimes adopted by male makers (eg. Duane Michaels). Small silver pen markings tie the three dimensional image to the two dimensional surface of the hologram, so that both interact.The instructions to the viewer to 'penetrate the surface of the emulsion' allude both to the physical act of viewing the hologram beyond the image plane, and the metaphysical act of penetrating superficial appearances to perceive their 'hidden agenda'. (6.1).The 'all-over' composition of the piece refers to the hidden construction of the hologram, in which light wavefronts have fallen all over the plate, making conventional ideas about composition irrelevant (2.1).

Title	**Enough Tyranny**
Description	4" x 5" glass reflection holograms, various colours. 32 x 42cm, 'flesh' colour.
Subject	Precious images of insect wings, pearls, a baby, combined with flat graphic of a man's hand and raised baton/gun barrel.
Idea	Vulnerability and domination.

'HOL' SERIES

Idea — Involves holistic or metaphysical concerns:

Title — **Web**
Description — 50 x 60cm reflection hologram - loose.
Subject — Net with large enough mesh (about 6cm) for knots to be visible.
Idea — The hologram may be seen as an image of a piece of net. Alternatively it could be seen as symbolic of the holistic many-in-one or binding together, from the Latin root of the word religion, "ligare" to bind. It is seen on its own as an integrative rather than a competitive image.

Title — **Blue**
Description — 2 film 50 x 60cm reflection holograms - loose
Subject — Ground glass screen one metre square.
Idea — Lit blue screen for use in backgrounds. May be used as an element in collage, or on its own, like a sheet of sky, a colour of meditation.

Title — **Curtain**
Description — 50 x 60cm reflection hologram in blue and red.
Subject — Rich draped pan velvet lit from two sides.
Idea — The curtain is closed. I hope to combine it with an 8" x 10" stereogram of the curtain being opened, as an image of revelation.

CORNUCOPIA SERIES

Idea — 'Natural' images are chosen for their hologenic and sensuous appeal. They are not seen as significant on their own, but combined together in abundance they are intended to re-contextualize the hologram as organic and easy to live with, rather than the product of an alien technology.

Title — **Fish**
Description — 1 film 50 x 60cm reflection hologram - loose
Subject — Real fish swimming in the same direction, in painted water.
Idea — Hologenic natural image. Possible collage material. From sea cornucopia.
Status — Proof only. Viewing angle presents difficulties.

Title — **Concrete**
Description — ***Open-aperture*** film transmission hologram, 50 x60cm
Subject — All-over image of shallow ground covered in concrete pieces.
Idea — Concrete pieces, extend beyond the edges of the hologram, suggesting a section of a larger whole. Rainbow dispersions from the larger chunks of concrete transform them seemingly into opalescent coral.

Title — **CauliFlowers**(Cornucopia/Femi)
Description — Open-aperture film transmission hologram, 50 x 60cm.
Subject — Circle of flowers centred on cauliflower.
Idea — An efflorescent central floweriness, suggestive of female sexuality. Chromatic dispersions abstract the image except where it clusters round the image-plane as white.

Title — **Shells**
Description — Open-aperture film transmission hologram 50 x 60cm (1 unstable)
Subject — All-over image of shells on shallow ground.
Idea — Hologenic. Sea cornucopia. The *Cornucopia* series is in the initial stage. I may shape *Shells* as a vessel, horn or cone according to the Fibonacci spiral, or as curved paisley figures around the organic patches of instability in the hologram ie make a feature of instability marks.

Title	**Dorset Markers**
Description	Small limestone rocks ground to a flat surface on one side with holographic material applied in various ways.
Subject	A development from my **Solar Markers** made in Australia. An attempt to locate myself in my current habitat.
Idea	'Naturalized' holograms.
Status	Extremely experimental stage. Aesthetic problems to be solved vis a vis the unnatural plastic 'feel' of film. Am experimenting with bleached transparent reflections of flowers attached in a floppy way. Also transferring thin layer of metal diffraction grating foil with glue to rocks, or attaching self-adhesive embossings and foils, stringing them up with thin wires and other experiments.

APPENDIX E

the holographic image

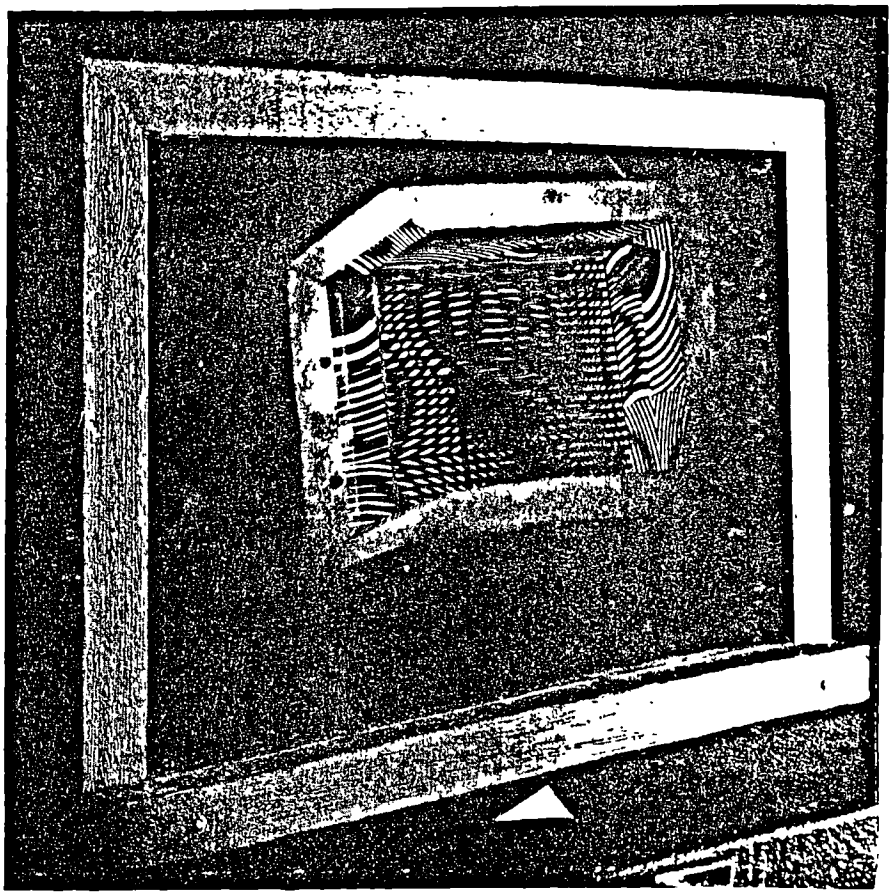
Holography is a new medium which has been made possible largely through the invention of the laser. It is best explained as a form of 3D lensless photography. The laser, one of the most exciting scientific breakthroughs of the century provides the necessary coherency of light. The image on the resulting holographic plate cannot be seen effectively in ordinary light. To view the hologram the beam of the laser is directed at the plate at the same angle at which the hologram was taken. There is still, as yet, limitations to the size of the image. Movie holograms are also a possibility. MARGARET BENYON one of the first artists to have worked in this field in this country is holding an exhibition of holograms and stereo-paintings at the Lisson Gallery this month. She contributes some personal notes on the medium.

IS IT ENOUGH for artists to concern themselves simply with aesthetic choices when brain physiologists are dealing with the raw material? I think there has been too much preoccupation with the 'fall-out' of science and technology, the consumables, rather than direct research by the artist in new fields. If art is about the relations between people and their environment, its proponents are in a position to make aspects of our environment more tangible if they are at the sources of its change.

In the case of my own work, to present a situation allowing different options, would be to prevent the work functioning in a particular way, that is, constant, and with the selection and construction being inseparable from the content. My work is supported by a common area of knowledge, and sometimes refers explicitly to other works which are now part of common experience. We categorize existence in terms of continuous fragments of information and it is not necessary to present 'total' experience by the inclusion of other sensory modes, experience being 'total'. Our method of dealing with total experience is to break it down, which is what I have done with holography. The stereo-paintings and holograms are linked by ideas about space and real illusion – that is, illusion which is self evident. In the stereo-paintings the images appear to lift out and occupy their own position in space. They appear independent of the surface. The holograms deal with visual phenomena that are exclusive to the holographic medium. Holographic images are physically explicit to the extent that they are used in industry instead of the objects themselves for purposes of comparison.

The holographic image requires adjustment to a condition that is outside the normal. In physical terms the surface defines the extent of an object and can always be related to a mass. The holographic image redefines surface as having no material support. It measures space in its own terms and does not apply borrowed or artificial standards from outside. It is possible for an apparition to hang in space, or block another apparition. One view of a multi-exposure hologram of a quantity of regular solids may give the cue as to whether other exposures are of the same objects taken from different positions, or of different ones. It is only by kinaesthetic response – imagining back through the objects to the other side – that a decision can be made.

A change in medium means a change in language. My use is not symptomatic of a holistic approach. I do not attempt to define a total situation.



Margaret Benyon Hologram 1969 *holographic plate* 5" × 7" *Lisson Gallery*

45

EVENING STANDARD, TUESDAY, MARCH 3, 1970—11

ART NEWS

Richard Cork

Life in the round with a laser's help

HARDLY A WEEK passes nowadays without some pundit publishing the banns of a provocative new marriage between art and technology. As scientific research discovers fresh avenues to explore, so the argument runs, the artist should leave his outmoded studio and march bravely into the laboratory of the future.

If art is to provide a true reflection of the century we live in, then it must shed its traditional skin and don the armour of the machine age.

The thesis is compelling enough. Renaissance artists, after all, used the twin inventions of oil-paint and perspective to introduce revolutionary ways of seeing in their own day, so why should modern artists not follow suit?

STARTLING

There have been men in this century who pioneered a completely new approach, of course: Moholy-Nagy, for one, who taught at the Bauhaus and was convinced that orthodox painting and sculpture ought to be replaced by a more original medium of expression.

Perhaps his most startling innovations were the Light Modulators, plastic constructions that were set in motion to create continuously changing effects of light.

These objects served a twofold purpose: they painted with real light rather than the artificial light created by the artist on his canvas; and they replaced static sculptural mass with transparent open volumes in motion.

Moholy-Nagy succeeded in coming to terms with the possibilities of his age and treated his work with the impersonality of a scientific researcher.

But, although the example set by such a man has aroused increasing interest among progressive students who feel dissatisfied with existing media and consider that their potential has been exhausted, few of them do actually abandon the paintbrush or easel in favour of technological art forms.

It is extremely difficult for an artist to understand scientific developments sufficiently to exploit them for his own ends; and the cost of the equipment necessary for experiments can be prohibitive.

COHERENT

All honour, then, to Margaret Benyon, who is currently exhibiting at the Lisson Gallery, for pursuing her fascinating researches against all the odds. This young artist recently became interested in the possibilities of holography, an amazing form of three-dimensional lenseless photography made with laser beams. She assembles various objects — a still-life arrangement of fruit and crockery, or small painted constructions of her own—and translates their images on to specially prepared glass plates with the help of coherent laser light.

The technicalities of the process are too complicated to be described here, but it is helpful to realise that the laser beam is split in two, one half directed towards the object and the other towards the plate.

The two halves recombine on the surface of the plate to form a misty pattern that only becomes an intelligible picture when a single laser beam is trained on to the surface of the glass.

And what a picture! The spectator looks through the glass frame of the hologram at a complete reconstruction of the still-life that Benyon orginally assembled. It is almost as if the actual teapot, the bowl and the fruit were sitting there behind the frame, so tangible do they appear.

But they are not: they only exist inside the glass frame itself, reconstructed by the strength of the laser beam. If a hand is placed behind the glass, we can see it quite clearly: and yet the still-life is there as well, more real than the hand.

MAGIC

Most astonishing of all is the fact that the spectator can even look at the still-life from various angles—from below, from the side from the top—as if he were looking at reality. This is more than mere illusionism; this is scientific magic, so powerful that the mind cannot take in its implications all at once.

Benyon helps us to do so by making one of her holograms out of a cardboard cut-out parody of Picasso's Demoiselles d'Avignon, the painting that sparked off Cubism.

The comment is appropriate. Just as Cubism attempted to capture a number of different viewpoints with one painting, so holography succeeds in reproducing real objects that can be viewed from several angles.

The hologram only gives a monochrome record, of course; but its three-dimensionality is so convincing that it is easy to believe the apples in the picture are green and the bowl has blue stripes.

The camera is beaten at its own game, therefore, by a transparent piece of glass and a laser beam. Holography is an invention, a product of scientific research, and in the future it may be applied to the cinema or television. The prospect is a heady one. Will we be able to see our newsreader from different angles as we move round our holographic TV sets?

Could holographic movies be shown in a circular arena, with the audience walking round them to take in all possible viewpoints of the actors concerned? The possibilities are bewildering.

But from Benyon's point of view, as an artist, holography is just one facet of her overall interest in optical art. Upstairs in the Lisson Gallery, her stereoscopic paintings can be looked at through tinted spectacles that make the shapes on the canvas leap out of their frame.

One particular painting consists of a series of small coloured dots which float towards the spectator in a dramatic snowstorm, tempting him to snatch at them and hold them in his fingers. This time, the illusionism is more conventional and far less thought-provoking, but it is all part of an aim stated by Benyon in a notebook: "Making the invisible world visible may be what art's about—one could take this literally, e.g. demonstrating 3 + 3 = 7."

PRECOCIOUS

In other words, she wants to explore the unexpected and mysterious elements in art, bringing them out of her technological hat like a conjuror. If this programme involves the use of new materials, she is not afraid to think like a scientist.

Most of her holographic research has been done in laboratories at Nottingham University, where she holds a fellowship, and at the National Physical Laboratory. She is a precocious example of a new type of artist, and, although she is still a startling exception at the moment, her work may be setting the pattern for the future. The Lisson Gallery could well be housing the most prophetic exhibition that London has seen for many, many years.

Exhibition at Lisson Gallery, 68, Bell Street, N.W.1. Open Tuesday-Saturday, 11-7.

ARTS MAGAZINE
February 1970

London

by DAVID RUSSELL

Holography was invented in Britain by Dennis Gabor in 1948, but we have had to wait until now to see a show in London which explores the artistic possibilities of the medium. At the Lisson Gallery this month Margaret Benyon shows a number of holograms as well as anaglyphs and other stereoscopic paintings. Among painters using holography she is unusual in that she is immediately occupied in widening the scope of the medium through technical research which she is at present carrying out at Nottingham University and the National Physical Laboratory; most painters are content merely to turn an idea over to the holographer without taking a hand themselves in the subtleties of the process. Thus she is gradually exploring and extending a world as mysterious and pregnant as that of the early photographers, or the early cinema.

Through the roseate glow of the holographic plate we see, like Alice, a world that appears real, but which is in fact entirely illusory; it is a world where materials never decay and where a lunar stillness prevails. Any motion it possesses is supplied by the spectator moving his eyes and thus uncovering fresh visual information with the movement. This has led Margaret Benyon to work with interference patterns within boxes, and the possible variability of the interacting layers can be precisely calculated. This promises a further stage in the researches of painters like Soto or Riley. Benyon has also constructed miniature architectural environments whose planes and spaces appear to change in similar fashion—a transformation of Picasso's *Demoiselles d' Avignon* is something of a holographic tour de force. It still requires, of course, some effort of the imagination to prognosticate the future of holography. Cineholography, holographic walls in houses, holographic television, are all potential developments. The dangers can also be anticipated: an increasing corporeal alienation, the sublimatory ersatz world finally making activity unnecessary, the cerebral correlatives of the sense of touch replacing the reality. It will be interesting to follow the progress of the art, and it is likely that Margaret Benyon, who also takes a very coherent interest in the philosophical implications of her work, will be in the vanguard. Apart from holography, I like her large stereo paintings which become interestingly related to the space of the gallery, with forms often advancing in front of the picture-plane to appear disconcertingly among the spectators. For this experience one is obliged to wear red-and-green spectacles, but it's worth it.

Agam pursues some of the same ends, but in a more strictly cartesian way, although his dissolving faceted surfaces do take on a certain rather conventional mys-

Holography as art

Contrary to the impression given in *AM* No 46 by Peter Fuller, the inventor of the hologram, the late Dennis Gabor, was especially concerned with display holography. In thanks to me for a paper written on holography as an art medium (*Leonardo* 1973) he wrote in a personal communication on February 28, 1973, 'I am very interested in this subject, and I hope that one day I will be able to give you, artists, something really powerful; panoramic holograms extending to infinity, in natural colours'. I might add that we holo-artists have not been content to accept holography as a donation from its inventor, but have since been making a number of innovations ourselves. In his condemnation of the hologram in *AM*, Peter Fuller quotes Gabor from 'The Social Context of Art' about the need for the revival of individual handwork. I quote Gabor from the same publication: 'Too much of the true creativity of our times has gone into science and technology'. The two views are not incompatible. It has been the aim of independent artists in many branches of what Peter Fuller calls the 'mega-visual tradition', to act against the standardization of consumer needs and tastes which dominates it. It is a true democratization of culture for people to be handling holography themselves in an independent, individual fashion.

The 'hands-on' nature of holography is an inappropriate target for Peter Fuller's fashionable Luddism. In 'Seeing Berger. A Revaluation of Ways of Seeing' he says that the development of holography has 'proved entirely consonant with, and readily exploitable by, a monopoly capitalist culture which seeks to distort and extinguish free imaginative and creative activity on the part of those who live within it'. This is not true. My holograms *Brave New World, Third World,* and *Unclear World* are pieces critical of 'monopoly capitalism', and I have not been prevented from making or showing them.

He writes further that '. . . the very *process* of making a hologram does not allow for the admission of a human imaginative or physically expressive element at any point. The representation is not worked; it is posed and processed'. This is also not true. It is possible to work through a number of stages in the making of a hologram. There is the choice of making of the subject to be holographed, through to the making of test plates and final exposure, or the making of a master plate/film. The holographic masters can be optically transferred on to the final hologram in a number of ways, each of which allows for imagination, expression, or the other components of a human being that drive us to try to make art. There can be even further manipulation of the piece, either in the way that it is shown or combined with other media. In all these stages there can be feedback from the medium, and from people who see the finished hologram. This can suggest alteration of the original starting point, further ideas, etc, or there can be a straightforward process from A to B. What happens in the making of a hologram is not vastly different from that used with other media. Workers in clay, paint or wood find that they have their limitations too.

He continues, 'Hence, the hologram remains a peculiarly dead phenomenon compared with the painting'. This is a statement possibly prejudiced by the fact that Peter Fuller has not seen as many holograms as he has paintings. It stretches the imagination to hear rainbow holograms described as 'dead'. Holographers could equally describe paintings as peculiarly flat and uninformative compared with holograms, but we have seen too many paintings which go beyond their formal visual qualities to be that unwise. I suggest that, since there is still a great deal of ignorance about holography, information about its properties would be more useful than biased views, so that readers could be in a position to make up their own minds.

The hologram teaches us many things. Why should not contemporary artists experiment directly with the world, in full acceptance of its physical laws, such as the behaviour of light, rather than separate their creative thinking processes from the discoveries and conclusions of other realms of research. For the first time in history we have a medium in which a part is also a whole. Rather than Fuller's 'master' concept of which as a woman I am instinctively suspicious, perhaps we could propose the non-hierarchical one of 'integration'.

Margaret Benyon
c/o Dr W. Rodwell
U.K.A.E.A.
Winfrith
Dorset DT2 8D8

ART MONTHLY

Dec 1982/ Jan 1983
No 62, p 22.

The law and holography

Henry Lydiate must know already how many artists are grateful to Artlaw Services for their much needed assistance, so it is obvious that a minority group such as holographers could not fail to be delighted to read his article in *AM* 60 devoted exclusively to their medium. Since the problem of pirating already exists in holography, and is likely to become a much larger problem in the future, the article showed foresight.

It reinforces the need for all artists, not just holographers, to try to educate themselves about information property rights in general. In the case of holographers, this extends to patent rights, since holography originated in the world of science. A personal example of the gap that exists between that world and the artist's is that an idea of mine for a holographic jig-saw, published by *Leonardo* in 1973, was patented by two scientists in the U.S. in 1978. If that little © is omitted, it is an open invitation for people to copy your work. Unfortunately in most cases artists cannot afford the costs, time and bad feeling involved in litigation.

In the case of the original hologram, I think it is worth pointing out that the signature, date and © should be physically inscribed on the glass or film substrate, rather than included within the hologram image. Unless the signature and © is included optically in such a novel way that the method is extremely difficult for the holographic pirate to unravel, rather like the watermark in paper currency, they will be copied along with the image, and there will be no way that the general public will know that the hologram is not the original.

On the subject of the substrate, Henry Lydiate's article was unintentionally a little confusing when it stated that 'holograms are not images fixed in a material form; they are light'. In fact the holographic image is not independent of a material form of some sort. I have seen holograms on glass, film, thermoplastic, metal foil, paper, and even 'Gladwrap'. The Soviets have a holographic screen on which a holographic movie can be projected from a 70mm film strip. When this material substrate is destroyed, the hologram is destroyed. In the case of visual display holography, silver-halide emulsions are almost exclusively the most popular type, and these use photochemical processes akin to those used in conventional photography. So it is not strictly true that holography is 'a non-chemical action of light on a plate producing an un-fixed image', and that 'unlike a photographer, he does not use paper, glass, metal or even a screen to hold it or show it.'

The history of holography is very short, and techniques are evolving at an exponential rate, but I believe that it could be argued that the visual display hologram is sufficiently close to photography in its current stage of development to be regarded as a sibling, with interesting ramificatons for painting and sculpture. Outside the visual area there are myriad weird and wonderful types of holograms which take us firmly out of the post-industrial into the age of information. I believe that in general the holographic artist is in a similar position legally and socially to any other artist using non-traditional media. Incidentally, the patents for display holography are owned by Atari. The subject of patents is too extensive to go into here, but this fact should not affect artists, particularly in the U.K. I understand from patent agents that no U.K. patents exist.

In conclusion, holographers' original master holograms *can* be copied, either by contact copy, producing an inferior duplicate, or mass-produced by embossing, also producing holograms degraded in quality, and we need protection. The work of Artlaw Services in this direction is greatly appreciated.

Margaret Benyon
Holography Studio
c/o Crestworth Ltd
Sterte Avenue
Poole
Dorset

REAL IMAGE. No 1, p14. 1984

Letter to Frank Popper, organiser of the exhibition **ELECTRA: Electricity and Electronics in the Art of the XX Century**, 10 December 1983 – 5 February 1984, from Margaret Benyon.

Dear Frank Popper,
The recent ELECTRA exhibition at the Musée d'Art Moderne, Paris, was a rare opportunity for artists working outside the conventional media to exhibit, and for the exposure and assessment of holographic art work.

I was not able to see the exhibition, and discount the rumour that the MAM displayed a hologram of a rubber tyre in preference to other work which might demonstrate more vividly why some artists think it reasonable to work with holography rather than paint or bronze. I believe that holography provides useful new ways of comprehending the world, and that the MAM has indeed conceded this possibility by showing some holograms in the ELECTRA exhibition, but judging by the entries in the catalogue I feel that an opportunity has been lost for the exhibition of a more fully researched and representative body of holographic art work. You state that 'Holography as art has attracted a certain number of artists who have formed a colony largely centred upon themselves, or around the theorists in the field, without having enough distance for assessment of a "holographic art" on its own terms.'

I should be interested to discover who are considered to be the theorists in the field and whether they have an art-critical function. Since there has been virtually no support from the art establishment, it is not surprising that holographic artists build their own means of survival through a communal network of exchange of services and support. The enforced separate development of holography is damaging, both for individual holographers and, I think, for art itself. Video and performance art had similar starting dates, but the art institutions are coming to terms with their assessment, and they take place within a serious art context. This is not the case with holography, and some of the responsibility for this state of affairs rests with the art institutions.

The relationship of holography as art to other holographic areas, to the general public, and to the art world is complex and rife with misinterpretation and prejudice. I am privileged that the catalogue includes some of my own writing on the subject.* I should like to have the chance of commenting on one passage from this section, on p46:

'Curiously enough she classes such artists as Salvador Dali, Bruce Nauman, Lowry Burgess, Simone Forti, Amy Greenfield, Yaacov Agam and Carl-Frederick Reutersward as being outside the real holographic research, because, according to her they have often commissioned holograms based on themes in their works made in other media.'

My actual statment in Leonardo was as follows:

'Artists who are not holographers, for example Salvador Dali, Bruce Nauman, Lowry Burgess, Simone Forti, Amy Greenfield, Yaacov Agam and Carl-Frederick Reutersward, have commissioned holograms based on themes in their work made in other media.'

I meant by 'artists who are not holographers' those artists who do not actually go through the process of making the holograms themselves, but commission holographers to make the pieces for them. That you extrapolate from this that these artists are excluded from 'the real holographic research' is a distortion of my original statement. It depends on what is being researched. Your statement that 'holographic research can be carried out not only with the aid of laser transmission, but also by the simple reflection of transmitted white light' suggests that research goes on at the viewing stage rather than the making stage of holographic activity, since holograms are not made with white light. I should have thought that research also goes on before the piece is finished.

The context of this statement was an extremely brief listing of a few of the individual artists in holography. In retrospect this list does seem to polarise itself into those above-mentioned artists who are accredited within the art world, and those others who actually make their own holograms but are not taken seriously as artists. Ostensibly, the separation of art and science still continues in holography with the major technological advances originating from scientific institutions, and with holography as art generally not accepted by the art institutions except when it is carried out by artists who have made art successfully in other media.

Yours sincerely,

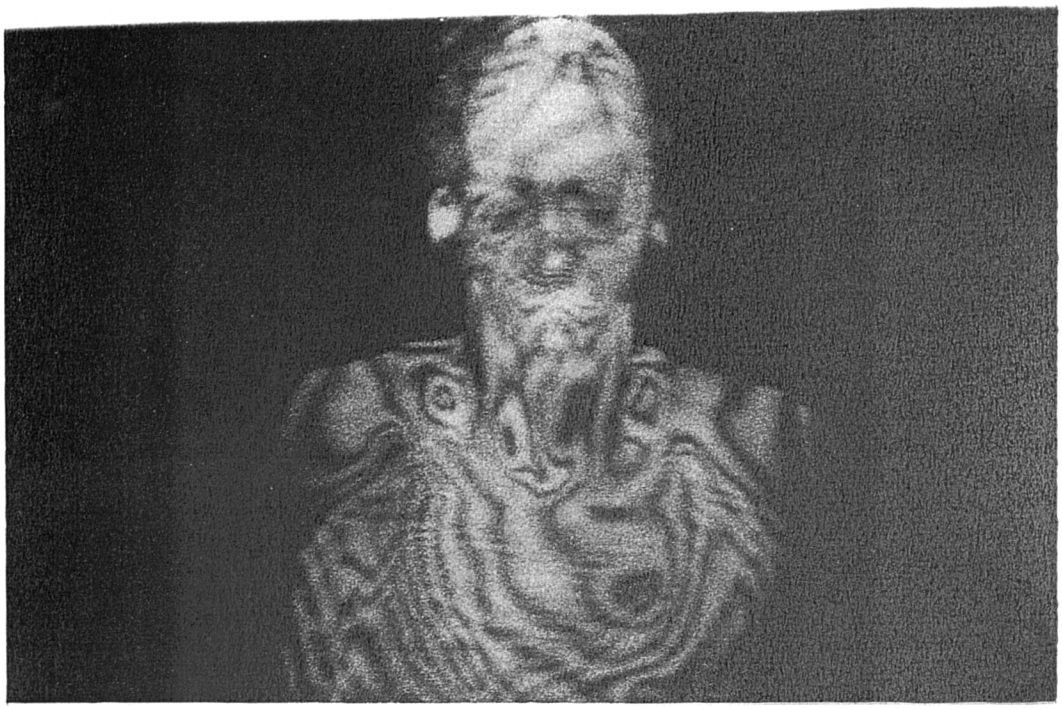
Margaret Benyon.

*'On the Second Decade of Holography as Art and my Recent Holograms' Leonardo. Vol. 15, No 2, 1982. pp 89-95.

WOMEN'S ART MAGAZINE
No 41 July/August 1991

LIVING WITH HOLO-GRAPHY

MARGARET BENYON



above *top* **Margaret Benyon** 'Tiresias' 1981 white light transmission hologram

above **Margaret Benyon** 'Benedict Revealed' 1987 double exposure reflection hologram

Margaret Benyon pioneered art holography in the late 1960s. She held the world's first solo holographic art exhibition 1969, and has been a professional holographer for 23 years. Her work is include in a number of private and public collections world-wide, including the Australian National Gallery, the Museum of Holography, New York, the Calouste Gulbenkian Foundation, and the Victoria and Albert Museum. She has received a number of awards, and has held 12 solo exhibitions and 57 group shows, from Tokyo to the USA, Australia and Canada. She currently lives and works in Dorset, UK.

The popular perception of holography is of an amazing futuristic illusion, magic three-dimensional images performed by laser on a flat surface, a clever commercial gimmick. The first hologram that people see nowadays is probably the little glittery sticker on their credit card.

The private face of holography is rather different. There is a hidden agenda behind the three-dimensionality of holograms, which is the holographic principle itself. In holography we have a new way of structuring that suggests integration, rather than hierarchies. A part of a holographic image provides the whole of the image of which it is itself a part. It records all the details of light from a subject or scene all over the photosensitive plate or film, so that if the hologram is broken or cut up, it will still contain the whole picture. I have an idea that the clue to the strong presence of women artists in holography is connected with these integrative properties of the hologram. The number of women artists in holography is almost equal to men, and a healthy number of the strongest artists are female.

The hidden aspect of art in holography is also the artists themselves. The modern hologram is 27 years old, and some of us have been working with it for most of that time. I have a body of work that spans 23 years. The art world bias against holography, and the fixed idea of curators that no holographic art work exists, means that I have not had a solo show of my work in an accredited art venue in the UK since 1973. (They have all taken place overseas). However, being ignored is the lot of most women artists, and nothing unusual.

The first phase of my work with holography (1968-1973) was an exploration of those properties not accessible in any other medium. The second phase (1978-81) was mytho-symbolic, holistic, cross-cultural. The third phase (1981-1991) uses the human body exclusively, in a personal, almost therapeutic way. For example, my female Cosmetic Series arose partly out of an awareness of my inner self still around 23 years of age in a rapidly aging body, and partly from the use of cosmetics in pulsed holography. Make-up helps to prevent the laser light from penetrating the epidermis of the skin and lighting up the subcutaneous layer to produce the waxy appearance so familiar in a pulsed hologram. The holographic image is all surface, with no substance. Neither the art world nor the art/science/technology world can get a grip on this work, because the series also takes a confrontational attitude to kitsch, and worst of all, combines holography with the outmoded traditional art medium of framed painting. My male Cosmetic Series, although begun with the same brief as the female series with sympathetic males, is turning out to be about male authority.

My holograms are small and intimate, generally exhibited in a 'domestic' space on a wall, close to the living space of people's everyday lives. I do not want to do away with the quiet attitude that this sets up. I am suspicious of large scale spectacular work and see a fascistic, dominating, patriarchal element to it. I am suspicious of the 'master' concept of art which emphasizes high status rather than rapport. I believe that female artists should not opt out of the social difficulties that are common to the majority of women, but work within the realities of being a woman in a man's world. I have no doubt that women have been, and still are, excluded from technology by men in a very basic way, just as they are largely excluded from substantial recognition in the art world. I first taught myself how to make holograms in an engineering block that had been deliberately built with no women's lavatory.

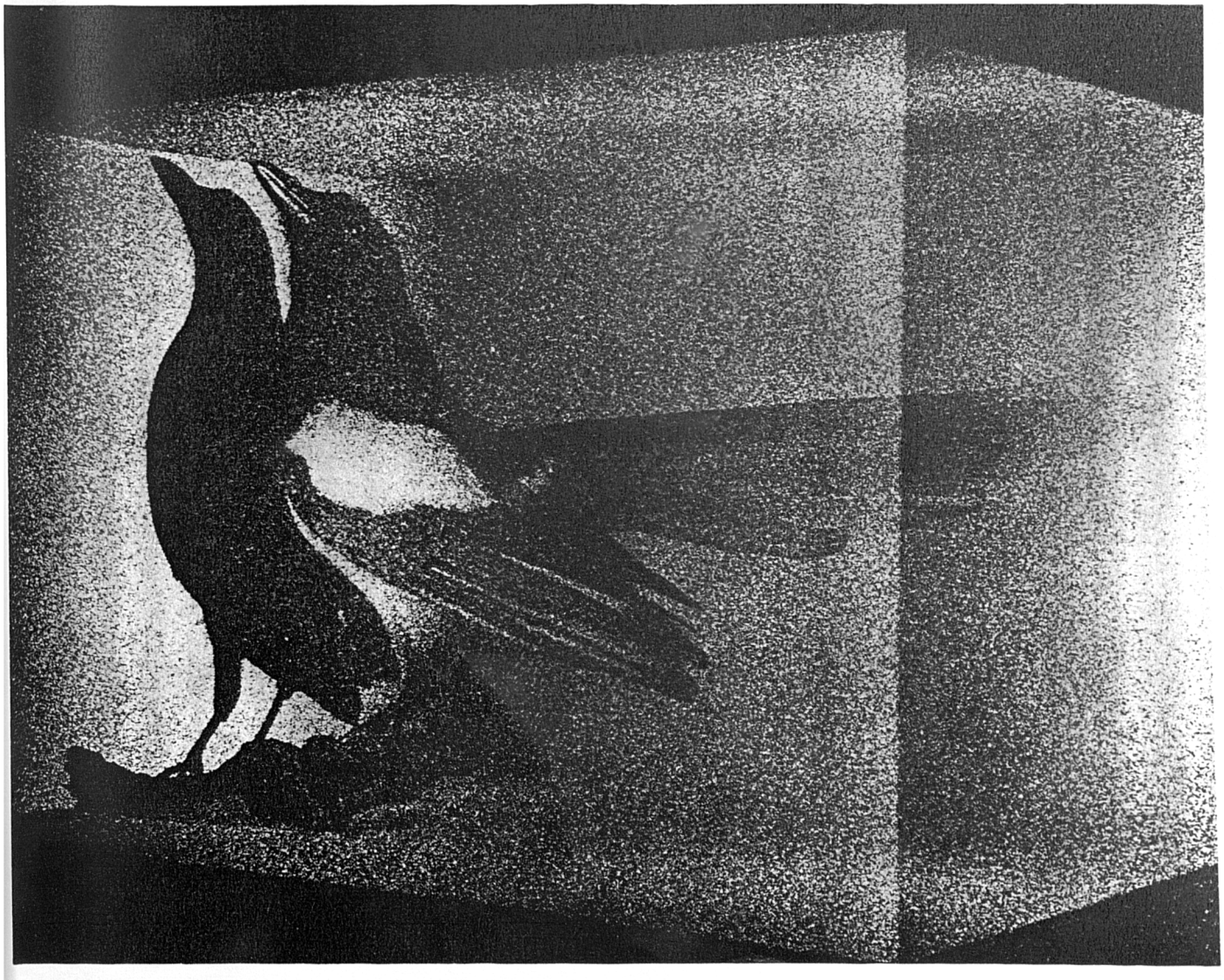
Despite this, ambitious public holographic projects by artists like Sally Weber and Birgitte Burgmer today compare very favourably indeed with

Margaret Benyon 'Tigirl' 1985
Self-portrait. Reflection hologram & reproduction

such projects made in the name of art and technology by exclusively male artists in former times.

Like many artists in the UK, I work at home with my children around. Rather than the more usual British artist's studio in the bedroom, mine is in my garage. It is extremely low-tech, containing a low-powered laser, hand-made optical components, and a darkroom of chemicals which I mix myself. The 'art and technology' connection is irrelevant to me, although I recognize that this is a convenient way for people to categorize holography as an art medium. For me there is no art/science debate. I have been living organically with holography as art since its inception. This is rather different from the superimposed art/science establishment collaborations, typified by the Art and Technology exhibition organized by Maurice Tuchman in the '60's, which were exclusively male.The artists most often quoted as the first to make art with holography are myself, Bruce Nauman, and Harriet Casdin-Silver. The difference in approach between my own and Bruce Nauman's in 1968 is that he had holograms made for him by a commercial company. Both approaches are valid, but I regarded it as important from the beginning to make my own holograms, and believed that this 'hands-on' approach was important at the time for the discovery of those aspects of the medium that are unique to it. That holography could be taken out of the reach of individual artists by the operations of multi-national companies fills me with dread.

Margaret Benyon 'Bird in Box' 1973
Laser transmission hologram



WOMENS ART MAGAZINE
No 42 September/October 1991

Letters

Cycle of damage

I am one of the artists featured in the chapter on Holographic Arts Practice in the book Culture, Technology & Creativity in the Late Twentieth Century reviewed by Sara Selwood in the last issue of Women's Art Magazine. The rare opportunity that the Women's Art Magazine gave me of speaking with my own voice in that issue has been offset by yet another 'superior' review which makes a mockery of my article. I am disappointed to learn from the review about the unspecific "problems" associated with this work, that it appears "limited", and even more so to hear that I have "ignored the implications of the origins of the technologies' origins in military research". That holography was born out of military research is an oft-repeated and very old lie that people in the art world tell each other. It wasn't. It was born out of an intuitive leap in the mind of Dennis Gabor as he was watching a game of tennis in Rugby. Holography is a principle which behaves according to the natural laws of light. It provides the only visual model we have for undivided wholeness and non-fragmentary thinking, and could provide a very positive direction out of current cynicism, fear and ignorance.

What I found damaging about the review is that ignorance about the field means that artists working in it are yet again condemned unjustly, and the positive lessons we can learn from holography are ignored. I can not believe that the reviewer has seen Paula Dawson's holograms, or seen children playing delightedly in them, otherwise I feel she would not feel so free to be sarcastic about them. They do not threaten, although knowing Paula I expect that her use of the word 'cosy' about them was probably ironic — she's a very laid back and funny woman.

Lasers are used for warfare, but shouldn't that be even more reason why artists should be out there counteracting the sinister uses with peaceful ones? I have made anti-war holograms in a military academy with cadets stomping up and down outside. Surely this is better than hiding, pretending that we can keep ourselves free from the social misuses of technology if we restrict ourselves to paper and pencil (which can also be seen as technology). The existing uses of light in art reach back to the transfiguration scenes of medieval art. Do we have to contract cultural Alzheimer's just because we change from one medium to another, from paint to holography?

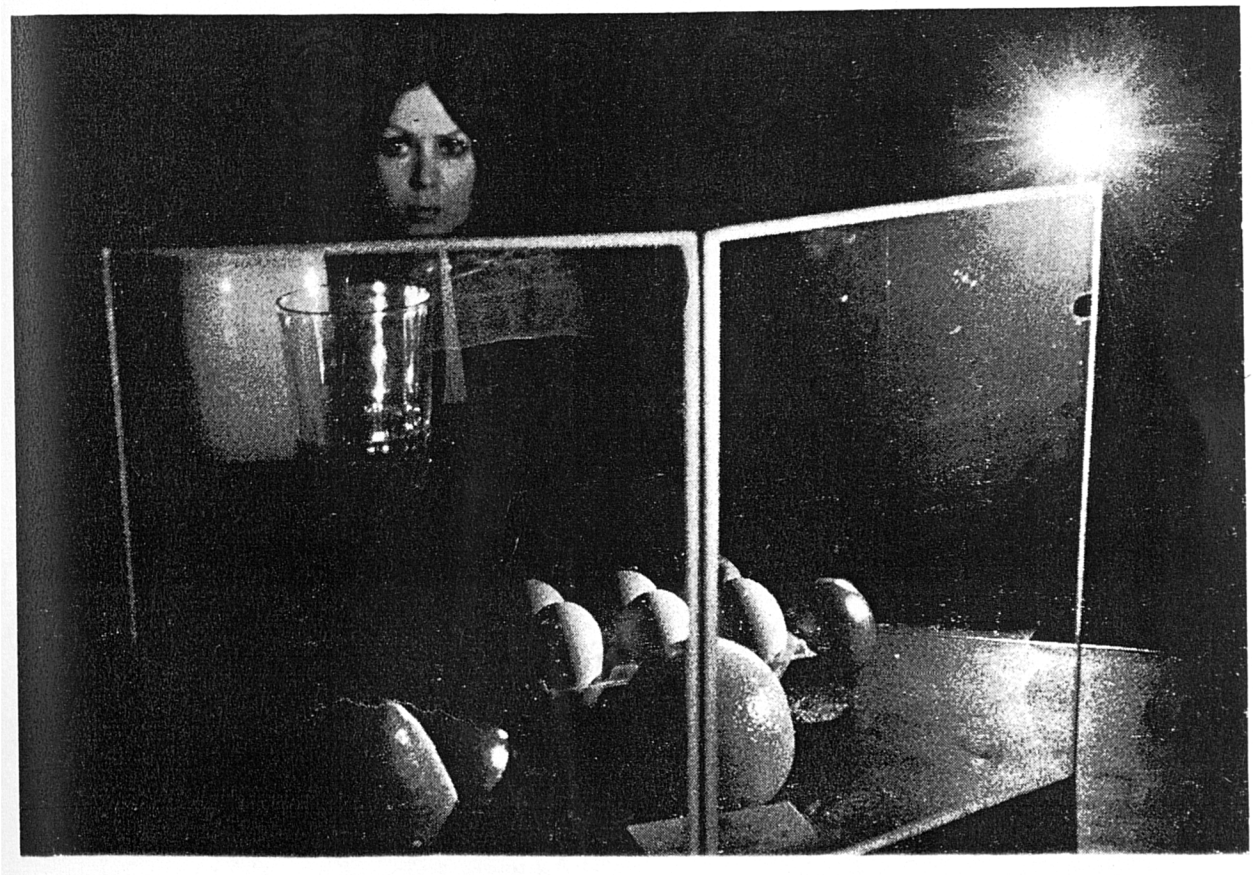
I confirm Sara Selwood's observations about the suspicions of the art establishment towards holography. I have been censored out of the art world for most of my working life because of my medium and my gender, and the self-perpetuating cycle of damage is not improved by her review.

Yours sincerely
Margaret Benyon

APPENDIX F

icographic A quarterly Review of International Visual Communication Design **October 1971**

Editor of issue number 2	John Halas
Design and layout of issue number 2	Patrick Wallis Burke Geoff White
Contributors to issue number 2	Sir Alfred Ayer Margaret Benyon Jonathan Benthall Asa Briggs F Borden Mace Ryszard Otreba Ion Popescu–Gopo Lord Snow Aubrey Singer



Laser holography as a new medium for visual communication

Margaret Benyon and
Jonathan Benthall

This article has been based on a paper prepared by Margaret Benyon for the VisCom 71 Congress. Use has also been made of some extracts from an introductory note by Jonathan Benthall for a recent exhibition of Miss Benyon's work.

A hologram is a three-dimensional photograph. The viewer looks through what appears to be an almost clear piece of glass, as if through a window, to see on the other side a scene which appears to be exactly as it was in the original instance, with all the parallax parameters, except that it has no mass, and one can pass one's hand through it. By movement of the head it is possible to see round and behind objects, as far as the size of the plate will allow. It is the photographic recording of all the details of the light coming from an object or scene, and it is only realisable through the use of laser light. Because the information is all over the plate, if it is broken into pieces each piece will reconstruct the whole image.

Holography can be regarded as a method of lensless photography by means of which three-dimensional images can be reconstructed. The holographic process is divided into two stages. To make a hologram of an object, a laser beam is split into two, and both beams are spread out by a lens. One beam (the reference beam) falls straight onto the holographic plate; the other (the object beam) falls onto the object and the light is scattered on to the plate. The holographic plate is coated with an emulsion which is photosensitive, and records the interference pattern from the two beams falling onto it. The plate is processed like an ordinary photographic film. To view the hologram, the plate is illuminated with a spread laser beam directed at the plate at the same angle and distance from the plate as the original reference beam. The light is diffracted to produce a three-dimensional image of the same size as the original object. The interference pattern in the emulsion directs the reconstructing beam to travel on as in the first instance, and to the eye there is no difference.

Holography, which Margaret Benyon uses as an art medium, is probably a more radical development than photography. Photography depended principally on new chemical techniques, but its optical properties had been familiar since the Renaissance.

The theoretical concepts of holography were stated by Dennis Gabor in 1947, though they would have been intelligible to nineteenth century physicists. Practical implementation was made possible later by the development of the laser - a source of light all of whose waves are *coherent*, or in step. Laser holography was first achieved by Leith and Upatnieks in 1963. Holographic techniques have since been developed which do not require lasers.

Although holography still has no major industrial applications its future applications are thought to be numerous; they include special testing and analysis, information processing and storage, and three-dimensional movies, television, X-rays and microscopy.

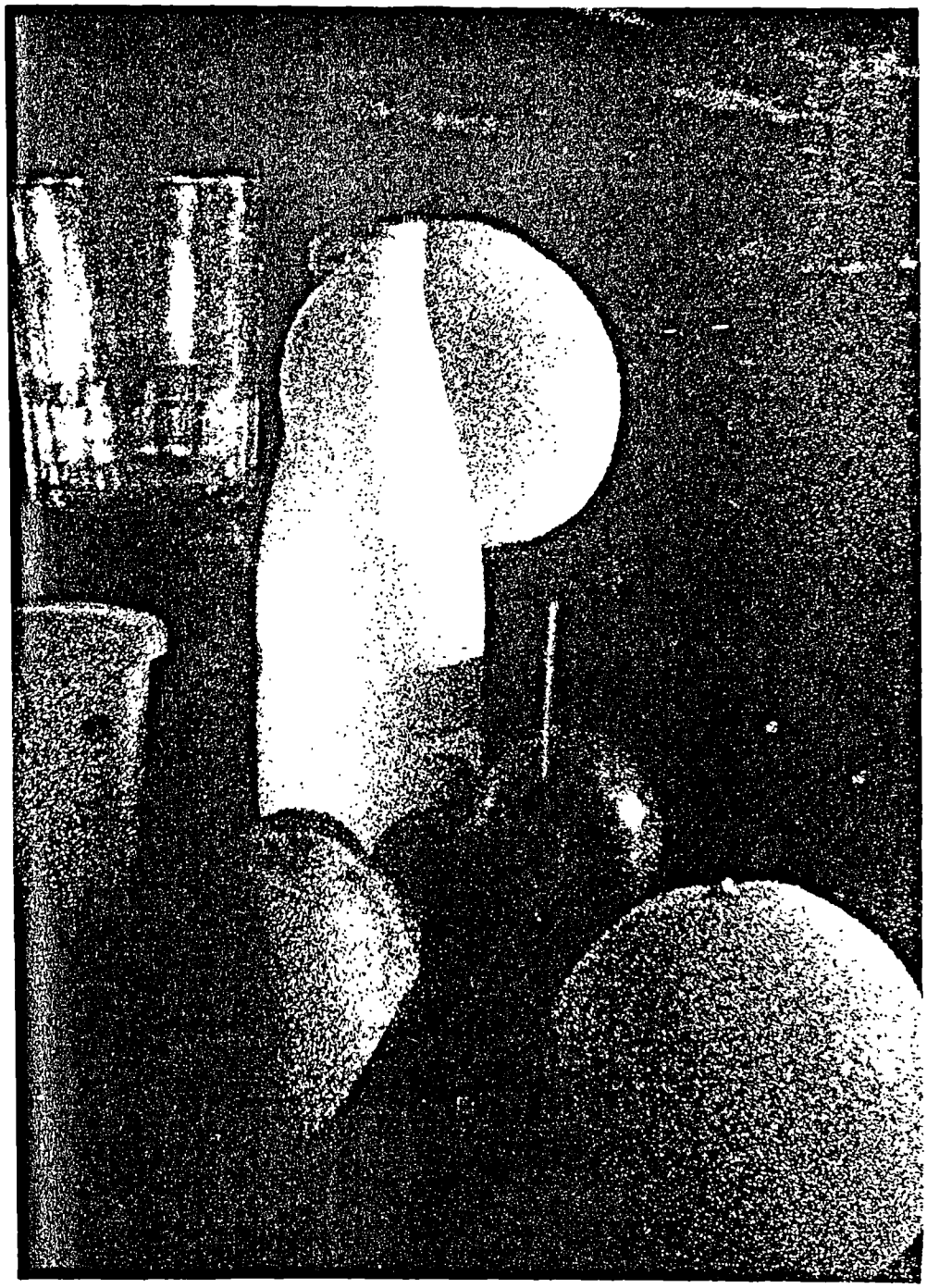
Jonathan Benthall has argued that the importance of holography as a medium is a by-product of a far more fundamental principle, that of interference patterning. He points out that his view finds support in a speculative, as yet unpublished paper *Quantum theory as an indication of a new order in physics*, by David Bohm, Professor of Theoretical Physics at Birkbeck College, London. Professor Bohm believes that the optical lens was a key factor in the development of modern scientific thought, since it brought into sharp relief the (approximate) one-to-one correspondence between points in an object and points in its image. This strengthened man's awareness of the relationships between parts of an object, and encouraged the enormous extension of analysis and synthesis as a method of enquiry.

But now, according to Bohm, 'relativity and quantum theory imply undivided wholeness, in which analysis into distinct and well-defined parts is no longer relevant'. The laser hologram is a technique which can give an immediate perceptual insight into what can be meant by undivided wholeness in science, as the lens did for the notion of analysis of a system into parts. This is because there is no one-to-one relationship between parts of the illuminated *object* and parts of the *image of this object* on the holographic plate. 'Rather, the interference pattern in each region... of the plate is relevant to the whole of the interference pattern on the plate'. But the interference patterns are not *only* on the plate, whose function is merely to make a relatively permanent 'written record' of the interference pattern of the light *that is present in each region of space.* Bohm goes on to argue that holography suggests the germ of a new notion of physical order as a total order contained or *implicated* in each region of space and time. His arguments are of great interest, since it is often complained that one of the reasons why science has become so esoteric is that since Einstein there have been no easily understood visual models of physics.

It is true that an effort of imagination is needed, when one looks at a hologram, to grasp what is happening in time and space before one's eyes. A similar effort would have been needed in the 1840's to guess some of the implications of daguerrotypes and calotypes.

Margaret Benyon's major interest in holography is with 'phenomena that are peculiar to the holographic medium'. She has experimented with

A triple-exposure hologram. Three separate images can be seen as the plate is turned through 60°. The hologram gives more information than is possible with a two-dimensional photograph, since one is able to look round the sides of the object.



Photograph above shows a double-exposure hologram. By exposing the plate to two different set-ups it is possible to achieve the appearance of 'weightlessness'. The glass appears to hang in space above the fruit, and the orange seems to float through the bottle of milk

Photograph at top of facing page shows a detail from a hologram in which there appears a 'non-hologram' of a hand. Anything that moves more than a fraction of a wavelength of light (about 1/10,000mm) will not record. The hand in the hologram has not recorded, and appears paradoxically as a solid 'hole' or three-dimensional silhouette

multi-exposure holograms, heat trails and other effects. In a recent paper she sets out some of the limitations and potentials of the holographic process.

Factors which can present problems in the practice of holography are concerned with size, coherence and stability requirements, expense, and the need for a particular light source for viewing.

The size and coherence limitations are linked in that the distance over which the coherence of the laser can be relied on is short. For instance, the helium-neon laser commonly used in holography has a coherence length of approximately 30cms, and the length of the reference beam and the object beam must not differ by more than this by the time they reach the plate, which means that objects are restricted to sizes not over 30cms. Recently, however, coherence extenders have been added to lasers to increase coherence to lengths of several metres. Stability problems arise from the fact that one is recording an interference pattern of light waves, and if the object moves more than a fraction of a light wave (about 1/10,000th mm) the hologram is ruined. These stability problems can be overcome by 'flash' holography involving the use of pulsed lasers. An American company has produced holograms of live human scenes fitting into an area 8 ft tall, 10ft wide and 10ft deep, by using a pulsed laser developed by themselves.

The expense involves mainly the cost of equipment, such as the laser. The price of lasers is expected to drop during the next five years. There has been a steady decline in the price of lasers since 1967. RCA plans to produce lasers in large quantities and at low prices. They propose a cost of 70 dollars each for a 1mW laser on sales exceeding 2000. A 1mW laser would be sufficient to make and illuminate a 9x12cm hologram. An 8mW laser would provide approximately the power required to make an 8x10in hologram. This kind of laser would, at present, cost about £700. With the additional expense of optical equipment, it would cost a little under £1,000 to establish a basic holographic studio/workshop. For a commercial enterprise, lasers larger than 8mW would be necessary.

The special light sources for viewing are monochromatic, in the case of transmission holograms. Optimum viewing conditions for this type of hologram are by means of laser, and in a darkened environment, but a mercury arc lamp with a narrow band filter can provide an image comparable with a laser reconstruction, and is less expensive. In fact, any compact white-light source is suitable, provided that an absorption filter with a bandwidth of 300A is available,

as for reconstruction, spatial coherence is required only over the area subtended by the eye at the hologram plane. A brighter hologram can be obtained by bleaching the plate, thus improving the optical efficiency by 50% Unbleached, or amplitude holograms have an efficiency of about 6%. A low efficiency 8x10in hologram can be reconstructed in daylight with a standard mercury arc source. Many of the materials giving high reconstruction efficiencies are not yet commercially available, though this will change. It might be possible to record a hologram on sensitive material, and then copy it onto one with a high diffraction efficiency. An inexpensive light source is the sodium lamp, the yellow light used in street lighting. This provides a reasonable reconstruction but with a loss of detail, because there are two yellow lines of light close together, which provides slightly different reconstructions.

It is possible to make a hologram which can be reconstructed in ordinary white light by putting the reference beam and the object beam on opposite sides of the plate in the recording stage. This has the effect of recording the interference fringes in the thickness of the emulsion, hence the designation 'volume' hologram. The hologram can be viewed in sunlight, or with a torch, the emulsion selecting only the wavelengths it needs from the colours in the white light to reconstruct the image. White-light reflection film holograms have been produced on a large scale in the United States.

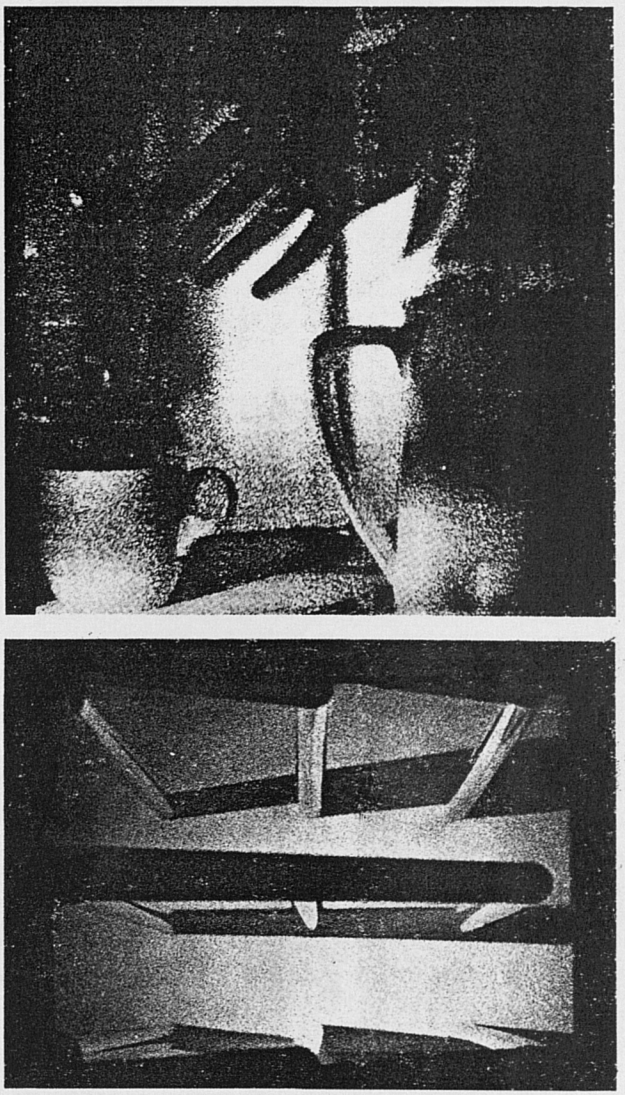
Full colour holography involves a similar process to white-light holography, in that each wavelength of colour is recorded in the depth of the emulsion, so like white-light holography, it also suffers from a lack of suitable material. There is cross-talk between the colours, and the colours change due to emulsion shrinkage. Large scale displays of colour holograms may be hindered by the lack of a blue laser with sufficiently high output.

An American company has produced holograms for educational purposes. They describe a hologram designed to teach children about height and width. The image is made up of several blue blocks, one of which is the same size as the actual block that has been given to a child. The other block images are either too tall or too short. The child is asked to fit the real block into the image which he thinks is the same size. If he fits the real block into an image that is too high, the top of the image remains blue. This idea for a holographic template lends itself to assembly-line inspection techniques for industry. In biological research, holograms can be taken of micro-organisms. They contain the entire visible depth of the specimen and can then be viewed under a microscope. Specimens can be studied which do not last long emough for usual microscopic analysis. This can be of obvious benefit to educational problems, as can be holograms of 3-dimensional models, such as molecular structures. Holograms of three-dimensional models might one day provide space-saving, convenient and inexpensive substitutes for actual models. The National Committee for Audio-Visual Aids considers that three-dimensional maps would be welcomed by geography teachers who at present use expensive terrain models. The Department of Cartography at the Royal College of Art, London, is investigating the possibility of hologram maps in conjunction with Imperial College, London.

The advantage of being able to move across the front of a small display to obtain different views of the same scene would be partially lost with a large stationary audience and a large projection screen, which is one of the problems in the development of holographic motion pictures. The other problems are the development of a camera, and the increase in power required in a pulsed laser system, both of which make the method unattractive for scenes of the size of a large garden and upwards. Holographic stills cameras are likely to precede holographic movie cameras. Holographic cameras at present in use are little more than a small laboratory set-up with a cover, allowing holograms to be taken of objects not more than a few inches in size. The hologram camera is too complex and expensive at this moment and is likely to find a limited market in specialist industrial and photographic organizations. Large scale motion picture holography is likely in the next twenty ot thirty years, rather than in the next decade, but small screen three-dimensional motion pictures have been demonstrated, and may represent the first step.

Three-dimensional real-time television is also presented with many technical difficulties, the most prominent of which are the low resolution of current camera and display devices, and also the formidable bandwidth required.

But as Jonathan Benthall has pointed out, the bald prospect for holography is unexciting, even nostalgic if one recalls the brief boom in 3-D movies during the early 1950's. But if holography is as radically a new medium as is suggested, it will develop not only in ways that are predictable, but also in new and unpredictable ways. It will, over the years, influence our art, our everyday perception, our language, our reality.



Photograph above shows the image of metal rods coming right up against the holographic plate. Parallax motion is emphasised in viewing the plate. The hologram measures space in its own terms and does not apply borrowed or artificial standards from outside

APPENDIX G

Leonardo, Vol. 6, pp. 1–9. Pergamon Press 1973. Printed in Great Britain.

HOLOGRAPHY AS AN ART MEDIUM

Margaret Benyon*

Abstract—*Art ramifications of holography are discussed, beginning with an account of the author's change from painting to holography in 1968. The perceptual directness of holography was one of the factors that led to this change. The possible place of this new medium for art is discussed, bringing in such factors as our awareness of three dimensions and the reaction of the public to holograms in exhibitions. Possible future directions are indicated. She points out that the use of advanced technology by artists raises ethical questions and other issues.*

A number of holograms made by the author are described, demonstrating aspects of the medium, such as pseudoscopic images, the making of 'non-holograms' and multi-exposures. She covers briefly some of the technical limitations and potentialities of holography.

I. INTRODUCTION: THE HOLOGRAM

The reaction of most people on their first look at a *hologram* (Fig. 1) is one of astonishment and occasionally disbelief. They look through what appears to be an almost clear piece of glass, as if through a window, to see on the other side a three-dimensional image which looks like an actual scene but exists only in the form of light. They have a strong desire to reach round the glass and touch objects that they can see round and behind, and,

* Artist working in the Department of Architecture and Building Science, University of Strathclyde, 131 Rottenrow, Glasgow G4 ONG, Scotland. (Received 2 May 1972).

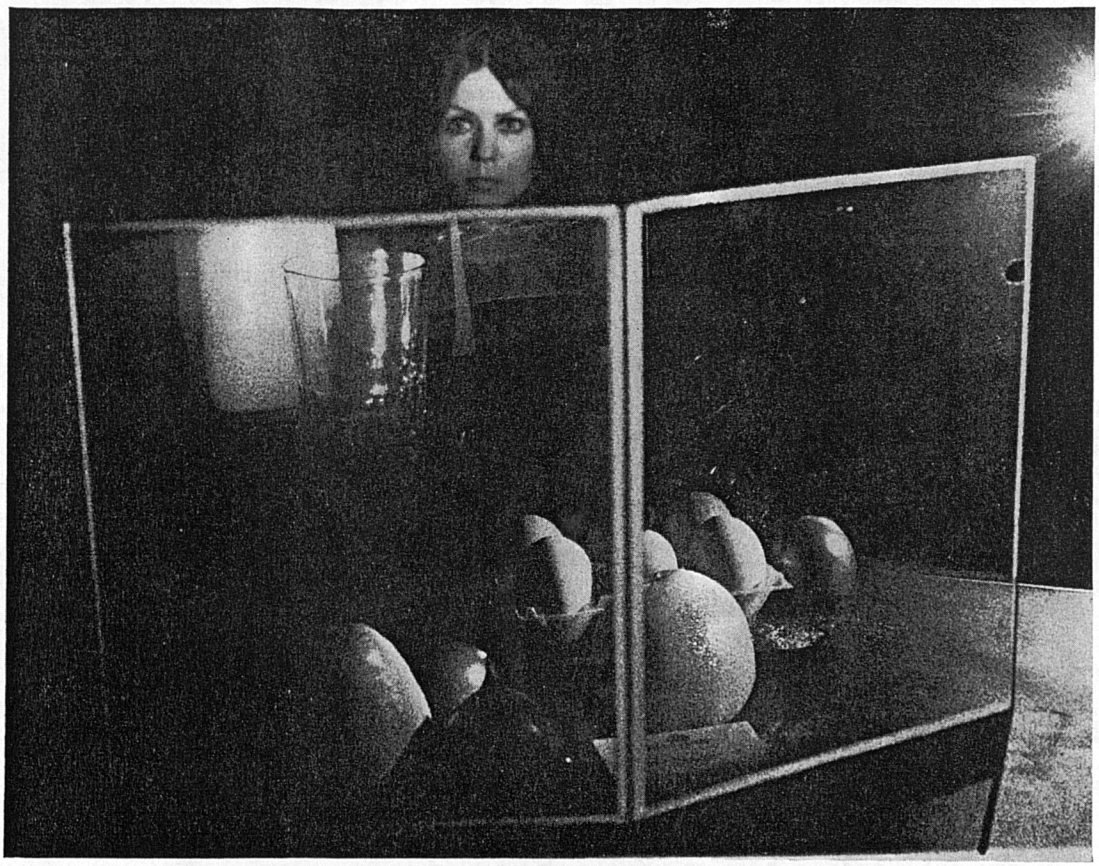


Fig. 1. View of a hologram. A photograph cannot properly show the three-dimensionality of holograms.

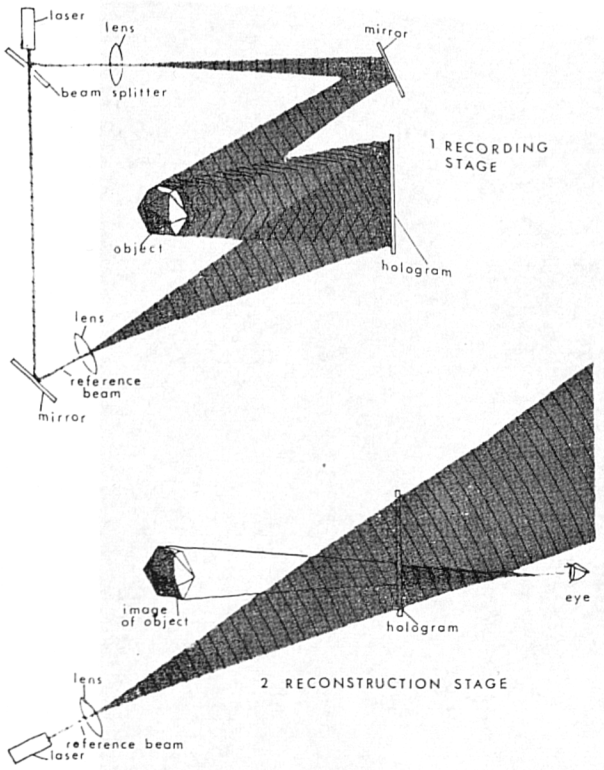


Fig. 2. Diagrams showing the recording and reconstruction stages used in holography.

if they attempt to do this, their fingers pass right through the image. The three-dimensional (3D) image is seen as if a real object were present, unlike other methods of recording 3D images, which show only one angle of view.

An article in *Leonardo* by H. Wilhelmsson [1] gives a full technical explanation of holography but I believe a brief account of the holographic process is desirable here. To make a hologram of an object (Fig. 2), a *laser beam* is split into two and both beams are spread out by a lens. One beam, the *reference beam*, falls straight onto the holographic plate; the other, the *object beam*, falls onto the object and the light is reflected onto the plate. The holographic plate is *photosensitive* and records the *interference pattern* from the two beams falling onto it. The plate is then processed like an ordinary photographic film. The point about the interference pattern is that it allows a record to be made of the detailed properties of the light reflected from the object, that is, the phase relations to which the plate is not sensitive as well as the intensity to which it is. The laser light used is *coherent*, that is, the light waves are 'in step' or *in phase*, so that the crests or troughs in the waves all travel along together. The *random* wavefront from the object meets the coherent wavefront from the reference beam at the plate and they interfere to produce a pattern of light and dark according to whether the waves are in or out of phase. To view a hologram (Fig. 2), the plate is illuminated with a spread laser beam or reconstruction beam directed at the plate at the same angle and distance from it as the original reference beam. The reference beam acts

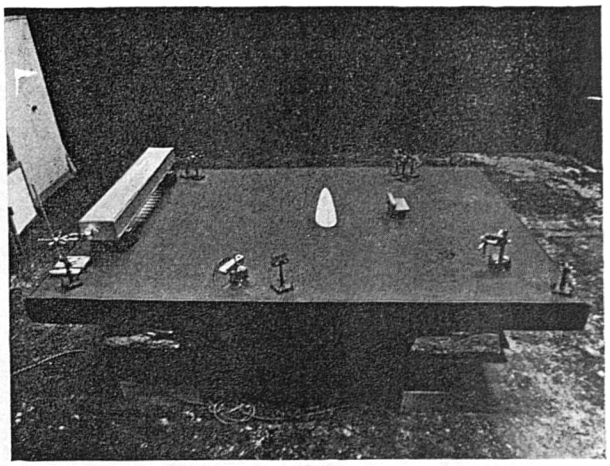


Fig. 3. Vibration-damped table (8 × 6 ft) built in the Department of Architecture, University of Strathclyde.

as a sort of coder and the image is decoded by the reconstruction beam. The light is diffracted to produce a 3D image of the same size as the original object. The interference pattern in the emulsion directs some of the reconstruction beam to travel on, as did the light from the object in the first instance. To the eye there is no noticeable difference between the image and the object.

II. NOTES ON THE HOLOGRAPHIC TECHNIQUE

Holographic work requires a laser, optical components such as lenses and mirrors, and a vibration-free working surface (unless one is fortunate enough to have a pulsed laser). Pethick has devised a system of sand-based holography that replaces the need for a vibration-free table [2]. Figure 3 shows my own table, which consists of a concrete slab supported on inflated motor scooter inner tubes.

Factors that can present problems in the practice of holography involve size of objects and plates, coherence of light used and rigidity of objects and of equipment. The size and coherence are linked in that the distance over which the coherence of the laser can be relied on is short. For instance, the helium-neon laser has a coherence length of approximately 30 cm. and the lengths of the reference beam and the object beam must not differ by more than this by the time they reach the plate. This means that objects are restricted to sizes not over 30 cm. Recently, however, coherence extenders have been added to lasers to increase their coherence to lengths of several metres. If the object being recorded moves more than a fraction of a light wavelength (about 1/10,000 mm) a hologram will not be obtained. This problem can be overcome by 'flash' holography, involving the use of pulsed lasers. Conductron Corporation of Ann Arbor, Michigan has produced holograms of scenes fitting into a space 8 ft high, 10 ft wide and 10 ft deep by using a pulsed laser they developed.

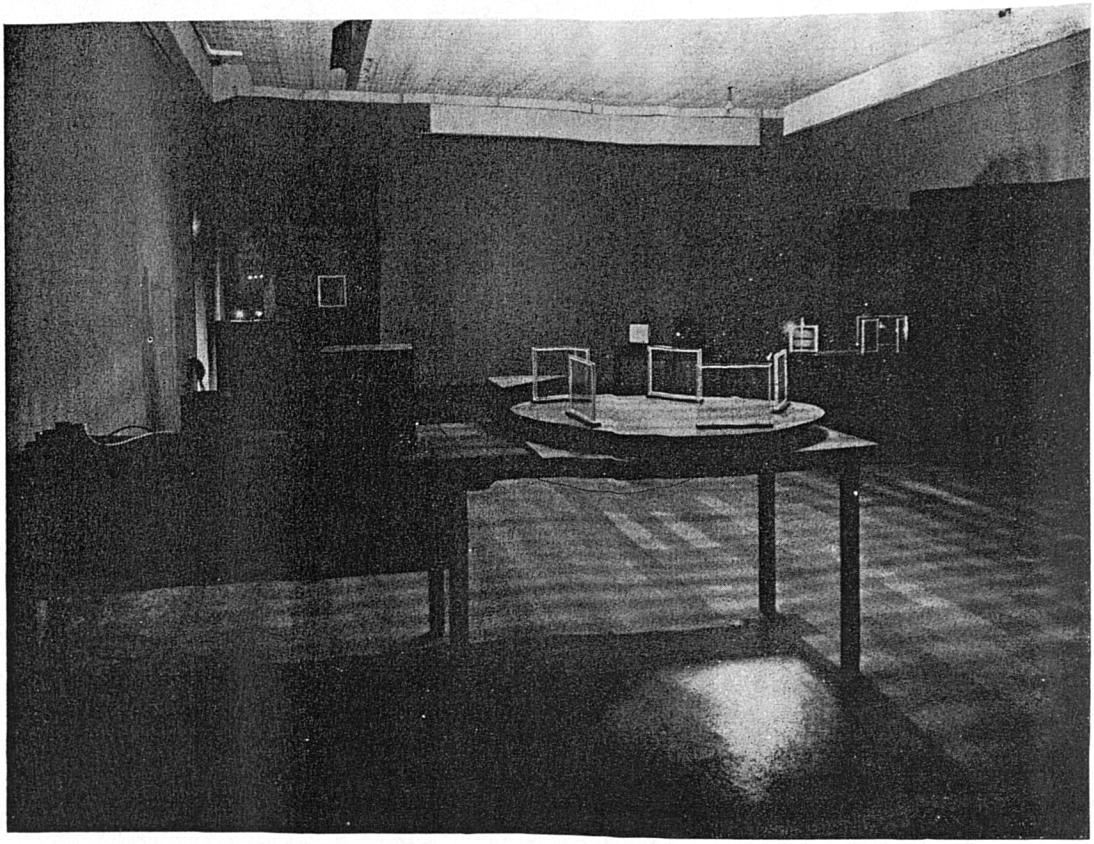


Fig. 4. *Hologram Exhibition, Nottingham University*, 1971.

The cost of equipment at present is high, especially that of lasers, but laser prices are expected to drop considerably in the next few years. Mass-produced small lasers (1–3 mW) suitable for taking small holograms are now available at approximately £100–£200. The power required to take 8 × 10 in. holograms would be from 8 mW upwards. An 8 mW laser at present costs about £700 and, with the additional cost of optical equipment, it would cost approximately £1000 to establish a basic studio/workshop with this laser.

The special light sources for viewing are monochromatic in the case of *transmission* holograms. Optimum viewing conditions for this type of hologram are by means of a laser in a darkened environment but a mercury arc lamp with a narrow band filter can provide an image comparable to that of a laser and is less expensive. In fact, any compact white-light source is suitable, provided that a filter with a narrow enough bandwidth is available. Reconstruction only requires coherence over the area subtended by the eye at the hologram plane. A brighter hologram can be obtained by bleaching the plate. An inexpensive light source providing reasonable image reconstruction is the sodium lamp, the yellow light used in street lighting. Figure 4 shows the layout of my exhibition at Nottingham University in 1971. (Under normal exhibition conditions overhead illumination is not used. All that is seen are the individual light sources of different colours and the illuminated glass plates of the holograms.)

It is possible to make a hologram which can be reconstructed in ordinary white light by putting the reference beam and the object beam on opposite sides of the plate in the recording stage [3]. This has the effect of recording the interference fringes in the thickness of the emulsion, hence the designation *volume* hologram. The hologram can be viewed in sunlight or with a torch, the emulsion selecting only the wavelengths it needs from the colours in the white light to reconstruct the image. These are also called *white-light* or *reflection* holograms and have been produced on film on a large scale in the United States.

Full colour holography involves a similar process to white-light holography, in that each wavelength of colour is recorded in the depth of the emulsion, so, like white-light holography, it also suffers from a lack of suitable recording material. There is interference between the colours and the colours change due to emulsion shrinkage [4].

Some of the possible future developments in holography are, for example, computer-generated holograms of hypothetical objects and recording of a hologram with sound to be read out with light. Microwave holography, holographic memories for data storage, holographic movies and T.V. are also under investigation. The development of holographic T.V. and large scale movies [5] are probably beyond the next decade but holography is at the end of the 'settling-in' stage necessary for new inventions and is at the point where it can begin to be used by artists.

III. AN HOLOGRAPHER'S VIEW

Put simply, a hologram is a 3D photograph. It can also be a powerful way of affecting human sensory response. My use of holography as a medium began in 1968 as a logical development from my interests as a painter and was associated with the making of a number of large *stereoscopic anaglyph* paintings. As early as 1963–1964 I had been using the interference pattern on which holography is based, in order to question the abstract expressionists' assumption that the criterion of excellence in a painting was that it should be treated as a flat surface. The graphic interference pattern was a means of altering the picture plane spatially without reverting to Renaissance space, perspective and traditional illusionism. My first holograms were of constructions incorporating interference patterns. The holographic principle was carried over into the subject matter, to make an image in which a change in the pattern occurs as the spectator moves.

An important factor in my change from painting to holography was that the latter is perceptually a more direct medium. By this I mean that to experience a hologram one needs no special art education. The illusion is self-evident.

The nature of the image, as opposed to its interpretation, cannot be misunderstood. Unlike the painted illusion, it is not dependent on suggestion and variable subjective responses. This is not to say that there are no difficulties in viewing the hologram—in our culture a sophisticated awareness of three dimensions is undeveloped. The situation could be compared with that of early movie-goers who were disturbed by parts of bodies cut off by the edge of the screen.

I should not like to give the impression that the illusionistic connections behind my change from painting to holography are important now. My motivations have changed. There are, as yet, no hypotheses in aesthetics for the domain of holography. There are none of those esoteric criteria one has to take for granted as a painter, which tend to make a mystique of art. It would be undesirable to perpetuate old art hypotheses in a new form like holography. This means that the public's general knowledge about art can be a disadvantage, so occasionally I have deliberately referred back to earlier art forms to bridge the gap between public expectations and my use of the medium. This is possible with holography because it is close enough to the traditional forms of painting and sculpture. An example of what I mean is a hologram I made of a 3D model interpreting Picasso's 'Demoiselles d'Avignon', a Cubist masterpiece that is now part of a common area of knowledge. The hologram was intended as a comment on the way holography automatically achieves the aim of Cubism to show three dimensions on a two-dimensional surface.

Another example of what I mean is a series of holographic still lifes (Figs. 1 and 5) I made from 1969–1970 as a result of feedback from viewers of holograms. These comprised a cross-section of

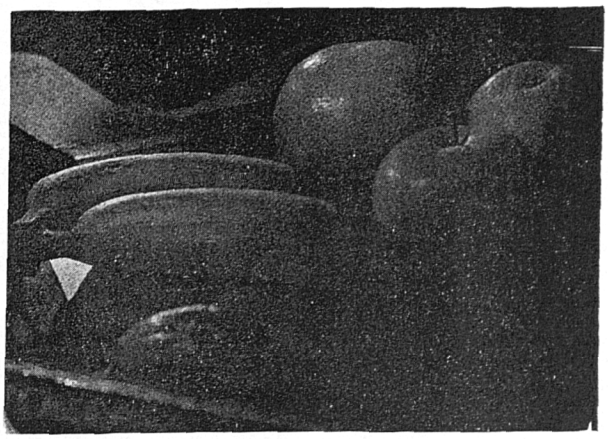


Fig. 5. Detail of a holographic still life, 8 × 10 in, 1969.

viewers who largely did not understand what was being seen and who were further confused by abstruse subject matter. My intention in the still lifes was to provide the viewer with images of familiar objects, in order to present the 3D properties of holograms in a commonly known art genre, without the encumbrance of new ideas.

Response to holograms depends on the way they are presented and the intention behind their presentation. A recent experiment carried out by an environmental psychologist, D. Canter, and myself compared a hologram and photograph of the same model room. It is interesting to note that viewers showed no major difference in attitudes towards the two. However, in exhibition conditions, where it is obvious that there is nothing behind the plate and there is no experimental task to perform, response varies widely. Some people, for instance, saw colour in holograms where the subject matter was familiar to them, occasionally to the extent that it was difficult to convince them that the image was monochromatic. One five-year-old reacted more violently than one would wish, bursting into tears of frustration because she could not grasp an illusory apple. (I have in fact on occasions included real apples amongst the illusory ones presenting the two together so that they are seen as equivalent.)

I am aware that, in the still lifes, I am operating with a restricted code but this does not preclude an elaborated one on a different level in the same work, which the viewer has more chance of ascertaining once there is an understood basis of communication. Art-for-art's sake activities attempt to make art as 'serious' as science or philosophy and forget that these subjects, especially the former, have an interface with the general public even if these fields are not understood by them. I see the still lifes as one way of inviting people to become involved; there are others, ranging through the possibility of viewers handling the holograms physically and searching for the images themselves, to actually making holograms.

The fact that I have my own laser equipment and have begun teaching holography to students I see as a breakthrough in my own development. One idea connected with people handling holograms

would be to make a hologram which would be cut into regular pieces. Each piece will still contain the whole picture because the necessary visual information is contained in each fragment of the plate. The cues for fitting together this holographic jigsaw puzzle would come from the different angles of view of the image and not from the edges of the pieces, as with the usual 2D game.

Increasing the availability and flexibility of the medium is of more interest to me than virtuoso work, such as full-colour holography. White-light holography greatly increases the availability of the medium because the image can be reconstructed by sunlight or the light of a torch. I have done some (so far unsatisfactory) work with this technique. Art possibilities with a new medium depend on the state of development of the medium. For instance, development of suitable hologram copying techniques could lead to multiples for large-scale distribution. This has in fact already begun. Over a million holograms on a film base have reached the hands of the public, most of them reproduced in journals. This aspect of the technique I view with ambivalence, as the desirability of severing the connection between art and the art market made in working with holography as research is an attractive proposition. Nevertheless, the research stage will be passed through, technical difficulties will be overcome and, hopefully, more and more artists will be using holography to produce different work from that now possible.

In this sense, I am not circumscribed by the medium, because the technique of the medium is developing all the time. In using holography, specialization is necessary to provide the knowledge and expertise required in any exploration of the means of expanding perception. Clearly, if one is going to use a new medium in a way that is new, one needs to work with it to understand its potential. Holography is difficult, requiring effort and patience, even for a highly experienced technician, so credible assessment is not possible in determining whether or not holography will develop as an effective art medium but I believe it is essential that it becomes more accessible to other artists.

Progress has been made in this direction by physicist Lloyd Cross and sculptor Gerald Pethick [6]. In 1969, they formed Editions Inc., the world's first non-industrial holographic studio, open to artists interested in pursuing holography as an art form, as well as to commercial media groups. They give holography courses at their School of Holography in San Francisco and planned to open a branch in London in 1972. In 1970, they were instrumental in bringing about an exhibition called 'N Dimensional Space', which started at the Finch College Museum, New York, and toured the U.S.A. It comprised work by a small number of artists such as Robert Indiana and George Ortman and I was able to take part in this simply by mailing a hologram. Another artist using holography is Carl Frederick Reutersward who has been making holograms for several years. A large hologram (46 × 61 cm), constructed by J. H. Jaffe of the Weizmann Institute of Science, Rehovot, Israel was shown at the Art and Science Exhibition held on the occasion of the opening of the new Tel Aviv Museum in Israel in 1971 [7]. Bruce Naumann, a Los Angeles, California, artist, has had holograms made of himself by Conductron Corporation mentioned above (one of the very few firms to my knowledge to have made custom holograms). Unfortunately, this firm has reduced its work in holography but has done some notable work. There may be no reason beyond the experiential why Naumann's body should be shown in the form of holograms rather than photographs but the holograms are interesting and a good example of the gap in the approach between an artist and those whose ideas of pictorial holography do not go beyond the 'pin-up'.

Most displays of holography are limited to images of, for example, toys and chess sets. An holographer, Ralph Wuerker, has recently been making holograms of art treasures in Florence, Italy. This application differs from mine in that I use it as a medium in the way a film-maker uses film or a painter paint. Rather than producing holograms of art works, there seems more point in using holography as an art medium itself and developing its unique properties. It could be very disappointing as a medium if new visual ideas are not realized through it.

Many authors in *Leonardo* have stressed the desirability of artists being aware of developments of the mid-20th century, both from technical and philosophical points of view. They have also stressed the danger of subcultures of artists proliferating without a broad sense of social responsibility. Only thoughtful use of holography will prevent it from being left to the 'fun' specialists. I see my own use of holography in art as complementary to the objectives of engineers or of physicists [8]. An artist is not subject to the same restrictions. This may be the reason for the cooperation I have met with on the part of most engineers and physicists with whom I have worked. In the words of the scientist J. Gates [9]: 'It seems likely that since so much of our conception of the outside world comes to us in visual terms, and holography is likely to extend and expand the scope of visual presentation, that some effect, and possibly a very great effect, will eventually be felt by the man in the street. In a way, one may perhaps draw a parallel with the understanding of electricity and the development of that new technology at the time of Faraday. The uses made of those ideas have so permeated physics and life in general today that we probably never spare a thought for the kind of doubt and uncertainty for the true worth of the ideas that must have existed at the time. Although it is rather a farfetched speculation that holography might have a comparable significance, we must not underestimate the very great impact that visual presentations can have.'

An artist working with aspects of new technology should share the concern for the social misuse of it,

instead of sitting back and 'doom-watching'. I see holography as being part of a future world in which grass would also grow. One can take an optimistic view of new technology that it can lead to conservation of effort and resources —the miniaturization of computers is an example—achieving the same results with less and less consumption of materials and energy. Many persons think of the assembly line and dirty machines as symbols of technology but many new technologies require clean surroundings and quietness (for holography these are essential). I agree with Toffler's statement [10]: 'Those who prate anti-technological nonsense in the name of some vague "human values" need to be asked "which humans?" To deliberately turn back the clock would be to condemn billions to enforced and permanent misery at precisely the moment in history when their liberation is becoming possible. We clearly need not less but more technology . . . Reckless attempts to halt technology will produce results quite as destructive as reckless attempts to advance it.'

I raise this issue because I have been condemned for using technology in art—and a potential instrument for war, at that. I do think that many artists can be blamed for the ecological crisis in our part of the world because they try to avoid the reality of society's productive processes in a reactionary and dangerous way. The separation of art from the changing patterns of life could lead to the end of art. Art activities taking place outside art galleries are brought back into them instead of widening the art location. In working with a medium from the beginning of its development, it should be possible, in a small way, to influence the direction of its use and perhaps even of the direction of further technical research. Working 'underground' in engineering and scientific laboratories, having little contact with other artists and the art world, I see as significant in itself.

Some claim that artists might be considered a part of an early warning system of dangers to society. This is a functional view that as an artist one is responsible not to art history but to the society in which one lives. I am not so naïve as to think that art can effect changes except through the infiltration of artists into areas not traditionally theirs and the slow progress of education.

With holography virtually unused as an art form, I feel that to use it in any one particular way would be to achieve an artificial and limiting sophistication. Instead, I prefer to look on the holograms I make as prototypes, some capable of generating others at a later date and some not.

One could use holography to obtain visual disorientation similar to that experienced during hallucinatory states. An example of this would be to look into a hologram of a mirror and not see one's reflection. With holography it is possible to record things invisible to the naked eye or turn space 'inside-out'. I have been working with holograms in which the conjugate of the virtual image is used to show pseudoscopic space, that is, the image is turned back to front spatially. I have found that this phenomenon is most readily seen with a non-figurative configuration in which hollows become mounds and vice versa. I have made a 'pseudoscopic' hologram containing a hypercube. (Just as a square is a 2D section of a cube, so a hypercube is a 3D section of a 4D 'cube'. The latter exists only as a mathematical concept, although its three-dimensional sections can be constructed.) In the hologram, the back of the hypercube appears to come forward and the front to recede. We are, like Alice, on the other side of the mirror. The hologram serves to remind us that notions such as left and right are one-dimensional and are determined by an arbitrary act of choice.

My most recent hologram was of a continuous surface. The viewer sees the front and back of the object as continuous. The idea came from G. L. Rogers, a pioneer holographer, and the technique involved the making of a mould of the back of the object, then making a double exposure hologram of both front and back. I do not think there is a need to deform objects to make them look mysterious or surreal—holography does this anyway. If the intention is to make a metaphoric statement with objects, I do not believe the hologram is useful except possibly as a photographic record.

An example of a hologram showing something invisible to the naked eye is shown in Figure 6. Anything that moves more than a fraction of a wavelength of light during the exposure will not record. Normally invisible currents of hot air show as black traces when seen against a lit lackground. The hand in the hologram appears as a solid

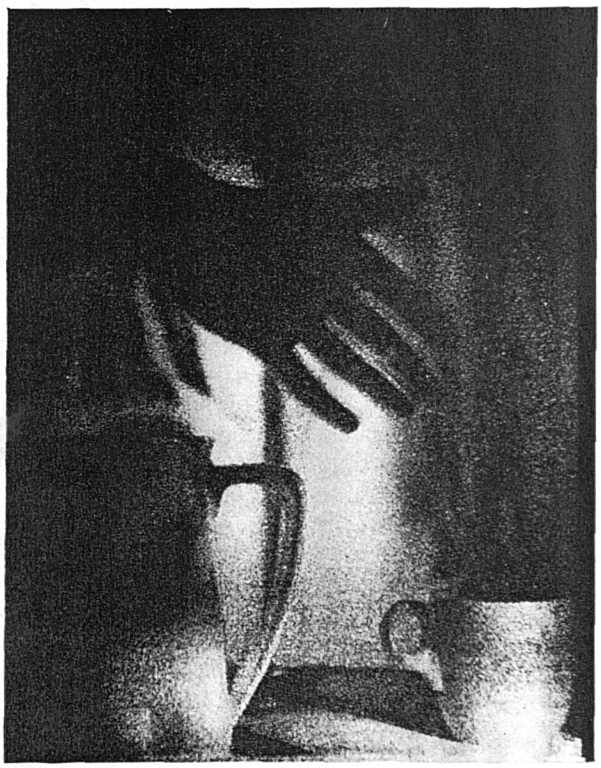


Fig. 6. View of a non-hologram of a hand and of currents of hot air above a cup of hot liquid, 10 × 8 in., 1970.

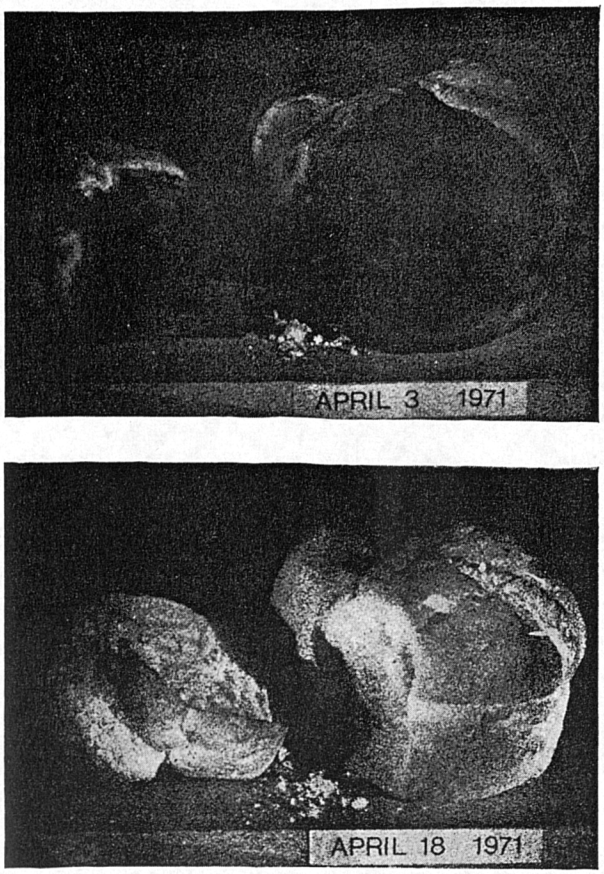


Fig. 7. *Views of holographic exposures of a loaf of bread 15 days apart*, 9 × 12 in plates, 1971.

hole that one can look around, a three-dimensional silhouette.

Another paradox can be seen in Figure 7. A series of exposures of a loaf of bread, taken over a number of days, shows a reversal of our normal experience of freshness. The last image looks the freshest because the bread was stale and hard enough to record well. The first image looks black because the bread was moist and soft. This series shows one of the differences between holography and photography.

Figure 8 shows a double exposure hologram. By exposing the plate to two different set-ups, it is possible to achieve, for example, the appearance of weightlessness. The glass in the hologram appears to float in space above the fruit and the orange through the bottle of milk. In one of my earlier holograms, pieces of folded metal appeared to float in space because their supports were covered with black velvet. Because this moved slightly during recording it eliminated the image of the supports.

A hologram of a more straightforward nature is one I made of nine long metal rods. These were arranged in a three by three square and came right up against the holographic plate, casting shadows across its surface. Viewed from the ends, the rods emphasize parallax. 'The strange black shadows they cast remind us that this is not a sculptural object, but a pattern of interacting events in space and time'

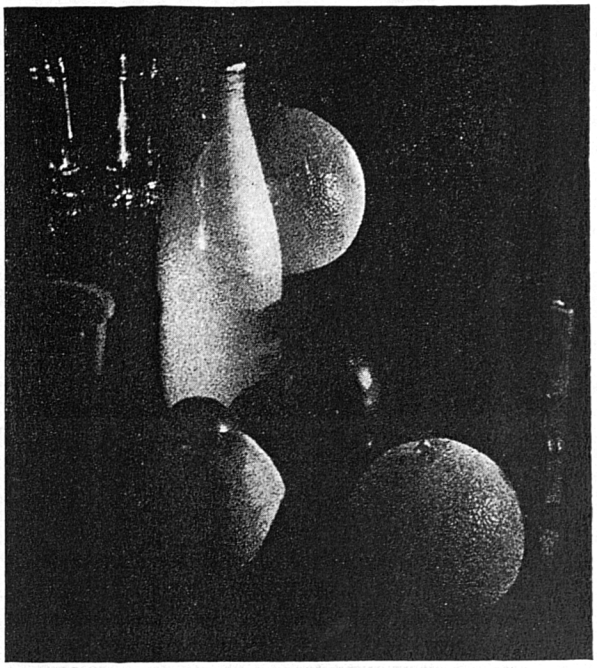


Fig. 8. *View of a double exposure hologram*, 10 × 8 in, 1970.

[11]. The shadows leave their mark in the emulsion and can be seen in ordinary light, without reconstruction of the hologram. In another hologram the direct laser beam is reflected by a set of parallel glass plates to multiply into many points of light. Holography could be an extension of existing uses of light in art, which rely mainly on the fixture in which light is contained or on the 'painting' of surfaces with light.

The small format and restricted field of view of a holographic plate is an excellent means (similar to psychology of perception test objects) of presenting an object for concentrated study. Figure 9 shows a triple exposure hologram that resembles a perception demonstration. Three separate images can be seen as the holographic plate is turned through 60°. Each image gives a cue as to whether the other exposures are of the same arrangement of regular solids taken from different positions or of different ones. The hologram gives more information about this than is possible with a two-dimensional photograph, since one is able to look round the sides of the image. I see the use of holography and its remarkable properties as favourable conditions for art to take place. It provides a visual analogy of relativity and quantum theory as methods of enquiry which suggests undivided wholeness rather than the relationship of parts to the whole [12]. In this way, holography has also provided a possible explanation of the way the brain works [13].

Present limitations on the size of holograms disturb some critics of the medium, as does the fact that the record formed on the plate cannot be manipulated because one is dealing with a light phenomenon involving lines too small to be etched or drawn by hand. I feel that hologram size is only

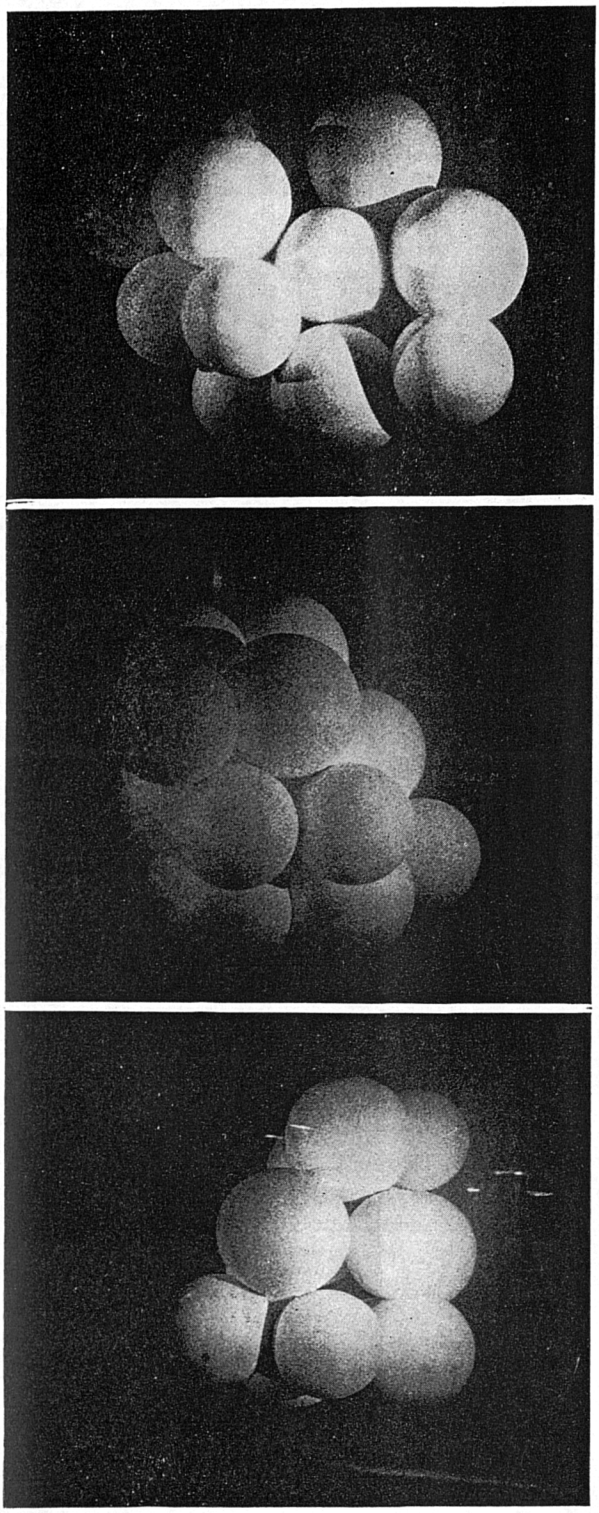


Fig. 9. View of a triple exposure hologram (three separate images are seen on the same plate as it is turned through 60°), 8 × 10 in, 1970.

a problem from the point of view of art tradition. The requirement of direct intervention of the artist's hand would rule out a large amount of established work of this century. Matter in all its states has been used by a number of artists in recent years. In any case, it is becoming widely acknowledged that art does not reside in material entities. The choice of medium is not in itself significant. The credit for exhibitions arranged by artists of laser beams as purely physical phenomena, for instance, should go to the inventor and manufacturers of the laser, rather than to the 'artist'. To quote, for example, D. Gabor, the inventor of holography: 'Too much of the true creativity of our times has gone into science and technology' [14]. It is up to the artist to change this state of affairs.

Fellowships at the Universities of Nottingham and Strathclyde have given me access to equipment not generally available and a number of organizations and individuals have been very generous in their help [15]. My present Leverhulme Fellowship is in the Department of Architecture at the University of Strathclyde.

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APPENDIX H

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ON THE SECOND DECADE OF HOLOGRAPHY AS ART AND MY RECENT HOLOGRAMS

Margaret Benyon*

Abstract — *Some implications for visual art that persist from the first to the second decade of holography and some recent ones are discussed. This updates an article by the author in* Leonardo *in 1973. A short discussion of hologram types currently in use is given. Mention of individual artists from various traditional art disciplines now using holography is made to indicate the need for a critique. There is a discussion of the position of artists in the context of prevalent commercial activity in holography.*

Attitudes towards issues raised by holographic art are described, such as those of technical excellence and of the 'master concept' in which artworks are intended to fit into a hierarchy of quality. Examples are given of the author's holograms combined with other media, of narrative and political types and of those in which an integrative function is demonstrated and used as a theme. Some of her multicolour rainbow holograms are also described. A connection made between holography and Australian Aboriginal painting indicates an influence on her work of the Australian environment.

I. INTRODUCTION

Holography as an art medium has been discussed in previous articles in *Leonardo* [1–4]. The wider field of display holography, now carried out in a number of countries, comprises various types of holograms, ranging from demonstration pieces used by scientists, to commercial holograms made for sale and for advertising, to those made as art works.

There is a growing number of practical textbooks for beginners [5–9] and for experienced holographers [10–11]. Books such as these are available, for example, from the Museum of Holography in New York City [12], which is a resource and exhibition centre for holographers and is performing a valuable service in educating the public about holography. The Museum has also instituted an artist-in-residence programme for experienced holographers [13] and is prepared to supply information on galleries and courses. The Holographic Film Foundation, New York City, has an artist-in-residence programme that is restricted to residents of New York State.

Artists who have no technical background but would like to make holograms are advised to take a short introductory course. Many colleges and universities teach holography as part of their curriculum. Special courses are given at the School of Holography, San Francisco; the New York Holographic Laboratories, New York City; the Holography Workshop, Dept. of Fine Arts, Goldsmiths College, London [14] and the Physics Dept., Lake Forest College, Lake Forest, Ill., U.S.A.

The Holography Book [9] lists additional institutions in the U.S.A. and elsewhere that present such courses and also lists galleries that show holograms, although some of this information is out-of-date. To the above courses one might add those given at Laser Affiliates in San Francisco [15] and at the Fine Arts Research and Holographic Center in Chicago [16]. Holograms can also be seen at the Musée de l'Holographie, Paris [7] and at Matthias Lauk's Museum für Holographie, Cologne.

II. HOLOGRAM TECHNIQUES

The late Dennis Gabor invented in 1948 the principle of wavefront reconstruction of a hologram. With the subsequent development of the laser, E. N. Leith and J. Upatnieks were able to apply the idea in a practical way in a *laser transmission hologram*, and the first holograms of 3-dimensional objects were displayed in the latter half of the 1960s. These early laser transmission holograms were lit from behind with coherent light sources. Now holograms are generally viewable in white light, a pronounced practical advantage.

Reflection holograms are lit from the front with an ordinary, short-filament spot lamp. The image in a reflection hologram is generally monochromatic, and the colour depends on processing chemistry and the colour of the recording laser. Silver halide emulsions are the most popular recording media for

*Holographer, c/o Dr. W. Rodwell, UKAEA, Winfrith, Dorset DT2 8D8, England. (Received 19 Nov. 1980)

display, but reflection holograms using dichromated gelatin have high efficiency or brightness. Reflection holograms have less image depth than the transmission type.

White light transmission (WLT) holograms provide deep scene capability, but lack vertical parallax. However, this is not obvious, and they give brilliant coloured images, viewable with an ordinary, clear incandescent light bulb. A WLT hologram has the characteristics of a prism in that the light passing through it is dispersed in a vertical plane and the eye sees the image in one wavelength or colour, changing according to eye height. For this reason it is often called a *rainbow hologram*. The *achromat*, which produces an uncoloured image, was developed from this type of hologram by the inventor Stephen Benton.

White light transmission holograms are usually second generation, in that they are made from a master or first generation laser transmission hologram. Many reflection holograms are also second generation, producing images that appear just behind the hologram surface, or in front of it, or in between. These holograms are sometimes referred to as *image-plane, image-transfer* or *focused-image holograms*. In a hologram, the virtual image is behind the plate/film, and the real image is in front. A reflection or a transmission hologram can be turned over to produce the real image between the hologram and the viewer. The image will be magnified and distorted, unless the hologram has been recorded with a parallel beam, and it will be pseudoscopic (turned inside out).

An *integral hologram* is a combination of a white light transmission hologram and a panoramic stereogram. It is sometimes called a *multiplex hologram, holographic movie* (or *'Holodeon'* [3]), *synthetic movie* or *holographic stereogram*. The process for making an integral hologram, devised by Lloyd Cross, involves recording a large number of consecutive views on standard cinema film and, with the use of a special optical camera, producing a corresponding series of vertically narrow views on holographic film. With the film joined at the two ends to make a vertical cylinder and illuminated from below by an ordinary clear short-filament lamp, viewers can see limited animation when it is rotated on its axis or when they walk around it. There are semi-cylindrical and flat variations of this standard format.

The equipment required in holography can be very expensive, but independent holographers have made ingenious improvisations. An example is the tunable large lenses made by Lloyd Cross for his rainbow camera made from Plexiglas and a vinyl plastic bag filled with mineral oil. Artists have the additional difficulty of obtaining technical information in an atmosphere of sometimes unnecessary secrecy. However, I believe that they need the practical experience of holography to understand its potential. Some of them find integral holography limiting, since the holographic stage of the process is done by commercial firms. The most recent technical development, which opens up holography to the mass market, is embossing. Atari, of the Warner Communications Company, now holds the patent licence covering off-axis holography in the consumer field, but this should not affect the activities of interested artists.

III. HOLOGRAPHY AS ART

In the newsletter, *Holosphere*, published by the Museum of Holography in New York, technical aspects of holography are emphasized, but it does also include contributions from artists. A new journal of holographic art, entitled *Image Plane*, welcomes articles contributed by artists. It seems, however, that art writers and theoreticians have been largely unwilling to spend the time necessary for the assessment of holographic art on its own terms. In a similar way, not many holographers seem to take a close interest in other kinds of contemporary visual art. If holographic art is taken to be not merely a demonstration of design and manipulative skill but of originality, then artists could avoid mistakes similar to those that occurred in the early history of photography.

Although the number of holographic art works available for exhibition is still very small, there are now probably enough to begin to establish a critique of them. There are holographers who have come from the fields of dance, painting, sculpture, photography, film, interior design, the theatre, glass work and poetry, and they are producing holograms of wide diversity.

Here I shall mention only a few individual holographers. There are, for example, Rudie Berkhout, Dan Schweitzer and Sam Moree in New York City, who use the highly saturated brilliant colour of white light transmission holograms to make colour structures, delicate scenes and landscapes. The pioneering achievement and environmental feel of Harriet Casdin-Silver's holograms, and the large number of early reflection holograms by Anaït Stephens [3] are noteworthy. Ruben Nunez combines glass, motion, and cosmic imagery in his holograms and Peter Nicholson has specialized in holographic portraiture. Rick Silberman's image planes, Bill Molteni's work with integral holograms, and holograms by Randy James, Setsuko Ishii (Japan), David Hlynsky and Michael Sowdon (Canada), Rebecca Deem, Alexis Krasilovsky and many others need to be seen for a fair assessment of the potential for art in holography.

Artists who are not holographers, for example, Salvador Dali, Bruce Naumann, Lowry Burgess, Simone Forti, Amy Greenfield, Yaacov Agam and Carl Frederick Reutersward, have commissioned holograms often based on themes in their works made in other media. Two scientists who have contributed their special expertise are Nick Phillips (Advanced Holographics, Loughborough University, U.K.) in reflection holography and Stephen Benton (Polaroid Corporation, Cambridge, Mass.,

U.S.A.) in white light transmission holography. The *1981 Holography Directory*, compiled by the Museum of Holography, is a comprehensive listing of persons involved in holography.

Artists can strongly influence the use of holography away from kitsch, which is dominant in display holography. Unfortunately, those who make holograms primarily for sale tend to use banal imagery to please a consumer public. Many holography 'galleries' are shops where holographic artwork can sometimes be seen amongst the commercial holograms.

Opinions differ widely among artists on the merits of different types of holograms for art works. With respect to cylindrical integral holograms, Al Razutis has said, 'The Multiplex stereogram ... fails to articulate clearly the synthetic relationship between its evident shape (the cylinder) and the holographic image contained within. (The magic of the artifact in the bottle will not suffice as aesthetic gesture)' [18]. On the other hand, Amy Greenfield, a film–dance/video–dance artist has written that 'traditionally, circular space has been the space of sacred dance, the sacred dance ritual. Integral holography makes possible a sacred dance space for the 1980s' [19]. David Hlynsky compares transmission with reflection holography in this way: 'Transmission holograms mimic sculpture in their display requirements but are hard-pressed to compete with the "monumental" presence of traditional sculpture.... Reflection holography more easily camouflages its novelty by occupying the spaces previously reserved for "works on paper" ... it seems somehow more natural for the flat works of the past to evolve some dimension than for the sculptural works of the past to achieve a new flatness' [20].

My own experience bears out Hlynsky's statement. The practice of hanging some of my reflection holograms on a wall at eye level, illuminating them from the ceiling by a mini-spot lamp and 'hybridising' them with conventional media, such as gouache and pen drawings, has provoked a favourable response that was lacking to my earlier transmission work displayed in a non-traditional manner. With these reflection holograms I have attempted to approach the expectations of the art public as I had approached the general public with earlier holographic still-lifes [2]. Familiar kinds of art works can serve as a basis for understanding unfamiliar ones.

IV. ON MY HOLOGRAMS

Here I shall discuss my work subsequent to 1972, when I reported on my earlier work in *Leonardo* [2]. It will be clear from both these accounts that I do not limit myself to a single approach. I regard my holograms as representing phases along a path of planned activity with some unplanned branches, in opposition to the 'master concept' of art in which art works are graded in a hierarchy of quality. In a hologram a part of an image provides the whole of the image of which it is a part. This suggests a different value structure from that of mastery for the ordering of art works. Technical excellence, also, is relative to an artist's aims. The technically brilliant and very large holograms now being produced in research and commercial laboratories I find often pointless, taken as art.

A recent exhibition of my work at the Museum of Holography in New York was titled 'Phases' [21], because the phase relationships of coherent light are what the holograms record and because there have been phases in my approach to holography. My very first pieces, exhibited in the Nottingham University Art Gallery (1969), continued my preoccupations as a painter within holography. Subsequent exhibitions at the Lisson Gallery, London (1970), the Icograda Congress, Vienna (1971), and the Richard Demarco Gallery, Scotland (1972), contained holograms in which I used unique aspects of the medium, introducing unfamiliar notions about space, time-reversed imagery and double exposures in which two solids seemed to share the same space. I made 'non-holograms' that showed motion invisible to the naked eye, 'solid holes', and '3-dimensional silhouettes'.

Then, in 1972 I began to make holograms with themes on the social dangers I perceived from the increasing sophistication of holography and of technology generally. The birth of my two children in 1974 and 1976 has meant a change in my priorities. My most recent phase of work is associative, cross-cultural, even 'holistic' in approach. Holography has become a catalyst.

'Brave New World' (1972) is a hologram that includes narrative aspects such as a small animal in a derelict landscape, with a throwaway bottle in the foreground, suggesting the destruction of ecological cycles, and in an afterglow of laser light a sky in which the words 'Brave New World' appear. It is meant as an ironical comment about the newness of the medium and a warning about a possible future world. 'Third World' (Fig. 1) is a hologram

Fig. 1. 'Third World', transmission hologram, silver halide on glass. 20 × 25 cm, 1972.

containing a photograph of a cheerful African woman standing in her hovel, with a quotation of a statement by the science-fiction writer Ray Bradbury (U.S.A.) that says people will soon have 3-dimensional holograms ('friendly spirits') transmitted into their houses to walk round. In the context of a Third World hovel this is heavily ironic.

'Greetings' (1978) is a hologram of a photograph of a starving mother and child, combined with Christmas baubles. Shown amongst Christmas cards, it was meant to draw attention to the over-commercialization of this 'religious' celebration in Western countries. Here the unique visual properties of the medium were emphasized not within the hologram itself, but with the context in which it was shown. Holography had not been seen within the genre of the greetings card. Holographic artists can take advantage of the fact that visitors to holography exhibitions are from a wide cross-section of the general public.

Like 'Greetings' my holograms 'Unclear World I' (Fig. 2, top) and 'Unclear World II' (Fig. 2, bottom) convey a message that begins to reveal itself if the first two letters of their titles are reversed. They show a spherical model of the Earth covered with missiles and are reflection holograms combined with drawing. 'Unclear World I' has been sprayed on the emulsion side of the hologram with matt black lacquer and engraved through paint and emulsion to the glass, and the engraved parts have been painted in from the back with white gouache. When the hologram is reconstructed, the engraving shows as fine white lines on the surface. The engraving contrasts the snake of the children's game of chance 'Snakes and Ladders' on rungs marked SALT (the acronym for the Strategic Arms Limitation Treaty between the U.S.A. and the U.S.S.R.) (Fig. 2, top, right) with the snake as *ouroboros*, the symbol of unity and infinity (Fig. 2, top, left). 'Unclear World II' (Fig. 2, bottom) has been sprayed with black in one area of the emulsion side, so that the part of the plate left clear is almost transparent, being a bleached hologram. Under this transparent area has been placed a sheet of paper with a drawing of a world at the beginning of its human habitation, filled with animals, plants and birds, that threatens to be obliterated by the dark area of the hologram showing the world with its missiles. It seems to me particularly appropriate for artists using advanced technology to draw attention to the danger of nuclear war.

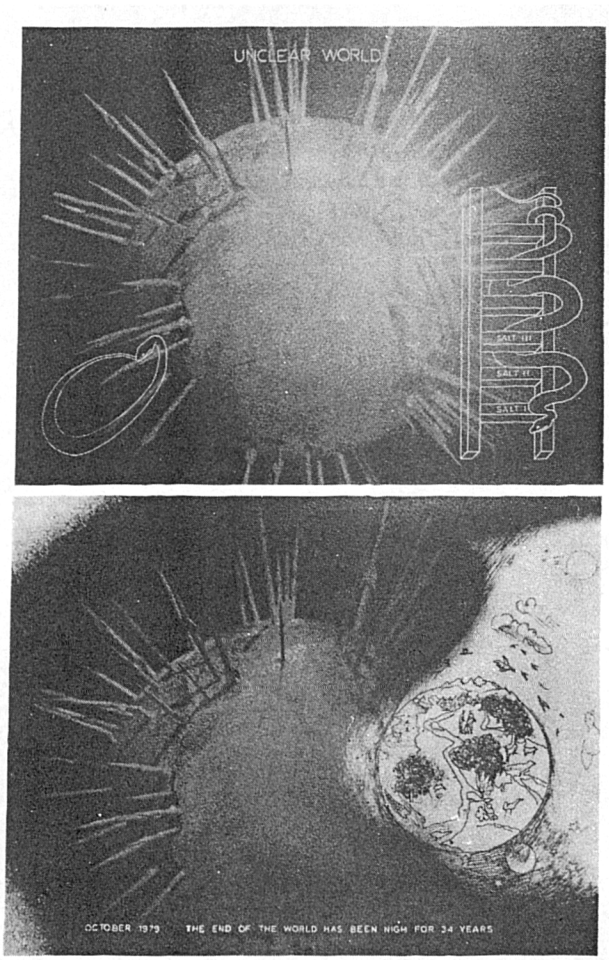

Fig. 2. (Top) *'Unclear World I', reflection hologram with engraved emulsion, silver halide on glass,* 20 × 25 cm, 1979; (bottom) *'Unclear World II', reflection hologram and drawing, engraved emulsion, silver halide on glass,* 20 × 25 cm, 1979.

Some holographic artists object to holograms 'hybridized' with other media, but I have found they permit me to treat a wider range of themes. 'Hyperworld', 'Binding', the 'Secret Sacred' series, the 'Greenhouse' series, 'Lattice I' and 'Lattice II' involve writing, drawing and engraving. In combinations of images outside and inside a hologram, the hologram appears as a reminder of the immaterial in the material world. The 'hard', technological medium of holography also permits artists to work in a contrasting soft, romantic, even 'picturesque' manner in their response to life experience. My 'Greenhouse' series holograms, subtitled 'Creation Myths' (Fig. 3), 'An Automatic Eden' and 'Electric Garden' are an overwrought and 'feminine' use of 'masculine' technology.

'Lattice I' involves a grid, drawn into the emulsion surface of the hologram that appears to be cast back into a holographic image of the same grid, almost like a real shadow. There is an ambiguity about the grid that does not map anything but the surface it covers, yet it conveys the separation of the image from the real world. In 'Lattice II' the same hologram left bleached and transparent is laid over a painted grid of different colours; the painted subtractive colours of the grid produce variations in the green additive colour of the hologram from deep blue-greens to olive and gold.

The theme of 'Binding' (Fig. 4) is integration, the mystic idea of many-in-one. It involves the double exposure of an array of twigs that interweave with themselves and with a thread-like drawing. The Latin root of the word religion is *ligare*, to bind, and the derivations of the Sanskrit *yoga* and *tantra* are binding and weaving. The recurrence of web-like images in the work of holographers is not a coincidence. Mystical aphorisms such as 'we are all

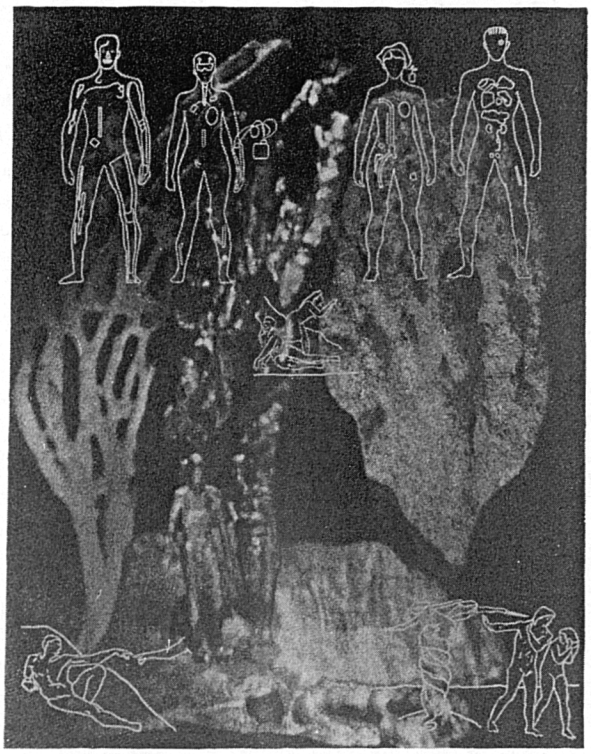

Fig. 3. 'Greenhouse I: Creation Myths', engraved reflection hologram, silver halide on glass, 25 × 20 cm, 1980.

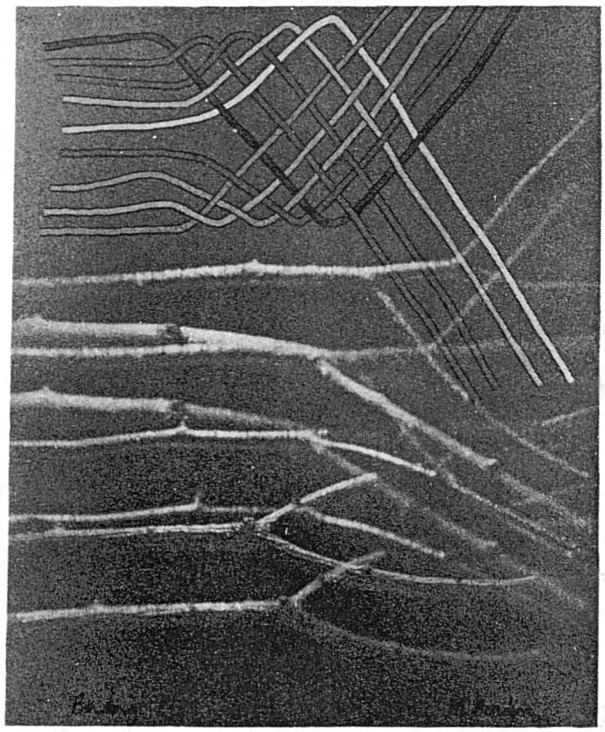

Fig. 4. 'Binding', reflection hologram and drawing, silver halide on glass, 25 × 20 cm, 1979.

one' and 'the universe in a grain of sand' take on for me a new meaning with holography.

To me, the particularly exciting aspect of holography is not that it records visual appearances, but that it is a principle suggesting undivided wholeness, rather than the relationship of parts to a whole. It provides a link with other realms of thought about the physical world and one's own consciousness and presents one with a new way of ordering.

People are invariably fascinated to learn that if a hologram is broken each piece shows the whole picture from the perspective at which it was recorded. With 'Jigsaw' (Fig. 5) they can discover this for themselves. A reflection hologram is cut into six pieces with straight edges and mounted onto wooden blocks for easy handling. Each piece of hologram still contains the whole picture because the necessary visual information is contained in each piece of the plate. The cues for fitting together this holographic jigsaw puzzle come from the different angles of view of the image, and not from the edges of the pieces, as with the usual 2-dimensional puzzle.

Fig. 5. 'Jigsaw', six parts of a reflection hologram mounted on wood blocks, silver halide on glass, 20 × 25 cm, 1978.

My earlier 'Jigsaw', a laser transmission hologram, was made in 1972. It is an interesting sidelight on the poor communication existing between the worlds of art and of science and technology that my idea, published in *Leonardo* in 1973 [2, p. 5], was patented by N. M. Rugheimer and S. R. Chestnut in 1978 [22]. As in 'Jigsaw' I attempted to reveal the optical mechanism of the holographic process, so in 'Test Plate' (1978) I tried to show what goes on in the physical process of making a hologram. Rough fragments of a holographic plate were each exposed separately to the same subject and used as test plates for various processing formulae, which resulted mainly in a change of colour in each. One of the pieces was not washed, and will change with time. The fragments were mounted and displayed together as a single work.

Serial images initiated by Eadweard Muybridge (U.K., 1830–1904) in photography take on an

experiential change in holography. In 'Twigs' (1979) the changes in the spatial relationships of a series of double-exposed twigs arranged linearly draw a viewer's gaze into the depth of each hologram in a non-linear fashion. Double exposure can produce topologically interesting phenomena. 'Bird in Box' (Fig. 6) followed an experiment I made with a pioneer holographer Gordon Rogers [23]. The box in the hologram is a continuous surface, comparable with the Moebius strip. 'Wide angle Still Life' (Fig. 7) no longer exists. It was a casualty of my early work with lamination. In this work, fractured pieces of hologram were interspersed with 2-dimensional photographic positives of the same scene, in a manner so that the two were roughly equal in area. The difference in visual information received from the two kinds of images was quite striking. Over the 25 × 40 cm area of the piece, a single broken piece of hologram showed the whole scene, whereas a section of transparency showed a disconnected small part of it.

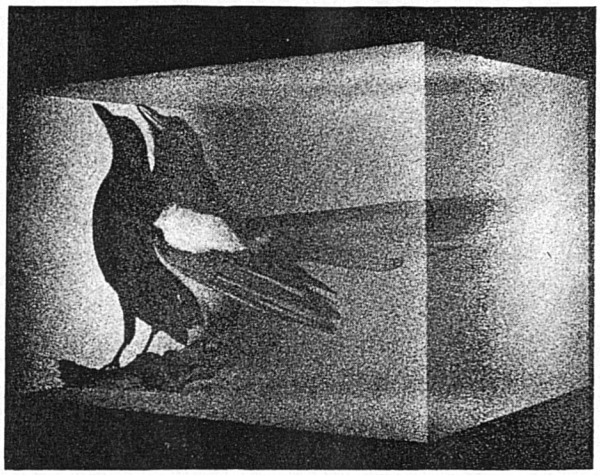

Fig. 6. 'Bird in Box', transmission hologram, silver halide on glass, 20 × 25 cm, 1973.

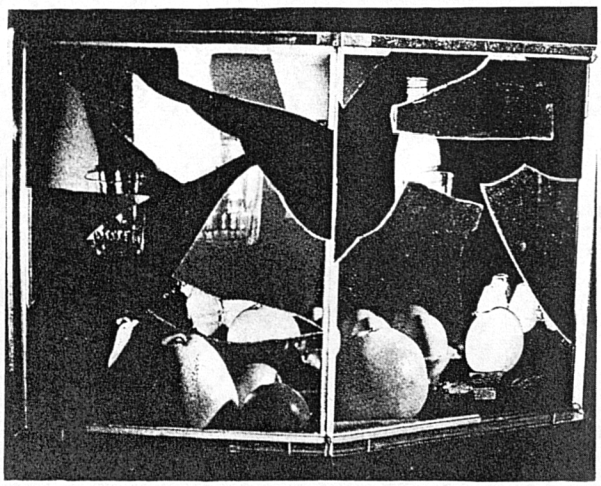

Fig. 7. 'Wide Angle Still Life', transmission hologram and film positive, silver halide on glass, 25 × 40 cm, 1972.

My 'Secret Sacred' series (Fig. 8, see colour plate) combines holograms of an Australian Aboriginal totem (a public burial post, usually standing on open ground), with drawings and the written statement 'This is not a secret sacred object'. It comments on the cultural roots of society in Australia, where I have lived for the last five years. I am saluting Australia's ancient origins and rituals by means of advanced technology, and the tragedy of what has been happening to the Aboriginals after the arrival of the Europeans is implied by the enigma of the written statement. Which aspects of the series are not either secret or sacred is not easily resolved. For instance, what happens to a hologram image when the light reconstructing it goes out? The Australian Aboriginals have a holist view of the world. Life is considered one, the land and what is on it are not separate entities for them, and the past, called 'dreamtime', is not separate from the present. I find an interesting link between holography and Aboriginal painting. There is a particular visual quality in some North Arnhemland work that is called *bir'yun*, which is to do with the reflection of light from the surface of fresh water, leaves or a shining tin roof [24]. This is also present in their myths of ancestral creators, the Rainbow Serpents. This quality is the shimmering effect of finely cross-hatched paintings producing an apparent sensation of brightness. In most cultures light is associated with emotional uplift, joy and even revelation. People speak of something 'dawning on them', of 'enlightenment'. The effect of a holographic image on some people is also a brightening, as when the Sun comes out from behind a cloud.

In Canberra, Australia, there is direct sunlight almost each day of the year. I have taken advantage of this in viewing my holograms whilst working on them. The Sun is a very good point source of light for looking at holograms. Those working in this way become aware of the positions of the Sun, and of their location on the Earth. My first hand-held 'Solar Marker' was made as an exchange piece with an Australian sculptor, John Davis, who uses raw materials from nature in his work. My 'Solar Markers' use the 'raw' materials from nature as an intended contrast to the 'cooked' cultural, technological medium of the hologram [25]. Holography is often called the medium of the future. The message of 'Solar Marker' is that the past is not separate from the future. The piece is structured around the early elemental concepts of earth, fire, air and water. A hologram of an underwater scene (water) is mounted on a burnt rock (fire and earth) and is taken outside (air) to reconstruct in the direct rays of the Sun (Fig. 9). The hologram is inscribed in the four corners with the words, hot, wet, dry and cold. There is play on the 'light' image of the hologram that appears to be inside the 'heavy' rock. The piece is intended as a small universe through visual ambiguity.

Although most of my recent pieces have been of the reflection type, 'Rainbow Rainbow' (1978) and 'Black Rainbow' (1980) are rainbow transmission

Fig. 9. 'Solar Marker', reflection hologram (silver halide on glass) mounted on a rock and viewed from above. approx. 4 × 3 cm, 1979.

holograms that make use of rainbows in the imagery. 'Rainbow Rainbow', made at the National Measurement Laboratory, Sydney, is a multicolour hologram of a model of painted rainbows. Red and green lasers were used to produce an approximation to the original colours. 'Black Rainbow' is a study piece for another hologram not yet made that will involve the making of an achromat. 'Black Rainbow' was the result of collaboration between me and Stephen Benton. A white-light transmission hologram of a globe is combined by double exposure with a laser transmission of arcs that flare into rainbows when lit with white light. The piece concerns the reconciliation of opposites. A marked, dark world contests the sight/site of rejoicing, as rainbows leap.

I am indebted to the Department of Physics, Australian National University, Canberra, the National Measurement Laboratory, Sydney, and the Royal Military College, Canberra, which provided me with facilities during 1979 and 1980.

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APPENDIX I

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Pulsed Holography as Art

Margaret Benyon with John Webster

Abstract—Holographic artists working with continuous-wave lasers are restricted mainly to rigid, still subject matter. The pulsed laser 'freezes' moving subjects for the duration of the holographic exposure and increases the artist's scope to include live subjects. This article gives a historical background to pulsed holography, a short description of the pulsed laser, a comparison between continuous-wave and pulsed holographic practice and a discussion of individual holographic artworks made with a pulsed laser.

I. INTRODUCTION

Holographic artists have been constrained in their choice of imagery to date. One reason is that the cheapest and most reliable laser commonly used by holographic artists—the low power, continuous-wave (cw) helium–neon laser —does not allow movement in the subject. If the subject being recorded moves more than a fraction of a light wavelength (about 1/10,000 mm), a hologram will not be obtained. This instability can be used to advantage with live subjects in the type of 'non-hologram' first used by an artist in Margaret Benyon's work *Hot Air* (1970) [1]. In this technique, the subject is back-lit only and appears as a solid hole that one can look around, a three-dimensional silhouette. This sort of hologram is now universally known as the *shadowgram.* However, if the cw laser is powerful enough to keep the exposure short (about 4 seconds or less) and if attention is given to environmental temperature control and length of settling times, it is possible to record a surprising number of floppy materials, even flowers [2]. It is also possible to record motion picture images of live subjects to form *holographic stereograms*, now being used to advantage by an increasing number of artists [3]. However, there are still relatively few holograms of live subjects. With pulsed holography, the artist is freed from model-making to generate images from the real world. The pulsed laser gives out a very powerful flash of light of extremely short duration, typically about one tenth of one millionth of a second, which enables moving subjects to be effectively 'frozen' for the period of the exposure and eliminates the need for a vibration-free table. This greatly enlarges the potential of holography as an art medium.

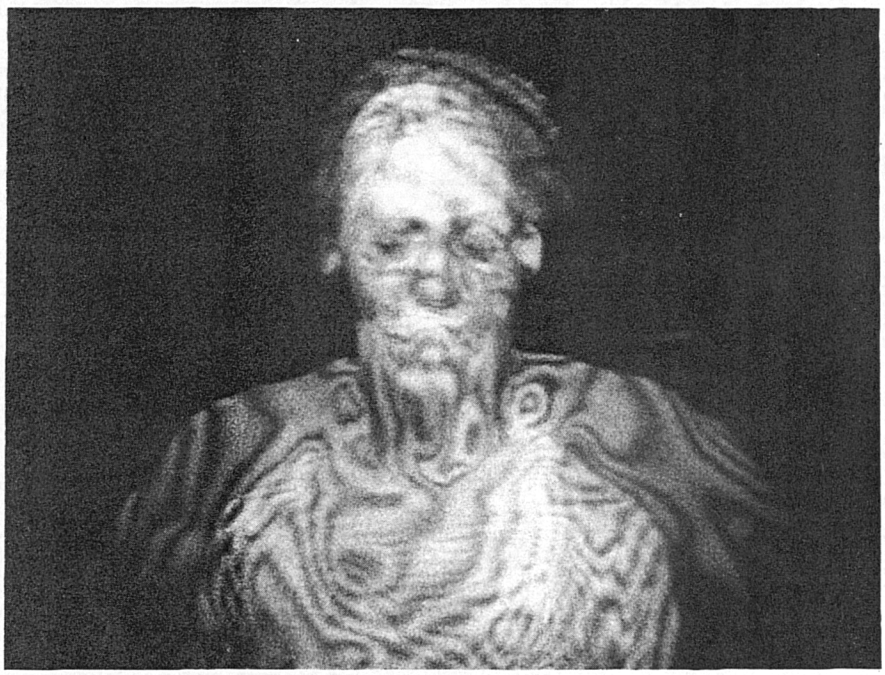

Fig. 1 *Tiresias*, white-light transmission hologram, silver halide on glass, 30 × 40 cm, 1981. In this hologram the images of a man and a woman are superimposed to form a single androgynous being. The patterning on the figure is produced by two exposures separated by an interval of a few microseconds, the light and dark fringes representing a movement of half a wavelength of laser light. Double-pulsed holography gives a direct visual readout of outer and inner body movements.

II. HISTORY

The first laser was a pulsed ruby laser built by Theodore Maiman in 1960. Both pulsed and cw lasers soon became available for research purposes [4]. Early pulsed holograms were dim, deficient in contrast and suffered from 'noise'—an overall graininess. Leading scientists pioneering in the field were Ralph Wuerker (TRW Inc.) and Lawrence Siebert (Conductron Corp.). In 1966 Siebert designed an improved pulsed laser which recorded live subjects with greater clarity, depth and brightness. Concurrent with making holograms of moving images was the search to make holographic images move. The pulsed laser was used to produce short holographic movies, one of the most notable being the movie of a goldfish swimming in a tank, made by Alex Johnson (Hughes Research Labs) in 1968.

Artists pioneering in the field included Bruce Nauman, Carl Frederick Reutersward and Peter Nicholson. In 1969 Nauman exhibited in the U.S.A. a number of pulsed holograms of himself; these were the earliest known holograms by a recognized artist [5]. The holograms were produced for him by the Conductron Corporation. In 1970 Reutersward exhibited pulsed works made with Hans Bjelkhagen [6]. During the 1970s

Margaret Benyon (artist), 40 Springdale Avenue, Broadstone, Dorset BH18 9EU, U.K.

John Webster (physicist), John Webster Associates, Avery Lodge, Long Lane, Marchwood, Nr Southampton, U.K.

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Fig. 2. *Counting the Beats*, white-light transmission hologram, silver halide on glass, 30 × 40 cm, 1981. A hologrammetric double portrait of a man and a woman.

Peter Nicholson, a sculptor by training, made considerable advances in holographic portraiture working with the old McDonnell-Douglas/Conductron laser.

The end of the decade saw further technological advances. Nick Phillips at Loughborough University made major advances in the chemical techniques that have improved holography [7]. He also produced large (1 metre by 1 metre) pulsed transmission holograms, aided by improvements in pulsed technology brought about by John Webster and J.K. Lasers [8]. In 1978 Nicole Aebicher produced the first animated pulsed reflection portraits at the Laboratoire de Physique Générale et Optique (LOBE) in Besançon, France. Australian artist Paula Dawson also worked at this facility, where she produced pulsed holograms for display in sculptural installations and a large environmental hologram. At the Cinema and Research Institute (NIFKI) in the Soviet Union, Victor Komar produced a special holographic screen for viewing a holographic movie of nearly 50 seconds duration comprising 70 mm sequential pulsed holograms. NIFKI's research into holographic cinema has led to substantial developments in large holographic screens and large pulsed lasers for scene illumination.

In the 1980s, sales of pulsed lasers have increased. They are in use in universities and commercial companies worldwide. Leading practitioners such as Hans Bjelkhagen, Peter Nicholson and John Webster are advancing the technology. In Britain, Applied Holographics is using pulsed lasers in the development of machines for producing hundreds of *reflection holograms* in quick succession. In Rome, the Department of Physics at the University is using a portable pulsed laser in the restoration of artworks. Also in Rome, Daniele Fargion has opened an accessible pulsed facility. The Museum of Holography in Paris has a good pulsed facility, where Canadian artist and filmmaker Michael Snow produced a number of holograms with John Webster for the Canadian Expo '86. Lasergruppen Holovision in Sweden has a pulsed facility and has worked with artists. Of particular interest to artists is the founding of a Holography Unit at the Royal College of Art, London, which houses a 10-joule pulsed laser.

III. THE PULSED LASER

In the field of holography the ruby laser is so far the only pulsed laser suitable for producing display work [9]. A ruby laser [10] consists of a synthetically grown ruby crystal rod of the highest purity. Its finely polished ends are profiled so as to enhance the beam quality. Special mirrors positioned at either end allow the light energy to pass back and forth along the rod. A high-voltage power supply directs energy to a flashlamp, which stimulates the atoms in the ruby rod to an excited state. This leads to laser action in the form of a powerful burst of light. The pulse duration can be made as short as a few billionths of a second with the use of a device called a *Q-switch*. Additional ruby rods are often used to amplify the pulse.

IV. MAKING HOLOGRAMS WITH A PULSED LASER

Pulsed ruby lasers have a reputation for being very expensive, large, dangerous and frequently temperamental. In the past they have often required additional developmental work before yielding high-quality results. Moreover, their limited availability is a significant concern for artists. The first step is to afford, or gain access to, a suitable pulsed laser. The holograms discussed in this article were produced on a 10-joule laser facility manufactured by J.K. Lasers. Webster's improvements to this laser have led to a diminution of 'noise' and to vastly improved beam quality and reliability. Manufacturers like J.K.Lasers are rapidly introducing improvements such as a reduction in both the size of the laser head and the robustness of design. The ruby laser is becoming almost as easy to operate as the helium-neon laser most commonly used by holographic artists, which works merely by being switched on and off.

Although the prices of pulsed lasers change rapidly, and nearly always upward, current costs give a rough idea of their expensiveness. A one-joule laser currently costs about £30,000 ($45,000). It will give sufficient power to make holograms of objects 0.5 m^3 in size, such as the human head, if the light is used economically. A three-joule laser would permit objects of up to 1 m^3, about the size of a person, to be holographed onto a plate or film size of 0.5 m^2. For a ten-joule laser allowing large scenes to be recorded, an investment of about £50,000 ($70,000) would be necessary. The optics to go with the laser can exceed £5000 ($7000). Special coatings matched to the wavelength of the laser are necessary to withstand the high-energy density of the beam. Ordinary optics would be destroyed by a pulsed laser. However, under some circumstances, it is possible to use ordinary optics if the beam is expanded first with a negative lens.

Holographic experience on a cw laser is recommended before graduation to the pulsed laser [11]. Many of the basic rules of holography are shared by practitioners using cw and pulsed lasers, although processing chemistries are adapted to suit their respective requirements. In the pulsed work discussed here, proprietary formulae have been devised to take into account the response of the emulsion to

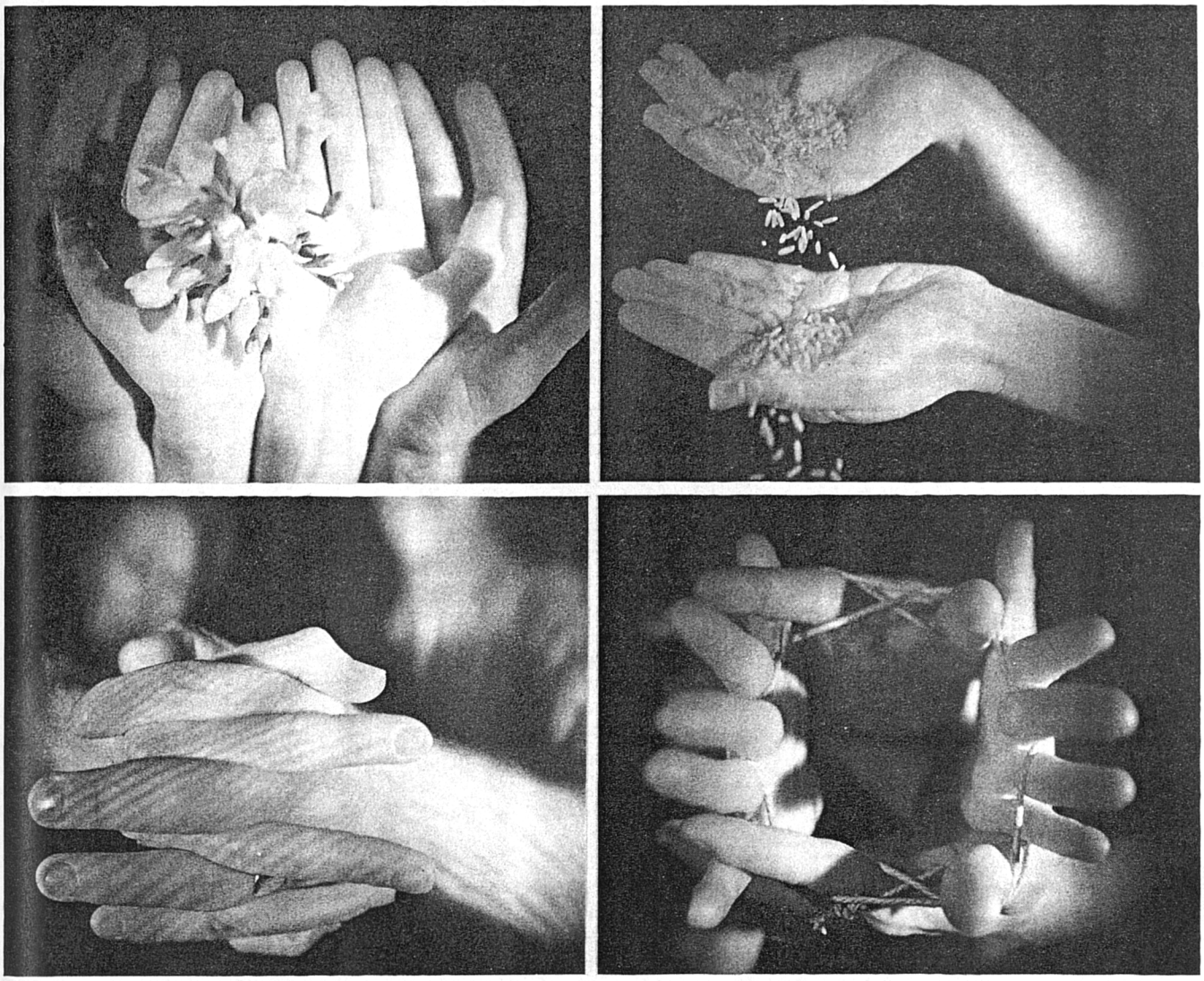

Fig. 3. From *Conjugal Series*, four reflection holograms, silver halide on glass, 8 × 10 in, 1983. *Conjugal Series* contains a number of differently coloured holograms of male and female hands carrying out a series of actions. In *Hands and Freesias II* (a) the hands nurture flowers. In *Hands and Rice* (b) the pulsed laser captures an instant as grains of rice pour from one hand to another. In *Tango* (c) hands are clenched in a grim dance, while in *Cat's Cradle* (d) they are bound together in play.

exposures lasting a few billionths of a second.

As in any laser workshop, the working environment should be as dust-free as possible. This is particularly the case with a pulsed laser, since dust on the optics would be burnt in. In pulsed holography it is not possible to clean the beam with a spatial filter at the last stage of its progress through the 'setup' as in cw holography. If the high energy of a pulsed laser were focused to a point so that it could be passed through a spatial filter, air breakdown would occur; as a result, the beam would be reflected back into the laser and the ruby would be destroyed [12]. Current pulsed laser designs place the spatial filter inside the laser. Housing the 'setup' within tubes, as Wuerker did with his early '*holo-camera*', would make it dust-free and safe. In pulsed holography, safety rules have to be obeyed because of the high-energy levels involved. Eye accidents have occurred with both cw and pulsed lasers, but the latter are more dangerous. Provided that holographers know the system they are using and abide by the established safety levels, the pulsed laser is safe. Live subjects whose eyes are open need to be illuminated through a diffusing screen. Care must be taken to prevent light from the reference beam and scattered light from reaching the eye. Special developments now taking place in fibre-optic technology should circumvent many of the problems associated with handling a beam that has dangerously high energy levels.

The Q-switched beam is of such short duration that it is difficult to see. This presents practical difficulties in the setting up of a holo-camera. The path of the beam is usually mapped out with a helium–neon laser. Although both beams are red, they have different wavelengths. Systems are now being developed which will provide 'modelling' lights in portraiture studios, analogous to a studio photographer's complex flash setup. The difficulty of attempting to see an image during the brief flash from a ruby laser becomes most acute when making transferred holograms. Most modern holograms [13] are illuminated with white light from either the front (reflection) or the back (white-light transmission). There are one-step techniques that can be used with both types of holograms, but most contemporary work involves a two-step process, analogous to that of the film and the print in photography. First, a laser transmission hologram is taken; this becomes the master from which white-light viewable transfers are made. Positioning the image in its spatial relationship to the transfer plate is usually done in cw holography. This is difficult in pulsed holography, and the alternatives of careful measurement

or the hit-and-miss approach are not very satisfactory for the visual artist.

Another consideration in the making of transfers is that the ruby wavelength is close to the infra-red. The eye is not very sensitive to this wavelength. Some adjustments in processing the transfer hologram are necessary to bring it closer to the yellow colour of the sun, to which the eye is most sensitive. The pulsed laser is still an exotic instrument; and unless an artist can find a way of buying one for personal use, it makes most sense to arrange time on a pulsed laser for laser transmission holograms only. Hire time can still amount to more than £1000 ($1400) a day, with technicians. However, with careful preparation a number of different images can be generated in a comparatively short space of time with a pulsed laser. Modern pulsed transmission holograms can give a depth of several metres. They can be exhibited in their primary state if special light sources, such as filtered mercury arc or sodium lamps, are used. Pulsed transmission holograms taken as masters can be transferred at a more leisurely pace with a cw laser in the artist's studio, as is the case with the holograms discussed in this article. This allows for further creative work in the superimposition of images or in combination with other media. Holographic artworks often involve a number of stages in the making of the final work. Masters can be transferred in a number of ways, each allowing for those visually expressive, conceptual and emotional aspects that drive an artist to make art.

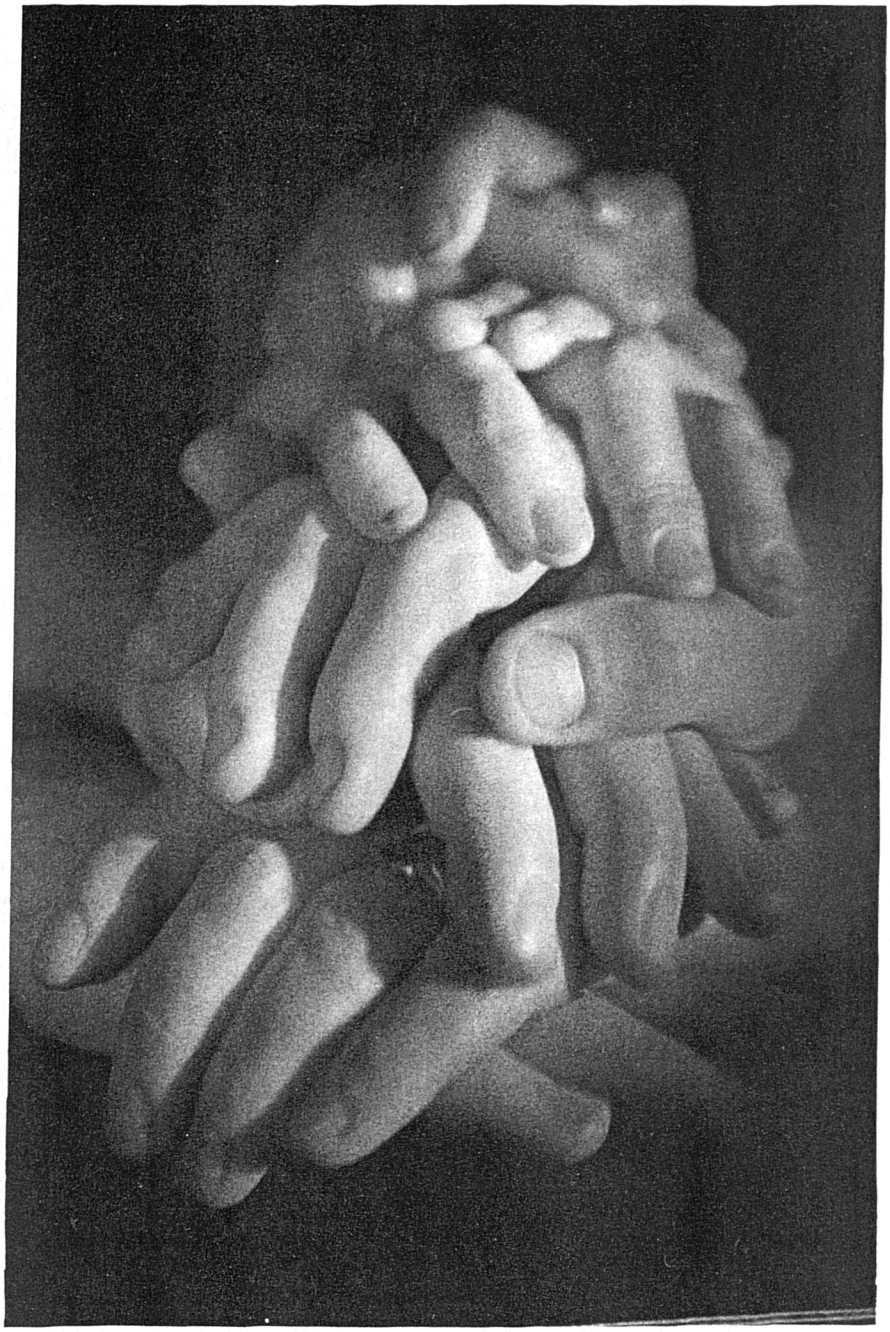

Fig. 4. From *Conjugal Series: Pile of Hands*, reflection hologram, silver halide on glass, 8 × 10 in, 1983. A pyramid of the generations is formed of male and female hands with a child's hands on top.

V. INDIVIDUAL HOLOGRAMS

Margaret Benyon has been using holography as an art medium since 1968. John Webster has been using holography as a scientific tool since 1969, and for three years has been using pulsed holography for studying fuel elements in nuclear reactors [14] and for the conservation of artworks at the University of Rome. He also has a personal interest in portraiture. We began a cautious collaboration based on mutual benefit. In this collaboration the artist mainly contributed drawings and ideas, while the scientist together with a technician, Chris Mead, made the masters; however, there was some overlap. For instance, one of the masters used in *Tiresias* (Fig. 1) stemmed from Webster's wish to make a hologram that, for medical purposes, would show as much movement as possible. Benyon assisted in building the rig for overhead illumination and in exposing and processing the holograms.

Our collaboration has often involved the use of the laser in a double-pulse mode. This produces two exposures separated by an interval of a few microseconds. Any movement that has occurred between the pulses is contoured in the image by light and dark interference fringes, each fringe representing a movement of half a wavelength of light. Double-pulsed holography is exciting because for the first time it permits one to see directly the pattern of outer and inner body movements. The dark and light fringing is like a ritualistic tattoo that bears a direct relation to our breathing and to the coursing of blood in our veins. It reveals the beating of our hearts, the traditional seat of the emotions. In *Counting the Beats* (Fig. 2), a holographic double portrait of a woman and a man (the artist and the scientist), the pulse in the woman's jugular is directly visible on the skin as a rippling necklace of patterns. The title of the piece derives from a poem by Robert Graves:

> Counting the beats
> Counting the slow heart beats
> The bleeding to death of time in slow heart beats
> Wakeful they lie.

This sombre theme is accompanied by lighter play between the sexes. The horizontal fringes on the head of the man indicate that he is nodding "yes", and the vertical lines on the woman that she is

shaking her head "no". The piece is structured around the reconciliation of opposites.

The work *Tiresias* also derives from the holistic nature of the medium. In this hologram, the images of a man and a woman are superimposed to occupy the same space [15]. An ambiguous form results: the mass oscillates between male and female, passing through an androgynous stage in between. Both these holograms were transferred into a white-light transmission mode. They were intended to be a two-plate display. By identifying both characters in the *Counting the Beats*, the more conventional portrait, people can then unravel the superimposition of the same two participants in *Tiresias*. Each plate was intended to assist in the perception of the other [16].

The *Conjugal Series* (Fig. 3) consists of seven differently coloured reflection holograms of male and female hands carrying out a series of actions. The cumulative effect of juxtaposing selected plates from the series reflects the sequential nature of pulsed work. The theme is marriage in the wider sense: conjugal/conjugate. In holography the conjugate of an image is its antithesis: another image can be obtained on the opposite side of a hologram by reversing the direction of the reference beam. In the *Conjugal Series*, images of nurturing, feeding, dancing, playing can also be interpreted as smothering, wasting, struggling, constraining. In *Hands and Freesias I* and *Hands and Freesias II* (Fig. 3a) male and female hands give, receive and nurture flowers. In *Hands and Rice* (Fig. 3b) the pulsed laser captures an instant as grains of rice pour from one hand to another. In *Tango* (Fig. 3c) the hands are clenched in a grim dance, while in *Cat's Cradle* (Fig. 3d) they are bound together in play, with the fingers projecting out into the viewer's own body-space. In *Binding II* they are bound together at the wrists in a more negative manner. A female fist is clenched into a small corner of the hologram, whilst a male hand spreads out over most of the area of the holographic plate. In *Pile of Hands* (Fig. 4), also in the *Conjugal Series*, a pyramid of the generations is formed of male and female hands with a child's hand on top.

The straightforward representational use of the pulse, as in most of the *Conjugal Series* holograms, presents a technical problem in the portrayal of human skin, at least of the Caucasian type. Conventional holographic portraits often have a waxiness that is reminiscent at best of the candlelight paintings of Georges de La Tour and at worst of the morgue. This is because the ruby laser light penetrates the epidermis and illuminates the subcutaneous layer. Layers of makeup form an effective barrier, and colour is used to compensate tonally for the bleaching effect of the monochromatic red light. With human subjects care should be taken to have the illumination coming from a natural overhead direction. The authors have found that people most commonly react to representational portraits by expressing a wish to have portraits made of themselves. A holographic portrait industry would seem inevitable. To date, however, portraiture has been expensive and limited primarily to company directors and public figures.

Fig. 5. *Facial Codes* (detail), four reflection holograms, silver halide on glass, 16 × 20 in, 1984. Male and female heads express positive and negative emotions.

One might expect that it would be easier to achieve a likeness in pulsed portraiture than in photography, since a hologram provides more information about the person. This is not so. A photographic likeness is generally achieved by selecting the most representative image from a number of other photographs, some of which are not like the subject at all. In pulsed portraiture, waxiness and the slightest distortion caused by aberrations in the optical setup can render the subject unrecognizable. Skin texture can appear flatteringly smooth for aged subjects. Eyes caught in an unblinking stare can appear fishlike. Holographic portraiture requires care, sensitivity and, ideally—to avoid an alienating image—the opportunity to choose from a number of exposures. It is possible to approximate skin colour in reflection transfers by a technique of preswelling the emulsion [17] in combination with 'Pyrochrome' processing [18]. Because the images in *Conjugal Series* are symbolic rather than representational, colours felt to be most appropriate to the images were chosen in a range from green to red. For instance, *Hands and Freesias I* has a fresh, springlike quality only when it is yellow, slightly tinged with green. *Hands and Rice*

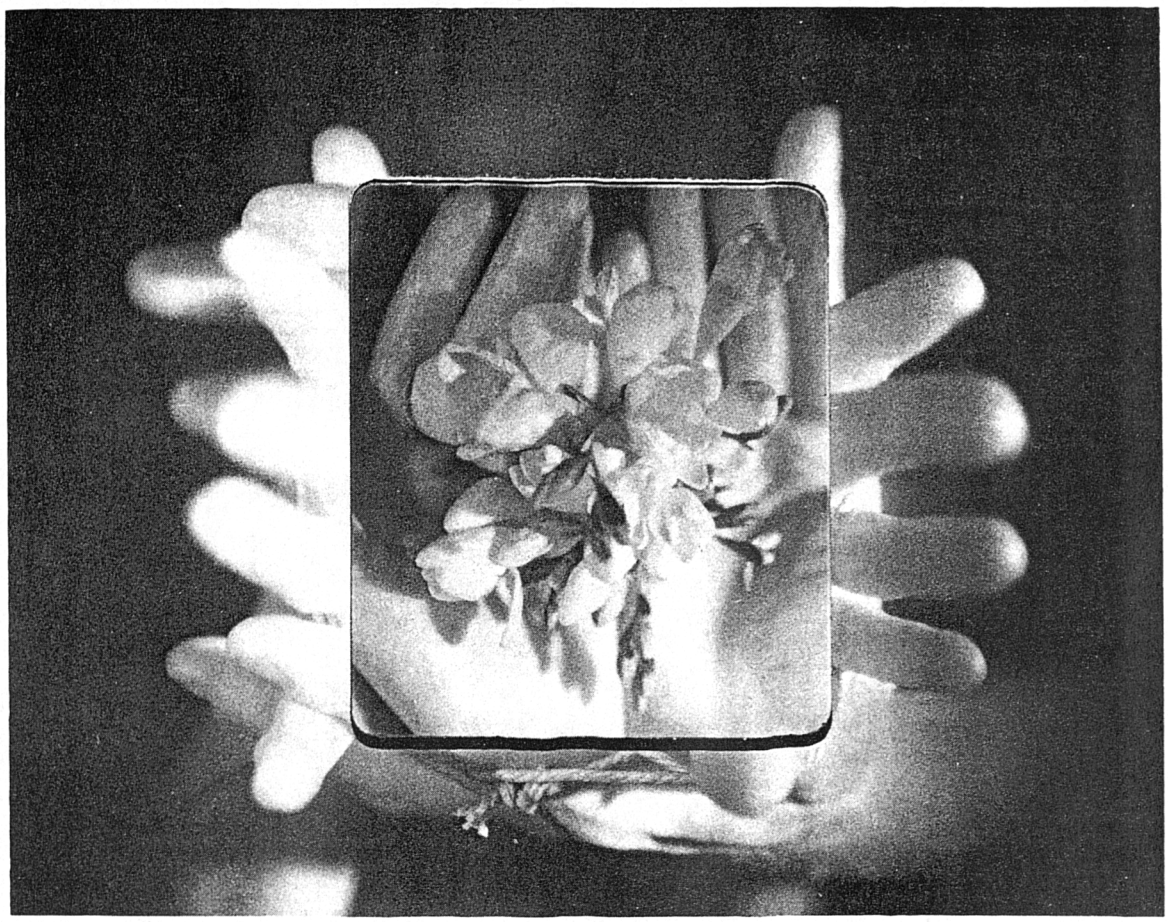

Fig. 6. *Presentation*, two reflection holograms, silver halide on glass, 4 × 5 in and 8 × 10 in, 1984. The projecting real image of fingers in one hologram appears to hold another hologram containing its own separate space.

looks at its best in brilliant yellow-orange. *Pile of Hands* has peculiar visual qualities: according to the monochromatic colour in which it is made, it can take on the appearance of baroque Indian temple sculpture (yellow), or a pile of sausages (light red) or a decorative Victorian dessert (green). The holograms are mounted in a juxtaposition of colour opposites.

In 1984 more interferometry of the emotions was carried out in *Anatomy of a Smile* and *Facial Codes* (Fig. 5). In these holograms the emotion, not the person's head, is the subject. In *Anatomy of a Smile* three interferometric reflection portraits of the artist were mounted together to show the fleeting patterns of motor activity that are set in motion when a person smiles. Because the patterns fade in the areas where the expression is the least intense, they are indicators of vitality. In *Facial Codes* four reflection holograms of male and female heads express negative and positive emotions. The heads resemble the eighteenth-century carvings of Messerschmidt in that the fringes are codified into sections which are sometimes symmetrical. The interference patterns on the heads are also symmetrical in places and uncannily similar to Maori body tattooing. There is an affinity with twelfth-century Japanese wooden sculptures whose surfaces are so worn away that the woodgrain is strongly visible. Xerox images from these early sources surround the holograms. The shamanistic aspect of art activity—the artist as healer—is suggested through primitive, cathartic expression.

In *Tigirl* (Color Plate No. 1) the fringes on the face of the artist are combined with the stripes on a tiger's head. In *Cosmetic* (1985) the same hologram appears to be tinted. Because it is spatial, a holographic image cannot be retouched. This piece, however, shows one solution to the problem: a brightly coloured painting placed underneath the transparent plate tints and alters the holographic features that are image-planed. This idea depends on careful registration of the painting with the holographic features, otherwise the mixed techniques contest rather than reinforce each other. Brush-marked shadows give the holographic shadows a texture and vitality, and the under-painting lends a subtle colouration to the holographic image. The emphasis on cosmetics in the recording stage of the pulsed hologram is carried through to its final presentation.

Optical aberrations, such as the 'rolling' effect that occurs when a *collimating lens* is used incorrectly, can be used to animate an image. This aberration was used in *Limbo* (1984) in which a flat two-dimensional image of a rod on the surface of the hologram seems to be measuring the gap between a pair of hands placed behind and in front of the plate. The holographic image of one of the hands appears to swing over and under the rod as the viewer moves from left to right. In *Presentation* (Fig. 6) the projecting real image of fingers in one hologram appears to hold another hologram containing its own separate space. In *Stress Relief* (1985), an adaptation of *Hands and Rice*, the plate itself has been stressed, causing large curved fringes to go across the image, and real rice grains have been scattered on its surface amongst the illusory ones as a memorial to the millions who have died in famines in this technological age.

Hands and Rice and *Hands and Freesias* have become successful commercially [19]. Royalty arrangements help to subsidize holographic work that is experimental and more difficult for the general public to accept, such as the interferometric and mixed media pieces

discussed in this article. These pieces are originals or limited editions produced by the artist, and for these there is little commercial outlet. Holography is still generally not accepted by established art galleries and institutions, except when it is carried out by artists whose work in other media has been commercially successful. Holographic artists have had to build their own means of survival through a communal network of exchange of services and support. Video and performance art had similar starting dates (around 1968); since art institutions are coming to terms with them, they can now take place within a serious art context. This is not the case with holography. Its enforced separate development has been damaging for individual holographers and for art itself.

VI. CONCLUSION

Technical constraints on the holographic artist are undeniable, but advances are being made which enlarge the vocabulary of the medium. Holographic stereograms use motion picture images from the real world. These are being extended by Stephen Benton [20] and Bill Molteni in the Arts and Media Technology Program at the Massachusetts Institute of Technology to include computer-synthesized images of hypothetical objects. Full-colour work [21] is still at the laboratory stage, but a holographic image seen with all its natural colours demonstrates how unnatural monochromatic or pseudocolour holograms appear. The artist's interest in holography is not that it makes second-hand experience as 'authentic' as possible by accurate reproduction, but that it can provide useful new ways of comprehending the world. The artist's means of revealing this is through the medium itself. For an enduring future, the medium has to be not only powerful, which holography unquestionably is, but flexible. Pulsed holography is an essential advance in this direction. For spontaneous and natural imagery, particularly of human beings, the pulsed hologram has much to offer.

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17. John Kaufman, "Pre-Visualization and Pseudo-Colour Image Plane Reflection Holograms", in *Proceedings of the International Symposium on Display Holography* **1** (1982).
18. Walter Spierings, "'Pyrochrome' Processing Yields Colour-Controlled Results with Silver-Halide Materials", *Holosphere* **10**, Nos. 7-8 (July/August 1981).
19. A license to publish a 4 × 5 in. format of *Hands and Rice* on film has been granted to Third Dimension Ltd, a company which mass-produces and distributes film holograms, in exchange for royalties. Film is a cheaper substrate than glass for silver-halide emulsions. Holographic images can now also be embossed onto PVC (polyvinylchloride) film, and distribution of the type of hologram seen worldwide on credit cards is now taking place. The embossing company Light Impressions Ltd has considered similar royalty arrangements with artists. It has been generally believed that such mass-production methods do not achieve the high-quality results acceptable to artists. However, the technology is advancing at a rapid rate and an increasing number of artists are becoming interested in such arrangements. Unlimited editions of an artist's images can be made available to people who could not otherwise afford to buy their work, and the artist is freed from the grinding production routine. The market definition of art as unique or limited to editions is a commercial phenomenon of fairly recent origin, and it is the visual, emotional and conceptual manifestation of the work that should be most important. The lasting quality of Dürer's prints, distributed on the streets in such numbers that the blocks wore out, was not diminished by mass-production.
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GLOSSARY

coherence length—the distance over which light retains its phase identity sufficient to form the interference fringe pattern necessary to record a hologram.

collimating lens—a lens, or a mirror lens, for producing a parallel beam of light. In holography, a collimator is used in the two-step transfer process to produce an undistorted final image.

holo-camera—the holo-camera consists of a total optical system built by the holographer for taking holograms, comprising both the optical hardware and the design of the setup. This will differ according to the type of hologram to be made.

holographic stereogram—in the holographic stereogram, perspectival images are produced from motion picture film of live action, computer graphics or digital video mixing and then recorded in a series of vertically narrow views onto holographic film. The holographic stereogram is then presented in a cylindrical or flat format to give a transition of perspective and angles of view, with the potential for a wide range of subjects. The technology of holographic stereograms has improved to the extent that they are now often difficult to distinguish from true holograms.

laser transmission hologram—a hologram made to be viewed by transmitted light, either by a laser or a specialized light source.

Q-switch—a device inserted into the optical cavity of a pulsed laser to improve its *coherence length*. Without it, the structure of the pulse is not a single pulse but many small ones. The Q-switch confines the light until it has built up energy, then releases it in a single large pulse.

reflection hologram—a hologram made to be viewed by reflected light.

shadowgram—the generic term most commonly used by artists for holograms in which the subject is back-lit only.

steroegram—in the stereogram, discrete images of an object are recorded with a shift in perspective for viewing by the appropriate eye of an observer. This makes a flat image appear to be three-dimensional.

white-light transmission hologram—a hologram made to be viewed by transmitted white light.

APPENDIX J

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Cosmetic Series 1986–1987: A Personal Account

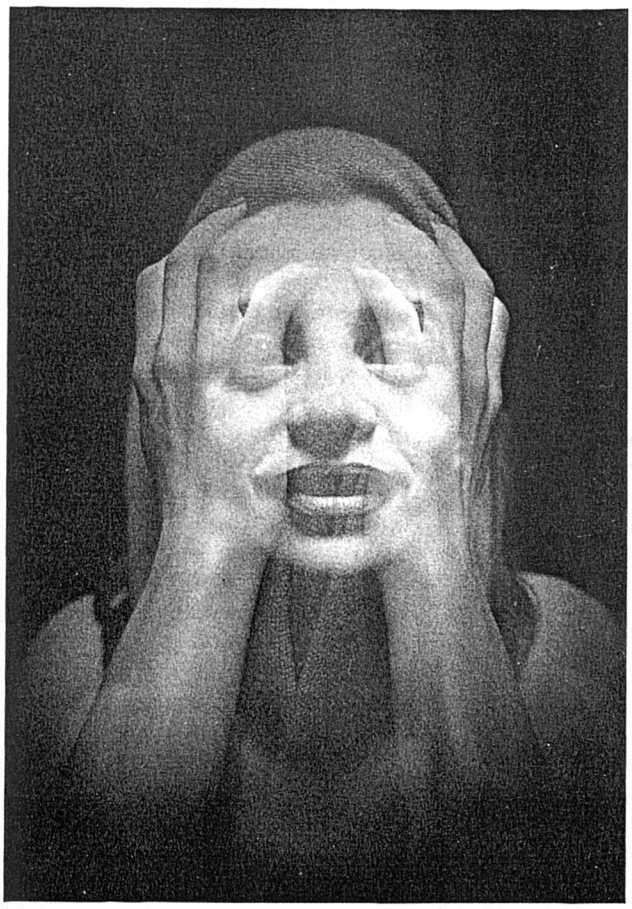
Margaret Benyon

ABSTRACT

The painting of our bodies for the ritual of dance is likely to have preceded cave painting as the first visual expression of culture. The subject of the *Cosmetic Series* stems from these early beginnings, but recreated in a medium appropriate to the present day, the pulsed hologram. *Cosmetic Series* portrays the faces of young women, beautified with the cosmetics used when recording a pulsed-laser hologram. The ideas underlying these portraits are cultural, socio-political, art-historical, documentary, psychological, holographic and personal. This paper gives a personal account of the background to these works.

Nowadays, whenever I am asked for my thoughts on the future of holography, I become evasive. I think back to the days when I made my first holograms. It may not even occur to those artists now entering the field of holography that there was a long period when it was by no means certain, as it is now, that holography was here to stay. In those days (1968–1973), the only technology available to me, as a lone (and female) artist making holograms in Britain, was the laser transmission hologram, which could only be exhibited with specialized light sources and in darkened conditions. Although I knew that it was necessary for holography to advance beyond such primitive technology in order to have a future, I was so preoccupied with bringing to light as many ideas as I could with the technology available that I tried not to think about this obvious fact [1].

Fig. 1. ***Benedict Revealed,*** **double-exposure reflection hologram, 30 × 40 cm, 1987. The closeness of a holographic image of a person to a spiritlike, dematerialized version of that person suggests such extremes of human consciousness as 'out-of-body' experiences.**



Nevertheless, at that time I was sustained by a strong mental picture. I saw myself in a room filled with daylight whose walls glowed with holograms in brilliant pure colours. As I sit writing now, surrounded by a small jungle of plants and the clutter of children, I realize that I am in a room very like it. The faces of my *Cosmetic Series* look out at me, burning bright from their frames on the walls. The point is that my mind-picture had been set too far ahead, way off in the twenty-first century, after my own death. Now, 20 years later, holograms are not only being lit without lasers but are also being made without them. My own misprediction was born of the slow early growth of holography, a field now gathering faster and faster momentum.

This paper concentrates on the ideas and details underlying my current work because, despite the growing number of holography journals that now exist [2], there is still little outlet for detailed discussion of individual artworks. In this paper, holography per se will be discussed only in terms of its relevance as a motivating factor. In this respect, the most important aspect of the pulsed-laser technique, for me, is that the pulsed laser 'freezes' moving subjects for the duration of the holographic exposure and makes it possible for the artist to make holograms of human beings. Further technical discussion of my pulsed work can be found elsewhere [3].

The account that follows is partly personal, because I believe that creative exploration of the medium itself, however powerful, is not enough to produce art that continues the great tradition of art that has been handed down to us. I regard art practice as a symbolic activity, and our encounter with whichever medium we use to make art needs to be passed through our own individual intellectual, emotional, experiential make-up. It needs to emerge in a way that reflects this individuality, translated into a form that is universally recognizable beyond our own private experience. Work that has not gone through this sort of transformation is usually a 'copy', an eclectic reflection of the

Margaret Benyon (artist, holographer, educator), Holography Studio, 40 Springdale Avenue, Broadstone, Dorset BH18 9EU, United Kingdom.

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Fig. 2. *Cosmetic Series: Gaelle*, reflection hologram and gouache painting, 30 × 40 cm, 1986. That this series is on the edge of kitsch is a comment on urban society, a 'cosmetic' or surface reaction. In a hologram, surface is redefined as a 'skin' without substance. The production of cosmetics is based on packaging and advertising, as much as it is on the actual product.

Fig. 3. *Cosmetic Series: Self-Portrait #1*, reflection hologram and gouache painting, 8 × 10 in, 1985. (Collection: John Kaufman) This piece initiated the idea of the *Cosmetic Series*.

culture that surrounds us. I believe that the remoteness and sadness of much postmodern work is unnecessary [4]. The adjustment that holographic artists must make to the realities of physical laws, in order to practice holography at all, gives them a great advantage over artists practicing in traditional media. Holographic artists are in a good position to understand that the character of things cannot be known in any complete way independent of ourselves. I celebrate, rather than mourn, the uncertainty principle.

I can understand why an exploration of the uniqueness of holography might be a sufficient motivating force for many artists. I found it to be a necessary first step myself. We are now seeing people of all ages and from all parts of society being transformed by their first sight of a hologram, inspired to turn their lives upside-down and to become like artists, driven, *having to* make holograms. Holography is making artists out of people who have had no art training and little knowledge of art. Perhaps they are responding to something primitive in the hologram that takes them back to the first moments of life. Light is the first thing we see when we first open our eyes.

We still lack a wider explanation of human consciousness, into which the near-mythical response of some people to the hologram might fit. For instance, there is as yet no reasonable explanation for the 'out-of-body' episodes sometimes experienced by people near death, experiences that have been recorded in all cultures. People who have had an 'out-of-body' experience remember it quite vividly and in every detail, no matter how long ago the experience took place, and it invariably has a profound effect on them. These experiences are almost always associated with bright light, often a tunnel of light. Current scientific opinion holds that during the physical crisis that triggers the experience, the part of the brain that deals with feelings associated with the experience of light, the limbic system, may have become starved of oxygen. It is also postulated that we may be born with encodings in our brain capable of triggering these experiences. Such theories may also explain the powerful hold that the hologram, an image formed of light, has on some people.

The similarity between a holographic image of a person and a doppelgänger—or a spiritlike, dematerialized version of that person—has parallels

with such extreme manifestations of human consciousness as the 'out-of-body' experience. This has had some bearing on my own preoccupation with pulsed imagery for the last 7 years, and partly underlies my *Cosmetic Series* and other works. In *Benedict Revealed* (Fig. 1), the smiling image of a young woman looks out through a veil, suggestive of a shroud of chador, and through her own translucent fingers.

THE *COSMETIC SERIES*

A Woman's Experience

Had I known that the future of holography as a visual medium would be as assured as it now is, all my early doubts would have been replaced by a monstrous strength of purpose that might have blotted out all fine-tuning to other inner messages. Listening to myself as a woman has led me to child-bearing and has been a strong motor for my art. *Cosmetic Series* arose out of a need for a positive self-concept. At the age of 46, I felt that I had some psychological adjustments to make. A sense of exile from my own body, the discrepancy between feeling 23 years old and living in a rapidly aging body, led to a wish to regenerate myself symbolically through images of younger women. In real life, my own female climacteric is likely to coincide with my daughter's puberty—a positive life-situation for regeneration!

In Britain the socio-economic position of women artists is such that they can expect to make at most half the income that male artists enjoy, a ratio that holds true for all age categories. At around the 35 to 45 age bracket, when male artists expect to be earning the maximum from their work, women artists "at this time in their life-cycle normally drop out of professional practice in large numbers" [5]. There are few works carried out by women artists of my own age that I can indicate as influencing this series. I have always admired the power and self-awareness of Liliane Lijn's work [6], and Mary Kelly's treatment of female preoccupation with aging in *Interim* [7] is comprehensive. Her use of humour makes her work enjoyable for a wide range of people. The tongue-in-cheek kitsch of the *Cosmetic Series* has a similar purpose (see Fig. 2), although my own work incorporates an element of defiance towards 'the art establishment', born of many years of blanket rejection. Although Cindy Sherman is a younger artist, I find that her photographic recreations of herself have some connection with my *Cosmetic Series*. Her complicity with her viewers is similar to what I have tried to create in this series.

That the female *Cosmetic Series* is on the edge of kitsch comes directly from the fact that I now live in Britain, in an urban, industrial society. The holograms that I made when I lived in Australia were very different [8]. It also comes from the medium itself, pulsed holography, which in recent years has become commercialized and in which these sorts of images are dominant. The work is a comment on 'surface' reaction, a 'cosmetic' reaction to urban society. In physical terms, a surface defines the extent of an object and can always be related to mass. In a hologram, surface is redefined as a 'skin' without substance. The production of cosmetics is based on packaging and advertising, as much as on the actual product [9].

The Recording Event

The making of the master holograms for this series took place at the Musée de l'Holographie, Paris, on an 'exchange of work' basis. The director, Anne-Marie Christakis, helped me to make the master holograms, and all the expenses involved in making these were covered by the Musée, in exchange for finished pieces made from each of these masters in my own studios, which the Musée could then exhibit.

In my pulsed work prior to the *Cosmetic Series*, I had considered it important to use myself as a model (Fig. 3), because there was a shamanistic, 'artist-as-healer' element to the work. For the regenerative aspect of the series it was necessary to use young women and to document them at a certain age (around 23 years old). The documentary aspect is reflected in the titles, which are simply the real forenames of the women who took part. I wished to give each woman a positive feeling about her looks, by asking her to make herself look beautiful in the laser light. I led her first to look at herself in the continuous-wave helium-neon laser, which is reasonably close in wavelength/colour to the pulsed ruby light used for the actual recording. She could see for herself the unnatural bleaching effect that the laser had on her skin; by applying green and blue cosmetics to lips and eyes (an idea originating from John Webster [10]), she could produce a 'beautiful' version of herself, bathed in the smoothing, cosmetic effect of the laser light. Each woman reacted differently to the project, each according to her temperament, but I was surprised at the serious, almost academic way in which each approached the work. One woman was visibly taken in by her own unexpected beauty, looking, entranced, at herself

Fig. 4. ***Cosmetic Series: Flora*****, reflection hologram and gouache painting, 30 × 40 cm, 1986. The emphasis on painting the face in the recording stage of the pulsed hologram is carried through to the hologram's final presentation by its fusion with a painted image of the same face. A mixture of additive and subtractive colours produces a new, subtle range of tints.**

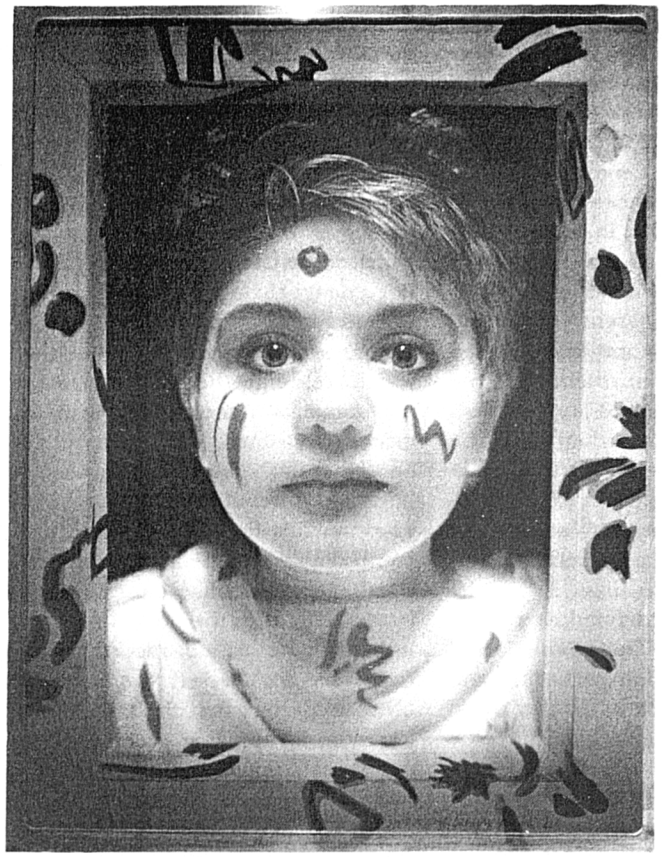


Fig. 5. *Cosmetic Series: Sophie*, reflection hologram and gouache painting, 30 × 40 cm, 1986. In this piece I employ a reversal of media, that is, the painted graffiti on Sophie's face are present in the hologram but not in the painting.

Fig. 6. *Cosmetic Series: Voiles*, double-exposure reflection hologram, pseudocolour, 30 × 40 cm, 1986. In this hologram a range of colours has been produced, not by painting, but by swelling the holographic emulsion before and after exposure, using two separate masters.

in the laser light, grooming away nonexistent strands of hair to make herself quite perfect and to prolong the experience of looking at herself. As extra embellishment, I added drawn motifs on one or two of the faces, such as the leaves in *Flora* (Fig. 4) and the graffiti in *Sophie* (Fig. 5).

The Finished Work

The emphasis on painting the face during the recording stage of the pulsed hologram is carried through to the final presentation of the hologram in reflection mode, through fusion of the hologram with a painted image of the same face. Sometimes the greens and blues originally used on the lips are repeated in the colours of the paintings, as in *Sonia* and *Margot* (Color Plate B No. 1). The holographic images are frontal and central, partly to give a classical, hieratic quality to the finished works, but mostly because I had to merge a spatial image with a flat one on the image plane, and a full frontal view is flatter than any other orientation of the head.

Because the holographic image is a reconstruction of light wavefronts, it cannot be retouched. This means that the original image must be accepted, warts and all; however, it can then be modified externally to a surprising extent, in the following manner. A brightly coloured gouache painting is made to correspond as closely as possible to the holographic features (see Color Plate B No. 1). When this painting is placed underneath the transparent holographic plate, it alters and emphasizes the holographic features. A new, subtle range of tints is also produced from the mixture of the subtractive colours of the painted face with the additive monochrome yellow of the hologram. The success of the modification depends on the careful registration and alignment of the painting with the holographic features, so that it enhances rather than conflicts with them. In practice, this is rather difficult to achieve while still maintaining the necessary spontaneity in the brushwork, so that the brush marks lend a texture and vitality to the hologram. I wanted to 'loosen up' the image slightly, to get away from the waxy, morguelike feeling that pulsed portraits sometimes have. I expanded this 'cosmetic' idea into a whole series as a way of recognizing that holographic artists are past the pioneering stage and can now begin to farm. I also wanted to demonstrate the

special ability of pulsed technology to record sequences of images [11].

In one or two of the works I have altered my use of the media. For instance, the painted graffiti on the face of *Sophie* (Fig. 5) are present in the hologram and not in the painting, and the viewer must look at the piece from different vantage points to determine which is which. In *Voiles* (Fig. 6), a range of colours has been produced, not by painting, but by swelling the holographic emulsion both before and after exposure, using two separately mastered images. This 'post-swelling' introduces brushed patches of changed colour that also serve to loosen up the image.

Choice of colour and tone in the painting reinforced painterly mores. While working to maintain the spatial integrity of the hologram, I found that red did indeed come forward, and blue receded, just as I had been taught when I was a painting student. It proved impossible to use red backgrounds in the painting, because a receding image was a necessary requirement for a background. The hologram became the 'machine' that predetermined the painting, in the same way that Sol LeWitt's ideas become the machine that makes his art. It became the system by which my activity was controlled. A feature of the *Cosmetic Series* is that when the light illuminating the hologram is out, there is still a painting on the wall. Living with my own holograms, I tend to light the holograms only when I want to look at them, when I have visitors, or when I need extra illumination in the room. This means that for much of the time there is a black piece of glass taking up wall space, unless the reflection hologram is used with other media.

A Male Series

An early and continuing theme in my work has been the unification of opposites, male and female. Once the female series was exhibited, it took on a life of its own and seemed to call for its male counterpart. The young men participating with me in the making of a male series would be given the same brief as the female 'models', that they should make themselves beautiful. Young men with whom I discussed the cosmetic idea found some difficulty with it, because Western men do not generally use cosmetics, and they needed to enter the project with a previsualization of their own enhanced image. However, when I described a male *Cosmetic Series* sited further back in our evolutionary history I caught their interest. I think that probably before we painted the walls of caves, we painted our own bodies. I grew up as a child in Africa, the cradle of humankind, and had seen how the Kenyan Masai paints himself with an impasto of red mud, which makes his body appear statuesque and extremely beautiful. I felt that the broader male body structure would create larger, more ritualistic images that would be identifiable as icons, in a way that women's images, painted in the makeup of today's fashion, are not.

So far I have completed one painted male hologram, *Stephan* (Fig. 7). In this

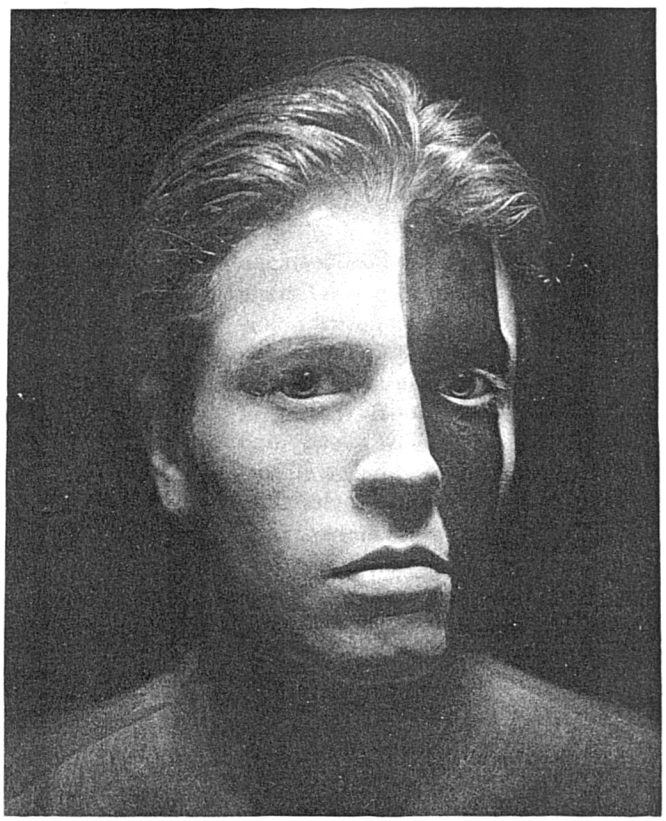
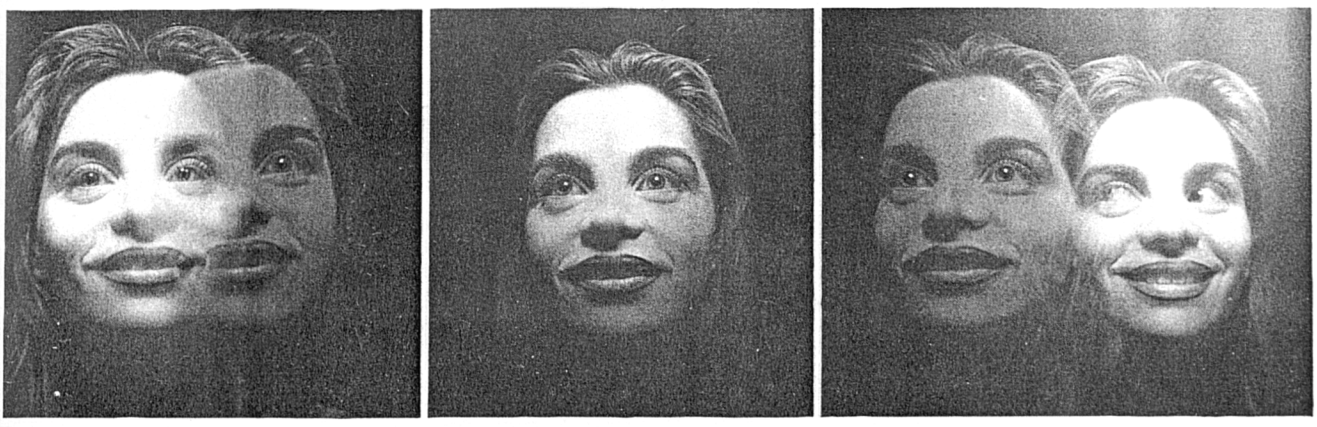


Fig. 7. ***Cosmetic Series: Stephan*****, reflection hologram and gouache painting, 8 × 10 in, 1987. Once the female *Cosmetic Series* was exhibited, it acquired a life of its own and seemed to call for its male counterpart.**

Fig. 8. ***Benedict Comedienne*****, reduced image, multi-exposure reflection hologram made up from a number of 4-×-5-in test masters, 8 × 10 in, 1987. Different separate images of the same woman appear and disappear as the viewer looks across the hologram.**



work, the holographic image, a three-quarter view of the face, had to be flattened in order to combine it with a painting on the image plane. I did this by reducing the image in the transfer stage to half its normal size, using a convex lens. I was surprised to find that the result was glamorous and not as different from the painted females as I had expected.

CONCLUSION

I should prefer to continue my development as an artist through pulsed holography. However, despite the rapidity with which good pulsed facilities have been multiplying all over the world in the last 3 years, it is still difficult for artists, myself included, to gain access to expensive pulsed technology. In the future it may be possible for artists to undertake cooperative ownership of pulsed equipment. However, it is likely that my next project will not be in pulsed holography but instead will be a retrospective look at some of the ideas that I began working on many years ago but have not developed beyond single pieces. When I return to pulsed holography, I should like to work with a phenomenon I call the 'shared member', a disconcerting and bizarre sharing of human bodily parts. I have already used this idea in the left-hand image of *Benedict Comedienne* (Fig. 8), in which the shared, third eye appears more striking and grotesque in three dimensions than it would in a flat photograph. In three dimensions this phenomenon can look like a genuine genetic mutation. In pulsed holography, it should be possible to work with entirely new symbolic biogenetic structures, part-human, part-sculptural, such as I introduced in my work in *Greenhouse I: Creation Myths* (1980).

No artist making holograms today and attempting to show them in a serious art context can avoid the depressing bias of the art world against holography. An example of this is the initial response by Simon Wilson of the Education Department of the Tate Gallery in London that "these things are not art" [12]. This response was later modified:

> Modern art is notoriously not medium specific and the question therefore is not one of medium but of the thing's (whatever the medium might be) quality as art. This raises the possibility that the Tate may be in ignorance of the existence of high quality art being made in the medium of holography ... [13].

This corresponds with my belief that holography is not art, but a condition in which art can happen [14]. I believe that resolving the status of holography in art should be a central issue in contemporary art debate.

References and Notes

1. Margaret Benyon, "Holography as an Art Medium", *Leonardo* 6, No. 1, 1–9 (1973). Happily some of these ideas, like the shadowgram technique I used in *Metal and Hand Non-Hologram* (1969), *Metal Rods* (1970) and *Hot Air* (1970, Collection Australian National Gallery), are now being used extensively by holographic artists.

2. Editor's Note: The *Current Literature* section of this issue contains a list of holography journals and related publications.

3. Margaret Benyon with John Webster, "Pulsed Holography as Art", *Leonardo* 19, No. 3, 185–191 (1986).

4. Chris Titterington, "Light Into Art", *New Scientist*, No. 1598, 66–70 (4 February 1988). Titterington is assistant curator of photographs at the Victoria and Albert Museum, which has now begun not only to collect but to exhibit holograms by artists. From January to July 1987, the museum exhibited art holograms along with photographs by artists in *Towards a Bigger Picture*. So far the collection of holograms comprises predominantly women's work, including my *Tiresias* (1981).

5. Quoted in the Gulbenkian Foundation Report, "Economic Situation of Visual Artists" (Calouste Gulbenkian Foundation, 98 Portland Place, London W1N 4ET, United Kingdom, June 1988).

6. Liliane Lijn, "Imagine the Goddess! A Rebirth of the Female Archetype in Sculpture", *Leonardo* 20, No. 2, 123–130 (1987). Liliane Lijn sometimes uses technological media as diverse as synthetic fibers, optical glass prisms and sound-to-light microprocessing systems in her work.

7. In Mary Kelly's *Interim*, photographic images are paired with handwritten text.

8. Margaret Benyon, "On the Second Decade of Holography As Art and My Recent Holograms", *Leonardo* 15, No. 2, 89–95 (1982).

9. In 1987 the skin-care product company Vichy carried out research for future marketing strategy that sheds interesting light on current attitudes of men towards women's cosmetics. They photographed a young woman both made-up and not, and showed the photographs to 260 men: 67 percent preferred the woman without makeup, 80 percent thought she looked easier to talk to and 87 percent thought that she looked more intelligent.

10. John Webster and Anne-Marie Christakis, "The Use of Makeup in Portraiture Holography Using the Pulsed Ruby Laser", in *Proceedings of the Third International Symposium of Display Holography* (Lake Forest College, IL: forthcoming).

11. The expansion of the idea into a series was made easy on the pulsed laser by the use of a fixed setup. Settling times, and the need to make the subject stable—necessary requirements with continuous-wave holography—are eradicated with pulsed holography. It is possible to make sequences of holograms with little more effort than the introduction of the subject, exposure and processing of the hologram.

12. Answer given by Wilson to a questionnaire compiled by Gwyneth Thurgood for an article in *Leonardo* relating to the fact that public collections lack work reflecting the technological age. The response to this questionnaire was not adequate for publication. An interesting measure of the support and recognition given to holographic artists from within the holography world, and that given to artists in the art world, could be made by comparing the Shearwater Foundation Awards (Posy Jackson Smith, Project Director), and the Turner Prize. The Turner Prize of £10,000 is awarded annually by the Tate Gallery to one individual (not necessarily an artist) seen to have most benefited art in the United Kingdom that year. Shearwater Foundation Awards are announced each year to honour a group of holographic artists who have a distinguished record of creative excellence; the amount awarded in 1987 to six artists, myself included, totalled $60,000—an amount far exceeding the Turner Prize. With the fine arts in the United Kingdom defined by the government as a narrow, unprofessional vocation, and fine-arts education being dismantled and amalgamated into the applied arts, holographic artists are indeed fortunate to have the support of the holography world.

13. From private correspondence with Wilson.

14. For my credo on holography, see Margaret Benyon, "Speculations About Holography", *PHASES* (New York: Museum of Holography, 1981) pp. 40–41.

APPENDIX K

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Do We Need an Aesthetics of Holography?

Margaret Benyon

ABSTRACT

This article discusses problems regarding aesthetics and the assessment of holography as art. The author recognizes the demand for new formulations in aesthetics, comments on their scarcity and describes the relationship between traditional aesthetics and innovative art. Some reasons are given for the bias against holography in the art world, and basic indicators of the presence of art in holography are outlined.

arts: any of the academic subjects that are not considered to be a science.

art: skill acquired by experience, study or observation.

fine art: an art (e.g. painting, sculpture or music) for which aesthetic purposes are of prime importance.

aesthetics: a branch of philosophy dealing with the nature of the beautiful, and with judgements concerning beauty.

—Longman's Dictionary

Some Problems with Traditional Fine Art and Aesthetics

My first thought on being asked by Nancy Gorglione to write on the aesthetics of holography was to wonder whether her request was prompted by my recent work, the *Cosmetic Series* (Fig. 1) [1], which is about beautification, or perhaps because I have been making art with holography since its inception in the art field [2]. Aesthetics is a subject that needs discussion, but one that I view with suspicion, in common with many other contemporary artists. The question must be asked, How relevant to artists using holography are 'received' definitions of art such as we find in the dictionary?

How do we really see our work in relationship to fine art, 'high art', that great tradition that has been handed down to us from the grand European perspective of history? How do we understand the relationship of our work to contemporary art and where we stand now, in the global village? The term 'fine art' cannot be applied to societies that do not make a distinction between art and 'fine art', and how we conceptualize artefacts from other cultures has become controversial. The repression of women in the history of high art continues and is still of serious concern today. The term 'fine art' has become almost obsolete nowadays and embarrassing to use because of its elitist connotations.

I believe that our perception of art, like our perception of reality, has to be continually updated. A change in art challenges the old aesthetic principles and raises a demand for new formulations. The crude definition of the 'arts' as anything that is not science has to be revised. Similarly, many inherited aesthetic notions are no longer relevant to contemporary work. Aesthetics is a branch of philosophy that studies the arguments that people use to classify things and activities as art, not art, good art, bad art, as well as beauty, decoration, taste, etc. The application of aesthetics to holography needs a more comprehensive enquiry than is possible in a single article. What I can do here is to make some introductory comments on the subject [3].

Baudrillard and his followers believe that 'truth' is no longer an issue because all signs are interchangeable and we have difficulty distinguishing the real from the artificial [4]. Yet aesthetics insists on a real moral difference between art and non-art. Aesthetics is not egalitarian in that it makes available work fit into limited available spaces, and not the other way around. The exercise of aesthetics is exclusionary, but it cannot claim to be definitive in an absolute way. Much of the running dialogue of artists has to do with making adjustments to current standards of judgement. For instance, in the 1930s, many agreed that electrical instruments could not make music; nowadays, this canon has been revised.

There is a gulf between philosophical aesthetics and the visual arts, in my opinion. Aesthetics has usually emphasized general problems concerning the nature of art, or beauty and aesthetic value, and appears to be a highly specialized subject in debate with itself over small technicalities [5]. Aestheticians develop new aesthetics to take into account work that has already happened and that the art world has already accepted. In contrast, it appears that it is the artist who takes the risks and produces the real theories for the art world and aestheticians to sanction or not. Every artist who makes a hologram is in effect theorizing through his or her practice. As has been the case with the beginning of art movements in this century, the artists in holography are initiating the theory themselves.

If I had to compare the value of aesthetic distinctions with the larger implications of practising as a female in a male world in which my human rights are noticeably curtailed, I would have to answer that the demands of feminism are more basic than aesthetic questions. Similarly, in a culture in which traditional fine art is sitting on the edge of a cliff, we have to ask ourselves questions about its survival, relative

Margaret Benyon (artist, holographer), Holography Studio, 40 Springdale Avenue, Broadstone, Dorset BH18 9EU, U.K.

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Fig. 1. *The Artist: Richard Hamilton,* **reflection holograms, 32 × 43 cm, 1991. These are two of four reflection holograms made in collaboration with painter Richard Hamilton, a major figure in the Pop Art movement. These images are part of the** *Male Cosmetic Series,* **in which the theme of beautification has been superseded by the author's response to male authority. (Photo © M. Benyon)**

to our own. Rather than moulding ourselves to institutional aesthetic theory, holographic artists may be better advised to look to larger philosophical theories of representation and semiotics for an understanding of symbolic articulation in society. During the 1980s, art criticism shifted its focus from the identification of specific aesthetic objects to an analysis of representation itself. Semiotics and media science are areas of current debate in holographic art, outside aesthetics.

Nowadays, arbiters in the art world have been largely biased against art made with holography [6]. Art and artists can exist without the rationalizations of aestheticians but have trouble when others dispute their right to do so. Artists can, and do, go ahead without an aesthetically defensible rationale for their actions. Contemporary works of art widely regarded as excellent are produced by artists who do not fit existing institutional theories. Artists using holography can take heart from this.

The Technical Bias of Display Holography

Aesthetics as a branch of philosophy that deals with notions of beauty, decoration and taste has a connection with contemporary art that tends to be downgraded towards the crafts. Craftspeople in transition towards art will become a beauty-oriented segment of the crafts, a 'minor-art' world within the craft world. However, the makers in this beauty-oriented segment do not use the same criteria as the 'high-art' world. Artists invading a craft are careful to appropriate only those aspects of it that the art world in which they participate finds acceptable. These are not the practical aspects, since 'high art' or 'fine art' is nonutilitarian, being a professional practice that does not rely on the effectiveness with which it earns the practitioner a living [7].

This has some relevance to artists using holography. Many of the workers in the display area of holography are interested in it because it gives them an opportunity to grasp a fascinating new technology. They feel themselves on shaky ground when art issues are raised. Many who are not artists cannot in fact recognize holographic art when they see it, and misinterpretation is rife. An artist who is more interested in displaying virtuosity than in expressing personal ideas or emotions is more prepared to take on assignments proposed by others. Artists who master technical skills usually begin to think, talk and act like craftspeople. They become more interested in technical virtuosity and control than in the content of the artwork they are producing. Artists recognize that there is a technical or craft element to their work, but they also insist that they contribute something beyond skill, so that ideas and technical means are bound together in their work.

To be on safe and respectable ground, many holographers prefer to keep to a discussion of technical matters because this is a definite, concrete area, and because there is no other content to the work produced. Improving the technology is obviously necessary and beneficial to the development of the whole field. However, this technical emphasis can distort and misrepresent the real achievements of artists who are attempting to merge 'in-house' issues of

holographic technique with larger and more universal issues.

In the visual arts, the relationship of fine art to applied or commercial art is comparable with the relationship in science between, on the one hand, pure science and research, and on the other, applied science and technology. This helps explain the presence of fine-art artists at the experimental leading edge in the history of display holography. The small numbers involved are perceived by some to make the artists' contribution unimportant, but their role in the history of display holography has been seminal.

Why the Art World Is Biased Against Holography

Some artists using holography have been taken seriously by the art world and already have gained a tenuous position in the history of art by representations in art books and the presence of their works in national public collections. An increasing number of established artists are also becoming involved with holography for short periods. I found that my early holograms exhibited in 1969 and 1970 were well received in the art world and, in fact, gained an international acclaim that is still of benefit to me. Some of this work is classed as 'avant-garde classic' in public collections. I had no difficulty in touring my early work and showing in serious art venues, even though the holograms were laser transmissions. The fact that I had the credibility of my preceding work as a painter and that my 'hands-on' appropriation of holography from the science to the art field was pioneering work may have helped. Although the art world in general puts less emphasis on 'firsts' than does the world of science, followers-on of any new movement are generally taken to be less important than the initiators.

Professional artists integrated into the mainstream art world produce work that is acceptable, creates no tension, is recognizable and understandable—and for this reason could be seen as boring. They make the bulk of work that is called art in our society. From these artists, a few adjudged exceptionally good are singled out and sanctioned as the best artists the world has produced. What complicates the answer to the question of why there have not yet been any 'great' artists in holography is that its pioneers have primarily been women, and a healthy number of its strongest artists are female.

Female art historians in the last 2 decades have been exploring in great detail the larger question of why there have been no great women artists [8]. If the female artist is seen to be performing a political act by merely attempting to work, the added difficulty of being a holographer makes visibility seemingly impossible [9]. Despite my favourable reception in the early days, I have not had a solo show in the United Kingdom in a serious art gallery since 1972. This lack of dialogue is bound to affect one's work, in the same way that female artists' exclusion from the life classes affected their careers in former days. I suggest that artists in holography should question the master concept of art that puts more emphasis on high status than on rapport. The nude model was unavailable to aspiring women artists in the period of Western art extending from the Renaissance until near the end of the nineteenth century. This meant that it was institutionally impossible for women to achieve excellence or success on the same footing as men, no matter what their talent or 'genius'. The feminist critique of the history of art reveals biases and inadequacies not merely in regard to the question of women artists but in the formulation of crucial questions of the discipline as a whole. Notions such as 'innate genius' or the 'master' concept of art have been questioned. The master concept of art indicates a social hierarchy that is top-heavy with men—not merely in the traditional roles of artist as male and of muse and model as female [10].

With the rise of a more conservative political climate and the commercialisation of holography, the use of the holography in the visual arts is currently viewed with skepticism, not only by art commentators but by artists working in more traditional media. When artists and art historians have spent their lives building up attitudes and skills in the traditional area, this is only to be expected. The scale of investment of the art world in its own institutional networks of information and cooperation may explain the unwillingness of traditional mainstream galleries to include more holograms in art exhibitions nowadays. It is unfortunate, but there is still not a great deal of good art in holography for these galleries to include.

Reviews from large, mixed holography exhibitions, in which work by scientists and commercial companies is jumbled with that by artists, reflect the current confusion. Often the critics' low opinion is formed because they have no idea that the works they are reviewing are not made by artists at all. Commercial producers masquerade as genuine artists. This happens because of the free advertising and sales that can be made by participating in holographic exhibitions seen as 'cultural' or 'artistic'. Also, we have to bear in mind the dictionary definition of the arts as "any of the academic subjects that are not considered to be a science". Resistance by artists and reviewers who have grown up with that dictum to a process that originated in the science field is understandable. This resistance is reinforced when they see work that seems more concerned with the demonstration of a technique than with content, concept or other art factors.

Art-world criticism of new technology (and holography is increasingly pigeon-holed as new technology) seems to be based on suspicion that it is associated with military research and that its manifestations are somehow transitory, ephemeral. Lasers are used for warfare, but in my opinion that is even more reason artists should be counteracting the sinister uses with peaceful ones, ephemeral or not (see Fig. 2, Color Plate A No.3) [11].

The sanction of the art world is a tautologous reality [12]. If practising artists want to have their work accepted as art, they will have to persuade the appropriate people to accept it as art, or take the more difficult alternative of organizing a new art world. (This alternative has been used successfully in the past, for instance, by Alfred Stieglitz in photography.) In practice, the subworlds of the various media are separate, almost noncommunicating segments of the larger art world. As is the case with holography, there is the occasional encouraging cooperation of the larger art world. There is no serious reason holography should not be accepted. It fits a number of current trends. Many contemporary artworks resemble holograms in their use of kitsch, models, form of lighting, etc. [13].

An interesting aspect of the work presented by the artists who attended the International Congress on Art in Holography, held in July 1990 at St. Mary's College, Notre Dame, Indiana, was that most of it was mixed media or installation. Most of the artists had been seeing and presenting their work in this way from the beginning (except for the initial period of introduction when there is a tendency to explore the prop-

erties unique to the medium) and will continue to do so. Beyond the millennium, holography treated as a novelty medium, separate from all others, will very likely be seen as a transitional stage in its development [14]. It has more characteristics in common with other media than distinct from them. Arguments for the autonomy of holography disregard the message of interconnectedness that the holographic principle conveys.

Support Networks

No art world can protect itself completely and forever against change. There has to be new, young work for any field to survive, and we holographers have fresh information to bring into the art area. Holography is evolving so rapidly that what is true today will not necessarily be so next year. A short time ago the holography world was so small that it was possible for most of its practitioners—artists, scientists and entrepreneurs—to know each other. This is now no longer the case, with the growth in the number of people involved. Display holography has been settling down into patterns that already exist for other techniques, services and products [15].

Some holographic artists are innovative artists who have been part of the conventional art world of their time but have found it unacceptably constraining. They have maintained a loose connection with the conventional art world but have difficulties realizing and distributing their work. They lose the constraints, but also the advantages, of the art world. In the case of holography, they come up against other conventional worlds, those of science and commerce. Innovative artists are often successful at creating their own organizations and display places; for instance, visual artists devise works they cannot exhibit in galleries, like earth or sky works.

Work that aspires to be accepted as art must usually have a developed aesthetic apparatus and channels through which critical discussions can take place. Despite appearances to the contrary, holography has in fact been developing this apparatus over the last 20 years. A small but rapidly growing international network of artists constitutes an embryo art world within the holography world. Selective value judgements about art in holography are being made continuously: decisions about which holographic artists should be asked to exhibit, which artists are to be given awards (such as those given by the Shearwater Foundation [16], the Fulbright Commission [17] and the holographic materials industry), which artists are to attend conferences, which artists are to be invited to teach and lecture on the subject, edit journals, curate shows, etc. However, the importance of these decisions is relative to the larger survival issue of how we expand such a small field. Expense is still a major problem for artists.

There are alternatives to mainstream art institutions that support and provide services to art holographers. In the holography world, there are museums, artist-in-residency (AIR) programs, galleries, journals, educational courses, conferences and the holography industry. The artists in holography have their own networks and are in regular communication with each other through group exhibitions, correspondence and personal visits to each other and to the holographic centres that exist in each country. Not enough recognition is given to the potential power of these networks. Ideas and visions are important, but their success and permanence rest on organizational support, not on their intrinsic worth. Whether a work is 'lasting' is the major criterion by which people recognize great art [18].

No Definitive System of Art Exists

Numerous theories of art have been formulated in the course of this century, often incompatible with one another. A brief roll-call rapidly induces breathlessness—there are hundreds of them, too many to list here. The theories to which artists feel most responsible are those of their own generation. This roll-call should be sufficient to suggest strongly that how to define art, in whatever medium, is a task that has defied all efforts for the art of this century. I suspect that this is also true of past art.

It is therefore beyond the bounds of credibility that any one person or theory can say what art is. Nor can it be stated, definitively, what has to be done, or avoided, to make art. An artist should not be expected to comply with someone else's idea of what good art is in order to achieve acceptance. One cannot succeed as an artist merely by trying, and one does not get better—except as a craftsperson—by diligent practice. One can only hope, in the words of Samuel Beckett, to "fail a little better next time" [19]. What does help to improve an artist is seeing plenty of good, stimulating artwork in any medium, keeping in touch with tendencies in art, exchanging views with other artists, being involved with all one's faculties,

Fig. 2. ***Cosmetic Camouflage,*** **reflection hologram post-swollen with acid, 32 × 43 cm, 1991. Camouflage in the image of a soldier includes a form of optical camouflage, which looks like an animated dappling of the face when seen at a distance. (Photo © M. Benyon)**

opening oneself up to possibilities, and keeping a notebook of ideas, a sense of humour and a reasonable bank balance.

There is no such thing as an absolute and definitive system of art or of art criticism. It is necessary to accept the existence of wildly disparate worldviews. Many contradictions are present in the body of art, but these contradictions are not usually present unreconciled in the work of a genuine artist, however contradictory and quixotic this work may at first appear to be. Each artist works to his or her own coherent vocabulary of meaning, and it is this that should be used to assess the validity of their art as art, and as good or bad art. For instance, there is little point in criticizing a work for not demonstrating one of the roll-call theories, for example, 'truth to the medium', which emphasizes the unique characteristics of a medium, when an artist is aiming for exactly the opposite—to make holography resemble other art media as much as possible. The intentions given in artists' statements accompanying the exhibition of their work should be used as a basis for criticism.

I see current art practice as a necessary background for a critique of art using holography as a medium. But to adapt specific art theories to holography is relevant only where these concepts are used in specific holographic artworks. If we wish the criteria for assessing holography as art to be the same as for mainstream art, we have to accept that here, regretfully, politics and the profit motive, as well as fashion, play a large part. Holographers can expect no special pleading.

Suggested Basic Indicators for Art in Holography

Intention is important. The making of art is deliberate. It is generally the by-product of a controlled path of art activity that bears a relationship with other works by the artist. Other indicators of the presence of art are originality, influence, success, intelligence, knowledge, discipline, awareness, and technical control corresponding to the artist's ideas. If the work is to be classified as art, it should be intended as art by its maker or recognized as art by the art world. I suspect that most scientists would feel insulted if they were classified as artists. If a scientist exhibits a hologram, it should not be received as art but as display, unless the scientist specifically intended it as art. Then it can be assessed as art, bad art, good art, etc.

There are good, even seminal, artworks made by holographers who normally do not work as artists. Ken Dunkley, an engineer, produced a single, important piece, *Thoughts* (1973), which was intended as art, and I believe was greatly influenced by the fact that the women in his family were artists. Because he had grown up with art, it was a procedure he was comfortable with, and he was able to make an intended piece of art. There are also creative scientists, like Stephen Benton, who have collaborated with many artists, and who have an unusually intuitive nonverbal grasp of art potentials. Computer-generated images by Benton, Toshihiro Kubota's exquisite full-colour doll [20], and Nils Abramson's light-in-flight work are important to artists for the large conceptual, aesthetic and creative dimensions they open up. Their holograms may be the most memorable and covetable pieces in an exhibition, but unless they are intended, curated and exhibited as art, they should not be received as art holography but as creative display holography.

We need to be sure that what artists have done, and are doing, with holography is properly understood. Commentators, most notably John Hanhardt, curator of film and video at the Whitney Museum, New York, feel that a critical language, a vocabulary, needs to be developed before holography can find its own voice. This is probably because there is little serious writing about art in holography that is not scattered widely in exhibition catalogues, and difficult to find [21].

The main source of holographic art theory is still the artists themselves. Holographic journals print exhibition reviews and articles about art in holography, but these are often superficial. *Leonardo* is an exception, but holographic artists need to persuade editors of art journals to include regular articles on their work. Even if this proves difficult, as many of us have discovered, art journals will often print a letter to the editor. I have found that it is possible to publish on art in holography in this way, particularly rebuttals whenever holography is disparaged. On one occasion even my own manifesto was published as a letter [22].

Conclusion

Despite the problems stated in this article, I believe that holo-artists should be part of the art world. In my assessment of whether we need an aesthetics of holography, I have tried to be objective, but those of us who knew we were artists before we were holographers and went into holography thinking that it would enrich the art area, know what we are largely missing now. We need to get out of this ghetto. I believe that artists in holography should have the theoretical resources, the cultural and art-history disciplines, and the institutional support made as available to us as they have been to the fine arts for so long. If not, holographic art practice may turn out to have been a speculative blind alley. Artists using new technology should reassess the suitability of the traditional, quiet art gallery, designed for looking at art, and appropriate access to the art market. I also believe that art institutions should become much more flexible and begin to redefine themselves as 'content' rather than 'receptacle', setting up their administrative apparatus around that content.

In conclusion, artists will make holograms whether or not their work is accepted in the art world. There are people born with a drive to make art, or whatever society likes to call art, as part of their make-up as human beings, and some of them have chosen holography as their medium. Whatever society does with them, or does not do, despite the conditions they work under—above or below the poverty line, decade after decade, recognized or not—they will work at making art whenever they can, until they die.

References and Notes

1. For accounts of the author's *Cosmetic Series*, which involves the traditional art area of painting within holography, see M. Benyon, "Cosmetic Series 1986–1987: A Personal Account", *Leonardo* 22, No. 3/4, 307–312 (1989); M. Benyon, "A Holographic Artist's Viewpoint: Margaret Benyon FRPS", *The Photographic Journal* 128, No. 11 (1988); and M. Benyon, "Art Concepts in Holography: Works from the Male Cosmetic Series", in *Proceedings of the Fourth International Symposium on Display Holography* (Lake Forest, IL: in press).

2. It was the fine artists who forged the first links with science and took holography out of the lab. The year 1968 marks the first involvement of artists. Artists Bruce Nauman (U.S.A.), Margaret Benyon

(U.K.), Harriet Casdin-Silver (U.S.A.) and Carl Frederik Reuterswärd (Sweden) began exploring the potential of holography from 1968 to 1969 and started showing the results between 1969 and 1970. The author's approach was to make holograms herself, proving that nonscientists could make holograms. Her early laser transmission holograms laid the groundwork for subsequent explorations in the field. Exhibitions of this work are documented in the following catalogues: *M. Benyon. Paintings and Holograms* (Nottingham, U.K.: Nottingham Univ. Art Gallery, 1969); *Holography. First London Expo of Holograms and Stereoscopic Paintings* (London: Lisson Gallery, 1970); and *Paintings and Holograms* (Nottingham, U.K.: Nottingham Univ. Art Gallery, 1971).

The author's exhibitions, lectures and papers from this period introduced other artists, such as Ruben Nuñez, to the medium. For example, *Hot Air* (1970), now in the collection of the Australian National Gallery as an 'avant-garde classic', introduced the shadowgram technique that was later developed by Rick Silberman and is now commonly used worldwide by many holographic artists.

3. This is part of my investigation *How is Holography Art?*, which I am currently carrying out at the Royal College of Art, London, with the sponsorship of Ilford Ltd. The thesis for this project is currently in a transitional stage between a thesis and a book.

4. See J. Baudrillard, *Simulations* (New York: Columbia University, 1983); and J. Baudrillard, "The Ecstasy of Communication", in Hal Foster, ed., *The Anti-Aesthetic* (Port Townsend, WA: Bay Press, 1983).

5. Richard Kostelanetz, ed., *Esthetics Contemporary* (New York: Prometheus Books, 1978).

6. D. T. Lightfoot, "Contemporary Art World Bias in Regard to Display Holography: New York City", *Leonardo* **22**, No. 3/4, 419–423 (1989).

7. H. Becker, *Art Worlds* (Berkeley, CA: Univ. of California Press, 1982).

8. L. Nochlin, "Why Have There Been No Great Women Artists?", in Thomas Hess and Elizabeth Baker, eds., *Art and Sexual Politics* (Collier Books, 1973).

9. M. Benyon, "Living with Holography", *Women's Art Magazine*, No. 41 (July/August 1991).

10. Art historians other than L. Nochlin who have been examining the question of women in art have produced a number of publications. Some of these are directed at re-establishing the histories of neglected or forgotten women artists and exploring the historical circumstances in which women have worked as artists. Others explore the ideologies of class, race, sex and power as they have affected both the work of women artists and the representations of women. See E. Honig Fine, *Women and Art: A History of Women Painters and Sculptors from the Renaissance to the Twentieth Century* (Montclair, NJ: Allanheld and Schram, 1978); R. Betterton, *Looking On: Images of Femininity in the Visual Arts and Media* (London: Pandora Press, 1987); R. Parker and G. Pollock, *Framing Feminism: Art and the Women's Movement 1970–1985* (London: Pandora Press, 1987); G. Pollock, *Vision and Difference: Femininity, Feminism and the Histories of Art* (New York: Routledge, 1988); L. Lippard, *From the Center: Feminist Essays on Women's Art* (New York: E. P. Dutton, 1976); G. Greer, *The Obstacle Race: The Fortunes of Women Painters and Their Work* (New York: Farrar, Straus, Giroux, 1979); W. Chadwick, *Women, Art and Society* (London: Thames and Hudson, 1990); and the catalogue for the National Museum of Women in the Arts, Washington, D.C., U.S.A.

11. I have made antiwar holograms, *Unclear World I & II* (1979), in a military academy with cadets drilling outside. Surely this is better than hiding, pretending that we can keep ourselves free from the social misuses of technology if we restrict ourselves to pencil and paper (which can also be seen as technology). The existing uses of light in art reach back to the transfiguration scenes of medieval art. Do we have to suffer cultural memory loss just because we change from one medium to another, from paint to holography?

12. The institutional definition is tautologous because it includes the word 'art' (artworld) in its own definition: "A work of art is . . . an artifact . . . upon which has been conferred the status of candidate for appreciation by some person or persons acting on behalf of a certain social institution (the artworld)". G. Dickie, *Art and the Aesthetic: An Institutional Analysis* (Ithaca, NY: Cornell Univ. Press, 1975) p. 34.

13. This point was substantiated by Chris Titterington in his address to the International Congress on Art in Holography, "The Critic and the Curator's View", *Report: International Congress on Art in Holography* (Notre Dame, IN: St. Mary's College, 1991) pp. 13–23. The congress, which was organized by Douglas E. Tyler and took place 18–22 July 1990, was held at, and sponsored by, St. Mary's College, Notre Dame, Indiana, U.S.A. The congress brought together 35 international representatives of art holography and four curators to discuss relevant issues and to present artwork. The congress was designed as a prototype for a larger conference and included a lengthy evaluation and a summary of the main addresses, which were published in the *Report*, cited above. Titterington is assistant curator of photography at the Victoria and Albert Museum, South Kensington, London. He regards holograms as a natural part of the museum's remit and has purchased holograms for its collection.

14. The executive editor of *Leonardo*, Roger Malina (with whose father, Frank Malina, I can remember engaging in an exchange on aesthetics a couple of decades ago), gave some insight on this, in answer to a question about the editorial scope of the journal: "First, we deal with what used to be called the fine arts. . . . Second, we have an unabashed focus on the use of contemporary science and technology in the arts. This editorial focus is somewhat problematical from a theoretical basis as only rarely has the medium (acrylic paint . . .) remained a defining characteristic after an initial period of technological introduction. . . . It is important to see the evolution of holography into a component of 'mixed-media' art making—whether the use of holography combined with painting, stage set design, installations, etc. I have no doubt that in 50 years the title of our first special issue on holography, "Holography as an Art Medium", will be seen as a transitionary way of asking the question." Roger Malina, letter to author, 12 December 1990.

15. M. Benyon, "Display Holography in Britain," *Proceedings of the Third International Symposium on Display Holography* (Lake Forest, IL: 1988) pp. 17–22.

16. The Shearwater Foundation is the only foundation currently funding artists working in art holography and is the single foundation worldwide that has set up a program to identify and support the highest achievements in this field. Besides its annual holography awards, it also supports activities and institutions that provide needed services to art holographers. For example, the Shearwater Foundation provided a 2-year funding commitment to enable the International Congress on Art in Holography to take place in 1990. For additional information on the Holography Program, write to Posy Jackson Smith, Suite 116, 502 Lake Avenue, Lake Worth, FL 33460, U.S.A.

17. The Fulbright Commission annually offers two Fellowship Awards in the Arts. Grants are made available to one artist from the United Kingdom and one artist from the United States to enable them to pursue studies in their specialist fields for 9 months in each other's country. The field of art in which the award is offered changes each year. Two British artists working in the field of holography, Andy Pepper and Patrick Boyd, have received awards from Fulbright. The American recipient in 1991 was Christian Schiess, for his work in light transmission, not holography. For further information, write to the Fulbright Commission, 6 Porter St., London W1M 2HR, U.K.

18. This raises the large archival question about working in a medium based on silver halide. Do holographic artists band together as a group and pay for the research that needs to be done on this, as suggested by Posy Jackson Smith during discussions at the International Congress on Art in Holography. Do we wait until photopolymers become sensitive enough for use with low-power lasers?

19. From a BBC television programme, 1990.

20. Editor's Note: See Color Plate C No. 1 for a reproduction of Kubota's Japanese doll.

21. Published books not associated with actual exhibitions include: B. Burgmer, *Holographic Art: Perception, Evolution, Future* (La Coruña, Spain: Daniel Weiss, 1987); P. Zec, *Holographie: Gesichte, Technik, Kunst* (Cologne: DuMont Verlag, 1987); and *Holography as an Art Medium*, Special Issue of *Leonardo* **22**, No. 3/4 (1989). To my knowledge, *Leonardo* is the only journal that regularly publishes texts written by the artists themselves.

22. M. Benyon, "Holography Today", letter published in *Art Monthly*, No. 81 (1984).