Study: modern masters like Jackson Pollock were “intuitive physicists”



Enlarge / *Collective Suicide* (1936), by Mexican muralist David A. Siqueiros, is an example of the “accidental painting” technique developed by the artist.

reader comments

35 with 22 posters participating

Share this story

There’s rarely time to write about every cool science story that comes our way. So this year, we’re running a special Twelve Days of Christmas series of posts, highlighting one story that fell through the cracks each day, from December 25 through January 5. Today: the fluid dynamics of modern painting techniques.

In the 1930s, a small group of New York City artist—including Mexican muralist David A. Siqueiros and Jackson Pollock—began experimenting with novel painting techniques and materials. For the last few years, a team of Mexican physicists has been studying the physics of fluids at work in those techniques, concluding that the artists were "intuitive physicists," using science to create timeless art.

"One of the things I have come to realize is that painters have a deep understanding of fluid mechanics as they manipulate their materials," said Roberto Zenit, a physicist who is leading the research at the National Autonomous University of Mexico. "This is what fluid mechanicians do. The objective is different, but the manipulation of these materials that flow is the same. So it is not a surprise that fluid mechanics has a lot to say about how artists paint."

Zenit is not the first physicist to be fascinated by Pollock's work in particular. Back in 2001, physicist Richard Taylor found evidence of fractal patterns in Pollock's seemingly random drip patterns. His hypothesis met with considerable controversy, both from art historians and a few fellow physicists. In a 2006 paper published in *Nature*, Case University physicists Katherine Jones-Smith and Harsh Mathur claimed Taylor's work was "seriously flawed" and "lacked the range of scales needed to be considered fractal." (To prove the point, Jones-Smith created her own version of a fractal painting using Taylor's criteria in about five minutes with Photoshop.)

Then in 2011, Boston College physicist Andrzej Herczynski and Harvard mathematician Lakshminarayanan Mahadevan collaborated with art historian Claude Cernuschi on an article for *Physics Today* examining Pollock's use of a "coiling instability" in his paintings. This is basically a mathematical description for how a viscous fluid folds onto itself like a coiling rope—just like pouring cold maple syrup on pancakes. The patterns that form depend on how thick the fluid is (its

viscosity) and how fast it's moving. Thick fluids form straight lines when being spread rapidly across a canvas, but will form loops and squiggles and figure eights if poured slowly.

> *Pollock: "I can control the flow of paint. There is no accident."*

Herczynski *et al.* measured the thickness of lines and the radius of the coils in a Pollock painting showing this effect, and used that data to estimate the flow rate of the paint as the artist's hand moved across the canvas. Pollock was also known to play with texture and viscosity when mixing his paints, often adding solvents to make them thicker or thinner. This, combined with the 2011 analysis, suggests that Pollock relied heavily on physics when painting. There's even 1950 video footage of Pollock at work, in which he asserts, "I can control the flow of paint. There is no accident."

Zenit's interest, however, began with Siqueiros. Art historian Sandra Zetina contacted him about her suspicion that fluid dynamics played a role in Siqueiros' techniques. Zenit learned about the artist's 1936 experimental workshop in New York to encourage his fellow artists to abandon classic painting techniques and experiment with other ways of painting. (A young Jackson Pollock was among the attendees.) They used less viscous house paint instead of oils, and used wood and other unusual surfaces rather than canvas. That's how Siqueiros came up with his famous "accidental painting" technique.

The technique involves pouring layers of paint on a horizontal surface and letting whorls, blobs, and other shapes form over time. Zenit and his colleagues were able to replicate the patterns formed by this technique using their own experimental apparatus, essentially placing a dense fluid on top of a lighter one. This creates a classic instability, because the heavier liquid will push through the lighter one. They published those results in *PLOS One* in 2015. According to

Zenit, Pollock's own dripping technique relies upon the same instability to produce curly lines and spots on his canvases.

- Bottom center-right detail from David A. Siqueiros' "Collective Suicide."
  A. Aviram, MoMA/Roberto Zenit
- "No. 32" by Jackson Pollock is a classic example of his famous dripping technique.
  Kunstsammlung Nordrhein-Westfalen, Düsseldorf, Germany/R. Zenit
- Example of Jackson Pollock's "flying catenary" technique.
  Roberto Zenit
- "Lion-bicyclette" (1937) by Oscar Dominguez is an example of the "decalcomania" technique.
  Roberto Zenit
- "Fetiche y tabú 28" (2017) by Octavio Moctezuma, part of an ongoing collaboration on the fluid dynamics of watercolor techniques.

At a meeting of the APS Division of Fluid Dynamics in November, Zenit summarized this earlier work and also gave a preview of ongoing research into three other painting techniques. The first is the "flying filament" or "flying catenary" technique used by Pollock before he had perfected dripping. Zenit and his colleagues recreated the fluid action by mounting a paint-filled brush on a rapidly rotating mechanical arm. The paint forms various viscous filaments, which are thrown against a vertical canvas.

Zenit is also studying something called the "decalcomania technique," favored by such artists as Max Ernst, Oscar Dominguez, and Remedios Varo. It involves painting a surface and then covering it with a flexible sheet of plastic. Then the artist rips off the canvas, which removes a lot of the paint, but not in a uniform manner. "It forms these tree-like structures," said Zenit. "In my field we call them fingers."

Preliminary results indicate the unusual patterns formed by this technique are the result of a specific type of instability that occurs when a less viscous fluid is injected into a more viscous one.

Finally, Zenit's lab is investigating the fluid physics of watercolor painting, collaborating with a local Mexican artist named Octavio Moctezuma. "He comes to the lab with his materials and paints, and we film him," said Zenit, the better to study the underlying physics. Because watercolors have such low viscosity, the dynamics are very different—and thus, the techniques artists employ are also different. Notably, it's common for watercolors to exhibit the well-known coffee-ring effect.

> *"[Artists] learn about the flow of fluids through repetition and empiricism."*

Coffee rings are the pattern you get when a liquid evaporates and leaves behind a ring of previously dissolved solids—coffee grounds, in the case of your morning cup of joe. (You can also see the effect with single-malt scotch.) It forms because the liquid evaporates more quickly at the edges of the drop than at the center. So whatever liquid remains at the center flows outward to the edges, dragging particles with it. Those particles stick to the edge of the ring, forming a dark outline around the stain. Similarly, when a drop of watercolor paint dries, the pigment particles of color break outward, toward the rim of the drop.

So how do artists deal with the coffee ring effect if they don't want that accumulation of pigment at the edges to happen? According to Zenit, adding alcohol to the watercolor paint can prevent it. Alternatively, an artist may wet the paper before applying the paint. "Instead of the drop remaining pinned the paper, the ink runs off," he said. This allows the artist to play with various different effects, such as generating unusual color gradients.

“You see artists working and you immediately recognize that they know what they are doing, they know the physics,” said Zenit. “They just don’t have the formal training. They learn about the flow of fluids through repetition and empiricism. We’ve learned a lot about our own subject just by watching them work.”

[embedded content]
Courtesy of Roberto Zenit and Sandra Zetina, National Autonomous University of Mexico.
DOI: *PLOS ONE*, 2015. 10.1371/journal.pone.0126135 (About DOIs).

https://arstechnica.com/?p=1419777