

# Light, Movement and 3D

## Light Images Viewed as Photographs

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### Abstract

When a two dimensional light shape is projected onto a moving photo-sensitive receptor the resulting image may be read by the eye/brain as a three dimensional image. If this phenomenon is combined with a mechanical drawing machine and mathematical figures, it allows some exploration of the following topics. 1. The perceptual process of reading these non-figurative light drawings as 3D photographic images. Particular reference is made to the expressive use and control of tone and colour. 2. The aesthetic differences between images created by line and by light. 3. A philosophical question may be put. A photograph usually represents 'reality', do we read it differently where no real object existed?

### Opening limerick.

*In creating an image by light  
we work in the realms of the night  
in terms of perception  
create a deception  
putting sense of the real to flight*

### 1 Introduction.

**1.1 Process, aims, and context.** The logic of topics in this paper is as follows. 1. The aims are stated and put into an art context. 2. The machines are discussed in terms of maths, geometry and mechanisms. 3. Visual and perceptual problems are defined with reference to tonality. 4. The production of the images is outlined. 5. Images are assessed for 3D properties. 6. The aims related to conclusions. Appendix. The mechanics of the turntable machine.

This paper is about art process, in particular the perception of 3D in machine made photographic light images. Maths, science and engineering are an inevitable component, as drawing machines are used in the production of the art works. The maths is concerned with the (time and speed) ratio of one motion to another and with the mathematical shapes generated by different types of movement and linkages. Science (photographic) is involved, as the modulated light trace is set to fill the exposure range of the digital camera. Engineering, both mechanical and electrical, has to be precise and capable of repeatability if the machine is to function as a design tool and serve the principal aim below. The content therefore combines experience of art process, maths, science and engineering.

#### 1.2 Aims

**To explore the 3D aspects of light images.** This paper is concerned with the expressive impact of light images with particular reference to the perception of 3D as it might be compared with a conventional photograph. The most rewarding strategies are discussed.

**To compare line and light.** Given the facilities in 5.2, it is feasible to compare a line drawing with a light drawing from the same machine and at similar settings. See Figures 4 & 5.

**To question our reading of photographs.** Does the absence of an object alter the way reality is perceived when reading an image in photographic form? This question is implicit throughout.

**1.3 Context.** It is important to place this study in both the narrow context of the author's work [5] & [6] and the wider one of current and past art practice [4]. The author's work [5] is instructing machines to draw following simple numeric sequences. Pen and light have been used in many versions of six machines; here one aspect is being highlighted; reading light drawings as 3D images.

**1.3.1 Other work.** Many artists, including Moholy-Nagy [1] and others [2], have employed light in their work. There are now so many different categories ranging from sculptures to computer outputs that it is difficult to classify them. A very large selection can be found on the internet [4]. They could be broadly divided into two areas; those where the lights themselves are the end result and those where the light action is recorded. Many artists now rely on digital control which appears in both the above areas.

**1.3.2 The Author's light machines.** They are analogue, but share one aspect with digital, in that they may be programmed and act as design tools, producing large numbers of different images. However, they sit within the kinetic constructivist tradition. The purpose of the light images in particular, is to try to manipulate the eye/brain perceptual process and 'recreate' a photographic image without the prior existence of an object. This is how the author's work differs from most of that described in 1.2.1 above. From examples below it is hoped to show progress has been made towards realising the aims.

## **2 The nuts & bolts - geometry, maths and mechanisms**

**2.1 The basis of the machines.** The machines rely on simple maths, sine waves, rotation, ratios, linkages, and sequential timers. Simple instructions, in the right order, generate rich and complex drawings. To explore the perceptual elements of light traces, the Turntable machine was chosen. See Appendix.

**2.2 Current turntable machine.** The current version has attributes which can be used alone or in various combinations. It was set to produce calligraphic sinusoidal lines, where perspective effects, tonal gradation and colour might be created easily. Simple shapes are more likely to suggest 3D than complex programmed drawings and advantage was taken of the rotating light pen recording onto a digital camera.

## **3 Definition of the problem – line, perception and tonality**

Having dealt above with the aims, context and nuts & bolts, it is now possible to define the visual, perceptual and tonal problems associated with reading a drawing or photograph as representing objects. From childhood we have to learn to 'read' both the above as representing objects. To take this one step further, the impression of 3D in a drawing and photograph depends on the perspective and tonal range respectively. In line drawings there is minimal information and our perception process does an extraordinary job in deriving meaning from them. Many simple drawings e.g. the harmonograph in Figure 11, do possess a 3D feel and it is surprising how a few lines can hint at it. By adding tone and colour to line drawings the impression of 3D is enhanced dramatically, again see Figure 11. It is interesting to compare line and tone images from the same machine setting. See Figures 4 & 5. With photographs it is self evident that we derive most information from the middle tones (there is minimal information in the highlights and shadows). A photograph generally relies on these for impact at the expense of the highlights and shadows. Perspective in both drawings and photographs reflects how the eye/brain works; we perceive near objects as being larger than those further away.

Given that the middle-tones are important, we need to know the range of tones available to us for maximum information. The maximum range of the best digital sensors is between 8 to 9 stops i.e. is between  $2^8 = 256:1$  and  $2^9 = 512:1$  [7]. To approach this in a light machine is difficult. If the light pen is modified with graduated filters, a 2 stop (4:1) range is possible leaving a 6 stop range (64:1) still needed. The relative speed difference, edge to centre on the turntable, is 3 stops (8:1) and this helps to reach a total of 5 stops (32:1) So a useful range does exist which may be stretched in Photoshop. The problems are therefore perspective and the quality of mid-tone gradation.

**3.1 Perspective.** This is the lesser of the two problems; drawing shapes which suggest depth (i.e. sinusoidal) is relatively easy. The addition of turntable rotation, reciprocal sun & planet motion and rotation of the pen creates rich sine wave type forms..

**3.2 Middle-tones.** A light trace starts as a highlight against a black background which is the opposite of what is needed to create rich middle-tones. The exposure is biased towards the mid-tones and the relative

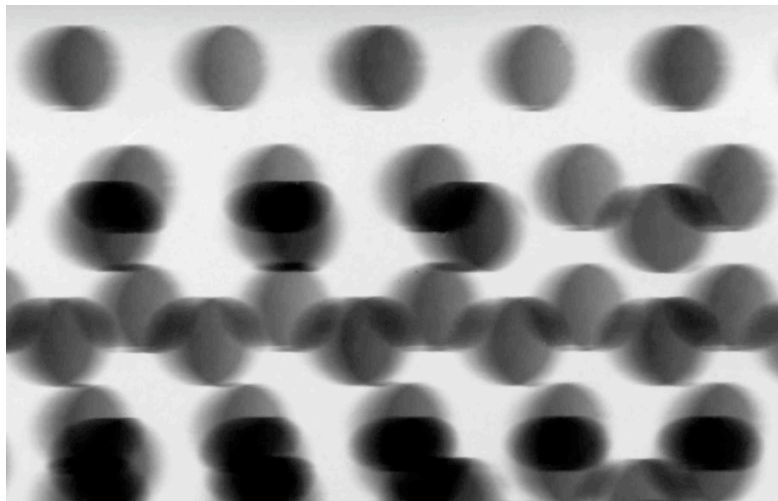
speed differences in the turntable/linkage motion helps with the remedy. Turntable speed is fast at the outside to zero at centre and the linkage movement varies from fast in mid cycle to zero.

**3.3 Spread of tone/colour.** Perspective and mid-tones have been defined. The next objective is to spread the tones widely to minimise the amount of black background. A slit light source (giving a calligraphic effect) with a graded tone/colour filter assists in this and when the light pen crosses a previous path it also adds mid-tones. Finally, programming the pen to pass over the largest image area minimises the black background. In the Appendix, a light source is shown fitted to the turntable machine.

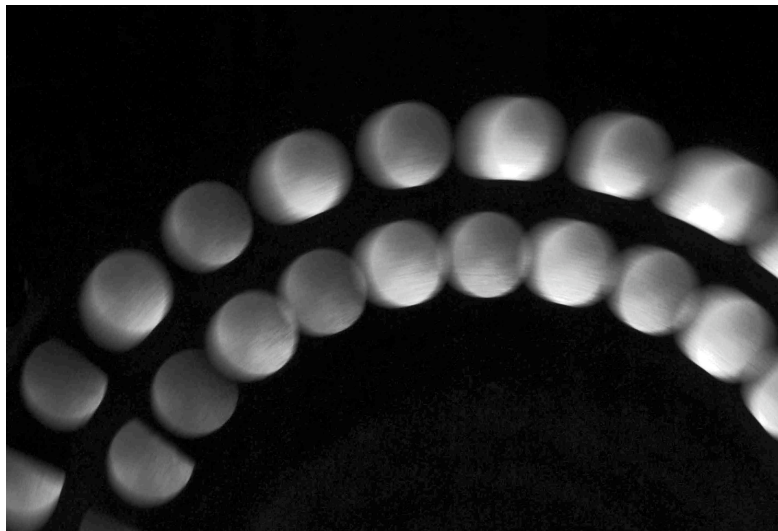
#### **4 From discs & spheres to colour images.**

In this section the effect of a moving light on a light sensitive surface is examined at the most basic level. This helps chart the progress from simple images to the present complex ones in colour.

**4.1 The 'tennis ball' effect.** If a disc of light is recorded in motion (using a shutter mechanism) a 'photograph' of a tennis ball is seen. This began a train of thought: can a moving light trace create an image which is read as a photograph without the existence of an object before the camera? This question supplied the motivation for much recent work; an example of which is shown in Figure 3.



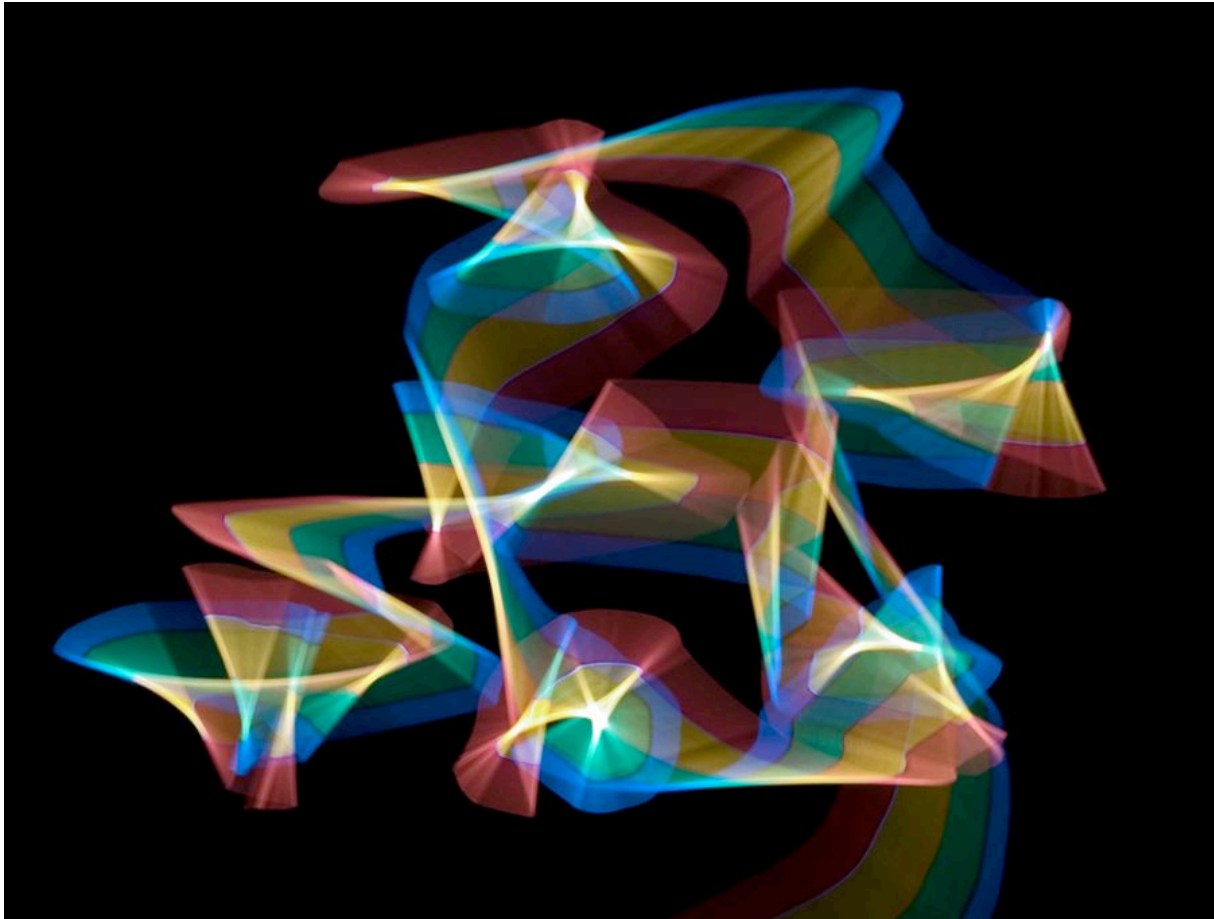
**Figure 1** *Earlier test*



**Figure 2** *Tennis balls - current image*

**4.2 Settings Figures 1 & 2.** The machine was set to produce a spiral, with a louvre type shutter (rotating flap) between the camera and light unit. The louvre design causes gradation during opening/closing.

**4.3 Recent light image.** From the basic principals in 4.1 and 4.2 above, it has been possible to progress to the most recent machines. Below is one example of a light pen unit (see diagram in Appendix) drawing an image combining slit rotation, circular and side to side movements. It is this type of image on which the 3D debate is centred.



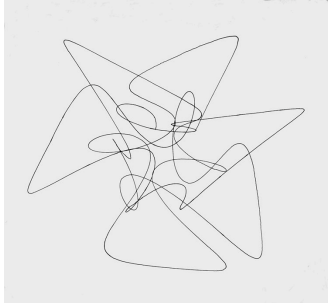
**Figure 3** *NSEW image-fixed colour filters and rotating light slit. Compare with Figures 5 & 16.*

### **5 Assessing the images.**

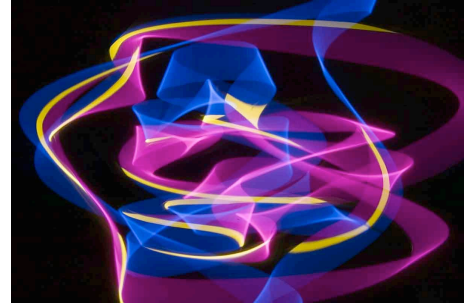
The final step in addressing the aims is to compare images in various groups. Factors which effect the character of the light drawings are discussed. It is hoped that some 3D characteristics show in the images.

**5.1 Geometric differences** The pen action is governed by different geometry from the light unit. This is because the rotating pen is fixed **above** the turntable and the compound movements occur under the pen. The light pen unit is **on** the turntable and its movement combines with the turntable/sun and planet linkage. The camera is above the machine, in the 'pen position' relative to the turntable. To match the pen drawing exactly with that of the light unit, the camera would have to be sited on the turntable and the rotating light pen placed above it. In spite of this, some family resemblances exist.

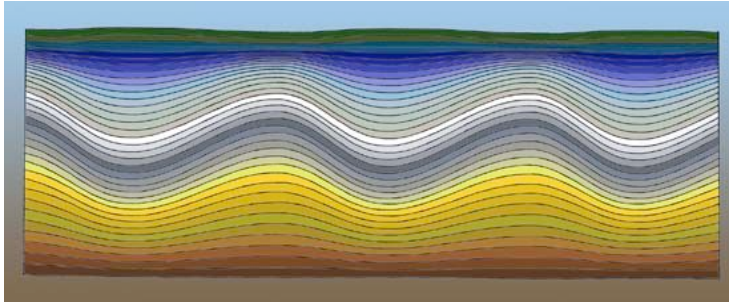
**5.2 Line drawings compared to light traces.** Two sets are shown; Figures 4 & 5 have similar settings on the same machine; the sine wave drawing Figure 6 may be compared to light image Figure 7.



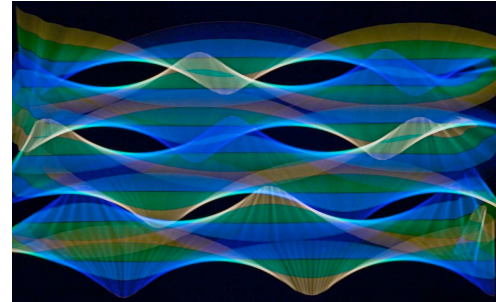
**Figure 4** *Pen drawing, same settings as Figure 5.*



**Figure 5** *Light image; camera zoomed in.*

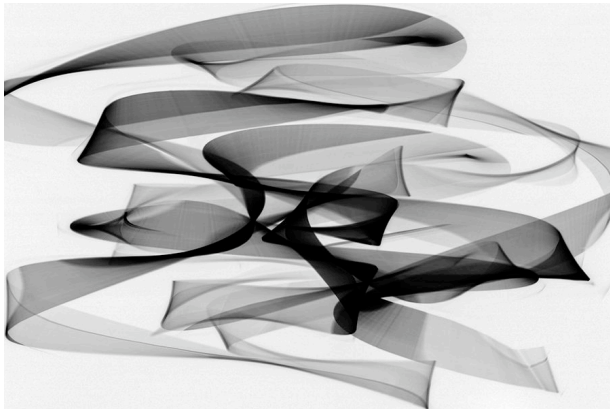


**Figure 6** *Sine wave machine drawing, similar in feel to -*

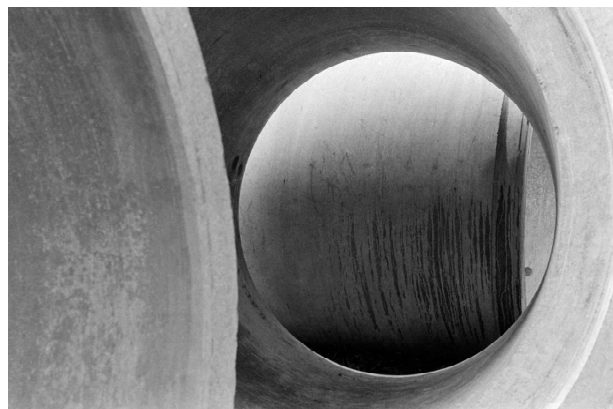


**Figure 7** *Rotating light slit-NSEW machine.*

**5.3 Tonal gradation.** Monochrome light images might establish whether greys alone can generate a 3D effect and provide a comparison to black and white photographs as well as coloured light pictures.



**Figure 8** *Light image, tonal inversion.*



**Figure 9** *Abstract image of pipes exploiting greys.*

**5.4 Colour.** When using light traces, the drawing point can be any shape or size. Experience shows that a rotating slit generates interesting images; recent work has a multicoloured set of filters placed over the slit at right angles. A number of these images have been published and exhibited. They are significantly different from line drawings where colour is added in Photoshop. Line drawings are hard-edge flat images; colour light images have a softer trace and begin to suggest a 3D element. See Figures 10-17.

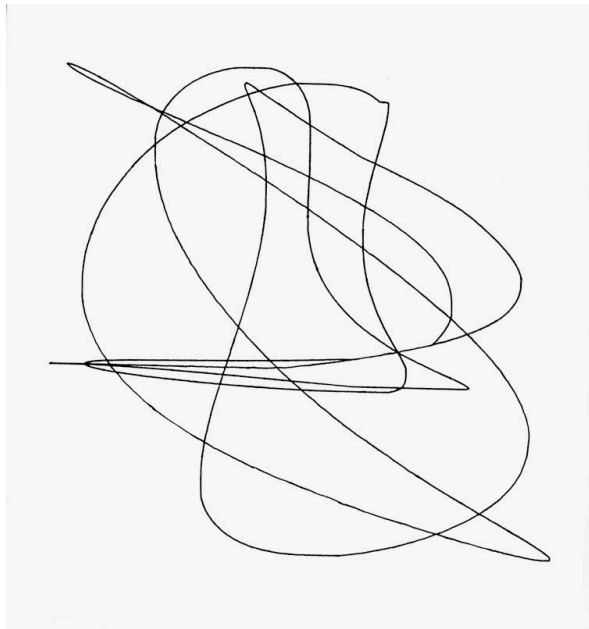
**5.5 Independent colour changer.** In an earlier set-up the colour and the slit aperture were tied together. In the machine used here the colour is changed independently, increasing the expressive effect and altering the character of the image. This arrangement, coupled with the rotation of the slit, generates images where the 3D effect is most likely to emerge. Compare colour in Figures 3 & 5 with Figure 16.

**5.6 A calligraphic line.** Perhaps taking a lead from painting, a light source may act as a broad brush, not only putting down colour, but capable of displaying varying tones in the slit as it moves across the

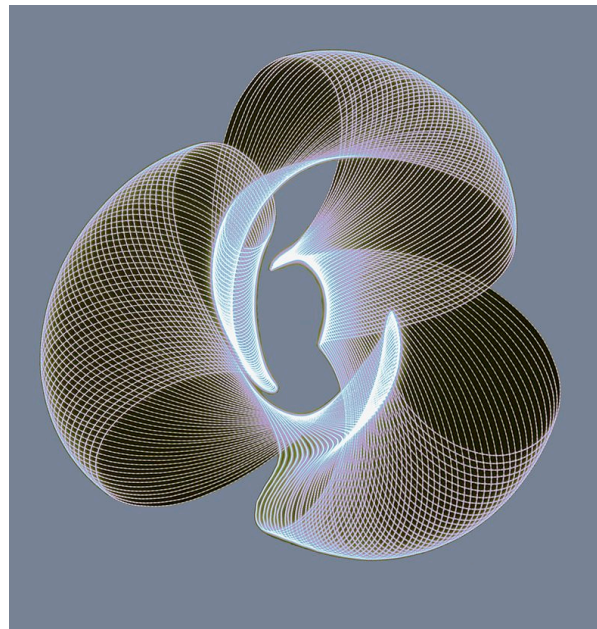
recording space. Where this combination of tonal variation, colour and calligraphic shape occurs, the suggestion of a three dimensional effect is strongest. See Figures 14 & 16.

**5.7 Inversion.** As it is easy to do in Photoshop, the effect can also be tested with the tonality and colour inverted so that the image appears on a white ground instead of a black one. See Figure 14.

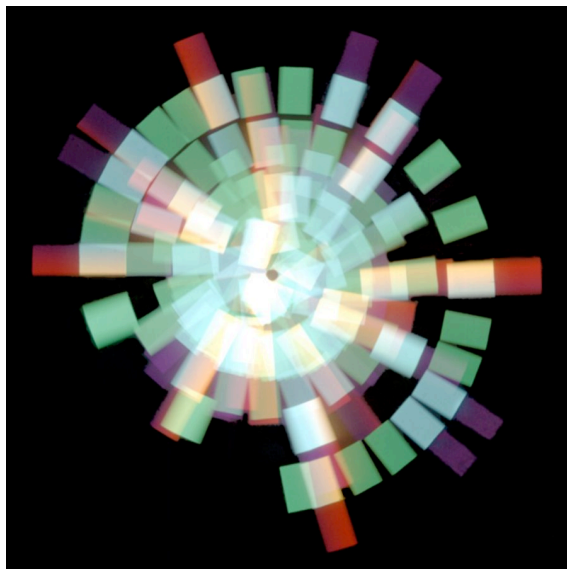
**5.8 A Continuum?** By displaying a flat drawing, conventional photographs and light images, the case for 3D may be assessed. Where on the continuum between drawing and photography do light images belong?



**Figure 10** *NSEW drawing- little 3D feel.*



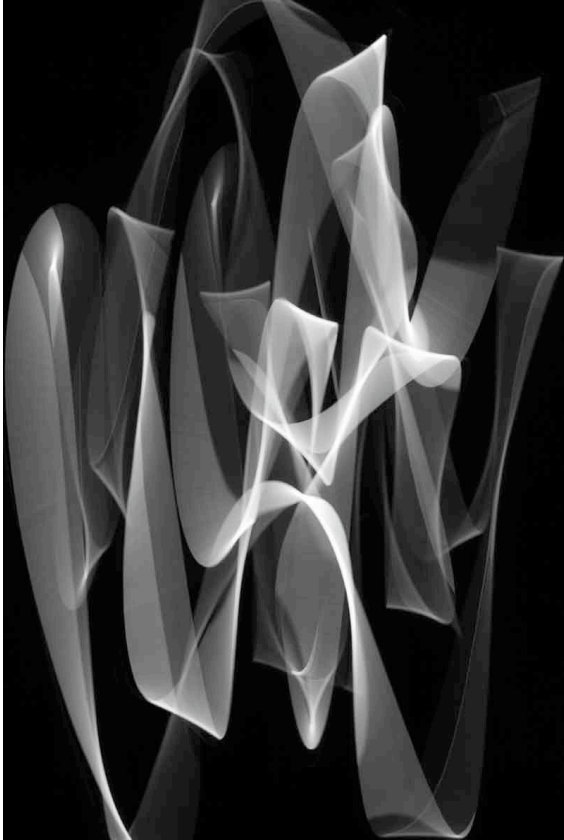
**Figure 11** *Linkogram & colour - some 3D feel.*



**Figure 12** *Early turntable image with little 3D. This has some of the 3D effects seen in Figure 2 but lacks any perspective to help it along.*



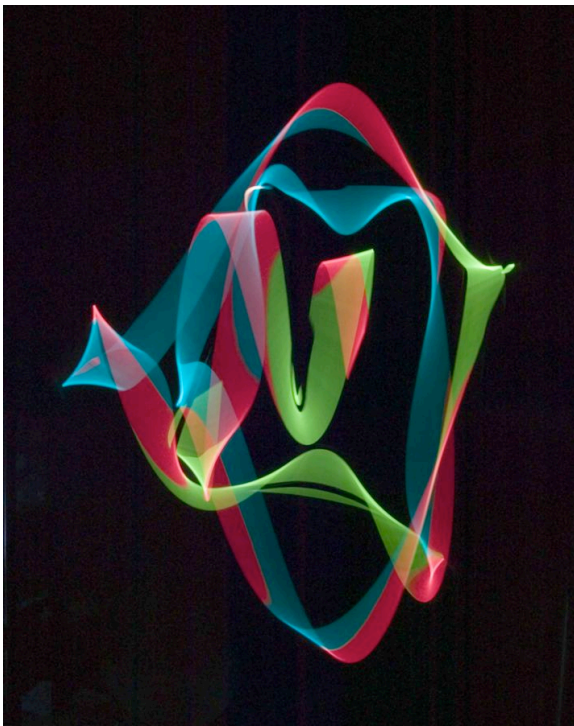
**Figure 13** *Thistle photograph; this has 3D character which comes from perspective and selective focus.*



**Figure 14** *Greyscale image, calligraphic effect*



**Figure 15** *Sweet corn-similar tonality to Figure 14*



**Figure 16** *Colour image, calligraphic line*



**Figure 17** *Pepper photograph*

## 6 Summary.

The differences between line drawings, light images and photographs have been examined. In offering conclusions, based on the author's experience with viewers, three questions arise: **1.** Can light images be viewed in the same way as conventional photographs? The answer is 'YES'; we can not avoid doing so partly because both share the same mid-tonal information. **2.** Do light images display more 3D qualities than line drawings? The answer is 'YES'; with the exception of line drawings with strong perspective; adding tone and colour usually increases the feeling of 3D in an image. **3.** Does the absence of an object in a photograph distort our perception of reality? The answer is NOT VERY MUCH; reading photographs as representing the outside world is now innate; we often see photographs containing abstract motifs. This relegates the absence of an object before the camera to a minor issue and is unlikely to distort our perception. It helps to remember that the viewer's response to a picture is governed by what they bring to it [3]. A logical approach - hypothesis, questions, experiments and evidence can only go far, given that the expressive effect of an image is a mixture of neurology and viewer subjectivity. However, it is hoped that by posing and answering questions (albeit narrow and limited) about reading 3D images, some insights have been created about how art works in the very specific instances shown above. The viewer must judge where light images sit on the above continuum in respect of their 3D properties.

## References

- [1] Moholy-Nagy Laslo - Light painting hinged celluloid George Eastman collection. 1936
- [2] Malina F - Kinetic Art Theory and Practice - Dover Publications New York pg 37 1973
- [3] Gombrich E H - Art and Illusion - Phaidon Press - London pg 155 1977
- [4] [www.dataisnature.com](http://www.dataisnature.com) show the range of work
- [5] Jack Tait - Beyond Photography - Focal Press - shows applied images throughout 1977
- [6] [www.taitographs.co.uk](http://www.taitographs.co.uk) shows the range of work and machines
- [7] British Journal of Photography Vol 153 no.7612 pg 32 2007

## Appendix The Turntable machine.

This was the machine used to produce most of the images. The main elements are shown on the diagram.

