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## MEUSNIER DE LA PLACE, JEAN-BAPTISTE-MARIE-CHARLES

(*b*. Tours, France, 19 June 1754; *d*. Mainz, Germany, 17 June 1793)

*mathematics, physics, engineering*.

Meusnier was the son of Jean-Baptiste Meusnier and Anne le Normand Delaplace. The family was for generations engaged in law and administration; the father was a counsel attached to a court *(présidial)* at Tours. He tutored his son, and only during his last years at Tours did Meusnier go to school.

From 1771 to 1773 Meusnier was privately tutored at Paris for entrance into the military academy at Mézières, where he studied in 1774–1775 and graduated as second lieutenant in the Engineering Corps. His mathematics teacher was Gaspard Monge, under whom Meusnier did his only published mathematical work, on the theory of surfaces.

His paper, read at the Paris Academy of Sciences in 1776, supposedly led d'Alembert to state: "Meusnier commence comme je finis." It also led to Meusnier's election, at twenty-one, as a corresponding member of the Academy. He was placed in charge of continuing the descriptions of machines approved by the Academy, and in February 1777 he presented to

the Academy the seventh volume of the *Recueil des machines approuvées par l'Academie*. During 1777, now a first lieutenant, he was sent to Verdun to study mining and sapping. From 1779 to 1788 he worked as a military engineer on the harborworks of Cherbourg, where he displayed great ingenuity and perseverance, despite red tape and intrigues, in the building of the breakwater and the fortification of Ile Pelée. To provide drinking water for this island he spent much time on experiments on the desalinization of seawater. In March 1783 Meusnier, sent into debt by his work, presented his machine to the Academy.

During 1783 the first balloon ascensions took place. Meusnier, on leaves of absence from Cherbourg, began to study the theory of this new field, aerostation. In December 1783 he read before the Academy his "Memoire sur l'équilibre des machines aérostatiques." The next month he was elected a full member of the Academy and was immediately appointed to a committee on aerostation, other members of which were Lavoisier, Berthollet, and Condorcet. The results of his work on this committee were presented in November 1784 in "Précis des travaux fails à l'Académie des sciences pour la perfection des machines aérostatiques," with a theory and detailed construction plans for dirigible balloons. It led to no practical results at the time.

During this period Meusnier began a collaboration with Lavoisier on the synthesis and analysis of water; Meusnier was especially interested in the production of hydrogen in quantity from water. On 21 April 1784 they presented to the Academy a continuation of the paper presented in June 1783 by Lavoisier and Laplace on the synthesis of water from oxygen and hydrogen "Memoire où l' on prouve par la décomposition de l'eau que ce fluide n'est point une substance simple ...." It was also a heavy blow against the phlogiston theory, which Berthollet and others soon abandoned in favor of Lavoisier's "théorie française." Meusnier also collaborated with Lavoisier on the improvement of oil lamps for city street illumination. Their ideas were contemporary with those of Aimé Argand and perhaps inspired the construction of his lamp.

In May 1787 Meusnier became a captain; in July 1788, he was promoted to *aide-maréchal général des logis au corps de l'état Major* and major.

From then on his career was with the army, and in July 1789 he became a lieutenant colonel. With his friends Monge and Berthollet he joined the Jacobins in 1790. With many other academicians he was appointed to the Bureau de Consultation Pour les Arts et Métiers to study inventions useful to the state. Meusnier invented a machine for engraving assignats that greatly reduced the possibility of producing counterfeit notes. In February 1792 he was appointed colonel, then *adjutant général colonel*, and in September 1792 field marshal. Sent in February 1793 to the armies of the Rhine commanded by Custine, he participated in the defense of the fortress of Kassel during the siege of Mainz by the Prussians. He was wounded on 5 June and died twelve days later. His remains were brought to Paris (Goethe witnessed the procession leaving Mainz; see his *Kampagne in Frankreich*), and were later transferred to Tours, where in 1888 a bust was erected on a pedestal containing his ashes.

The "Mémoire sur la courbure des surfaces," read in 1776 and published in 1785, was written after Monge had shown him Euler's paper on this subject *(Mémoires de l'Académic des Sciences* [Berlin, 1760]), In the "Mémoire" Meusnier derived "Meusnier's theorem" on the curvature, at a point of a surface, of plane sections with a common tangent and also found, as special solutions of Lagrange's differential equation of the minimal surfaces (1760), the catenoid and the right helicoid. His results can be found in any book on differential geometry. In the "Mémoire" on aerostation (1783) Meusnier presented a theory of the equilibrium of a balloon, the dynamics of ascension, and the rules for maneuvering a balloon. To maintain appropriate altitude even with the disposal of ballast he proposed a balloon filled with hydrogen containing a smaller balloon filled with air (known as *ballonet d'air*); he also suggested a model with air in the larger balloon and hydrogen in the smaller, In the "Précis" of 1784, the result of a great many test experiments, Meusnier gave a detailed plan for the construction of a dirigible balloon in the form of an elongated

ellipsoid with another balloon inside. For propulsion he suggested revolving air screws worked by a crew. He described two possibilities; a small dirigible 130 feet long carrying six men and one 260 feet long (130 feet minor axis) with a crew of thirty and food for sixty days, able to fly around the earth. In his formula for the stability of the balloon,

$n$ is the distance from the metacenter to the center of the balloon, $P$ the weight of the objects collected at the center of the gondola, $E$ the weight of the balloon as concentrated at the center, $l$ and $h$ the major and minor axes of the balloon, and $x$ the height of the hydrogen when the balloon is on earth, the hydrogen rising above the air in the balloon.

The principle of the revolving screw had also occurred to David Bushnell of Connecticut in the construction of his submarine (1776–1777). Meusnier knew of Bushnell's invention.

After Cavendish had shown nonquantitatively in 1781 that the combination of oxygen and hydrogen yields water, Lavoisier and Laplace in 1783 presented to the Academy an account of their work on the synthesis of water; Monge had also performed this experiment. Meusnier suggested more exact measurements to Lavoisier and constructed precision instruments for this purpose. Their "Mémoire" of April 1784 showed how they had decomposed water into its components; the hydrogen was obtained as a gas and the oxygen in the form of an iron oxide. For many this famous experiment carried convincing evidence against the phlogiston theory.

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II. Secondary Literature. "Notice sur le général Meusnier," in *Revue rétrospective*, 2nd ser., **4** (1835), 77–99, contains biographical notes on Meusnier by Monge and others, the originals of which have not been found. Partly based on these is Darboux's "Notice historique sur le général Meusnier," in his *Éloges académiques et discours* (Paris, 1912), 218–262, also in *Mémoires de l' Academie des Sciences*, 2nd ser., **51** (see above). In it are many particulars on Meusnier's work in Cherbourg and in the army of the Revolution. See also L. Louvet, in *Nouvelle biographic générale*, XXXV (1865), cols. 264–267. Bibliographical details based on independent research in the printed and MS materials are in J. Laissus, "Le général Meusnier de la Place, membre de l'Académie royale des sciences," in *Comptes rendus du 93$^{e}$ Congrès national des sociétés savantes, Tours, 1968*, Section des Sciences, II (Paris, 1971), 75–101. Meusnier's work on decomposition of water can be studied in books on Lavoisier. His works on aerostation have been analyzed by F. Letonné, "Le général Meusnier et ses idées sur la navigation aérienne," in *Revue du génie militaire*, **2** (1888), 247–258; and by Voyer, "Les lois de Meusnier," *ibid*., **23** (1902), 421–430; "Le ballonet de Meusnier," *ibid*., 521–532; and "Le gnénéral Meusnier et les bullous dirigibles," *ibid*., **24** (1902), 135–156— German trans, in *Illustrierte aeronautische Mitleilungen*, **9** (1905), 137–144. 353–361, 373–387. The third of these papers gives a

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D. J. Struik