Looking Beneath the Surface:
The Radial Spread of Ink in Water

Pery Burge

The phrase “going with the flow” describes both the content of my work and my artistic approach. My “chronoscope” paintings, full of naturally occurring forms, tracks and trails in ink, exemplify my role as a “catalyst-artist” who sets up potentially interesting conditions and then allows nature to take its own course [1]. The pictures present natural processes in microcosm, where tracks and trails of ink are visible threads of time, looking as if they could still move—similar to the work of Jackson Pollock, whose dynamic trajectories of paint capture moments in time [2]. Working in this way—thinking on one’s feet—presents the challenge of making fast, instinctive decisions based on what the ink is doing and what is artistically worthwhile. This open-ended, flexible approach has offered me many opportunities for experimentation, both on paper and, more recently, with ink in water (Article Frontispiece).

WATCHING WATER: BEGINNINGS

First let me place my work on radial spreads in historical perspective. The 19th-century chemist F.F. Runge [3] made “self-grown pictures,” as he called them, using scientific processes to create aesthetic images (as do I). His chemically formed pictures on filter paper record every stage of the process that made them. In some respects our work differs: Runge generated his 2D images by setting up chemical reactions; my 3D images are generated by physical reactions. However, his methods and mine have common elements, and I believe there is a way of combining them to create a 3D chromatography, as I will discuss in the concluding remarks.

I started to work with ink in water in 2004, when, working on a project on color, I was trying to encourage inks to mix and form new colors on their own. I tried dropping the inks in agitated water—they did not mix well. They did, however, do something special, namely, indicate the direction in which the water was moving. To observe more, I experimented with different inks and types of flow (turbulence and rotation) and photographed sequences of vortices that I introduced into the water and the vortex was created separately by draining the paint up. This invited further investigation, so through trial and error I developed a reliable method of producing the patterns. At that stage I also did some research to find out what caused these “inksplosions,” or radial spreads, an explanation of which follows.

RADIAL SPREAD

The distinguishing feature of my method is that the ink simultaneously generates the radial spread and provides a method of visualizing it. This makes the process different from my previous work on visualizing vortices, in which ink was put in water and the vortex was created separately by draining the water away. With the radial spread in ink, the process and the means of visualizing that process happen all at once. In some types of flow visualization, the addition of a visualizing fluid can cause disturbance to the original process [4]. My method has no such possibility of disturbance.

The process creates differing surface tensions with different types of ink. I place water, mixed with a small amount of acrylic ink, in a bowl and with a dropper add gold paint with a base of xylol [5] and oil. The paint takes up a flat, circular shape on the surface. Its size will vary according to how much it spreads: The range is about 1–3 cm in diameter. Using a dropper, I then add acrylic water-based inks (which have high surface tension) on top of the gold, forming domes less than 1 cm across. In sufficient quantity the ink can become too heavy to hold its dome shape and, after several seconds, gravity overrides high surface tension, causing the “piled-up” ink to drop downward slightly and burst outward at a high speed, moving in patterns emanating from the stagnation point. The radial spread happens too quickly for the human eye to watch its formation.
progress in detail. Photographic sequences, with exposures of one or more per second, capture the patterns and their evolution. The images often show the initially high speed of the spread because they record the path of the ink as it travels outward. From the photographs I choose which images to crop and magnify. Then, always treating the image as a whole, I heighten color and contrast to show the patterns to their best effect.

**Structural Features of Radial Spreads**

The patterns, the overall shapes of which depend partly on the surrounding gold wall of paint, often originate from a dipole vortex coming from the stagnation point and are usually axisymmetrical (Color Plate H). The individual characteristics of the ink play a large part in the development of the spread. Different inks react with water in different ways as defined by their Schmidt number [6], which represents relative ease of molecular momentum and mass transfer [7]. The original burst outward often forms a thin film of ink, which, depending on the type of ink, moves outward to form connections with itself or retracts from the water, sometimes forming strands as in the Article Frontispiece. The ink initially moves at a high speed in various paths—sometimes in straight lines or in scalloped lines (Fig. 1b). The ink continues to form a more complex network until it mixes with the surrounding liquid and the pattern becomes dendritic, then sinks. Channels of ink may emanate from bubbles at the stagnation point. Self-similar forms often occur: for instance, pitchfork bifurcations or polyhedral shapes reminiscent of soap bubble formations [8], as in Color Plate H, within the two older radial spreads above and below the new central radial spread.

**CONTINUATIONS AND CROSS-CONNECTIONS: LINKS WITH WORKS ON PAPER**

Many questions arose when I looked closely at these structures. There were clearly links to my previous work, because in both cases I was invoking natural processes to generate images. One recurring theme in my paintings is that an imaginary place or landscape could express a universal idea: a metaphorical landscape or “metascape.” For instance, in my picture *Hypervelovelocity II* [9], spinning clouds and streaming liquid shape the landscape—a visual metaphor for movement translating into form. How did the respective movements of ink and water translate into form in the water pictures, what made each pattern different, and what part did variables such as speed of flow, type of ink and temperature play in their evolution? Was the initial vortex pattern undergoing modification because of the chemistry of the ink alone or were there other factors? I felt certain that by learning how to control some of the variables so as to give these beautiful patterns their fullest expression, I would find myself exploring new artistic territory.

**Transformation and Evolution**

When painting on paper, I think in terms of generating a sequence of overlaid possible pictures, in which shapes transform and evolve until the ink stops moving. With radial spreads, these changes are captured and emphasized through the photographic sequence. By comparing stages in the sequence I can see how, for example, a simple structure evolves into something much more complex (Fig. 1).

**Microcosm-Macrocosm Connections**

Sequences can have a narrative influence on how images are viewed, as in *Pangea* (Fig. 2). A sequence taken from a point several seconds into the radial spread shows the mass of swirling ink beginning to disintegrate, like the break-up of the ancient supercontinent. As with my work on paper, I established a connection between small-scale and large-scale phenomena.

**Self-Similarity and Symmetry**

In *Pangea*, self-similarity appears in the small areas enclosed by gold paint [9]. Both self-similarity and symmetry are natural attributes of radial spreads, being consequences of the way a spread has formed. These features can be used as artistic devices for unifying an image—a shape repeated or mirrored can confer a sense of wholeness on the image. Moreover, symmetry can provide a visual resting point, for example, within the oval areas at the right of each sphere in Fig. 3, where, having followed vortices and meandering lines, the eye may rest for a while.

**Birth, Life, Death: New Interpretations**

With the work on radial spreads came an increased consciousness of a parallel between ink events taking place in the water and the life cycle of organic forms. There is the “birth” of the radial spread, whose relatively simple form emerges rapidly and unpredictably. Then “life,” during which the spread may develop in many directions, including inwardly, and thereby become increasingly complex. Finally, “death,” during which the spread mixes with the water, sometimes becoming dendritic or sinking to the bottom. These stages could be followed chronologically in sequences such as Fig. 1. Or one could compare different stages of spreads simultaneously within one picture. Figures 4 and 5 each show a variety of contrasting stages and forms, includ-

Fig. 1. Pery Burge, *Liquid Gold*, photograph, 2006. (© Pery Burge) a–d show pictures taken at 3-second intervals, showing the relatively high speed of the initial burst (b) compared with later stages when ink slows down (d). The ink increases in size from approximately 1 cm to 5–6 cm across.
ing, in Fig. 5, old and new spreads facing each other.

Images Full of Time

The idea of viewing several stages in one image encouraged me to explore the intriguing concept of “time-rich” images. How can we classify images in terms of how much time they contain, starting with static timeless ones and ending with dynamic time-rich ones? For instance, if a picture tells a story by showing more than one episode from the narrative, then perhaps it has more “time content” than a painting depicting a single moment in a story. For example, in its depiction of the Chloris-Flora transformation, Botticelli’s Primavera (c. 1482) combines two moments from Ovid’s narrative in one image [11]. A different sort of time-richness occurs when paintings capture a fugitive moment with dynamic paint marks that look as if they might change at any second, e.g. Jackson Pollock’s Autumn Rhythm No. 30 (1950) or A Bigger Splash (1967) by David Hockney. Both works would appear at the dynamic end of the time-rich scale. The arrangement for my ordering from static to dynamic drew upon Milton van Dyke’s book An Album of Fluid Motion [12], in which he arrange images of flow according to their increasing Reynolds number (the ratio of inertial forces to viscous forces).

My images of ink in water (aquascapes) are a natural continuation of the chro-noscapes, in which every ink event is recorded before the ink’s path becomes frozen in time when the ink dries. With ink in water, the ink’s path is also frozen in time, not physically by drying but digitally by the camera. Furthermore, with ink in water we see the dimension of time in various new ways. Photographic sequences take a single path through time by following one image’s progress, as in Fig. 1. It is also possible to highlight time by having blurred time-lapse images in which the ink seems still to move (Fig. 1b). Time can also be highlighted by including spreads that are at different stages (Figs 4 and 5) and by juxtaposing relatively static and dynamic elements— all the figures shown here contain this last feature.

CONCLUDING REMARKS

The work described here is just the start of an investigation into radial spreads. There are many ways forward; two are discussed in the following paragraphs.

An Idea for 3D Chromatography

This idea combines my methods with those of Runge. In Runge’s method, the flow of fluid across the filter paper is a result of capillary action. If, instead of his capillary flow, one uses the surface tension flow I have described above to facilitate chemical reactions, one might produce 3D chromatography. Here is an outline of my proposed method: Place the substance undergoing chemical separation on a liquid “platform” (such as the gold paint). The platform in turn floats on a liquid substrate (the equivalent of filter paper but with volume) that will be chemically reactive. The platform, which is non-reactive, serves two functions: First, it prevents interaction of substance and substrate until the radial spread begins; second, it facilitates the radial spread. When the spread begins, substance and substrate meet, resulting in chemical reaction and therefore separations of the substance. Separations are visualized by the radial spread, the color of which changes as it moves out and down through the substrate.

Filaments, Films and Networks: Every Picture Tells a Story

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Filaments, Films and Networks: Every Picture Tells a Story

By using the techniques I describe, one could build up informative visual profiles
of inks, dyes and paints. I do not know the chemistry of the inks I use (beyond thinking that they all contain acrylic). However, for someone with chemical knowledge and an interest in the science of diffusion, with its explorations of physical variables such as temperature and media, pictures such as mine could provide some valuable insights into the way ink works.

In this work I have enjoyed many revelations and surprises—the behavior of ink can be astonishing—and every time a new spread forms, I take pleasure in witnessing a unique event, for no two patterns are ever the same.

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References and Notes
1. To view some of my chronoscope paintings, see <www.chronoscapes.co.uk>.
2. Pollock made “poured paintings” from 1947 to 1950, for example, Number 14: Gray (1948). “In this period Pollock strove to free line from the representational image and make it a function of pure movement.” <cagallery.yale.edu/pages/collection/popups/pc_prints/details17.html>.
3. Runge made “self-grown pictures” by means of paper chromatography, whereby filter paper was spotted with a substance and reagents in the form of inorganic salts were then added, causing a visible chemical reaction, owing to capillary action, on the filter paper.
4. I. Grant, Optimage Ltd., verbal communication, 2006.
5. Xylol is a colorless, flammable, volatile liquid hydrocarbon used as a solvent.
6. The way networks form depends partly upon what the ink is made of, measured by its Schmidt number, and how it reacts with water. H. Stapountzis, University of Thessaly, Mechanical Engineering Department, Volos, Greece, verbal communication, 2006.
7. In fluid mechanics, the Schmidt number is a dimensionless number approximating the ratio of momentum diffusivity (viscosity) and mass diffusivity and is used to characterize fluid flows where there are simultaneous momentum and mass diffusion convection processes. F.P. Incropera and D.P. De Witt, Fundamentals of Heat and Mass Transfer, 3rd Ed. (Hoboken, Nj, John Wiley, 1990) p.345, Eq. 6.71, as cited at <en.wikipedia.org/wiki/Schmidt_number>.
11. In Botticelli’s painting Primavera, Zephyrus, god of wind, grasps Chloris, the fleeing nymph, who is transformed into Flora, goddess of spring.

Bibliography

Pery Burge trained as an artist in London and Cambridge and since then has been using ink on paper to create abstract landscapes. Recently she has been working with ink in water. An associate member of the National Society of Painters, Sculptors and Printmakers, she has displayed her work in exhibitions throughout the United Kingdom.