Fluid Effects in Manoel Veiga's Paintings

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Every successful leap in art opens new creative possibilities for the artists of the following generations. The more groundbreaking the new approach, the more fertile it may prove in liberating others to take further artistic risks.

When Jackson Pollock moved in 1945 from New York City to Springs, a village on Long Island, he left an urban landscape for a rural setting; simultaneously he abandoned the easel and the brush and begun experimenting with pouring paint onto horizontally stretched canvases. The artist thus invited nature into his work, engaging autonomous fluid dynamical phenomena directly in his painting process[1].

Pollock's radical innovations reshaped abstract expressionism; they also expanded the very notion of what may be considered a painting. It was a breakthrough, which unlocked the possibilities offered by deliberately deploying physics as a part of the creative process. Soon some of these possibilities were explored by other artists. Among those who inherited from Pollock both the horizontal placement of their canvases, and willful manipulation of fluid dynamics are Robert Motherwell, Sam Francis, Larry Poons, Linda Benglis, and more recently Jamie Nares[2]. Their individual techniques vary considerably and rely on such fluid phenomena as gravitational jets, thread breakup, drop formation, scraping flows, and a variety of liquid instabilities, often in combination of two or more. But their advances would have been unthinkable before Pollock.

The paintings of Manoel Veiga can be placed within this expansive heritage, and yet he forged a new and singular artistic idiom. Like the artists noted above, he eschews, for the most part, traditional use of the brush and places his canvases, or paper boards, horizontally (or nearly so) on the floor. From this by now "familiar" setup, however, the artist has turned in a new direction and developed an original approach, which privileges fluid dynamical processes that have played, with few exceptions, secondary roles before: mixing via diffusion and viscous fingering.

The artist's favored medium are acrylic paints, which are fast-drying suspensions, wherein pigment particles are dispersed in acrylic polymer emulsion. These paints, in general, have several physical properties, which are critically important for the unique painting technique of Manoel Veiga. They are water-based and soluble in water, but highly water-resistant when dry. Dry acrylics are also flexible and very stable, resistant to cracking and to discoloration (yellowing) under sunlight. These material properties, in addition to their flow characteristics, make acrylics ideal for artistic explorations.

To understand the fluid mechanical properties of the paints used by Manoel Veiga, and the painterly effects he is able to achieve with them, it is first necessary to delve into his preparation process. The artist prepares his paints by adding water to the ready-made acrylics and, if needed, mixing different colors in various proportions. Before application, these mixtures are thoroughly stirred. Crucially, the pigment particles in these paints vary in their solid densities, sometimes by more than a factor of 3, ranging from about $12\ lb/gal$ ($14 \times 10^{3}\ kg/m^{3}$) for phtalocyanine family (blue and green) to $40\ lb/gal$ ($48 \times 10^{3}\ kg/m^{3}$) for cadmium family of pigments (red). The pigment particles also differ in size (volume); for example, cadmium particles are much larger than those of phtalocyanine family, perhaps by a factor of 10 or more[3].

The artist has long paid careful attention to preparing his paint mixtures and has gained vast experience allowing him to modify them with a view toward their applications in his paintings. In his own words, "I started 20 years ago using only one mixture of colors per painting. First with very few pigments then, after some years and more confidence, using 10 to 12 pigments in a single mixture. Then I started using two different color mixtures at the same time and so on. […] The amount of water that I add when preparing the color mixture is also critical, altering its density, and I do it differently depending on what I want to do in the painting."[4] The artist also learned to carefully adjust the temperature and humidity of his studio in order to control the rate of drying of his acrylics.

Such acrylic paints, even when diluted, are usually much more viscous than water, but their viscosity strongly depends on the amount of water added. Manoel Veiga uses primarily medium viscosity acrylics of *maximum* dynamic viscosity likely similar to that of a typical cooking oil, about $100\ mPa \cdot s$ or two orders of magnitude higher than water (viscosity of water is very nearly $1\ mPa \cdot s$). Thus, even a highly diluted mixture would have a much greater viscosity than water, likely by the factor of 10 or greater.

The foregoing considerations set a stage for a preliminary discussion of the particular technique developed by the artist, a descendant of Pollockian mechanics[5]. While the artist has experimented with many variants, and his skills in manipulating the physical properties of the paints and the details of their application have gradually evolved, two principal approaches can be distinguished. In the first, one or more suspensions, each of a *single* pigment component, is poured or spattered onto the horizontally laid-out canvases (attached to plywood supports and at times slightly tilted) or sheets of paper, and then, before the paint dries, water is applied using a vaporizer. Typically, a very thin water layer is spread on paint-free surface near the edge of the painted area, enabling diluted pigment to flow and mix with water.

In the second approach, one or more multi-component mixtures are deployed in a similar manner, and water is sprayed more directly onto the painted surface. This process leads to the separation of colors, followed by (or simultaneous with) diffusion into unpainted regions covered by water. In order to highlight the fluid dynamics involved, we describe below separately the two basic physical mechanisms involved, in their simplest versions: flow of a single, one-component acrylic paint into a clear water layer; and mixing accompanied by color separation of a two-component paint.

In the first scenario, an acrylic suspension, composed of single-specie pigment particles homogeneously dispersed in diluted resin emulsion, is deposited from a paint-laden brush from above and close to the canvas. Acrylic paints dry by evaporation of water therein, limiting the time for their manipulation. Depending on the amount of water added and room conditions (temperature and humidity), the drying time can be extended up to several hours, giving the artist time to guide his mixtures. The delay between the deposition of paint and spraying is critical, as it affects its density and viscosity before the mixing commences. During wetting, some of the water may be absorbed into the mixture, in effect reversing to some extent, and in some parts, the evaporation process.

The fluid dynamics, which unfolds at this stage, is the primary conduit toward the painterly effects the artist is able to conjure. The denser and more viscous paint suspension begins to flow into water mixing with it. Due to small local perturbations, such as unevenness of the canvas and variations in the paint density, which get amplified during the flow, the propagation of the interface proceeds in a non-uniform way, with a variation of the advancing front's speed, creating a pattern of pigmented intrusions of varied widths and intensity jutting into the erstwhile colorless regions.

The process, as is suggested by the intricate patterns created in the artist's paintings, especially in the mixing zones, involves complex interplay of several physical mechanisms. The flow is induced in part by gravitational convection, as the canvas is often slightly tilted (using a shim underneath the board to which it is attached), in part by diffusion due to the density gradient, and in part due to the so-called fingering instability,[6] whereby less viscous liquid (water) displaces more viscous one (paint) creating elongated "fingers." Even in the absence of the tilt, gravity exerts some effect because the paint forms a raised layer above the surface of the canvas.

Viscous fingering itself, even in the simplest case of two liquids mixing between closely spaced horizontal plates (the so-called Hele-Shaw cell), has been studied extensively and is still subject of active research requiring computer simulations. The important distinction, which to a large extent determines the detailed morphology of the resulting pattern, is whether the two liquids are *miscible* or *not miscible*. In the former case, the viscous fingers tend to be thin compared to the intrusions of low-viscosity fluid, with numerous smaller brunches sprouting from their sides; in the latter case, the fingers are apt to be thicker, with oblong rather than sharp tips and few side-branches[7].

These observations are born-out by the subtle effects seen in Manoel Veiga's work, especially where a single-pigment mixtures were deployed. Since acrylic paints are soluble in water, thin and "hairy" fingers penetrating into water are to be expected. As an illustration, consider a series of paintings on cardboard, represented at the exhibition by [untitled, page No]. In this work, a few sweeping deep-green lines of thickness 2-3 mm, and some stains of the same color, were first deposited on paper and then wetted. Here the protruding fingers, mostly of lighter shade and 1-2 mm thick, are sometimes sparce, and in other areas, which were wetted more, denser and overlapping. In the latter places, the whiskers are widened, diluted, and blurred by diffusion. Elsewhere, the viscous fingers remain mostly intact.

The interplay between viscous fingering and diffusion becomes even more intricate when the acrylic paint is a multi-component suspension. Consider, for simplicity, the case of just two species of pigment particles dispersed in the acrylic emulsion, for example phtalocyanine blue and cadmium red. When such paint is deposited on a slightly tilted canvas, it begins to flow and simultaneously becomes *stratified*, with the denser blue particles settling down below the less dense red ones – just as water with higher concentration of salt sinks below the layers of lower salinity in the oceans. As a result, the flow separates the two colors, the blue pigment being retarded by friction with the canvas and the red flowing more freely. This separation is enhanced further by the addition of sprayed water which mixes more readily with the top layer, reducing its viscosity and so allowing it to flow faster. The effect is a red "halo," streaked with blue tongues, surrounding darker blue regions. [Example from exhibition]

Orchestrating such color separation requires meticulous preparation, fine balance, and very careful dosage and timing of added water, particularly when more than two pigment components are mixed into the paint. Over many years of patient practice, through trial and error, the artist perfected his skills and has achieved astonishing artistic effects, resembling colorful lava flows or perhaps, as the tile of the exhibition suggests, maps of *terra nullius* – contours of alien terrains, which still await discovery.

This achievement in manipulating complex mixing flows in the service of artistic aims suggests a comparison with a series of sculptures made by Linda Benglis called *Contraband* (exhibited in the Whitney Museum of Art). The sculptures rely on very different materials – colored molten rubber, which is then poured onto inclined surfaces or floor – yet they also depend on gravitationally induced convection and mixing of pigmented viscous liquids. The two artistic approaches, therefore, share some essential components in their fluid dynamical genealogies.

For all their similarities, however, the details of the physical processes deployed differ crucially, and lead the two artists in divergent directions. Notably, Benglis' mixing liquids are of the same viscosity and density and so neither diffusion nor viscous fingers are evident in her sculptures. The impact of these works is vastly different as well. The latex sculptures are displayed on the floor, as they were poured, suggesting a down-to-earth repose with a frozen-in memory of their dynamic origins, see Figure 1. Indeed, after her creative campaign over a period of several months in 1969, and having explored the technique in a number of pieces of varying sizes and shapes, the artist never returned to this form of expression.

The abstractions of Manoel Veiga, like those of Jackson Pollock, are created on the floor but thereafter *repositioned* in vertical and displayed on walls. The fluid dynamical effects are therefore cognitively severed from their mechanical origins. Through steadfast experimentation, the artist's abstract topographies gradually acquired exquisitely nuanced form, inviting closer inspection at ever smaller scales – and also demanding a more detailed analysis by physicists. The paintings present an opening, a foray: they invoke foreign vistas and intimate as yet unknowable possibilities.

References

1. A. Herczyński, C. Cernuschi, and L. Mahadevan, *Painting with drops, jets, and sheets*, Physics Today, June 2011, pp 31-36.
2. M. H. Miller, *Interview with Jamie Nares*, The New York Tines Style Magazine, April 24, 2022.
3. The dry pigment compounds are polydisperse, so that the constituent particles vary in size, clustering in some range around the average. The present discussion ignores these variations, and the tendency for larger particles to rise above smaller ones when a mixture of particles of similar densities is stirred.
4. Private communication.
5. C. Cernuschi and A. Herczyński, *The subversion of gravity in Jackson Pollock's Abstractions*, Art Bulletin, XC No. 4, pp. 616-639 (2008)
6. The technical term is Saffman-Taylor instability.
7. Jing-Den Chen, *Growth of radial viscous fingers in a Hele-Shaw cell*, J. Fluid Mech. 201, pp. 223-242 (1989)

Figure 1: *Contraband* by Linda Benglis (photo Christopher Burke Studios)