Fluid dynamics and Pollock's paint applicators

Andrzej Herczyński, Claude Cernuschi, and L. Mahadevan

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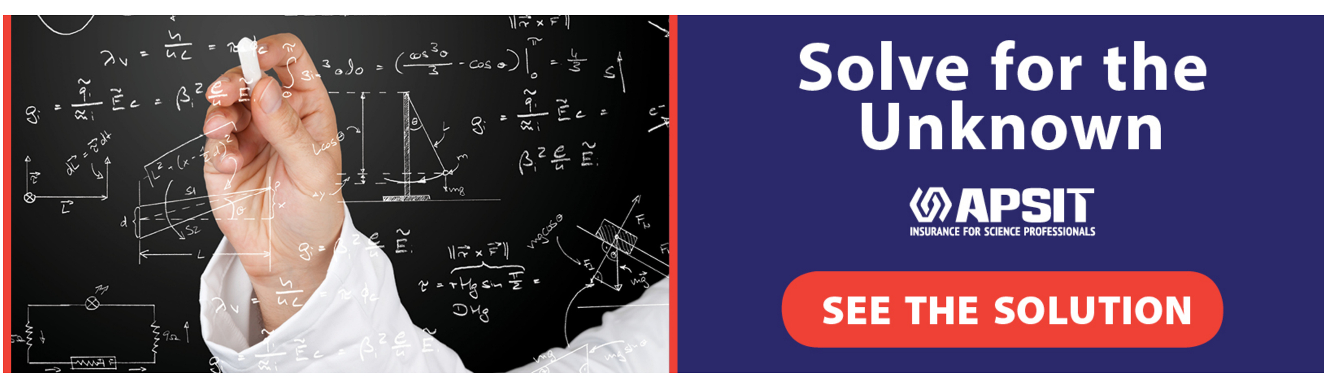

a Newtonian viscous fluid, for which the shear rate is proportional to the shear stress. But paint is a complex non-Newtonian fluid that does not satisfy this linearity requirement.[1] Experiments with a cylindrical wooden rod initially dipped into a container of ordinary wall paint can readily show that the scaling relations do not conform with observations.

For a video showing the formation and shape of Pollock's paint jet, see http://www.youtube.com/watch?v=ajZCjlxv7GI. Observe that the shape of an actual jet does not conform with the theoretical shape shown in figure 4b of the article, because the authors drew the figure without taking into account that paint also is an incompressible fluid. This property implies that the initial radius of the jet is smaller than the radius of the rod, as observed in the video, instead of larger, as shown in figure 4b.

Reference

1. V. N. Constantinescu, *Laminar Viscous Flow*, Springer, New York (1995), p. 26.

Michael Nauenberg
(michael@physics.ucsc.edu)
University of California, Santa Cruz

My compliments to authors Andrzej Herczyński, Claude Cernuschi, and L. Mahadevan on their quantitative analysis of Jackson Pollock's painting technique. The article offers welcome insights into his creative process and artistic achievements. I was especially pleased that the authors explained why the term "drip painting," commonly used to characterize his preferred method of deploying viscous material, is both incorrect and misleading.

I was somewhat puzzled, however, by the authors' choice of the word "trowel" to describe Pollock's favorite paint applicator and by their use of it interchangeably with "rod" and "stick." He did mention using a trowel, but he generally applied fluid paint with hardened brushes—he said he used them "more as sticks rather than brushes." Surely a trowel (from the Latin *trulla*, meaning "ladle") would hold much more paint than a rod or stick. The authors failed to note that Pollock also painted with flexible, soft-bristle brushes, from which the material flowed very differently than it would from a stiff stick or hardened brush. Even more curious, they never mentioned his well-known use of basting syringes, which dispense a lot more paint than do either sticks or brushes and therefore give a much longer line; they also produce squirts that have their own kind of trajectories and velocities.

Examples of Pollock's paint applicators are preserved and displayed at the Pollock-Krasner House and Study Center (http://www.pkhouse.org) in East Hampton, New York. The artist's former home and studio, it now belongs to Stony Brook University. The collection also includes many still photographs and three motion pictures that show Pollock using the tools and materials in question. I think the authors would have benefited from examining those resources at the museum, where the paint-covered floor of Pollock's studio vividly testifies to the variety and dynamic character of his technical innovations.

Helen A. Harrison
(helen.harrison@stonybrook.edu)
Pollock-Krasner House and Study Center
East Hampton, New York

Herczyński, Cernuschi, and Mahadevan reply: Since our primary aim was to invite readers to consider very simply the physics of pouring paint, we modeled paint as a Newtonian liquid. That model, as Michael Nauenberg writes, assumes a linear relation between the stress and the strain rate. Paint, a suspension of pigments and polymers in a solvent, may indeed exhibit nonlinear rheological characteristics. Taking that into account would lead to slightly different relationships than those we propose, but many of the qualitative features—for example, the coiling patterns on the substrate—would remain the same. However, effects due to elastic stresses, surface-tension gradients during drying, and so forth are not included in our description. We should have clearly noted the caveats of our minimal approach but are glad to have the opportunity to do so now.

Nauenberg also claims that our qualitative sketch of a thinning paint stream is inconsistent with observations. In fact, the shape of a draw-down jet is controlled by the competition between viscous and gravitational forces via the dimensionless parameter $\mu^2/\rho^2 g R^3$, where R is the radius of the jet at its origin, μ is the viscosity, ρ is the density, and g is the acceleration due to gravity. For highly viscous paints, the parameter is large, and thinning would be relatively gradual as a result.

Helen Harrison is correct to point to Jackson Pollock's wide range of implements, such as brushes of different bristle types and basting syringes. The artist kept experimenting and exploited many other techniques, even occasionally imprinting the canvas with his hand. Different tools produced different flows depending on the way Pollock employed them, though one cannot reliably infer a given technique from a given mark. Although those issues deserve attention, our study focused on the artist's most characteristic and distinctive effects: the linear tracks that appear in the poured abstractions he created between 1947 and 1950.

Andrzej Herczyński
(andrzej@bc.edu)
Claude Cernuschi
(claude.cernuschi@bc.edu)
Boston College
Chestnut Hill, Massachusetts
L. Mahadevan
(lm@seas.harvard.edu)
Harvard University
Cambridge, Massachusetts

Energy threat from overpopulation

The mega-scale Desertec project (PHYSICS TODAY, July 2011, page 21) calls for solar energy collection in the Sahara. The solar energy will then be converted to electrical to be carried to Europe on high-voltage transmission lines and undersea cables. A leading proponent of Desertec is quoted as saying that one of the reasons for the project "is exploding population" (PHYSICS TODAY, July 2011, page 22). Serious questions need to be raised about some aspects of the proposal.

Instead of addressing "exploding population," a world-threatening problem, the proposal would accommodate it and thereby guarantee that the population will continue to grow. That will make everything worse.

Desertec might work in a peaceful world, but increasing overpopulation is a main driver of our current condition of perpetual war. Tall electrical transmission towers and undersea cables are tempting targets for terrorists. Remember that at the outbreak of World War I almost 100 years ago, one of the first things the British did was to send out naval parties to sever the undersea cables and destroy the relay stations that the Germans used to communicate with their African colonies. German naval raiding parties, meanwhile, were destroying the cables and relay stations the British used to maintain communications with their global empire.

We first need to deal successfully with the urgent problems of overpopulation (see my article, "Thoughts on long-term energy supplies: Scientists and the silent lie," PHYSICS TODAY, July 2004, page 53). Doing so will reduce the pressures for continuing war and increase the chances that Desertec might be a success.

Albert A. Bartlett
(albert.bartlett@colorado.edu)
University of Colorado at Boulder

Siphoning off the last word

Before the whole siphon issue goes away (see PHYSICS TODAY, August 2011, page 10, and previous comments cited therein), I thought I'd point out why people often think that siphons depend on atmospheric pressure. In the most familiar examples, atmospheric pressure is required to set up the siphon, as one "sucks the liquid up" into the pipe, hose, or other conduit.

Once the siphon is set up, of course, the tensile strength of the liquid itself is what keeps it going. Liquid tensile strength is something that a lot of people don't understand, however, and they confuse the setup condition with the continuous operation of the siphon.

Glen Davidson
(interelectromagnetic@yahoo.com)
College Place, Washington ■