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Guest editorial essay

The stereoscopic art of Ludwig Wilding

With the invention of the stereoscope, Charles Wheatstone transformed not only our vision of pictures, but also our understanding of some intricacies of spatial perception. In his obituary notice in *Nature*, the following comments were made by Signor Volpicelli of the Academia dei Lincei: "Our countryman, Leonardo da Vinci, in 1500, or thereabouts, conceived and was the first to affirm, that from a picture it was not possible to obtain the effect of relief. But Wheatstone, reflecting profoundly in 1838, on the physiology of vision, invented the catoptric stereoscope, with which he philosophically solved the problem of the optical and virtual production of relief" (1876, page 502). Thus, the stereoscope could restore the dimension of depth missing in single pictures. But have many such paired paintings been produced by artists since Wheatstone's death? There certainly are some, and they represent tours de force on behalf of the artists, but they have not attracted much attention. Salvador Dali produced some large paired paintings in the 1970s. At about the same time an alternative technique was devised by the artist Ludwig Wilding (figure 1).

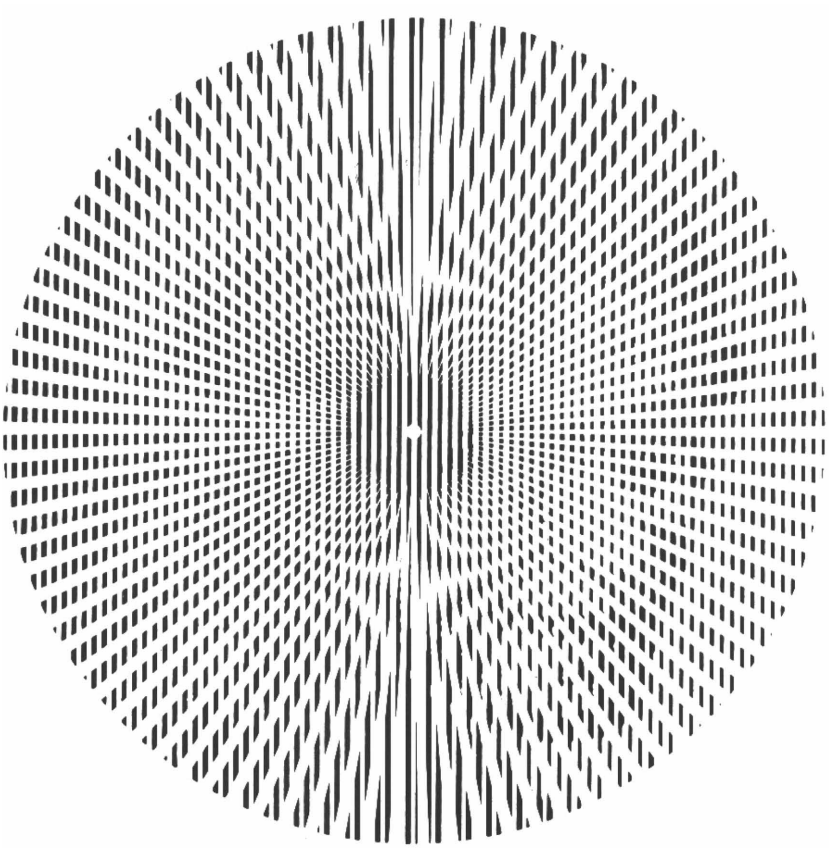

Figure 1. *Moirémage* by Nicholas Wade. A dual portrait of Ludwig Wilding in the interference patterns formed from a vertical grating and radiating lines. The portraits are defined by reductions in the line density on the left, giving the impression of a negative image. That on the right appears like a more conventional positive portrait as the parts defining the face are darker.

Paintings in two-dimensions allude to the depth that they do not contain: a variety of stratagems is enlisted to convey the impression that surfaces on the picture plane are at different distances from the viewer. The lengths to which artists have gone to fool the eye attests to the difficulty of achieving this (Ebert-Schifferer 2002). Another strategy is to produce two paintings with defined horizontal disparities between them and viewed with the aid of a stereoscope. If the paintings are large then they are typically placed facing one another and combined by means of a mirror stereoscope. Such paired pictures are individually flat and the depth is determined by disparity. Some novel techniques, like autostereograms, have been introduced in recent years and they have been adopted by computer artists, engaging immense popular appeal.

It is as though artists were reluctant to introduce the physical dimension that they were striving to simulate. Wilding has done precisely this, but the result is the perception of a far greater depth than is physically present. Moreover, his technique does not involve any additional viewing devices. It is based on disparities between moiré fringes generated by the interference of transparent and regular repetitive patterns separated slightly in depth. Figure 2 is taken from a pamphlet (Wilding 1977) and the work shown was on display at a large exhibition that Wilding held in 1978 at the Marburg meeting that saw the founding of the European Conference on Visual Perception (ECVP). The work is large (180 cm square) and real relief is relatively small (about 5 – 15 cm). None the less, the apparent stereoscopic space can be much greater, and it varies with the viewing distance of the observer (because disparity between the moiré fringes varies with viewing distance). At the meeting, people were seen walking towards and away from the works in order to determine the limits of depth that could be seen before rivalry set in. The front surface of the work shown in figure 2 was made out of strips of black elastic nailed to the top and bottom of the frame, whereas the transparent front was screen-printed on plastic in other works. The stereoscopic depth can be produced from curved as well as flat surfaces, and opposite directions of depth are often incorporated in the same work.

The relationship between the spatial frequencies of the transparent and printed patterns determines the direction and amount of the depth seen, and they can be given precise mathematical descriptions (Kondo et al 1990). If the spatial frequency of the foreground (transparent) grating is m cycles deg^{-1} and that of the background (printed)

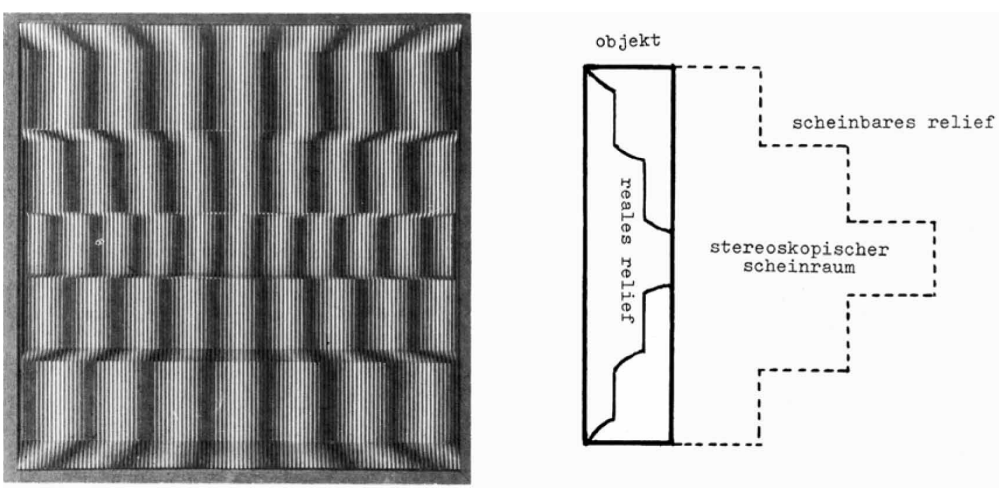

Figure 2. A frontal view of a stereo interference work by Ludwig Wilding and a schematic diagram of its structure as seen from the side (from Wilding 1977). The moiré fringes seen on the left derive from the interference between the transparent vertical grating and the vertically striped background printed on the rear surfaces.

grating is n then that of the moiré fringes will be $m - n$ cycles deg^{-1} and the depth is given by $[m/(m - n)] \times d$, where d is the physical separation between the two gratings. If $m > n$, then the moiré fringes are seen protruding, whereas for $m < n$ they appear to recede. The latter is generally more compelling because the stereoscopic space seems to lie behind the frame of the work. Lateral head movements yield motion parallax the velocity of which follows the formulations given above (Kondo et al 1990).

It is difficult to demonstrate the stereo effects in two dimensions, but an attempt is made with the paired photographs in figure 3. A better way of experiencing the depth effects is to consult the article by Spillmann (1993): it is accompanied by transparencies and printed designs by Wilding which enable the depth to be experienced more directly. The printed pattern can be folded rather like the surfaces in figure 3. By far the best way of experiencing these remarkable effects is to see the actual works. Ludwig Wilding's artwork can be found in many galleries around the word. They were seen by those who attended the Marburg meeting and Wilding also staged an exhibition at the ECVP at Bad Nauheim in 1986 (see Spillmann 2003). Another excellent chance is now offered with a major retrospective exhibition to mark Wilding's 80th birthday. The venue is the Museum für Konkrete Kunst in Ingolstadt, Germany, and his exhibition is on display from May 20 to July 1. Ingolstadt is the home of the sole German museum devoted to Konkrete Kunst. Within Germany the concept of concrete art has a particular resonance: it is distinguished from abstract art and it reflects an emphasis on the cold and calculated line, standing for nothing else and allowing little

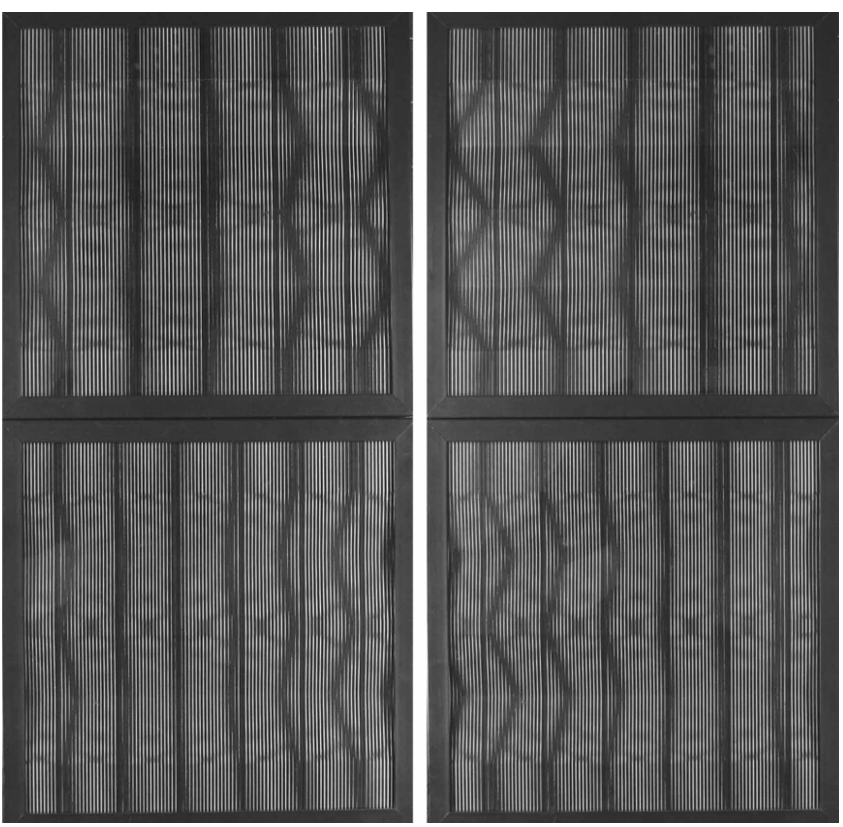

Figure 3. Paired photographs of two of Wilding's works (PSR VII below and PSR VIII above). The photographs were taken with a separation of the camera of about 6 cm. Free fusion of the stereopairs will yield opposite depths of the moiré fringes. The works are 18.5 cm square and the maximum physical separation between the transparent and printed surfaces is about 5 mm.

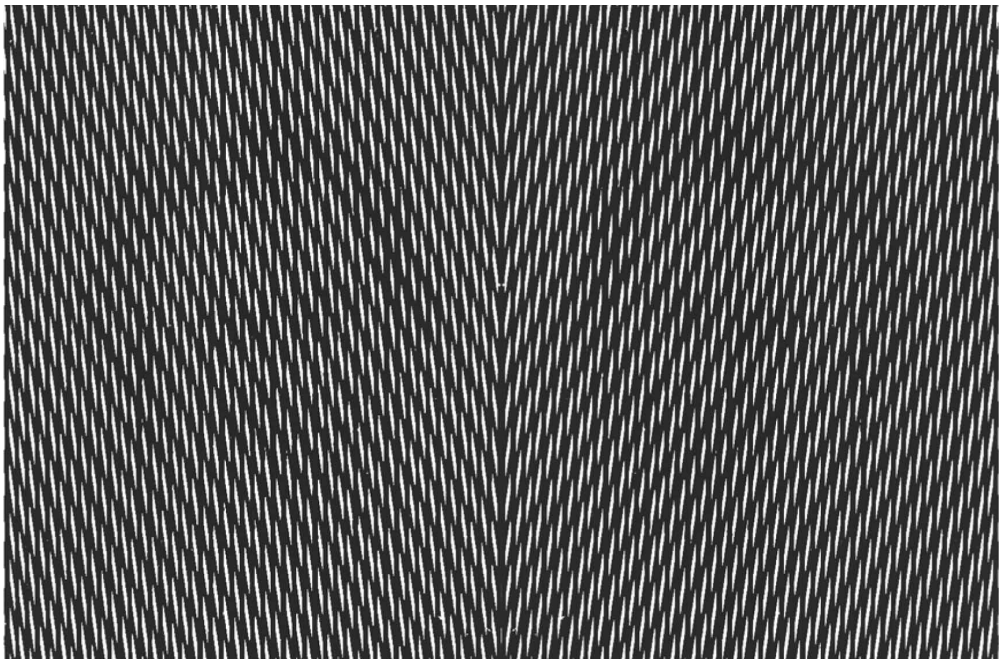

Figure 4. *Moiré master* by Nicholas Wade. Paired perceptual portraits of Ludwig Wilding based on a photograph taken at his studio in Buchholz in 1984.

involvement of the artist's hand, let alone emotions. The homage to Ludwig Wilding shown in figure 4 would not come under the concrete umbrella: it would be banished because of the reference, albeit indistinct, to his portrait!

Wilding's stereoscopic art has fascinated not only perception but also *Perception*. They have been reproduced in several articles, and have been analysed in detail in the journal (Spillmann 1993; Wade 1978; Wade et al 2005). Wilding's art is not confined to stereo interference patterns, nor to two-dimensional moiré patterns: he has examined the perception of space utilising a wide variety of phenomena, including spatial illusions, anamorphoses, perspective paradoxes, fractals, moving moirés and apparent motion, all of which will be on display in the exhibition.

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