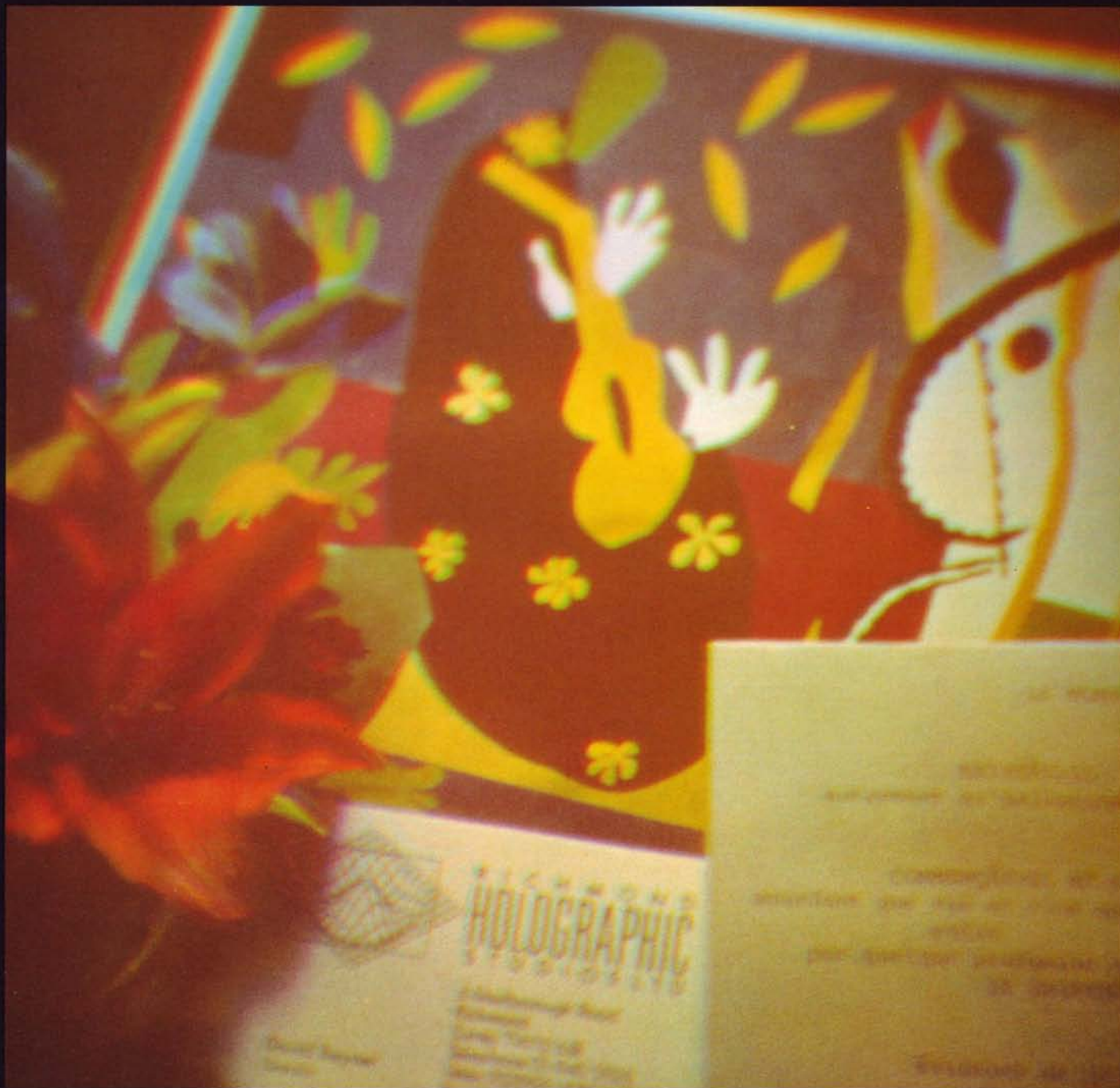


Holographics

International



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Spring 1989 Number 5
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—The International Magazine of Holography—



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Spring 1989
Number 5

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Cover: Richmond Holographic Studios' new colour hologram. See page 11.

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Colour Controversy

Part I

Dear Sunny,

The article "True Colour: Oxford Blue" published in the last issue of your magazine (issue 4) contains some fundamental inaccuracies which I feel I must point out. The essence of the article is that the new colour holograms exhibit more realistic colours because the triangle formed by the new wavelengths chosen covers a larger area of the CIE chromaticity diagram. Two important facts are often overlooked when adopting this approach of "making a bigger triangle":

1. The gamut of real surface colours covers only a fraction of the area indicated by the CIE diagram; and

2. The reconstructed colour depends primarily on the reflectivity of the object at the wavelengths used.

Let's examine these two facts one at a time: the consequence of the first is that the triangle (or other polygon) corresponding to the wavelengths used need *only* cover the area corresponding to the gamut of possible surface colours, and no more. As a guide to the area covered by the gamut, we can refer to early work on colour television by Wintringham [1]. (Pointer [2] has extended the gamut by including newer dyes and pigments, but it is unlikely that any of these are encountered in display holograms.)

Figure 1 shows the gamut plotted on the 1976 CIE chromaticity diagram, together with the triangles corresponding to 476-514-633nm and 458-528-647nm (incidentally, the difference in the areas of these triangles was highly exaggerated in the diagram accompanying your original article). It is clear that the larger triangle (used in the new work reported) covers the entire gamut comfortably, and the smaller (used in much of my own work, for example) covers all but a small portion in the deep purple region. This region corresponds to highly saturated dyes and pigments of very low luminance unlikely to be present in everyday objects (such as coloured pencils, say). The chances are, then,

that any object chosen to be hologrammed has CIE co-ordinates lying well within the boundaries of *both* triangles. Just for comparison, I have plotted the standard set of primaries for colour television which shows that it covers *less* of the yellows than either of the first two triangles. So statements in your article implying, for example, that when using 514nm "...almost all of the yellow will be excluded" are clearly incorrect.

Let us now come on to the second point: when recording a multicolour hologram, the only colour information we have from the object is its reflectance value at the chosen wavelengths. The question is, then, which wavelengths do we choose in order to obtain the most natural colours in the final hologram? The answer, as I have indicated before [3], is to choose the wavelengths to be near 450, 540, and 610nm. This combination has been derived from previous work unrelated to holography [4]. (It can be seen from the diagram that the triangle formed by these wavelengths also covers most of the gamut of possible object colours.)

In the light of the above, the holograms reported in your article probably *do* exhibit better colour rendition in the yellow and blue regions, but this has little to do with the size of the triangle formed. It is instead related to the fact that the blue and green components happen to be nearer to those in the "ideal" set previously suggested, i.e. 450 and 540nm (I see little advantage, from a colorimetric

point of view, in using 647 instead of 633).

To illustrate the point, if 540 were used in place of 528, the enclosed triangle would actually be smaller but the colour rendition would probably improve. One reason that some previous workers have not used the 528 line is simply that the power output is much lower than that for 514 in an argon laser. The same goes for the blue (458) component, except that the lack of suitable recording materials has also prevented its use - it is certainly impressive to see high quality deep blue reflection holograms on silver halide.

I hope that the above arguments help clear up some common misconceptions about colour holography. Having been involved in the subject for some ten years I am always fascinated to hear of new developments, and the work you have reported is certainly of interest, but it is vital to view such developments in the context of the work already published worldwide, so that the ultimate goal of routinely producing high quality full-colour holograms may be realised sooner.

Yours sincerely

Kaveh Bazargan,
Director, Focal Image Ltd,
London

References

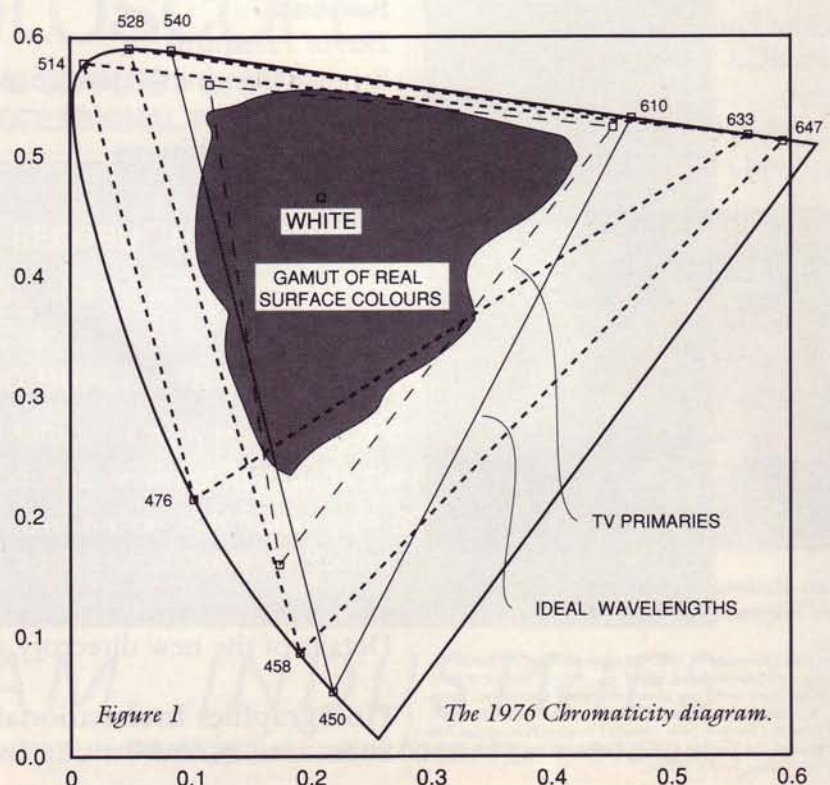
- [1] W T Wintringham, "Color Television and Colorimetry". *Proc. IRE* 39, 1135 (1951).
- [2] M R Pointer, "The Gamut of Real Surface Colours", *Color Res. Appl.* 5, 145 (1980).
- [3] K Bazargan, "Review of Colour Holography", *Proc. SPIE* 391, 11 (1983).
- [4] W A Thornton, "Luminosity and Color-Rendering Capability of White Light", *JOSA* 61, 1155 (1971).

Credit Where Credit's Due

To the Editor:

Please Note that Claudette Abrams' *Personal Effects* holograms, (*Holographics International*, Summer '88) were in fact produced at Holographics North in Burlington, Vermont. Claudette is one of 18 artists we have been privileged to work with.

Dr John Perry
Holographics North Inc



Colour Controversy Continues

Dear Sunny,

I would like to make a couple of corrections to the news article "True Colour: Oxford Blue" in the light of what Dr Bazargan has correctly stated in his letter in this issue.

Although it is true that almost all colours found in nature lie within the gamut formed by the laser wavelengths 476, 514 and 633nm, I believe that a larger gamut is still necessary to overcome the extreme amounts of desaturation (colour shifting towards white) which is inherent in colour reflection holography [1]. If holograms did not desaturate, then the smaller triangle should have been able to produce yellow, purple and blue holograms, but it did not. These wavelengths fail not just because of the colour rendering characteristics but also because of this desaturation. Until the desaturation is decreased the triangle has to be made large enough so that the colours of the image in the hologram do not shift away from the colours of the object.

The wavelengths suggested by Thornton are similar to those used in my work and do render colours much better than the other

combinations used for making holograms. Thornton, however, was working on selling fluorescent lights where luminescent efficiency is much more important than in holography. This may be why the red line is so short in his bulbs. I used the 647nm red line because one can get more power and coherence out of a krypton laser than a HeNe - I don't claim that it gives better colour rendition than the 633nm line, but it's probably not much worse. In any case, Thornton himself postulated that the larger the colour gamut area (the triangle) the better the colour rendering [2] (although this has met with some criticism).

Paul Hubel,
University of Oxford.

References

- [1] P M Hubel and A A Ward, "Colour Reflection Holography", *Proc. SPIE 1051* (to be published in 1989).
- [2] W A Thornton, "Color-Discrimination Index", *JOSA 62*, 191-4 (1972).

Editorial

Spring is here already, at least here in Britain it's been pretty spring-like, and yet our last issue was *Summer '88*. Why?

We were already late with the last issue when disaster struck. Insufficient instructions to the printers meant that seven out of the eight stereo pairs were unviewable when we got the issue back. Though they fitted us in as quickly as they could, there was inevitably some delay in getting the issue reprinted and back to Britain to be mailed out.

At this stage I would like to thank our printers New Concept Complete Printing and Publishing Services Ltd, not only for reprinting the last issue, but for all the help and support they've given the magazine since we started back in '87. They have done a first class job and we are extremely grateful.

The delay in issue 4, has lead to the publication of the *Directory and Buyer's Guide* being put back until September to allow everyone to submit forms. Those forms which were sent in after issue 4 will, of course, be used and we will also accept second forms from those people if they change address or areas of activity.

In any case, though this explains what happened to autumn, it doesn't leave you any wiser about what happened to winter. I could blame it on the fact that, here in Britain, we have had almost no winter weather. But the real reason is much more mundane: starting 1989, we have altered the schedule by one month so that the magazine is not being compiled over Christmas.

Now, I have no objection to working at this time of year but, as a journalist, I find it very difficult to reach people in the three weeks between the middle of December and the Twelfth Night. Anyway, having the magazine come out in February/March was fine, but we couldn't call it winter. Hence two missing issues.

Subscribers need not be concerned that they have lost out. You subscribed for four issues and not one year, so you will continue to receive HI until you've received four. I would also like to remind those of you who started subscribing after having received a free issue in the post that this was a *free* issue. For instance, those of you who subscribed after a free issue two will receive issue six, etc.

We have used the break between last issue and this one quite productively. Not only have we switched from manual to computerised page make-up but we have recruited an Advertising Manager, Geoff Harris, who will be taking care of our advertisers, old and new, from now on. Please send all your advertising enquiries to him at the address given on page 3.

Lastly I would like to apologise to Sidney Dinsmore and Ann MacArthur (we think) for the incorrectly labelled photograph in the last issue.

Sunny Bains

Directory Dismay

Dear Ms Bains,

Imagine my surprise on reading the brief (page 10) and editorial (page 3) in the Summer '88 issue of *Holographics International* that the Museum of Holography would not publish its international directory. Though my tenure started in mid-October '88, I can assure you that we ARE publishing the same directory.

There are some points of issue here.

Conflict of interest - HI is publishing its own directory. The article appears self-serving to promote your own publication. This is what we called in our last US election, negative campaigning. In the editorial, is it necessary to belittle MoH's policy of pre-paid advertising? MoH did not invent pre-paid advertising and the practice is fairly standard in the US.

Timeliness - the point of the negative remarks about MoH was that the directory had

not been published in a timely manner. These remarks appear in the Summer issue of HI which, I believe, came out in November or December, and did not arrive in the US until late December/early January. The pot is calling the kettle black.

The world needs several holographic journals and maybe a few different directories until things sift out. We also need co-operation and understanding so that the promise of holography is fulfilled. Our parochial interests must remain in their proper place.

Your assistance in this matter will be most appreciated.

Sincerely,

Martha L Tomko,
Executive Director,
Museum of Holography,
New York.

The One We Had To Print

Dear Miss Bains,

Just a quick note to say how much I enjoyed reading issue 4 of *Holographics International*.

Of particular interest was the article on stereo viewing. I have tried the direct method before without success; always having to revert to a viewer. But this time, following the instructions in the magazine, I was success-

ful. I thought the results were absolutely beautiful and I do hope you will continue to use this method of illustrating holograms. The article has given me all sorts of ideas for my own work.

Thank you very much.

Yours sincerely,

R Gibson FBIPP, FRPS

Holomart in £5m Expansion

A "Museum of Holography" is to be opened in central London by Holomart Plc as a showcase for its ambitious plans to become a vertically-integrated holographic printing, packaging and design company. The public flotation of the company has raised £5m (US\$9m) since the autumn

to fund its rapid expansion.

Joint managing directors of the new public limited company are Bruce Snyder, one of the founders of Applied Holographics, and Ron Holland. Their strategy is to acquire established printing, holographic and design companies which have

potential for rapid growth. They aim to offer potential clients a full-range of holographic services from concept, through film or embossed hologram production, to printing and hot-stamping. The first areas to be targeted will be the gift and promotional markets.

Holomart has waited two years to secure the building for the museum, which is directly opposite the British Museum. The company's headquarters will also be located in this building, which was bought for £1.25m. The British Museum attracts 4m

visitors a year and the holography museum's proximity to such a major tourist attraction bodes well for its success.

Plans for the museum include a holographic gift shop at street level, a permanent display of mainly commercial holograms in the basement (1500 sq ft), and changing artistic exhibitions on the first floor (1000 sq ft). Ian Lancaster, former director of the Museum of Holography in New York, will be director of the new museum. He expects the new exhibition will open next spring.

The Museum of Holography in New York, a non-profit organization, has disputed some of the assertions in promotional material issued by Holomart relating to Ian Lancaster's time as director in New York. Both Snyder and Lancaster have denied that any of the statements are untrue, although they admitted that the statement in a Holomart brochure that Lancaster turned the New York museum from a "loss maker to a profit-centre" might be seen as misleading.



View from the top of the new "Museum of Holography" in London with Holomart directors Ron Holland and Bruce Snyder in the foreground and the British Museum in the background.

Newcastle Polytechnic Opens Lab

A new display holography laboratory was recently completed in the Physics Department of Newcastle-upon-Tyne Polytechnic in Britain. The laboratory was developed in response to demand from students and industry for a fully equipped, flexible holographic facility.

The staff most closely involved with the new lab are Dr Alistair MacGregor, Senior Lecturer, and Graham Rice, a former civil engineer. Dr MacGregor has been involved with research into optical pattern recognition and computer generated holography for some time, while Rice became involved with the Polytechnic in mid-1987 in order to experiment with display holography for commercial applications.

The success of their early work, carried out on a low budget, convinced Head of Department Dr John Wilson to invest in further facilities and to incorporate practical holography into a number of undergraduate and postgraduate courses within the Physics Department. Recently there have also been moves to offer courses in display holography to arts, graphics and de-

sign students.

The new lab has been developed as a resource for industrial and commercial use as well as teaching and research. Experienced holographers can hire the facility by the day, while it can be contracted out for longer periods to commercial concerns who require it for a specific project.

The studio is fully equipped with a large isolation table and all the usual continuous wave holographic and dark-room facilities. As well as the new lab's 3 watt argon-ion laser, the Physics Department has the ability to build specialist optical equipment, for example, many of the lasers used within the department were built there. These include HeNe, Nd:Yag, carbon dioxide and dye lasers. The department also has extensive optical coating facilities.

Newcastle Polytechnic will offer short courses in display holography starting this summer, and an artist-in-residence programme is also in the pipeline. Those interested in using the new facility should contact Graham Rice or Dr MacGregor. Telephone (+44) 091 232 6002, extension 3516.



Researchers at Newcastle Poly's holography lab (from l to r): Dr Alistair MacGregor, Paul Dunnigan and Graham Rice. Photo by Colin Dixon.

Tomko Takes Over at Museum in New York

Martha Tomko has taken over as Executive Director of the Museum of Holography (MoH) in New York. She replaces Ian Lancaster who left last summer.

She has worked as an arts administrator for almost 20 years. Her last position was as General Manager of the BC Pops Orchestra in Binghamton, where she

significantly increased subscriptions and donations. Previously, she held a number of administrative and fund-raising positions in art museums and other arts organisations.

When the appointment was announced, Chairman of the MoH Board, Mary Ann Crawford, said, "We are delighted to

have an individual with outstanding leadership skills and arts administration experience to direct the Museum in its second decade." The announcement was made at the end of November last year.

Ms Tomko is presently working on her first major project for the Museum, putting on an ex-

hibition for the National Geographic Society of Washington, DC, entitled *As We See It: Exploring the World of Holography*. The exhibition will open sometime this spring.

For further information about the Museum, which celebrated its twelfth anniversary in December, call (+1) 212 925 0581.

3D Media Conference in Montreal

The *International Conference on Three Dimensional Media Technology (3Dmt)* will be held at the Grand Hotel in Montreal, Canada at the end of May this year. The programme, which will run in parallel with the *Production '89* conference, will include sessions on 3D film, television, holography and sound.

The meeting will include screenings of 3D films, live dem-

onstrations of 3D television systems, and there will be workshops open to conference participants, where they will be able to make their own holograms.

For more information and registration details, contact: The 3Dmt Organizing Committee, Bryan Building, Room 315, 7141 Sherbrooke Street West, Montreal, Quebec, Canada, H4B 1R6.

Fringe Research's New Pulse Facility

A new pulse portrait facility has recently been set up by Fringe Research Holographics in Toronto, Canada. The new facility is based on a holographic camera designed by British holographer Dr John Webster. The camera incorporates a 10 joule ruby laser with a pulse of 20 to 30 nanoseconds.

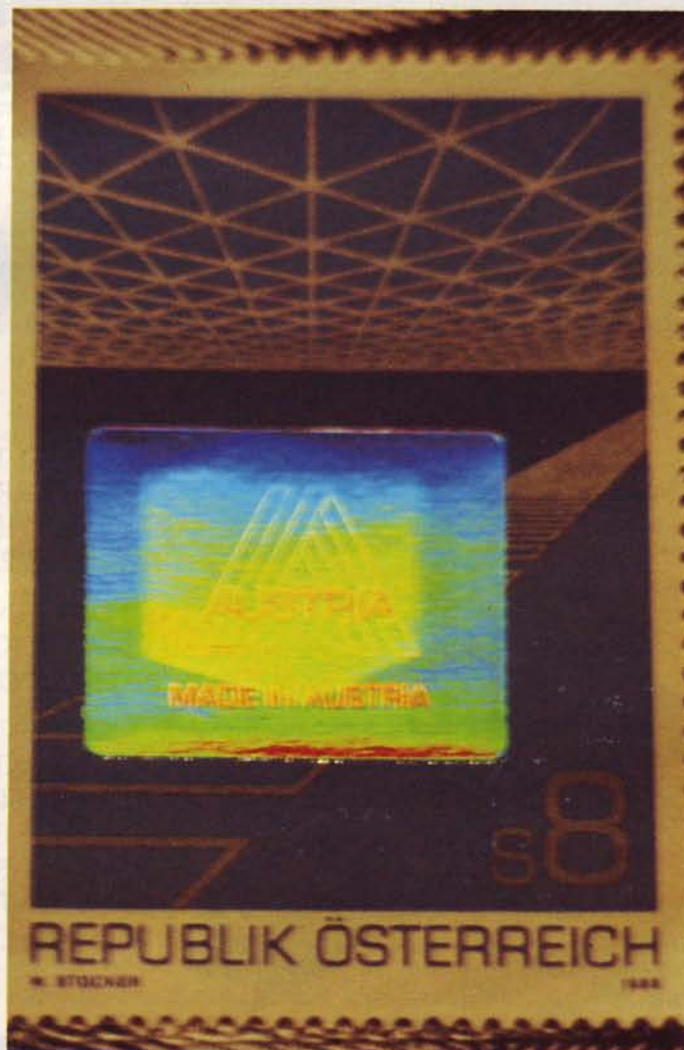
Since it was finished towards the end of last year, the facility has been used by several artists including Claudette Abrams, who shot a series of 22 master holograms of small animals for a collection to be called *Anima, Animas*.

A current project is to find out how well pulse holograms will work on photopolymer. This is

being carried out in conjunction with Bill Molteni and Polaroid Corporation.

The pulse facility was funded by the Canadian Department of Communications' Cultural Initiatives Program, the Ministry of Citizenship and Culture, and by Holographics North of the US. Fringe Research Holographics already had a continuous wave studio, and the company claims that the new facility enables it to offer one of the most complete ranges of holographic services in North America.

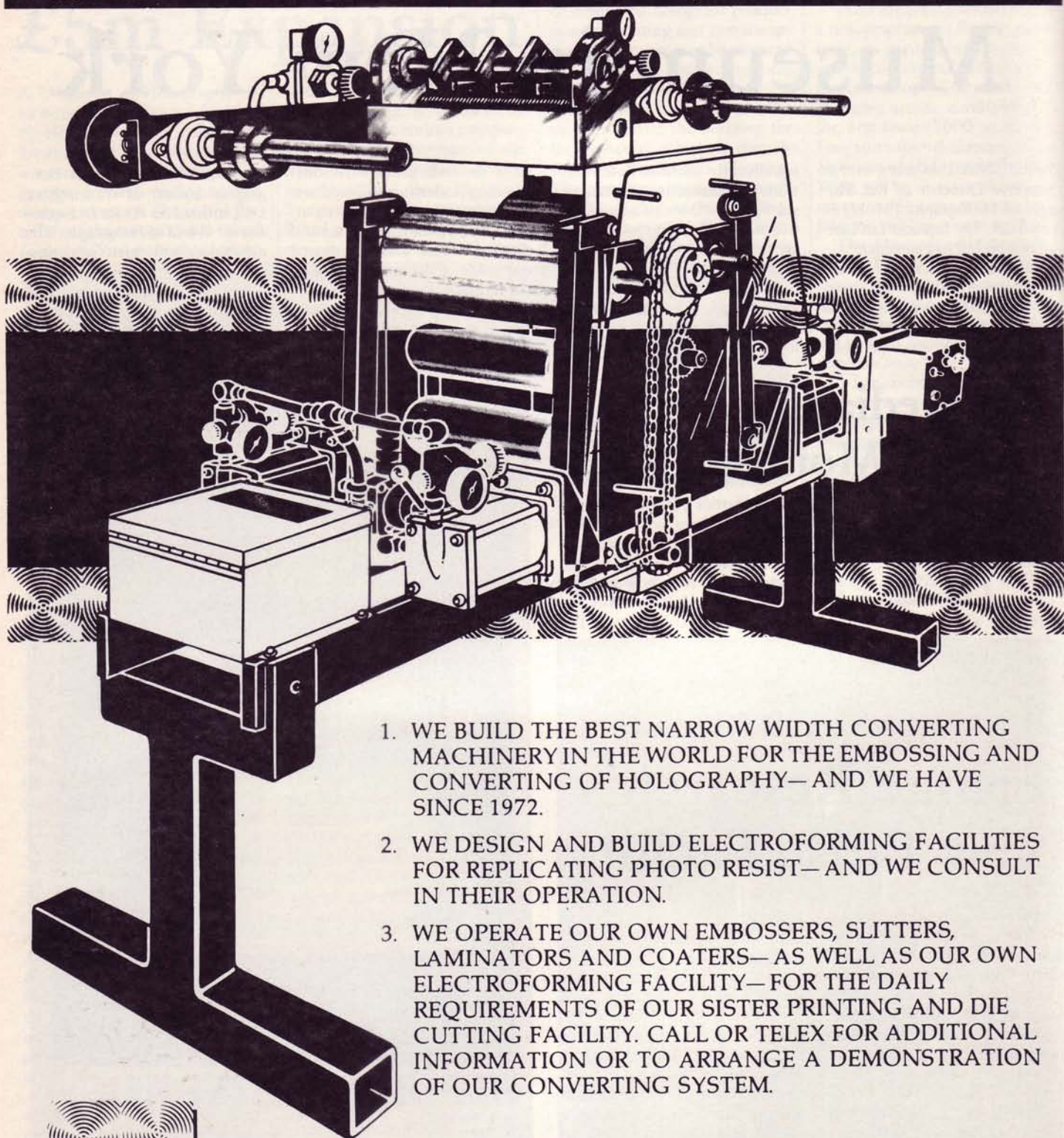
Fringe Research Holographics are at 008-1179A King Street West, Toronto, Canada M6K 3C5. Tel: (+1) 416 535 2323.



The Austrian Federal Post Office has issued the world's first holographic postage stamp, designed to highlight Austrian exports. The first issue of 3.5 million stamps sold out in a matter of days, and production of an additional 4 million stamps is being considered as a result of demand. The hologram was produced by Light Fantastic Plc of Britain, and the printing and hot stamping was carried out by the Austrian Governmental printing press.

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New ABN Cover

National Geographic magazine featured its third holographic cover on its centennial issue, which came out in December last year. The hologram was produced by American Banknote Holographics.

The gold-coloured embossed hologram takes up the entire front and back covers. The front is a two-channel pulsed hologram of a globe made of Steuben crystal glass, one image showing the globe intact with the other showing it being shattered. An advertisement for McDonald's hamburger restaurants appears on the back. The lettering on the spine is also holographic.

The crystal globe used in the hologram was significant in two ways. Firstly, it was identical to the awards being given to fifteen "Pioneers of Discovery" as part of the centennial celebrations: these included Jacques-Yves Cousteau, Sir Edmund Hillary, Senator John Glenn and Dr Jane Goodall. Secondly, the theme of the awards was "can we save our

fragile earth?", and the shattering globe in the hologram was intended to be symbolic of the delicate nature of life on the planet.

Bruce Dale, photographer with *National Geographic*, was in charge of tackling specific problems relating to the globe: this was a job in itself. By the time the project was completed they had broken some 200 glass and three lead crystal spheres. Ken Haines, Beth Roberts and Harley Weller of American Banknote were in charge of the actual holography.

Together, they had to design a pulse system that would allow them to take a hologram of the globe as it fell, and then another as it fell and was shot by a zinc pellet at the same time. According to Barbara Moffett of the National Geographic Society, "This one was quite a challenge and very difficult to accomplish, so I have a feeling there won't be anything like that again for a while... but I wouldn't say never."



The National Geographic Society award with a Steuben crystal globe like the one featured in the centennial issue holographic cover.

Lake Forest Workshops 1989

The 18th annual series of *Holography Workshops* will take place at Lake Forest College, USA, this summer. Two courses, one for beginners and one for advanced students, will be run from 10th-14th and 17th-21st July respectively.

The advanced class will include lectures from many well-known holographers, including Emmett Leith, Nils Abramson, Stephen Benton, Hans Bjelkhagen, Tom Cvetkovich, Tung Jeong, A J Languedoc, Nick Phillips, Richard Rallison, Steven Smith and Ed Wesley.

Subjects covered will include all types of materials and processing, computer generated stereography, colour control, fibre optics applications, new hardware

and software, electroforming and embossing, interferometry, pulsed and integral portraiture, and other significant developments. The course fee is US\$800.

The beginners' course includes tuition by Tung Jeong and others, and a lot of practical work. College credits are offered for this course. Students will make transmission, reflection, rainbow, focused image, cylindrical and other types of hologram, as well as learning the basics of holographic optical elements and interferometry. The fee for this course is US\$725.

For more details and a registration form, write to: *Holography Workshops*, Lake Forest College, Lake Forest, IL 60045, USA.

Wise choice on reflection

Telescope manufacturer Wise Instruments of Britain is offering its expertise in the manufacture of large collimating mirrors to the holography market.

Custom-made mirrors are available in all sizes up to 50 inches. Prices range from about £600 (US\$1100) for a 16in mirror to over £35 000 for one of the largest sizes. The company

has recently supplied a 37in f3 mirror to a holography company based in Scotland.

Wise can also supply other optical equipment, including lenses, prisms, and optical wedges.

For further details contact Peter Wise at Unit 9, Hollins Business Centre, Marsh Street, Stafford, ST16 3BG, Britain. Tel: (+44) 0785 223535.

Towne in a Spin

Towne Laboratories of the United States has announced that it is now able to supply large scale, custom photosensitized holographic plates.

Plates are available in sizes up to 18x18 inches, spin-coated with 1.5-2.5 microns (+/-10%) of S1400-30 photoresist.

In addition to clear glass, chrome and iron oxide coated plates are available with this special spin-coated photoresist. In

application, iron oxide coated plates are reported to have significantly fewer reflective exposure problems than chrome or other reflective processes, Towne says.

Dip-coated iron oxide plates are also available in sizes up to 24x32 inches.

For further information, contact: Towne Laboratories Inc, 1 US Highway 206, PO Box 460, Somerville, NJ 08876, USA. Tel: (+1) 201 722 9500.

Showtime in Stuttgart

Two major holography exhibitions took place in the German city of Stuttgart late last year under the overall title of *Holography Weeks*.

Holographica '88, which was billed as the world's largest holography exhibition, was held in conjunction with the *Hobby und Elektronik* show from 10th to 13th October. Over 70 000 people attended the overall event, which was organised by the Museum for Holography and New Visual Media of Pulheim, near Cologne.

Over 150 holograms were displayed, representing the security, advertising and scientific uses of the medium, as well as an impressive collection of art holograms, including work by Rudie Berkhout, Doug Tyler and Sam Moree. Holograms from several countries in Europe and North America were joined by examples of work from China.

One week later, a second exhibition opened in Fellbach, just outside Stuttgart. Entitled *Art: The Third Dimension*, it featured work incorporating light, sound, painting and sculpture, as well as

holograms. Sponsored by the local electricity company, Neckarwerke, this exhibition ran for about five weeks, until 25th November.

The majority of the work fea-

tured was by German artists, including Dieter Jung, Brigitte Burgmer, and Mike Mielke, as well as some new and less well-known names. Work from Japan and the United States was also on display.

The success of *Holography Weeks* will have strengthened the already flourishing commercial market in Germany, where there are well-established galleries and other outlets in all parts of the country. There are also plans to make *Holographica* an annual showcase for new developments in holography.

A full review of the two *Holography Weeks* events appears on page 19.



Queues in Stuttgart outside the *Holographica '88* Exhibition.

2D to 3D

Five alumni of the Chicago School of Holography in the US have written a book entitled *Holography for Photographers*. Published by The Fine Arts Research and Holographic Center, which operates both the School and the Museum of Holography in Chicago, the book was specifically written for photographers, both amateur and professional, who have darkrooms.

"This is the first book that delivers practical, hands-on instruction in making holograms for an audience that is already half-way there... photographers. The book focuses on getting photographers started in actually making holograms... it tells them how to set up their own holography lab for under US\$1000, including exactly what to buy

and where to buy it," says Craig Bonda, President of the School's Alumni Association and one of the authors.

Holography for Photographers explains how to make single and multiple beam reflection and transmission holograms. The authors do not attempt to explain all of the physics behind holography, but rather to show how simple it can be to record objects in three dimensions as opposed to two.

Other projects that this group are contemplating include producing kits which will contain everything needed to add holography to an existing darkroom, and a holography telephone 'hotline' for novices is also contemplated.

The book was written by

Meeting in Bulgaria

The annual *Holography Conference*, which is held every third year in Lake Forest, USA, is to take place this year in Bulgaria in May. The organising committee is chaired by Yu N Denisyuk, the inventor of white light reflection holography. Tung Jeong is co-chairman.

Major topics to be discussed are: display holography; holographic interferometry; non-destructive testing; holographic optical elements; dynamic and polarization holography; recording materials and systems; and opto-electronic information pro-

cessing. There will also be a holography exhibition. The working languages will be English and Russian.

The registration fee for *Holography '89*, which takes place from 21st-24th May in the Black Sea resort city of Varna, is US\$150. For further information, write to: Holography '89, Central Laboratory of Optical Storage and Processing of Information, Sofia 1113, PO Box 95, Bulgaria; or contact the Holography Workshop, Lake Forest College, Lake Forest, IL 60045, United States.

Craig Bonda, Ira Brodsky, John General, John Hoffmann and Jim MacShane with photos and illustrations by Lynn Schultz and Bill Zacher respectively.

Copies can be obtained from Holographic Design Systems,

1810 S Broadway, St Louis, MO 63104, USA, at US\$6.95 plus \$1 for postage and handling. The Fine Arts Research and Holographic Center is at 1134 W Washington Street, Chicago, IL 60607.

Light Fantastic Gallery Closes

Only a few months after revamping the premises, Light Fantastic Plc of Britain has had to move its holography exhibition out of the Trocadero, which is off Piccadilly Circus in central London.

The building, which is an indoor shopping mall with a number of exhibitions on the upper floors, was recently bought by the Brent Walker Group Plc from ESN Property Management Co Ltd, and the new owners decided they wanted to develop the building as a purely shopping centre. Light Fantastic accepted a sum of approximately £750 000 (US\$1.3m) to give up its lease which, says Managing Director Peter Woodd, it accepted willingly.

The building is being refurbished and, even before Light Fantastic left at the end of September last year, the work was starting to cause a nuisance with plaster and dust regularly falling from the ceiling, Woodd said. As this redevelopment work would continue for two years the company was glad to leave. It is now considering alternative sites for the exhibition.

Light Fantastic, which became a public limited company in June of last year, has recently opened its new Commercial Centre of Holography at Gelders Hall near Loughborough. The company says that at its new location it can show clients every step of the holographic process from design concepts to shims.

The company continues to expand its embossing activity following the success of *The Mirrorstone*, the holographic children's book, which is now being printed in ten languages. Recent contracts have included several in the security and packaging fields.

Light Fantastic's new Centre is at 4E/F Gelders Hall Road, Shepshed, Leicestershire, LE12 9NH, England. Tel: (+44) 0509 600220.

Richmond Make Multicolour Matisse

Edwina Orr and David Traynor of Richmond Holographic Studios (RHS) in Britain recently unveiled a full colour stereogram which they completed at the end of last year. They used a new combination of existing techniques to produce the hologram for about £500 (\$900) in materials and equipment hire.

RHS combined a technique involving colour-separated multiplexing (Molteni, Lake Forest proceedings, 1982), in which three stereogram masters are made from colour-separated photographs, with their own work making pseudo-colour reflection holograms. These two techniques together, they realised, would enable a full-colour hologram to be produced with a colour mix which was independent of the observer's position.

The hologram was made in three basic steps: filming, mastering and copying. In the first step, the objects (a reproduction painting, some flowers, and some written material) were put on a turntable and black and

white slides were taken separately through red, blue and green filters. The turntable was then rotated through about 0.55 degrees and a further set of photos was taken. In all, 108 photos were taken through each filter, each with a different turntable position.

The slides were front projected onto a white screen to form the images for the stereogram masters. Each slide was positioned by hand in an improvised mount and illuminated by 95% of the output of a 1 joule pulse ruby laser. The light was passed through a ground glass diffuser which 'cleaned up' the pulse beam. With a continuous wave laser this can be done using a spatial filter, but this is too dangerous with pulse work as it leads to too high a concentration of energy at one point.

Making a stereogram involves the master being divided into adjacent vertical slits, each slit being a hologram of a different photograph. When the final stereogram is viewed, each eye looks through a different slit,

thus seeing different images which, together, show parallax. To divide the plate into these vertical slits, the RHS team used an adapted typewriter to move a 2mm slit along the plate for each exposure. Three such masters were made, one for each colour, using the three sets of 108 photos.

To get the full-colour copy hologram, they used the standard method for pseudo-colour work, which involves swelling the emulsion before exposure by a different amount for each of the three colours. The final hologram, which measures 25cm by 20cm, shows a good full-colour effect, although the definition was not high enough to read the text that was used as one of the objects.

The whole process was carried out in 20 days, and resulted in RHS's first multiplexed hologram. They found the process quite tedious, but think that with some thought and mechanisation, both the quality and speed of this technique could be significantly improved.



Stereo photographs of the stereogram made at Richmond Holographic Studios featuring *The Sorrows of the King* by Matisse. Photos by David Pizzanelli.

To view stereographs: hold the prints so that they are evenly lit, at arm's length at eye level. Look under the bottom edge of the page at some distant object. Position the prints so that this object can be seen beyond the middle point of the left print with your left eye open and beyond the middle of the right print with your right eye open. Blink alternate eyes to check. Keeping your gaze fixed on the object, move the prints into your line of vision. You will find you can see three images which are out of focus. Keep your eyes fixed as if looking right through the magazine to the object, concentrating on the middle image. Once you have "locked on" to it, it should resolve into focus in 3-D. Slowly moving the prints to your normal reading distance may help.

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Looking Through the Pinhole

Making a pinhole camera out of a shoe box is a standard experiment done in school science classes all over the world. The Optics Section in the Physics Department of Imperial College, London, has used the principle of this simple device to make pinhole holograms which may have applications in optical computing and information processing.

In this technique, a hologram is made with a pinhole between the object and the recording plate. Thus the pinhole, in effect, becomes part of the object. When the hologram is reconstructed, all the light has to pass through the image of the pinhole, just as it had to pass through the real pinhole when the hologram was being made. However, since the real pinhole is not there, other devices can be placed where its image appears in order to manipulate the image of the object.

One of the experiments carried out by the Imperial team of Shenchu Xu, Geraldo Mendes, Stephen Hart and Chris Dainty, was to make two holograms of different objects on the same ho-

lographic plate, moving the pinhole slightly after the first exposure. They could then block out one of the images by putting a small object (in this case a knife edge) at the position of the appropriate pinhole, leaving the other image to reconstruct normally.

Further development of this idea could allow a hologram to be made with many different images on it, each with its own pinhole in an array. A series of shutters could then be placed in the plane of the pinholes so that any combination of the images could be viewed by opening and closing the relevant shutters.

Another possibility would be to replace the shutters with a liquid crystal device which, instead of simply allowing an image to be "off" or "on", could change the intensity of the image, introducing a grey scale. In either case, it would allow the appearance or non-appearance of the individual images to be programmable.

Another experiment carried out at Imperial involved putting a diffraction grating at the point where the image of the pinhole

appears. The resulting image showed the different diffraction orders and so looked like several copies of the original placed side by side. Other optical elements could be used in a similar way to manipulate the image.

If points in each of several images, each "represented" by a different pinhole image, were arranged so that they activated different detectors in an array, then this system could act as an opti-

cal interconnect and so could have applications in optical computing.

So far, the group has used arrays of 273 points, each 50 microns in diameter and separated by 250 microns, with a total image size of a few square millimetres. This is only slightly larger than would be needed for an optical computer, and as yet they see no reason why the work could not be scaled down.



*Holograms of archaeological and art treasures from the Ukrainian city of Kiev, including the one pictured above, will be on show in York, England, from 1st May. The treasures in Kiev's museums depict the long and eventful history of this region, during which it has been occupied by many different peoples. The artifacts are too precious and fragile to travel, but the holograms allow them to be displayed all over the world. The exhibition, entitled **Russian Holograms: Treasures Trapped in Light**, will run until 31st October at the St Saviour's Archaeological Resource Centre, St Saviourgate, York. Call (+44) 0904 643211 for further information.*

LA Meeting is Biggest Yet

SPIE, the international society for optical engineering, held its OE LASE '89 meeting in January in Los Angeles. Over 6000 participants attended the various conferences which made up the meeting, making it the largest optics meeting to date.

Holography was represented by *Practical Holography III*, a two-day conference on materials, applications and techniques chaired by Stephen Benton. It included a panel discussion entitled "Commercial and Fine Art Holography", and a holography exhibition.

The first session on materials included: Kaveh Bazargan's new geometry for recording one-step

full-colour holograms; T Kubota's recent work on dispersion compensation of reflection holograms; Paul Hubel's techniques and analysis of colour reflection holograms; Glenn Wood's announcement of a new red silver halide recording material with increased sensitivity at 633nm; and the progress of Polaroid's DMP-128.

The applications and techniques session included: holographic optics for vision systems by M Freeman; an ingenious holographic fingerprint sensor from Fujitsu Labs, Japan; the description of a hologram on a photocopier by Xerox; T Honda's printing of a holo-

graphic stereogram using a liquid crystal TV receiver; and J Walker's description of the in-situ full-colour pseudo-colour holographic stereogram work she's doing with Stephen Benton at MIT.

This is just a brief recap of some of the papers presented. Full details will be available from SPIE soon in their Proceedings, volume 1051.

The panel discussion on commercial and fine art holography was moderated by Suzanne St Cyr and included Tom Cvetkovich, Ed Dietrich, Russel La Coste, Craig Newswanger and Doris Vila. The panel was an interesting cross-section of these two sides of holography.

The holography exhibit was a small selection of the highest quality displays from the technical, commercial and artistic dimensions. What stood out were the recent advances in colour holography and the application of these techniques in holograms by Kubota, Hubel, News-

wanger, and a team from MIT (Benton/Walker/Plesniak/Klug). It was a rare opportunity to see all of these together in one room. The exhibit also included displays of commercial holograms made with Polaroid photopolymer and with embossing techniques. Half of the exhibit was devoted to fine art holography, which included M Teitel's award winning *Murray's Fourth Birthday* among many others.

The conference as a whole was a bit too big, with many interesting sessions held in parallel. In particular, the sessions on electronic imaging, such as image understanding, 3-D TV, high-definition TV, projection displays, and non-holographic true 3-D displays, were running at the same time in a different hotel.

The other SPIE conference on holography was *Holographic Optics: Optically and Computer Generated*. See SPIE Proceedings, volume 1052, for more information.

Shearwater Awards '88



Gemini Stones: a new piece by John Kaufman, one of the 1988 Shearwater Award winners.

The recipients of the second annual Shearwater Foundation Holography Awards were announced late last year. Six holographers were each awarded US\$10 000 in recognition of their exemplary work.

The winners were: Rebecca Deem, John Kaufman, Douglas Tyler and Doris Vila, all of the United States; Setsuko Ishii of Japan; and Dieter Jung of Germany.

The awards were initiated in 1987 to promote and encourage the art of holography by providing support and recognition to pre-eminent artists in the field. The programme honours artists who have had a distinguished record in holography for at least five years and whose work has attained the highest calibre of artistic achievement, the Foundation says.

The award recipients are chosen by the Foundation's Board of Directors from nominations provided by a confidential group of advisers from the field of art holography. Shearwater is one of few American foundations currently funding artists in holography.

Brodel Sentenced in Drugs Trial

Jonathan Brodel of Ascot Holographic Systems in Ascot, Britain, was given a one year jail sentence, suspended for 18 months, for allowing his home to be used to manufacture drugs. The crime was detected when a chemical company reported a large order of benzyl methyl ketone (BMK), one of two ingredients needed to manufacture amphetamine sulphate (known as "speed"), to the police.

In his defence Brodel said that in 1986, after reading a paper on holographic chemistry, he had asked a chemist, co-defendant Paul McGowan, to assist him in experimenting with the techniques described in the paper because they involved chemicals he was unfamiliar with. Brodel, McGowan and a third defendant, Christopher Bishop, claimed that the BMK was just

one of many chemicals that they had purchased in order to carry out these experiments.

According to Detective Constable McNeillie of Windsor Drug Squad, however, they bought a large amount of the chemicals necessary for producing speed, and token amounts of the others. Prosecuting counsel Nicholas Browne told the court: "They had enough BMK and formamide to make more than one kilogram of pure amphetamine sulphate with a street value of £20 000 (US\$35 000)."

Two holographers, Dr Nick Phillips and Graham Saxby, were called as expert witnesses in the case. McGowan claimed that he needed the BMK and formamide because he wanted to produce an optically active compound, and cited work done by American holographer Richard Rallison

which, he claimed, vindicated this use. In their evidence, however, both Saxby and Phillips testified that the usefulness of BMK in processing holograms was doubtful.

According to the police, Brodel admitted that he did know of McGowan and Bishop's initial intention to make drugs, but said he took no part in it. He also claimed that, after McGowan and Bishop had failed in their attempts to make the drug on earlier occasions, he thought they had given up the idea. The chemicals, he said, were ordered without his knowledge.

Paul McGowan and Christopher Bishop received jail sentences of 36 and 21 months respectively, having been found guilty by the jury of conspiracy to manufacture amphetamine sulphate.

Anäit's Artistic Accolade

Anäit (Arutunoff Stephens) has been included in the most recent edition of the international art encyclopedia, the *Thieme Becker Künstler-Lexicon*. Anäit, who lives in Santa Barbara in the United States, has been an artist since the 1960s when she first started working in resins, and she subsequently moved on to working in holography.

She is presently working on a project inspired by Monet's *Water Lilies* using the pulse laser facility she set up two years ago. The holograms are multiple exposure pieces which include holograms of lillies, water ripples and, to add a note of realism, common pollution such as bottle caps. The working title for the project is *Light Waves: Liquid Light*, and it will consist of a series of 16x20 inch pieces which will be hung together as a mural.

New Experience For Liverpool

Holographic Experience, believed to be the biggest holographic exhibition in Britain, opened in Liverpool towards the end of last year.

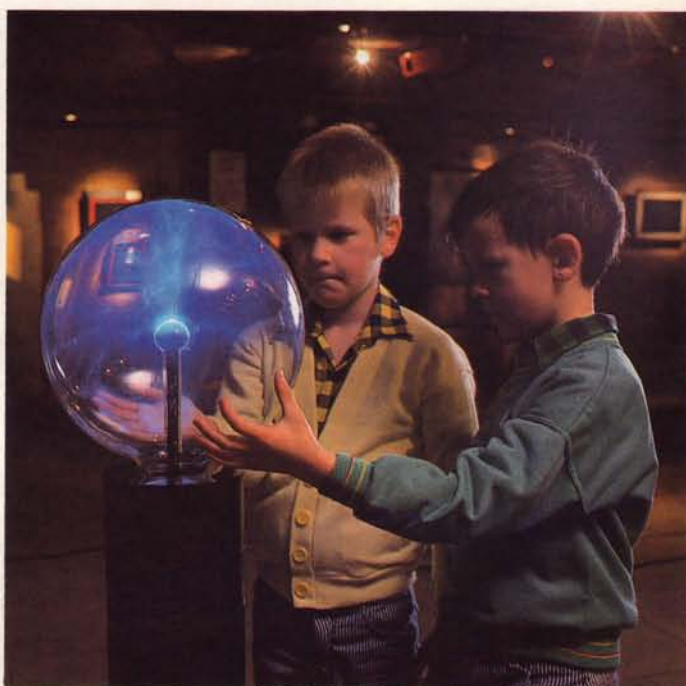
The exhibition and the associated shop are run by Pat Osborne and Mark Broadbent, both relative newcomers to the field. Mark started collecting holograms two years ago after receiving one as a present from Pat, his fiancée. She later persuaded him to turn his hobby into a business.

Their new exhibition is at Albert Dock, a newly developed tourist and leisure centre housed in renovated dock buildings. The project was funded through a loan of £10 000 (US\$18 000), as well as a grant of £5000 from

the English Tourist Board.

The location is ideal, Pat says. They previously had an exhibition in the main shopping area of Liverpool, but found that people were more interested in shopping than seeing holograms. Albert Dock is home to several other attractions, including the new northern branch of London's Tate Gallery.

The exhibition contains holograms from all over the world, although British artists are particularly well-represented. As well as art and commercial holograms, *Holographic Experience* shows other high-tech effects, such as a plasma ball and a robot with a TV screen face, and sells the usual range of holographic novelties.



Children fascinated by a plasma ball at *Holographic Experience* in Liverpool. Photo by Steven Eckersall, Studio 3000, Stalybridge.



Pictured above is a two-channel, multi-colour hologram of a woman blowing up a balloon which then pops. Made at the new Fringe Research Facility (see page 7) and at Holographics North in Burlington, Vermont, the hologram was first shown at the SPIE conference (see page 13) where it was well received. Holographics North, founded by Dr John Perry, who started his career in holography by attending a course at Fringe Research, is best known for its large-format corporate holograms. These include pieces for Pontiac Motor Division and Digital Equipment Corporation. However, Holographics North has also produced holograms for several artists, including Michael Snow, Dieter Jung and Antonio Peticov.

New Lab For Canada

The Photon League has nearly completed its holographic studio for Canadian artists. Based in Toronto, the group is an incorporated non-profit organization set up as a co-operative to provide facilities and a discussion forum for holographic artists in Canada.

Equipped with a 50mW HeNe laser and supporting equipment, the new studio was

funded by the Canada Council. Use of the facilities is open to any Canadian artist who joins the Photon League.

The yearly membership fee is \$100, and the League says that studio rental will be at a low daily rate. For further information, please contact: The Photon League, 110 Sudbury Street, Basement, Toronto, M6J 1A7, Canada.

New Company for Illinois

A new company, Holographic Industries Inc, has been established in Lincolnshire, Illinois, to manage a chain of holographic retail galleries in major shopping centres across the United States. The company has a close association with Holicon Corporation of Evanston, Illinois, which is a producer of commercial holograms.

Robert Pricone is president of the new company. The other principals are Dr Hans Bjelkhagen, Dr Max Epstein and Dr

Michel Marhic.

The company's first holographic gallery, the Light Wave, opened in November 1988 in the Woodfield Mall in Schaumburg, Illinois, one of the world's largest indoor shopping centres. In addition to the usual holographic products, the gallery displays high priced art holograms, many from Dr Bjelkhagen's large collection.

Holographic Industries is at 3 Warwick Lane, Lincolnshire, IL 60015. Tel: (+1) 312 945 2670.

Events Calendar

3rd March - 30th April

Dream Points, an exhibition of Douglas Tyler's work. Museum for Holography and New Visual Media at Cologne, West Germany. Phone (+49) 02238 51054 for further information.

14th March

Matthias Lauk, Director of the Museum of Holography and New Visual Media in Germany, talks to the Holography Group of the Royal Photographic Society in London. Meeting starts at 7.30pm at the Challoner Club, 61 Pont Street, SW1.

11th April

Francis Tuffy, researcher on stereograms from computer graphics, speaks at the RPS Ho-

lography Group meeting. For time and place see 14th March.

1st May - 31st October

Treasure Trapped in Light: exhibition of Russian holograms in York, Britain. See page 13.

9th May

Stephen Crouch, Director of Holoscan Ltd, speaks at the RPS Holography Group meeting. For time and place see 14th March.

21st - 24th May

Holography Conference in Varna, Bulgaria. See page 10.

24th May - 18th June

Kamera Aktiv in Hamburg, West Germany. External exhibi-

AT&T Call For Polaroid

A Polaroid Mirage hologram features on the cover of a new brochure for customers of the US telephone company AT&T. The booklet is titled *AT&T Globe*, and the 4cm (1.5 inch) diameter hologram depicts a world globe.

This type of hologram is the only one to use Polaroid's patented photopolymer technology. The process allows light to reflect through several layers of film to give the hologram more depth, and it is easily visible in a wide-range of lighting condi-

tions, says Polaroid. The result, the company says, is a distinct improvement over embossed holograms.

AT&T considered a number of types of hologram before choosing the Polaroid Mirage. "The hologram is unique and innovative, and that's exactly the message we want to communicate to our customers," AT&T direct mail manager Ellen Donker says. The booklet will go to an audience of 1.3 million telephone subscribers.

tion of the Museum for Holography and New Visual Media. Phone (+49) 02238 51054 for further information.

30th May - 1st June

3Dmt: conference on three dimensional media technology in Montreal, Canada. See page 7.

30th August - 30th October
Visiona '89 is a multi-media exhibition to be held in Zurich, Switzerland. External exhibition of the Museum for Holography and New Visual Media, Cologne, West Germany. Phone (+49) 02238 51054 for further information.

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Tackling Everest: A Personal View

The idea of making a hologram of Mount Everest came during a very wet January in the English Lake District last year. My climbing partner, Al Evans, a Granada Television cameraman, was due to accompany the British Services Everest Expedition in February in order to make a documentary series. He and other members of the film crew were in Windermere in order to film expedition preparations.

I was introduced to Captain Roger Antolik, who was in charge of all things photographic for the expedition. He told me that he was short of black and white film for the trip, and, as I worked for Ilford, he asked if I could help. This is when I had the idea for the hologram.

Ilford had supported the development of a holographic system to provide three dimensional hardcopy using holographic stereoscopy. Nick Phillips and his research assistant, Steve Done, had built a camera and had produced a promotional hologram of an entirely computer-generated image by Electronic Arts. It seemed to me that if it was possible to produce a ho-

logram of a purely fictitious scene, then surely it was possible to produce a holographic stereogram of an actual object, even if that object was Mount Everest.

Roger Antolik had never seen a hologram before, and certainly didn't know what a multiplex hologram was. However, another drink and the deal was struck: he would take some photographs of Everest for me in return for a quantity of black and white film.

Before the expedition left for the Himalayas, Nick Phillips and I met up with Antolik at the Royal Geographic Society in London, conveniently close to the Royal College of Art where, a little later, he saw his first hologram. I supplied him with written instructions about the photography the following week, and wished him and the expedition well.

The expedition flew from RAF Brize Norton to Katmandu in Nepal. From here the 36 team members and the film crew trekked to the Nepal/Tibet border and on to base camp in the Rongbuk Valley. While the climbers were tackling the mountain,

unsuccessfully as it turned out, Antolik surveyed likely spots to take the photographs for the hologram. The location we had agreed on in advance, on the Rongbuk Glacier, proved to be just too crevassed to be safe. Instead, he identified a suitable location between the site of the base camp and the Rongbuk Lamastery, some six miles from the summit of the mountain.

He spent a day surveying the ground, and the following day he returned with his camera and shot 340 pictures at a separation of 1 metre along a line. At each point the camera was aligned with a reference point on the mountain using an index mark on the focusing screen of his Olympus OM2. The pictures were taken using a 50mm lens, with Ilford FP4 film exposed on automatic.

Back in Britain, I had given us a 20% chance of just getting usable film back from Tibet. I was, therefore, very pleased to welcome Antolik to our lab with 10 very precious rolls of exposed film. These were developed at Ilford and my assistant, Ged Finney, and I examined them. The

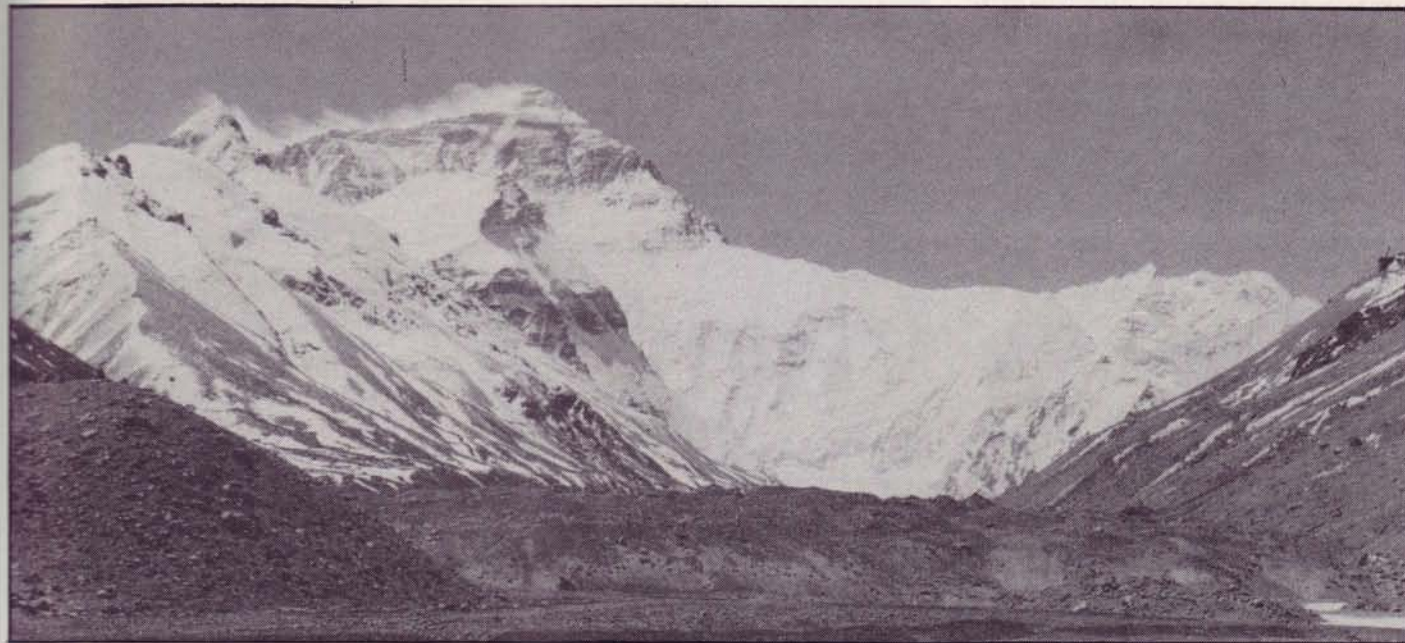
vertical registration appeared to be very good, but could we make a passable multiplex?

The films were taken to Nick Phillips' lab at Loughborough University and copied into positive on a rostrum camera, which also provided the essential pin registration. Phillips and Steve Done produced the masters and a late night phone call confirmed that they looked very good. They shipped one master to my lab and Ged Finney and I produced some reflection copies. Additional copies were made at Loughborough.

At this point lots of people became interested in the result. Granada wanted to incorporate the hologram in the title sequence of the TV series, called *On the Big Hill*, and they asked for a blue replaying hologram. The expedition management committee invited the hologram, and me, to a reception at which it received royal interest from HRH Prince Philip. It was then displayed at the press launch of the TV series in London. Sadly, despite our production of a bright blue image, it didn't appear on television.

The hologram is not without its warts, but it exists, thanks to the faith and skill of those who were willing to support the project through every stage. With their help, we succeeded in producing a holographic stereogram of perhaps the most beautiful landscape on earth.

Alan Adshead



Mount Everest: probably the largest holographed object in the world.

An Exploration of Art and Perception

In contrast with the vast number of scientific and technical articles on holography which have appeared over the past twenty years, there has been very little written concerning the aesthetic qualities of the medium. *Holographic Art/Perception/Evolution/Future* by Brigitte Burgmer is a slim volume of some seventy pages of text and eight pages of colour plates, yet in many ways provides the most seminal text yet written on the subject.

The book is published in an edition of 1500 copies, including 100 copies complete with a paper jacket designed by the artist "as a collage of crayon drawing and embossed holograms, numbered and signed". Thus the work itself becomes an example of some of the issues explored in the text. The hand-made cover is beautiful, yet the jagged edges and raised surfaces of the pieces of plastic provide a difficult tactile contrast to the smooth texture of the paper delicately embellished with pencil, crayon and ink. More uniform and no less pleasing is the standard cover (for the rest of the edition) which shows both a subtlety of sensibility and (I think) a sense of humour: a design marked out in silver ink is printed onto silver paper. Thus when viewed full on it disappears, and can only be seen when the book is viewed obliquely.

The volume is in four chapters, translated by four different people, sometimes in collaboration, which may in part contribute to the fragmented quality of the text. In terms of style it is like a notebook, presenting thoughts and observations, rather than delivering a comprehensive doctrine. This more tentative approach invites the reader to shape his or her own opinions, triggered by a phrase or paragraph, rather than persuading by a sustained linear argument.

Of particular interest are those sections relating to the perception of the holographic image, and the artist's struggle to make representational art using such an effective recording medium. "I can point out those holograms which are reconstructions of a simple object - eg. a head, a water tap or a motor - existing as light appearances without artistic intention. The artistic holograms, on the other hand, are not aimed at reproducing a known object as closely as possible; rather they culminate in original artistic realities."

Although somewhat dualistic, this division makes a good antidote to reading Umberto Eco's pronouncement (in *Travels in Hyper-Reality*) that "holography could only prosper in America, a country obsessed with real-

ism, where, if reconstruction is to be credible, it must be absolutely iconic, a perfect likeness, a 'real' copy of the reality being represented."

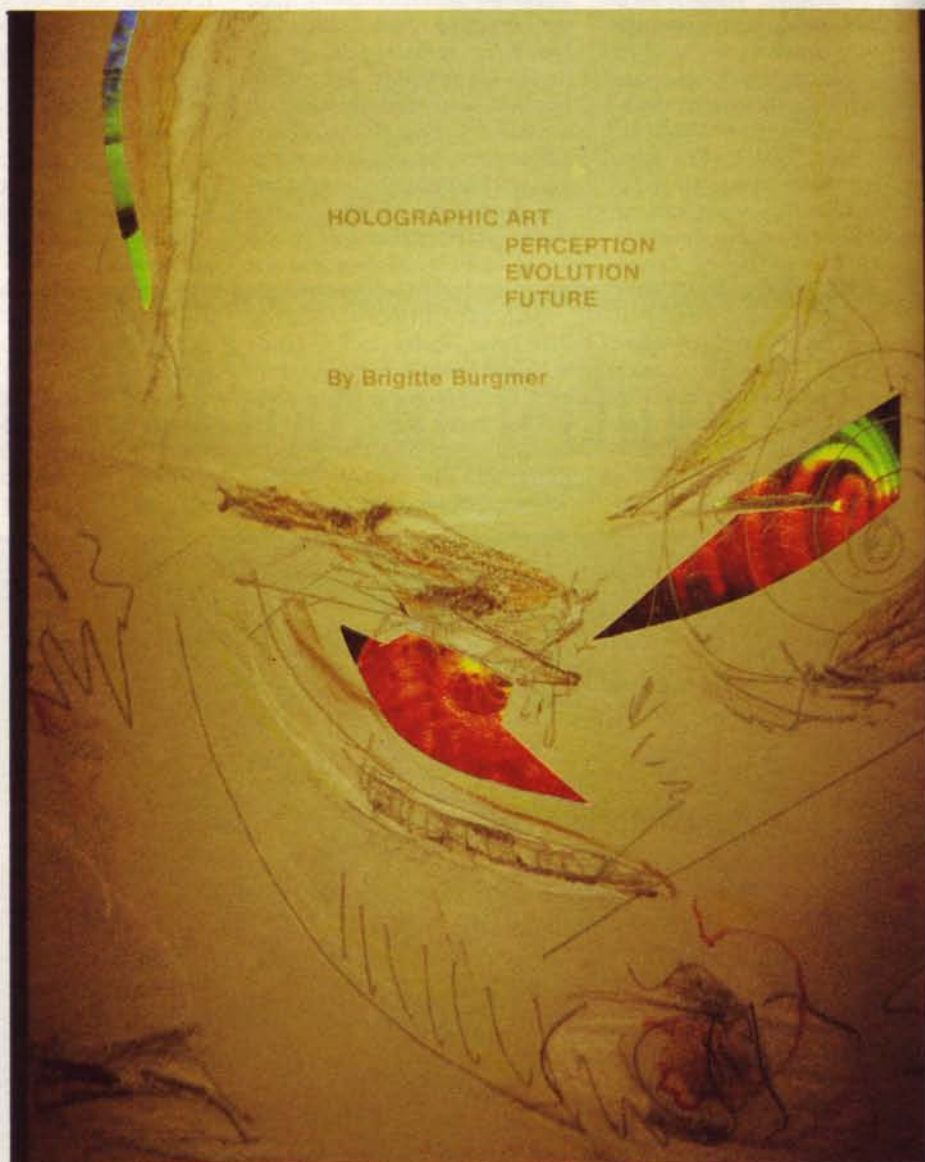
Brigitte Burgmer's little book is a seed packet of ideas, which, with any luck, will provoke other artists to take up their pens or plug in their word-processors and make their own contribution to this important but much neglected aspect of holography.

The publisher of Burgmer's *Holographic*

Art/Perception/Evolution/Future is Daniel Weiss, Benito Blanco Rayoi 9-13A, 15006 La Coruna, Spain. Tel. (+34) 481 290745. (ISBN: 84-404-1618-0).

The prices are US\$15 (or equivalent) for a standard copy and US\$49.50 for the limited edition. At time of writing, about fifty of the initial hundred copies of the limited edition were available for sale.

David Pizzanelli



Cover of the limited edition of Brigitte Burgmer's new book. Photo by David Pizzanelli.

Holographica Pulls the Crowds

by Andrew Pepper

If holography can take a city by storm, then that is what happened during the *Holography Weeks* held towards the end of last year in Stuttgart, West Germany. The *Weeks* title was something of an umbrella concept to cover two main events which were taking place in this southern German city and its surroundings.

Art: The Third dimension, an exhibition of holography, electronic and light/laser art, opened on 21st October for a five-week run at a regional gallery in Fellbach on the outskirts of the city. Not surprisingly, holography featured heavily in the show, which also included installations using light, sound, paint and sculpture. Sponsored by Neckarwerke, the area's electricity supply company, the exhibition covered an unusual range of work and techniques.

Visitors were able to see a collection of individual pieces and installations from all parts of the quality spectrum. Holographic pieces ranged from a massive woven wool and fabric wall piece by Setsuko Ishii (Japan), which incorporated six large holograms of fibres integrated into the surrounding textures, through to commercial embossed holograms incorporated into graphic illustrations by Leonore Zimmermann (Germany). Although work from Japan and the USA (John Kaufman and Randy James) was included, the ma-

jority of exhibitors live and work in Germany.

One of the 1988 recipients of the Shearwater award, Dieter Jung, showed a colour installation with white light transmission holograms. Several examples of work by Brigitte Burgmer were also on show, as well as some familiar pieces by Mike Mielke. Work was not limited to the more familiar names, however, as several people who have recently become involved with the medium were included.

Perhaps the most encouraging aspect of the holograms was their lack of reliance on traditional and imitative presentation. Plates and film were off the wall, incorporated with other media, juxtaposed with traditional images and, perhaps most importantly, seen with the other overtly technical media which made up the exhibition. Holography is not the only medium to be regarded as a cheap gimmick without content, and it was timely to be reminded of that. An illustrated catalogue with details about all those participating in the exhibition is available from Neckarwerke, Bahnhofstrasse 16, 7012 Fellbach, West Germany.

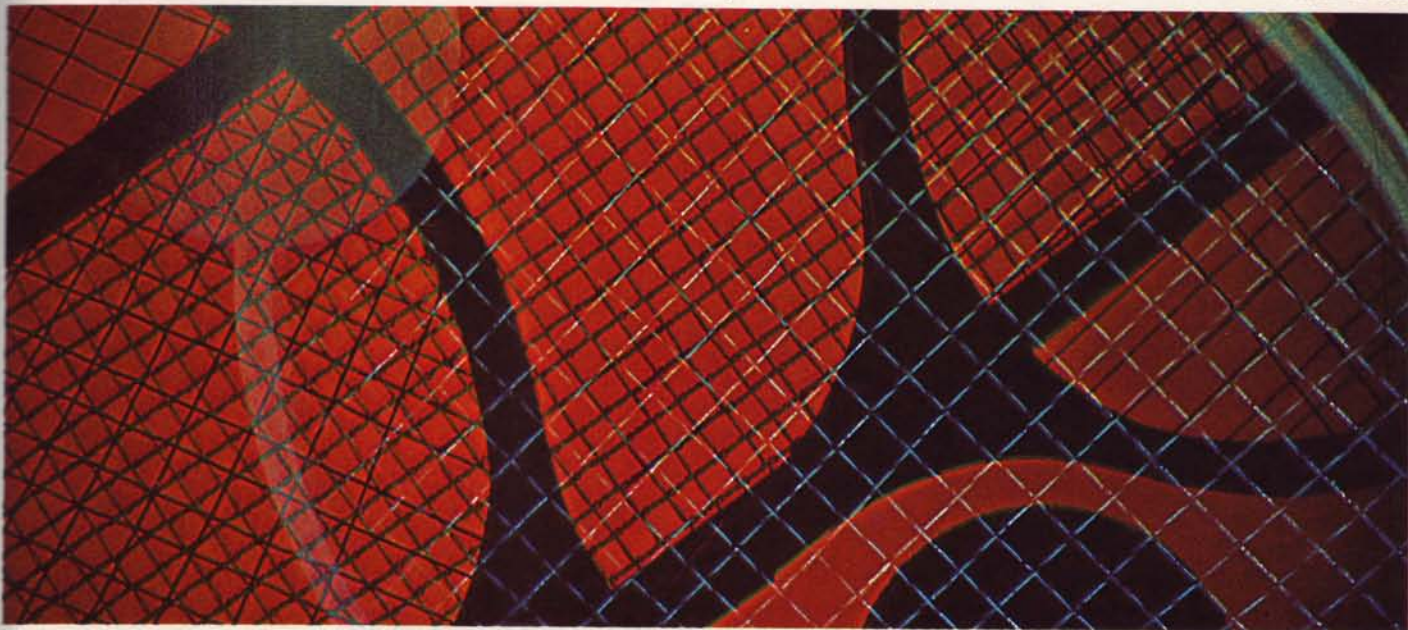
The other event of the 'weeks', *Holographica '88*, was held from 10th to 13th October in the voluminous halls of the Stuttgarter Messe, a trade exhibition complex close to Stuttgart City Centre, and was mounted in association with *Hobby und Elektronik '88*,

the biggest fair for electronics and hobby-related products in southern Germany. Well over 70 000 people attended the event and it is thought that many extra visitors were attracted by the holography exhibition.

It is an unusual concept to have a holography exhibition connected with one for hobbies and electronics, the danger being that the holograms would become "absorbed" by the other exhibits and be seen as a technique suitable for a casual hobby. *Holographica* was very carefully organised to have a presence and identity of its own, being housed in a separate and self-contained hall accessible directly from the main exhibition entrance, making it physically separate from the hobby items. The model trains and remote-controlled gadgets were far enough away so as not to be a distraction.

Organised by the Museum for Holography and New Visual Media based in Pulheim, near Cologne, with sponsorship from the Stuttgarter Messe and the KKB Bank, *Holographica* was promoted as the world's largest holography exhibition. Such claims can be taken lightly, since it is, after all, the quality of an exhibition which is of interest, rather than its size. The exhibition was, however, extremely large, covering a space of 2000 square metres and showing over 150 holograms. It is impressive that such an exhibition should be organised for such a short run, and that during those few days it was crowded, with an atmosphere in the hall similar to the excitement which accompanied some of the large holography exhibitions which took place in Sweden, America and Britain during the 1970s. Many new and rarely-seen pieces were on show in an exhibition which covered medical, measuring, security, advertising and art aspects of the medium.

The resources and extensive collection of the Museum were used for the selection of exhibits, with new pieces added specifically for this event. It is some reflection of the



Tennis by Carmenza Dominguez, one of the many pieces shown at *Holographica* in Stuttgart last year.

scope of the Museum's collection that they can include five examples of work by Rudie Berkhout, three by Doug Tyler and four by Sam Moree, plus individual pieces from others producing quality and innovative work. Probably the only other collection with such key samples of work in holography is the Museum of Holography in New York.

Although having an international flavour, with examples of work from America, Britain, Canada, China, Denmark, France and Germany, *Holographica* also included recent examples of commercial work from closer to home. The world's first postage stamps containing embossed holograms, which were released the previous month in Austria, were available for inspection, along with the impressive 1988 Zander Calendar, with a different embossed hologram and graphic presentation for each month of the year.

The now standard credit card embossed holograms, as well as the less often seen Australian bank notes (see *Holographics International* Spring 1988), were also included. From China came two wall lights, incorporating holographic diffraction gratings, which would have been very much at home in any local Chinese restaurant.

Promotional and advertising holography was also represented, the highlight being a display commissioned by the French company Aerospatiale. Made by AP Holographie, it contained three large-format white light transmission holograms mounted in an arc side by side. The centre hologram showed a representation of the control panel

of the proposed European space shuttle, with the left and right plates providing views out of the shuttle 'windows' to show a landing strip and space ship. The three holograms combined to produce an image area 3.72m wide, 1.12m high, with a depth of 3.5m. The well-designed display unit allowed each hologram to be illuminated perfectly, without distortions or overspill of light. Very often the final display of holograms is something of an afterthought, but this piece was obviously designed with this in mind.

During *Holographica*, a seminar evening called 'Holography - a new dimension for advertising', organised by the Museum in connection with the Association of German Advertisers, attracted an audience of over 500, which gives some indication of the interest in holography as a communication medium in Germany. Not only were several specific examples discussed and illustrated, with an assessment of reasons for using the medium, but a hologram was made in full view of the audience. Dr Peter Heiss from the University of Cologne talked the audience through the production of a single beam Denisyuk hologram, and by illuminating the optical layout with a green safelight he was able to make all of the stages visible. A video camera relayed the scene onto a giant screen so that the entire audience could see each stage. This included the film being positioned in front of the object, the exposure being made, the plate processed and, finally, the resulting, very bright, hologram being displayed.

During the seminar, Matthias Lauk,

founder and director of the Museum for Holography und New Visual Media, was presented with the 'Plateau Award'. Presented annually by the Centre for Applied Research in Art and Technology (CARAT) based in Gent, Belgium, it was awarded for his contribution to the popularisation of the medium of holography.

Holography also featured alongside the hobby and electronic suppliers in the main part of the *Hobby und Elektronik* exhibition. Two holography stands, almost opposite each other and selling similar products, were operated by Holographie Hofmann and Holographie Ulrich G Roth. Visitors could also choose from similar products on a stand in the *Holographica* hall upstairs.

If the events which took place during the 'weeks' can be taken as an indication of the interest in holography in Germany, then the commercial and visual markets seem buoyant. There are already well established shops, galleries and outlets in many parts of the country and it appears that more are about to open. After the success of *Holographica* there are already plans to make it an annual event. If so, it could become an important international showcase for new developments in all visual aspects of the process, and a chance to see new creative pieces from artists, designers, researchers and producers.

One of the main criticisms I have of this first *Holographica* was the lack of an exhibition catalogue, but the fact that the event took place on the scale that it did is more than encouraging.

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Exhibition Troubleshooting

by Melissa Crenshaw

As Artistic Director of the Third International Exhibition of Holography held in conjunction with the Symposium at Lake Forest College in July last year, Melissa Crenshaw was responsible for organising the exhibition jury, designing the layout of the exhibition, and installing the art works. In retrospect, once the art works were returned to the many holographers who graciously loaned them for the exhibition, she has thought of a number of ways that the exhibition could have been improved. In this article she describes a few of the details involved in such an undertaking in the hope that this information might benefit individuals or organisations whose responsibility it is to organise similar exhibitions in the future.

The hologram selection for Lake Forest was done by the exhibition jury from a slide competition. When organising such a competition, time is of the essence. Information regarding jury deadline for a future exhibition should be published in various journals early enough so that everyone has a chance to hear about it. Specific job duties need to be decided upon early so that it is clear whose responsibility it is to co-ordinate public announcements.

Unfortunately, duties for the Lake Forest

Exhibition were not outlined until March, two months before the jury date, due to a late staffing change. At that time I became the Director, with the responsibility of getting the information out to the public.

Why was there no holography directory when I needed one? Neither was there a comprehensive list of artists working in holography. As it was too late to change this situation, letters were sent out to many key people, such as directors of labs and holography instructors, and to holography gal-

leries and organisations. In some cases this worked very well, as evidenced by the great response from the students at MIT and the Art Institute of Chicago. In other cases the information did not get so well dispersed.

In order to accommodate a number of slides which arrived up to 10 days after the jury met, a second jury was held. Even so, there were still a number of artists who didn't receive the slide submission forms in time.

Once a directory is published, or lists such as the one from this exhibition are available, more artists can receive information in time to submit slides to an exhibition jury.

The jury was selected by Dr Tung Jeong. It included Doris Vila, Ed Wesly, Dr Michael Croydon, and myself, with Dr Jeong on hand as a tie-breaker. The slides were judged anonymously, and artists' names were not discussed.

There is always some criticism about having a jury that is made up of holographers in-



Installation view: Sydney Dinsmore looking at hologram entitled *On Moving/Moving On*, by Fred Unterseher, 1988. Photo by Melissa Crenshaw.



Installation view: transmission holograms. Photo by Melissa Crenshaw.

stead of professionals from the art community outside holography. If it had been possible to view the works first hand, a jury of outsiders would have made more sense. However, when dealing with slides, I feel that artists and teachers in holography still have a better idea of what they are looking at than someone without experience in the field. Nor am I sure that an artist's statement describing the kinetic effects of pseudoscopic swing would make a lot of sense to someone unfamiliar with this art-form.

I would also like to mention that Dr Jeong made a decision to carry on the tradition at Lake Forest of inviting the members of the jury to show holograms of their own during the exhibition. These invited art works by jury members were not judged in the slide competition.

The Slides

The most efficient way to select pieces for an exhibition is to actually see them. Slides rarely do justice to three-dimensional works and this can be a particular problem with holograms.

Abstract works and holograms derived from diffraction gratings are often at a disadvantage to representational images. Keeping this in mind, an artist's statement was requested to accompany each work submitted to the jury. In some cases this was helpful in understanding the intention of the artist.

This year we had a number of mixed-media art works, and statements helped clarify the intent of the total installation. They also made it possible to adhere to the restriction of considering only artistic works for this exhibition, eliminating a few documentary and commercial works.

One major problem facing the slide jury was that the quality of the holograms was often masked by the artist's inability to effectively record the hologram in photographic format.

It is standard practice in the field of art to submit slides of your work for consideration for exhibitions, as well as for grant applications. This visual support material is often all

the artist has to represent their best image.

A mixture of well-recorded slides of acceptable holograms and poor quality slides of fantastic holograms results in a few gems being overlooked because the slides are so hopeless that it's impossible to get much idea of what the hologram really looks like.

A number of holograms were rejected because of this problem. Even with the advantage of the artist's statement, it was assumed that artists had sent the best representation of their work. Judging was based on this premise.

It has often been suggested that holographers should submit videos of their work to an exhibition jury. This is probably the best method available for such a purpose. The problem with video is that it is less accessible to artists than is making slides. Holographers have enough trouble surviving financially as it is. Having to own video equipment or pay a professional to record your work would only widen the gap that exists between the "haves" and the "have-nots" trying to make it in this expensive art-form.

Exhibition Space Preparation

Although my floor plan and construction re-

quirements were submitted to the College three weeks before I arrived, it wasn't until after one whole wall was constructed and in place that someone decided it was against fire regulations. The wall then had to be cut into sections to meet the regulations. Luckily this was realised before the opening night.

Don't assume anything. These things are ultimately the responsibility of the exhibition director. Be sure to check these things out yourself well in advance.

There were two galleries for the exhibition, one for reflection and one for transmission holograms. It was evident once I arrived on site that the reflection room gallery needed to be completely repainted. It is unreasonable to expect art work to hang in a room where the walls are full of nail holes. So, you just have to get on with it despite the loss of your days off. It's easy to say: "That's not my job", but the final responsibility to do things professionally rests with the exhibition staff.

Installation

Shipping, insurance, and customs clearance for the holograms were all handled by Virginia Crist. This was no easy task, especially considering that she was also solely responsible for all of the correspondence and housing arrangements for the entire symposium. Her familiarity with the procedures from the 1985 exhibition kept the shipping and receiving problems down to a minimum.

All incoming holograms arrived at the Science Building and were checked by Mrs Crist and Ed Wesly. Ed checked the holograms for damage and a condition report was issued for each one. The condition reports were checked at the end of the exhibition when the display was dismantled.

Practically all of the holograms arrived ready to install. We were fortunate because only two holograms required some additional minor support to the framing system to assure they would hang safely during the exhibition. Unfortunately we did have two additional holograms which were sent with frames unsafe for hanging.

Difficult decisions had to be made during



Installation view, holograms from left to right: *Luminescence*, Marie Andrée Cossette, 1988; *Premonition/Aftermath*, 1987 and *Promise City*, 1988, Nancy Gorglione; *Light Modulator*, 1988, William Padnos. Photo by Melissa Crenshaw.

installation. On the one hand the artist is taking a personal risk, wall space has been dedicated in the floor plan for the work and there is an obligation to hang what was accepted by the jury. However, on the other hand, there is the overriding concern for adequate (meaning protected) display of the art work. If the frame or support structure isn't safe, then it must wait until time permits to build something that is. Unfortunately these two works were not remounted in time for the opening. That's the chance artists take when sending out work that is not exhibition-ready.

The total time for the installation on site took 15 days. These days were 12-18 hours long and there were no days off. The work was carried out by two full-time installations people, Alan Tate and myself, two full-time assistants and a large number of volunteers towards the end.

People affectionately referred to as "go-fers" are absolutely essential to the success of any exhibition. Alec and Aleshia Jeong were incredible in their enthusiastic dedication to this somewhat thankless job. They did everything from painting walls to fetching coffee. After the opening night, Alec and Aleshia, along with Ed Wesly, were on hand while the exhibition was open to answer visitors' question, meet the press and keep a close eye on the art works.

Dr Jeong allowed us an open budget during the installation, which is essential as a million little items are needed to complete the

installation successfully. If we'd had to go through lengthy channels for every item required on site we wouldn't have finished on time. It is simply not possible to pre-plan for every nut and bolt that will be needed. This kind of petty cash flexibility is necessary for getting an exhibition ready for opening night.

Most important to the success of this exhibition was the assistance of Alan Tate, who is one of the top lighting people in the field. He has a wealth of experience from his days installing shows at Interference Gallery in Toronto and from working on the various sites for the Canadian *Images in Time and Space* exhibition. An "Alan Tate" is absolutely essential! He does wiring, can get a light in the most precarious position, and is a delight to work with. If there had been no Alan Tate, there would have been no opening night.

Much of what we do in the field is volunteer work. It is the eleventh hour volunteer staff that can make the difference between success and failure. Sydney Dinsmore, another holographer with vast exhibition experience, arrived a week before the opening as a volunteer to pitch in and assist in the final lighting and fine tuning. Much of the fine tuning, cleaning, mounting signs, lighting baffles, and all the other last minute details essential to the final look of the exhibition would not have been finished in time without Syd's diligent assistance.

Holographers have a tendency towards ca-

maraderie which has kept this field going during its uncertain history. On the Saturday and Sunday nights before the opening many people came in to help with the final touches. Without being asked they just knew to come in and see if there was anything they could do. Most of the artists had been through similar experiences installing their own work. The exhibition was a great hive of activity and co-operation the weekend before the opening.

I would like to mention two artists whose work was accepted for the exhibition but was unfortunately not displayed. Paul Newman's acceptance letter was lost in the international mail on its way to the UK, and so his work entitled *Siva's Dance* was not sent in to the exhibition. Betsy Connors' *Spaceship, 1988* was damaged before she had a chance to ship it to us. Fortunately both artists were at least represented in the catalogue.

All in all, I am proud of the art works the artists allowed us to show at Lake Forest. These works were not purchased for the exhibition and no loan fees were paid. Hopefully, in the future, with the support of the commercial holography community, loan fees or honorariums will become the standard for such important international exhibitions. As for now I can only offer my thanks to the artists working in holography for their support of the Third International Exhibition and to Dr Jeong and others at Lake Forest College for their continued support of the arts.

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Introducing: The Slab

A vibration isolation system, known as "the slab" and believed to be the largest of its kind in the world, is at the centre of a new holography facility in Toronto, Canada. The 3000 sq ft lab, set up by Light Construction Inc, opened in November last year.

The custom-made slab provides a stable surface for large format holography. Designed by Adcon Engineering and Light Construction, the 5.5x10m table consists of post-tensioned concrete weighing 38 200kg, reinforced with more than a kilometre of steel and suspended on air cushions. Both argon and krypton ion lasers are used to produce holograms of up to 1.0x1.5m with a depth of more than 3m.

The table was developed under a grant from the National Research Council. Holographers working at the new facility include Michael Page, who runs holography courses at the Ontario College of Art, Al Letts, Alan Tate, Claudette Abrams and Stuart Rosenberg.

One of the first holograms produced on the slab was of the largest nugget of gold ever found, commissioned by the Canadian government. Another commission was from the Canadian Imperial Bank of Commerce for a metre square transmission hologram of a backlit globe to be shown at a conference on international currency exchange.

Light construction is promoting the new facility for the holographic recording of cultural artifacts (historical, artistic, scientific

and educational) using a variety of techniques for origination and duplication. The company will also produce holographic images of the artifacts for distribution through national and provincial museums, science centres, public art galleries and the educational system.

Among the benefits of using holograms to replace valuable artifacts in exhibitions, Light Construction believes, is the increased access to cultural heritage it allows, by lowering costs of shipping, insurance and display. Also

it allows the for the display of objects which are too valuable or fragile to put on public exhibition.

The company says it hopes to expose the public and curators to the potential of holographic imaging as a tool for visualising three dimensional subjects, thereby sensitising the market and stimulating a demand for holographic services and products.

Light Construction is at 2154 Dundas St West, Toronto, Ontario, Canada M6R 1X3. Tel: (+1) 416 533 4692.



The Canadian Imperial Bank of Credit and Commerce commissioned this hologram of the "Western World" and its money.

Integrating Pulse with Other Holographic Work (Part II)

by Fred Unterseher

Fred Unterseher continues his two-part article on the pulse holography project undertaken at Holocom GmbH.

Reduced Image Transfers

In addition to the considerations of frequency changes and beam contouring, we

varied the following parameters when mastering and transferring holograms.

Mastering:

- 1. Distance between the object/subject and the H1 master.
- 2. Focal length of lens positioned between the object/subject and the H1

master.

Transferring:

- 1. Focal length of lens positioned before H1 (re: rainbows).
- 2. Focal length of lens positioned between H1 and H2 (re: reflection and achromat).
- 3. Focal length of lens between a master containing a reduced image (reduced image master: RIM) and the H2 transfer (reduced image transfer: RIT).

We found that combinations of the above techniques lead to our best results for reductions.

The following includes different set-ups and techniques for reducing the image in the transfer hologram. The first and most simple is for a rainbow succeeded by reflection plus achromat transmission and a RIM.

Rainbow Reduction Holograms

The rainbow reduction transfers were based on four factors:

- 1. Recording frequency.
- 2. Distance - object/subject to H1 in the master recording.
- 3. Type of lens, HOE or RIM used, plus the focal length value.
- 4. Distance between lens etc. and H1 in the transfer recording.

Slit width is an optional consideration, the sizes we used varied from 3mm to 3cm.

We found the following method to be the most simple to use. It was particularly effective with a RIM when recording for embossed holography at wavelength 457.8nm.

RIT and RIM Holograms

- 1. RIT: Reduced Image Transfer

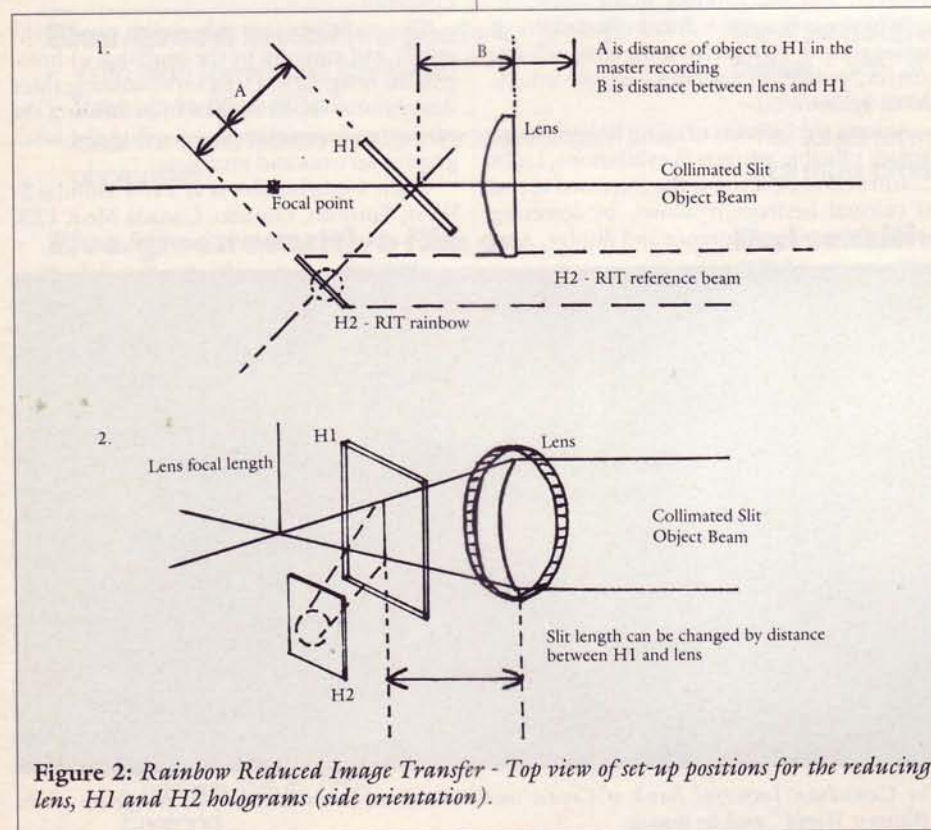


Figure 2: Rainbow Reduced Image Transfer - Top view of set-up positions for the reducing lens, H1 and H2 holograms (side orientation).

- 2. RIM: Reduced Image Master
- 3. RIT from RIM: Reduced Image Transfer from Reduced Image Master.

It is necessary at this point to make some distinctions between the above terms. A RIT is ordinarily a transfer hologram with a reduced image produced directly from an H1 pulse master with reduction optics in the transfer set-up. Since a RIM is essentially a RIT, the primary difference between them is determined by the intended use of the hologram. A RIT is usually considered a finished product for display, where a rim serves a similar function to that of a conventional H1 master used primarily for making transfers. A RIT from a RIM normally implies an involvement with a mass production process.

We produced RIM Holograms in 20x25cm and 20x30cm formats. We found that they were useful in three ways:

- 1. Reduction optics are not necessary in a transfer set-up when a RIM is used as the H1 master. An example of a RIT from RIM is a silver RIM to a transfer in photoresist for embossed holography.
- 2. The RIM can be easily shipped to other locations or companies for production

purposes.

- 3. A RIM can be used to further reduce a reduced image.

Reflection and Achromat Transmission Reduction Holograms

The reflection and achromat reduction transfers were based on three factors:

- 1. Recording frequency.
- 2. Distance - object/subject to H1 in the master recording.
- 3. Type of lens, HOE or RIM used, plus the focal length value.

The major consideration for these holograms is the distance from the object/subject to H1 in the master recording.

The essential difference between these two holograms, as is generally acknowledged, is the side of the transfer hologram that the reference beam strikes.

An achromat transmission being in this case an open aperture image plane hologram. Although depth in this hologram is very limited, it is sufficient for use in embossed holography.

Apart from the reference beam orientation, the hologram set-ups are similar in that the reduction lens is placed between H1 and H2 for both recording arrangements. (See figure 3, numbers 1 and 3).

General Guidelines for Reduction Holograms

The suggestions below may be helpful when recording reduction holograms.

- 1. We found it important, or at least useful, to work with collimated beams for recording and reconstructing the H1 holograms.
- 2. Because reduced images tend to concentrate the light, it is sometimes necessary to use high ratios, from 8:1 to 20:1, to minimise the effects of "burn in", particularly for reflection transfer holograms.
- 3. A holographic processing chemistry that yields a low noise hologram is beneficial, especially when producing a RIM or recording from one, in order to avoid an accumulation of noise in the final hologram.

Practical Reference Charts

All of the charts (figs. 4 and 5) are based on master H1 holograms recorded with a pulse ruby laser (wavelength 694.3nm). The charts' measurements are derived from the playing back of the H1 holograms where the actual object holographed was a black and white cube measuring 9.5x9.5x9.5cm. All reference and reconstruction beams were collimated and the recording material used was Agfa Gevaert Holotest 8E75HD NAH.

The charts are to be used as a reference intended for practical use when producing reduction holograms. In addition, they are to be used in combination with each other. They are built around the interrelationships of the following factors:

- 1. Distance from object to H1 - recording distances used were 30cm, 60cm, 90cm and 120cm.

- 2. CW Laser Frequencies - reconstruction frequencies used were:

Argon wavelength 457.8nm - re: photoresist and DCG;

Argon wavelength 488.0nm - re: DCG;

HeNe wavelength 632.8nm - re: silver (close to krypton).

- 3. Reducing lenses - plano-convex condensing lenses:

One with 30cm diameter, 72cm focal length, f number 2.4;

Two with 50cm diameter, 120cm combined focal length, f number 2.4.

The measurements have been gathered from actual holograms. That is to say the issues of emulsion shrinkage etc. have been automatically included.

Note that it is interesting to observe the opposition of frequency change to the effects of the lenses.

Object Size Reduction Charts

These two charts (figure 4) are used as a reference to determine an image size reduction based on the distance of the object to H1, and how that relationship is additionally affected by frequency and the lenses used. No noticeable change of the reconstructed object's size was observed simply by changing frequencies. However, the addition of the lenses produced marked differences.

Our calculations are based on the use of relatively inexpensive plano-convex condensing lenses.

- Chart A lens:
30cm diameter, focal length 72cm, f number 2.4;
Rate of reduction (re: chart) - from 17% to 59% of actual size.
- Chart B lenses:
Two with 50cm diameter, combined focal length 120cm, f number 2.4;
Rate of reduction (re: chart) - from 28% to 68% of actual size.

Size changes are based on measurements of the front of the image-planed image of the recorded cube.

Reconstruction Distance Chart

This chart (figure 5) can be used as a reference to determine the distance at which the holographic image reconstructs from the H1 hologram. It is most practical to use when planning transfer set-ups.

The H1 holograms were exposed with wavelength 694.3nm at the following distances from the object: 30cm, 60cm, 90cm and 120cm. The chart compares the relationship of each H1 hologram to the image plane reconstruction at one to one and with the reducing lenses (30cm diameter, f number 2.4 and 50cm diameter, f number 2.4), coupled with the effects of frequency changes with argon at wavelengths 488.0nm and 457.8nm, plus HeNe with wavelength 632.8nm.

Mass Production

The overall aim of the project was to explore various possibilities for integrating pulse holography with other holographic techniques,

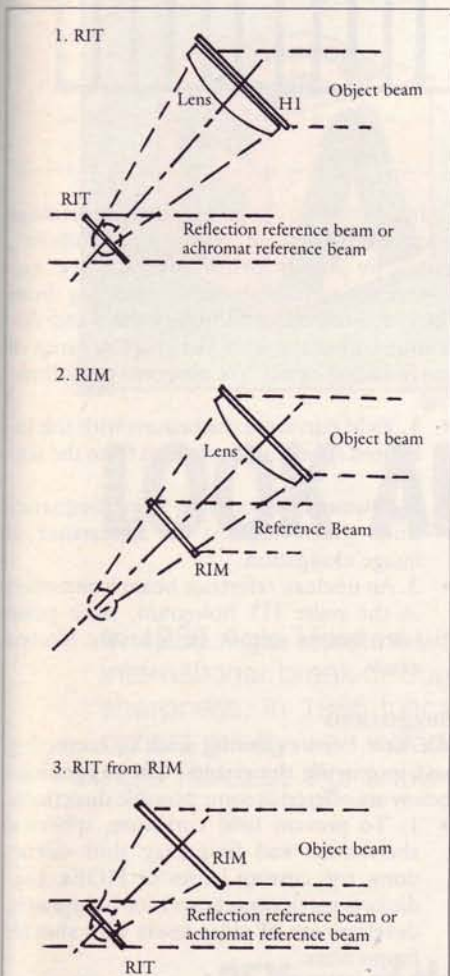


Figure 3: RIM and reflection plus achromat transmission RIT holograms-top view of set-up positions for the reducing lens, H1 and H2 holograms.

allowing the pulse camera to function as a multipurpose mastering system for H1 holograms applicable for mass production holography.

One of the key issues for commercial application was that most mass produced holograms tend to be restricted to shallow depth and small formats, making reduced imagery an attractive option.

To date, the major types of holograms considered for mass production include:

- 1. Embossed holograms.
- 2. DCG and photopolymer holograms.
- 3. Silver holograms (re: film photocopies).

Generally these holograms require different recording techniques and materials exposed with different CW laser frequencies.

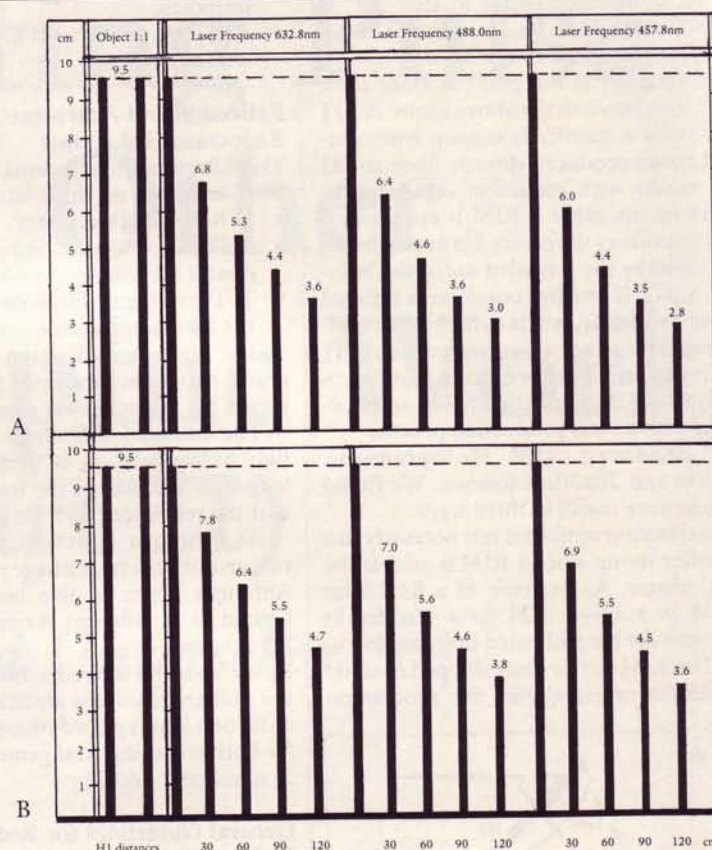
Even though there are inherent problems with using pulse holography in combination with techniques typically used for mass production, our results have received a positive response from clients as well as the general public. Although we are aware that problems exist, this first phase of work certainly seems to warrant further development.

Thus far we have produced pulse holograms that have been integrated with the following types of holograms used for mass production:

- 1. Embossed holograms - RIMs and 1:1 for photoresist/embossed.
Results - 1:1 and reduced image embossed holograms as rainbows and achromats, standard size formats.
- 2. DCG holograms - RIM for DCG transfer.
Results - DCG RIT, 4x5 inches.
- 3. Silver halide Holograms - RIM for reflection sub-master.
Results - reflection film photocopies, 4x5 inches.

Figure 4:

Object size reduction charts.



Problems

Although we found our results acceptable, we found numerous problems as well. These are far beyond the scope of this paper, however we will identify some of the ones we noticed and suggest possible ways to address them.

In addition to the usual problems of image plane holography, ie. vignetting, "burn in", etc., the major problems that we encountered were distortions resulting from the combination of frequency shifts and distortions inherited from the characteristics of the reducing optics. We observed the following:

- 1. Field curvature distortions with the inherited spherical aberrations from the lenses.
- 2. Distortions resulting from frequency shifts which manifest the appearance of image elongation.
- 3. An unclear reference beam is recorded in the pulse H1 hologram, since pulse laser beams cannot be spatially filtered easily.

Suggestions

We have been exploring ways of correcting and improving the results. The suggestions below are offered as some possible directions:

- 1. To prevent field curvature, spherical aberrations and frequency shift distortions, try: custom lenses or HOEs; pre-distortions of objects and/or holograms; development of pulse lasers with shorter frequencies.
- 2. To prevent the flattening effect, try using specific visual cues in the image composition (eg. overlapping, forced perspective).
- 3. To prevent problems caused by a non-spatially filtered reference beam, try improved high energy optical equipment.

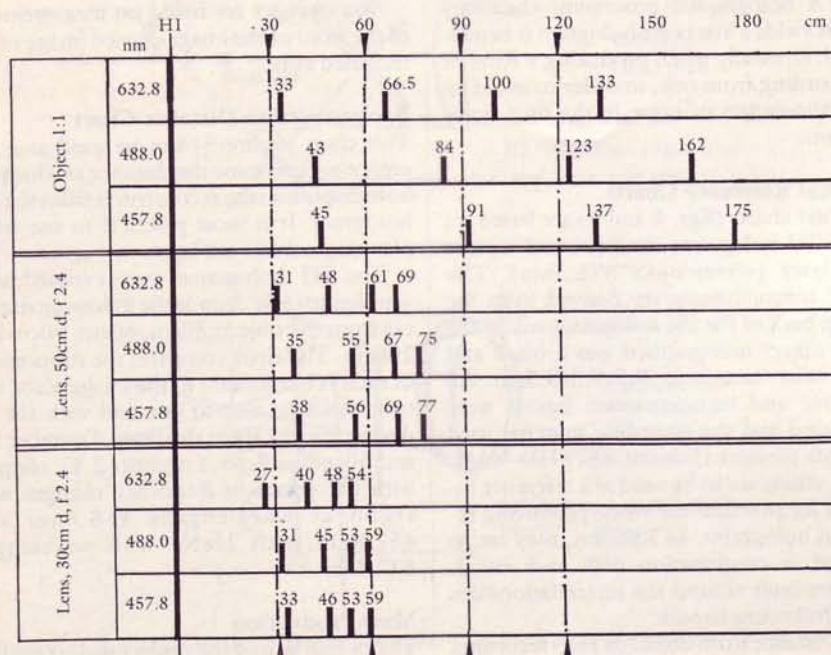
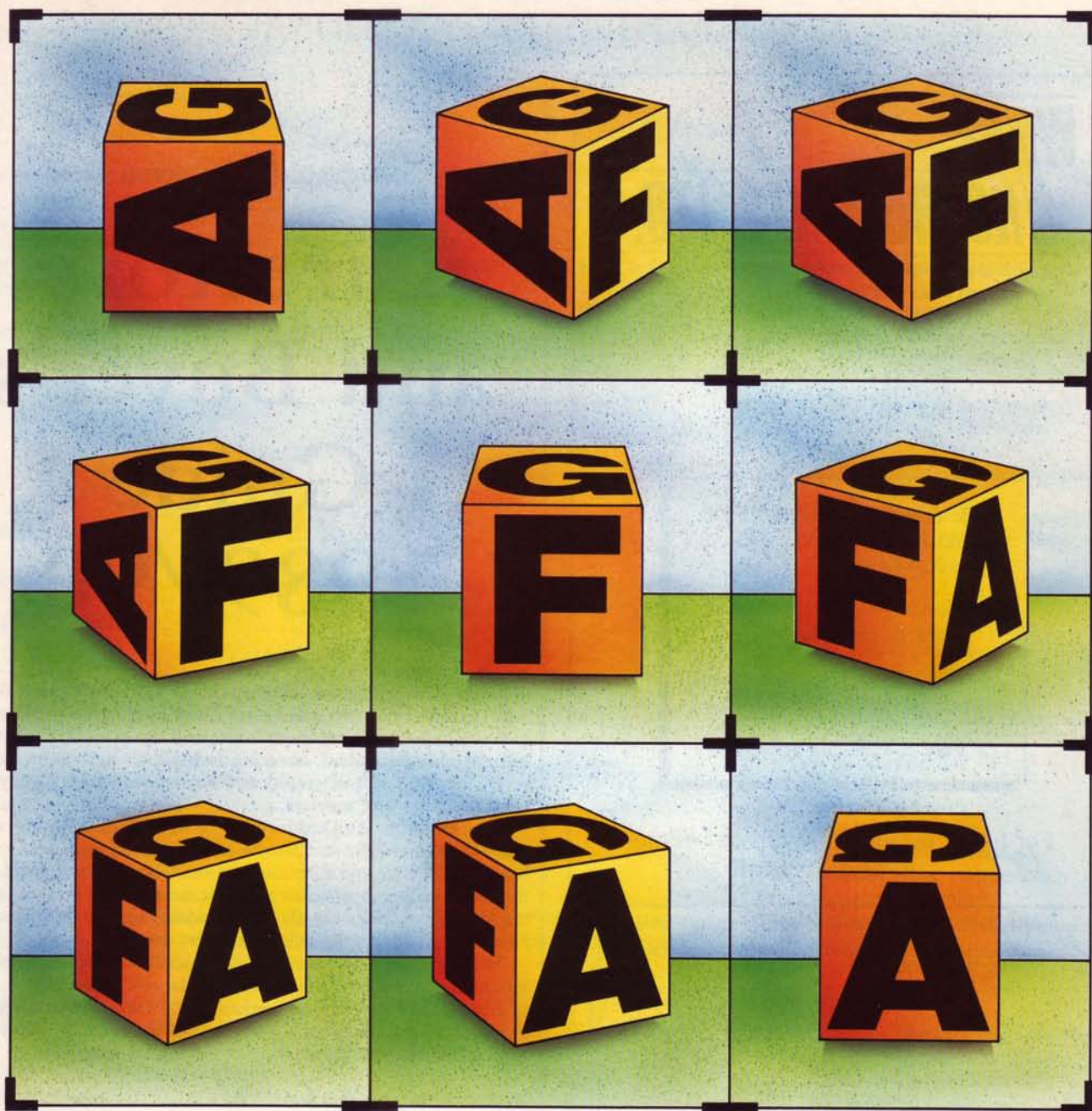


Figure 5: Reconstruction distance chart.



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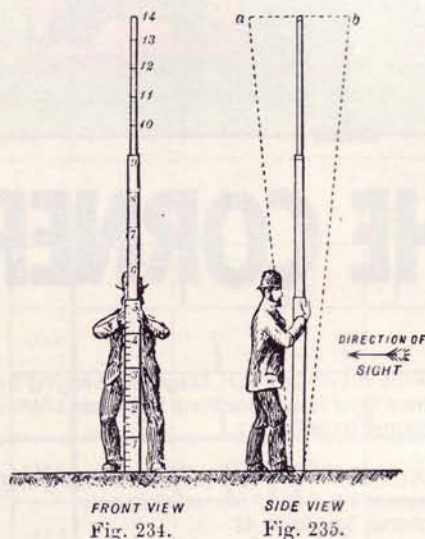
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Holographics International Directory and Buyer's Guide 1989/90

The Holographics International Directory and Buyers Guide 1989/90 will be published this autumn. We aim to make this the most comprehensive and up-to-date guide to the industry yet published, covering individuals and companies directly involved in holography and companies which supply them with products and services.

Basic entries in the Directory will be free of charge. These will include the name of the company or individual, address, contact names (companies only), and telephone, fax and telex numbers. In addition, there will be a comprehensive classification scheme so that users of the Directory can see exactly what products and services you are offering. This will be fully indexed for easy use.

The Directory will be sent to all subscribers to Holographics International, at no extra cost. It will also be sold separately, at a price of £10/US\$20. We will be marketing the Directory by direct mail throughout the holographic industry and to other relevant individuals and companies. It will also be available for retail sale.

Business area classifications:

Indicate your business areas by marking the list opposite. The items selected will be listed after your entry, and you will also be indexed under each one.

Please indicate those areas which best describe your business and in which you have a real interest. If a major area of your business is not adequately covered by an existing category, please indicate in the space provided and we will consider adding an extra category.

Extended/highlighted entries:

You may add to the information contained in your free listing by booking an extended entry. Additions may consist of lines of text giving further details about your business, and/or your company logo to highlight the entry.

The charge for additional text will be £25/US\$50 for up to five lines (approximately 40 words), with extra lines costing £5/\$10. Company logos will cost £40/\$80 (size up to 2 column cm).

In-column advertising:

You may include a column-width (60mm) boxed advertisement immediately below your free entry. Such adverts will be listed in the index to advertisers.

The minimum size available is 5 column centimetres, for which the charge will be £75/\$150. Additional column centimetres will cost £15/\$30.

To obtain your free entry in the HI Directory, complete a copy of this form and return it to Holographics International, BCM-Holographics, London WC1N 3XX, to arrive by 31st May 1989 at the latest.

Name of company or individual to be listed:

Individuals will be listed alphabetically by surname, companies by first letter of name as written (excluding any initial "The", etc). If there is likely to be any doubt, please indicate correct alphabetical listing.

Business address:

(Please include postal code)

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Contact names (companies only):

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You may list up to two company employees and their job titles. Their names will also appear in an alphabetical listing. You may if you wish list more than two employees by taking an extended entry (see opposite).

List of classifications:

Please tick appropriate classifications.

1. Mass producers of holograms

- 1.1 Embossing
- 1.2 Silver halide
- 1.3 Dichromate
- 1.4 Photo-polymer
- 1.5 Transfer to photoresist

2. Origination for mass production

- 2.1 Stereograms/integral
- 2.2 Continuous wave
- 2.3 Pulsed
- 2.4 Pseudo-colour
- 2.5 Stock images

3. One-offs and limited editions

- 3.1 Stereograms/integral
- 3.2 Continuous wave
- 3.3 Pulsed
- 3.4 Pseudo-colour
- 3.5 Natural colour
- 3.6 Portrait service
- 3.7 Animated holograms

4. Holographic fine artists

5. Galleries, museums, retailers

- 5.1 Commercial galleries (all or most holograms on sale)
- 5.2 Galleries of holographic art with changing exhibitions
- 5.3 Permanent or semi-permanent exhibitions
- 5.4 Museums of holography (curating)
- 5.5 Private galleries (not open to general public)
- 5.6 Retail outlets for holograms and holographic items
- 5.7 Museums and art galleries which often show holograms
- 5.8 Scientific exhibitions of holography

6. Commercial applications of display holography

- 6.1 Security holograms
- 6.2 Business promotional products
- 6.3 Holographic novelties (jewellery, cards, badges, etc.)

7. Industrial applications of display holography

- 7.1 Non-destructive testing

7.2 Computer-aided design

7.3 Holographic optical elements

7.4 Head-up displays

8. Manufacturers of holographic equipment and materials

8.1 Lasers

8.2 Optical equipment (general)

8.3 Photo-materials (general)

9. Distributors of holography equipment and materials

9.1 Lasers

9.2 Mirrors, lenses, and bench equipment

9.3 Fringe lockers

9.4 Isolation tables

9.5 Etalons

9.6 Holographic kits

9.7 NDT kits

9.8 Lighting

9.9 Chemicals, film and plates

9.10 Speciality chemicals

9.11 Laminating materials

10. Academic/scientific holography research

10.1 Scientific research

10.2 Medical research

10.3 Industrial research

11. Holographic education

11.1 Art schools and colleges offering holography courses

11.2 Colleges offering technical/industrial training

11.3 Speciality holography colleges or courses

11.4 Tutors

11.5 Providers of educational materials

12. Other holographic services

12.1 Consultants

12.2 Marketing and distribution

12.3 Wholesalers

12.4 Hot stamping of holograms

12.5 Rental of holography studios

12.6 Rental of holographic equipment

12.7 Model makers

12.8 Holography agencies

13. Publications on holography

13.1 Newsletters

13.2 Magazines

13.3 Other publications

14. Other organisations involved in holography

14.1 Holography societies and associations

14.2 Other organisations

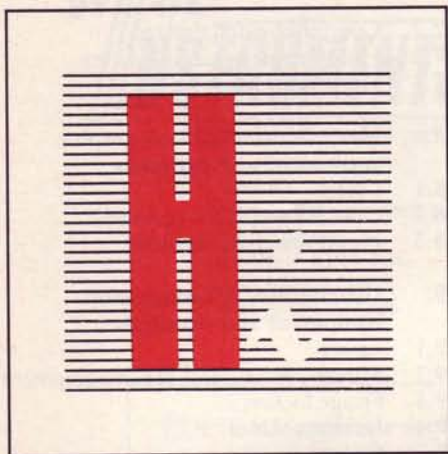
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If part of your business is not adequately covered by the classifications above, please suggest additional categories:

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If you would like to receive details of display advertisement charges, please tick box. ☐



Sending News

If you wish to send information for publication in the next issue, please make sure it arrives by April 15th at the latest. Please send photographs as well, if you have any. They should be either black and white prints or positive colour slides. If possible, send both. We are especially interested in hearing from galleries about special or changing exhibitions, from those conducting research into display or industrially applied holography, and from artists, but we also welcome information on new products etc. All copy and photographs should be sent to the address given on page 3. Those who wish to send material by courier (Federal Express, DHL, etc) should phone beforehand.

Back Copies

Holographics International has back copies of all issues available for sale. They can be obtained at a cost of £5 or US\$8 each including postage. Ordering and payment details are as for subscriptions: see adjacent form.

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We hope you have found this issue of *Holographics International* informative and interesting.

In future issues we will continue to cover artistic, scientific and commercial uses of holography and to look at the people and companies who are researching into, marketing and making holograms. Each issue will feature technical articles, news of the latest developments in the world of holography and independent reviews.

Our subscription price is £15 or US\$25 for four quarterly issues and a copy of the *Holographics International Directory and Buyer's Guide*, which will be published this year. The directory will be sold separately at £10 or US\$20.

We plan to make our directory the most comprehensive guide yet to the people and companies involved in all aspects of holography. It will be fully classified to allow holographers, or those interested in doing business with holographers, to find each other easily. Details of how to make sure of your free listing are on the previous page.

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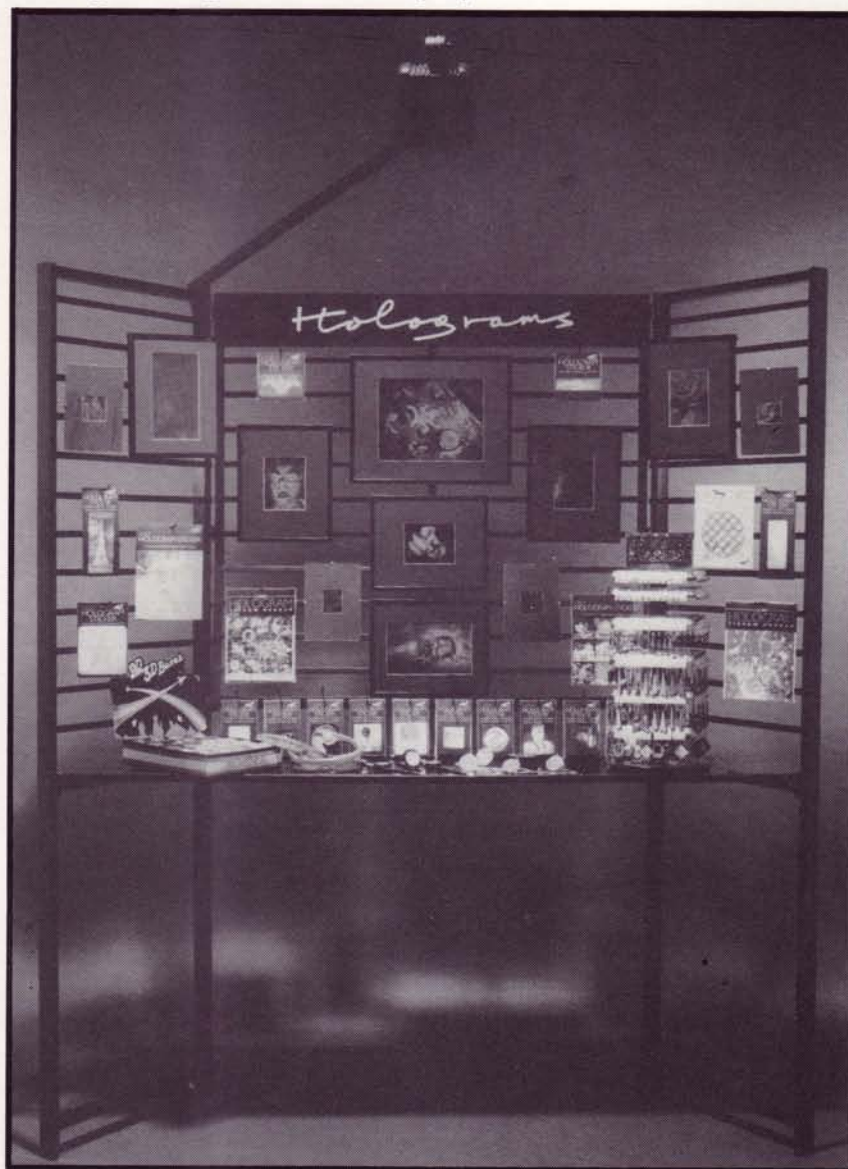
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