Some Notes on Theo van Doesburg (1883–1931) and his *Arithmetic Composition 1*

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> The evolution of painting is nothing but an intellectual search for the truth by means of a visual culture. [...] We are painters who think and measure [...] Most painters work like pastry-cooks and milliners. In contrast we use mathematical data (whether Euclidean or not) and science, that is to say, intellectual means. [...] We reject artistic handwriting. If one cannot draw a circle by hand, one may use a compass. All instruments which were created by the intellect due to a need for perfection are recommended (van Doesburg, 1930/1974, pp. 181-182)

> The parallels between Art and mathematics must be drawn very carefully, for every time they overlap, it is fatal for Art (Lissitzky, 1925/1968, p. 348)

I was moved by Marion Walter's (2001) article in this issue to look with a similarly-attuned mathematical eye into some of the art historical background to the van Doesburg painting she worked with. I am still unable to respond fully to her puzzlement about the 'arithmetical' nature of the work which might justify its title, but here are some notes about certain awarenesses and potential themes concerned with both the painting and the artist.

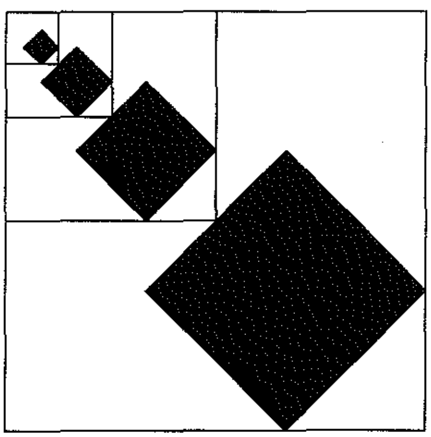


Figure 1

Two striking features of this painting *as a painting* (rather than as a geometric diagram) turn out to be the centrality of one diagonal (bottom right to top left of the square canvas) to the dynamic sense of the image as a whole and, second, the picture's complete symmetry about this diagonal. The former effect is achieved without any part of the actual diagonal being drawn in (other than the two corners defined by the edge of the square canvas), none that is other than three points of it being marked where the vertical-horizontal grid gnomons meet the diagonally-placed squares (see later)

Part of the strong diagonal effect comes from the fact that pairs of sides of the black squares are parallel to this virtual main diagonal (so it is not just mathematics that invokes the art of seeing things which are not there) Yet this is so, despite the fact that a full third of the opposite main diagonal is actually drawn in as a side of the largest square and there are equally many sides of squares parallel to this second main diagonal

Arithmetic Composition 1 was the last major work that van Doesburg painted before his death early the following year in 1931. In letters, he said of this piece that:

> It is as much the pyramid as the falling stone, as much the drake across the water as the Echo, it is as much time as Space, the infinitely large as the infinitely small (cited in White, 1997, p. 291)

> I can make a thousand paintings on this spatio-temporal plane because the universal is inexhaustible! The next will have the following proportions: 8 - 16 - 32 - 56 and the colour will be harmonious [...] I accept the pyramid as an instance of such a universal form, beautiful because elementary and impersonal, therefore always stable from the observer's point of view! Such a universal form remains as such permanently since it is a mathematical structure. I want a genuine structure of this sort for painting, for the plastic arts, for architecture. (cited in Lowe, 1990, p. 232, original in French, *my translation*)

The first quotation suggests a dynamic quality of potential movement in both directions: self-similar ripples getting smaller and smaller *within* the picture being juxtaposed with the prospect of continuation and growth *outside* the frame of the painting. [1] As Wassily Kandinsky (1912/1946) observed, in his enormously influential essay *On the Spiritual in Art*:

> The similarity between art forms of the past and present can easily be seen, though diametrically opposed to each other. The first is purely external and, therefore, without a future. *The second is spiritual, therefore, containing the seed of infinity.* (p. 10, *my emphasis*)

Arithmetic Composition 1 was produced contemporary with (and as an exemplar of) van Doesburg's declaration of the six tenets of 'Concrete art', one of whose statements is that: 'the technique must be mechanical, i.e. exact, anti-impressionistic'. This was:

> a 'universal' art which he [van Doesburg] believed could be achieved by mathematical and systematic methods of composition (Overy, 1991, p. 188)

Lowe (1990) writes of an earlier belief he himself had held that these last works by van Doesburg formed the first instances of serial (we might nowadays say 'fractal') construction in abstract art. Certainly, it is striking how van Doesburg's terminology changes from 'composition' to 'construction', and a construction based on a rational, geometric, syntactic structure at that In a one-page piece van Doesburg wrote in Paris in 1930 (but which only posthumously appeared post-war in the first edition of a journal *Réalitiés Nouvelles*), three of his seven observations about a move in art 'from intuition to certainty' (as the piece was titled) were:

> 3. Mathematical or rather arithmetical control is what can furnish contemporary painting with cultural value. Mathematics is not only the basis for all the sciences, it is also the foundation of the arts in major epochs. As soon as the artist makes use of elementary forms as means of expression, his work is not 'modern' but universal.
>
> 4. Having moved through different periods of plastic [2] expression (that of arrangement, of composition, of construction), I came to create *universal forms* constructed on an arithmetical base by pure elements of painting
>
> 6. The relationships [3] of each construction are controllable arithmetically and always correspond to the initial scheme.. (1947, p 3, original in French, *my translation*)

Taken in conjunction with his quotation I gave at the very outset ('We are painters who think and measure'), it is possible that, at one level, this 'arithmetic control' he writes of is simply that afforded by measurement applied to the elements and relationships present in the picture, in order to place them, to design them in. But there is more than this at work, I feel

A related question for we who come to his (or any other artist's) work with a mathematical eye is to ask in what sense are we mathematising the work and in what way (and I am grateful to Nick Jackiw for using this term within earshot) are we *re*mathematising it? In other words, to what extent did mathematics consciously play a role in the creation of the piece in the first place; to what extent is mathematics designed in? Similar considerations apply to those who 'find' complex mathematical (mainly arithmetical) relationships in, for example, Bach's music (see e g. Hofstadter, 1979) or (mainly arithmetic/geometric ones) in Malevich's paintings (see e.g Milner, 1996).

Lowe makes a similar observation about van Doesburg's painting, contrasting its relation to mathematical conceptions with that of fellow de Stijl painter Vantongerloo, some of whose works were explicitly linked by title to algebraic formulae and geometry With Vantongerloo, Lowe claims:

> the mathematical construction suggested by the title of these works remains hidden. Frequently, the relation between the mathematical formula and the works themselves is in no way evident
>
> By means of a biased analysis of a tryptch by Van der Weyden, Vantongerloo tried to show the existence of an underlying geometric schema in the former's work [which is precisely what Milner (1966) does, though more successfully to my mind]. Based on this historical precedent, he pretended that the artists must have followed the track of using geometry in painting and abstract constructions.
>
> The geometric organisation of van Doesburg's *Arithmetic Composition* is on the other hand completely evident. It is not the basis for the composition, it is the composition In this picture there is no concession to arbitrary arrangement or taste The *Arithmetic Composition* is graspable not because of its imitation of objects, but by its logical construction A picture sufficient unto itself, autonomous, thus rediscovered and which can be understood without reference to nudes, the countryside, etc (1990, pp. 229-230, *my translation*)

These questions seem to me to be closely related to discussions about ethnomathematics. (See Dick Tahta's comments on page 24 of this issue, as well as his 1980, 1992a, 1992b articles. In these latter three pieces, he argues that with neolithic stone balls and sriyantra patterns there was no mathematical intent, while in a Piero della Francesca painting he believes there to be evidence that there was.) For me, this issue is, to some extent, characterised by Gerdes' (1986) strong claim:

> The artisan, who imitates a known production technique is - generally - not doing mathematics But the artisan(s) who discovered the technique did mathematics, developed mathematics, was (were) thinking mathematically (p 12)

van Doesburg, Mondrian and diagonals

Nearly fifteen years earlier, in 1917, van Doesburg had established and edited an international art, architecture and aesthetics review, *de Stijl* ('the Style') [4] which was heavily influenced initially by the work of his elder Dutch art colleague and sometime collaborator Piet Mondrian During the late 1910s and the 1920s, Mondrian was developing a style of painting (unhelpfully translated as 'neo-plasticism' - see [2]), which was less well-known than the different but also geometrically-influenced 'Cubism' of roughly the same time. van Doesburg's own work in the period 1918–1924 fitted well within this former style

In a statement of the general doctrinal principles of neo-plasticism (which Mondrian prepared in 1926, though earlier versions from 1920 are also equally insistent on this), the sixth and final tenet reads "All symmetry will be excluded". According to Paul Overy, one stylistic feature of much of the de Stijl group work was "a studied and sometimes extreme asymmetry of composition and design" (1991, p. 11). At its most pure, this style had very few 'elements' to work with, either of form or colour: straight lines and ninety-degree angles, horizontals and verticals only, and a very restricted palette consisting only of the three primary colours (red, blue and yellow) together with black and white.

The abstract images Mondrian and (initially) van Doesburg created within these constraints were very stable and balanced compositions (and, in consequence, static) but *never* symmetric. (Even in as spare and stark a composition as Mondrian's 'Composition with two lines' (1931) - which comprises a pair of black Cartesian axes on an otherwise white square canvas hung diagonally at 45° - one axis is noticeably thicker than the other, in order (I believe) to block the lurking potential symmetry.)

Starting in 1917, Mondrian hung some of his square canvases slantwise (he usually painted on oblong canvases), so the edge of the canvas itself offered a diagonal, but he resolutely used only verticals and horizontals within the image itself. Slightly earlier, in 1914, Mondrian had written of how he claimed he worked with these linear elements:

> [I] constructed *consciously*, though not by *calculation*, and directed by higher intuition [...] *chance* must be avoided as much as *calculation* (quoted in Schapiro, 1978, p 250)

In 1916, when van Doesburg was first getting to know Mondrian, he visited Mondrian at an artists' colony in Laren, a village near Amsterdam, and wrote about this visit:

> On the whole I got the impression that van Domselaer [a composer] and Mondrian are totally under the spell of Dr Schoenmaeker's ideas The latter has just published a book about 'Plastic mathematics'. [5] Sch stands on a mathematical basis. He considers mathematics as the sole pure thing; the only pure standard for our feelings. Therefore a work of art must, according to him, always be based on a mathematical foundation. Mondrian implements this by taking the purest forms for the expressions of his emotions, i e. the horizontal and vertical line (cited in Blotkamp, 1986, p. 10)

These elements, while spare and clean, carried many human connotations As one instance, Overy (1991) claims:

> In the early aesthetics of De Stijl, as defined in the writings of Mondrian, the horizontal line is a schematic representation of the earth, the horizon. The vertical line is the impingement of man on his environment [...] For Mondrian the orthogonal relationship embodied a balanced configuration, a harmonious equilibrium. Into this balance van Doesburg introduced the diagonal. (p 71)

Mondrian frequently wrote about his art in terms that closely connect with Gattegno's characterisation of mathematics as attending to relationships in themselves, observing:

> Throughout the history of culture, art has demonstrated that universal beauty does not arise from the particular character of the form, but from the dynamic rhythm of its inherent relationships, or - in a composition - from the mutual relations of forms. Art has shown that it is a question of determining the relations. It has revealed that the forms exist only for the creation of new relationships: that forms create relations and relations create forms. In this duality of forms and their relations neither takes precedence (1937/1988, p 15)

Many of van Doesburg's 'Counter-composition' paintings from the mid-1920s were square and contained square imagery, but made full use of the diagonal: in fact, the diagonals predominate *within the image itself* (The effect of this is underlined in Lemoine's (1987) book which is printed on unfamiliarly near-square pages.) Only one of van Doesburg's pictures was ever hung as a diamond. Overy (1991) comments:

> By the mid-twenties he [van Doesburg] had come to believe that it [the diagonal] could represent the human body in movement by purely abstract means and the experience of speed of modern mechanized life, as a symbol of natural power harnessed by man. At the same time he believed that diagonal relationships more completely realized 'the spiritual', because they opposed the gravitational stability of the natural and material structure of horizontals and verticals He intended to convey this by using the term Counter-Composition. (p. 71)

In a much-publicised break with van Doesburg and *de Stijl* in 1924, Mondrian criticised van Doesburg's inclusion of diagonal lines within his work and broke off relations with him:

> After your arbitrary correction of Neo-Plasticism, any collaboration, no matter of what kind, has become impossible for me. (cited in Schapiro, 1978, p 233)

The possible reasons for his significant investment in excluding diagonal lines is worthy of further consideration. (Is it of the same order as those ancient Greek mathematicians who would allow *neusis* constructions and those who would not?)

Malevich and black squares

John Milner, in the book [6] Marion Walter referred to at the end of her piece, observed something similar about the effects of diagonals in the square-canvas paintings very frequently deployed by near-contemporary Kazimir Malevich:

> As a square format is neither vertical nor horizontal, it retains the full energy of its diagonals. [...] It [the square canvas] focused attention on the inner rhythms because neither the vertical nor horizontal proportions dominated the painting (1996, pp 14, 31)

One of Malevich's most notorious paintings has become known as 'Black square', though in fact he entitled it 'Rectangle'. It was a white square canvas almost entirely covered with a centered, uniformly black painted square, which was to become emblematic of Russian constructivism. This painting is frequently hailed as the first 'truly abstract' painting (though some of Kandinsky's work a little earlier is also pointed to in this same respect).

Malevich wrote:

> In the year 1913 in my desparate struggle to free art from the ballast of the objective world I fled to the form of the Square and exhibited a picture that was nothing more or less than a black square upon a white ground. [...] It was no empty square which I had exhibited but rather the experience of objectlessness. (cited in Schapiro, 1937/1974, p 202)

van Doesburg had encountered Malevich's painting (and Russian constructivist art in general) while in Germany in the early 1920s and had used this image on the cover of an issue of *de Stijl* in 1922, referring to it as replacing the cross as the new emblem of the age.

However, there is a mathematical irony here: in some sense, this work is simply a painting of a black square and hence as completely representational as any 'realistic' painting. Yet frequently artists, when pursuing 'the abstract', the absolute, the infinite, turn to specific images and elements as their means, means which we see as mathematical.

Van Doesburg showed himself to be alive to aspects of this irony, when he wrote:

> We speak of concrete and not abstract painting because nothing is more concrete, more real than a line, a colour, a surface. A woman, a tree, a cow; are these concrete elements in a painting? No. A woman, a tree and a cow are concrete only in nature; in painting they are abstract, illusionistic, vague and speculative. However, a plane is a plane, a line is a line and no more and no less than that. (1930/1974, p. 181)

Returning to van Doesburg's Arithmetic Composition 1

I have retaken these steps in order to draw out a little of the significance within the history of van Doesburg's art of certain features of this image which at first (mathematical) sight might appear unexceptional. They include:

- the existence of a global line of symmetry for the picture (striking for an artist and architect who had effectively eschewed symmetry for his entire career);
- the presence of a key diagonal line (though not drawn in) as well as the use of actual diagonals within the image, in the sides of squares, parallel and perpendicular to this central diagonal;
- the use of black squares (both in relation to the original colour tenets of neo-plasticism and to Malevich's historically significant painting: van Doesburg had never painted entire black squares before);
- the use of alternating light pastel shades of primary colours in the background (not present in the mathematised drawings given in Walter's article) which call attention to the gnomons

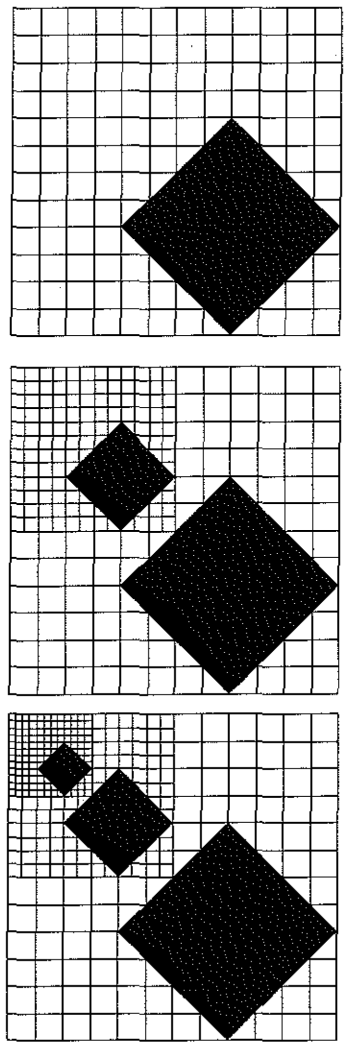
Viewed with a mathematical eye, certain questions remain: for instance, why did the picture itself not suggest going beyond the four squares shown? But this also may have had to do with the fact of a painting itself necessarily being static, however encouragingly and suggestively dynamic the image, or evoking a general process for $n = 4$.

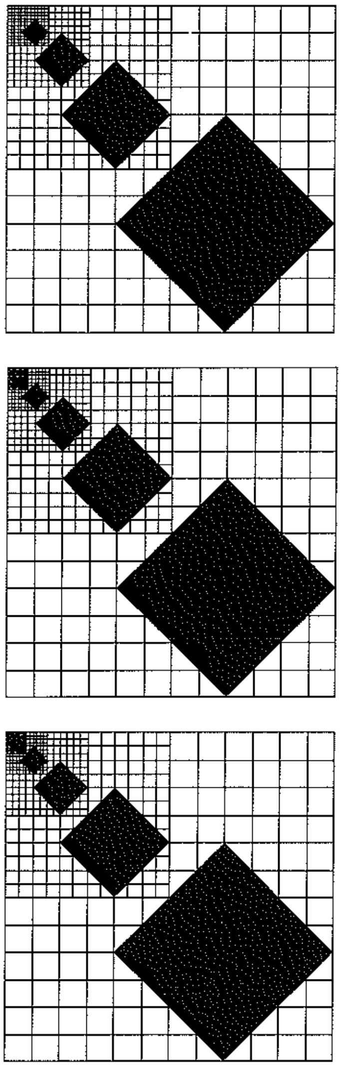
But the issue of static and dynamic, of space and time, of the discrete and continuous is also there. Before painting this picture, van Doesburg had created a series of sketches (one of which, *Study for Forme Universelle II*, Walter mentions in her article). But, more significantly here, he had also produced a film storyboard in the late 1920s (presented in an article in German which appeared in 1929 entitled 'Film as pure form', an issue connected with an exhibition 'Film and Photo') He wrote in this article about the recent advent of 'talking' films and the dynamic work of film in relation to static painting, while also observing how Cubism and Futurism themselves created new 'optics':

> This kind of dynamic light form implies, in fact, a new kind of art, an art in which the 'one thing after another' of music and the 'one thing next to another' of painting are brought together in one (van Doesburg, 1929/1966, p. 8)

Below is a reconstruction of a sequence of images (the ones Marion Walter mentioned which convinced her that exactness was indeed a core concern for van Doesburg) They appeared at the outset of his piece as an illustration, but were not directly addressed in the text The set of images was captioned:

> From Surface to Space. Six moments of a space-time construction (with 24 variations), formation of a diagonal dimension





Thus, the element of time in the creation of the image (recall the quotation 'it is as much time as Space') could be made manifest. (This also recalls Nunokawa's (1994) article on how the genesis of students' geometrical drawings can be very informative of how they are seeing the finished images.) The gently-coloured, gnomon-shaped regions in the actual picture call attention to themselves as a geometric configuration from the way the underlying grid is used in the picture's construction, even though that grid is not present in the final image, which indeed may account for this aspect of the painting

If the storyboard had been made into an animated film, could it have been of use as a mathematical film, perhaps of the sort made by Nicolet and Gattegno? What is involved in (re-)mathematising a film, with its tacit organising time presence, compared with (re-)mathematising a painting? (See, for instance, the discussion of one such film in Tahta, 1981.)

The role of mathematics, both in terms of offering images as elements for these pictures, and as a symbolic mechanism potentially implicated in their creation, remains unclear to me. And it is also true that any such mathematisation must, of necessity - just as with Walter's stressing the line structure and ignoring the colour of *Arithmetic Composition I* - miss out on certain conventional connotations of such elements. Is my wish to see what certain artists are working with as mathematical, and to be interested in mathematising the resultant work, simply a limitation on my part (albeit one supported by various writers) or a form of cultural imperialism, in which mathematics claims sole rights to being the 'true' means for expressing the True?

Acknowledgements

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Notes

[1] A number of van Doesburg's paintings in the mid-to-late 1920s (which, unlike this one, he termed 'Counter-compositions') have this sense of being partial, inviting a continuation outside the frame of the canvas

[2] The Dutch adjective *beeldend* and backformed noun *beelding* are key terms (used in the title of Schoenemaekers's (1916) *Principles of Plastic Mathematics* - see also [5]) and have no good translation into English. Overy (1991, p. 42) writes:

> However, Mondrian did take over some of Schoenemaeker's terminology. The terms *beeldend* [plastic] and *nieuwe beelding* [neo-plasticism] have caused more problems of interpretation than any other in the writings of Mondrian and other De Stijl contributors who adopted them [...] *Beeldend* means something like 'image forming' or 'image creating', *nieuwe beelding* 'new image creation', or perhaps 'new structure'. In German, *nieuwe beelding* is translated as *neue Gestaltung* [and *Gestaltung* is the term van Doesburg (1929/1966) uses in his article 'Film als reine Gestaltung' (translated as 'Film as pure form') - see later]

[3] The French noun *le rapport* means both "relationship" and "ratio", a fact which has particular resonance here

[4] van Doesburg wrote:

> but it is these first products of the new style, created by others, that confirm the correctness of the assertion which I made in 1912 in an article in the journal *Eenheid*: 'When the criterion was beauty, the undulating line came to the fore; but when the criterion was truth, the line simplified itself; this new criterion will lead it to end in a straight line.' In the use of the straight line I saw the consciousness of a new culture. 'The Straight Line' was the title I wanted to use before I hit upon *De Stijl*. (cited in Jaffé, 1970, p. 221)

[5] Schoenmaekers' book *Princples of Plastic Mathematics* has never been translated into English: the largest English-language fragment I found (some sentences also appear in Baljeu's (1974) book) was incorporated as part of a libretto for a vocal piece entiled *De Stijl* by Louis Andriessen (1996) for four women's voices, female speaker and large ensemble: the libretto consists of excerpts from this book by Schoenmaekers and one by van Domselaer about Mondrian

The chorus recites:

> The line of the perfect circle is not perfection of the first order
> The line of the perfect circle is perfect as a line. But it is not perfect without limitations, it is not perfect as an unending line, it is not perfection of the first order, it is not *the* perfect line.
> The perfect straight line is 'the' perfect line
> *Why?*
> Because it is the only perfection of the first order. Likewise its ray, the perfect eternal ray, is perfection of the first order. The perfect eternal ray is also 'the' perfect ray. For only it is as *ray* a perfection of the first order.
>
> The cross-figure.
> The figure which objectifies the concept of this pair of perfections of the first order is the figure of the perfect right-angledness: or, in other words, the cross-figure. This is the

figure that represents a ray-and-line reduced to perfection of the first order It characterises the relationship between perfections of the first order as a perfect right-angled relationship, a 'cross' relationship This figure is actually 'open'. [ ]

[6] This book of Milner's comprises quite a striking example of a form of mathematisation of an artist's *oeuvre* Milner uses geometry, almost as a tool of reverse engineering, in order both to analyse and make claims about both how and why these canvases were painted as they were, with geometry serving as an embodiment of a spiritual aesthetic of divine proportion

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