Soap Bubbles Between Art & Science

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On March 16, 2019, a large exhibition on soap bubbles in art and science opened in Palazzo dei Priori, home of the National Gallery of Umbria in Perugia, Italy. Marco Pierini, the director of the Galleria Nazionale dell’Umbria, curator together with Michele Emmer of the exhibition, wrote in the Introduction to the catalogue that the Soap Bubbles. Forms of Utopia Between Vanitas, Art and Science exhibition was inspired by Michele Emmer and his book, Bolle di sapone. Tra arte e matematica. The exhibition was initially intended to be a kind of mise en scène of the volume, physically bringing together the images accompanying the text. However, as organization and research efforts progressed, variations, additions, and deviations to the framework were implemented, modifying the guidelines and rendering the initial catalogue, which was already abundantly vast and well structured, even richer.

The history of soap bubbles most likely begins with the slow diffusion of soap in Europe; soap bubbles were a side effect of this diffusion. They fascinated children in the northern regions of Europe, especially Holland and Germany. In the sixteenth and even more in the seventeenth century, playing with soap bubbles was likely a popular pastime among children. This is suggested by the hundreds of paintings and engravings on the topic of bubbles. What has inspired artists, however, has been the fragility and vanity of human ambition that the bubble symbolizes. At the end of the 1660s, Isaac Newton began to study optics. In 1666, he wrote Of Colours and New Theory of Light and Colours in 1672. He published his notes on the theory of colours in his 1704 work Opticks. It is probable that the widespread pastime of blowing soap bubbles, on the one hand, and artists’ fascination with them, on the other, was what prompted scientists to ask questions about soap film. Colour was certainly one of the main reasons.

A series of engravings by Hendrick Goltzius is considered to be the beginning of the bubble’s thereafter frequent appearance in Dutch art in the sixteenth and seventeenth centuries. Goltzius’s most recognized work is called Quis evadet? (“Who will be spared?”) dated 1594. For artists the sixteenth and seventeenth centuries were the period of greatest interest in soap bubbles; bubbles started to appear constantly in depictions of the broader theme of human frailty and, more in general, of children’s games. One of the most famous works was created in different versions by Jean Siméon Chardin in the early eighteenth century and is called Les bulles de savon. Only in the nineteenth century it became understood that soap films provide an experimental model for mathematics and physics problems, thus fully inserting soap films in the mathematical field of Calculus of Variations. Joseph Antoine Ferdinand Plateau was not the first to study soap bubbles and films. However, it was his experimental observations that decisively influenced the work of mathematicians, even though, as an experimenter, Plateau’s work was mainly directed at physicists and chemists. In 1873 he published the result of fifteen years of research in two
volumes of the treatise *Statique expérimentale et théorique des liquides soumis aux seules forces moléculaires*. Thanks to Plateau’s experiments, it was possible to create surfaces of mean curvature zero, i.e. minimal surfaces, of which either the equations or the geometric generator are known. The idea is to draw a closed contour with the only condition that it contains a limited portion of the surface and that it is compatible with the surface itself; if then a wire identical to the previous contour is constructed, immersed entirely in soapy liquid and then pulled out, a set of soapy films is generated representing the portion of the area under consideration. While painters like Edouard Manet painted soap bubbles on their canvases in those years, Plateau was not satisfied with their spherical shape and experimented with the physical and chemical properties of soapy water to find completely new forms.

With his experiments, Plateau had posed two problems to mathematicians: one that is known as Plateau’s problem and the other on the geometry of soap films. In 1931, the mathematician Jesse Douglas published a work entitled *Solution of the problem of Plateau*. For his work on minimal surfaces, in 1936 Douglas received the Fields Medal, the highest recognition for a mathematician awarded every four years at the International Congress of Mathematicians. In the early 1960s, Ennio De Giorgi and Ernst Robert Reifenberg introduced a completely new approach to solving Plateau’s problem. The idea is to generalize the concept of surface, of area and boundary, looking for a more general solution. By using De Giorgi’s method (the so-called Perimeter Theory) and the Geometric Measure Theory (Integral Currents) introduced by Herbert Federer and Wendell H. Fleming “Plateau’s problem” could be solved. The problem of the study of singularity remained, and was addressed and solved by several scholars, including Mario Miranda, Enrico Giusti, and Enrico Bombieri in Italy and Federer, Fleming, and Fred J. Almgren, Jr. in the United States. Bombieri received the Fields Medal in 1974 also for his contributions to the theory of minimal surfaces. Another question remained: were the laws on the geometry of soap films that Plateau discovered experimentally correct or not? In 1976 Jean Taylor showed that the Plateau’s laws were correct.

My Personal Dream. In 1976 I met Jean Taylor and Fred Almgren and we decided to make one of my films in the series *Art and Mathematics* on Soap Bubbles, partially filming at the University of Princeton. In 1984, alongside Elio Bisignani, we made a series of pictures of the Plateau’ solution for the cube, calling it *Soapy Hypercube*. Both the film and the pictures were included in the 1986 Biennale Internazionale d’Arte di Venezia dedicated to the theme of *Art and Science*. One of my dreams was the idea of making a big exhibition on the theme of soap bubbles. On March 16, 2019, finally the exhibition on Soap Bubbles opened in Perugia.