Digital hologram ambitions.

My ambition to create computer-generated holograms began whilst I was studying for a BA(Hons) degree in Scientific and Technical Graphics at Plymouth Polytechnic, Plymouth College of Art, and Cornwall Technical College. The hologram bug had already bitten after seeing the first-ever international exhibition of creative holography in the UK, at The Photographers' Gallery, London, in 1981. I returned to Plymouth determined to teach myself holography, whilst, at the same time, explore a career in computer graphics and animation. It didn't take long for an idea to materialise - to combine computer graphics with holography. After conducting some research, I learned about holographic stereography, a specialised form of holography that creates a holographic image from a stereographic sequence of photographs. In particular, I learned about the cylindrical holographic stereograms, called integral or multiplex holograms, invented by physicist and holographer Loydd Cross of the USA in 1971. I promptly wrote to the author of the first book I ever bought on holography, Michael Wenyon, to ask if he knew of anywhere in the UK that could make such holograms. We had, at that time, been learning how to write software using Plymouth Polytechnic's mainframe computer and the Fortran programming language, to create simple 3D computer models, render 2D images, and output them to a pen plotter. My idea was to computer-generate a stereographic image sequence and use this to commission a multiplex hologram. Michael replied, pointing out that there was likely nowhere in the world that could make one at that time. My holographic ambitions thwarted, at least temporarily, I created a computer-animated anaglyphic/3D educational video instead. Anaglyphic video itself was quite groundbreaking at the time, and mine conveyed the structure of molecules and the valence shell electron pair repulsion theory (VSEPR). During the final year, in 1983, I finally made my first hologram, a simple single-beam Denisyuk hologram of a metal belt buckle in the form of a ram's head.

After graduating in 1983, I was extraordinarily fortunate to be offered a position at Richmond Holographic Studios, one of the first hologram studios in the UK, working with pioneering artists-holographers Edwina Orr and David Trayner as a trainee holographer and holography tutor. Edwina told me some years later that it had been my interest in computer-generated digital holograms that had swayed her to offer me the position. In fact, a 3D wireframe image of a sinusoidal wave, which I created whilst at college, was adopted by Richmond Holographic Studios as its corporate logo.

My next foray in combining computer graphics with holography came in early 1984. While working at Richmond Holographic Studios I was approached by Edwina Orr and Eve Ritcher, a producer and curator of some of the world's first hologram exhibitions, including *Light Dimensions (1983)*, a landmark exhibition hosted by the Royal Photographic Society in Bath and later by the Science Museum in London. The latter exhibition was visited by over 250,000 people. Following the enormous success of the Light Dimension exhibitions, Eve Ritcher

organised her first creative holography exhibition, *Light Years Ahead - The Best of British Holography*, and invited me to contribute a holographic work. I was, of course, honoured and excited to do so, given that my work would be shown alongside those of many pioneering artists and my holography idols. Time was short, and so I chose to use the same computer-generated molecule images that I had hoped, two years earlier, to use for the production of an integral hologram, and used for my anaglyphic educational video, to create a two-image holographic stereogram. Whilst simple in nature, the hologram, as with all types of holograms in those early days, was a challenge, and a huge achievement when it worked. Light Years Ahead - The Best of British Holography was the first time I showed a work in a creative holography exhibition.

In 1985, in recognition of my ambitions to create computer-generated digital holograms, I was offered a place by Dr. Stephen Benton within the Spatial Imaging Group at MIT in the United States. At the very same time, however, holographer and artist Peter Miller invited me to work alongside him and pioneering holographers Prof. Nick Phillips and Graham Saxby FRPS to co-found and build a new Holography Unit within the Photography Department at the Royal College of Art in London. Peter would serve as the full-time Senior Tutor, with Prof. Phillips and Graham Saxby appointed as part-time visiting lecturers. One full-time post remained: Senior Technician, which Peter offered to me.

Because my ambitions in holography had always been creative, I initially declined. But when the first round of interviews failed to produce a suitable candidate, Peter approached me again. The

decision became a genuine crossroads, MIT or the RCA! Peter ultimately persuaded me to accept on the understanding that I would work with him, in a fluid and non-delineated partnership, to establish and run the world's first and only Master of Arts degree in Creative Holography; that I would design, build, and operate the UK's first dedicated pulsed-laser holographic portrait studio; that I would collaborate with and learn from the inimitable Prof. Nick Phillips; and that I would have full access to the RCA's facilities to create my own holographic artworks.

Although MIT would have offered a more direct route toward my digital holography goals, I felt it would be predominantly technical and offer far less scope for creativity. At just 27, I became the youngest 'senior' staff member in the history of the Royal College of Art, and Dr. Steven Benton would later compliment me on producing the world's first 'digital' holographic stereograms.

Side Note: In 1986, Peter Miller left the RCA under difficult circumstances, and I was offered the Senior Tutor position. Acknowledging my relative inexperience, and out of respect for Peter, I declined. The role was eventually given to the commercial holographer and former accountant Michael Burridge, who was brought in to manage the unit's finances. As noted in Holographic Visions by Sean F. Johnston (2006), I therefore became a de facto tutor in practice.

AMIGA-BIRD - the world's first home microcomputer generated hologram.

From 1985 to 1987, my attention, as a creative holographer/artist, was focused on pulsed laser hologram portraits of animals and people. In 1987, however, something took place that would greatly influence my career over the following 10 years and my ambition to further the art of computer-generated digital holography, namely the introduction of the Commodore Amiga 500 home micro-computer, together with the software program Sculpt3D. The Amiga 500 computer, launched in 1985 and costing £499, was the first home microcomputer capable of creating sophisticated computer-generated models and images. The Amiga, along with Sculpt3D, the first computer graphics generation, raytracing, and rendering program for a home microcomputer, allowed an artist to create photorealistic digital images of objects and scenes with reflections, shadows, and transparency, for the very first time at home. No longer was it necessary to beg, steal, or borrow time on an expensive high-end computer workstation or mainframe computer. Of course, I purchased one immediately.

The Commodore Amiga 500

Eager to try out my new creative tool, I began learning how to create 3D computer models and images. Also in 1987, the Royal College of Art Holography Unit was honoured to receive a visit from Dr Stephen Benton of the Spatial Imaging Group at MIT, USA, a leading pioneer in

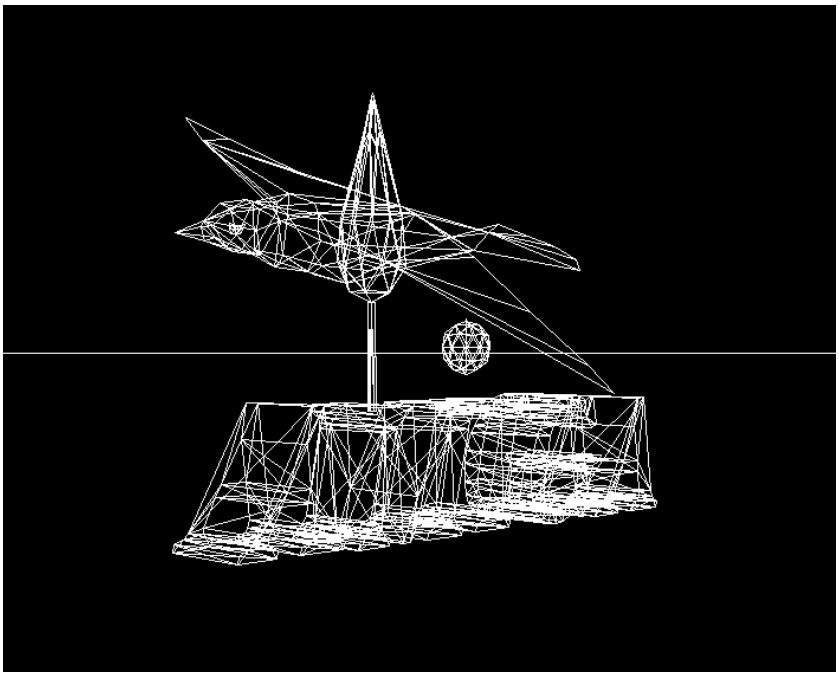
holography and famous for inventing the rainbow hologram. He showed us examples of his very latest work in holographic stereography, including a beautiful achromatic (black and white) 3D stereogram of a range of mountains made using aerial photographs. This inspired our own visiting lecturer, Prof. Nick Phillips, to design and build a holographic stereogram mastering system at Loughborough University, where he was based.

The system was funded by the Computers in the Primary and Secondary Education (CITE) government program and took over a year to complete. Once up and running, it was made available to RCA students and staff to use. The system required that a stereographic image sequence be provided in the form of a 35mm film strip, containing approximately 100 images or views. I took full advantage of the opportunity to create what is believed to be the first-ever holographic stereogram to be made using a home microcomputer generated stereographic image sequence, and so, in the autumn of 1988, I set out to provide Nick Phillips with a stereographic image sequence, generated using my Commodore Amiga 500 and Sculpt3D software.

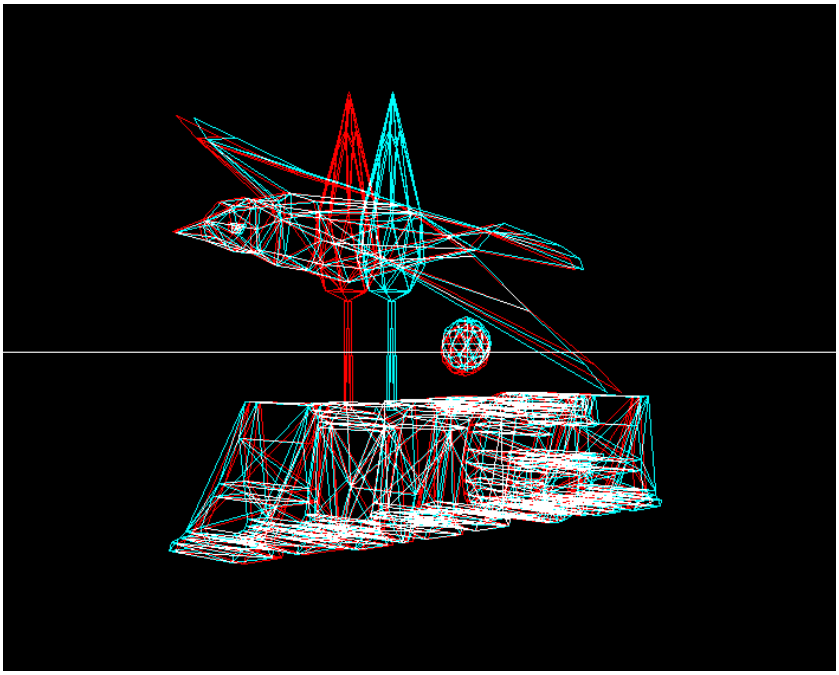
By necessity, I chose to create and render a simple wireframe model, albeit with a small amount of animation in the form of a bouncing ball which formed the dot of the 'I' in the word AMIGA, as each of the one-hundred frames in the sequence, even though only depicting a wireframe model, took several hours to render. A full colour, fully shaded model, even though the computer and software were entirely capable, would have taken several months to render.

Each frame, once completed, was saved to a floppy disk. After the full sequence was complete, I photographed each frame, one by one, directly off the computer monitor screen and sent the processed film strip to Loughborough University. The holographic stereogram, named AMIGA BIRD, was completed in early 1989.

This first stereogram was a test case and was created before it was possible to easily remove the keystone/perspective distortion from each frame. The hologram thus shows, what we would now call the 'carousel' effect, i.e., as unnatural swinging of the image as the viewer moves.

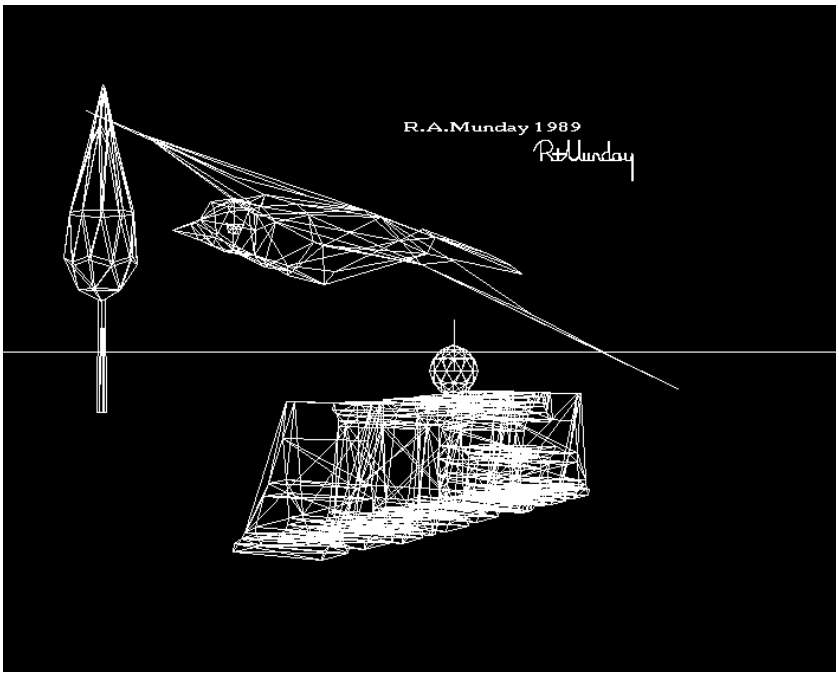


An original frame



An anaglyphic image

I chose to add a discrete end frame to the sequence such that, when the final hologram is viewed from a specific and extreme angle, my name, date and a signature appears. I believe that I was the first to add a credit to a holographic stereogram in this manner.



End frame showing credits

Early the following year, I persuaded the largest retailer of Amiga computers in the UK, the Amiga Centre Scotland, to show my hologram on their exhibition stand at the Commodore

Show, held at the Novotel in Hammersmith, London, in June 1989. It was accompanied by a video, running on an Amiga, which described how the hologram was made, and attracted the attention of hundreds of visitors and the computer press.

The display on the stand of Amga Centre Scotland at The Commodore Show.

As far as the author remembers, only four copies were made:

One copy resides in the Dr. Tung H. Jeong collection and is on permanent display at the Dr. Tung H. Jeong Holography Gallery, located in the Lillard Science Centre at Lake Forest College, Lake Forest, Illinois, USA.

One copy resides in the Jonathan Ross Collection, London, UK, gifted by the author.

Two copies are held by the author.

Articles have appeared in several magazines, including Holographics International Magazine and Amiga Format magazine:

The Amiga Centre Scotland stand where Munday's stereogram was exhibited.

Munday Makes It With an Amiga

A hologram by Rob Munday of the Royal College of Art in London, Britain, was exhibited at the UK Commodore Computer Show in June. Made using CITE programme equipment (see page 22), the holographic stereogram consists of images from computer equipment which costs less than £1000 (US$1600).

Rob Munday, who originally studied Electronic Imaging, has recently been conducting research into using low-cost computer systems to produce stereograms. In particular he has been using the Commodore Amiga, which is capable of solid modelling with realistic rendering of full colour images. The software allows for multi-coloured light sources which give the scene highlights and shadows, texture mapping, and a choice of surfaces including metal, mirror and glass. Full animation capabilities enables the generation of the 200+ views needed to make a holographic stereogram.

The first Amiga hologram, which was part of the display pictured, was monochrome and of a simple wire frame image, though Munday is already working on a colour sequel. He chose a simple subject partly due to the processing time necessary which, for a complicated subject, can be several hours for each frame.

Commodore has now given the CITE programme some more powerful computers, and a project designed to link personal computers with fast CRAY supercomputers has been initiated. It is therefore hoped that it will soon be a straightforward matter to produce complex colour holograms, using personal computers and the CITE project, in a relatively short time.

Holographers Meet in Bath

The *Second International Conference on Holographic Systems, Components and Applications* is due to take place in Bath, Britain, from September 11-13.

Organised primarily by the Institute of Electrical Engineers, the conference will include sessions on holography in measurement, display holography, computer generated holograms, photorefraction and phase conjugation, and holographic optical elements.

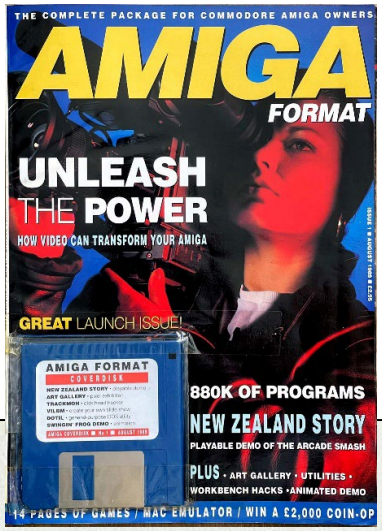
For registration details please contact Conference Services, IEE, Savoy Place, London WC2R 0BL. Telephone: (+44) 01 240 1871.

Zec Chairs FRG Holo Society

A holographic society was formed in the Federal Republic of Germany on March 3 of this year. Its chairman is Peter Zec, author of *Holographie-Geschichte, Technik, Kunst* (see reviews page), and its vice chair is taken by Brigitte Bürgmer, author of *Holographic Art/Perception/Evolution/Future.*

The society was founded to promote awareness of holography, and its members are mainly holographers and artists. To this end, the group intends to organise exhibitions, and has access to two holographic studios, in Osnabrück and Munich, in which members can produce their own work.

For further information contact Peter Zec, Deutsche Gesellschaft der Holografie, Lerchen Strasse 142a, 4500 Osnabrück, FR Germany. Tel: (+49) 0541 186059.



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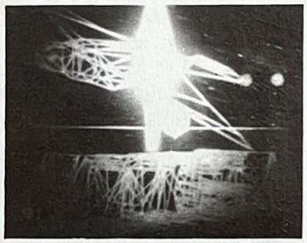
Microillusions is available on import from Digipro, Southampton (tel 0703-703030) at £79.95.

HOLOGRAPHIC AMIGA

One of the more unusual sights at the Commodore Show was the first hologram generated from a microcomputer image. Using equipment developed at Loughborough University and an Amiga 500, Rob Munday and his team, with advice from the Amiga Centre Scotland, have produced a 3D holographic view of a partially-animated wireframe bird rendered using *Sculpt 3D*.

To produce it, over 100 frames were generated and recorded onto a holographic plate in stereo pairs as a series of vertical strips. Viewing the image from the front, slight movements of the head reveal hidden parts of the object that would normally only be seen if it was real and solid. This is normal for a hologram as anyone with a bank card



knows. Usually though, the object from which a conventional hologram is taken is a 3D model; here it is a series of flat, 2D images. This is much more difficult and has previously only been achieved using high-powered Cray supercomputers. Now, in another first for the Amiga, a 3D computer model has been recorded holographically.

The physics is quite difficult, but if I understand it correctly, the process works something like this: conventional holography captures the image of a complete 3D object in such a way that the parts of it that can be seen vary according to your viewpoint, just as would happen with a 'real' object. In effect the hologram has superimposed an almost infinite series of 'views' of the object which are revealed as your viewpoint is changed. Stereoscopic holography has the same effect but in this case the 'views' are captured separately like the frames of a stereovision film, one for each eye, in the form of pairs of vertical strips on the plate.

The advantage of this method is that the content of each 'frame' is much more controllable so that any object capable of being modelled on a computer can be captured in 3D and even animated. The use of Amigas, or other cheap micros, also means that the commercial potential of such 'animated' holograms is much more likely to be realised. It is only a matter of time before full-colour, fully-animated sequences and even whole films appear.

The next article will describe my 1989-1991 DI-HO (Digital Input – Hologram Output) system, the worlds-first computer-automated digital holographic stereogram printer and digital holographic stereograms.