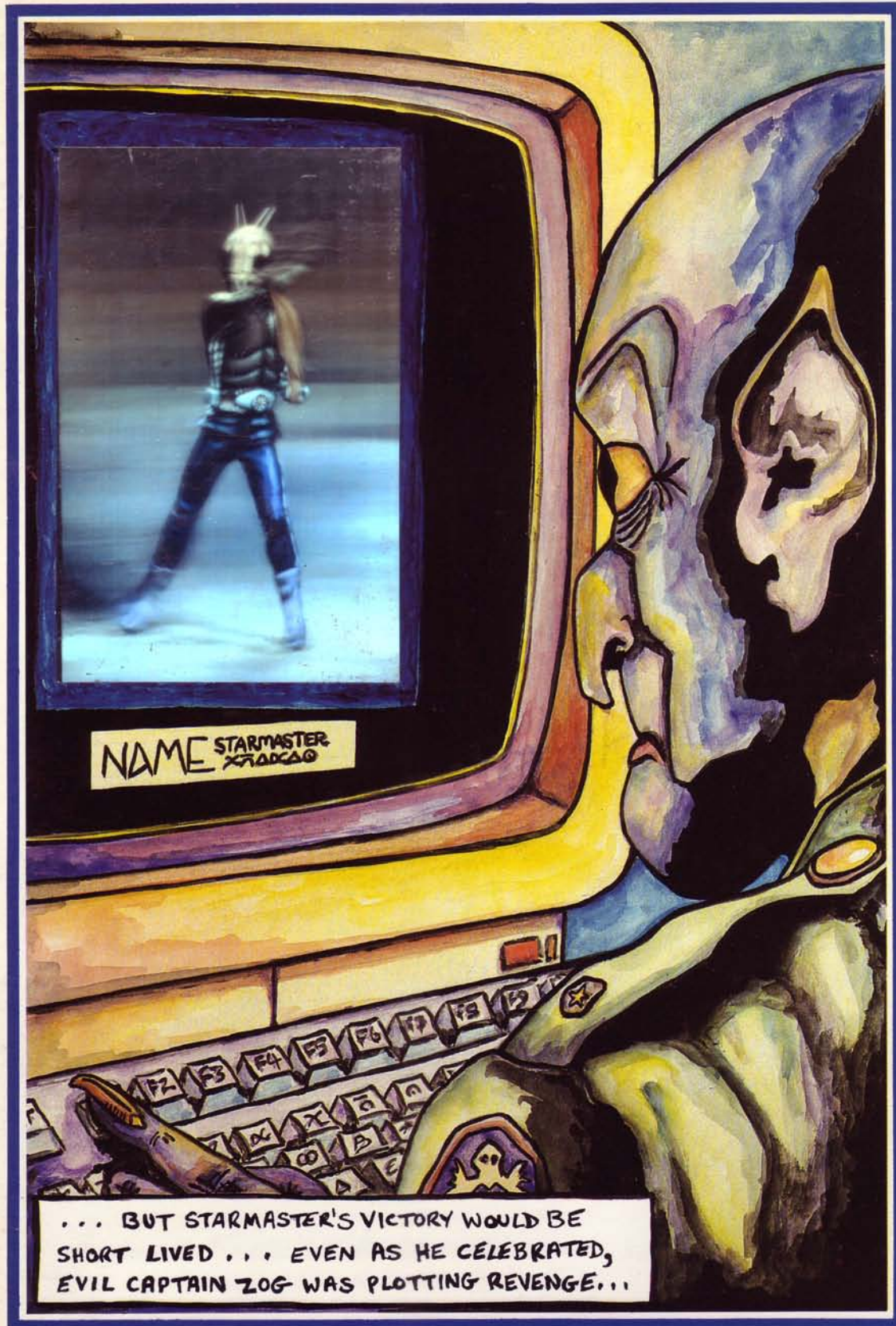


HOLOGRAPHICS

INTERNATIONAL



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Summer 1990

Number 8

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Summer 1990

Number 8

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HOLOGRAPHICS INTERNATIONALS



Making a hologram of a puff of smoke. See page 14.



Choice/What Choice? by Crenshaw and Dinsmore. See page 16

Cover: Hologram courtesy of Applied Holographics Plc, 50 Woolmer Trading Estate, Bordon, Hampshire GU35 9QF, UK. Tel: +44 4203 87271. Cover illustration by Judith Hackney.

5 Editorial and Letters

View on patent litigation/Britain vs England
Blyth amends DCG recipe

6 News

Patent battle judgement/Model tarantula has pulse portrait taken/MoH gets new curator/Third Dimension's C3D viewer/Holographix laser scanner/New Lanark's ghostly guide

14 People

Kac and Bjelkagen: *Omen*/Hubel gets full-colour from Ilford

15 Calendar

16 Review

Dinsmore and Crenshaw *Heidi von der Gathen*

17 Courses

18 Art

The work of Steve Weinstock *Mark Cottle*

20 Lab Notes

Fringe-locking: why, when and how *Rich Rallsion*

23 Science & Technology

Holo-Video system from MIT/Using holography to beat earthquakes/Night vision goggles/Chrono-Coherent Imaging for Medicine/Full-parallax holographic printer

31 Products

Full-colour laser/Linear positioner/Du Pont photopolymer

32 Patents

Listing of recent applications
Why you should be interested *David Pizzanelli*

34 Subscriptions/Advertising Index/Back Copies

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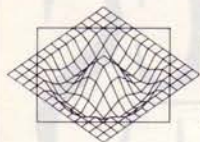
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Editorial

Litigation and Security

There has been a great deal of criticism of the use of litigation by ABN Holographics to prevent other companies from allegedly infringing its patents (see page 6). To a certain extent I agree with this criticism: I agree that the litigation will probably do the US holographic industry considerable damage; it will benefit producers in other countries who will be in a strong position to enter the US market as soon as the various patents involved expire.

However, ABN Holographics is, as far as I can see, simply using the patent and legal systems to its best advantage. Whether or not its claims are right or wrong (legally or morally), it will have gotten a certain amount of mileage out of it all and it is its right to try this for the sake of its shareholders: that's what business is about. Those who are affected by ABNH's tactics have the choice to fight them in the courts. If some companies don't have sufficient resources to do this it is not ABNH's fault, but the fault of the US legal system. Though I sympathise and am personally unhappy about what all this may do to the industry, I cannot condemn ABNH for its actions.

Equally damaging to the industry in my view are holographers who declare that holograms are easy to copy and are no use as security devices. I agree that those working in security should not be complacent and should always be looking at new ways of making holograms more secure, but that does not mean that holograms are insecure. Everything is relative, and the hologram is relatively quite good. Many supposedly secure documents (the US passport for one) would be significantly more secure if they used holograms. There are other even more secure techniques, but they are not always affordable or even appropriate. Rubbishing the security value of holograms in public is a sure way to undermine the industry as a whole.

HI Conference 1992

In late July 1992 we intend to hold a conference in London concentrating on display holography and its applications.

We are still looking for ideas to make this meeting one of the most productive

and "meaty" conferences yet, as well as looking for suggestions for associated social and other events. If you have ideas and/or would like to get involved with the organization of the conference, please get in touch with us soon.

We plan to announce further details of the structure of the conference and the session titles and chairmen by the end of February 1991, so watch this space!

Britain and England

At a recent holography conference, delegates representing different countries were asked to make speeches. One speaker was introduced as the delegate from England, and in the context this was incorrect. Because many seem to make the same mistake I would like to point out the correct position.

Britain consists of three nations: Scotland, England, and Wales; the United Kingdom also takes in Northern Ireland. It is as incorrect to refer to England when you mean the UK or Britain as it is to call the Soviet Union Russia. There is no quicker way to alienate a Scot than to describe him or her as English!

Holographics International

Readers may be interested to know that I have now successfully completed my studies in Physics at the University of London. I apologise for delay in bring-

ing out issues in the past (largely due to pressure of academic work) and look forward to being able to reward readers' patience with hard work leading to better, more frequent and more up to date issues in the future.

A constant feature of this editorial is my asking for feedback from readers on the magazine content and style. Perhaps I have not been specific enough in the questions that I have been asking. So...

Do you think the balance of news and features is right or would you rather have more of one and less of the other? Should there be more news about the business of holography, financial details of companies etc or should there be less news about business and more about innovation in art, technology and science.

Do those of you with non-scientific backgrounds find the *Science and Technology* section interesting and understandable or boring and difficult (or a combination of the two)? Do those scientists and engineers among you find this section too simplistic? What about the choice of topics? Interesting and current or not innovative enough?

What do you want more of (or less of)? How could the style of the writing and presentation be improved? What important subjects/issues do you feel are being missed out all together?

Editorial material for the next issue (no. 9) should be with us by 10th September. The issue 10 deadline will be 19th November. Photographs should be colour slides or black and white prints: colour prints are not suitable. I look forward to receiving your letters also. Best wishes to you all.

Sunny Bains

More on DCGs

Dear Editor

I would like to make the following addendum to my article on red sensitive DCG which appeared in issue 7 of *Holographics International*.

Tests on unexposed plates that had been left in equilibrium with air at controlled levels of relative humidity (RH) have revealed that this system does lose photosensitivity much more than conventional DCG if the RH drops below 55%.

At 44% RH, the sensitivity is barely half that obtained when plates are exposed at 60%. On the other hand, like conventional DCG, the processing is best done in a low humidity environ-

ment.

I would also like to mention that a full paper describing this chemistry has now been published by SPIE in the proceedings of their *Practical Holography Conference 1990* (Proc SPIE, Vol 1212, p190).

If anyone requires further help with or information about this recipe, or simply would like to relate their experiences with it, I would be delighted to hear from them.

Jeff Blyth

7 Bath Street,
Brighton BN1 3TB, UK
Tel: (+44) 0273 202069

THE ABNH/LIGHT IMPRESSIONS PATENT BATTLE

Amended Injunction: Victory for Both?

A preliminary injunction in force against Light Impressions Inc of California restraining infringement of a US patent was amended by the US District Court in San José in January this year, pending a full trial on the matter. The new judgement appears to concede points made both by Light Impressions and by American Bank Note Holographics Inc, which sought the injunction.

The patent, which is number 3 838 903 (Leith and Upatnieks, 1970) and known as patent 903, is fundamental in that it covers master to transfer copying. The judge decided that it would be in the public interest to allow the injunction to continue. Light Impressions says that the judgement clearly establishes their right to use the methods they are currently using, pointing to the judgement's wording:

"Defendants have already demonstrated that they can produce holograms for very little increased cost without invading the patent. The items subject to the preliminary injunction comprise only a small part of the Defendant's total business, and the injunction, while it may have monetary effect on Defendants, certainly will not cause their business to fail."

Also under discussion were patents 3 506 327 (Leith and Upatnieks, 1964), known as the "granddaddy" patent, and 3 984 787 (Leith and Upatnieks, 1971). The former expired two years ago and it was judged that two fundamental claims in the latter, numbers 11 and 12, were in fact the

same as claims 6 and 13 in the earlier expired patent.

The first of these claims concerns the production of a hologram by interfering a coherent beam which has reflected off an object with a reference beam on a detector. The latter describes the same situation with a diffused object beam.

As well as claims 11 and 12 being judged invalid, claims 3, 4, 6 and 7 of the 787 patent were deemed valid but not infringed. These concern unbleached laser-viewable transmission holograms (ie. holograms recorded as varying intensity on a developed photo-sensitive plate), where the interference patterns are "throughout its length and breadth".

The judgement has been interpreted differently by the two parties involved. In a statement released in March, American Bank Note Holographics, referring to the 903 patent, states that: "The court, in ordering this injunction, rejected a contention of Light Impressions that certain early publications invalidated the enjoined patent and affirmed its action of one year ago when it first issued a preliminary injunction under this patent. In addition to patent no 3 838 903 valid and infringed, the court also found six claims of 3 894 787 to be valid."

However, Steve McGrew, President of Light Impressions Inc, maintains that: "The methods used by Light Impressions have been determined by the court NOT to infringe the 903 patent. Thus, Light Impressions in

the view of the court is not infringing any patents."

Asked how he thought the case was likely to proceed, McGrew said: "All that remains in the patent phase of this litigation is to deal with ABNH's appeal of the Court's decision. The last time these issues were before the court of appeal (it) agreed with Light Impressions. ABNH has no new arguments, so we expect the District Court's recent decision to be upheld."

McGrew continued, "In

fact, ABNH launched the litigation by seeking an injunction to stop (us) making holograms altogether. That would have put us instantly out of business, and the rest of the industry would have fallen next."

Light Impressions has responded by filing a counter suit which, it says, charges antitrust violations, monopolization of the security hologram business, patent fraud, trade interference, and infringement of the company's 2D-3D patent.

ABNH declined to comment on the difference between the two companies' interpretations of the judgement or to speculate on the future development of the case.

The Lasersmith Inc of Chicago, Illinois, and Chroma Concepts of California have also been sued by ABNH for alleged patent infringement.

Finnish First



The post office in Finland issued two holographic postage stamps, pictured, earlier this year to mark its inauguration as a state commercial company. The stamps, which have face values of FIM 1.90 and FIM 2.50, bear identical holograms and differ only in colour. The hologram features the post office's symbol against a map of the world in the background.

Giant Spider Stalks St Louis Zoo



Piece commissioned by HUE Legwear and shown at New York's Bloomingdales last year. Apologies to arachnophiles, but it is editorial policy not to run pictures of spiders! Photo by David King.

Colourful Impressions

A colour 2D-3D embossed hologram designed for use with four-colour printing has been launched by Light Impressions Europe. Known as *Colourgrams*, they show images in their natural colours when viewed in the best light, the company says.

The Colourgram is a natural progression from existing uses of metallic foils in packaging and printwork, Light Impressions says, and is expected to be popular for brochures, packaging, etc. which are printed in colour. Mastering can be performed directly from a colour transparency, which makes the process fairly economical.

In the United States, the Traffic Control Materials Division of 3M has used a Light Impressions Inc hologram to illustrate its "cube corner technology", used in a new line of reflective sheeting for street signs. The hologram

offers a "moving" demonstration of the technology, and is featured in a sales brochure.

Light Impressions Inc also produced an embossed hologram for National Children's Dental Health Month in the US earlier this year.

Light Impressions Europe plc is at 5, Mole Business Park 3, Leatherhead, Surrey, KT22 7BA, UK. Tel: (+44) 372 386677. In the US, contact Light Impressions Inc at 149-B Josephine Street, PO Box 1899, Santa Cruz, CA 95061, USA. Tel: (+1) 408 458 1991.

Holographics North of Vermont, United States, recently completed a five channel 1x 1.5m hologram of a Tarantula spider for St Louis Zoo's *Living World*.

The five channels depict the one-metre wide model of a tarantula rearing back and then springing forward as the viewer walks by the hologram. The masters were shot by Dr John Perry of Holographics North with Michael Sowdon of Fringe Research Holographics at the Fringe pulse studio in Toronto, Canada.

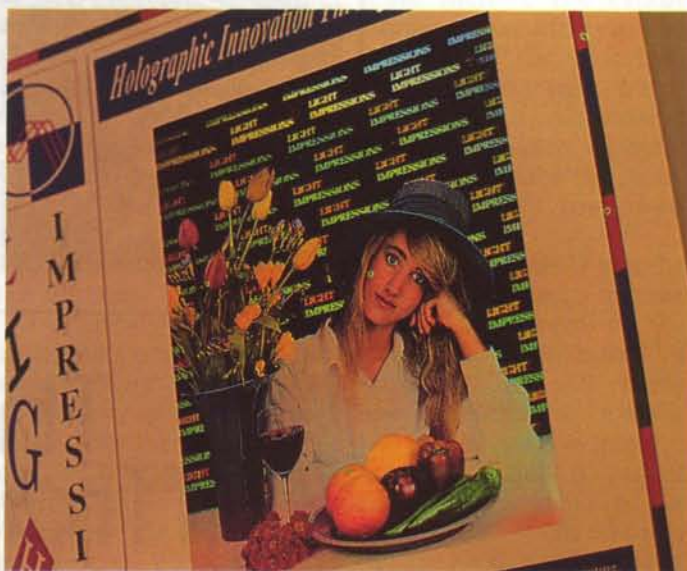
The piece was installed at the zoo in April where it joins two other large format works produced by Holographics North: one an image of a Tyrannosaurus Rex skull; the other a five channel piece showing the evolution of man.

Shown is another Holographics North piece which was commissioned by HUE

Legwear and displayed in Bloomingdales department store in New York city late last year to publicize the opening of their new stocking boutique inside the store. The transfers were made from ten masters, again shot at the Fringe studio. The three colour transfers with a viewing angle of 80 degrees were made at Holographics North in Burlington.

The company's other recent projects include holograms of a space station with shuttle and the Hubble Space Telescope, both made in collaboration with the Alabama Space and Rocket Center and Marshall Space Flight Center. The intention was to provide stock holograms of current interest to museums and schools internationally at an affordable price.

Holographics North Inc is at 444 South Union Street, Burlington, VT 05401, USA. Tel: (+1) 802 658 2275.



AHP Opens in Bonn

AH Prismatic Ltd of Britain has opened a showroom in Bonn, FRG, in collaboration with its exclusive German distributor Holographic Marketing Vertrieb GmbH (HMY). All AH products will be on show and will be available from locally-held stock.

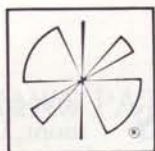
Barc Thompson of AH

Prismatic said that the move would benefit both companies, as well as their German customers. German retailers could now expect the same quality of service from HMY as British customers received directly from AH Prismatic, he said.

The move is expected to

help AH Prismatic achieve increased sales in the rapidly expanding German market, and will leave the company well placed for the single European market in 1992 and for increased trade in Eastern Europe.

The new HMY showroom is at Endenicher Strasse 14, D-5300 Bonn 1, FR Germany. Tel: +49 228 651332. Fax: +44 228 651332.



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New World Opens in Washington

The Art, Science and Technology Institute (ASTI) is staging a six-month international exhibition of holography in Washington DC, United States.

Hologram: Image of the Future features seventy holograms from a number of countries, including Britain, France, The Netherlands, Japan, Germany and the Soviet Union. Focusing on artistic, technical and commercial aspects of holography, the show will run from 26 April to 28 October 1990.

The present exposition is the opening event for *Holography World*, a specially designed exhibition area within Washington's Techworld Plaza. It is planned to host an annual six-month exhibition and a selection of other

events, including educational displays and seminars.

The construction of *Holography World* was made possible by a donation from Techworld Trade Associates, and enables ASTI to expand its range of activities. ASTI's existing *Holography Collection* display, also in Washington, remains open to the public and educational facilities will be provided at both sites.

Holography World is open to the public everyday except Monday at Techworld Plaza, South Lobby, 800 K Street NW, Washington DC 20001, USA. Admission is \$5 for adults and \$4 for children. *Holography Collection* and the Art, Science and Technology Institute are at 2018 R Street NW, Washington DC 20009. Tel: (+1) 202 667 6322.

German Society Launches Journal

The Deutsche Gesellschaft für Holographie (German Holographic Society) has launched the first German language holography journal, *Interferenzen*. The first bi-monthly issue (pictured) was published in February.



The journal focuses on technical and cultural aspects of holography, with news of business applications, exhibitions and symposiums. It costs DM5 and can be ordered from the Society.

The Society also held a retrospective exhibition of holography in the Federal Republic of Germany earlier this year to coincide with the tenth anniversary of the first holographic exhibition in the country.

The exhibition's 82 holograms illustrated most of the important areas of display holography. It was curated by Peter Zec, chairman of the Society. The exhibition catalogue, containing articles and photographs, is still available.

The Society's address is: Postfach 17 22, D-4500 Osnabrück, FR Germany. Tel: (+49) 541 7102199.

Wenyon & Gamble Go East



British art holographers Susan Gamble and Michael Wenyon have moved to Japan. They are continuing their work in holography at Tsukuba University's Institute of Art and Design, near Tokyo.

The pair, who began their joint career in holography in 1980 at London's Goldsmith's College, are pictured with *Zone One* from *The Heavens*, an installation of five long narrow holograms on easels, recently shown at the Apollohuis in Eindhoven in The Netherlands.

Museum Movements

Sydney Dinsmore has been appointed Curator of Collections at New York's Museum of Holography. She was the founding director of the Interference Fringe Hologram Gallery in Toronto, Canada, where *Choice and Circumstance*, her collaboration with Melissa Crenshaw, premiered last autumn.

Two new trustees have been appointed to the Museum's Board. Gilbert Colgate Jr, one of the new trustees, is Vice President of Product Development for United States Banknote Company. As one of the pioneers of holography in credit-card security, he holds four patents in security-related printing techniques.

Suzanne St Cyr, the other new trustee, has been active in holography for over thirteen years and is currently a principal in the Washington DC based consultancy Holographic Applications. Her experience covers technical, artistic and commercial aspects of holography.

Other changes at the Mu-

seum include the establishment of a residency for the recipient of the Fulbright Scholarship in light transmission, and a collaboration with *Holographics International* to produce the International Directory and Buyer's Guide.

The year 1990-91 sees the start of a campaign to raise new funding sources for the MoH. The establishment of an endowment will enable new acquisitions to be made and help to preserve the Museum's collection. As part of the campaign, friends of the Museum are being asked to lobby New York Mayor David Dinkins with postcards in an effort to secure funding from the city.

With the hoped-for increase in funding, the Museum also aims to establish a library of video material and an educational programme, partly sponsored by the Armour Foundation.

The Museum of Holography is at 11 Mercer Street, New York, NY 10013, USA. Tel: (+1) 212 925 0581.

Ginn Aims to Combine Novelty with Art

Ian Ginn Holography of the Netherlands has recently published its first catalogue, containing six images in silver halide aimed at galleries and gift shops. Prices range from about US\$8 for a 3x4 inch piece called *Laughing Buddha* to US\$45 for the 8x10 inch version of *Pandora's Own* (pictured).

Five of the six images are original, the exception being the well-known *Sleight of Hand* in which balls positioned between the fingers of a hand appear and disappear. The new holograms, Ginn says, have already been selling well in galleries and he hopes to offer a total of 15 images by Christmas. The holograms are produced by Laza Holograms of Britain.

Ian Ginn, also of White Tiger Holograms of Amsterdam, has been working pri-

marily for his new company since March. He shot the masters for his new range of

holograms with Paul Newman, a graduate of the Royal College of Art's holography course. With a background in fine art himself, Ginn's hope is to shoot and sell holograms which will appeal not only as a novelty but on an artistic level as well. His plans for the future include working in two colours.

White Tiger Holograms, which primarily uses holograms for specific commercial/promotional applications, has undergone a change of emphasis in the way it operates. Though it hopes to continue to work on the same number of jobs, the company will from now on be acting more like an agency, passing jobs on to hologram producers rather than just sub-contracting work. This will free much of Ginn's time for his new venture.

Ian Ginn Holography is at Postbus 116, NL-5070 AC Udenhout, The Netherlands. Tel: (+31) 4241 4358. Fax: (+31) 4241 4368.



Low Price Display Unit for Gift Market



Third Dimension Limited of Britain has launched an integral lighting/display unit for silver-halide holograms. It hopes that the unit, which is likely to be priced at under £30 retail, will make a major impact on the gift market.

The unit, called the C3D, illuminates a 5x4 inch hologram held in a plastic frame with a 10W halogen light. The frame can be adjusted through an angle of about twenty degrees, and the whole unit is mounted on a free-standing base. It is available with a range of 27 holograms.

Third Dimension Ltd is at 4 Wellington Park Estate, Waterloo Road, London NW2 7JW, UK. Tel: (+44) 81 208 0788.

More Capacity at Op-Graphics

Op-Graphics Holography of Britain has recently started using its own automated spot and line scanning systems for exposing film holograms. The spot scanning is done using a modified laser printer and employing only a 5mW HeNe laser for smaller holograms. The line scanning uses a unit constructed in-house using Newport precision motors and controlled by a personal computer.

The main advantage of these systems is that production capacity is greatly increased: scanning a laser beam across the film results in a very short exposure time per unit area of film. Scanning, Op-Graphics says, also improves diffraction efficiency thus giving increased image brightness.

Both systems can presently expose approximately ninety 10x8 inch (25x20 cm) film sheets per hour, which is a substantial increase over the company's previous methods of film exposure using a continuous wave laser. The line system is also capable of scanning any hologram up to about 20x24 inch (50x60 cm).

The company has been supplying customers with holograms made on the new system since February, and is now looking for new, large orders on commissioned work.

Op-Graphics Holography is at TechNorth Unit 4, 7 Harrogate Road, Leeds LS7 3NB, Britain. Tel: (+44) 532 628687. Fax: (+44) 532 374182.

Holographix Hopes for Laser Printer Breakthrough

A holographic laser scanning unit for use in office laser printers has been developed by Holographix Inc of the United States. The unit, which is claimed to be the first of its kind, was announced at the Shearson Lehman Hutton Imaging Forum in Boston this April.

The HX 310GS is designed as to be used in place of the polygon-based scanning mirrors presently used in laser printers. By using a holographic disc as the scanning element the new system can produce improved image quality, and is about 30% cheaper than existing scanners, Holographix says.

While Holographix will be manufacturing the laser scanning unit itself, it will also be licensing the technology to other manufacturers and

hopes to achieve a significant penetration of the laser printer market. Although the units will need to be adapted to the needs of different laser printer manufacturers, the basic design and parts are likely to be the same for all printers of the same class.

Holographix currently has prototype scanners in operation as demonstration units, and expects volume shipping of the new product to begin by the summer of 1991, Kenneth Liu, Vice President of Marketing, said. The company says it is close to signing a licence agreement with a major Korean company, thought to be Lucky Goldstar.

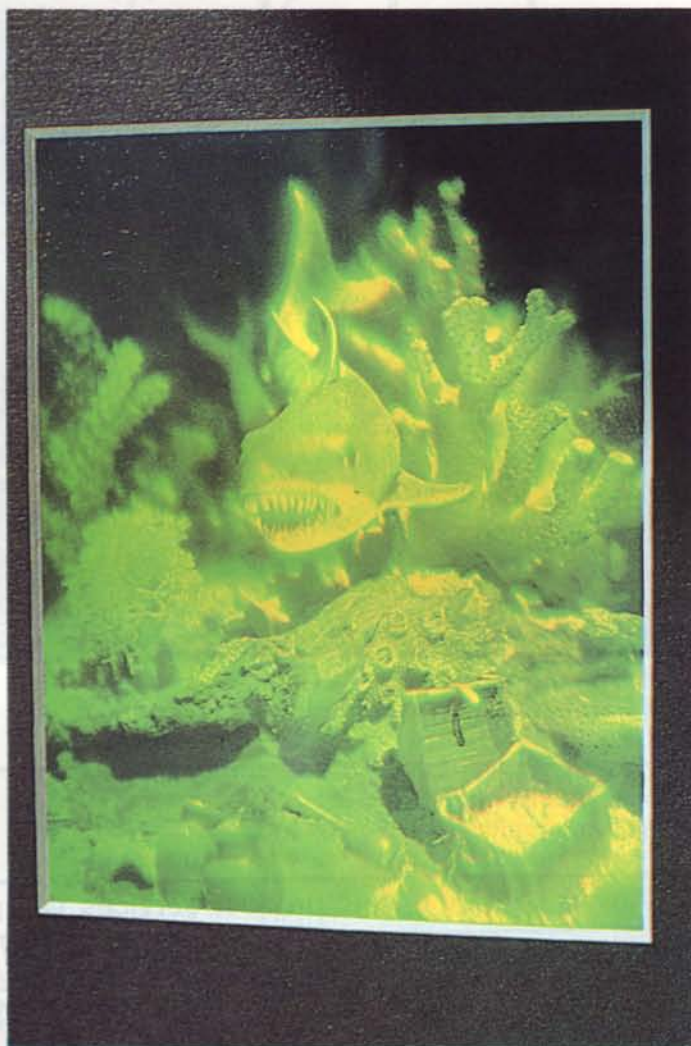
Holographix is at 87 Second Avenue, Burlington, MA 01803, USA. Tel: (+1) 617 229 8840.

Open and Shut Case



Holographic open and closed signs for shops and restaurants are being produced by HOLO GmbH of FR Germany. The door signs use a double-slit technique so that they can be read by both short and tall people, and are sealed within a plastic cover. Further details about these and other products in the HOLO-Design range can be obtained from HOLO GmbH, Holografielabor Osnabrück, Mindener Strasse 205, D-4500 Osnabrück. Tel: (+49) 541 7102173.

Polaroid's Big Fish



Holos Gallery of San Francisco, and Red Beam Inc, also of California, have collaborated to produce a series of six wall decor holograms using Polaroid's photopolymer film, which they say is both cheaper and brighter than silver-halide film.

The six images include *Saturn*, for which President of Red Beam Lon Moore is al-

ready known, and *Shark* (pictured). The wholesale price for a hologram framed in black matt board and completely packaged with instructions is US\$12.50, and distributor discounts are available.

Holos Gallery is at 1792 Haight Street, San Francisco, CA 94117, USA. Tel: (+1) 415 221 4717.

New Wöber Lights

A new hologram lighting system has been launched by Wöber Design Hololab.

The complete system consists of a 12V transformer and 20W halogen lamp, together with a standard 20x25 cm frame with glass (different sizes are available) and all re-

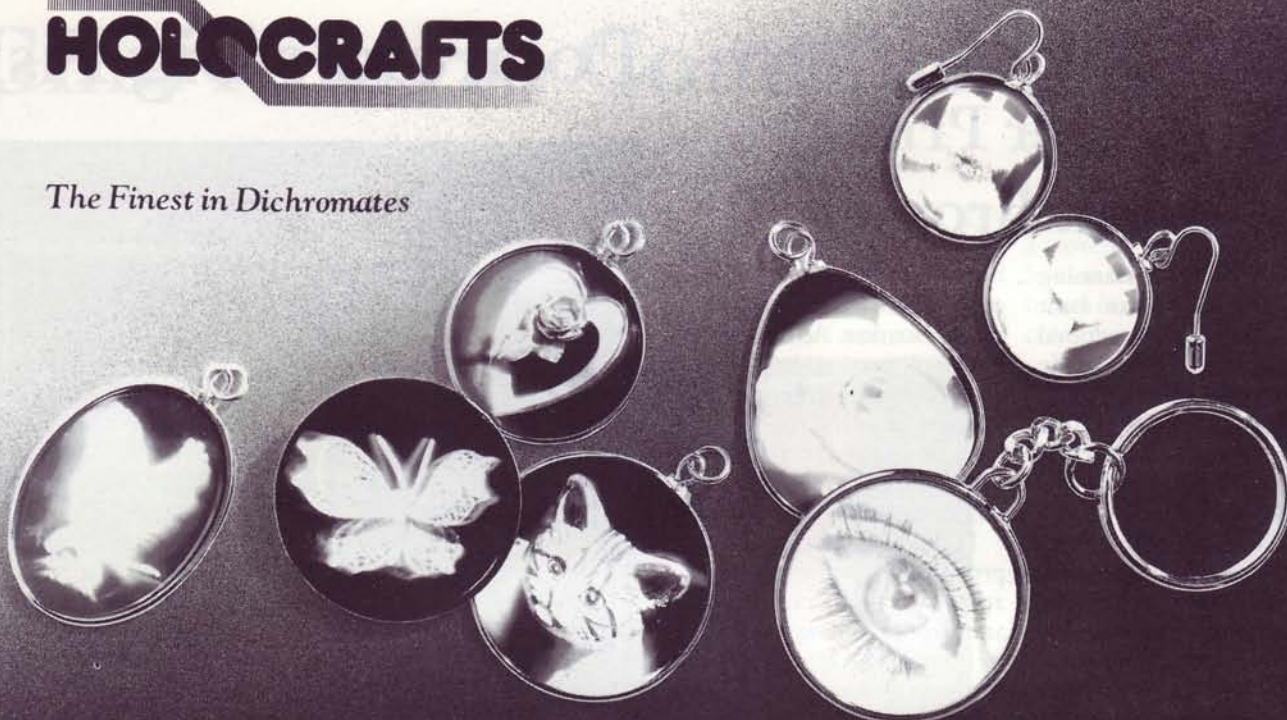
quired mounting fixtures.

Prices are from approximately US\$60 for orders of between 10 and 50 units.

Contact Irmfried Wöber at Wöber Design, Kahlenbergstrasse 6, A-3042 Würmla, Austria. Tel/Fax: (+43) 2275 8210.

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We specialise in high quality mass production of film holograms

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Eye-catching attraction on trade show stands -

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Bulgarian Display Hits Harare

A holographic exhibition in Harare, Zimbabwe, took place at the end of last year on the initiative of the former Bulgarian ambassador to that country, Mr A Antanasov.

The 20 Denisjuk holograms showed artifacts from the Bulgarian *Panagjuriste Golden Treasure* (400-300 BC), and examples of African art. They were produced at the Central Laboratory for



A hologram of African Art from the Harare exhibition.

10 Years in Paris

The museum of holography in Paris, France, celebrated its tenth anniversary in March. The number of visitors to the museum has now reached 200 000 each year.

In addition to the main exhibition, based at the Forum des Halles, the museum has arranged international tours, including the first display of holograms in China. More recently, museum director Anne-Marie Christakis curated an exhibition at the Hungarian National Museum in Budapest.

The museum, a non-profit making body, meets all expenses from its own activities.

The museum is at Forum des Halles, 15-21 Grand Balcon, F-75001 Paris, France. Tel: (+33) 1 40 39 96 83.

Optical Storage and Processing of Information of the Bulgarian Academy of Sciences, using Bulgarian plates.

The ten-day exhibition was seen by over 3000 visitors, who were also able to learn about holography through lectures and videos.

Annie Packs Them In

Visitors to one of Scotland's newest tourist attractions will be greeted by a holographic 'spirit guide'. *Annie's Magical History Tour* at the New Lanark Heritage Village in Strathclyde is described as a monorail ride to meet the spirits of the past.

Created by Renaissance Design Consultants, the attraction incorporates 2D and 3D figures, talking heads, lasers, projectors, and a sophisticated sound system. The monorail takes visitors through this 'spirit world', which illustrates the world of New Lanark two centuries

ago in an entertaining yet accurate way, Renaissance Design says. As the tour begins a hologram of a ten-year-old girl, representing Annie MacLeod, a young worker at New Lanark mills in 1820, hovers in front of visitors. At this time the town was the model for the landowner Robert Owen's famous social experiments in new living and working conditions.

Renaissance Design Limited is at The Clies, Menage Street, Helston, Cornwall TR13 8RF, UK. Tel: (+44) 326 572654.

Matthias Lauk, founder of the Pulheim Museum for Holography and New Visual Media in FR Germany, has sold his collection of holograms. The collection has been bought by the German state of Baden-Württemberg and will be displayed on permanent loan in the Media Museum in Karlsruhe, due to open in 1994.

The Lauk Collection, which has been widely exhibited throughout Europe, is an historical collection tracing the development of the holographic medium from the early seventies. The Pulheim Museum has built up its own collection of holograms over the last decade and the sale of the five hundred Lauk holograms is not expected to affect its work.

The Pulheim museum is also increasing its commitment to electronic, computer and video art. Matthias Lauk views the next logical step as the incorporation of holography into multi-faceted forms of media art, with exhibitions on this theme likely in the coming year.

The Museum for Holography and New Visual Media is at Pletschmülenweg 7, D-5024 Pulheim, FR Germany. Tel: (+49) 2238 51053.

The first fine art holography gallery in the southeastern United States opened earlier this year in Atlanta, Georgia. A rotating permanent collection owned by the gallery forms the permanent display, and periodic special exhibitions will feature work by leading holographers. The exhibition is free and open to the public from Tuesday through Saturday. Atlanta Gallery of Holography is at Suite E-2, Tula Arts Complex, 75 Bennett Street NW, Atlanta, GA 30309, USA. Tel: (+1) 404 352 3412.

Gallery is a First for Atlanta

The first fine art holography gallery in the southeastern United States opened earlier this year in Atlanta, Georgia. A rotating permanent collection owned by the gallery forms the permanent display, and periodic special exhibitions will feature work by leading holographers. The exhibition is free and open to the public from Tuesday through Saturday. Atlanta Gallery of Holography is at Suite E-2, Tula Arts Complex, 75 Bennett Street NW, Atlanta, GA 30309, USA. Tel: (+1) 404 352 3412.



The hologram of Annie, with 10-year-old Glasgow schoolgirl Rhiannon Brady, who was the model.

Vila in Vistas Latinas

The work of US holographic artist Doris Vila was featured in February's *Vistas Latinas* exhibition at New York's EB International Gallery. The aim of the exhibition was to show the work of a wide variety of Latin-American women and attempt to break down some of the stereotypes and misconceptions that exist about their work.

Vila is also known for her work in education, particularly her workshops in holography at the New York State Summer School for the Arts.

Vistas Latinas was sponsored by the Women's Caucus for Art 1990 National Conference, and included work by other artists such as Marta Chavez and Elizabeth Grajales.

Von der Gathen Runs Interference in Toronto

Heidi von der Gathen has been appointed Curator of the Interference Hologram Gallery in Toronto, Canada. She takes over the position which has been vacant since founding director Sydney Dinsmore left in 1986.

Von der Gathen has a Bachelor of Fine Arts degree from Chicago's Art Institute, where she majored in holography. She also studied at the Royal College of Art in London, Britain, during the 1987 summer session.

In 1988 she was artist-in-residence at the Museum of

Science and Technology in Ottawa, where she conceived, developed and installed an interactive children's environment. Last year she was chosen for the artist-in-residence programme sponsored by the Photon League in co-operation with the Canada Council and the Ontario Arts Council.

During the coming season at Interference, she plans to introduce a newsletter devoted to artistic aspects of holography, and a programme to display holographic art in public areas.

Three Colours From One Ilford Emulsion

Paul Hubel of the University of Oxford in Britain recently produced a full colour hologram on a single panchromatic silver halide emulsion,



Hubel's single layer hologram.

thought to be the first true colour hologram of its type. Previously a two-layer sandwich technique was used.

Although the hologram is not as bright as normal monochromatic reflection holograms, the colour fidelity and image sharpness are very high. The image resolution is also far superior to holograms recorded using the sandwich

layer technique due to the simultaneous exposure and lack of registration problems between layers.

Unfortunately, Hubel says his present processing regime leads to a noticeable noise level which causes desaturation of the image colours and lowers image contrast. He hopes experimentation with different chemistries will solve this problem.

The material used for this recording was an experimental pan-sensitive silver-halide emulsion produced by Ilford Ltd. Its sensitivity coverage is similar to that given by a combination of Ilford's commercially-available blue-green and red holographic films. The film was a test sample which Ilford made for research in colour holography and was not designed for high brightness.

Hubel is now writing his DPhil thesis, entitled *Colour Reflection Holography*. He hopes to continue working in the field when he returns to the United States later this year.

Smoke Gets in Your Eyes

Brazilian artist Eduardo Kac and Dr Hans Bjelkhagen of Northwestern University in the United States have collaborated to produce *Omen*, a 20x25 cm combination pulsed laser and computer generated hologram. It is currently on show at the Light-Wave Galleries in Chicago.

Omen consists of computer generated letters spelling the word 'eyes' which appear to spin through a luminous smoke cloud, recorded on a pulsed master. As the viewer moves in front of the piece, the word dissolves into and re-emerges from the smoke.

The piece was unveiled in February as part of a show of

Kac's work at the Museum of Holography in New York which ran until 22 June.

Working at Holicon in Evanston, Illinois, Bjelkhagen shot six 30x40 cm laser transmission holograms of smoke clouds created by Kac. The images of the letters and their arrangement were designed by Kac using a Macintosh II, and a series of 46 18x20 cm images of the letters was then recorded on movie film. A stereogram printer developed by Kac in collaboration with artist Dean Randazzo at the Holography Department of The School of the Art Institute of Chicago was then used to produce a

master from these images.

The final result (pictured) is a transfer combining the achromatic white light transmission computer master and the rainbow pulsed master.

Eduardo Kac can be con-

tacted at 1525 W Farwell 2B, Chicago, IL 60626, USA. Tel: (+1) 312 338 5334. Dr Hans Bjelkhagen is at Holicon, 906 University Place, Evanston, IL 60201, USA. Tel: (+1) 708 491 4310.



• **Until August 25**
Shadowplay, work by Charles Lisogorski and Ken Vincent. *Interference Hologram Gallery, 1179A King Street West, Suite 8, Toronto, Ontario M6K 3C5, Canada.*

• **Until September 9**
Captured Light: new work by leading artists including Analt, Benyon, Crenshaw and Dinsmore (see page 16), Deem, Harman, Kaufman, Pepper and Vila. Curated by Linda Law. *Museum of Holography, 11 Mercer Street, New York, NY 10013, USA. Tel: (+1) 212 925 0581.*

• **Until September 23**
10 Dogs and Other Holograms: a new exhibition by British artist Patrick Boyd. *Museum of Holography (see address above).*

• **Until September 23**
Sketching with light: work by Andrew Pepper. *The Gill Gallery, Newham Leisure Centre, 281 Prince Regent Lane, London E13 8SD, UK. Tel: +44 71 511 4477.*

• **September 6 - October 20**
Transitional States: a solo exhibition of the work of Mary Harman. *Interference Hologram Gallery, address above.*

• **October 16-18**
Holographics '90: conference and trade exhibition, or-



Sophie, Margaret Benyon 1986, part of Cosmetic Series. Benyon is an artist currently being shown at the MoH, New York.

ganised in conjunction with *Opto 7*, Nuremburg, FR Germany. *Details from Mesago Europe, Rotebühlstrasse 83-85, Postfach 10 32 61, D-7000 Stuttgart 1, FR Germany. Tel: (+49) 711 619460. Fax:*

(+49) 711 618079.

• **October 22-27**

Asia-Pacific Conference on Optical Technology: APCOT '90. Marina Mandarin Hotel, Singapore. *Contact: APCOT '90, 1 Maritime Square #09-*

43/20, World Trade Centre, Singapore 0409. Tel: +65 2788666. Tel: +65 2784077.

• **October 25 - December 8**
A joint exhibition by Steve Weinstock (see page 18) and Julie Walker. *Interference Hologram Gallery, address above.*

• **November 4-7**

Society for Experimental Mechanics (SEM) conference on *Holographic Interferometry and Speckle Metrology*, Baltimore, Maryland, USA. *Details from Dr Karl A Stetson, SEM, 7 School Street, Bethel, CT 06801, USA. Tel: (+1) 203 790 6373.*

• **November 4-9**

Optical Security and Anti-Counterfeiting conference to be held as part of SPIE's *Opticon '90* at the Hynes Convention Centre, Boston, Massachusetts, USA. *Contact SPIE, PO Box 10, Bellingham, WA 98225, USA. Tel: (+1) 206 676 3290. Fax: (+1) 206 647 1445.*

If you are organising an event or exhibition please let us have full details at least three months before it is to happen. Include the event name, date location, names of those involved, and an address and phone number where the organisers can be contacted.

Hungary Meeting

SPIE, the Society of Photo Instrumentation Engineers, held its first *Holography Institute* meeting at Tatabanya, Hungary, in June.

The Institute-type meeting is a form which SPIE has previously used successfully in other disciplines. About 30 scientists and engineers considered to be experts in their field are invited to the meeting so that ideas can be exchanged at the highest level. The intention is to allow an intense brainstorming session to take place without the distractions of a large conference.

The SPIE annual *Practical Holography* conference was held this year in Los Angeles, USA. Papers from the Massachusetts Institute of Technology Media Lab on holographic video (see page 22), and from the Tokyo Institute of Technology (see page 29), were among the papers

presented.

This conference has, in recent years, been held each January as part of *OE LASE*, SPIE's major symposium on electro-optics and lasers. Next year the holography meeting will take place as part of a symposium on electronic imaging, to be held at the end

of February 1991 in San Jose, California, and organised jointly by SPIE and the Society for Imaging Science and Technology.

Proceedings are available from SPIE, PO Box 10, Bellingham, WA 98227, USA. Tel: (+1) 206 676 3290. Fax: (+1) 206 647 1445.

Canadian AIR

Fringe Research Holographics of Toronto, Canada, would like to hear from Canadian artists interested in their 1991 Artist-in-Residence Program in pulsed holography.

Five to seven positions are available. Each artist will receive an honorarium of

Can\$500, up to Can\$750 worth of holographic materials, and two weeks of studio time to carry out their work. They will also be supplied with an advisor/technician.

Those wishing to apply should send a proposal including a sketch or photo of the intended holograms, a description of the artist's intent, 10-12 slides of recent work and a resumé. Submis-

sions must be in by 1 November 1990.

Fringe Research staff are willing to consult with artists who need technical advice before submitting a proposal. Call 416 535 2323.

Submissions should be addressed to: 1991 AIR Program, Fringe Research Holographics, 1179A King Street W, Suite 10, Toronto, Ontario M6K 3C5, Canada.

Crenshaw & Dinsmore: Choice & Circumstance

Two tableaux from a series of figurative works entitled *Choice and Circumstance* by Melissa Crenshaw and Sydney Dinsmore made their Canadian debut at the Interference Hologram Gallery last autumn.

The first, entitled *Is This What You Want?*, consists of five pulsed holographic images of the female nude. In four of these, Dinsmore and Crenshaw clearly draw direct and conscious influence from classical perceptions of the nude. This choice of the artists becomes interesting when you realize these classical perceptions of the female figure are generally the interpretation from a male viewpoint. *Is This What You Want?* is a re-interpretation of this traditional view-

point.

In these four images, a single female figure alternately protects her breasts, embraces herself, and withdraws into a foetal-like position. This lends the piece a very internalized and self-protective air. However, the fifth central image contrasts starkly with this passivity.

In this image, although we again see the female figure, she is positioned in a very provocative stance. The figure's back faces the viewer. One hand is tightly grasping and pulling the other hand's fingers. This image fairly seethes with tense emotion. It places the viewer within a dialogue they must consider, and they must address their own perceptions of gender roles. Is this truly what they



Detail from central image of *Is This What You Want?*

want?

The second tableau, *Choice/What Choice?*, examines the psychological effects of violence. Its method of examination is the seeming re-enactment of the violent act through flashback experiences. This piece appropriately enough has a more intuitive feel than the first. It is also more immediate in its emotional accessibility.

The focal point of *Choice/What Choice?* is a female torso that is captured during the act of having its clothing forcibly ripped away by several hands. Superimposed is the image of a woman crying out (shown on page 3). This image is flanked on both sides by images that either compose the focal point image, or that consider the residual personal dilemma and effects of the violent act itself.

Dinsmore and Crenshaw chose to tie the two tableaux together using monumentally scaled photographic murals. In concept they could be the ideal unifying element. In practice, unfortunately, they are the weak link in an otherwise strong chain. The imagery on the murals is selected from *Is This What You Want?*, where they create an interesting and visually balanced counterweight to that tableau. However, I find them less appropriate, and in fact too structured, when they are juxtaposed with the freer composition of *Choice/What Choice?*.

This is a somewhat minor issue, however, when considering the resounding strength of this selection of *Choice and Circumstance*. It would be interesting to see all four tableaux assembled.

Heidi von der Gathen

Dinsmore and Crenshaw's work can currently be seen at the Museum of Holography. See *Calendar*, page 15.



Photography Bewitched, an exhibition of recent pulsed holograms by Martin Richardson, was held at the Royal Photographic Society Gallery in Bath, Britain, earlier this year. The show contained over twenty pieces made since 1989, mainly rainbow transmission holograms.

Richardson is a graduate from the Royal College of Art in London, where he became the first student to receive a PhD in fine art holography. He is presently employed by Third Dimension Ltd.

Pictured is one of the earlier pieces from the exhibition, *Analytical Female* (1989). *Photography Bewitched* will be on show at the Lipworth Gallery in Florida, USA, in February next year. Further details in the next issue.

Holography Institute, California

Basic Holography

Four-hour hands-on introduction which includes making a 4x5 inch reflection hologram. Ideal for adult beginners as well as young art or science students.

Introduction to Holography

Four-day beginners' course for those seriously interested in how holograms are made, with optional lab topic. Students make different holograms in each day's four-hour session, either image-plane reflection or rainbow transmission.

Intermediate Holography - Colour Control

Four-day course, four hours per day, concentrating on colour selection and multi-colour composite imaging. Students will make one multi-colour hologram during the course. Those applying must have done the *Introduction to Holography* course mentioned above.

Advanced Holography - Animation

Five-day course, five hours per day, for those wishing to experiment at an advanced level. Students will produce one animated hologram by the end. *Introduction to Holography* is a prerequisite.

Advanced Holography - Special Project

A variable course designed by the student and faculty to allow particular interests to be pursued. Materials extra.

Multiplex Holography - Stereograms

Five day course held in San Francisco. *Introduction to Holography* (including both labs) and *Advanced Holography - Animation* courses are both pre-requisites. Students make one 120 degree multiplex hologram.

Dates by arrangement, fees approximately US\$160 per day. For further information, contact Jeffrey Murray, Holography Institute, PO Box 446, Petaluma, CA 94953, USA. Tel: (+1) 707 778 1497.

Los Angeles School of Holography

Weekend Holography Course

Introduction to holography, applications and techniques. Lab work includes reflection and transmission. Classes cover display and technology applications, art preparation, materials and equipment needed, mastering, transferring and stereograms, as well as rainbow, achromatic and colour holograms. Course takes place over Friday evening, Saturday and Sunday. Fee US\$450 (US\$375 for students), including textbook and all materials. Dates on application.

Information from David Schmidt, Los Angeles School of Holography, 23962 Craftsman Road, Calabasas, CA 91302, USA. Tel: (+1) 818 703 1111.

Newcastle Polytechnic

Practical Holography Introductory Course

Aimed at those with no prior experience. Students will learn the basic principles of hologram production through making their own single beam holograms. Fee £75 plus 15% VAT. Next date: 15th December 1990.

Practical Holography Advanced Course

Four-day course for people with some prior experience of holography, covering split-beam transmission, white light reflection, rainbow and pseudocolour holograms. Fee £325 plus 15% VAT. Next dates: 3-6 September and 17-20 December 1990.

Details from Graham Rice, Department of Electrical/Electronic Engineering and Physics, Newcastle upon Tyne Polytechnic, Ellison Place, Newcastle upon Tyne, NE1 8ST, Britain. Tel: (+44) 91 235 8620.

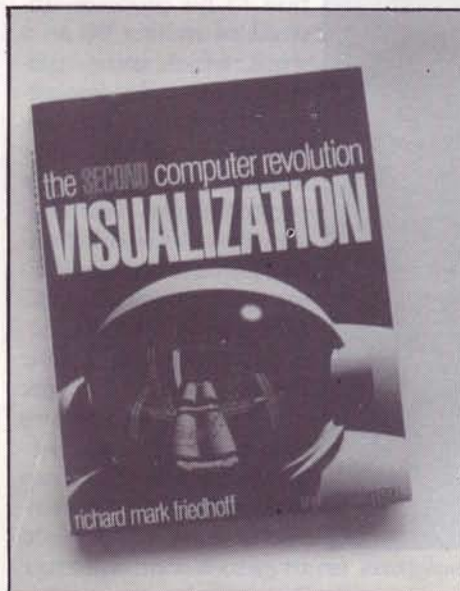
If you run a holography course which you would like us to list here, please send the following information: name of course, subject areas covered, types of lab work done, course length and dates, cost, address and contact number. Information should be sent at least three months before the course is to take place.

Visualization and Computers

Now that the holographic industry seems to have as much overlap with computing as with optics, those of us who are computer illiterate are going to have to catch up. *Visualization: The Second Computer Revolution* by Richard Mark Friedhoff and William Benzon is an excellent starting point.

The book covers the basics of optical perception and illusion, colour theory, stereography, photography, medical imaging, Fourier analysis and holography, and goes on to cover computer graphics techniques, fractals and artificial reality. The holography section is not large, but it covers the main techniques and is probably in proportion to holography's size within the overall imaging industry.

Visualization is a combination of a well-written pop-science book, a ref-



erence book, and a coffee table book which would keep the casual reader, whether artist or scientist, interested for some time. It is almost entirely in plain English (rather than in jargon), and is easy to read without being patronizing. It has over two hundred illustrations, most of them in colour.

Those only vaguely interested in computer graphics will be happy to know that almost half the book covers other subjects, but it is almost impossible to avoid getting sucked in to the computer section, if only because of the amazing graphic art which adorns its pages.

Visualization: The Second Computer Revolution by Richard Mark Friedhoff and William Benzon is published by Abrams at US\$49.50, and contains over 250 pages. Available from book stores, or by mail order from: Special Sales, Harry N Abrams, 100 Fifth Avenue, New York, NY 10011, USA.

Sunny Bains

Steve Weinstock: Dreams in Colour

by Mark Cottle

Steve Weinstock became an artist by a strange twist of fate. Before he started college he wanted to be an engineer but ironically a fascination for technology led him to change his mind. Now he is steadily building a reputation for bold and colourful holographic art.

Weinstock grew up in Los Angeles and went to Brown University in Providence, Rhode Island, USA, where he learned holography from Donald Thornton and Hendrick Gerritsen. Drawn to it by his fascination with the technology he became steadily more interested in the creative possibilities. Eventually he grad-

uated from Brown with a bachelors degree in fine art.

He explains: "By the time I was able to take the holography course at Brown I had already become pretty disillusioned with the world of engineering. After spending a year doing the basic stuff - masters, reflections and rainbow transfers - I started to experiment a little. At the same time I started to concentrate more on my art courses."

At first he found a conflict between his artistic instincts and the restrictions of the holographic processes he was using. He says: "I would plan a hologram and

shoot the master and by the time I got to the transfer I couldn't understand any more why I was making a hologram of that particular scene. On my art projects I could make things up as I went along, in holography I couldn't."

After much experimenting he found that the one-step shadowgram technique offered a solution to his problem. Instead of waiting up to a week, which using masters and transfers necessitated, he could now see his creations within a few hours. Four years after producing his first shadowgram he is still making improvements to his set-up to make it easier to use.

"Shadowgrams let me be spontaneous with the imagery in the holograms which is important because I usually end up making fairly abstract images. I think it's very hard to get an abstract image that still communicates

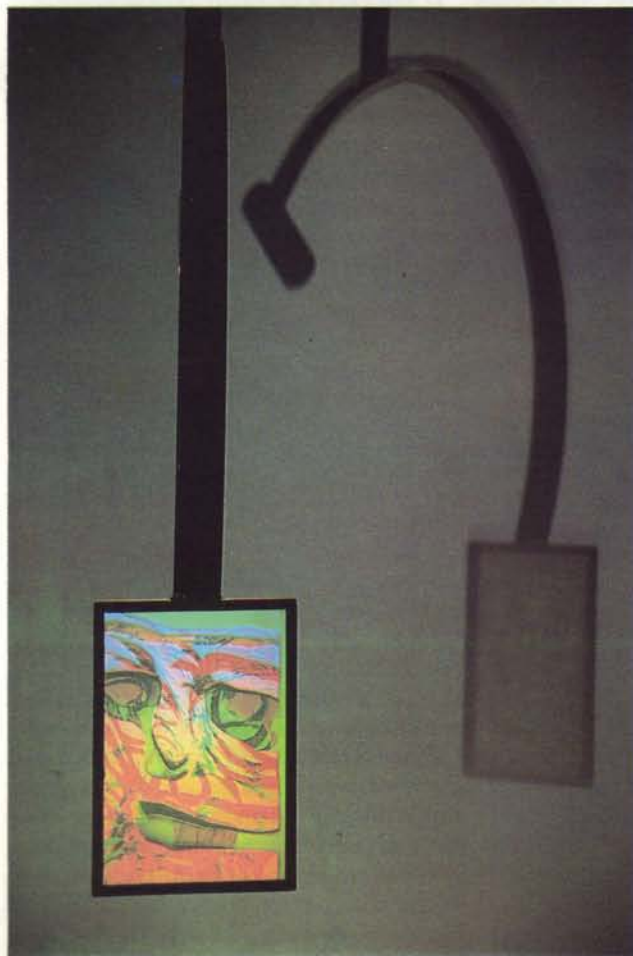
some sort of feeling, if you already know what you want it to look like before you see what the medium will do with your idea."

During 1986, while still a student, Weinstock spent six months working as a lab assistant to artists Michael Wenyon and Susan Gamble at Goldsmiths in London. In 1987 he moved back to his home city of Los Angeles where he helped establish the Holographic Visions gallery devoted to holographic art.

But, unhappy about a switch in emphasis from curated exhibitions to retail sales, he resigned from Holographic Visions in 1988. Keen to continue his own ideas he moved to become artist-in-residence at the Dennis Gabor lab at the Museum of Holography in New York.



Dreaming in Color, 1989. Hologram in Hand-Made Bed.



Face Sketch (In Fixture), 1989. 6x9 inch hologram in steel with light.



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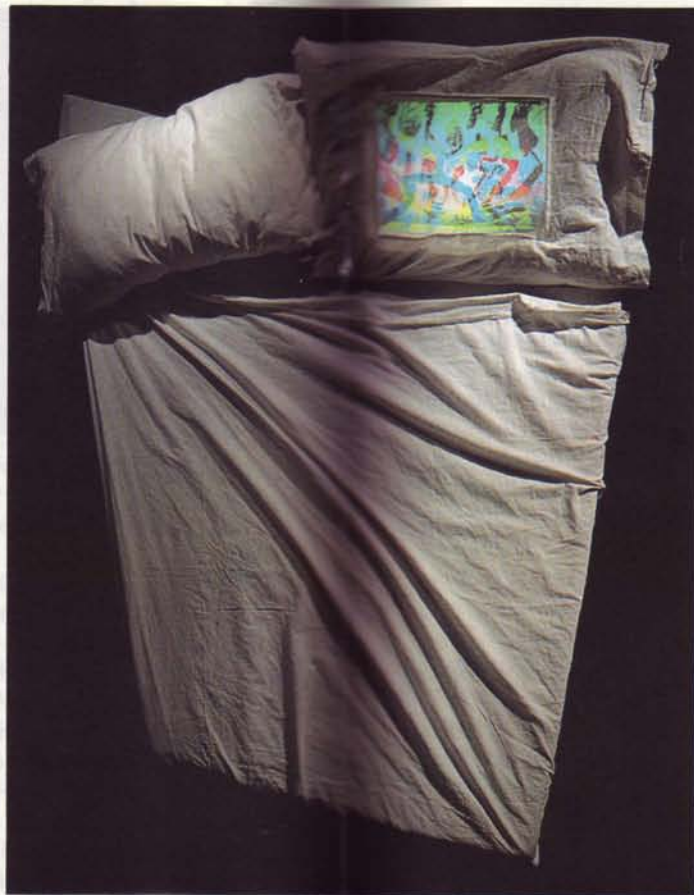
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Dreaming in Color, 1989. Hologram in Hand-Made Bed.

Also in 1988 he began work on a studio at his home in Los Angeles. Named, appropriately, the Hand-made Holography Studio he built most of it himself.

"I have worked as a carpenter, so figuring out how to build the cabinets and the furniture wasn't too tough and ended up being a lot of fun for me. By building everything in the studio myself I made it a comfortable place to be; less of a lab and more of a studio," he explains. As well as using the place for his own projects he invites other artists to use it to incorporate holography in their work.

Weinstock's do-it-yourself studio reveals something of his approach to his art. "I like making things. I like to make the frames that the holograms go into,"

Miters, 1990. Hologram in Birch Frame.



Through the Thickets, 1987. Hologram in Stained Glass Frame.

he explained.

Frames are a distinct part of Weinstock's work as an integral feature of his art. A 1987 piece titled *Through the Thickets*, based on a painting by Kandinsky, is framed to look like stained glass.

One of Weinstock's ideas is to use slumped glass - moulded and heated in a shape of the mould. I had never worked with this before, but this was a good excuse. It often seems like I have a new craft every time I make a frame."

His ideas often vent into the realm of the beat, such as a piece titled *Suit* which used a grey frame.

A 30 x 40 inch hologram made during his residency at the Museum of Holography reminded him of a stained glass window and so he decided to frame it. Later he extended the piece and the 30 x 40 inch high bed sculpture *in Colour*.

Weinstock claims that his art is about himself. When asked what he describes himself as, he replies "a sentential holography burns".

He said he saw his art as "less literal" and more with combinations of things. He explained: "With *Flower* I think more about the meaning of making an object into making something to f



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Miters, 1990. Hologram in Birch Frame.



Through the Thickets, 1987. Stained Glass with Holograms.

he explained.

Frames are a distinctive feature of much of Weinstock's work, often serving as an integral feature of his pieces. A 1987 piece titled *Through the Thickets*, based on a painting called *Blue Rider* by Kandinsky, is framed to resemble a piece of stained glass.

One of Weinstock's earliest ideas was to use slumped glass - glass placed on a mould and heated in a kiln so it takes the shape of the mould. He remarked: "I had never worked with glass before so this was a good excuse to learn about it. It often seems like I have to learn a whole new craft every time I want to make a frame."

His ideas often venture into the off-beat, such as a piece titled *Shadow in a Suit* which used a grey flannel suit as a frame.

A 30 x 40 inch hologram made during his residency at the Museum of Holography reminded him of a bad dream and so he decided to frame it in a pillow. Later he extended the idea and now the piece has been incorporated into a 70 inch high bed sculpture titled *Dreaming in Colour*.

Weinstock claims that he hates talking about himself. When pressed he describes himself as a "non-representational holographer with sideburns".

He said he saw his work becoming "less literal" and more a way of playing with combinations of materials. He explained: "With *Flower Power* I started to think more about the materials that went into making an object and less about making something to fit a clever title."

Another change in his work is the incorporation of light sources as integral parts of his pieces. He complained: "I got sick of hearing gallerists complaining about how hard it is to show work that needs to be lit the way a hologram does, so I'm starting to think of the light source as just another element of the sculpture."

And he summed up his current approach to holography by saying: "Because the holograms are more a material to me than finished products, I think of them as sketches."



Flower Power, 1989. Hologram in Wood, Steel and Glass.

Fringe Locking

by Rich Rallison

Why Lock?

In any holographic recording set-up there is a finite probability that the relative phases of the two or more interfering waves will change during the time necessary to complete the exposure; in other words, it is possible that something will move. Any perturbation at all can affect the final uniformity, brightness and viewing aperture of the recording.

Our success as holographers depends on how well we can reduce the probability of an untimely relative phase error. In other words we have to stop everything on the table from resonating, creeping, shrinking, distorting, buckling, flowing, rocking, rolling, sinking, expanding, bowing, settling, slipping or waving in the breeze. We have to stop air currents and stop changes in the air's refractive index caused by heating, etc. Two ways around the problem are to always make only contact copies in thick glass, or to only use a pulsed laser source, or both. For virtually all other tasks we must do what we can to eliminate any and all sources of movement in the air, components or table.

A wise holographer does his best to stabilize the environment and block drafts, uses rigid robust components and tests the table with a Michelson interferometer. Let me suggest that you test your table by setting up an interfe-

rometer with the arms as long as possible and display the fringes on a screen with a grid on it, or if possible place a pair of photovoltaic cells over a fringe and watch the differential voltage change.

Do your best to block all sources of error and let everything settle for an hour, then watch for fringe drift over 1 to 5 minutes. You may be surprised to see that your best efforts could not prevent the measurable displacement of a fringe over that much time. If you are working with a steel table, try holding your hand an inch or two away from the surface and watch the fringes drift slowly across the screen as the table heats up. A few experiments like this will convince you that there is often a good reason to go to the trouble to electronically stabilize your set-up.

When to lock

Production transfer type copying can benefit from stabilized set-ups, which give consistently better results. Exposing in polymers and resists often takes so long that you would be likely to get nothing at all if a fringe locker were not used. In less severe cases the use of a locker for exposures of more than a few seconds will always result in a recording of maximum fringe contrast, which usually means highest possible signal to noise ratios and highest diffraction effi-

ciency. I found that I could not make 8x10 inch reflection transfers into dichromated gelatin (DCG) from transmission masters without a locker on the line.

Most of my experience is with reflection transfers in DCG, as shown in figure 1, or with the fabrication of first generation HOE elements in sizes up to 16 inches square and exposures up to 20 minutes (above which time uncompensatable distortion tends to wipe me out in large formats).

Fringe lockers are best at compensating for simple linear thermal growth or contraction of a table. They also do well with common vibration problems but cannot do much for a flimsy or drafty arrangement. In other words, probably nothing can compensate for incompetence or ignorance of mechanical and optical principles, but when all else fails they can make the difference that counts.

Some of the problems a locker will not help much with include distorting plates or components, uneven heating of components by absorbed light, random graded air drafts, large drifts in laser frequency and large amplitude vibrations or transients. If you have arranged geometries so that fringes sensed by the locker are generated very near the film plane then a hologram will be formed in the local area in spite of the severe movements mentioned, but the rest of the plate will likely be blank, banded or dim.

The allowable movement for a successful exposure varies with the kind of recording being made and is best described in terms of a percentage of a fringe. At 100% fringe movement we get total cancellation, but even 10% is going to be noticeable. Our goal should be 5% maximum allowable, which translates to just 4nm of path length change in the worst case reflection geometry, but which may allow up to 1 micron in a narrow angle transmission set-up.

In general, the benefits of a locker will be most noticeable when making reflection holograms which tend to be several times more sensitive to path length changes than transmission holograms. Stabilization over many minutes with tolerances of under a hundredth of a micron may seem unrealistic, but that is what is required, and is about what you can get from a well made and properly employed fringe locker.

How to Lock

The first step in fringe locking is to get a good look at the fringes that are to be locked onto. They can be magnified at

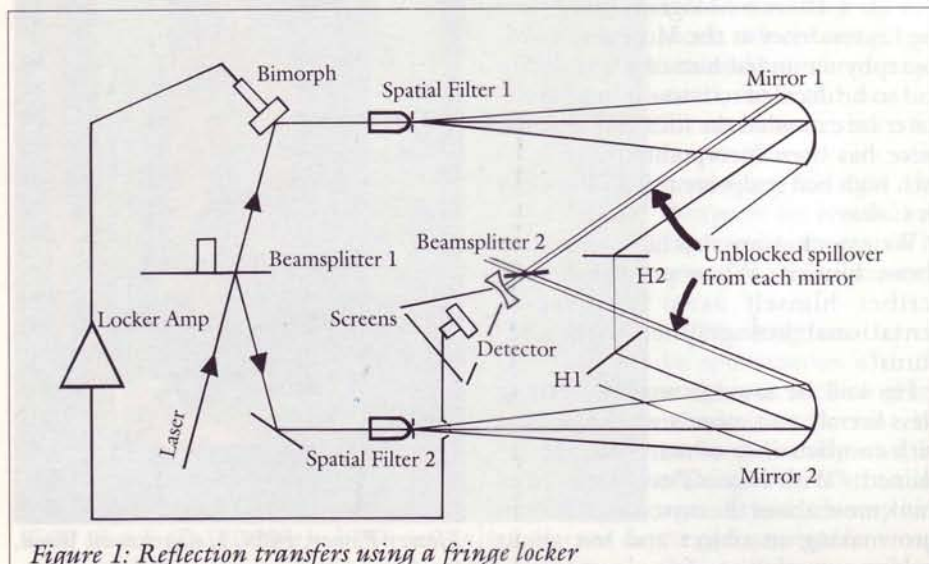


Figure 1: Reflection transfers using a fringe locker

the film plane at the expense of available energy or simply generated near the film plane for easy viewing and sensing electronically. It is very gratifying to be able to easily see with your eyes what is going on in real time so I have always chosen the fringe generation method rather than direct sensing and sampling.

I place a beam splitter behind or to the side of the film holder and orient it so that one of the input beams is reflected to be collinear with the other beam. A small cross scratched into the surface of the splitter helps to align the two beams on a screen placed on a distant separate table. Everything is adjusted to get the best contrast and size. The locker will do fine with only a 1mm fringe, but I like to have a few fringes blown up to several inches wide on a cross hatched white screen so I can watch even the tiniest quiver or catch a fluttering mode or a mode hop during the exposure.

Another very useful method of generating fringes is to make a small hologram in a holder near the film plane and lock onto the moire fringes that result from placing it back in the set-up slightly off its original angle. This presupposes that the set-up is stable enough to make at least a weak hologram without a locker, so if it isn't then it can be very frustrating. Otherwise, this is a very general method and can be used with available diffuse image light rather than the strictly locally available specular light needed for the beam splitter method.

I always opt for the beamsplitter when it is possible to get light where I need it, but have resorted to the hologram/moire method when I couldn't find it only slightly more cumbersome. One pleasant benefit is that it always produces straight fringes over a large area whereas the splitter may only yield the distorted centre of a zone plate with a single pair of fringes to lock onto and view. Since the task is usually to compensate for table growth it is also possible to create fringes using a completely separate laser with optical paths running parallel to the holographic set-up with one shared mirror.

The next step may have preceded the first step but not necessarily so. A transducer capable of introducing an optical path length change has to be introduced into one leg of the set-up. The common choice is to reflect off a mirror mounted on a piezo bimorph or a speaker coil. A bimorph is a metal disc coated with a ceramic material which shrinks or grows depending on which way a voltage is applied; with 30V in one direction, the disc

distorts like a drum head and moves a mirror about 3 microns.

Some drivers such as the Stabilock II move a bimorph far enough to be used in transmission mode by translating a wedge or prism to introduce a relative phase shift or optical path length difference (OPD). If two prisms are used it is not necessary to include the transducer in the original set-up prior to finding or generating fringes; the assembly may be pushed into place after the fact with only minor adjustments to prior alignments.

The two methods are illustrated in figure 2. Before making the choice of mounting wedges on your bimorph consider that it moves over about 6 microns, which may represent 30 fringes using a mirror at reasonable angles, but will be only 7 or 8 fringes when used with a 45° prism of refractive index equal to 1.5. OPD equations are given for each configuration where L is the maximum bimorph travel and n is the index of refraction of the prism.

Setting up the Stabilock

The final step is connecting and adjusting the electronic hardware. The electronics of the Stabilock II consist of a simple but subtle differential amplifier with a few tweaks for fine tuning. The amp is required to be both stable and high gain, responding to slowly drifting inputs and an occasional sharp transient or harmonic oscillation. In order to lock with a 20th of a fringe or better tolerance, the gain has to be as high as it can go without running the whole system into instability. The gain control is turned up until the fringes fuzz out and then it is backed off to where they are first clearly visible and solidly locked.

The frequency response or damper control may be left up all the way which will at least clip random transients. If this type of vibration is not likely, however, the system will have higher gain if the frequency response is set to lower frequencies only (this is known as "rolling off" the higher frequencies). As with everything, there is a trade-off involved.

Each set-up has its own peculiar resonances and weaknesses which can all be observed if you have generated an easy viewing port away from the set-up with large bright fringes. The general rule is that you tweak all controls and watch for the effects in your visual port or screen. Then, go for the hardest lock which comes by backing off a little from an unstable operating point.

After I get it all tuned up as best I can I stomp on the floor and tap the table

and a few suspect components to find and fix any problems with the locker off and then on. Next I begin rapid fire shooting, relying on the locker to compensate for about a fringe worth of movement in every shot. The locker will allow you to significantly increase your throughput as it cuts settling time dramatically in a production set-up.

I have used by now 6 different fringe locker designs and I really like the newest unit from MEI, the Stabilock II. It has an illuminated scale to let you know if it will work with available light and to centre the bimorph travel. The same scale lets you track the action during exposure and even measure the amplitude and direction of the drift. The dynamic range is the range of usable input en-

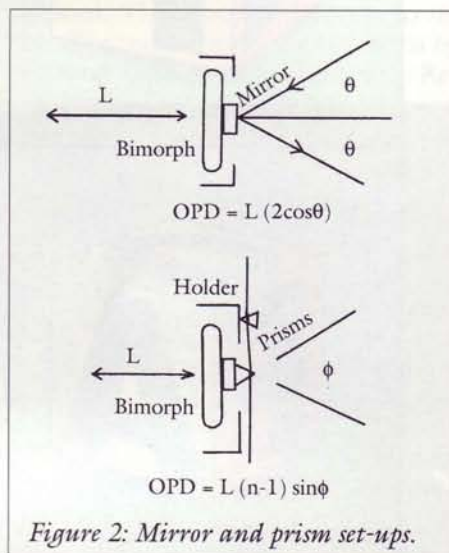
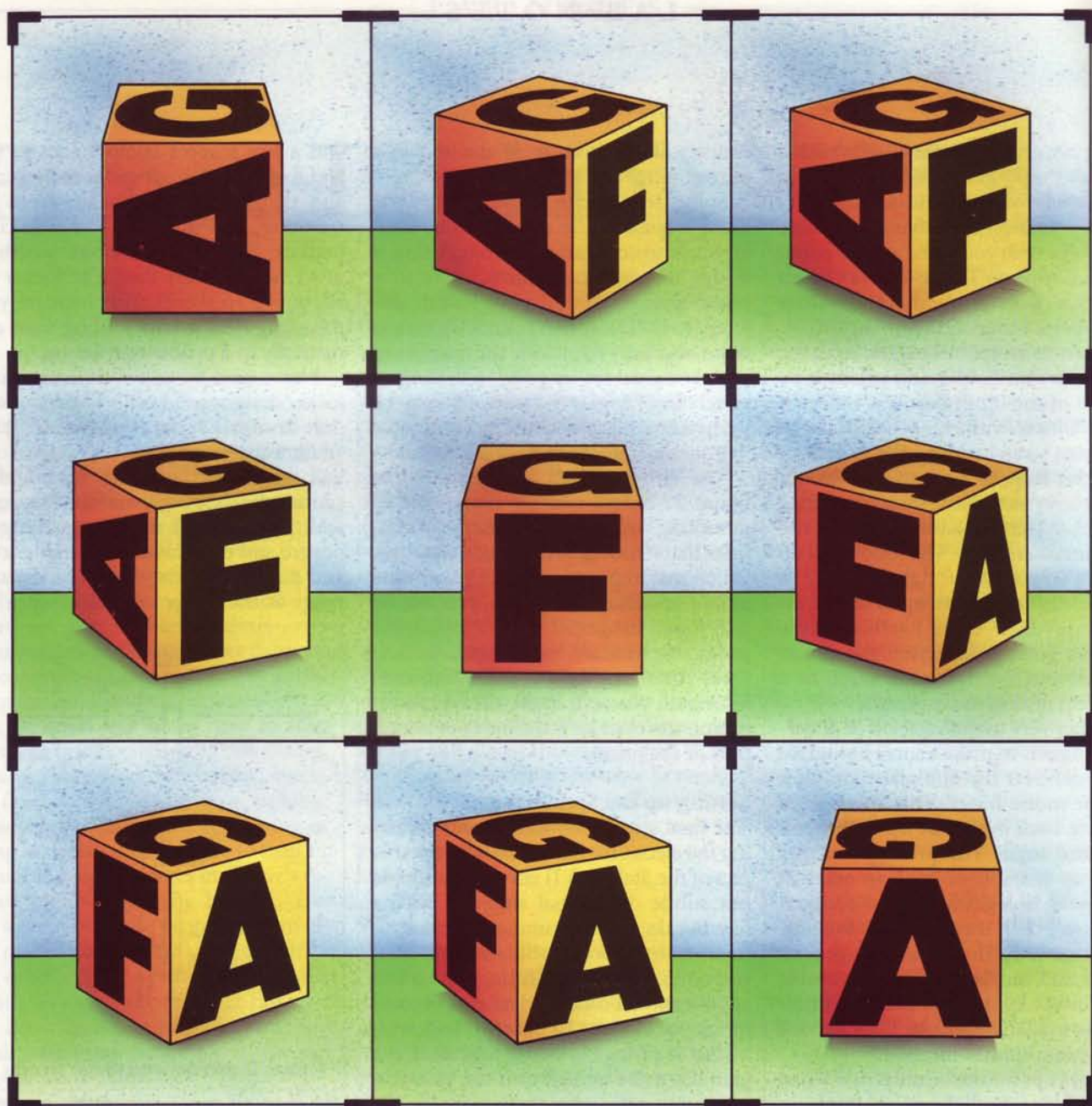


Figure 2: Mirror and prism set-ups.

ergies and is very large on this model.

The gain is incredibly high which means it will oscillate but it will also lock on very tightly. The stability is better than the specification of a 20th of a wave when care is taken to generate large clean smooth fringes. The sensors are simple, rugged photo diodes in a balanced differential pair and the bimorph is damped and rigidly mounted. Drift is very low without feedback and essentially zero after a lock is made. Monitoring via a strip chart recorder is made convenient from a BNC output connector.

Fringe locking is often advisable and sometimes necessary for successful production runs. First timers are advised to experiment with their tables, not only to discover how to use the equipment but to determine what is moving and what is not in any set-up. Locking is only difficult for the first couple of times, although it may require a little ingenuity and patience to generate fringes, and eventually experimenting with lockers can even be fun.



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MIT Does it in Four Dimensions

by Sunny Bains

Holography has recently come one step closer to producing the kind of holograms so far seen only in Star Wars: animated holograms generated by computer and output either in real time or from an electronic recording. This breakthrough, from the Spatial Imaging Group of the Massachusetts Institute of Technology Media Lab, uses an acousto-optic crystal to project the holographic image.

There are three basic steps to this technique. Firstly the hologram is generated on a computer, then it is transmitted to the acousto-optic crystal, and finally the image is manipulated with an optical system so that the hologram can be viewed.

Taking the final process first, figure 1 shows a generalised image relay system which will take a 3D image and transfer it to a position where it can be viewed easily. The objective lens forms a real image of the 3D scene and the field lens corrects distortions which the objective lens introduces, as well as preventing vignetting.

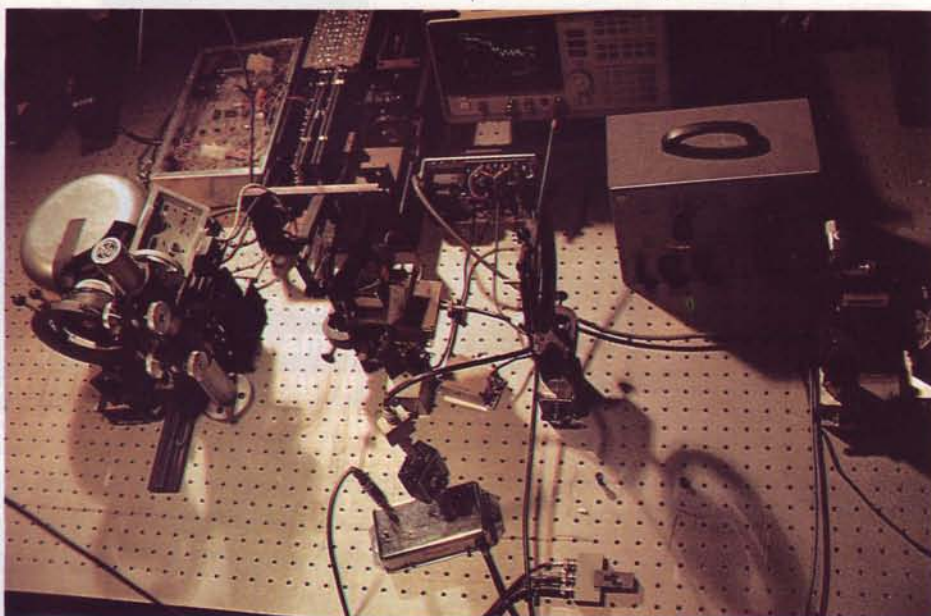
Of course, with holography it is relatively straightforward to build the optical system into the hologram itself. The objective lens, for example, can be built into the computer generated hologram (CGH) so that only the field lens is required to be present in the viewing system: this is known as 'breaking' the optical system holographically. Of necessity, then, the optical viewing system must be decided before the generation of the holograms can take place.

The hologram is made by creating a 3D scene within the computer (which may or may not include some of the display optics), 'illuminating' the object

from an appropriate place, and adding a reference beam: all this is done mathematically. The computer then takes samples of how all the light has added up (and interfered) at particular points. These points will each be represented as a pixel in the final hologram. The size and spacing of these points (which you can liken to the grain size on a conventional hologram) have to be calculated

area through which the 3D scene can be viewed). If we take a 10x10 cm aperture using the optical system shown in figure 1, we can calculate the SBWP for a hologram made in the image plane (at L2) with a reference point source along side L1. In fact this works out to be 1×10^9 samples or pixels on the computer generated hologram. If each point is defined as one of 256 grey scales (8-bit resolution) and the hologram frames are updated at 36 frames per second then this corresponds to 288 gigabits/second: too much information for existing technology.

So, though the hologram could be calculated, it would take far too long for a real time system: therefore the information content of the hologram has to be reduced. There are several ways to do this. The most obvious, of course, is by reducing the aperture/scene size. Re-



The apparatus used to produce moving holographic images at MIT's Media Lab.

before the computing is done.

The quantity which defines the amount of information (number of points or pixels) carried through this system is the 'space bandwidth product' (SBWP). This is related to the maximum spatial frequency (number of cycles per millimetre) of the hologram. Because there must be at least two samples per cycle in order to see the pattern, in one dimension the SBWP (number of samples to be taken in a line) is equal to twice the maximum spatial frequency multiplied by the length of the line to be sampled. In 2D this line of sampled points becomes a grid and is simply the product of horizontal and vertical samples.

This quantity, therefore, is proportional to the area of the aperture (ie. the

ducing a 10x10 cm hologram to 5x5 cm will reduce the information content by a factor of 4.

Another major saving can be made by sacrificing vertical parallax. In effect this means reducing the vertical aperture height to the minimum possible while keeping the resolution at the required level. Losing vertical parallax, however, introduces astigmatism to the system. This means that the depth and projection of the holographic image have to be limited so that blurring does not become too much of a problem.

If 0.5 dioptre astigmatism is the maximum which is considered acceptable, then the image can only be 16.7cm deep and project by 10cm. A vertical diffuser (figure 2) also has to be introduced in



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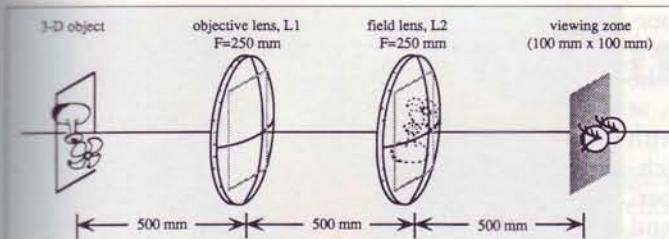


Figure 1: The generalized image relay system

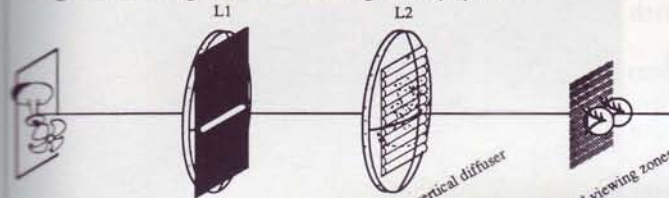


Figure 2: Horizontal parallax only imaging.

order to extend the angle of view from just a narrow slit. This function is carried out by a cylindrical lens in the display apparatus.

The slit width is given by the product of wavelength, distance, and number of horizontal lines per frame, divided by frame height. This is 0.41 mm for a 5 cm hologram with 64 lines per frame. This reduces the information content by a further factor of 123.

So the data rate comes down to about 7.3×10^7 pixels, or 584 megabits per second, which is within the range of existing computers, such as the *Connection Machine*. This is a computer with sixteen thousand microprocessors arrayed in a massively parallel SIMD twelve-dimensional hypercube architecture (or, in simple terms, a supercomputer).

Once the hologram has been calculated, it is sent line by line down an optical fibre and ultimately to an ultrasonic transducer. Here the optical signal, already changed into an electrical signal, is further changed into a sound wave. The wave propagates through a TeO₂ acousto-optic modulator: this is a crystal which undergoes a change of refractive index when it is exposed to sound.

Using shear waves, the crystal's bandwidth is between 50MHz and 100MHz which corresponds to between 162 and 324 pixels per millimetre. Because, for holography, 628 pixels per millimetre are required (twice the maximum spatial frequency of the hologram) optical reduction of the pixel spacing has to take place.

A HeNe beam is passed through the crystal at right angles to the sound wave to reconstruct the hologram. However, at this stage the image cannot be seen. Because the sound wave is moving along the crystal at 617 metres/sec, the hologram and the image are moving with it.

As each frame of the animation passes through the crystal the image sweeps from one side to the other, before starting again for the next frame.

To stop this movement, ie. to keep the frame still until the next is ready, the image is reflected off a polygon which acts as a scanner, deflecting the hologram in the opposite direction and so keeping

the image still. This process has another effect: by moving the image, the scanner is also moving the virtual position of the crystal. In other words, the scanner multiplexes information which is released over a period of time (the time taken for one frame to pass from one end of the crystal to the other).

Because the computer generates the hologram line by line, another scanner moves the image vertically to put one line on top of the other. The image is passed through the field lens to de-magnify it and the result is a moving three dimensional object, floating in space in front of the lens.

The holograms made at MIT were of wire-frame objects made up of a series of luminous points (so no other lighting conditions needed to be taken into account). Occlusion, that is the removal of surfaces or edges which are obscured by points in front, is an important depth cue and is approximated using a technique based on geometrical shadows.

The system can be truly interactive: ie. it can be edited in almost real time. So far the system can respond to a new instruction within seven seconds of the in-

struction being given to the computer. Also, by pre-recording the holograms, they can be moved into the frame-buffer in rapid succession giving up to 15 frames per second of animation: this appears as continuous motion.

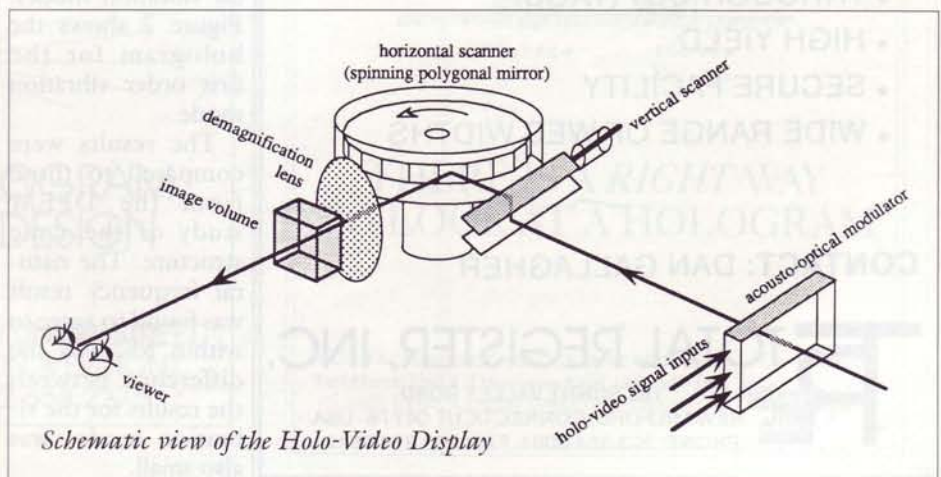
One obvious use for the system, even at its present relatively primitive stage, is testing computer hologram generation techniques: the result of using a new algorithm can be seen within seconds, in contrast to the much longer times taken for laser printing or electron-beam writing techniques.

For the future, the answers seem to be more and faster. Putting more computers and/or acousto-optic modulators in parallel, for example, could significantly improve the size, quality and frequency of the holograms. Ultimately colour could also be used in this system.

While waiting for computer technology to catch up with them, MIT researchers will be looking into using real-world data sources so that the system could be used in medical imaging or computer-aided design. Experimenting with higher bandwidth crystals to increase the size and resolution of the image is probably the highest priority, however.

The work described here was carried out over the last few years by a team of graduate students and research associates at the Media Laboratory supervised by Prof Stephen Benton. Among them were Mary Lou Jepson, Joe Kollin, William Parker, Pierre St Hilaire, John Underkoffler and Hiroshi Yoshikawa. The research was sponsored by USWest, DARPA, and General Motors.

For further information, see *Experiments in Holographic Video Imaging* by Stephen A Benton in the proceedings of the SPIE Holography Institute meeting which took place in Tatabanya, Hungary in June 1990.



Schematic view of the Holo-Video Display

Modelling for Quake Resistance

Researchers at Tianjin University in China have used holographic interferometry to study vibration properties of complex building structures, in order to test their suitability for construction in earthquake zones.

To ensure that proposed buildings are earthquake proof, it is important to study their natural vibration properties. The natural frequency vibration modes of the building must be substantially different from likely earthquake vibration frequencies, or it may become unstable.

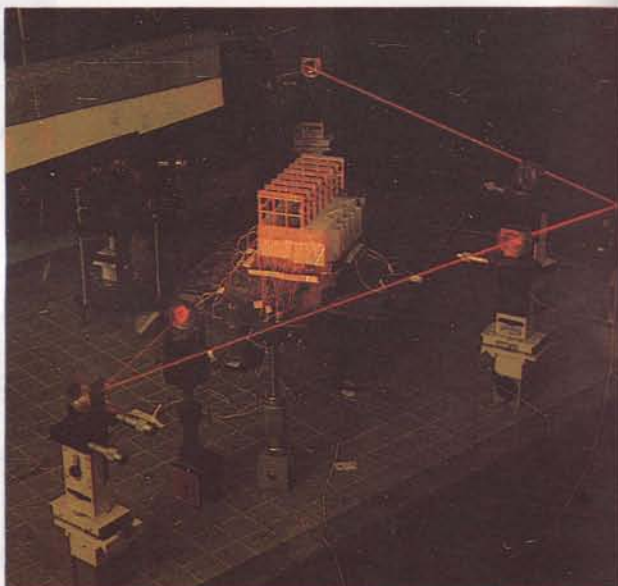
At present the main technique used for testing vibration properties is the dynamic finite-element method (DFEM). This is a mathematical analysis performed by computer which determines how a given mechanical loading will move or stress each small section of the structure. However, Lan Qi of the De-

partment of Water Resources and Harbour Engineering, and Hongen Gu of the Department of Physics, at Tianjin have come up with an interferometric technique which can be performed on models and gives results which are reasonably consistent with DFEM.

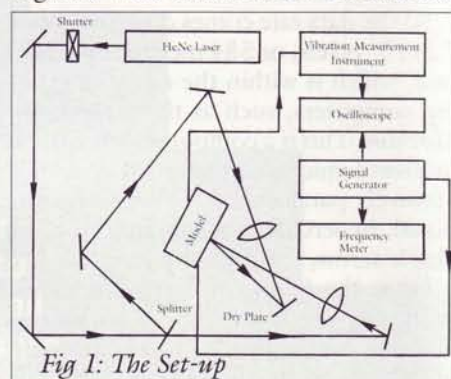
The first model used was of a single-storey hydroelectric power station which was being constructed in an earthquake zone. The 1:200 plexiglass model was glued to a piece of thick metal, which simulated the base of the real construction. Piezoelectric ceramic plates (which deform when a voltage is applied) were glued onto the lower part of the model. The model was vibrated by connecting some of these plates to a sine-wave voltage generator, with the remainder acting as sensors. When the vibration frequency reached the structure's natural vibration frequency, the model vibrated in resonant mode.

As the model vibrated at different orders of its natural vibration frequency, holographic interferometry was used to obtain time-averaged holograms of the system (see figure 1), which were then analyzed to obtain the natural vibration modes of the model. In this experiment, holograms were obtained for the first three orders of natural vibration modes. Figure 2 shows the hologram for the first order vibration mode.

The results were compared to those from the DFEM study of the same structure. The natural frequency result was found to agree to within 5%, and the difference between the results for the vibration modes was also small.



The experiment was then repeated using a model of a proposed sluice system combined with a pier, a ten-arch road bridge, a work bridge, and other structures. Though many simplifications were made for ease of modelling (including reducing the number of arches and changing the number of supports), holograms were obtained for the first five



vibration modes and the results were still within 5% of those obtained with DFEM.

The Tianjin researchers believe they have shown that the interferometric method can be used effectively with complex hydraulic structures. In the future they hope to combine holographic and speckle interferometry to improve their results further.

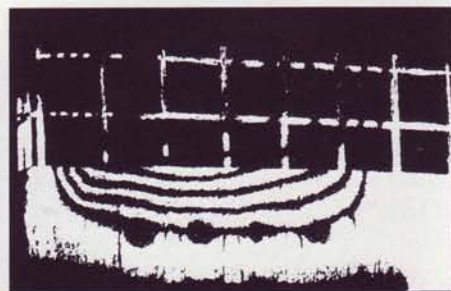


Fig 2: Hologram of first vibration mode.

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Light in the Darkness

Holographic optical elements are being used in new night vision goggles developed by OIP Instrubel of Belgium.

In conventional night goggle systems, instead of directly seeing his surroundings the viewer sees a picture produced by an image intensifier, allowing him to "see in the dark" electronically. The main problem with this is that the image intensifier saturates when it receives too much light, requiring the viewer to take off the goggles in order to see.

By using a HOE as an optical combiner, OIP Instrubel has eliminated this problem. A holographic mirror reflects the intensified image into the viewer's eyes, and allows him to see both this image and the real world at the same time. This is because the holographic mirror only reflects light which is incident at a certain angle and remains transparent to light from other angles. The in-

tensified image is incident at a shallow angle and is reflected into the eyes, while the real image is incident at 90 degrees



The new Holographic Night Vision Goggles, model HNV-1.

and passes through the mirror, also into the eyes.

In practice, if there is enough light to saturate the intensifier then there is

enough light for the viewer to see out of the goggles directly. As it gets darker the intensified image becomes predominant, although both are in fact seen superimposed all the time.

At present, OIP Instrubel is producing about 50 pairs of night goggles per month, each containing four DCG HOEs. These are manufactured in a cleanroom environment by a fully automated processing robot. The company also has in-house optical manufacturing and test capabilities.

The company plans to become a design, manufacturing and marketing centre for holographic components and systems, and is interested in contacting other companies which have developed a holographic product but do not have production and/or marketing capabilities. It is also offering development and manufacturing assistance with holographic components and subsystems.

Contact OIP Instrubel at Westerring 21, B-9700 Oudenaarde, Belgium. Tel: (+32) 55 333811. Fax: (+32) 55 316895.

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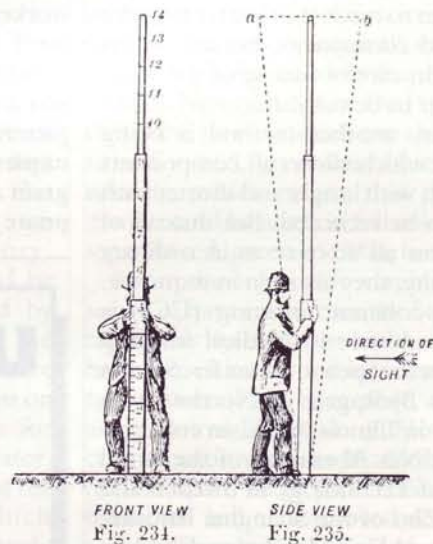
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holography

Light-In-Flight Applied to Medicine

Using visible light in medical imaging would be beneficial as it is non-ionizing and therefore completely harmless to patients. However, since light is scattered greatly by skin and other tissues, it is not possible to obtain clear images by simply shining light through the body.

One way that researchers have tried to overcome this problem is by using ultra-

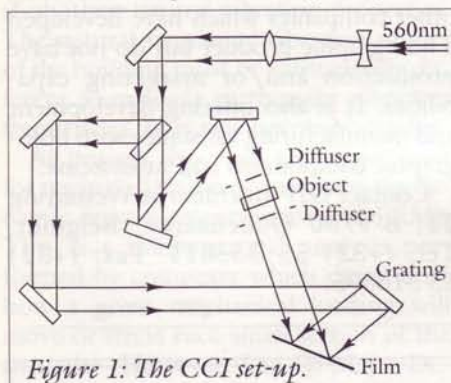


Figure 1: The CCI set-up.

fast shutters. Since the scattered light takes longer to reach the shutter than the unscattered component, because of its longer path, careful timing of the shutter allows it to be cut out.

However, another method is being developed which allows all components of the light, with longer and shorter path lengths, to be recorded. But instead of seeing them all at once as in ordinary photography, they are seen in sequence.

Chrono-coherent imaging (CCI) is the latest advance in medical imaging from Kenneth Spears, Jennifer Serafin and Hans Bjelkagen of Northwestern University in Illinois, USA, in collaboration with Nils Abramson of the Royal Institute of Technology in Sweden and Xinming Zhu of the Shanghai Institute of Optics and Fine Mechanics, China.

The CCI system makes use of the most fundamental concepts in holography: that only beams of light which are coherent will interfere to form a hologram; and that the depth of the hologram is the same as the coherence length. Since a light pulse has a very short coherence length, if a pulse is split into a reference and object beam in order to make a hologram these will only interfere when their path lengths differ by no more than one coherence length. For a pulse of 1 picosecond, as used by the Northwestern

researchers, the coherence length is 0.3mm.

If an irregular object is placed in the path of one of the beams, then differences in path length will be introduced. If the reference beam is coming from the right at an angle to the holographic plate (as in figure 1), then the unscattered light from the object beam will interfere with it further to the right than the scattered light, which has a longer path length and so will interfere with the reference beam where its path also is longer. This is light-in-flight holography.

What this means is that a continuum of different holograms is formed corresponding to the different path lengths. As a reconstructing laser beam is moved from right to left along the hologram plate and each hologram is viewed in turn, a changing image is seen corresponding to the time at which the exposure took place.

In initial experiments, this system has worked well. The researchers used a letter E (8mm high with a 2.5mm line width) sandwiched between two diffusers as the object. The letter was completely invisible to normal visual techniques, but by recording a CCI hologram and reconstructing it at the appropriate point with a HeNe laser, the letter

could be clearly seen.

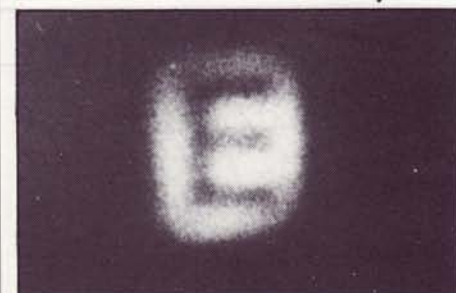
One drawback with this system is that a high-power pulse is needed to form an image, since a large amount of the light is absorbed by the object. Also, because the coherence length is very short, some useful rays which happen to have taken a longer path are missed. This decreases the resolution.

Early experiments suggest that imaging is possible through about 6.4cm of breast tissue, for example, which suggests that many clinical applications are possible. Work now in progress involves testing full-thickness replicas of possible objects to better define the limits of the system.

Given that even low doses of ionizing radiation are considered to increase the risk of certain health problems, any system which gives doctors an alternative to X-rays, even if in only a limited number of cases, could make a valuable contribution to good medicine.

For a full paper on CCI, see *Chrono Coherent Imaging for Medicine* in IEEE Transactions on Biomedical Engineering, vol 36, no 12, December 1989.

Sunny Bains



Result: the object seen through diffusers.

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Getting into Print

The development of a holographic printer to produce permanent copies of computer-generated graphics will be a dramatic leap forward for the holographic industry. Finally, 3D recordings of medical, architectural, and other computer graphics, displayed with nothing more sophisticated than a flashlight, could become routine.

Stereo systems to turn computer graphics into holograms already exist, but even the best of these require a hard copy (usually a photographic slide) of the graphic to make the actual hologram. In general, such systems are expensive and inconvenient.

At the Tokyo Institute of Technology researchers are working on a full parallax printer which takes data directly from a computer. Their technique is quite similar to that used to make conventional stereo holograms, but instead of vertical hologram strips the final hologram consists of many small hologram points.

Once a graphic has been designed, the computer "views" it from an array of viewpoints, and records each view. These pictures are then displayed on a liquid crystal screen. Light from a HeNe laser passes through the screen and is focused

by a lens. The hologram is recorded close to the focal point of the lens so that the recording is small and circular.

This hologram, the equivalent of a pixel or dot on a 2D image, is known as a voxel as it contains information about the volume of the object. The size of the picture used to make the voxel is determined by the viewing angle required of the hologram, the focal length of the lens, and the size of the voxels. The ultimate size of the hologram is immaterial, except in how it changes the desired viewing angle, and is limited only by the time available to make it.

The system being developed in Tokyo uses a Sun-4 workstation, a computer used in industry for designing in 3D which is about ten times faster than, say, an Amiga or Macintosh. Using this machine it takes half a second to calculate a 64x64 pixel picture for each voxel. Thus the hologram shown, which has 160x128 voxels, took about 3 hours of computer time. However, it took over 50 hours to actually record the hologram using the printer; ten seconds per voxel.

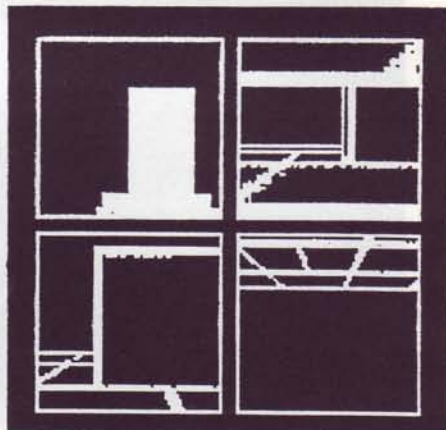
Masahiro Yamaguchi, Nagaaki Ohyama and Toshio Honda of the Tokyo Institute say that this is because

of the time taken to transfer data from the computer disk memory to the frame buffer or printer memory. This time could be greatly reduced by calculating all the pictures in advance and storing them on an optical disk for playing back later, and this is one of the techniques which they are currently working on.

Using this method the Tokyo Institute team believes that the time taken to expose each hologram could be reduced to about 0.1 seconds, bringing the time taken to make the same hologram down from 50 to 5 hours. With

pre-calculated data, it would be possible to make many exposures in parallel, with each additional optical head further cutting down the total exposure time.

The hologram shown was made using conventional holographic processing techniques. If this type of printer were to become a piece of office equipment it would clearly be a disadvantage if wet processing were required, even if it were done automatically; the chemicals would



Examples of views which are made into point holograms, or voxels.

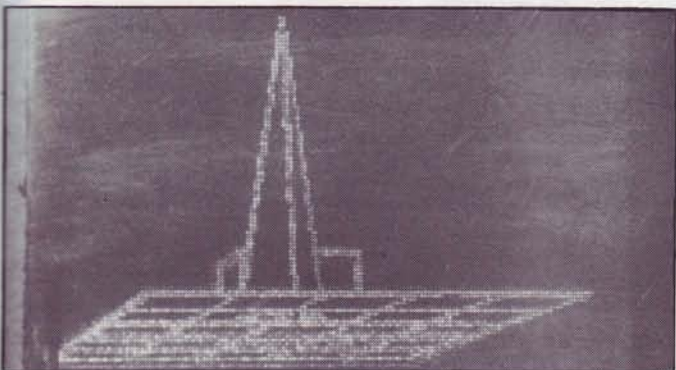
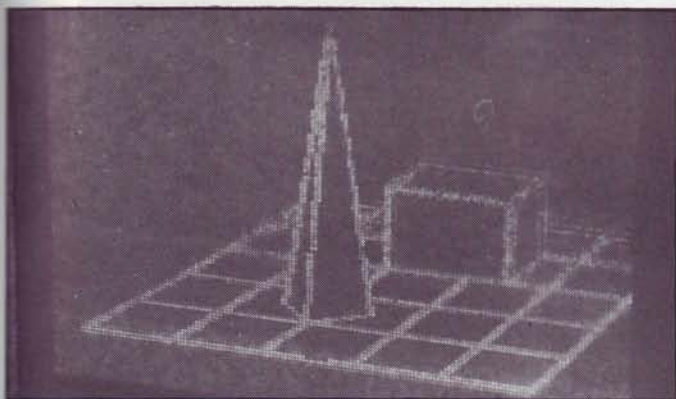
still need to be replenished and the processing equipment maintained.

Aware of this problem, Yamaguchi says he hopes to explore materials which need no wet developing at all, specifically the new photopolymers from E I Du Pont de Nemours & Co. Du Pont claims that these new materials can also be sensitized to red, green and blue simultaneously, which means that the holograms could be made in full colour using separate red, green and blue laser beams.

So far, the only major stumbling block seems to have come from the liquid crystal display systems; multiple reflections have caused unwanted interference patterns, contrast has been poor, and there are not enough grey scales. However, in collaboration with the Matsushita Electric Company these problems are being overcome and an improved display system has already been released.

With a holographic printer based on this technology and equipped with half a dozen optical heads, recording a 1000x1000 voxel hologram would take just over four and a half hours, or three times that if it were in colour. If and when such a printer becomes available the remaining problem will be to come up with a way to cut down the 17 days it would take with presently available computers to calculate the data for the hologram in the first place!

Sunny Bains



This hologram of a computer graphic, shown from different angles, took 50 hours to make using a single optical head.



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Du Pont Controlled Sales

OmniDex 352, a blue/green sensitive photopolymer which requires no wet processing, is now available from EI Du Pont de Nemours & Co of the United States. However, the material cannot be yet be bought off the shelf and is only available for use in display holography.

This photopolymer is the first to be released of a whole series which the company has been working on, and it is still being treated as experimental. Customers who wish to use OmniDex 352 must apply to Du Pont, explaining what the material is to be used for and how.

They must also sign a contract preventing them from disclosing the chemical content of the polymer or from patenting processes involving the material without reference to Du Pont.

Krishna Doraiswamy, Du Pont's Marketing Manager, explained that if those working with the material were allowed

to patent ways of using it, the company could find itself unable to sell the product. The contract, he said, would mean that after the experimental period, OmniDex would be available to everyone for all uses and not just for applications which had not yet been patented.

The OmniDex photopolymers need only to be exposed to white light and then baked in order to fix the hologram. Du Pont also says that 352 offers a predictable playback wavelength which can be tuned using another dry processing technique Du Pont has developed.

For further information about Du Pont's photopolymers, see issue 7 of *Holographics International*. If you wish to collaborate in developing uses for the material, contact Du Pont Imaging Systems, Optical Element Venture, PO Box 80352, Wilmington, DE 19880. Tel: (+1) 302 695 4893.

Three Colours: One Laser

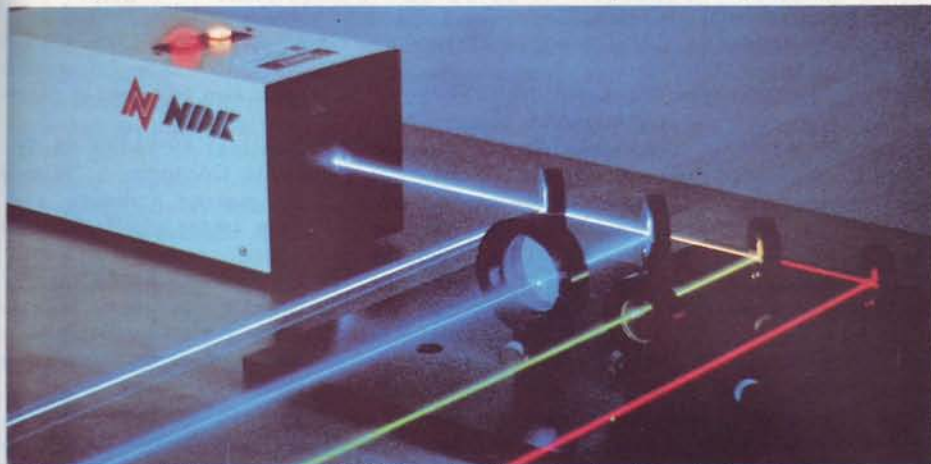
A laser with coherent red, green and blue lines is now available from Nihon Dempa Kogyo Co Ltd (NDK) of Japan. Called RGB Lasers, they are negative glow discharge hollow cathode HeCd⁺ lasers and are, the manufacturers claim, the first of this type to be commercially available.

The special feature of the RGB is that

um method, only produce four lines, mainly blue and ultraviolet.

This laser may be useful for full colour holography: the coherence lengths are more than 30 cm for red and green and about 10 cm for blue, which are long enough for small holograms. The blue line does, however, contain a TEM₀₁ (or donut) component in the RGB 300 (35mW) and 400 (50mW) models, although for the RGB 310 (15mW) the blue is TEM₀₀ only.

Intensity matching is reasonable,



it has green (533.7nm and 537.8nm) and red (635.5nm and 636.0nm) lines which oscillate simultaneously with the blue line (441.6nm). It also produces seven other lines (in the infrared and ultra-violet), but the RGB selects only the primary colours. Conventional HeCd⁺ lasers, which use the positive col-

though the blue is between two and three times greater than the red and green. Although the green lines are not as good as with an Argon Ion laser, for reasons of colour balance, the laser does cover a high proportion of the chromaticity diagram.

For further details about the RGB

Position Precision

MEI of Utah, United States, is marketing a low cost linear positioner for use in step and repeat processes, such as stereogram exposures. The US\$1490 system includes a 24 inch track with total carriage travel of approximately 18 in, and a programmable control board.

The positioner, which operates on a 120V AC supply, can move in discrete steps as small as 0.001 inches, and also allows continuous movement. The controller allows the increments of movement and velocity to be varied. It also incorporates a battery back-up to preserve programmes.

MEI is at 270 North 400 W, Hyrum, Utah 84319, USA. Telephone: (+1) 801 245 6911.

range of lasers contact NDK, Laser Sales Division, Sayama Factory, 1275-2, Kamihirose, Sayama-shi, Saitama 350-13, Japan. Tel: (+81) 429 52 7211. Fax: (+81) 429 54 3968.

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Notes on Listings

On this page is a listing of patents published in English, and opposite is the first of an occasional series of articles about patents. The author, David Pizzanelli, is a freelance holographer currently on a short-term contract with Light Impressions Europe Plc.

All patents here are assumed to be written in English. The format is as follows: country code/patent jurisdiction, date published (DD-MM-YY), patent number (#), authors/organization, and title.

Country codes are as follows: AU-Australia; CA-Canada; EP-European Patent; GB-Great Britain; IL-Israel; PL-Poland; SU-Soviet Union; US-United States; WO-World Intellectual Property Organization. Dates follow on from patents in last issue, up to March 1990 (latest available as we go to press).

It is important to note that some patent jurisdictions are excluded, notably Germany and Japan, because their papers are not written in English.

multiple-layer holography.

- AU 16-11-89 #34849/89, ICI Plc, *Photopolymerizable compositions suitable for recording holographic information.*
- AU 14-02-89 #591741, Ciba-Geigy AG, *Security Hologram.*
- AU 14-12-89 #591742, Ciba-Geigy AG, *Treating Gelatin in Hologram Process.*
- AU 21-12-89 #591960, The Babcock & Wilcox Company, *Video receiver generated holographic display.*
- AU 22-02-90 #593862, Ilford Limited, *Hologram prints.*
- AU 01-03-90 #39956/89, Nigel Murray Platt, *Holographic imaging and display.*
- AU 05-01-90 #37731/89, Michael Teitel, *Master hologram and micropattern replication method.*
- CA 26-09-89 #1259831, Hitachi Ltd, *Hologram lens.*
- CA 30-01-90 #1264968, Satori Limited, *Holograms.*
- CA 20-03-90 #1266795, Trilone Holography Corp, *Photographic booth with automatic holography camera.*
- CA 13-03-90 #1266579, Satori Limited, *Holograms.*
- EP 27-09-89 #333785, Hughes Aircraft Company, *Colour display device and method using holographic lenses.*
- EP 27-09-89 #334631, Fujitsu Limited, *Beam scanner.*
- EP 02-11-89 #339079, Denison Manufacturing Company, *Embossing of coated sheets.*
- EP 02-11-89 #122783, Fujitsu Limited, *Method and apparatus for light beam scanning using a hologram.*
- EP 08-11-89 #116896, Hitachi Ltd, Hitachi Koki Co Ltd, *Method of making a hologram lens and optical information processing equipment containing such a hologram lens.*
- EP 15-11-89 #317685, Research and Therapeutic Institute "Ophthalmos SA", *Holographic lenses for ophthalmological use.*
- EP 29-11-89 #135047, Hitachi Ltd, *A method of producing a hologram lens.*
- EP 06-12-89 #344696, Eastman Kodak Company (A New Jersey Corporation), *Holographic scanner spinner.*
- EP 20-12-89 #346869, Hughes Aircraft Company, *High efficiency holograms by*

- multiple-layer holography.*
- EP 10-01-90 #132724, Rubenberger, Karl, *Method and apparatus for the recording and reconstruction of holograms.*
- EP 10-01-90 #349634, Microelectronics and Computer Technology Corporation, *System and method for photorefractive holographic recording and signal processing.*
- EP 10-01-90 #350014, Canon Kabushiki Kaisha, *Volume phase type hologram and method of manufacture thereof.*
- EP 31-01-90 #352774, El Du Pont de Nemours and Company, *Photopolymerization sensitizers active at longer wavelengths.*
- EP 07-02-90 #124442, Commissariat a L'Energie Atomique, Paris, *Method and device for acoustic holography using an ultrasonic beam limited in space.*
- EP 07-02-90 #353602, Hughes Aircraft Company, *A system for reducing noise holograms.*
- EP 07-02-90 #353603, Hughes Aircraft Company, *Thin foil hologram.*
- EP 07-02-90 #353748, Sharp Kabushiki Kaisha, *A process for preparing blazed holograms.*
- EP 21-03-90 #278714, Holtronic Technologies Limited, *Improvements in apparatus for the positional detection of objects.*
- GB 04-01-90 #2220277, Na-

tional Research Development Corporation, *Holographic systems.*

- GB 10-01-90 #2195784, Leningradsky Institut Yader, *Apparatus for synthesis of elongated holographic diffraction gratings.*
- GB 10-01-90 #2220503, National Research Development Corporation, *Holographic camera.*
- GB 24-01-90 #2221057, National Research Development Corporation, *"Holographics apparatus".*
- GB 31-01-90 #2221325, GEC-Marconi Limited, *Optical elements.*
- GB 07-02-90 #2221550, Chubb Electronics Limited, *"Holographic Data Carriers".*
- GB 14-02-90 #2192292, Leningradsky Institut Yader Noi Fiziki Imeni B P Konstantinova Akademii Nauk SSSR, *Apparatus for copying holographic diffraction gratings.*
- GB 21-02-90 #2194353, William Bell Hugle, Holtronic Technologies Limited, *The method of and apparatus for the holographic positional detection of objects.*
- GB 21-02-90 #2222000, Glen Dimplex Limited, *Optical component used for flame effect in heating apparatus.*
- GB 14-03-90 #2222696, Ektach Ltd, *Holographic diffraction gratings.*
- IL 10-09-89 #89558, Hughes Aircraft Company, *Gas phase hardening of gelatin holograms.*

- PL 30-11-89 #148750, Politechnika Posnanska, PL, *Holographic head for examining combustion engine cylinder liners for condition and wear of their surfaces.*
- SU 15-08-89 #1500965, Grodnenskiy G Universitet, *Method of generating fringe pattern.*
- SU 30-10-89 #1518821, DN G Univ Im.30 o-Letiya Vosso Edineniya Ukra Iny s Rossiej, *Method of registering holograms.*
- SU 30-01-90 #1539518, Borulev Aleksejd, SU, Orlov Sergej, SU, *Methods of producing holographic interferograms.*
- SU 23-02-90 #1545191, Maltsev Georgijn, SU, Smirnov Sergej, SU, *Wave-front pickup.*
- SU 15-03-90 #1550470, Inst Radiofiziki i Elektroniki an USSR, *Method of three-dimensional analysis of light flux.*
- US 08-08-89 #4854674, Hughes Aircraft Company, *Process for improving holographic efficiency.*
- US 05-09-89 #4863224, Afian, Vartanian, Martirosian, Ryabikov, Strebkov, Tve-ryanovich, *Solar concentrator and manufacturing method thereof.*
- US 17-10-89 #4874214, Thomson-CSF, *Clear holographic helmet visor and process of producing same.*
- US 31-10-89 #4877313, Research Frontiers Incorporated, *Light-polarizing materials and suspensions thereof.*
- US 07-11-89 #4878718, US Navy, *Method for holographic correction of beams of coherent light.*
- US 21-11-89 #4882594, Polaroid Corporation, *Method for making a smooth, uniform image of a laser diode array.*
- US 19-12-89 #4888260, Polaroid Corporation, *Volume phase reflection holograms and methods for fabricating them.*
- US 26-12-89 #4889398, Riverside Research Institute, *Self referencing ambiguity free holography.*
- US 26-12-89 #4889780, Hughes Aircraft Company, *Multiple exposure hologram for minimizing crosstalk.*
- US 09-01-90 #4892369, Hughes Aircraft Company, *Holographic rear window*

Public or Patented?

Patents and litigation are again in the news, following the recent suit for patent infringement brought against the US companies Chroma Concepts and The Lasersmith, by American Bank Note Holographics. The seemingly endless case between ABNH and Light Impressions (see both *News* and *Editorial*), as well as the most recent litigation, centres on the patents taken out by the Battelle Development Corporation, of Columbus, Ohio, in the early 1960s.

The bound volume of patents at the London patent office readily falls open at the title page of the first of these fundamental patents by inventors Emmett Leith and Juris Upatnieks, and the pages have been well thumbed. In all probability, however, these are the traces left by an army of patent attorneys rather than reverential holographers.

The fact is that most holographers have tended to ignore the patent lit-

erature, written as it is in its own obscure language, quite unlike anything else either in law or science. Unfortunately, even as holographers look forward to the expiry of the early Battelle patents (some have already expired) in the hope that the litigation will become a thing of the past and everyone can concentrate on the task of making holograms, there are several thousand subsequent patents on holography. Worse still, at least a few of these are sufficiently fundamental to the commonly used processes as to be the cause of future legal battles as holographers begin to earn sufficient money to be worth taking to court.

While many holographers who came into the industry in the 1970s have been quietly getting on with their work, the mountain of patents has been steadily growing, covering every conceivable aspect of the subject. Just about every idea that was though worthy of jotting down

on the back of an envelope a decade (or two) ago has since been filed as a patent and in most cases granted, simply because of a lack of opposition.

This is the case because though a granting of a patent does imply that a search has been carried out by the patent office to ensure that the invention has not already been patented, no real search is carried out regarding the status of the invention outside the closed world of patent literature. Thus ideas which might be thought of as obvious, or already common knowledge amongst holographers, can emerge through the patent system if they are not contested.

After the patent has been granted there is usually a short period during which protests from interested parties can be lodged, but when this time has expired, the only way to challenge the validity of a patent is through the courts. This can prove exceedingly expensive, especially for small companies and individuals, so that litigation becomes a war of attrition wherein the side with the biggest bank balance has more chance of winning. Finally, it often seems that the lawyers on both sides are working towards a common goal: to make the case go on for as long as possible.

Studying the patent literature can, therefore, forewarn holographers of problems they may be storing up for themselves in future.

David Pizzanelli

stop light.

- US 16-01-90 #4893887, EI Du Pont de Nemours and Company, *Holographic image transfer process.*
- US 23-01-90 #4895419, Ciba-Geigy Corporation, *Contact copying of reflection or volume holograms.*
- US 30-01-90 #4896929, Xerox Corporation, *Holographic display module for displaying machine status.*
- US 06-02-90 #4898436, National Aeronautics and Space Administration, USA, *Spatial light modulation in compound semiconductor materials.*
- US 06-02-90 #4899318, Etienne Schlumberger, Maurice Schlumberger, *Method and device for reconstructing the shape and position of objects in space.*
- US 13-02-90 #4900111, American Bank Note Holographics Inc, *Embossed holograms formed on hard metal surfaces.*
- US 20-02-90 #4902082, Nissan Motor Co Ltd, *Projector device for vehicular display.*
- US 20-02-90 #4903314, Grumman Aerospace Corporation, *Single plate compact optical correlator.*
- US 27-02-90 #4904033, Fujitsu Limited, *Method for constructing holograms.*
- US 27-02-90 #4905202, Richard L Scully, *Detection panel and method for acoustic holography.*
- US 13-03-90 #4908285, Canon Kabushiki Kaisha, *Hologram member.*
- WO 08-09-89 #8908278, Fujitsu Limited, *Polarizing isolation apparatus and optical isolator using same.*
- WO 21-09-89 #8908857, Toray Industries Inc, *Polarizing film.*
- WO 28-12-89 #8912851, Garcon, Thierry, *Wide Visual Field Hologram.*
- WO 11-01-90 #9000268, National Research Development Corporation, *Under-*

water inspection apparatus and method.

- WO 11-01-90 #9000269, National Research Development Corporation, *Underwater inspection apparatus and method.*
- WO 11-01-90 #9000270, Kachanian, Kambiz, *Glass/crystal-glass/hollow glass hologram.*
- WO 11-01-90 #9000271, National Research Development Corporation, *Correction of aberrations in holographic underwater inspection.*
- WO 08-02-90 #9001182, Crouch, Stephen M, *Display of Holograms.*
- WO 08-03-90 #9002383, Grumman Aerospace Corporation, *Optical correlator system.*
- WO 22-03-90 #9002967, Grumman Aerospace Corporation, *Apparatus for opening and holding a frame and a method of mounting an optical element in a frame.*

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Back Issues

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Issue 1: Commercial survey; Computer-aided design; California focus; Vignetting; Imperial College.

Issue 2: New York education; Security holograms; Image blurring part I; Non-destructive testing; Holographic movies; Dennis Gabor profiled.

Issue 3: Black and white holography techniques; RCA final year show; Holograms without lasers; Image blurring part II; Danish focus; Full colour.

Issue 4: Pulse holography part I; Stereo photography; Lake Forest; Holographic endoscopes in medicine; Canada focus; Holograms on clothing.

Issue 5: A hologram of Everest; Stuttgart exhibition; The pitfalls of curating; Largest vibration isolation table; Pulse holography part II.

Issue 6: Holograms in graphic design; Colour with DCG; Multiplexing with CAD and stereo photographs; Museum of Holography, New York; Alexander's retrospective.

Issue 7: Recipe for red-sensitive DCG; Hologram Industries of France; Du Pont's new photopolymers; New York summer school; Image correlation at CIT.

Ad Index

Agfa-Gevaert Limited	22
AH Prismatic Limited	35
Chicago Museum of Holography	31
Crown Roll Leaf Inc	24
Diffraction Company	8
Global Images Inc	36
Holocrafts	12
Hologram Industries	2
Holographics North Inc	27
Holos Gallery	4
Ilford Photo Company	30
Laza Holograms	12
Op-Graphics Holography	27
Richmond Holographic Studios Ltd	4
Total Register Inc	26
UK Optical Supplies	28

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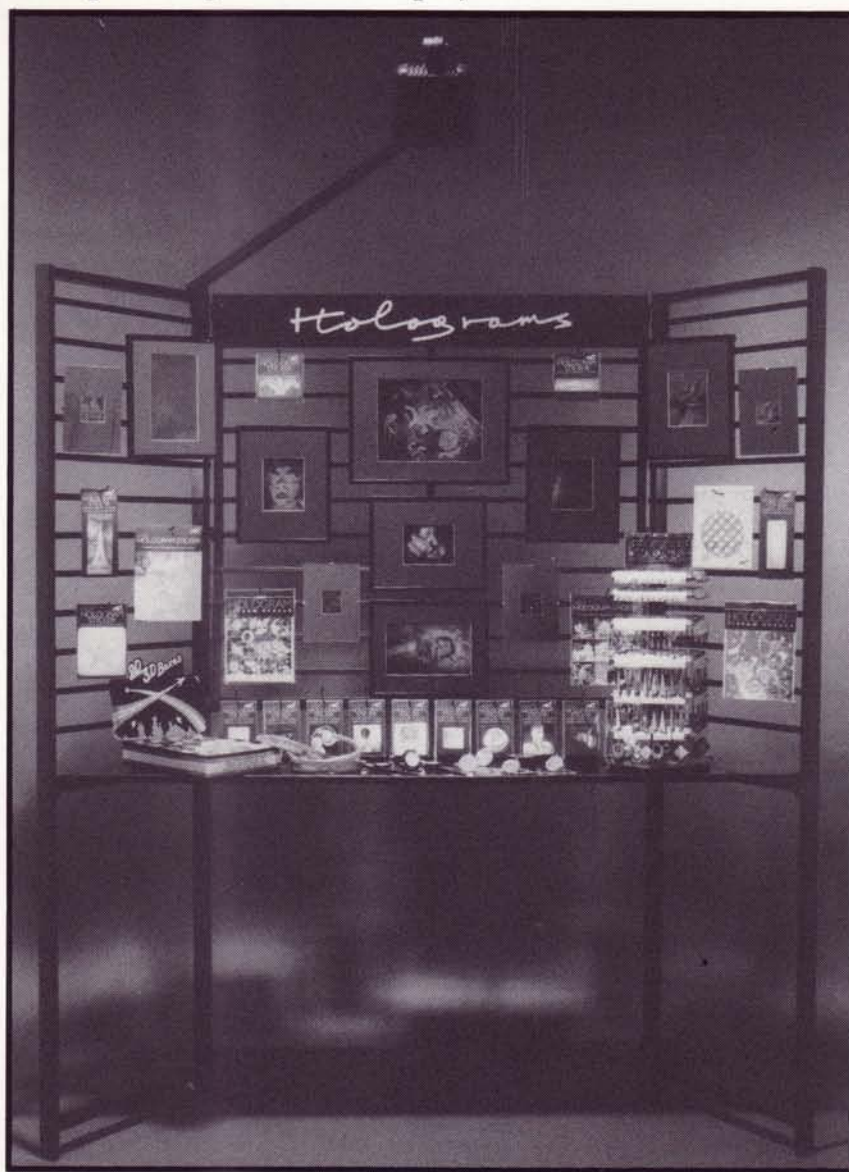
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