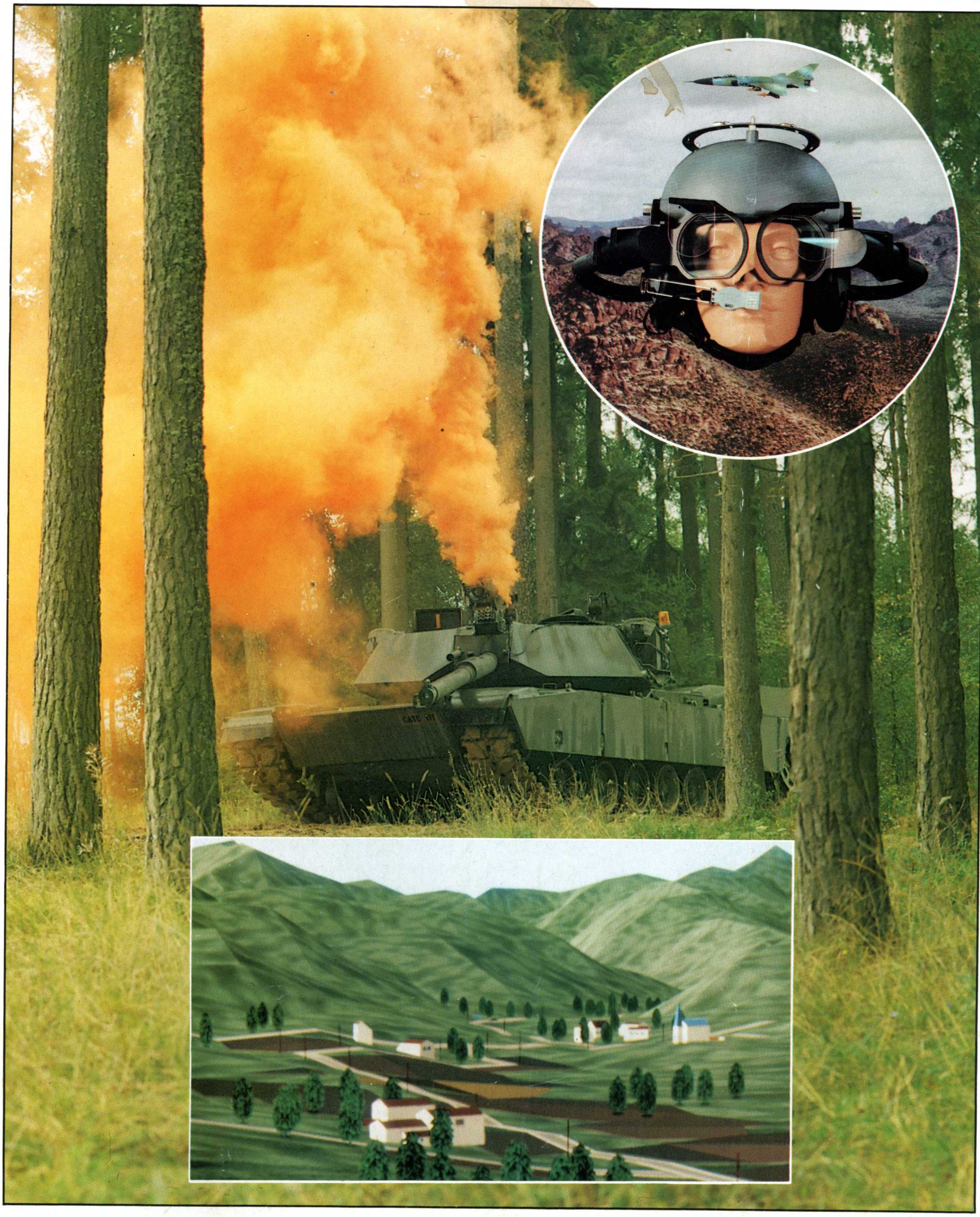
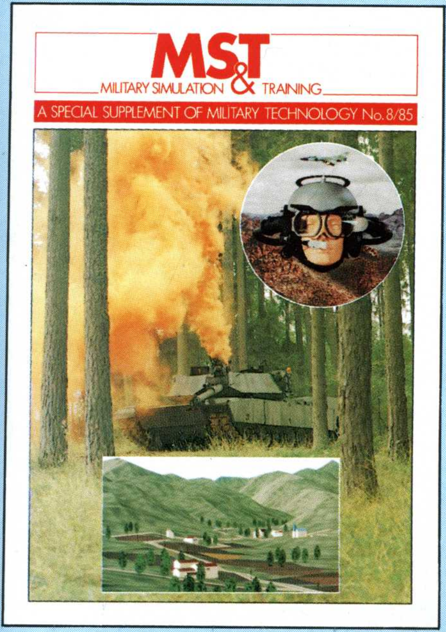
MS&T

MILITARY SIMULATION & TRAINING

A SPECIAL SUPPLEMENT OF MILITARY TECHNOLOGY No. 8/85



Contents



This months cover focusses on the new laser based duelling system that has been developed by Weston Simfire (possibly for the TGWSS competition), the VISA 4 CGI system that Thomson-CSF say will be in service by the end of the year at the latest, and the helmet mounted sight, developed by CAE which adds another dimension to the problem of simulating visual scenes.

Mönch Publishing Group

Managing Editor: Peter Abaza-Wevill BSc
Mönch Editorial Director: Wolfgang Flume
Executive Director: Manfred Sadlowski
Business Director: Jochen Essfeld
Production Director: Joachim Knoche
Mönch Marketing Director: Harald Helex
Design: Andreas Ziemer
Advertising Administration: Ursula Löhr
Typesetting: Graphik + Satz GmbH
Director: Wolfgang E. Wilczek

Printed in the Netherlands
by Van Boekhoven-Bosch bv, Utrecht

Mönch Publishing Group
Heilsbachstrasse 26, PO Box 14 02 61
D-5300 Bonn 1, Federal Republic of Germany
Tel.: 02 28/64 83-0
Telex: 8 86 94 29 mvb d
Telecopier: 02 28/64 83-1 09

Managing Directors: Marlies Mönch, Manfred Sadlowski

Index of advertisers

The Applied Holographics Holocopier system effectively frees holographic production from the constraints of laborious "one-off" production in clinically sterile conditions. Using the Holocopier, single or multiple holograms can be generated in standard print facilities.

Charles Beard

Holography in military training

Holography is a technique which can be used to create realistic three-dimensional (3D) images. It appears to be on the threshold of making truly major contributions to training technology and military training in particular. The British Army School of Training Support (ASTS) has researched holography as a follow-on to its successful development, evaluation and implementation of an Armoured Fighting Vehicle (AFV) Identification Training System. An investigation was made of civilian and military applications of holography, including some from the fields of simulation and training. Different types of holograms were looked at and the potential advantages were noted.

A comparison was made with other means of producing 3D comparison was made with other means of producing 3D images from which it appeared that either models or holograms were essential in acquiring spatial appreciation particularly in AFV identification training. A number of exciting innovations in holography were found to have occurred recently which could greatly help the military instructor. ASTS will be involved shortly in a series of small trials, which have been planned to further evaluate holographic training aids in mine and AFV identification.

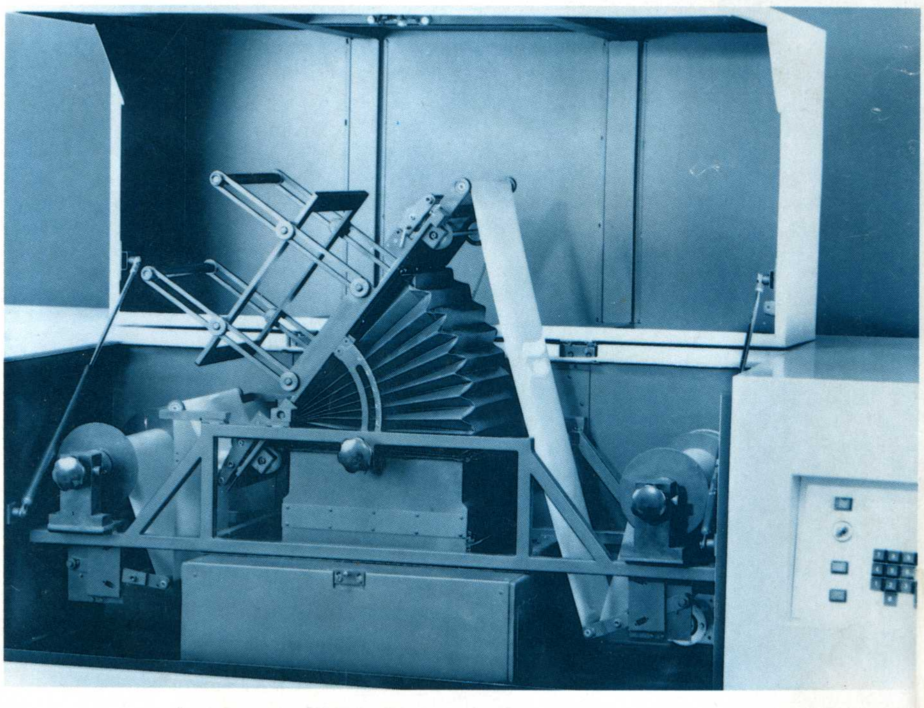
Holography is a technique which can be used to create realistic three-dimensional (3D) images. It has attracted a great deal of interest recently as a result of television publicity, exhibitions, and a fascination with the apparently solid images seen in empty space. Hungarian born Dennis Gabor invented holography while working in the UK, back in 1947, but it was the advent of lasers and research on military radar in the 1960s which made the prodution of holograms possible. Gabor coined the world holography from the Greek "holos" meaning "whole", and "graphis" meaning "image". In 1971 he was awarded the Nobel Prize for his achievement. The whole area of laser technology appears to be on the threshold of making truly major contributions to training technology.

I first became involved with holography in 1979 when working as a Training Development Advisor (TDA) to the Royal Engineers Training Development Team (TDT) in the United Kingdom. At that time the Ministry of Defence commissioned the University of Loughborough to produce holograms of a tank, a mine, a combat engineering tractor, and of a relief map section, so that their training potential could be assessed. Much was learnt but the holograms were seen to suffer from a number of disadvantages including being relatively expensive, difficult to display, and prone to damage easily. However, recent improvements in technology, including the use of new materials, new machines, and greatly reduced unit costs appeared to make holography much more feasible as an aid to training, especially in such areas as mine and vehicle identification, and map reading training. An investigation into the current state of holography and its possible use in military training appeared to be overdue.

The Army School of Training Support (ASTS), where I am a TDA, was asked early in 1984 to carry out such an investigation, in conjunction with the RETDT, and the information given here is based on that study.

Because the Ministry of Defence spends large sums annually on training and educational opportunities, new instructional technologies are constantly explored in an attempt to make education and training more cost effective. ASTS plays a vital role in that activity. Following a previous study, ASTS developed an effective Armoured Fighting Vehicle Identi-

The interior of the Holocopier III.



fication Training System (AFVITS) involving the use of 35mm slides, sound, video and 3D modules. The high cost of models and the potential advantages of the medium, meant that an extension of our study into holography made sense. We researched the literature and contacted a large number of individuals and organisations, learning what we could of existing civilian and military applications, with a view to assessing potential uses of the medium in training. At this point a brief explanation of holograms, and their advantages over models, may be called for.

Holograms and models

Holograms are 3D images recorded with the use of lasers and special glass plates or film. When developed and illuminated the images are not only 3D but can appear to float in space and move in relation to each other as the viewer moves, just as in real life. In theory holograms could be almost any size, but practical considerations of equipment and expense mean that the largest common size is 1m × 1m. The viewing of holograms may require a special light source of either laser, mercury or sodium lamps, but the most common holograms are white-light, that is, they can be lit by a beam from a slide or overhead projector, a torch, or even sunlight. Wotan, a subsidary of Siemens, have produced a most suitable little spot light; but a clear light bulb could also be used. Transmission holograms are the clearest of the white-light and are lit from the rear by a light passing through the hologram. Reflection holograms reflect light shining on them from the front.

In considering the advantages of holograms, say in relation to models, the following should be taken into account:

— The holographic image is closer to reality than any of the conventional types of image currently in use. Manipulation of the light source or movement of the viewer's point of view can provide a variety of 3D images from one hologram, for example side, top and front views of a vehicle, thus simulating the movement of that vehicle and the resulting changes in shape perception.
— The colour and nature of the holographic image can be similar to that obtained by using vision intensifiers, thus providing an extra realism to training which would otherwise prove difficult and expensive.
— Holograms are less expensive than the real thing or models of the real thing.
— Holograms are easier to store and transport than models.
— Holograms are easier to reproduce than models.

The advantages over models notwithstanding, there are some who still insist that holography is a solution in search of a problem. When a completely new concept in science or technology appears it may be a long time before it is exploited. The discovery of the element germanium was such a case: described as the only chemical element without any use whatever, it was nearly century before it found use as the raw material for the first transistors, and today it is used in the lens of thermal imagers. Even the laser was first stigmatised as a solution in search of a problem. Holography was, however, more fortunate; within a short time of its realisation ways were being found of putting it to work.

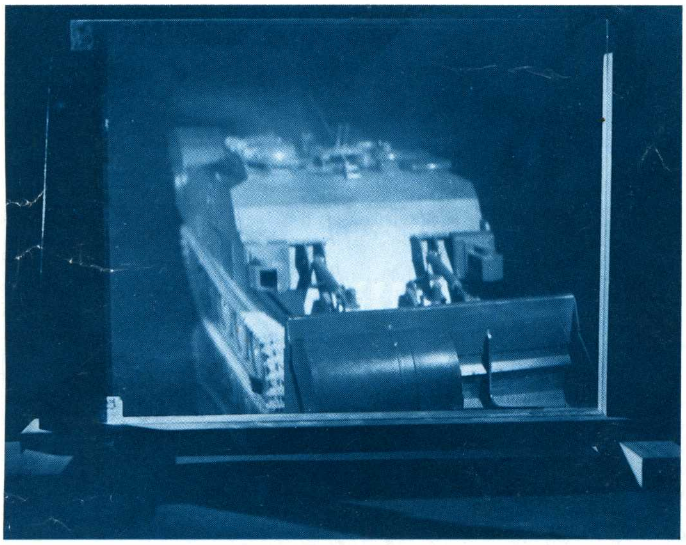
It may help our understanding of holograms if we think of them as allowing us to view a 3D scene through a window. By moving to different parts of the window, we are able to see the same scene from new angles. Even if a hologram is made of glass and is smashed into fragments, each small fragment may let us see the scene it records, but only from one vantage point. However, it is not necessary to smash a hologram to obtain copies of it. The most copied hologram ever must have been that of the American Eagle which appeared on the cover of some 11 million copies of "National Geographic" magazine in March 1984. Unfortunately that type of hologram was not of a suitable quality for training purposes, but Transmission or Reflection holograms might be, if a copier could be found to produce large numbers of good quality copies cheaply. The arrival of such a copier is one of a number of recent holographical developments.

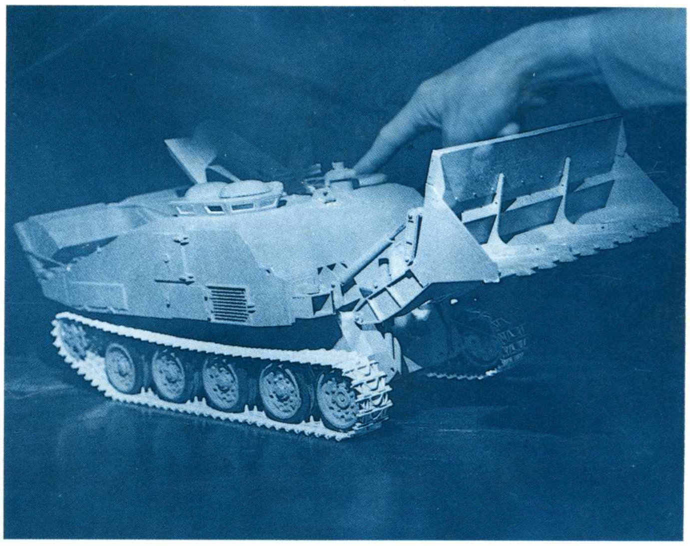
Some current uses of holography

Benjamin Franklin is reported to have chided scoffers at the time of the first manned balloon flight with the remark "what good is a new born baby?" The question has been asked "what use is a 3D image?" A radically new technique can be applied in two ways. The first comprises those applications which are simply different ways of doing something that can already be done by other means. The second comprises ways of doing something that could otherwise not be done at all. As far as holography is concerned the first category includes such applications as alternatives to models, visual records, data storage and pattern recognition, whereas 3D interferometry (used in materials testing), ultrasonic holography and holographic image enhancement represent totally new possibilities.

Among the practical uses found for the medium have been stress inspection and non-destructive testing based on holographic interferometry. Holography ferrets out invisible deficiencies in such products as electronic equipment, aero engines, vehicle parts, tyres, pressure vessels and even tennis racket handles. Also, bridges, dams, and underwater structures can be tested with the technique. Developments in the pipeline include the following:

— X-ray holography, enabling researchers to record a 3D view of human cells to facilitate tremendous improvements in the diagnosis of human disease.
— Computer graphics linked to holographic techniques to create 3D models from 2D information programmed into a computer, invaluable, for example, in saving the time of designers of industrial parts, vehicles or buildings.
— Data storage, utilising the fact that holograms, being essentially light waves, can reduce information to incredibly tiny dimensions approximating the wavelength of the light used; for example the Plessey Company is said to be working on a device the size of a television (TV) set which will be capable of storing the equivalent of 400,000 books (1M megabits).



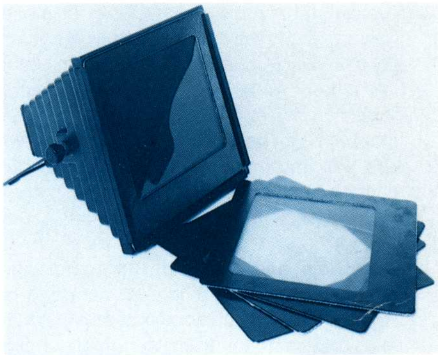


The photograph on the left shows a holographic image of a combat engineer tractor (CET). The photo on the right shows a different angle of the same CET with an instructor's hand pointing to one of the hatches in the roof that is pecular to this type of tractor. (Both photos courtesy of the Commanding Officer, Royal Engineers Training Development Team.)

Military uses of holography

A number of military applications have been found for the medium particularly in the United States where both the Department of Defense and the National Aeronautical and Space Administration (NASA) have used holography. NASA has been heavily involved in the subject since the 1960s. Applications tried include training in docking procedures and testing of the exterior tiles of the Space Shuttle. Holography has been called into service to help fighter pilots too. One of the difficulties facing pilots carrying out low-level sorties at night is actually seeing the terrain over which they are flying. One solution is the "head-up display" (HUD), in which a view of the terrain picked up by low-light (TV) or forward-looking infrared is projected optically onto the pilot's glare shield so that he sees the image of the scene at infinity, overlaying the real, standard scene. In daytime sorties the HUD is used for its normal function of displaying flight instrumentation and weapon-aiming information.

Marconi Avionics has developed such a display for the American F-16 fighter and details were given at a holographic exhibition at Bath in 1983. A useful spin-off from this work would be to use a cheaper, less sophisticated version of a HUD at ground level. A device in a vehicle which projects essential information at eye level on to the wind screen could be of great help to the driver, particularly in conditions of poor visibility. Such optical elements are likely to be a feature in the design of automobiles soon, displaying perhaps a digital indication of speed, and direction indicators. Other uses have been found for holographic optical elements. In an article in "National Geographic" magazine of March, 1984, Dr. John Caulfield described holographic optical elements as "cheap, easily shaped, and lighter than conventional glass lenses and mirrors, ...and they can serve as a helmet visor to block out the blinding radiation of laser weapons."



The Icon Viewer (Copyright Icon Holographics Ltd) can display holograms when fixed to a wall or in a "free standing" position.

Other applications suggested for the medium have been in:

— Simulation of flight and the undersea world.
— Laser type weapon fire simulation systems.
— Pattern recognition, where a memory bank of holograms of target vehicles could be stored and used in a missile to assist in the detection, identification and destruction of enemy targets.
— Weapon gunsights.
— Combining laser light of varied wavelengths for the simultaneous transmission of telephone calls on one optical fibre.
— Computer memory systems to prevent hackers breaking into sensitive databases.
— Aircraft recognition training.

Training technology and holography

The applications of holography to training technology are potentially legion. It has been said that we think in holograms. What then could be a better medium for conveying information than one consistent and in tune with our perceptual and cognitive patterns. The flexibility of holography is potentially enormous. Brain surgeons around the world could simultaneously study a master surgeon's art in unprecedented proximity. A student could take a jar of pond water, make a hologram with a portable camera, and then view the contents under a microscope. If he wished he could send the hologram, in complete safety, to a colleague in another country, for him to complete the analysis. The compatibility of holography with video cassette and video disc technology opens vistas that defy description. Holography has the potential for raising training effectiveness while realising large economies. However, to date there appears to have been little development of holography in training.

One example was a Manpower Services Commission (MSC) project in Britain in 1978. Holograms were used in two centres: engineering drawing was being taught to meet Technican Education Council objectives in the training of technicians (at West Bromwich College) and to naval artificers (at HMS Fisgard, Torpoint).

Students were divided into two groups at each centre and holograms were used in the training of one of these groups where the skills of translating from 2D to 3D (and vice-versa) through mental imagery were being developed. These holograms were shown in this experiment to be valuable remedial aids in the teaching of engineering drawing. It was concluded that holograms would be useful additional training aids in any context where people were taking the first steps in learning to develop 3D spatial appreciation, particularly where the time available for training was limited. The study pointed to the need for further research into 3D perception and instructional strategies.

3D imagery in training

The role and importance of models as a technique for training in armoured fighting vehicle (AFV) identification is acknowledged by many. A soldier who in required to fight in a 3D battlefield must be trained to identify in 3D. If 2D 35 mm slides of AFVs are shown, students are expected to interpolate from one to the other, and this is unreasonable. We sometimes try to compensate for the lack of 3D, for example in identification training packages, by simulating the whole vehicle with the videoing of the rotation of models. The visual perceptual differences and the perceived job-relatedness of models dictate that they should be used. However, models can be expensive particularly if they are supplied in kits which simulate a specific context.

An alternative is photography either as "stills" or in "moving" sequences. Photographs might produce a good likeness, but in no way can one be fooled into thinking that a photograph of an object is the object itself. One short of photography — stereo photography enables someone using special glasses to see a 3D image. The result of stereo photography is often very pleasing, but each trainee needs a special viewing aid and there is still something very stilted about the scene which detracts from the sense of realism. Also, objects at different distances are not usually in focus simultaneously.

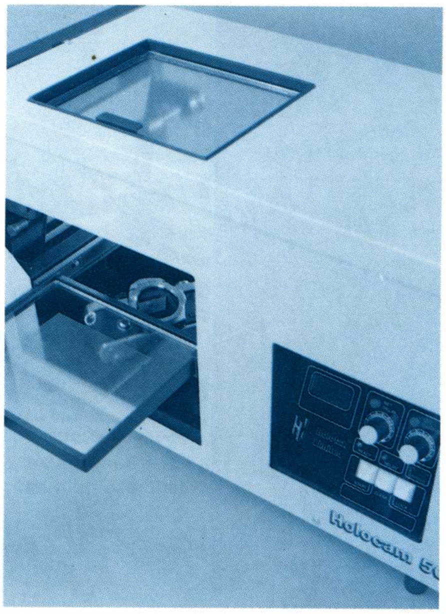
Perhaps one of the biggest drawbacks with photography is that once the photograph has been taken the viewpoint is fixed, although one can cheat a bit by using a movie camera, but then what you have is not one, but several photographs.

Another important point is that head movement, by allowing you to change your viewing position, allows you to "look round" obstacles. But head movement is also another important cue to the mechanism of parallax. This is the term used to describe the illusion that when two objects are more-or-less in line with one of your eyes, the more distant object appears to move in a contrary direction. Hence, without head movement we cannot have parallax and without parallax we lose yet another cue to distance and three dimensionality. If we are going to compensate for these failings it rather looks as though a different approach is called for and that could be holography.

Recent holographic developments

Holograms require lasers in their origination or "mastering". This normally takes place in a laboratory type situation. It is the most expensive part of the process of obtaining holograms and an average cost for an 8 inch × 10 inch hologram would be about 1,000 pounds, mainly because of the labour-intensive nature of the process. However, recently some holographic cameras, which include a laser, have made an appearance. These promise a more flexible, rapid and lower cost hologram production facility. The problem of guaranteeing that a trainee would see a particular view of a hologram has been around for some time although a wide range of light sources can illuminate holograms. What was needed was a suitable equipment to display holograms and recently one became available. Details of these and other developments are listed below:

— Applied Holographics of Witham, Essex have the AHS1 holocopier which, like a photocopier, can copy real objects or other 8 inch × 10 inch holograms, at the rate of 500 per hour, at a cost as low as 3 pounds each. For security reasons the company does not sell its machines but offers a bureau service.



The Holofax Holocam 50 has alternative object positions giving operational versatility. Here the lower position is used to make a hologram of a 35 mm camera body.

— Holofax of Hereford are a much smaller concern. Their portable HOLOCAM 50 produces 4 inch × 5 inch holograms at a materials cost of 50 pence each. A Training Officer might find that it has a useful research and development role, for example in trying out ideas with models, before arranging for more expensive holograms to be made. The machine costs 4,300 pounds and a larger machine is under development.

— Icon of London, have the VIEWER, which is potentially a most useful aid to the military instructor. It costs around 200 pounds and illuminates transmission holograms from the rear. It may be of interest that Icon, in association with Imperial College, London, have already produced natural colour holograms but it will be 2 or 3 years before these become commonplace.

— See 3 of South London, specialise in the production of very clear embossed holograms, which are stamped out in tens of thousands, but at a cost as low as 1 penny per square inch. This is the type of hologram likely to appear in books, magazines and training handbooks in the near future.

— Holographic film companies, such as Ilford, AGFA Gevaert, and Polaroid have made major advances recently, in the quality of their film.

— Aerodyne Research of the United States have developed computer generated holograms from digital information stored in a database.

Where are we now?

The time seemed to be right to apply holography to training in the British Army and identification training was the obvious starting point. So, a series of small trials of holograms of mines and AFVs will take place, in major centres involving subject matter experts, TDTs and ASTS, and operating within the context of exisiting training practices and packages. The need for holographic aids had already been established. In mine identification, real mines or good models are required and these, are not always available. So why not produce holograms or real mines in sufficient quantities? 3D, also important in AFV identification and models, can be very expensive and in short supply. Again, holograms could be the answer.

Subject to successful evaluation and agreement, these instructor packages will be copied for distribution to field units. At that stage consideration will be given to the development of further packages for example, for use in aircraft identification and map reading training, and the use of holograms in self instruction or distance learning contexts, will be examined. Possible benefits from distance learning include improved course entry level skills and reduced formal course time with a consequent reduction in costs while improving the effectiveness of training.

Holography still has a long way to go in the development of its eventual potential. Nevertheless, development is moving forward very rapidly with an increasing number of applications being found for it which will affect all of us. Military training should be included in these developments. The wheel has turned full circle. After all, it was military research in the 1960s which led directly to the rebirth of interest in holography. Some problems identified in holography in training in the late 1970s appear to have been overcome by a number of exciting recent innovations.

While there is still a need for further research into 3D perception and alternative instructional strategies, holography appears to have the potential for improving the effectiveness and efficiency of training, and pending British Army trials should demonstrate this. □