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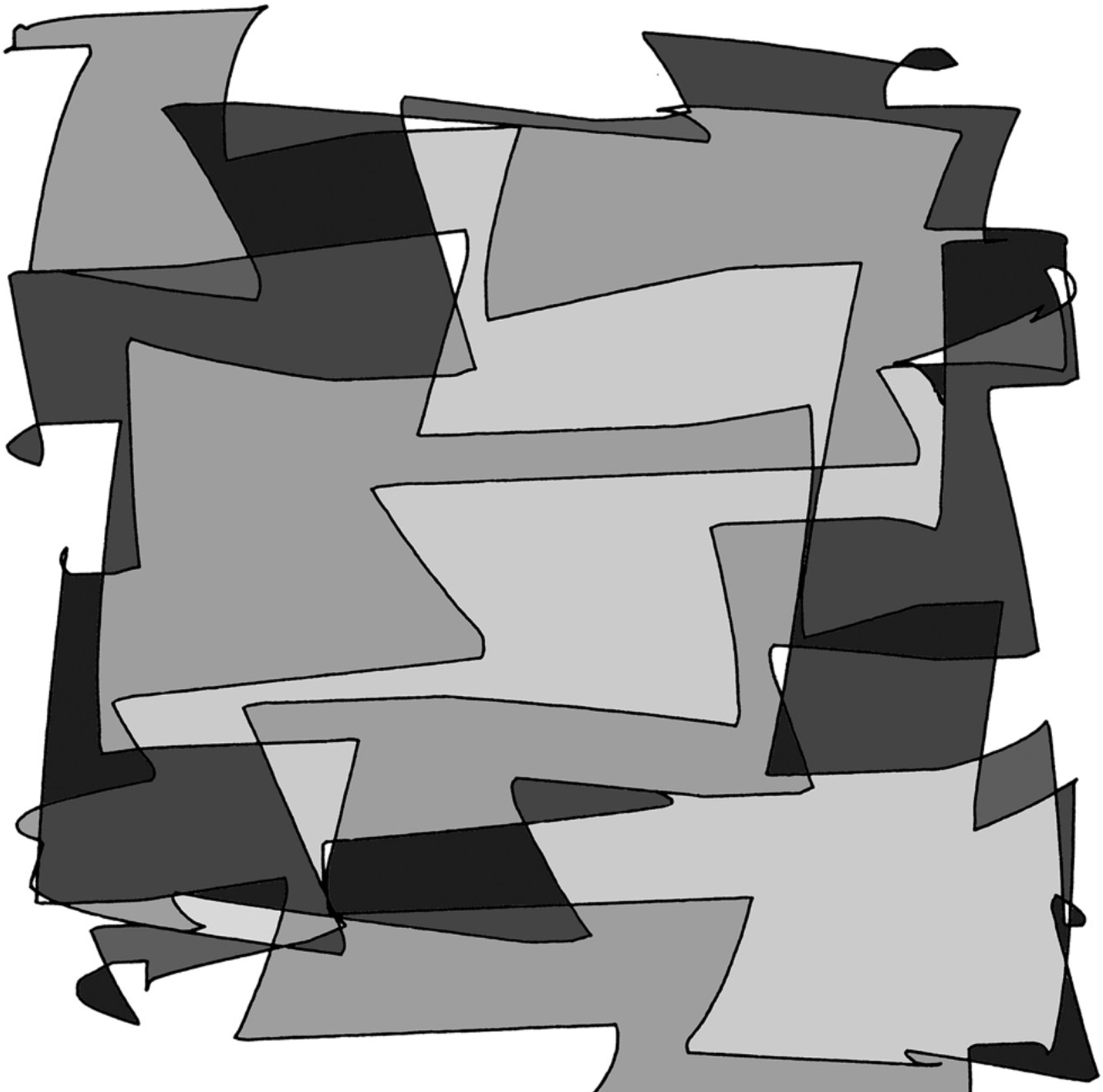
BULLETIN OF THE COMPUTER ARTS SOCIETY AUTUMN 2007

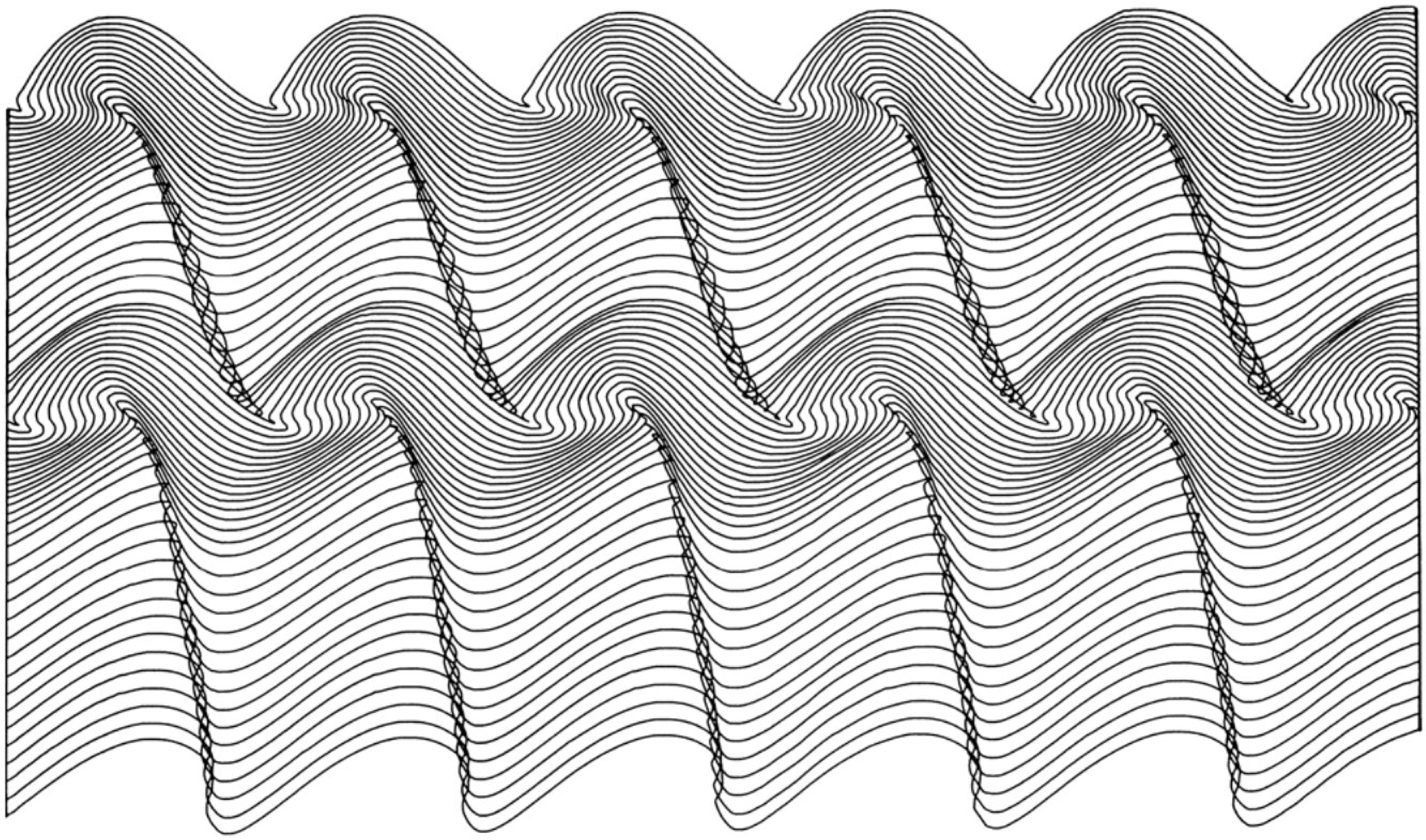
Taitographs

DRAWINGS DONE BY MACHINE



INTRODUCTION - *Taitographs*

Taitograph is the name and logotype for any drawings done by my machines. It describes a hybrid image, part drawing or photograph, processed in a digital computer and output as a print. During a long preoccupation with designing machines which draw, with either pen or light, questions over and above the design and engineering have emerged. In the context of abstract art, following the argument that creativity rests more in behaviour than in an individual object, it is suggested that the activity involved in designing drawing machines and their subsequent evaluation and application might inform the creative process. I have tried to relate the steps in building the machines to the issues surrounding the work.



Sinewave machine drawing showing latest 'wave break' feature: a recent image which is yet to have colour added

Curiosity-the common thread

The common thread running through the activities of mathematicians, computer programmers, and artists, interested in the machine made images seems to be curiosity. We are all fascinated by simple instructions producing complexity: excited and inspired by the diversity. In PAGE 64 the parallel was drawn between evolution and the development of artificial intelligence. Ellen Dissanayake[1+2] argues that 'art as behaviour' has been an essential component of our evolution. It is understandable, given the part machines have played in our civilisation, that as soon as we had a machine able to carry out instructions and take decisions that we would ask it to draw for us.

At art college in the 50s computers were rare: any curiosity had to be satisfied via other outlets and run alongside the study of another machine, the camera. (See **History** below) In the text and pictures I have outlined nearly fifty year's work from the late 50s to the present time. The technical aspects are covered in detail but what is perhaps more important are the questions raised about art process and the possibility of learning something about creative behaviour.

When instructing machines to draw, particularly analogue, most components of the activity are transparent unlike conventional hand/eye coordination where we are still trying to unravel the 'black box' of our neurological processes. I do accept that questions of mind and consciousness[3] play an inevitable part in any of our activities, they are and always will be involved in evaluation.

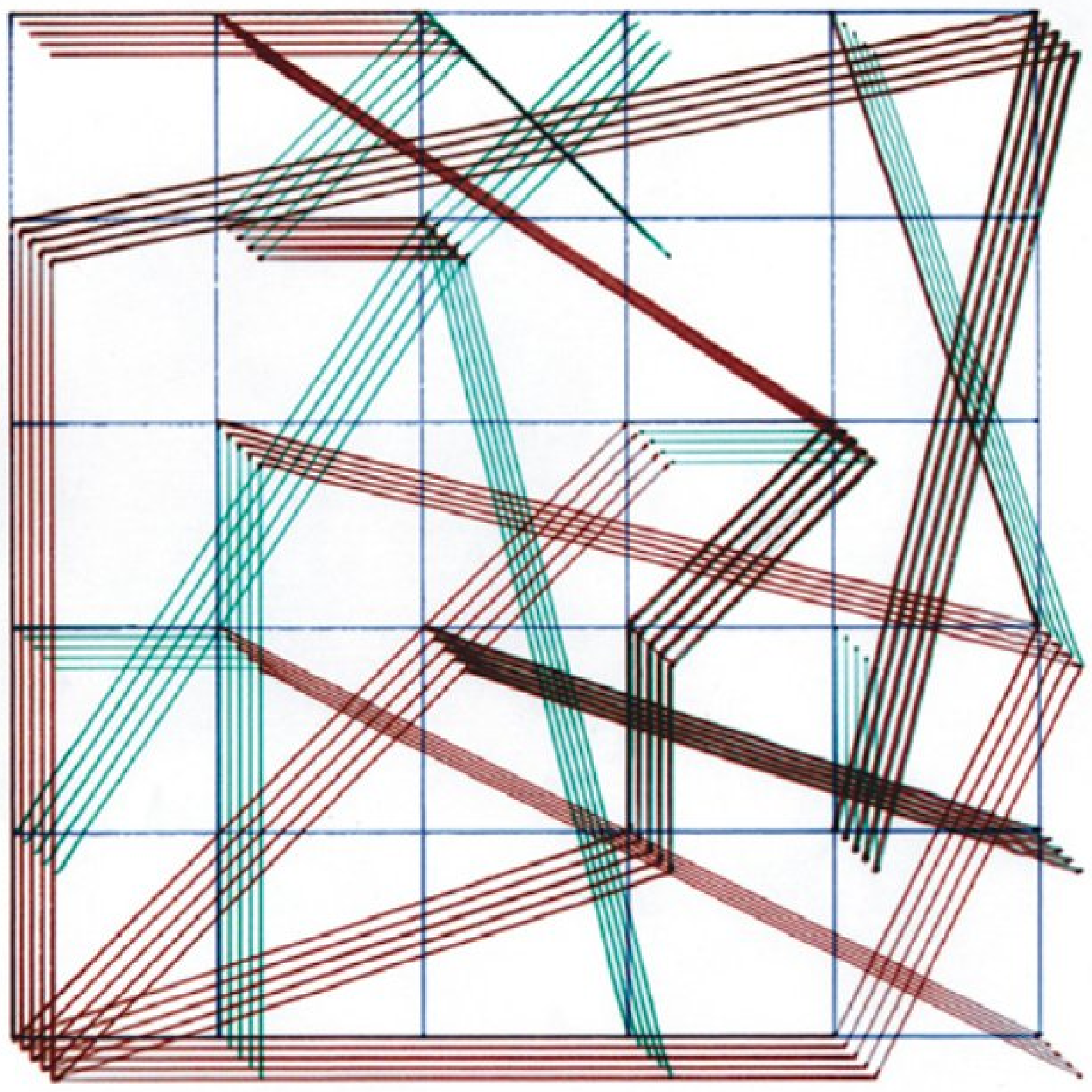
My position is that any extra transparency might help and clarify the questions which may be put. By asking the right questions we might find out how art works[4] and gain insights into the creative process.

Terminology-problems with words

There are two words which cause problems in any debate, 'art' and 'creativity'. Disagreement will persist so I will offer my definition. When teaching design I defined the difference between art and design as follows: If 50 people view a design, they will share a similar response. A poster is designed to send an unequivocal 'noise free' message. A chair will not be mistaken for a table, although if excellent it may have transcendent expressive qualities in addition to its function. If 50 people view an art object, their response, governed by what they bring to viewing it[5], conditions their reaction and makes it special to them; there will be 50 different experiences.

Whilst this is a simplistic definition it does establish some benchmark by which art may be judged. It is also useful if we can regard an object as a manifestation of art behaviour. This also applies to creativity and is a descriptor for the behavioural process of making something special. I think that creativity is not necessarily a property of the object but more a recognition of the process by which it came about. Creativity exists in the minds of the viewers; a creative object which has an independent existence seems unlikely.

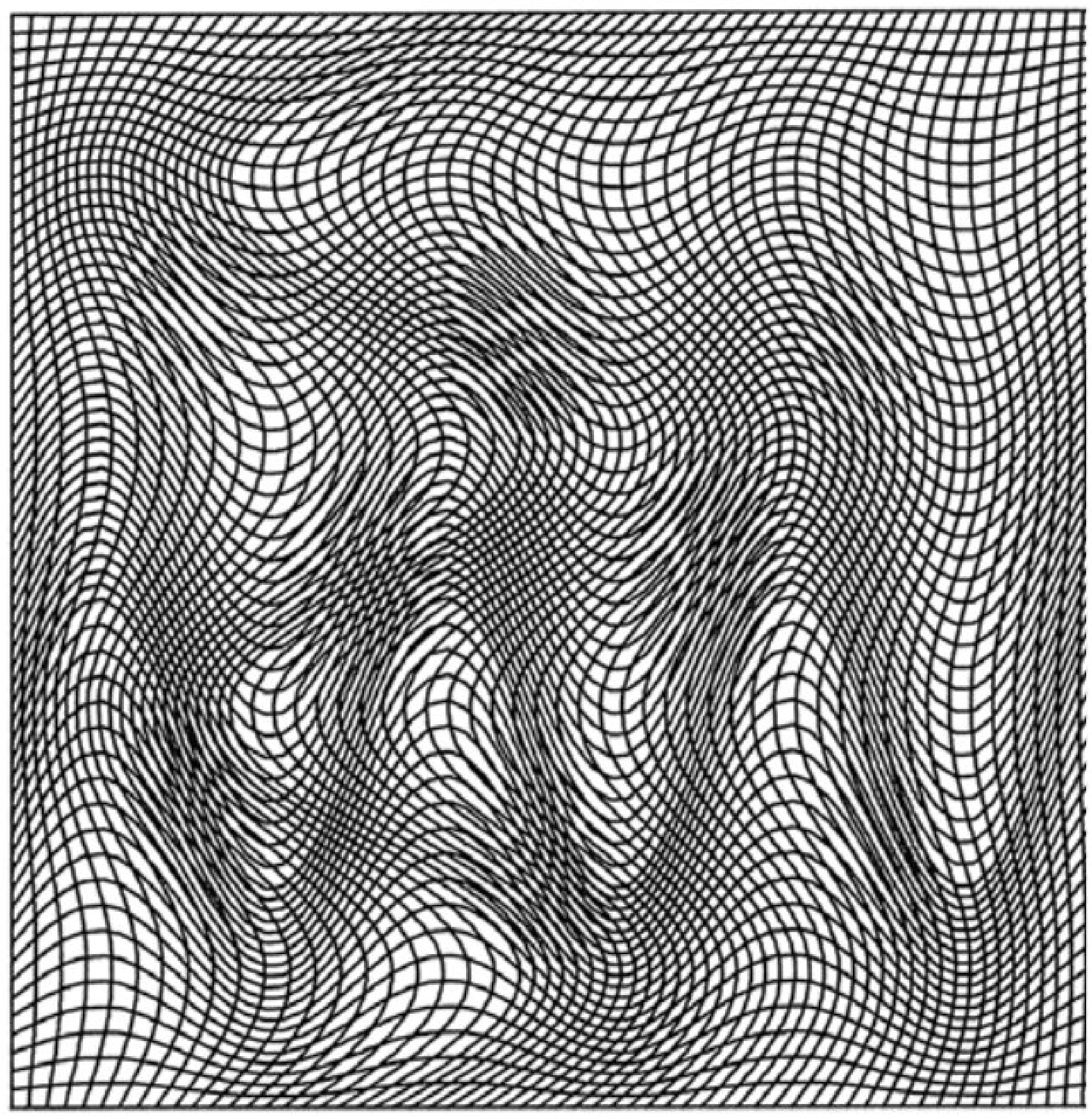
The above is a current and controversial debate, however with a constant act of reading and learning more persuasive ideas may emerge which change my views; our only enemies are notions of certainty.



Computer drawing after Kenneth Martin

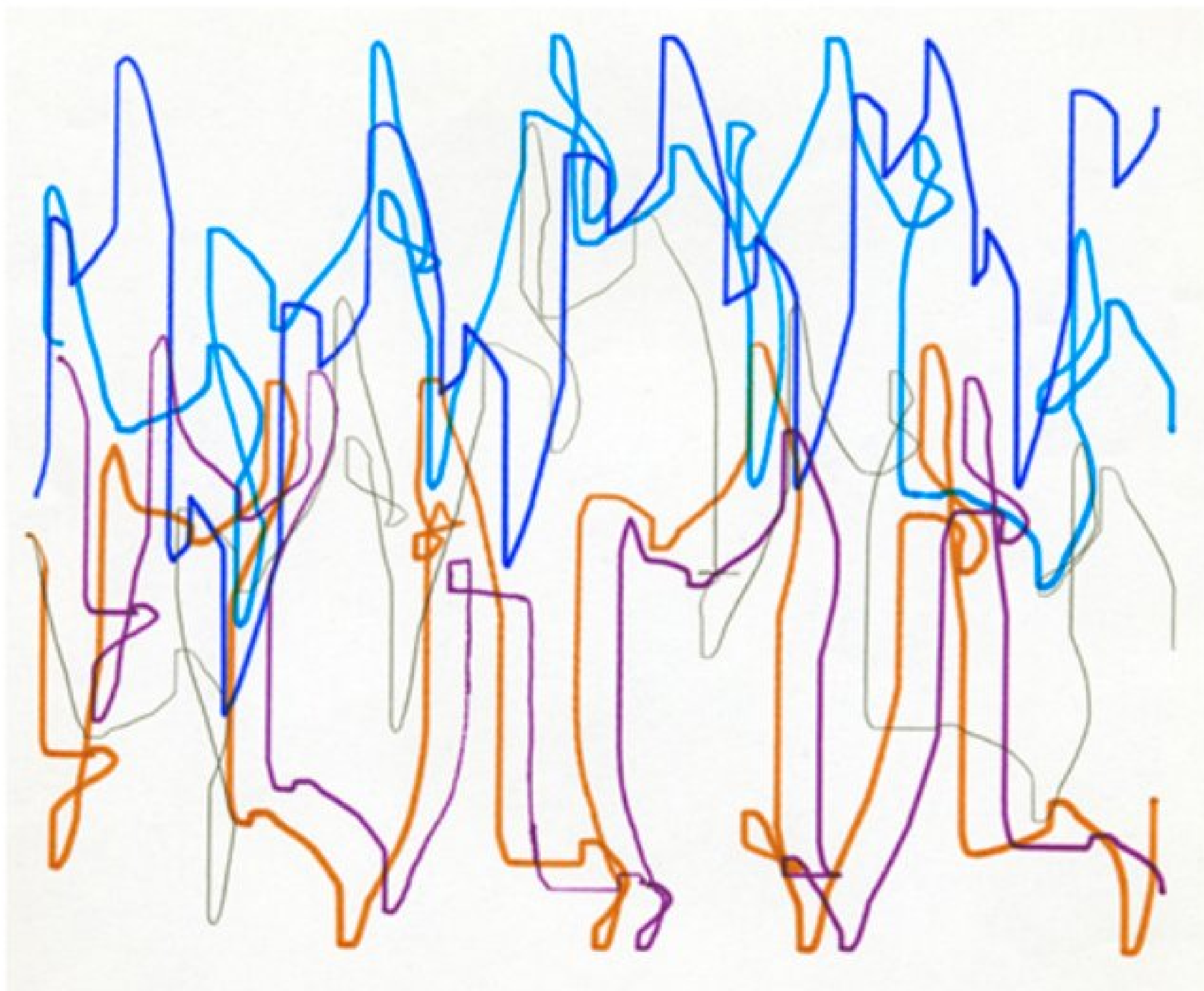
Influences

At art college and afterwards, I immersed myself in the range of work listed below. In cases, such as Cezanne, this had a direct bearing on my still life photography. Others were indirect and include Maholy-Nagy, Man Ray, Paul Klee, Kandinsky, Mondrian, Matisse, Kenneth Martin, Brigit Riley, Vassarely, Tanguely, Harold Cohen, Constructivism, Kinetic art, Cybernetics, and Artificial Intelligence. The influences did not lead



Computer 'chord' sine wave ratio 2:3 = musical interval a fifth

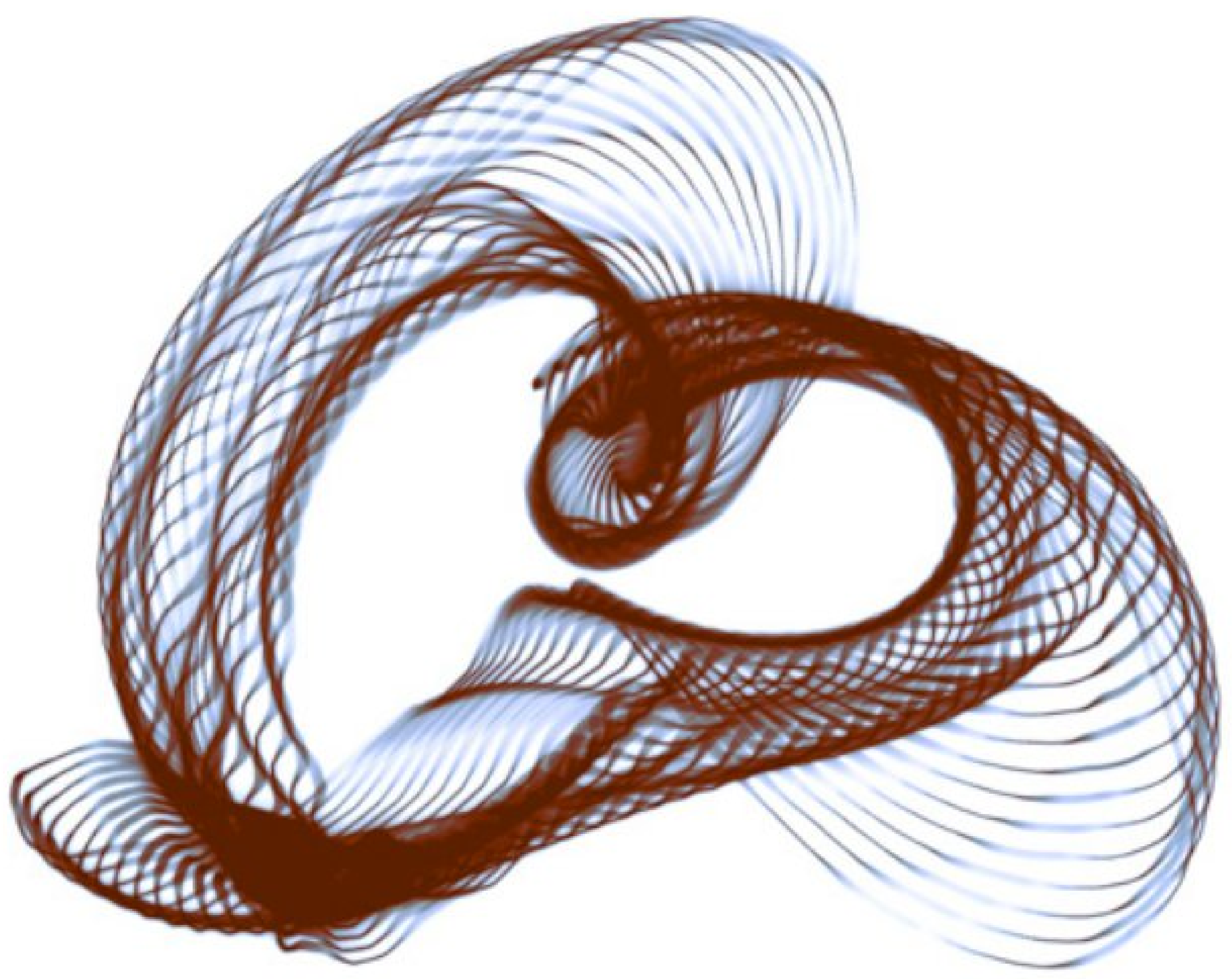
to machine building but developed alongside it. It was never my intention to 'mimic' the constructivist pictures; any parallels are 'homage' to the painters and an attempt to understand their preoccupations more fully. I am only interested in the significance of what machines can do. The Bauhaus movement has been pivotal, in particular the philosophies of Moholy-Nagy, Man Ray, Klee and Kandinsky. My work paddles in a backwater of constructivism with cybernetics thrown in for good measure!



Early Paul Klee inspired drawing - multiple pass- different pens

Early work

Early machines, built with Meccano and scrap parts, were crude by comparison to current ones, whilst the light machines were holders for photographic material which moved around under an enlarger light source. Computer programming was carried out on a Hewlett Packhard Calculator with an attached plotter. The calculator had 4k of memory, had Octal as its language and relied on ROM. Although it was basic and slow the line quality was good.



Linkogram drawing with light pen and pen lift

The current machines

The sections **1-6** and **Technical and Mathematical** below deal with the machines and contain detail intended for those interested in the engineering and mathematical elements. It is possible to understand the ideas from the remaining text, diagrams and drawings. All the machines are analogue devices; electro-mechanical systems using gears and linkages.

The analogue mechanical route was chosen **(see History**) as my work began prior to the availability of computers. It has proved useful in generating results which I might not have produced had I switched to digital as soon as it became available. The analogue machines can be programmed, albeit with very simple instructions, so that a satisfactory variety and richness can still be achieved. The six machines fall into two groups:

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GROUP ONE Harmonic based

In the first, the machines rely on some form of harmonic movement, however complex, and which may be programmed by adjustment of their settings, that is the start positions of the drives. These are self-contained and do not need any input from an external control unit. These machines are the Meccanograph 1, the Linkogram 2 and Sinewave 3.

With all the machines, efforts have been made to design a notation formula which will allow an image to be repeated. In some cases like the Linkogram and Meccanograh this works well and a high degree of repeatability is possible.

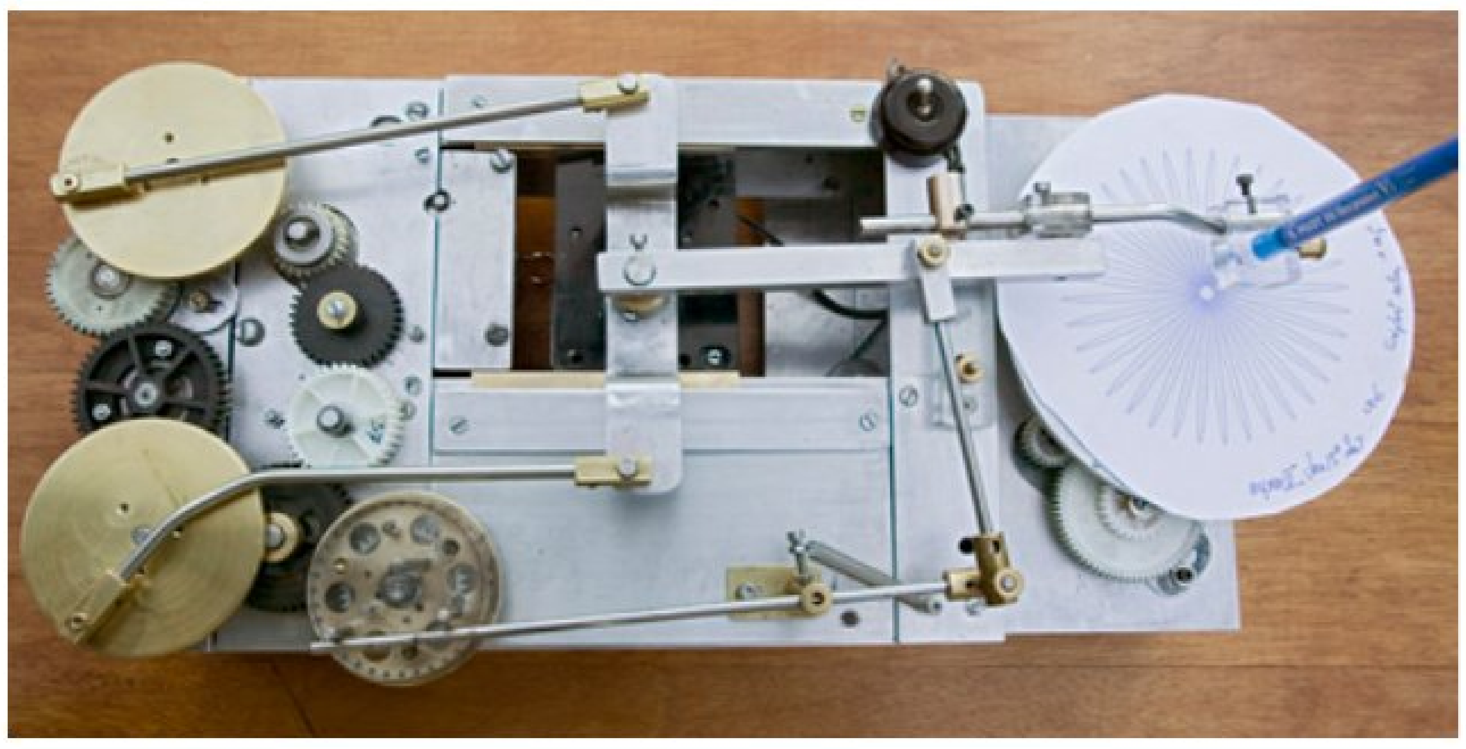
With the Sinewave machine, in its latest development, it is possible to repeat images with sufficient accuracy to show a close family resemblance to earlier drawings. Repeatability is essential if the machines are to be regarded as design tools and allow the development of an idea following trial, error and judgement. Without this prerequisite no notion of creative behaviour can be entertained.

NSEWsp drawing showing 'gestural' line quality

GROUP TWO Progam driven

The second group of machines are basically forms of X:Y plotters. In the case of the Turntable machine and also when a light source is used, rotation is added to the normal Cartesian coordinate system. The three machines are the NSEW 4, the NSEWsp 6 and the Turntable 4.

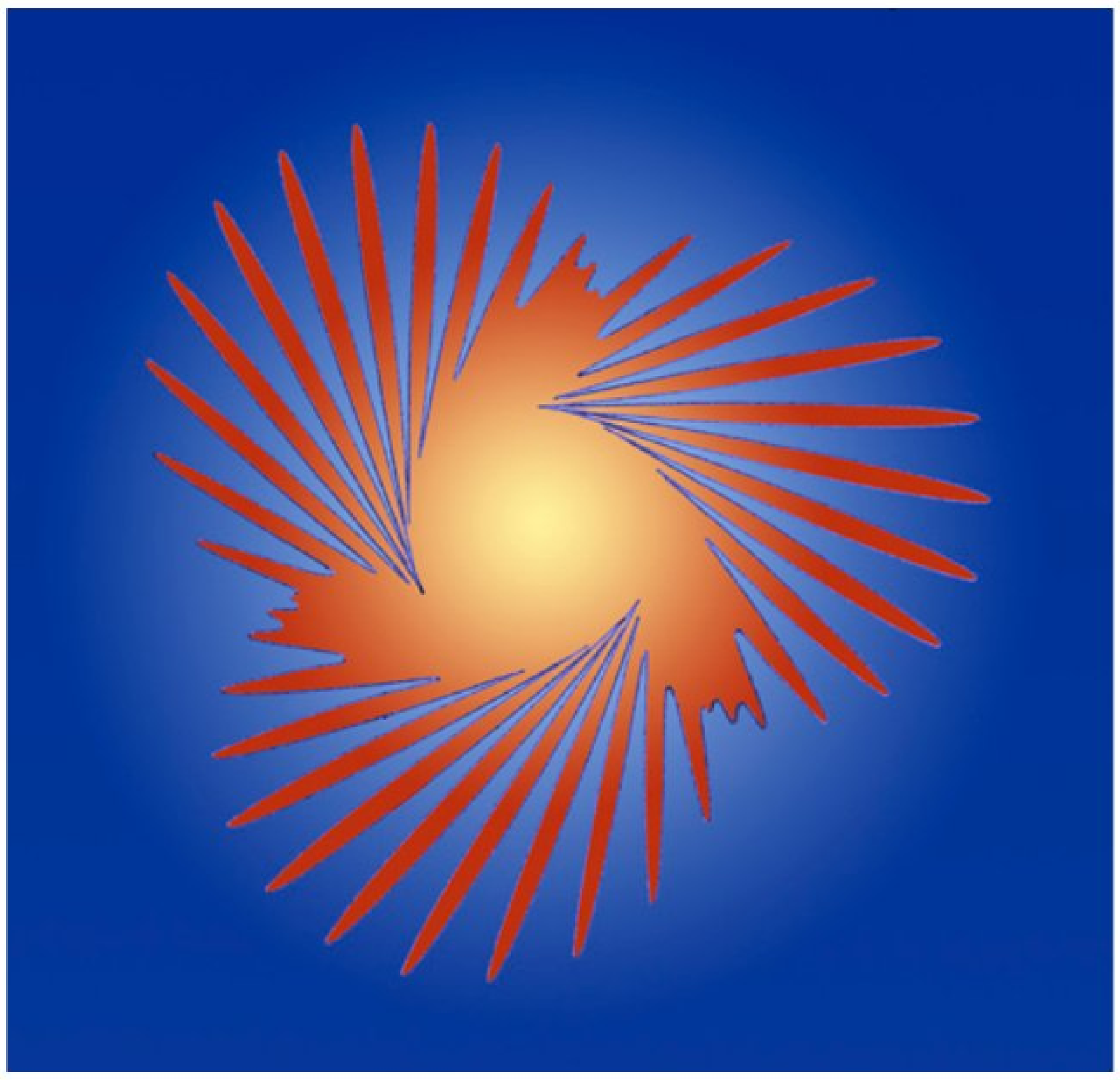
The term NSEW stands for north,south,east,west; the intent is to program the movement to allow a 'decision' to be made at each 'instruction change point'; the line could go in any of the four compass point directions. (This was inspired by earlier usage of a computer driven X:Y plotter)



'Meccanograph' type machine with variable X axis amplitude

1 Meccanograph* see note below

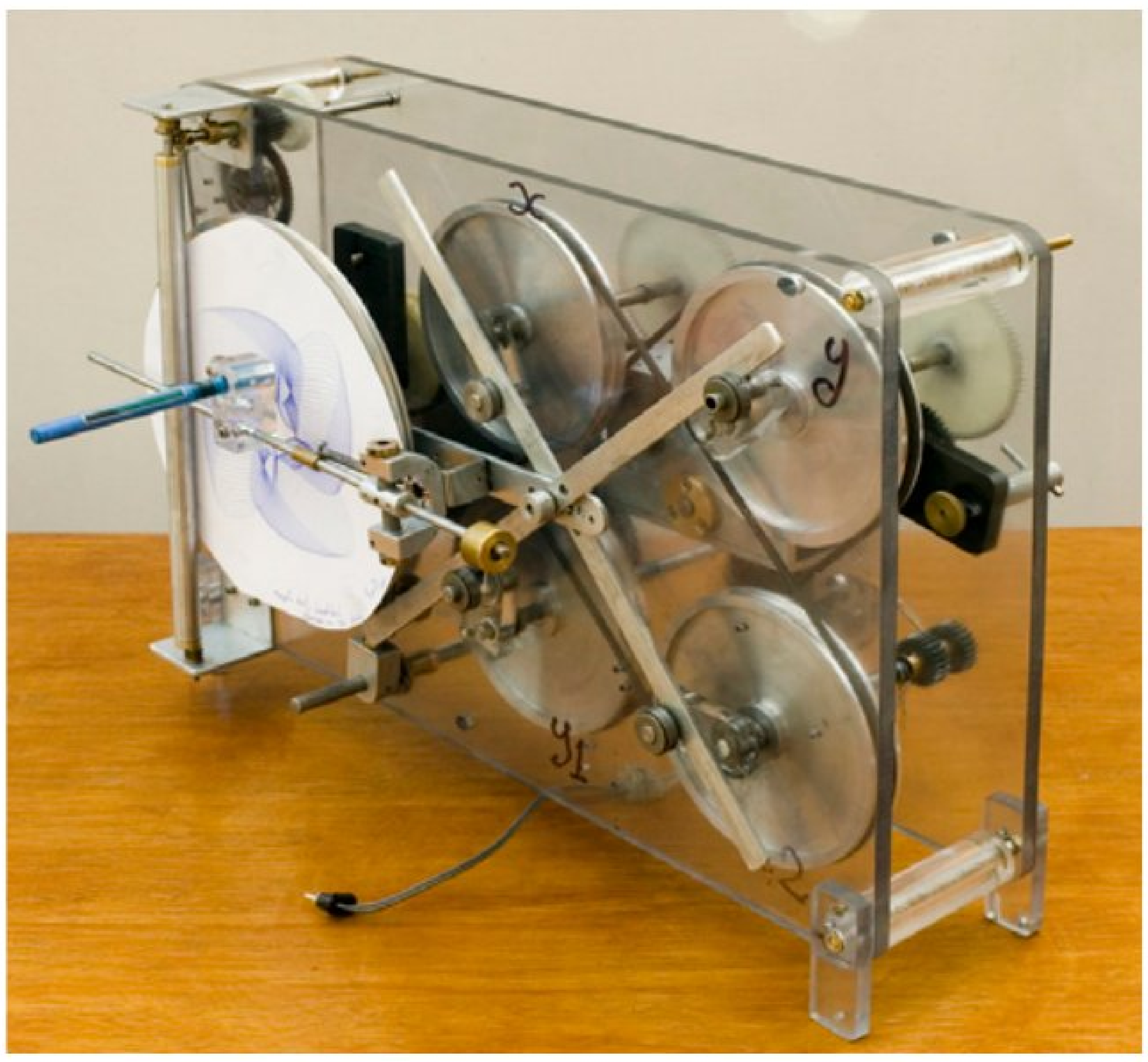
This is the simplest of all the machines and in its present form will only produce symmetrical circular images. (If extra gears and cams were introduced, as in 19c ornamental chucks, the drawing would be more complex and could be asymetrical.) In the Meccanograph, the gear ratio between the X axis and the turntable is set at 1:36 so that any amplitude growth on the X axis has to be in a whole number relationship with 36. The two wheels driving the growth/decay on the X axis (same system as described in detail on the Linkogram below) can be coupled with 48t and 44t gears which repeat their cycle in 12 revolutions. That is they move in and out of phase in 12 revolutions. The formula is to take the difference between the gears 48 – 44 = 4 and divide this into 48 giving 12. This will be the number of loops drawn. If the growth decay gears are used as



Meccanograph ‘processed’ drawing with varying X amplitude

above, the size of the loops will vary and form three sets; if the gearing is set to equal (48t and 48t) all the loops will be the same size. The number of different drawings available is governed only by the gear ratios adopted. (In Decheveron and Creighton machines large sets of gears were available see page 13) The only other variable added to the Meccanograh is a Y axis profile cam which has changeable pins which may be in different holes to generate extra complexity to each loop in the drawing. This machine was built mainly out of academic interest; the range of drawings is too limited to generate many drawings to compare with other machines.

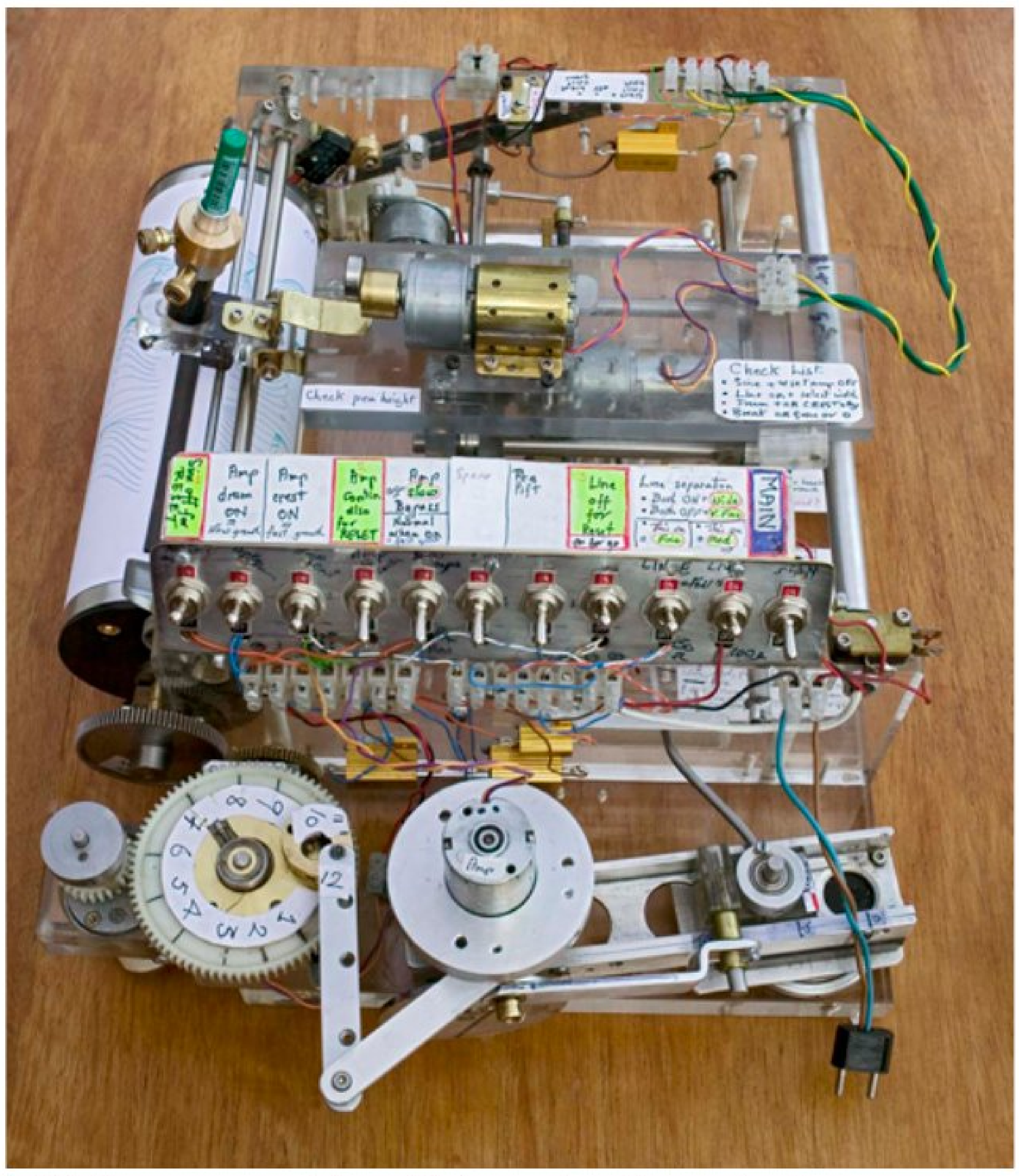
** Note: ‘Meccanograph’ refers to a drawing machine in a 1940s Meccano instruction book. A similar machine was exhibited at the ICA Cytbernetic Serendipity exhibition. This is not a criticism of the show; I found it a source of inspiration and recognised its significance.*



MkII Linkogram - refer also to diagram on page 13

2 Linkogram

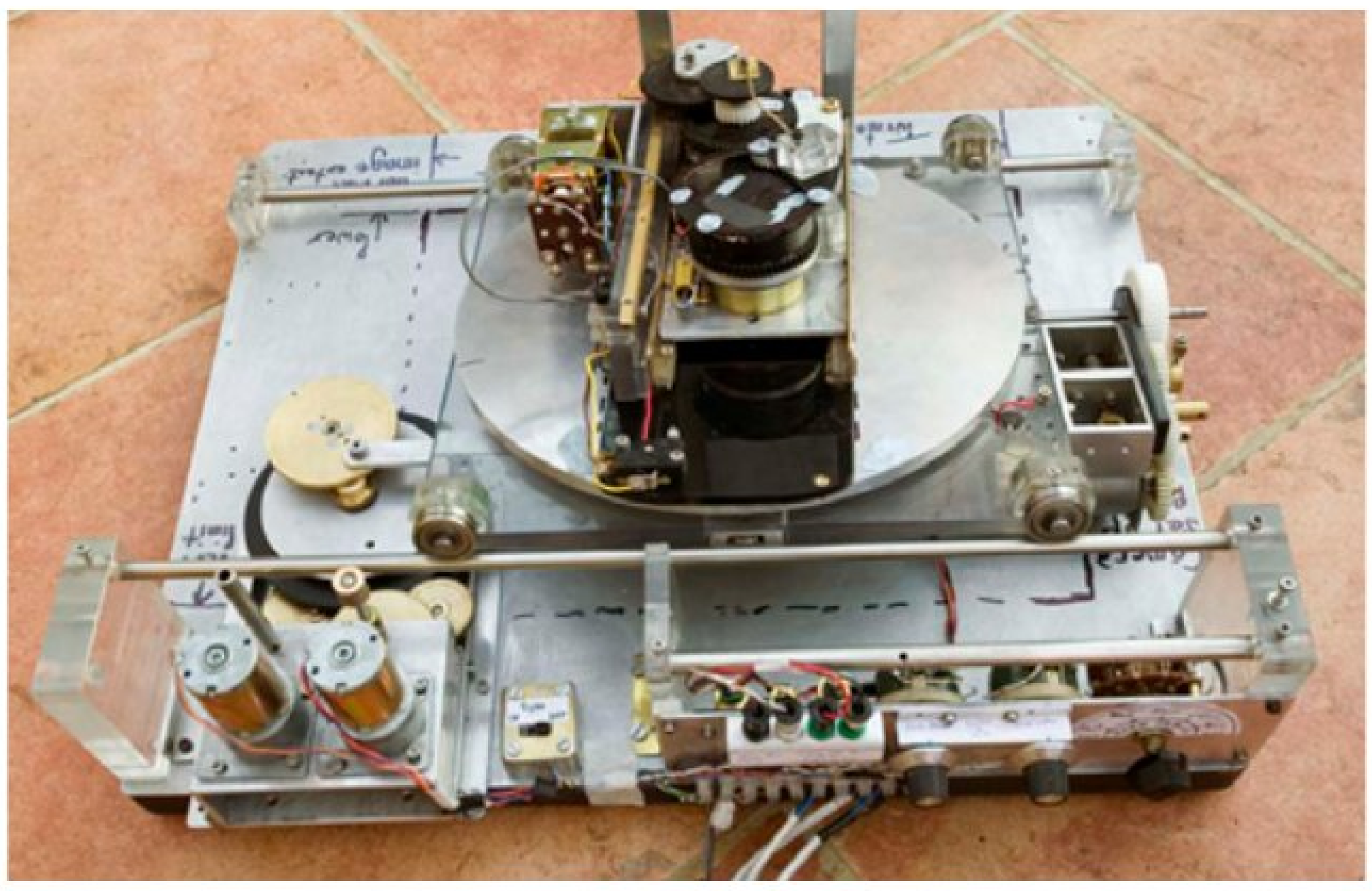
The Linkogram began as a redesign of the Harmonograph, avoiding pendulums and adding a turntable and pen lift mechanism. The Linkogram works as a design tool, can be programmed with high degree of repeatability and accepts a light pen. The Linkogram name was coined by John Sharp who recognised that it represented some steps forward from a Harmonograph in its range and versatility. The detailed nature of the underlying maths and workings is given below in the paragraph on **Technical and Mathematical** as the Linkogram workings demonstrate the mechanics which appear in many of the other machines.



MkII Sinewave machine with ‘wave break’ mechanism

3 Sinewave

The Sinewave machine is ‘programmed’ via switches to control line spacing, wave growth speed and is able to cause the waves to both move laterally and to break. The number of waves is governed by the gearing to the main sinewave gearbox shown on the bottom of the picture. Altering these gears can change the number of waves. Engineering this machine proved very difficult as a number of actions above had to occur simultaneously with precision. These were line spacing, wide, medium, fine and very fine; very fine is equivalent to an interline space of approximately one line thickness. This move to the next line has to take place at the end of each drum revolution (end of line). At the same time the amplitude of the sine wave had to grow and decay and is activated either at each revolution or at the crest of each wave and a choice of amplitude rate is also built in. A recent significant improvement has been to add a mechanism by which the wave can be made to break at the top of the crest. This is achieved by the drum containing a differential gearbox (similar to a car transmission) which allows two separate inputs to control the line. Whilst the sine wave is being drawn, an interuptor profile cam pauses the drum rotation long enough for the wave break to be drawn. This profile cam is driven by a separate motor which is near synchronous with the sine wave linkage. Over time some slippage occurs and causes the wavebreak position to progress relative to the initial start position on the crest. The addition of these recent modifications had increased the complexity of the machine and does represent a large step forward in the variety of available images.



Turntable machine with light pen unit attached

4 Turntable machine

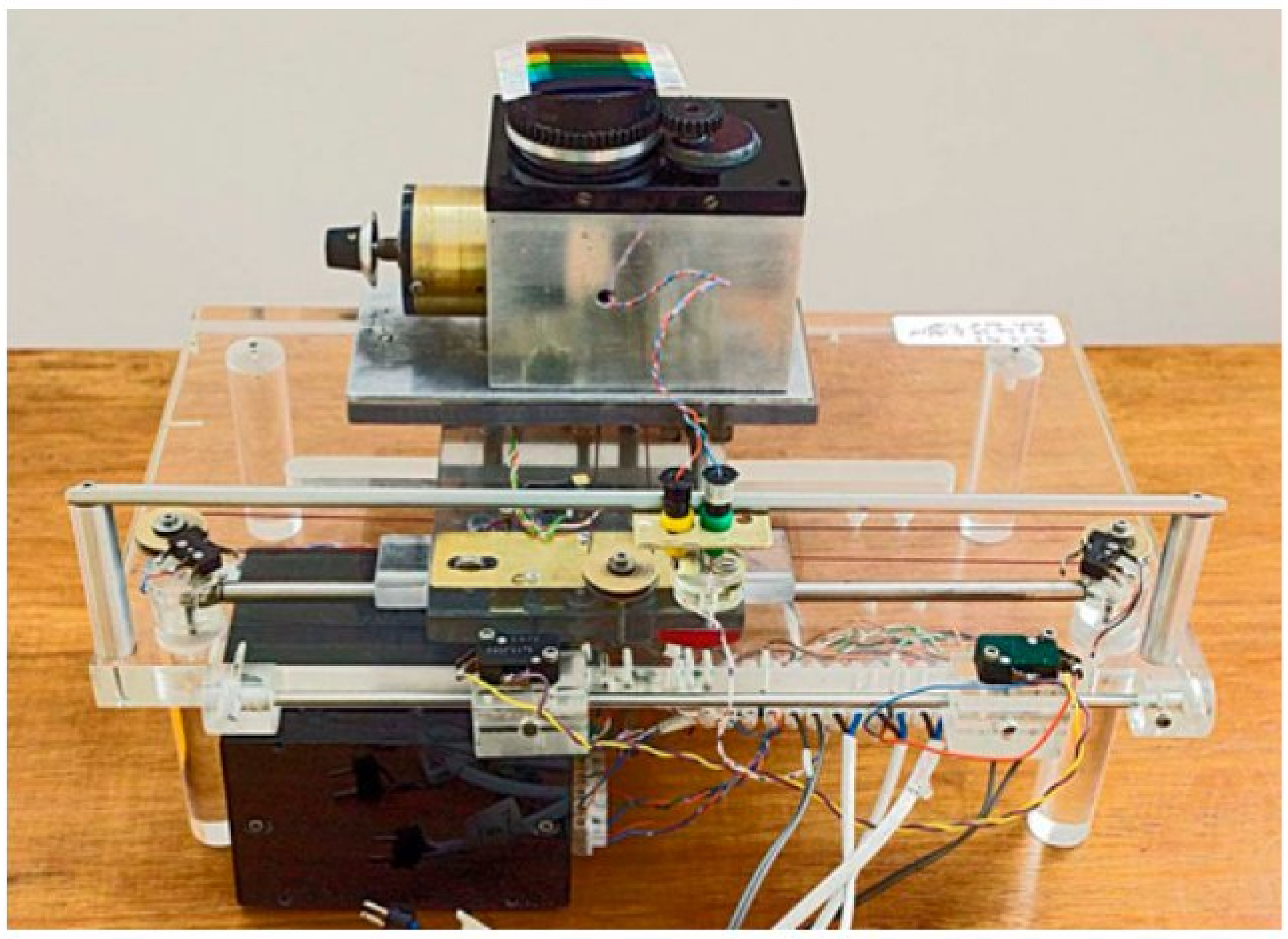
The purpose of this machine is to complement the NSEW machines described below by substituting a predominantly circular motion for a linear one and to design it to accept integral programs or accept instructions from the separate program unit (see below). Thus it stands midway between the two groups. The turntable itself is moved by a sun and planet X axis drive similar to that in the NSEWsp below.

This type of drive has proved so successful in providing a rich variety of drive input. The difference in this machine's sun and planet drive is that each motor is fitted with a variable resistor to control the speed and the motors can be almost synchonised so they remain in close step. If the planet wheel and its drive pin are to keep to the simplest configuration, the sun and planet motors need to rotate in the same direction. With the identical resistor settings motor speeds will only go out of phase slowly causing the growth decay of the sun and planet amplitude to be slow. If the motors are not synchonised and rotate in opposite directions, the growth/decay of the amplitude is fast. Positions between the two extremes may be set by use of the variable resistors.

To complement the controls, built into the sun and planet set up, the turntable has a wide range of speeds (via fixed value resistors) in its motor circuit coupled with a two speed gearbox, for high and low range settings. At this point, the number of variable strategies is already very high. This number is increased further by the turntable having a set of electrical contacts built into the centre shaft which are there to provide a d.c. supply for the light unit. The light unit, with an independent motor, runs on its separate carriage and clips onto the turntable. The carriage has on it a revolving slit light pen which is able to move to and fro along the turntable radius on an automatic reversing track. Finally there is a reciprocating colour change wedge which is driven via a gearbox from the light pen motor. All of these facilities are to make this machine particularly suitable to write with light directly onto a digital camera which can be suspended above the turntable. A separate revolving pen unit is available to mimic the action of the light unit for testing purpose as well as serving as a pen in its own right.

At present there is a discrepancy between the images generated by the onboard light pen and those of the rotating pen which sit above the turntable. This is a geometric mismatch; to solve it the camera would have to be rotated on the turntable with the pen static above it rather than the reverse. This may well be the subject of either a modification or a new build in the future.

GROUP TWO Dependent on programs.



NSEW machine with rotating pen unit in place

5 NSEW

This simplest NSEW machine has a linear drive applied to each axis and is fitted with override micro-switches which also reverse the direction. The linear drive was chosen as opposed to earlier rigs, which were driven by sinusoidal movement. This meant that the relative distance travelled by each axis depended on the pin position of the drive wheel. The effect when the controller switched on each axis drive was that the amount of pen movement varied although the input time instruction was the same.

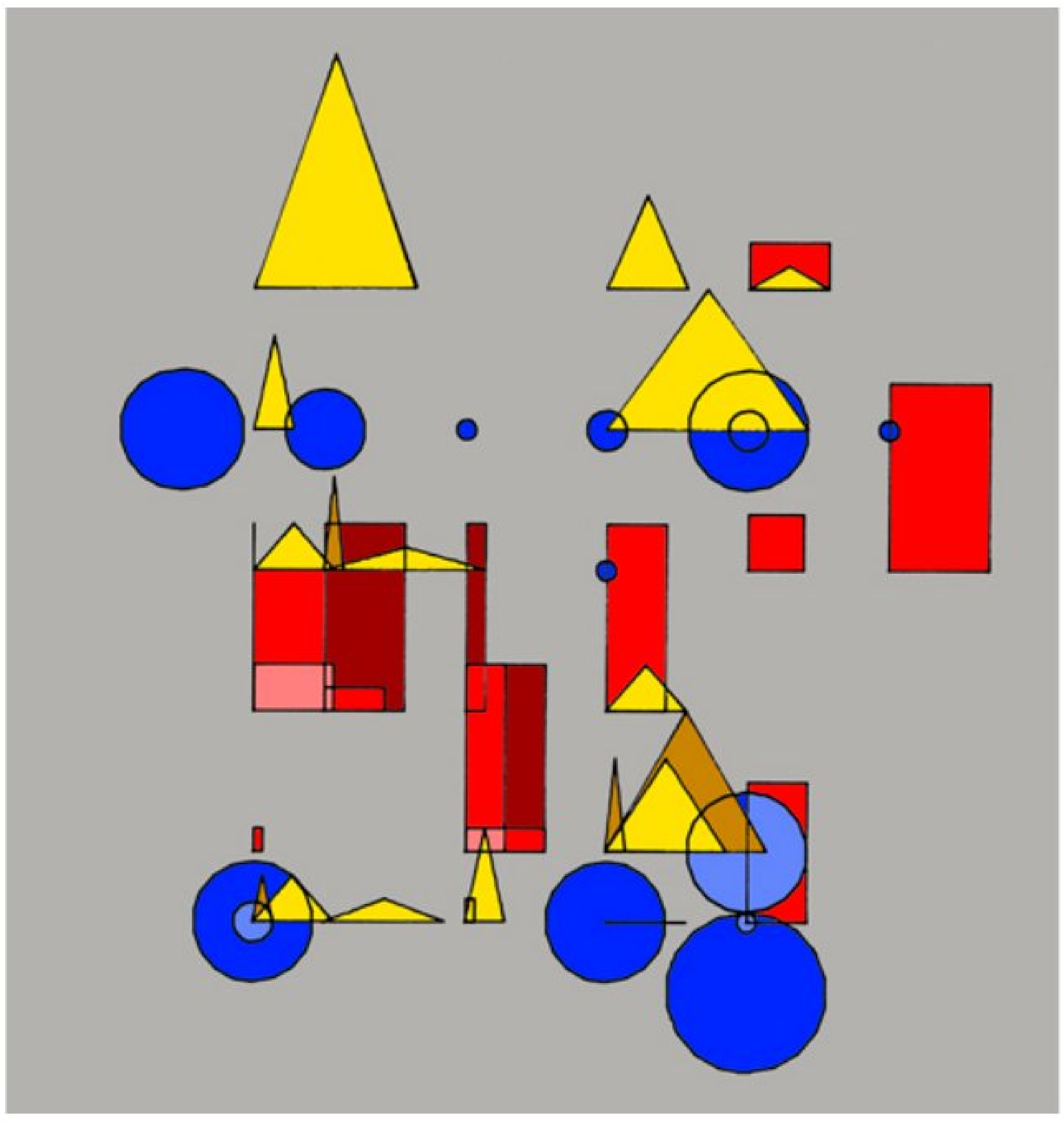
This had some advantages in earlier machines, where it added a degree of 'quasi randomness' to the program, but it did tend to dominate the drawing character .There were additional implications in having a varying speed of pen movement when a light source was used because the movement speed variation causes exposure problems. These variations are beyond the latitude of photographic paper. To achieve the best drawing quality of the light line, the linear movement proved to

5 NSEW continued on Pg 11

Computer sine wave drawing difficult to produce by analogue

Analogue and digital

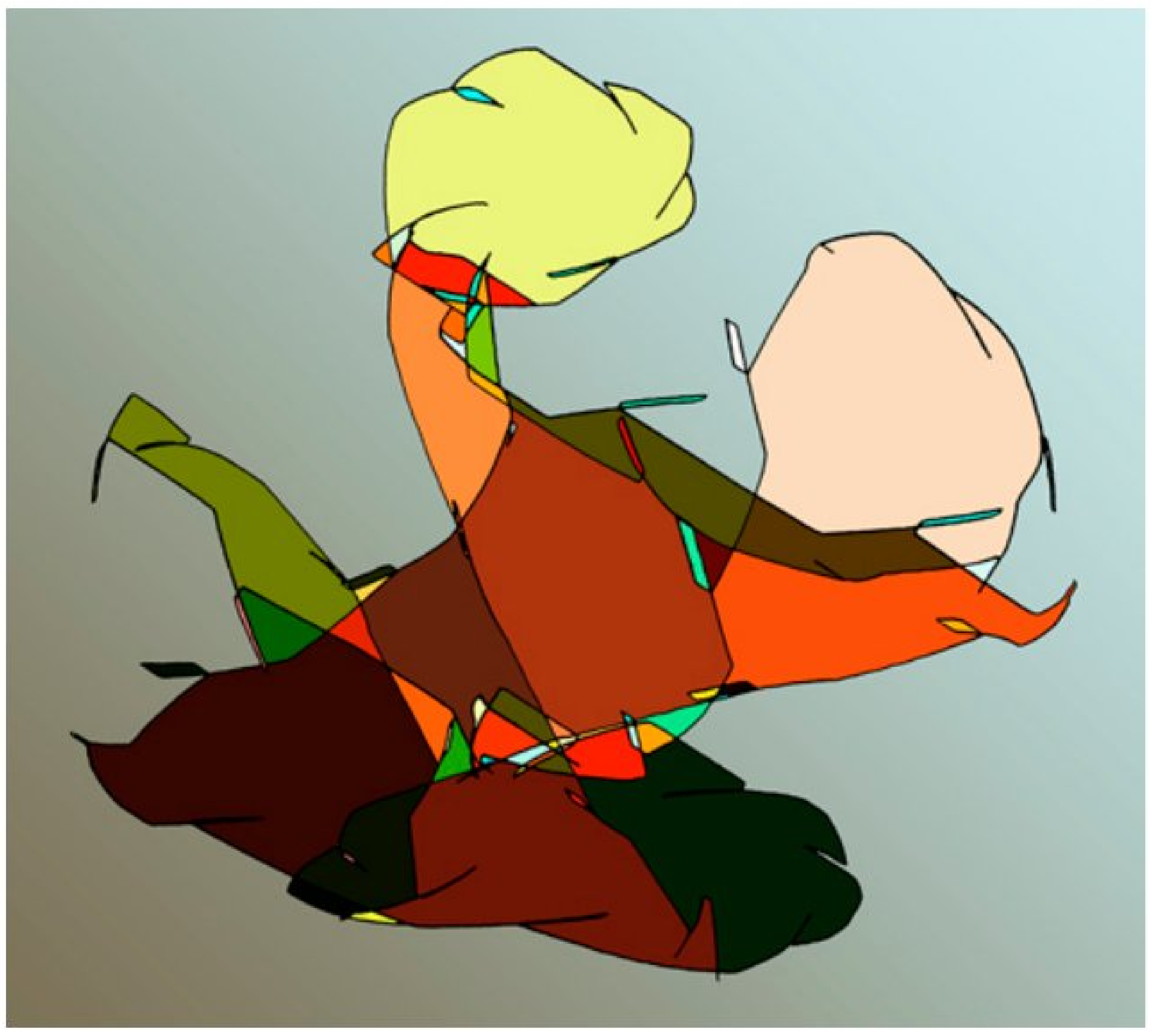
Are there any differences between digital programming and analogue machine building? Both accept simple numeric instructions and when run produce complex images derived from them. Digital programs are of course powerful, versatile and infinitely superior in terms of taking 'if, then, else' decisions; often able to interact and learn from the environment. If it was a question of comparing like with like then computer programs would be the obvious choice. Whilst there are some parallels, the differences are more of kind and less of degree. Building analogue machines is significantly different from writing a computer program; it uses intuitive three dimensional design skills, a feel for materials and engineering fitting ability. We may ask if different parts of the brain are used-logic in computing and engineering/spacial in analogue. Does this affect



Kandinsky inspired program - not possible with my machines

the creative process which we are trying to study? With analogue machines, I can not predict the outcome and I am often surprised by the results. Using a program and repeating drawings Still acts like a design process although there is only a vague feeling that a particular avenue will be fruitful. When writing a computer program, a more concrete notion is called for as to where the process is going. For instance, if the sine wave route is chosen, formulas are put in place, and a clear idea of the end result exists.

Program writing is exact and unforgiving; it runs or it does not. Admittedly, occasional program mistakes may be intriguing; this is similar to parts of the analogue process. The attractive thing about machine building is the total transparency of the process. We can watch, hear, feel and touch the wheels and linkages workingas they generate drawings. Clearly the scultptural qualities of some machines might well obscure this issue.

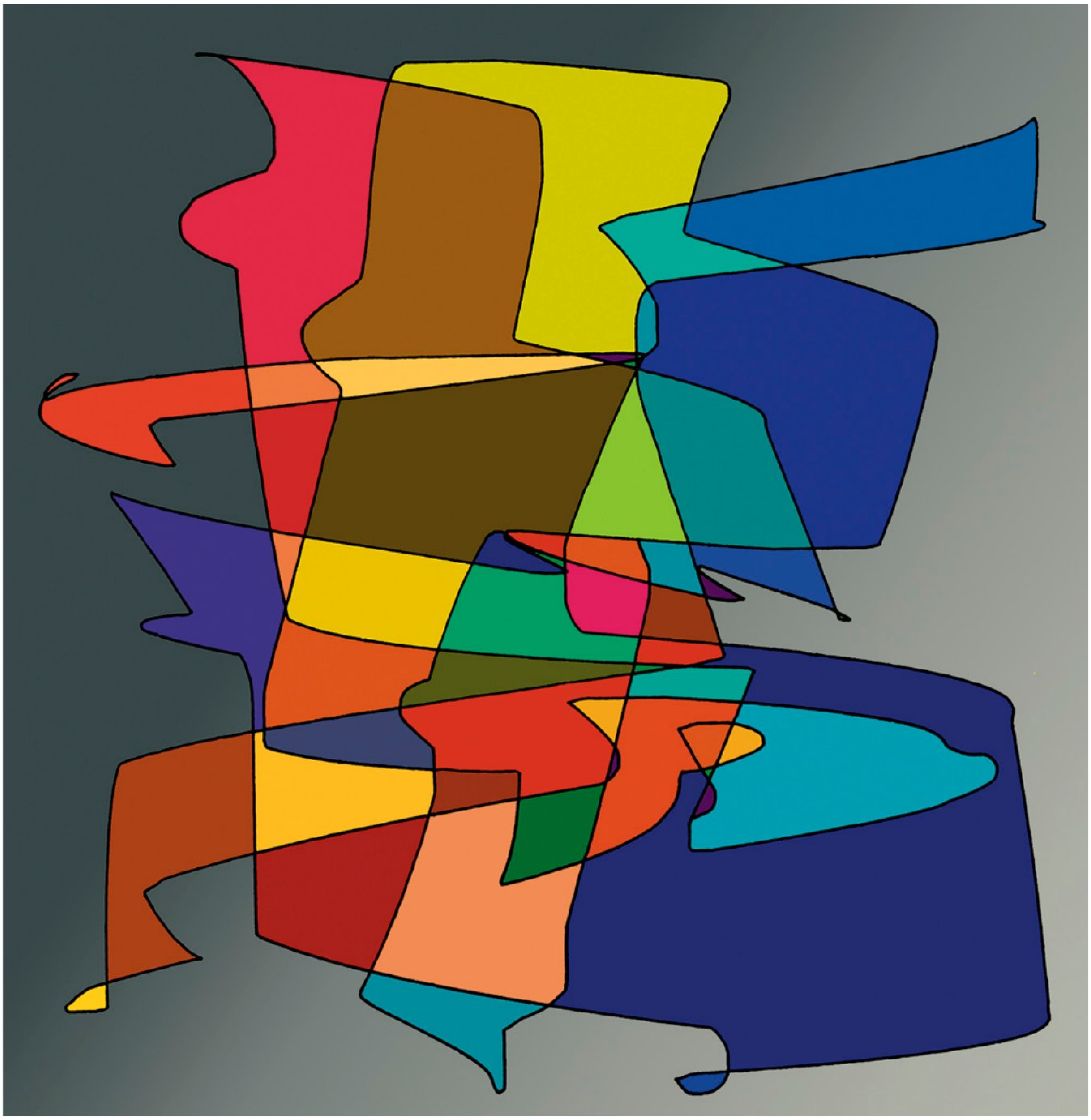


NSEWsp drawing with 'gestural' line, difficult to program

Graphic components

In designing drawing machines, there are a number of components which contribute to the final expressive effect and they need to be selected and built into the machine design. They are:

- Line quality, thickness and path (straight, curved, random or intermittent).
- The relationship of one line to the next; proximity and overlap.
- The growth and rhythm of sets of lines where any three dimensional character is sought
- Colour of either line or the intervening spaces.
- When light is used as a drawing agent, tone and gradation come into play.
- Overall distribution and relationship of the line, tone, colour to the whole image area.
- In analogue mechanical machines, each of the above has to be catered for by a particular mechanism which will work well with the rest of the machine's mechanisms.



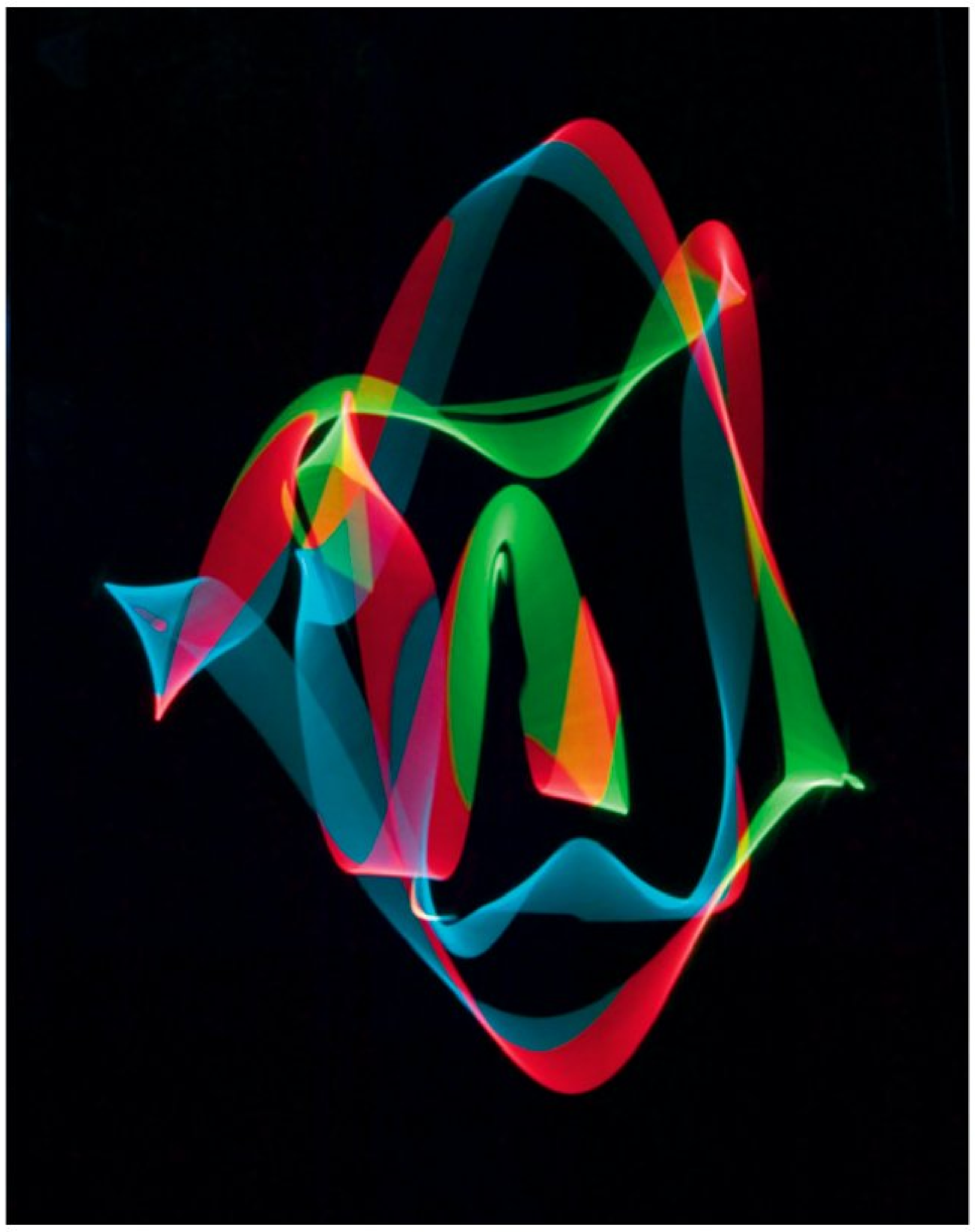
'Rainbow dance'- NSEWsp drawing with 'constructivist' spectrum colour scheme applied post drawing in Photoshop

Frequently adding a modification leads to 'knock on' effects which call for a measure of redesign. The creative behaviour called for in this process of engineering design is to carry out the two actions simultaneously, that is select the best group of graphic components and solve the mechanical problems in an elegant fashion. Whilst this activity is ongoing there is also the subconscious activity of visualising the effect of the decisions being made. The process becomes complete when testing/evaluating any group of parts and feeding the conclusions back into the starting point.

Adding colour

As an important graphic component, consideration must also be given to adding colour at the post drawing stage. It has been suggested by some viewers that the addition of colour detracts from the power and impact of the drawings in their 'raw' state. I have some sympathy with this view, but my primary concern is that the viewer is first drawn to look at the image. Colour is a powerful expressive tool when used subjectively and a supportive component of the drawing particularly when it is rule based as many constructivist strategies are. Colour attracts a wider variety of viewers than would a monochromatic image and once the viewer is captivated, then I hold that the essential qualities of the drawing will insinuate themselves into the viewer's mind, perhaps without them realising it.

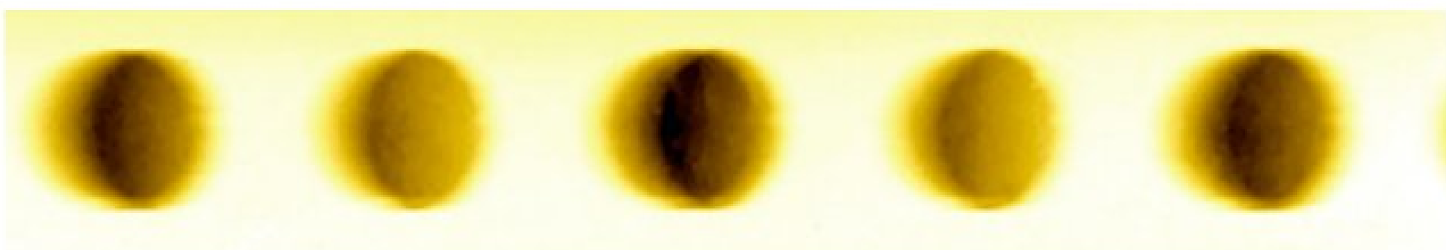
There is no doubt that the drawing qualities are paramount, but not all viewers bring the same experience to looking at images. It is also part of communication theory that a drawing's message is received with as little 'noise' as possible and just as



Turntable light Image with 'calligraphic light pen alongside still life photograph - are they perceived in similar ways?

important, a colour image is more likely to be retained. I am supported in this by Harold Cohen [4] who chose to add colour to his computer-generated drawings.

Perception of light drawings and photographs
Writing with light not only adds tonal qualities but raises other issues. The effect of a moving light disc, coupled with shutter mechanism, on a light sensitive surface creates a 'photograph' of a 'tennis ball'. Can this image be read as a photograph with no object present before the camera?



'Tennis ball' image from a moving light trace and shutter

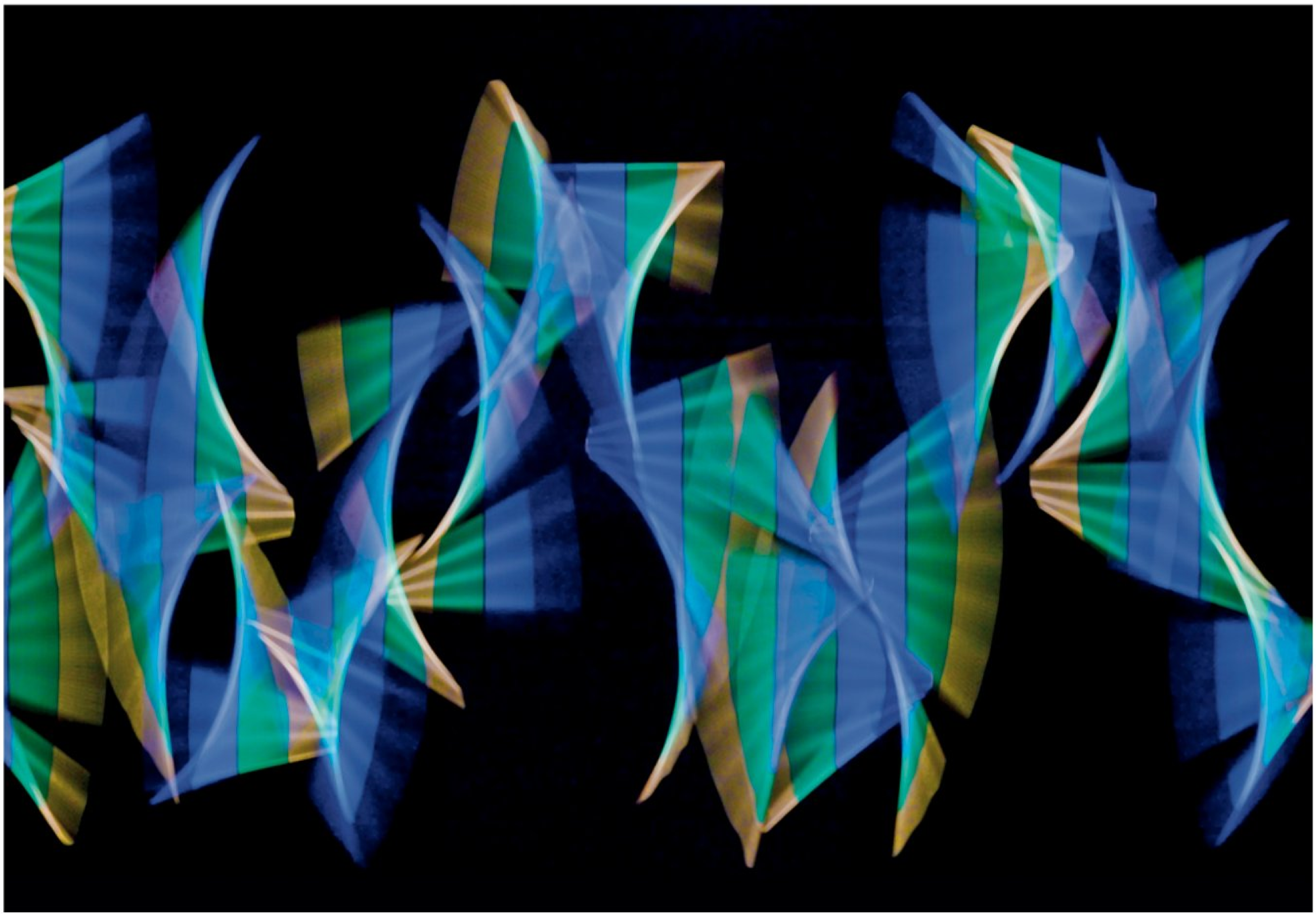
This sets the arena in which issues of reading images and perception might be addressed when machine pictures and photographs are seen together.

The impression of 3D in a drawing and photograph depends on the perspective and tonal range respectively. Our eye/brain does an extraordinary job in deriving meaning from just one line drawing. Simple drawings can possess a 3D feel; even a few lines can hint at it and adding tone and colour to a drawing enhances this effect.

Information and impact in photographs comes from the middle tones, more than shadows and highlights and perspective in drawings and photographs impinge on the eye/brain workings. We perceive near objects as being larger then those further away. Given that the middle tones are important, we need to know the range of tones available to us for maximum effect and to inform the design of the machine. When a digital camera is employed the following parameters need to be addressed. The maximum range of the best digital sensors is 8 to 9 stops, numerically 8 = 256:1 and 9 = 512:1.

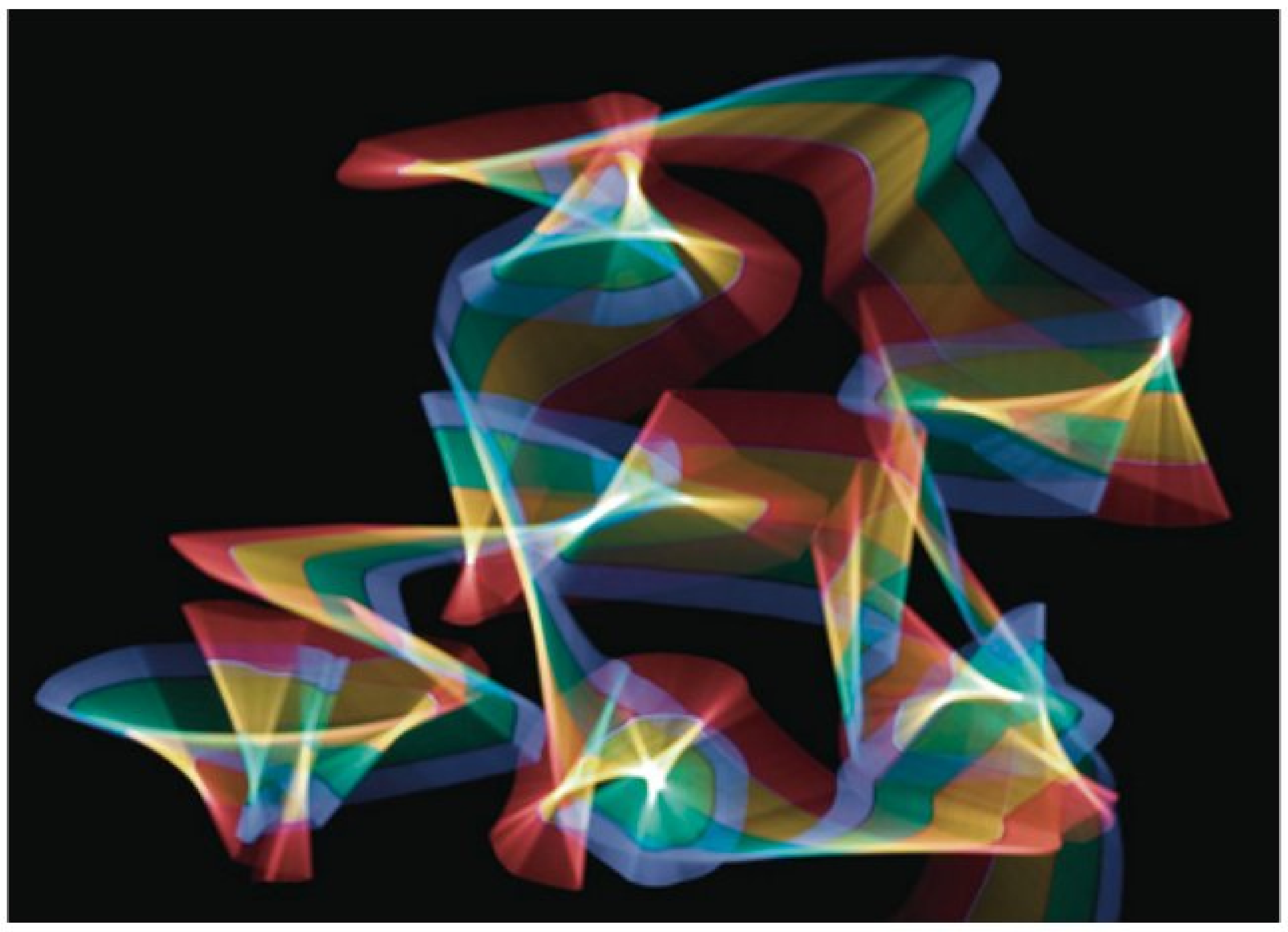
To approach this in a light machine is difficult. If the light pen is modified with graduated filters, a 2 stop (4:1) range is possible leaving a 6 stop range (64:1) still needed. The relative speed difference, edge to centre on the turntable, is 3 stops (8:1) and this helps to reach a total of 5 stops (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. Perspective is the lesser of 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 forms.

As regards 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. To remedy this the following steps are taken. The exposure is biased towards the mid-tones and the relative speed differences in the turntable/linkage motion helps to extend the range. Turntable speed is fast at the outside to zero at centre and the linkage movement varies from fast in mid cycle to zero. 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



Light pen drawing with rotating slit fitted with colour wedge-trying to produce wide tonal range

tone/colour filter assists in this and when the light pen crosses a previous path it adds further mid-tones. Making the pen pass over the largest image area minimises the black. Now that the machine speaks the 'photographic' language we can test the perceptual differences between a machine 'photograph' and a camera image. The interesting question is how the machine images are read. Does the eye/brain act in the same way with a light machine image as a photograph and assume an object was before the camera? What are the implications of looking at a 'photograph' of a non existent object? Has this any bearing on our notions of creativity? Is a creative entity something which did not previously exist? To test this I have included machine images alongside photographs. The viewer will judge whether they are the same or different. The intention is to test whether tonality and photographic characteristics are enough to trigger the same 'reading' by the eye/brain.



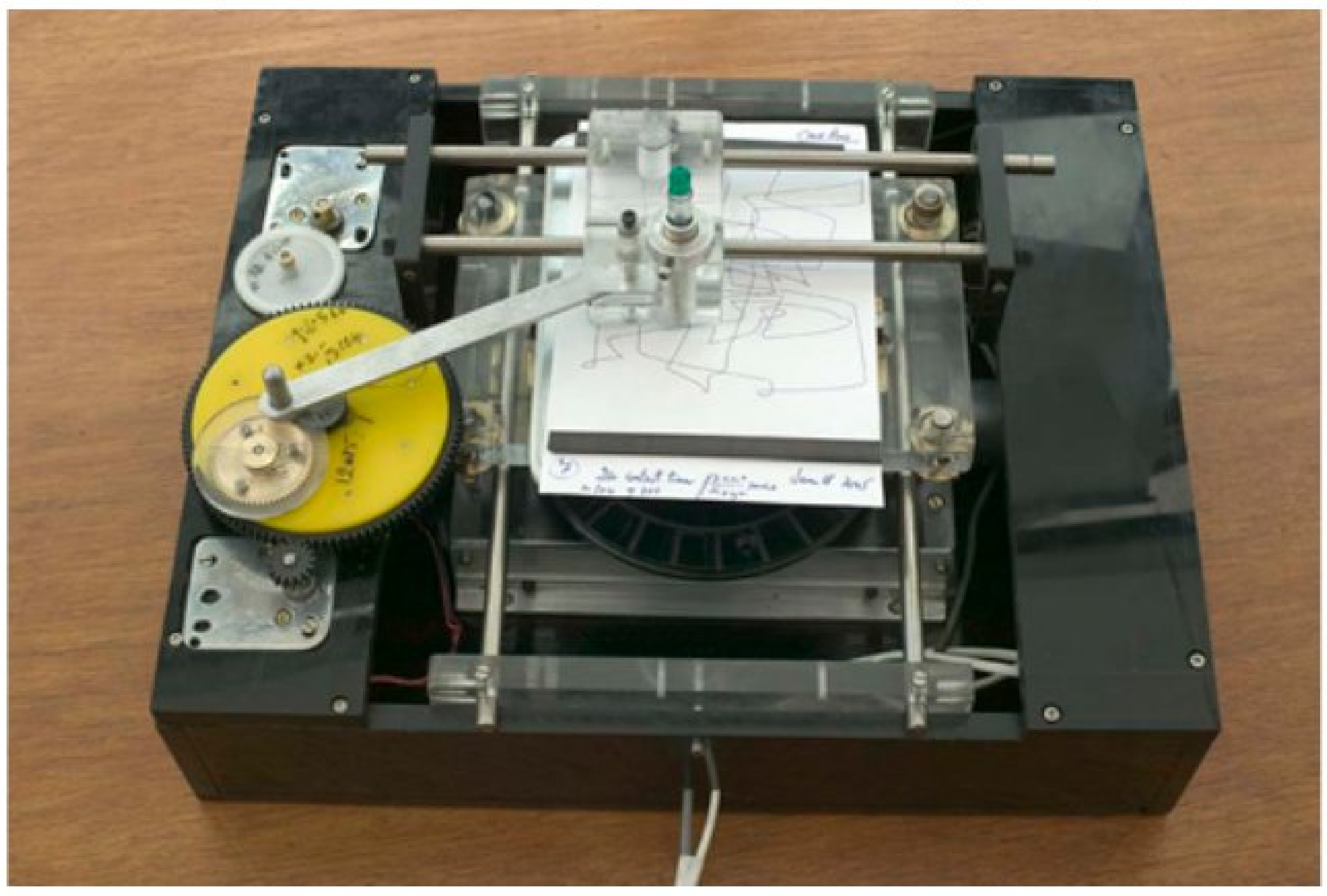
Light pen, rotating slit + colour wedge.

Lily still life

See also page 12 for two more images

5 NSEW continued from page 6

be best. The NSEW and the NSEWsp machines both depend on being controlled by a program.



NSEWsp machine showing sun & planet drive on left

6 NSEWsp

This plotter is a more complex version of the NSEW, with a sun and planet gear mechanism moving the pen instead of a linear drive, offering greater richness and variety. The importance of the sun and planet is that the drive for each axis can be split between two motors, one turning the sun wheel and the other the planet wheel which has the drive pin attatched to it. Furthermore, the rotation of the sun wheel turns the planet wheel via its gear connection with no other input whilst the rotation of the planet wheel offers a smaller amplitude but does not move the sun wheel.

So even without a program input, the sun and planet can generate complex harmonic movement, dependent to an extent on the gearing between the two. When the program is brought into play it is able to exploit this richness adding an extra dimension to the existing range of inbuilt options. The program unit has multiple outlets for the X and Y times, so the time output for the X sun wheel may also control the Y planet wheel and vice versa. This can produce lines which are not confined to straight lines changing direction at right angles as in the first NSEW machine; the variety of line quality and complexity is increased exponentially. I calculate the extent of possible images from the NSEWsp model to be in the order of 37 million.

The problem of accurate notation is still being worked on; there are so many imponderables in specifying the starting points in order to redesign a former image with modifications. The images produced are quite different to any made before. They represent a sea change, where the character of the image seems more akin to freehand drawing and possesses a quality quite different to images generated by computer algorithms. If the aim of designing drawing machines is partly to make images with 'human' characteristics, as Harold Cohen's Aaron Program implies, then the above change seems like an 'evolutionary' step forward. The intriguing thing is, unlike Aaron, it has not been given drawing 'knowledge', but still displays gestural line qualites associated with some styles of hand/eye images. I am still surprised that such comparatively crude and simple machines are able to generate images, felt by many viewers to posses significant expressive qualities. This is partly associated with the question "What will IT do next?" see below in **Evaluation - the third person effect.**

The main program unit in use now - others being designed

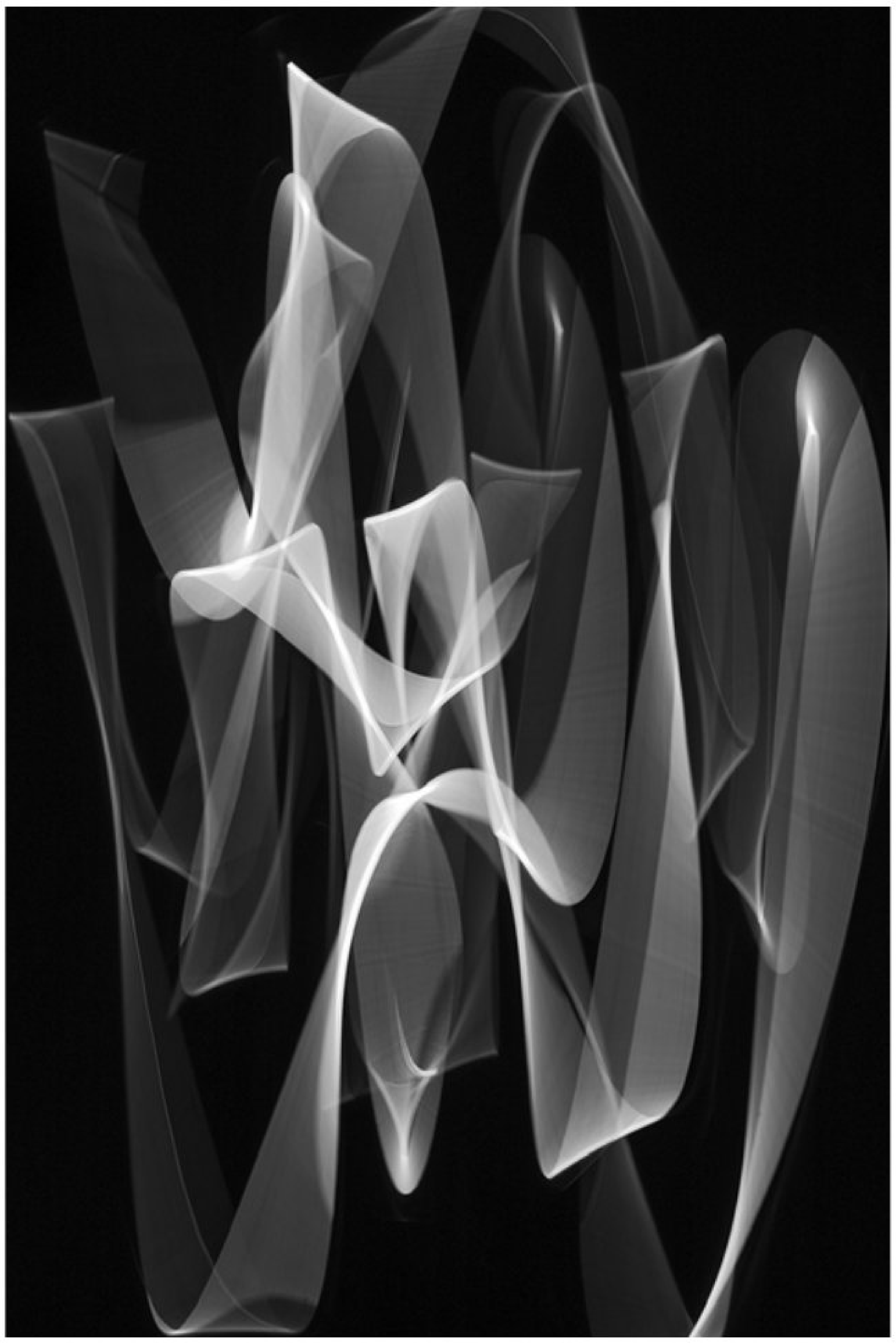
Program unit

This unit sends timed pulses to each axis-drive motor in turn. The timing, from two ganged sets of 24 point rotary wiper contacts, may be varied between 0-10 seconds in groups of 1, 2, 3 or 4. A bank of switches and plugs allows the output times and the reversing relay to have program input. The sequence of the 24 contact points is as follows:

X=1, X=2, Reverse A, Y=1, Y=2 , Reverse B, X=3, X=4, Reverse C, Y=3, Y=4, Reverse D.

The reason for the placing of reverse points between sets of X or Y pulses is to insert a time gap. This prevents both axes being switched on at the same time by wiper contact overlap, letting the motor come to rest. These points are at 3, 6, 9 and 12 o'clock positions and can activate a reversing relay. Reverse instructions may be taken via 'wander plugs' to the reverse relay unit. The program unit also has two separate slow outputs, serving as alternative timers and/or separate reversing switches. They operate at x2 and x4 the speed of the 24 point rotary timer. This increases the number of program alternatives.

The program unit, or sequence timer, controls each axis, and together with an out of phase reversing relay, mimics the random input in a computer program. This effect, and others produced by gear driven sequencial switches, is termed 'quasi random', to distinguish it from a digital context. It is important to govern the appropriate amount of random to achieve the optimum balance and to influence the aesthetic quality of the drawing. (See paras. **Technical and Mathematical** and the **Importance of Random** on page 12)

Further to page 10 - A pair of images with similar tonality to act as a test of how light images and photographs are perceived

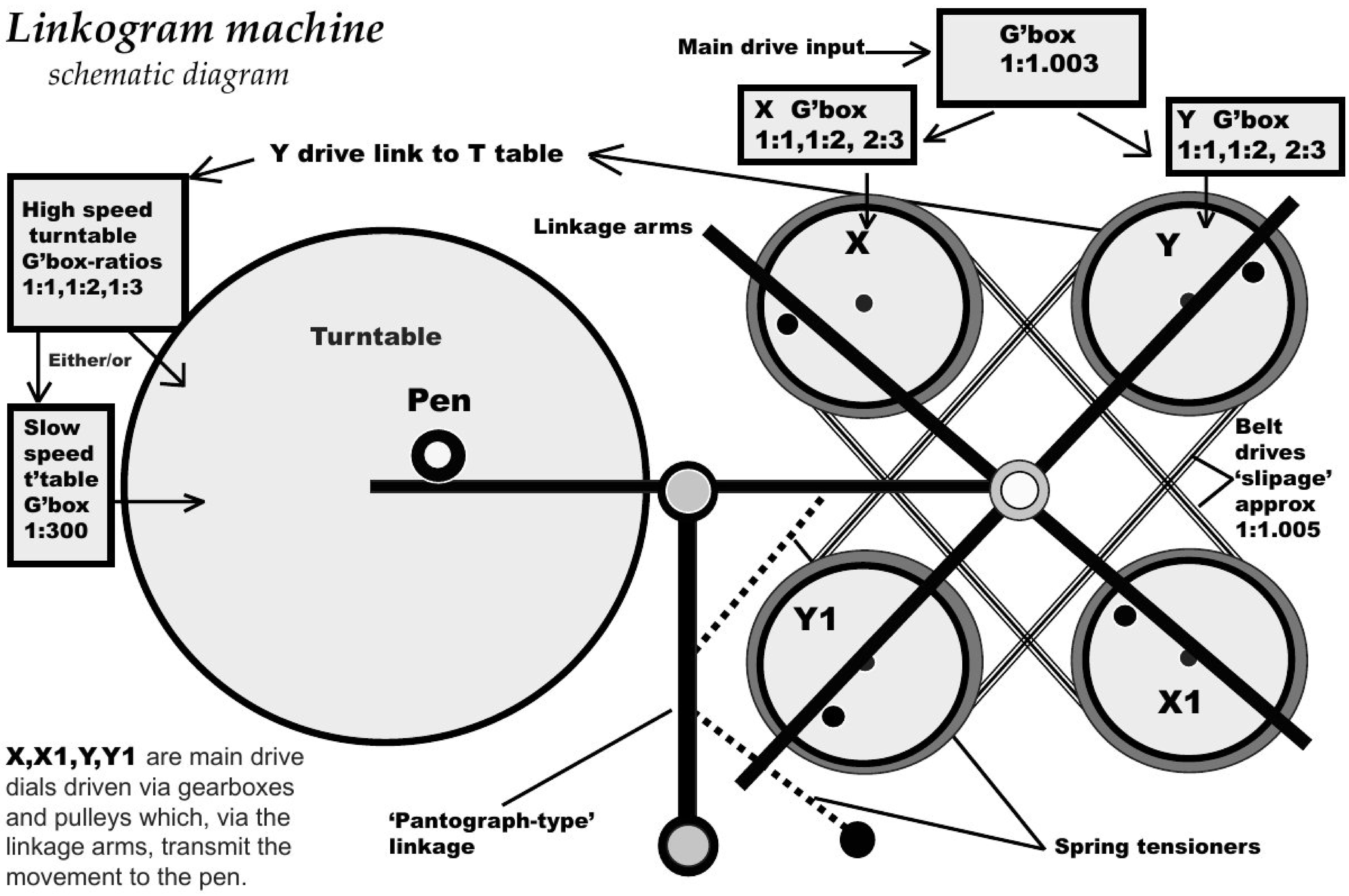
The importance of 'Random'
From the whole activity involved in making machine drawings it seems that perhaps the most intriguing is the amount of random input included in the design and programming. Using a cooking analogy, the amount of hot spice in the recipe has to be carefully judged. Too little has no effect, too much spoils the dish. The process is often an intuitive one. By random, I mean quasi random-see above- and achieve this in both my program and machine drive units by one or more of the following strategies:

- Use gear trains which take a long time to return to their relative start position.
- Use motors which are almost synchronous in speed and get out of step slowly but predicatably.
- In the program unit a d.c supply reverse unit runs parallel but out of phase with X and Y axes.
- Incorporate linkages or drive units like the sun and planet ones which although simple can generate a complex output.
- With the more deterministic machines a further quasi random effect is available if sufficient variables are employed at any one time. The use of a pen lift device or light shutter will generate a secondary line system or interference pattern where the pen lift speed is in a whole number ratio to an axis speed.
- Finally when light and colour is used there are tonal and colour mixing effects which add a great deal of extra qualities to the result. This is analogous to 'wet on wet' printing in silk screen where the colours mix in unpredictable ways.

Technical and mathematical
Two factors govern the effectiveness of a drawing machine; mechanical precision and mathematical ratios. These factors combine to achieve the design results as envisaged. The Linkogram is described below as an exemplar; the same principles apply to other machines where appropriate. To achieve good line quality in any of the machines backlash must be kept to a minimum. (far from easy with Meccano). The design intent is to draw each line very close to the next if the drawing is to have any aesthetic appeal. The overall aim is to allow the drawings to grow 'organically' around a basic Lissajous figure. Three aspects are involved:

- The relative frequency of the X Y axes/turntable.
- The amplitude growth/decay of the sinusoidal inputs on the X and Y axis, (achieved by two out of phase drive wheels per axis - see diagram).
- The phase differences between both the X and Y input and also between the sets of X and Y wheels.

The ideal phase ratio is one which produces a fine interline difference coupled with a smooth organic growth, which gives the drawing three dimensional qualities. From trial and error this phase ratio was



Annotated diagram of the linkogram machine; mechanisms shown are similar to those in other machines. See photograph page 5

found to be between 1:1.002 and 1:1.005. Two methods were used to generate this; pulley wheels or gearbox. In the 1950s I found that two 3in Meccano pulley wheels of identical size, coupled with a rubber drive belt, moved out of phase. Under reasonable load conditions they approached a range in the region of 1:1.01. Later on, with better engineering, this was improved to 1:1.003. More precision produced more consistency, accuracy and less backlash. In the Linkogram gearbox, two sets of gear wheels are coupled, so that the nett difference produced the ratio 1:1.003. The first gears are 48t/22t; the second gears 23t/50t; calculated as (48/22)x(23/50)=1.00364

The diagram shows the pulleys providing the phase change (= amplitude growth/decay) between the pairs of X and Y pulleys whilst the gearbox produces the 1:1.003 phase shift between the X and Y axes. All four wheels get out of phase with each other as the machine draws, whilst the turntable is directly coupled to the Y axis. In the current Linkogram machine, the pulleys are of 120mm diameter and turned out of high grade aluminium to a tolerance of 0.02mm (1/1000th in.) The groves are profiled to exactly match the rubber belt thickness to ensure that the 'belt creep' is consistent.

The Linkogram's program is set acording to the 'clock face' start position of the four main wheels; with the ratios of the X wheels (top left/bottom right) to the Y wheels (top right/bottom left) and all related to the turntable speed. A typical setting might be X=2, Y=3, Turntable=2. The notation formula for a particular drawing might be as follows:

X1 = x2 X2 = x2 at 12 o'clock Y1 = x3 , Y2 = x3 at 6 o'clock Turntable = x2 Pen mid position no lift.

The start position of the pen also alters the character of the drawing. Lifting and lowering the pen in a whole number synchronisation with the Y set of wheels affords further variety.

The organic growth of the lines is controlled by the very slight variation of the wheels' speeds; that is the X and Y sets differ by approximately 1:1.005 whilst the X:Y speed difference is 1:1.003. This means that the relative positions of the 'clock' settings vary as the machine draws and causes the line growth to continue at around x 1 to x 1.5 line widths on each revolution. The setting facility is sufficiently accurate to allow almost identical repeats. A light pen is available which enables the drawing to be made on photographic paper.

History

At Guildford School of Art I became aware of the harmonograph. Pendulums seemed too heavy and cumbersome; so I designed a machine using cams and linkages to replicate the Lissajous figures produced by a harmongraph. A turntable was added for good measure. I became aware much later on in 2005 of the Decheveron, Creighton and other machines in a collection at the Creighton

University USA where similar problems had been tackled and different solutions produced. Early machines were constructed from Meccano and whatever bits of scrap electrical components became available. What has now become my Linkogram machine went through many Marks where the problems were engineering, design and shortage of parts. Everytime a redesign was called for the former machine was cannibalised.

As a photographer I wanted to 'write with light' and built machines to operate under an enlarger employing shutters and colour change wheels. Some results were interesting but the machines were too simple and inaccurate to be satisfactory. I was encouraged by the work being done at Hornsea School of Art and by seeing Cybernetic Serendipity. This let me know that I was not alone; as working with machines to make drawings was not exactly mainstream at the time.

At Manchester College of Art I learnt lithography, etching and silkscreen and the application of these skills led to the book below. The design of light machines and print processes were introduced into my liberal studies curriculum. This was uncommon in schools of photography at the time and it led to Focal Press commissioning a book.[6] Machine drawn images were used in it as origins for lithographs and silkscreen prints. Insights gained into printmaking in general and the creative possibilities of the separation of line, shape, colour, collage and texture led to quite different images from conventional photographs. All this conditioned my approach to the use of colour which has assumed such an important role in my current work. Adobe Photoshop now takes the place of the printing presses; my work remains a printmaking activity.

Evaluation - the third person effect

With regard to evaluation, there is what I term the third party effect. This is associated with the expressions "Look what It has just done!" and "What will It do next?" It seems that to look at a drawing as if it had been made by a third person may have a significant influence on the way we operate and make judgements in the creative feed back loop. Does a 'third party effect' occur during the computer programing process? Most importantly, does the above effect help raise more questions about how art works.

Implications concerning creativity

In the above I have tried to address aspects of the whole process starting with curiosity, following through the actions and decisions involved in making drawing machines and evaluating their results. Without falling into a reductionist trap or risking accusations of dualism, I hope the case may be argued as follows. If viewers judge percieved behaviour or produced objects have qualities consistent with their notions of creativity, then we can proceed to ask specific questions about machine drawings. Can the activity and results add to our understanding of creativity and begin to unravel how art works? I believe that it is can for the following reasons:

- Compared to evaluating more conventional forms of art work, machine art offers more chances to get a purchase on a wide variety of pertinent issues.
- Curiosity is an unequivocal intent when simple numeric instructions generate complex images. Easier to address than motives for drawing a still life.

To test the above involves engineering and design problem solving. This is easy to understand; people are used to judging if a mechanism is an elegant solution. Primary school children will watch a machine drawing, form an opinion and see what is happening. If an image gets an instant 'wow' exclamation from children, something interesting has happened. It is much harder for people to be as clear about their reasons for reacting to a conventional art work.

Machine art forces into the open issues concerning meaning of lines, implications of three dimensions, perception of tone, the value of colour, the importance of random, mathematical ratios, mechanics of linkages, the character of analogue systems versus digital, and the psychology of evaluation. This is a formidable list. From an art teacher's stance it has significant value. In terms of transparency and accessibility there seems no contest when compared to more conventional forms of art appreciation.

Finally, I have found that viewers are far more comfortable in dealing with important art issues when a machine product is involved. The inhibiting expectation of expertise and prior knowledge seems absent. This alone must be a persuasive factor in seeking to find out how art works as art can only 'work' or exist within a viewer's mind. The machine drawing process gives us some access.

References

[1] Ellen Dissanayake - Homo Aestheticus - University of Washington Press
[2] Ellen Dissanayake - What is Art For - University of Washington Press
[3] Kenan Malik - Man, Beast & Zombie - Phoenix
[4] Harold Cohen - Tate Gallery Catalogue 1983
[5] Gombrich E. H.- Art and Illusion - Phaidon Press - London p 155 1977
[6] Jack Tait - Beyond Photography - Focal Press shows applied images throughout 1977

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also see www.taitographs.co.uk

PAGE 65 - Typo design and layout by Jack Tait

CV Jack Tait

1952-55 RAF NCO Aerial Photographer
1955-58 Guildford School of Art - Won prize for best work Yrs1+3 - ARPS in Architectural Photography
1958-60 Manchester Regional College of Art i/c Photography, Graphic Design School
1960-61 Associated Press - freelance work
1961-64 Derby College of Art - Head of Photography
1961 AIIP Illustrative Photography
1964 Kodak Colour Scholarship Three months study USA - produced first Kodak Calendar 1966
1965 Stillit Books (with Mike Hallett) first interactive program learning text - designed Stillit's logo
1965-75 Manchester Polytechnic - Head of largest/best funded photography school in Europe.
1972 MSIAD Photography. M Phil (CNNA) Colour measurement. Beyond Photography - Focal Press. Illustrated Dictionary of Photography - Fountain Press; it won Time Life Award, joint best book 1973
1965-75 Consultant Which Magazine,
1975-76 Singapore - freelance photographer - designed signing system Singapore Zoo
1976-80 London freelance photographer
1980 RCA PhD on 'The use of a computer to help understand how art works'. Not completed
1980-89 Head of Graphic Design Newport. Only B A Hons Graphic Design course in Wales
Introduced Apple Macintosh computers.
1986-98 Typographic designer on my wife's Arthur Machen Society magazine
1987-2003 Freelance architectural photography - Designed unique 6x9 superwide camera
1980-present Taitographs - drawing machines

BRIDGES MATH & ARTS CONFERENCE
Donostia = San Sebastian July 2007

A Short Report by Alan Sutcliffe

This year's Bridges Conference, Mathematical Connections in Art, Music and Science, was held in the School of Architecture, University of the Basque Country, Donostia.

The first talk in the conference, and the only one I shall mention, was Edge-Constrained Tile Mosaics by Robert Bosch of Oberlin College, Ohio. "In this paper, we build upon the tradition of [Ken] Knowlton, the father of computer-assisted mosaicking, and introduce ... mosaics whose building-block tiles must be arranged so that the patterns on adjacent edges of adjacent tiles match one another."

The objective is to render a known picture with a set of such tiles. Given a vocabulary of the tiles, a matrix of tile-edge matchings is constructed with a greyscale index for each tile type, and a dissection of the target image into tile-sized super-pixels with a greyscale value for each one. From all this, sets of equations are formulated and fed to a mathematical optimisation program.

The last mosaic shown in the paper was a rendering of part of the Mona Lisa "constructed from a set of 74 square 'Paul Brown' tiles, inspired by the Australian artist's pieces The Book of Transformations and Chromos." The conference exhibition had works by Robert Bosch, Jack Tait, myself and about 30 others.

Next year's Bridges Conference is in Leeuwarden, Netherlands, the birthplace of M.C. Escher.

www.bridgesmathart.org/2007/2007.html
www.dominoartwork.com
www.knowltonmosaics.com
www.paul-brown.com
www.bridgesmathart.org/art-exhibits/bridges2007/bridges-art-exhibit-2007.html
www.bridgesmathart.org/2008/2008.html

Extra Mural: Art or Accident?

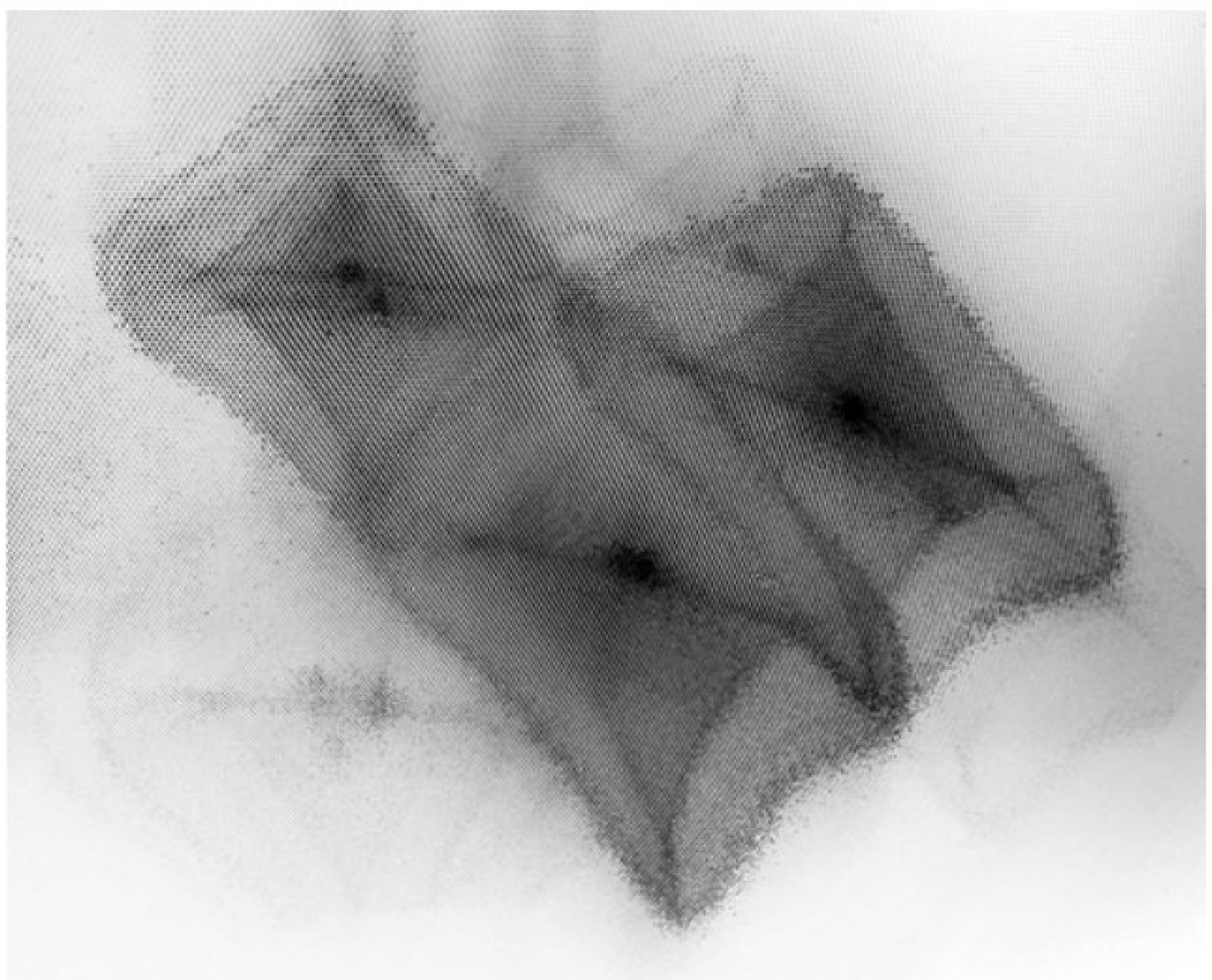
Digital

In the riverside pavement outside the Guggenheim Museum, Bilbao, on the conference day out

Found by Mathew Sutcliffe Photo by Alice Sutcliffe

Analogue

Negative image of sunlight reflected from parked cars onto the frosted window of a ladies room seen from inside the conference centre, Donostia.



Found by Nicola Sutcliffe Photo by Alice Sutcliffe

COMPUTER ARTS SOCIETY

BRITISH COMPUTER SOCIETY SPECIALIST GROUP

Bringing together artists and technologists
Exchanging techniques and ideas
Formulating needs for support
Helping to get works known
Exploring new forms

ABOUT THE COMPUTER ARTS SOCIETY

Aims

The Computer Arts Society (CAS) promotes the creative uses of computers in the arts and culture generally. It is a community of interest for all involved in doing, managing, interpreting and understanding information technology's cultural potential

Membership & fees

Membership is open to all who are interested in the aims and activities of the group. There is an optional annual contribution of £10 (€15 or $20 overseas) for which members receive a printed copy of each issue of PAGE

The British Computer Society (BCS)

BCS 50 YEARS
SPECIALIST GROUP

The CAS is a Specialist Group of the BCS
The CAS receives funding from the BCS

Website

www.computer-arts-society.org

Publication

PAGE the Bulletin of the Computer Arts Society appears quarterly and can be downloaded from the CAS website

Archiving computer arts

The CAS was active from 1968 until the mid 1980s There are significant archives of material from this era, mainly stored in homes and offices of people then active in the group

The CAS is worked closely with CACHe, a project in the Art History Department of Birkbeck, University of London, documenting UK computer arts in the years to 1980. CACHe ended formally in 2005 but the work continues. This leads to a wider interest in the archiving, study and presentation of computer arts from earlier years

Present & future computer arts

With so many novel and exciting developments in the creative uses of computers in the arts the society will continue its original aims of bringing together those active in this area

Collaboration

The society plans to hold joint events with other BCS Specialist Groups and to collaborate with other organisations

Education

The CAS plans to have an educational role in making students more aware of early work in computer arts and in helping artists to use computers creatively

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