



ON THE FLUID DYNAMICIST AS ARTIST

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ABSTRACT

This paper describes an amateur artist's journey from painting traditional landscapes and portraits that included incidental fluid dynamics – water, clouds and smoke – to realizing the legitimacy of fluid dynamics as the subject of a painting, rather than merely a source of auxiliary elements thereof. Recognizing that there have been very few fluid dynamicists who were also artists, the paper then inquires into the nature of an appropriate form for “Fluid Dynamics – the Painting,” and describes the steps toward one of many such possible works of art.

A painter paints to unload himself of feelings and visions.

- Pablo Picasso

1 INTRODUCTION

Breaking with tradition, I'm writing this paper in the first person as is done, for example, by artists describing their work in *Leonardo*, the journal of the International Society for the Arts, Sciences and Technology. This is for convenience and does not necessarily signal a relaxation of standards. I also apologize to my readers that dozens of illustrations I'd like to show are not available to me to reproduce without permission, which I have not sought. Instead, these are named by artist and sometimes title, and are thence readily accessible online by way of a Google Image search.

Many artists have invoked fluid dynamics incidentally by painting the sea, the clouds, etc.: Leonardo drew vortices in a stream, Van Gogh's *Starry Night* is a gothic swirl of vortices, Hokusai painted a great ocean wave, Church's *Cotopaxi* discharges a transverse jet into a crossflow, and Dali's clocks, having exceeded their melting temperature, soften and drip.

There is also ample evidence of scientists and engineers with artistic talent. Thermal-science giants Robert Fulton and James Naughton were painters as well as engineers. Samuel F. B. Morse, the telegraph inventor, was primarily an artist until age 47. Carl G. P. de Laval, of supersonic nozzle fame, exhibited strong artistic talent in his notebook sketches. Frank J. Malina, founding rocket scientist, gave it up to become the world's first kinetic artist. Architect Roger Hayward is most remembered for his outstanding illustrations of scientific apparatus in *Scientific American* magazine.

2 EARLY INFLUENCES

I humbly lay claim to a small piece of this legacy. Neither of my parents was particularly artistic, but my sketches caught the attention of a first-grade teacher who was dutifully on the lookout for

incipient talent. However, growing up as a farm boy in the agrarian South, I went through the public school system without the opportunity of special art training, managing instead to teach myself. (A self-taught artist misses the opportunity to learn from a master, but gains a certain freedom from the dogma of the times.) Later, while a graduate student at Princeton, I began oil painting.

Oils, for me, are the ideal medium. A proper work of art progresses through many sketches and thumbnails, but always ends up as oil on canvas. Beyond its great historical significance, oil painting is a *fluid* medium: one can work on it for days or weeks before the paint dries. I tried acrylics, but they dried on the brush while I contemplated what it was that I was trying to paint.

Given the oils, brushes, palette, easel and blank canvas, art boils down (for me) to two things: inspiration and technique. I've never lacked the inspiration. Dozens of paintings are backed up in my mind that I would love to begin, if not for the urgency of papers to grade and research proposals to write. These incipient paintings press me constantly, and more are added to the queue while I'm struggling to finish the one that's on the easel. But that's more about time management than inspiration. If I had to go down to the street corner and paint the cars going by for lack of inspiration, I'd have to give up art.

Technique is another matter. Initially only 1 of every 3 of my paintings rose to meet my expectations (that the painting must live up to what is envisioned in the mind's eye.) Now it's more like 2 of 3, but that is still barely considered a passing score. My 1990's painting of the Prague Castle was reworked several times before I had to decide that it was finished and "ok," though not my best work.

Luckily I don't have to depend on my artwork for survival, and I've never offered a painting for sale. In fact, I never considered pursuing art as a career, or as anything other than a hobby, because the pull of science and engineering was too strong.

The other side of me is a professional fluid dynamicist and educator: (PhD in the field, 60 publications listed by Science Citation Index, advisor to 17 PhDs at Penn State). That also began in childhood, when I first saw the beauty of fluid flows in science-fair projects, "Watch Mr. Wizard," and a build-your-own wind tunnel featured in *Mechanix Illustrated* magazine. An original fascination with airplanes and wind tunnels quickly reverted to the underlying fluid dynamics. I spent 20 years working on supersonic and hypersonic flows, finally to realize that those are dying topics. Recently my students and I have been exploring non-traditional fluid dynamics, where we've found many opportunities for innovation (e.g. [1-2]). Along the way, I was able to become the expert on the optical imaging of refractive flows [3], another outlet for my artistic tendencies [4].

3 THE ELEMENTS OF STYLE

I paint landscapes, historical subjects, portraits and the like. My painting style has been influenced by the Leonardoesque lithographic draftsmanship, precision, and odd spacetime perspectives of M.C. Escher. Lawren S. Harris's minimalist landscape style is very appealing to me, as are the windswept landscapes of Eyvind Earle and David Ligare. Though I have yet to venture into surrealism, I admire the work of the original surrealists Dali, de Chirico, and Magritte. Contemporary surrealists Jasek Yerka, Gil Bruvel, and Ilene Meyer also impress me with their organic and intricate dreamscapes, implausible landscapes, and printed-circuit-like renderings.

Each of my paintings begins with a collection of images from which inspiration is drawn. The collection may grow for years before the painting is actually attempted. The internet has become a great resource for digital images, but traditional magazine clippings etc. still play an important role.

The bound-and-numbered journal or notebook, containing both writing and sketches, is a gift originally given us by Leonardo and later used to advantage by de Laval, Edison, Naysmith, and many others. My own notebooks (begun in 1976 and now numbering 54 volumes) serve multiple purposes including notes on meeting presentations, records of phone calls, memoranda of ideas and insights, and even inventions, but impromptu thumbnail sketches have always had a place there (Fig. 1). These little sketches are important to the artistic as well as the engineering process: simple, cheap trials of concepts and ideas for a potential work of art, possible solutions to the Navier-Stokes equations, or perhaps a device. They are themselves miniature artworks, or if you prefer, building-blocks of right-brain engineering. Perhaps it's redundant for me to say what should be perfectly obvious: that the artist and the engineer should be sketching constantly.

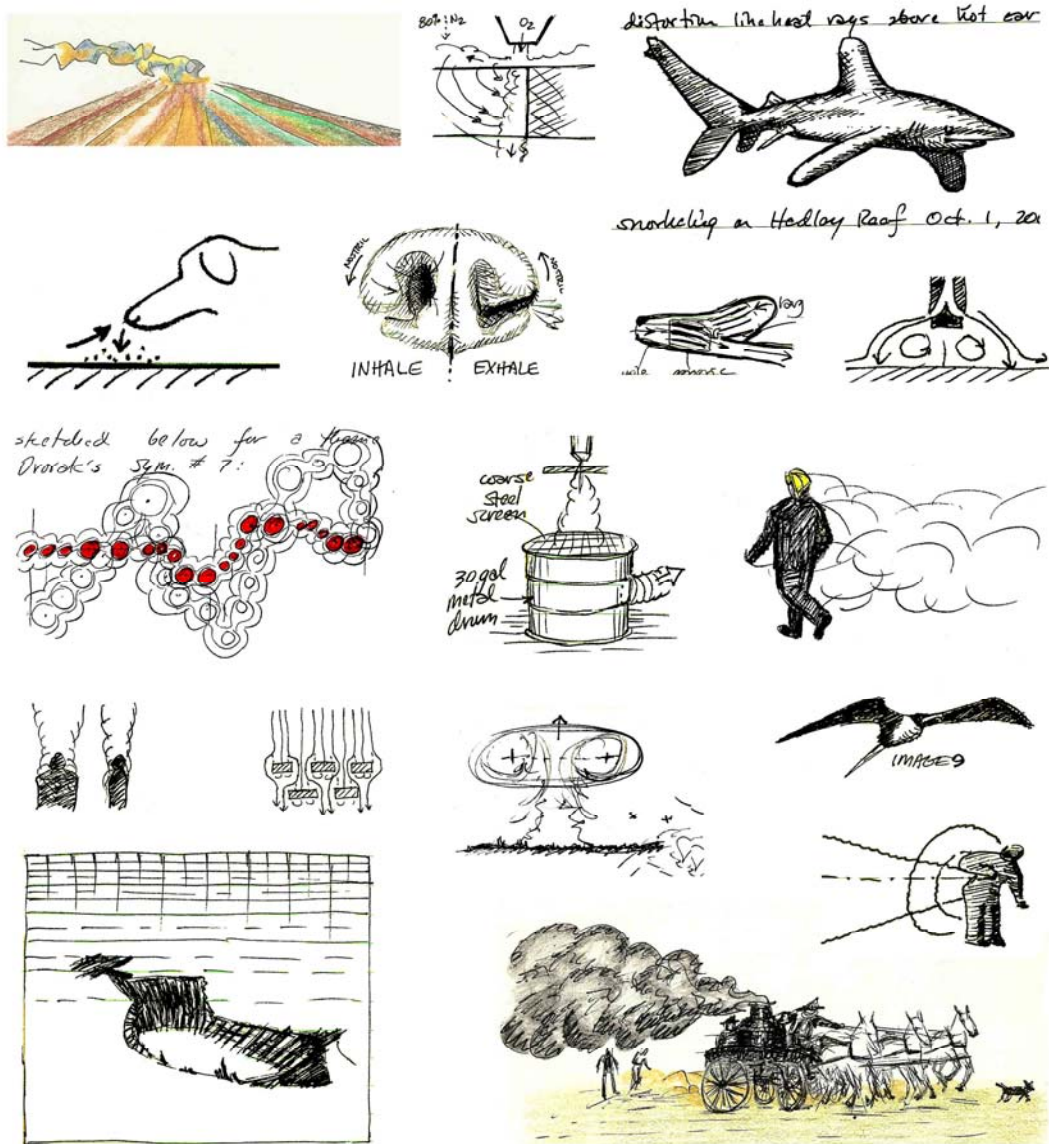


Fig. 1 – A selection of sketches from my notebooks, mostly from the last decade and mostly fluids-related.

Closely related to thumbnail sketches are *icons*. According to my own definition, these are simple minimalist sketches that stand in place of complicated ideas. Fig. 2 shows several icons derived from schlieren images of various phenomena (*schlieren icons*).

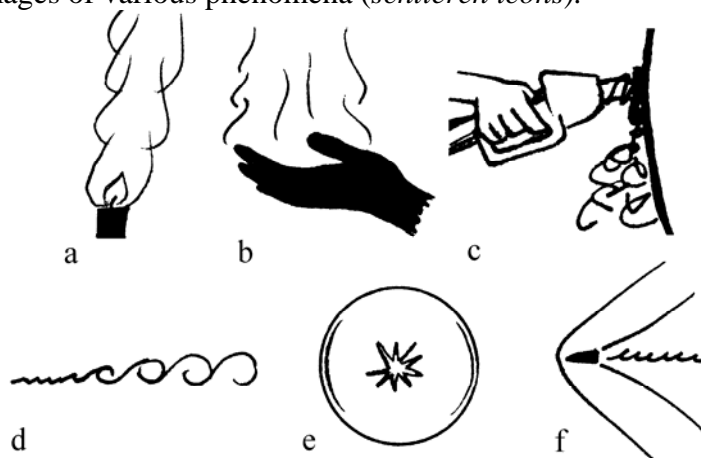


Fig. 2 - Schlieren icons: **a** turbulent candle plume, **b** convection from a human hand, **c** vapor leak while filling a fuel tank, **d** Kelvin-Helmholtz vortices in a planar mixing layer, **e** the spherical shock wave from an explosion, **f** supersonic bullet. Reproduced from [3].

Finally, for me, a series of thumbnail sketches or little paintings is required to build momentum toward a full-size painting. If I can get the composition and color scheme right at the thumbnail level first, it builds my confidence that the painting will succeed. The best of the thumbnails then serve as guides while rendering the painting. Adobe Photoshop software is also very useful up to a point: scanned images and thumbnail paintings can be modified easily in Photoshop to search for the desired effect, and color variations are also simple. Eventually a Photoshop image may qualify as the last step before the painting, but it can never stand as the final product in my opinion. Photoshop images look like exactly what they are, and for me there is no substitute for oil paint on canvas.

An example of a notebook sketch that eventually led to a painting is the shipwreck in the lower left of Fig. 1. Others, including Photoshop and color-scheme studies, will be shown below.

3 FLUID DYNAMICS IN MY PREVIOUS ARTWORK

Most of my artwork over the past 30 years did not feature fluid dynamics because I wasn't thinking that way yet. How I came to think that way is described in the next section. But first I'd like to show a few examples of "amateur art by a professional fluid dynamicist," and comment upon them.

The painting shown in Fig. 3a, from 1978, depicts rainwater collected in the leaves of a Spiked-Leafed Lobelia as inspired primarily by a photograph in *National Geographic Magazine*. At the time my artistry was immature, though, so I did not paint the sky and clouds reflected in the rainwater, as shown in the figure. That was added later.

The painting in Fig. 3b, 1989, was also inspired by a *National Geographic* photo. It depicts fluids almost entirely, but was painted in order to describe a mood (oily waves, foreboding clouds, and a looming iceberg in the North Atlantic.)

Fig. 4a shows my 1994 painting of the historic race between an airplane (Lincoln Beachey in a Curtiss Pusher) and an automobile driven by Barney Oldfield, based on a period photo of unknown origin. Regular vortex shedding is featured in the dusty wake of the car. (Oldfield lost the race.)



Fig. 3 – a) Spike-Leafed Lobelia, 1978. **b)** Iceberg, 1989, collection of Dr. & Mrs. C.C. Horstman.

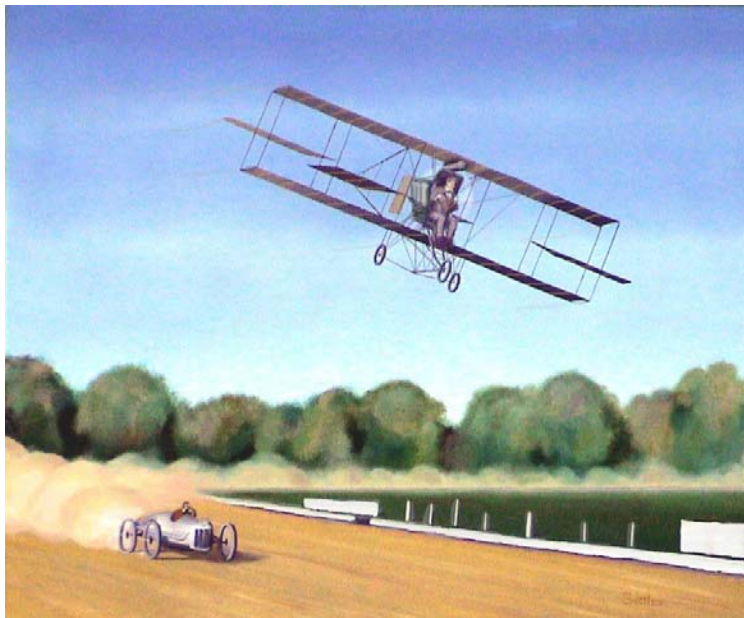


Fig. 4 – a) Race, 1994. **b)** Wilbur and the Wind, thumbnail sketch for a future painting

Fig. 4b is not yet a painting, but rather a mere thumbnail sketch worked up in Adobe Photoshop During the 2003 Wright Brothers Centennial. Little-known historical archive photographs of Wilbur Wright, combined with Kitty Hawk beach and sky background colors, convey to me his determination and strength of character, and urge me to paint his portrait. The flapping tie suggests the wind, but initially I agonized over whether to include the explicit Kelvin-Helmholtz rollers shown here in the background clouds. Is that an honest thing to do in an otherwise-straightforward portrait of a national hero? I've now answered that question: Yes it is. Not only are such clear vortices occasionally visible in the real sky, but also this portrait needs to address the wind as powerfully as it does Wilbur. The public won't understand the significance of the vortices to us fluid-dynamicists, but that understanding isn't required in order to appreciate this portrait.

Finally, Fig. 5 shows both my original notebook sketch and final 1997 painting of the 1946 atomic blast “Baker” at Bikini Atoll, as much a fluid-dynamic as a radiological event. An idyllic setting is portrayed, except for something horrific rising up out of the water. Rather than paint a hackneyed mushroom cloud, I found one frame from the time-worn US Navy black-and-white footage of this test that epitomized it (to me). Very early in the blast, a column of pulverized radioactive coral reef emerges from the sea in a shroud of millions of tons of seawater. The scale is set by the tiny warships in the path of the monster. There’s a shock wave too, of course, but somehow this point-of-view in the original footage failed to show it, so I didn’t paint it. The condensation skirt about the midriff of the column is at least a mute testament to shock-wave diffraction. I believe every artist must eventually paint a painting that only he can love. This is mine; no one is likely to hang it in their living-room, but to me it’s a success.

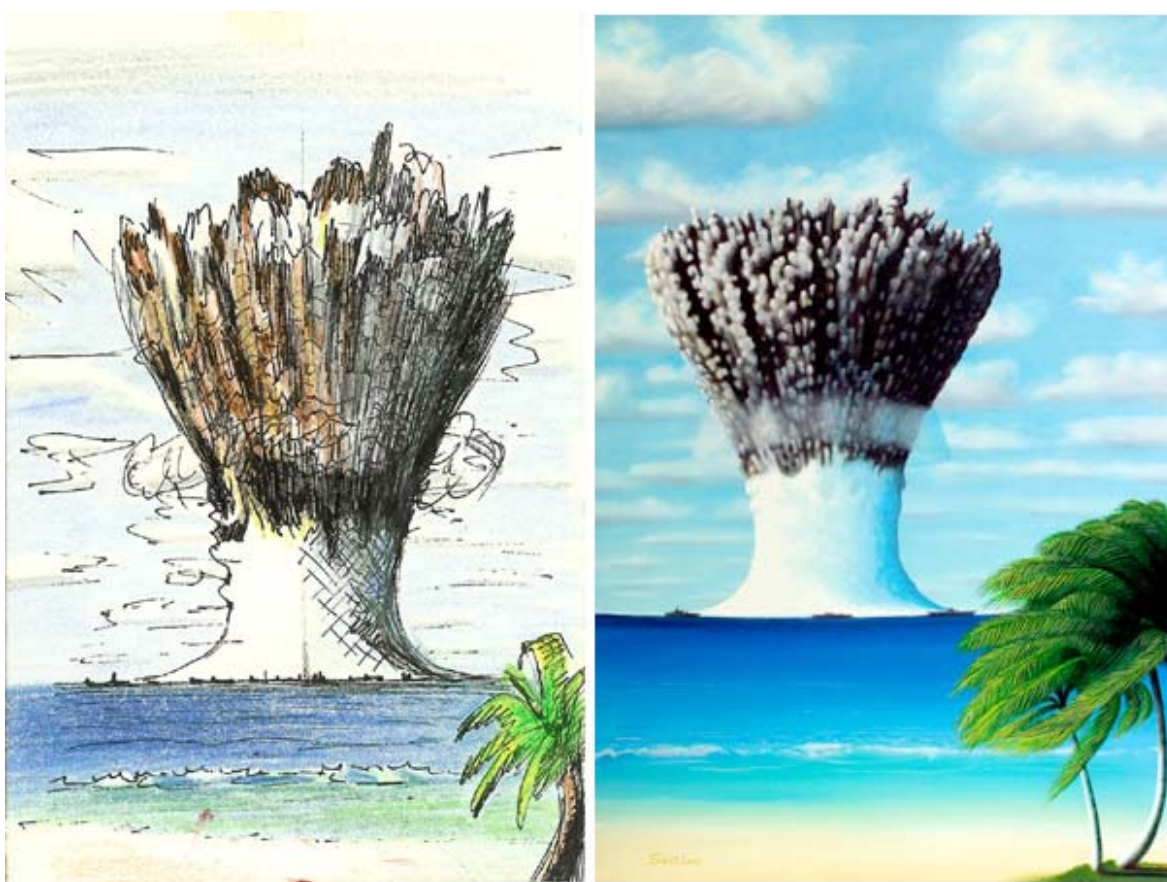


Fig. 5 – a) original notebook sketch, and b) final painting, Bikini Baker, 1997.

4 POSTULATES

Certainly I have not been anointed to lay down any rules about the role of fluid dynamics in art. On the other hand, I’ve arrived here and no one else seems to have, so let’s give it a try: tentative hypotheses, premises, candidate canons, postulates (in the sense that I postulate it and you, worthy reader, take a shot at it).

4.1 Legitimacy

As already demonstrated above, I postulate that it is entirely legitimate to deliberately use fluid-dynamic concepts and flow patterns in works of art. It has been done – more-or-less – for centuries, but mostly by artists not trained in fluid dynamics. Such training adds a new dimension, at least for me, but not a license to be egregious, trivial, or tacky. Include fluid flows as part of an artwork when the theme of the work requires it, and to whatever extent required, but never tack them on without good reason.

4.2 Illegitimacy

I have no wish to embarrass anyone so I'll keep this example as generic as possible. I've recently seen a purported work of art in which the artist took a well-known flow-visualization image and embellished it with his own brushstrokes. The embellishment covered only about 1/16th of the area of the original image, which otherwise appeared verbatim. The fluid-dynamicist who created the original image was not acknowledged. To me, this falls short of any basic standards for fluid-dynamic art, or even honesty. Appropriating a flow-visualization image into an artwork merely because it looks cool is not legitimate, in my opinion.

4.3 Fluid Dynamics as the Subject of Works of Art

Thus far we have considered fluid dynamics only as an adjunct to art, not the subject thereof. Is it legitimate to create art in which fluid dynamics is itself the central theme? Poster art for fluids conferences immediately comes to mind, as well as the revered Gallery of Fluid Motion at the yearly meetings of the American Physical Society's Division of Fluid Dynamics [5]. Visualized flows (experimental or computational) with artistic value certainly qualify as works of art, and I and many others have created such artworks (see also [6,7]).

However, I want to raise here a much more specific question: Is it legitimate for a painter to feature fluid dynamics as the theme of a painting? As far as I know it has never been done, though it has been possible to do it for centuries. How would one go about creating "Fluid Dynamics - the Painting"?

In the abstract that I submitted for this paper, I confessed that I had produced no such works and was not ready to say how they should be done, though I was interested in the concept. Now that some time for contemplation has passed, I'm ready to speculate tentatively on this topic.

I think that such a painting, to be legitimate, must go beyond a mere mural, collage or poster for a technical meeting. My sketches, for example, randomly thrown together in Fig. 1, do not make a fluid dynamics painting. I also think that such a painting needs to say something meaningful about fluid dynamics, but it should not be so ambitious as to try to say everything about it. In other words, there could be many different versions of "Fluid Dynamics - the Painting."

To conclude this paper, I'll describe an approach to just one of these.

5 FLUID DYNAMICS – AN OIL PAINTING

Initially, several ideas for this painting occurred to me and were rejected: an historical fluid dynamics collage, a "Classic Concentration" gameboard with the Navier-Stokes equation overlaid,

and similar dumb ideas. Eventually I at least began to accumulate some picture elements that I liked: a wall of fluid icons as hieroglyphs, the “Lady in the Flame,” the ancient candle, the flight of a great bird, liquid surface waves with Froude number > 1 , Henri Werle’s disk vortex as a table, and Jupiter’s swirls and spots in a birthday cake (Fig. 6). One important picture element was drawn from a photograph (by Peter Wallack, with permission) of that most elegant bird, the Great Egret, in flight.

If this paper wasn’t already non-traditional enough for you, then surely it has now gone over the line. But that’s how a painter gets his inspiration: not by force, but rather by letting his subconscious mind work on the problem over a period of time.

Of course, these diverse picture elements aren’t going to come together to depict any classic representational scene. So it was that I found myself plunging through the looking-glass into the world of surrealism, hoping the while that there would be a path back. Once there, however, I found a simple 3-D space that encompassed my imagined picture elements: a free water surface with a perpendicular wall and a column. A flooded ancient ruin, if you absolutely must be representational. But in this ruin, fluid dynamics rules (Fig. 7).

Painted almost entirely in yellow ochre and cobalt blue in the summer of 2006, the painting turned out somewhat pale rather than in bold colors. The column with its collection of fluids symbols stands out in forced perspective against the flat background. The great bird, in becoming airborne, drags one leg through the water to create the familiar Kelvin-wedge wave pattern (also symbolic of supersonic motion through the atmosphere). The background wall is embellished by stone-carved hieroglyphs that are read in vertical columns. From left to right, the themes of these 14 delineated columns of fluid icons are: 1) evolution, 2) geophysical fluid dynamics, 3) potential flows, 4) fluid instabilities, 5) plumes and shear layers, 6) profiles of all sorts, 7) supersonic flows, 8) instrumentation, 9) thermodynamics and turbomachinery, 10) flight, 11)-12) obscured, no theme, 13) weapons, 14) war.

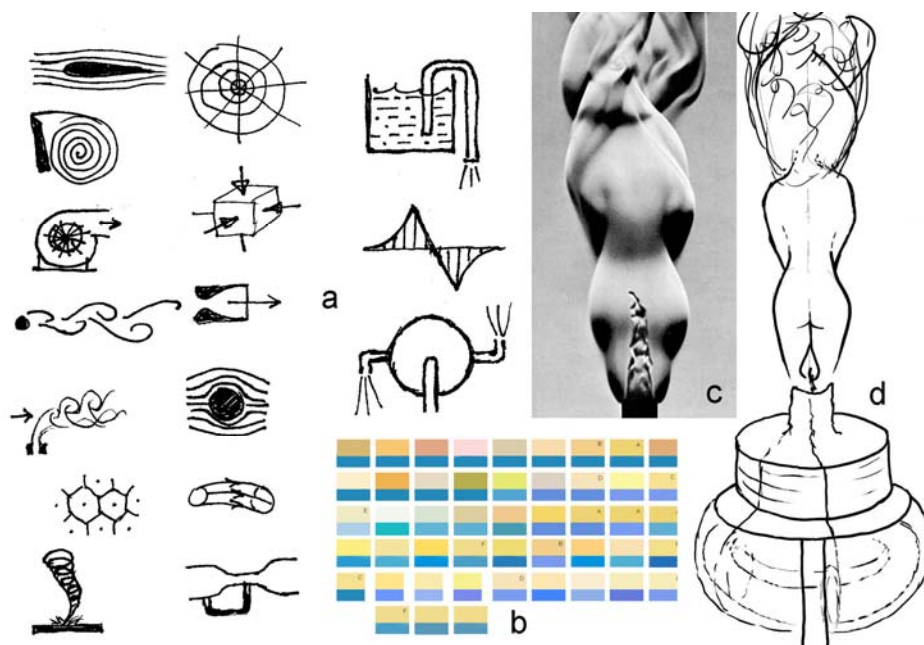


Fig. 6 – a) example fluicons, **b)** color study for the wall and water elements of the painting; The last examples of sandstone and blue-grey water were chosen, **c)** The Lady in the Flame, from [8] courtesy Battelle, **d)** thumbnail of the column, bottom to top: toroidal vortex separation after Henri Werle, Jupiter cake, candle, and The Lady in the Flame.



Fig. 7 - Photograph of “Fluid Dynamics – An Oil Painting.”

Art criticism to date has been uniformly negative. One artist claimed that I was applying engineering logic to art, which was just all wrong. I’ll continue the criticism myself by noting that the flow is going both ways from the center of the column, almost certainly violating continuity. Candles do not produce undulating flames (burners do). Some of the fluid icons (*fluicons*, not to be confused with the company of the same name) in the painting admittedly provide an outlet for my sardonic sense of humor. Finally, the female nude form has been a classical standard of artistic beauty forever, in case anyone objects to the Lady in the Flame).

Of the many thousand fluid dynamicists in the US alone, surely I cannot be the only amateur artist. I hope this exercise spurs some of the others to paint something, even if only out of indignation.

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