

HOLOGRAPHY

NAEA 2014

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Essential Question

Is it necessary or inevitable for Art Educators to become a hybrid of a UX Designer, User Experience Designer, User Experience Architect, with Art Education?

Apple iPad3 Preview – Hologram Demo Really?

[https://www.youtube.com/watch?
v=Km6XxThm4Ec](https://www.youtube.com/watch?v=Km6XxThm4Ec)

3D Holographic Power Point Presentation @ ASE 2013

[https://www.youtube.com/watch?
v=eLavoahAfv8](https://www.youtube.com/watch?v=eLavoahAfv8)

Digital Obscura
Multi Touch
Musion 3D Projection

[https://www.youtube.com/watch?
v=fytjazzt0M8o](https://www.youtube.com/watch?v=fytjazzt0M8o)

Holographic 3D Digital Projection Explained Musion and Christie Digital

[https://www.youtube.com/watch?
v=pSICZ_7hpho](https://www.youtube.com/watch?v=pSICZ_7hpho)

Future Technology

Holographic TV

<https://www.youtube.com/watch?v=k8trP3V-tqE>

What is a Hologram?

Greek

holos=complete **graphein**=to write

- Physicist - A record of the interaction of two mutually coherent light beams in the form of microscopic pattern of interference fringes.
- Well-informed lay person – a photographic film or plate that has been exposed to laser light and processed so that when illuminated appropriately it produces a 3-D image.
- Simply put – A hologram is a picture recorded with laser light.

What is a hologram?

- A hologram is a complete record of the information and when correctly illuminated it generates a replica of the object wavefront, enabling you to see an image that in every respect replicates the object, with full parallax in all directions.
- Holography is like photography in that light information is recorded in photosensitive film. A hologram is a recording of the light wavefront interference pattern reflected by an object. This record, then functions as an optic: When light is projected through the hologram, the light wavefront interference pattern of the original object is reconstructed and this, the brain interprets as 3-D.

(Saxby, 2004; Riskin, MIT)

Holography

A slice of history

Holography has been around since the late 1940s. **Dennis Gabor**, an Hungarian electrical engineer, first conceived of the fundamentals of holography while attempting to improve the resolution of the electron microscope. He created the first transmission holograms and demonstrated this to the scientific world. He would receive a Nobel Prize for his work in 1970.

See handout for more history!

Holographic Image

Wave phenomena of:

Diffraction

- The change in direction of a wavefront encountering an object. Usually refers to the case whereby light is bent by passing through a small aperture.
- The interaction between a reference beam and a beam disturbed by passing through a transparent object generates an interference pattern that could be recorded in the form of a hologram.

Holographic Image

Wave phenomena of:

Diffraction

- There is no essential difference in its nature between the wavefront refracted by a transparent object and that reflected by an opaque one.
- Both are examples of diffraction by the object; both contain the entire information about the object, and this information is encoded in the hologram in the same way.

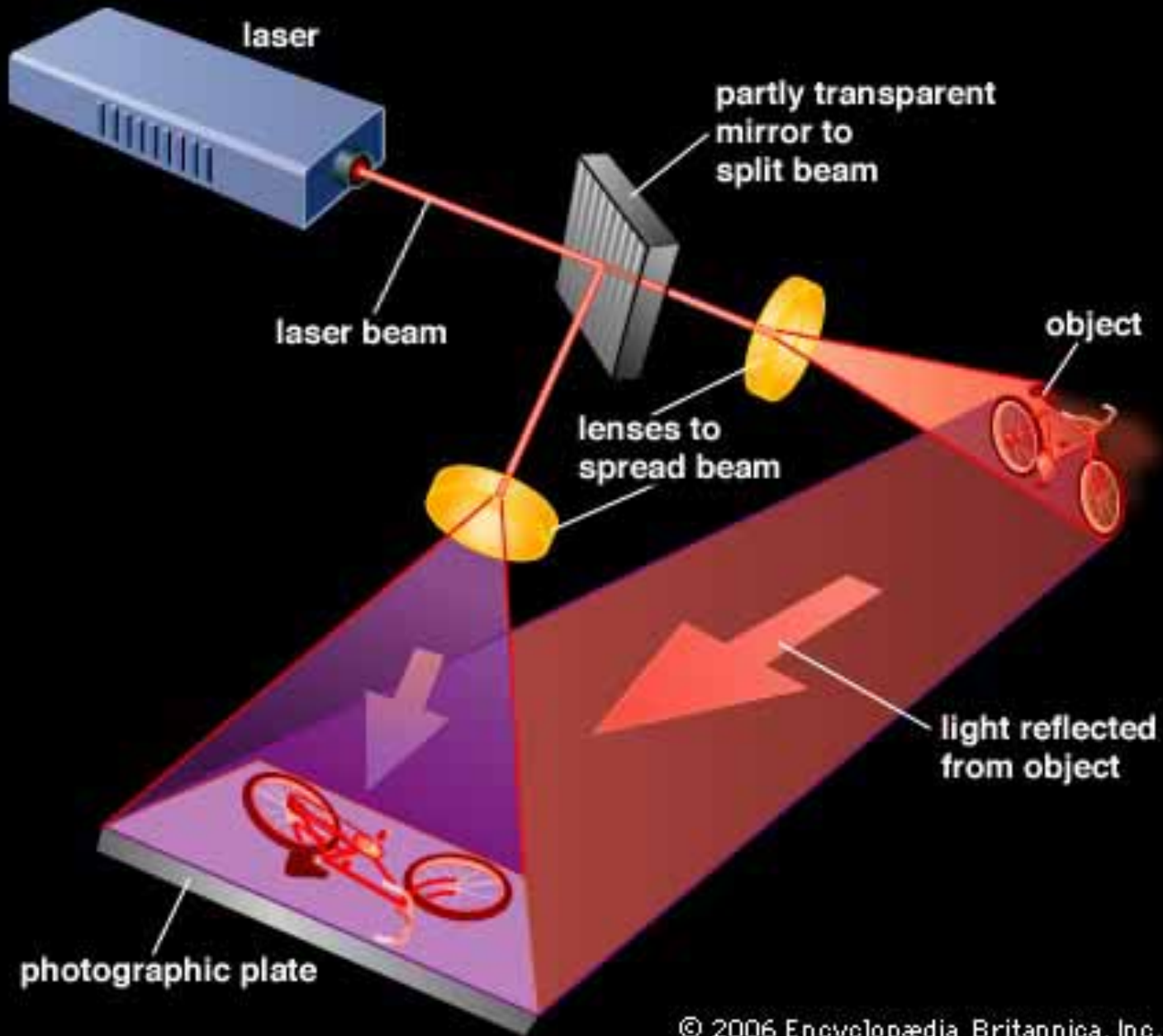
Holographic Image

Wave phenomena of:

Interference

The combining of two waves so that their amplitudes add at every point. When two coherent waves are so superimposed, the result will be either an increase in amplitude (constructive interference) or decrease in amplitude (destructive interference). The result is an interference pattern which records the relative phase relationships between the two waves, thus storing the characteristics of the individual waves.

This is how a hologram works.



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Two main categories of holograms

Transmission Hologram

- Made with the object and reference beams incident on the holographic emulsion from the same side.
- Any hologram which is viewed by passing light through it, toward the viewing side. Transmission holograms are made by allowing both object and reference light to impinge on the same side of the plate.
- If you look along the reconstructed object beam (image beam) you will see different perspectives of the image – it appears to be three dimensional and has a full parallax.

(Saxby, 2004; Untereseher, 1996)



Two main categories of holograms

Reflection Hologram

- Made with the object and reference beam incident from opposite sides.
- Made by allowing reference and object light to impinge on opposite sides of the plate.
- The finished hologram is viewed by allowing light to reflect from it to the observer.

(Saxby, 2004; Untereseher, 1996)



Three Amazing Holograms

[https://www.youtube.com/watch?
v=vtVydMcrY5w](https://www.youtube.com/watch?v=vtVydMcrY5w)

The Basic Types of Holograms

Laser Transmission Holograms

The Real Image

- An image that the light actually passes through is called a **real image**.
- In most holograms you will find it difficult to see this spurious real image. This is because the emulsion has a finite thickness (at least 10 wavelengths) so rather than being just on the surface of the emulsion, the fringes that form the hologram run through its thickness like the slats of a venetian blind.
- This affects the diffraction efficacy, as the brightness of the image is largely determined by the **Bragg condition**. This states that when a beam of light passes through a thick grating (i.e. any grating that is several wavelengths thick), light of a given wavelength will emerge if and only if the wavefronts emerging from each spatial cycle of the grating have optical path differences that are a whole number of wavelength, that is are all in phase.

(Saxby, 2004)

The Basic Types of Holograms

Laser Transmission Holograms

Bragg's Condition

- **Bragg Diffraction (Bragg's Law):** Diffraction which is reinforced by reflection by a series of regularly spaced planes which corresponds to a certain wavelength and angular orientation. The angle at which this reinforcement occurs is Bragg's angle.

Named after

Sir William Bragg and his son Sir Lawrence Bragg.

The Basic Types of Holograms

White-light transmission holograms

- If one could find a way of placing a fairly shallow object, or its optical image, right into the plane of the emulsion, it would be possible to play back a 3-d image from a transmission hologram using a white, or at least only partially filtered, light beam. You can't do this with a solid object, or at least only partially filtered, light beam. You can't do this with a solid object, but what you can do is to create a real optical image across the emulsion plane using either a lens or another hologram. This **real image** becomes the object for the hologram. When it is produced by a lens, the result is called a *focused-image hologram*; when it is produced by another hologram it is known as a *transfer hologram*.

The Basic Types of Holograms

Reflection Holograms

White-light reflection hologram

- The simplest form of reflection hologram is the single-beam or **Denisyuk** hologram, in which the beam falls on one side of the emulsion, acting as the reference beam, passes through the emulsion and is reflected back by the subject matter on the other side, forming the object beam.

Stephen Benton
The Bartlett Head
White-light transmission - Rainbow



3D Holographic XXL Installation at Aula Medica – Karolinska Institute Stockholm

[https://www.youtube.com/watch?v=fFOD9Q-
uboQ](https://www.youtube.com/watch?v=fFOD9Q-
<u>uboQ</u>)

Master “H1” and Transfer “H2” Holograms

- An H1 hologram is simply another name for split-beam transmission hologram.
- An H2 hologram is the next step after the H1.
- While a H1 hologram appears as if you are looking at the object through a pane of glass, a H2 hologram makes the object appear to “jump out” at the observer.

Transfer Principle

- Involves the use of this real image as the object for a second hologram.

Master “H1” and Transfer “H2” Holograms

Setup 1

- An H2 is made from a H1
- He becomes the **virtual object** for the H2

Setup 2

- Minor changes must be made to the H1 setup in order to shoot a successful H2
- The hologram made from the H1 setup is flipped around so it faces the opposite side and is put in alignment with the reference beam – making it the object beam.

(www.angelfire.com)

How It's Made Holograms

Discovery Channel

[https://www.youtube.com/watch?
v=XtvAhL1IzOI](https://www.youtube.com/watch?v=XtvAhL1IzOI)

Portraiture and pulse laser holography

A holographic portrait is recorded in a few nanoseconds with a ruby pulse laser on a holographic film. It contains a vast amplitude of information about the person as it captures reflected laser light from every direction and angle.

Holographic Stereogram, Multiplex, 360 Degree

- A holographic stereogram begins as a set of flat images that represent perspective views of a subject taken at intervals along a straight line or around a circle; alternatively, they may be the cinematic or animated record of some event in time. All the images are multiplexed into a single hologram in such a way that for any viewing position the two eyes of the viewer see only the two images appropriate to that view point.

Holographic Stereogram, Multiplex, 360 Degree

- Is a form of a hybrid of photography and holography.
- Photographs taken from many different perspectives.
- The pictures together contain all necessary information about the multiple views of a subject just as a hologram does.
- A hologram synthesized from all of these views is capable of yielding a 3-D stereoscopic image.
- Makes the complete geometry of the object viewable.
- Horizontal Parallax wholly or partially taken over by movement.

Multiplex Stereo Hologram Dancers

[https://www.youtube.com/watch?
v=SDWI36_oaTY](https://www.youtube.com/watch?v=SDWI36_oaTY)

Brain of Alice Cooper
Salvador Dali

[https://www.youtube.com/watch?
v=XufsVOyCpbQ](https://www.youtube.com/watch?v=XufsVOyCpbQ)

Dali



Dali Holograms

Brain of Alice Cooper

Crystal Grotto

Dali Painting Gala

Holos! Holos! Velazquez! Gabor!

Submarine Fisherman

Polyhedron

Melting Clock

Ikuo Nakamura



Procacci - Holography - NAEA 2014

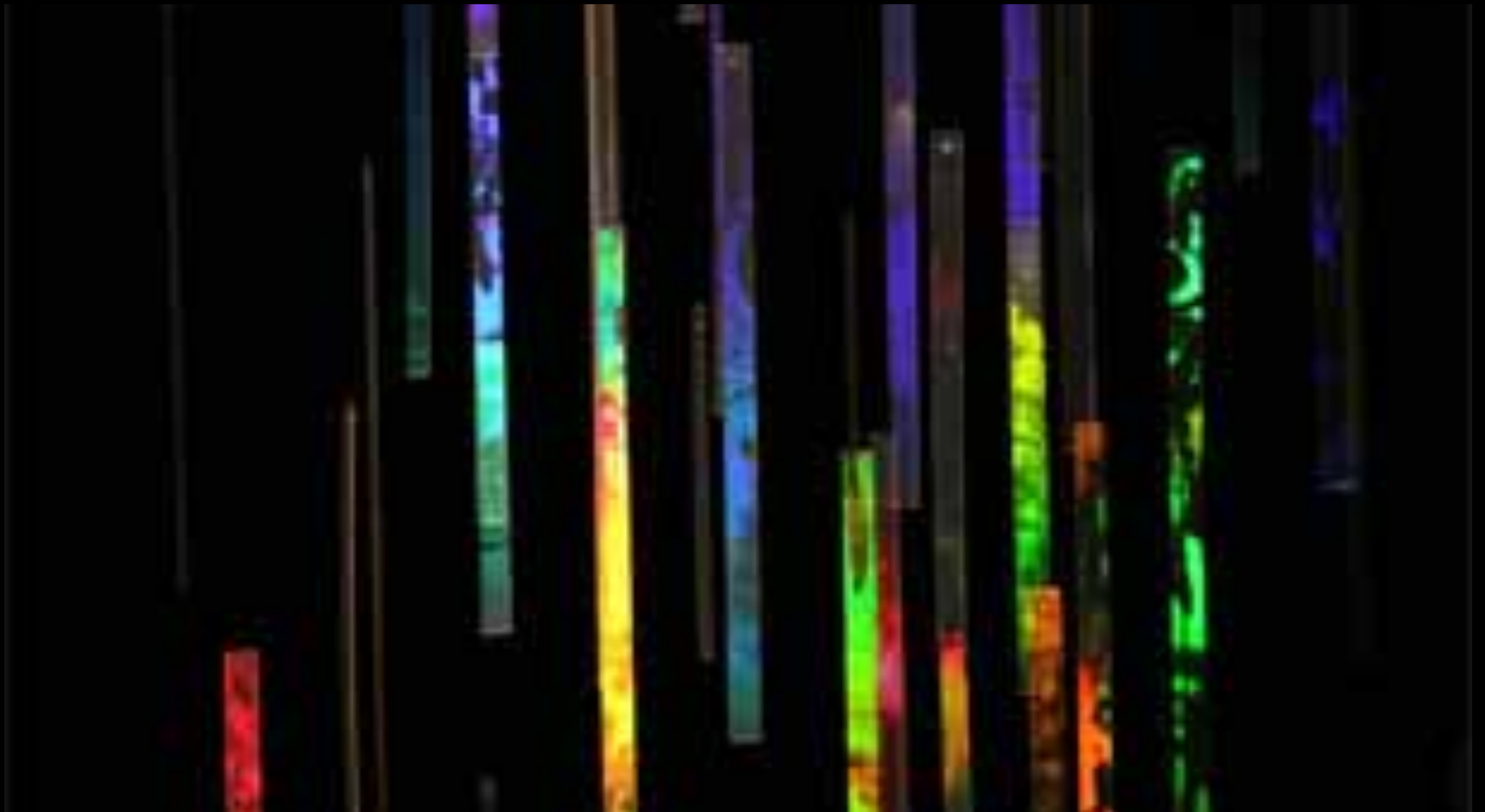
Betsy Connors
Peabody Essex Museum

[https://www.youtube.com/watch?
v=zw0133nKlcs](https://www.youtube.com/watch?v=zw0133nKlcs)

Betsy Connors



Betsy Connors



Betsy Connors



Paula Dawson



Paula Dawson
EEVblog #3
World's Largest Laser Hologram

<https://www.youtube.com/watch?v=RrGR-f1VNHI&list=PL4FD43C351F7AF798>

Rudie Berkhout



Rudie Berkhout

Legacy in Light

[https://www.youtube.com/watch?
v=K9S7AXM9VQQ](https://www.youtube.com/watch?v=K9S7AXM9VQQ)

Dieter Jung



James Turrell



James Turrell



Ana Maria Nicholson

Holographer

Interview

<http://www.anamarianicholson.com/>

John Kaufman

Holographer

[https://www.youtube.com/watch?
v=irlBm3Msfro](https://www.youtube.com/watch?v=irlBm3Msfro)

Digital Holography

Advantage

- The information in the holographic record can be analyzed directly by a computer without having to be optically reconstructed.

Only recently

- Resolution has been adequate for something like standard Fresnel holography to be carried out using CCD arrays instead of silver halide and other photochemical layers to record the interference patterns.

Digital Holography

- Digital Holography is holography using a digital recording of the holographic interference rather than photochemical methods.
- At present it is limited by the resolution of recording devices to **far-field** and **Fourier transform** formats, through this situation is likely to improve as resolution approaches the wavelength of light.

Digital Holography

Hot topic

- Applied Optics
- SPIE – International society for Optics and Photonics

Michael Klug – MIT

large scale full-parallax stereograms

Far-field Holograms

- Single beam transmission holograms made with the beam in line with the emulsion plane.
- The layout is similar to Gabor's original concept.
- For this reason they are also called Gabor holograms.

(Saxby, 2004, pg. 55)

Fourier-transformation hologram

- This hologram uses a configuration that records the optical Fourier transform of the object wavefront.
- Fourier-transform holograms are important in information processing and pattern recognition.
- They are (at present) the only type of hologram that readily lends itself to being drawn directly by a computer.

(Saxby, 2004. pg. 55)

Digital Holography & 3-D Imaging

OSA – The Optical Society

www.osa.org

- The Digital Holography and Three-Dimensional Imaging meeting provides a forum for science, technology, and applications of digital holographic, and three-dimensional imaging and display methods. Topic areas include interferometry, phase microscopy, novel holographic processes, 3D and novel displays, integral imaging, computer generated holograms, compressive holography, full-field tomography, and holography with various light sources including coherent to incoherent and X-ray to terahertz waves. This is a highly interdisciplinary forum with applications in biomedicine, bio photonics, nanomaterials, nanophotonics, and scientific and industrial metrologies.

Digital Holography

OSA – The Optical Society

www.osa.org

- Topic Categories
- Advances in Digital Holographic Techniques
- 3D Imaging and Display Systems
- Computer Generated Holograms
- Compressive Holography
- Transport of Intensity
- Quantitative Phase Imaging
- Holographic Lithography
- Digital Holographic Microscopy
- Digital Holographic Optical Processing
- Metrology and Profilometry
- Holographic Remote Sensing Techniques
- Fourier Transform Light scattering
- Biomedical/Clinical / Medical applications
- Novel Applications of Digital Holography

Architectural Mapping Obscura Digital

[http://www.obscuradigital.com/work/detail/
YouTube-Play/](http://www.obscuradigital.com/work/detail/YouTube-Play/)

[https://www.youtube.com/watch?
v=cKQPPxG_SBY](https://www.youtube.com/watch?v=cKQPPxG_SBY)

Architectural Mapping

Ralph Lauren 4D Experience

<http://4d.ralphlauren.com/>

Interactive Architectural Mapping
Design is Dead
ERISTOFF

[https://www.youtube.com/watch?
v=yXUEXWaoapQ](https://www.youtube.com/watch?v=yXUEXWaoapQ)

Interactive Architectural Mapping

1024 Architecture

[https://www.youtube.com/watch?
v=SQRf1LAymgs](https://www.youtube.com/watch?v=SQRf1LAymgs)

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