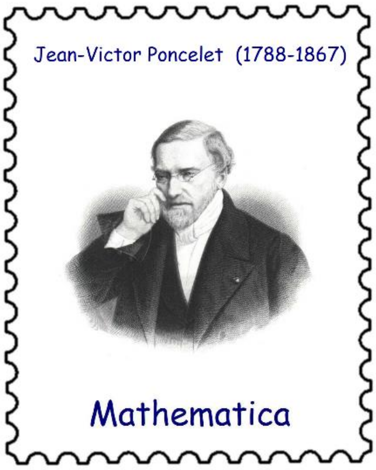
**JEAN-VICTOR PONCELET** (July 1, 1788 – December 22, 1867)

by HEINZ KLAUS STRICK, Germany




JEAN-VICTOR PONCELET was born out of wedlock to ANNE-MARIE PERREIN and CLAUDE PONCELET, a rich and influential landowner in Metz. It was only a few years later that the father, a member of the *Parlement de Metz*, the regional court for Lorraine, married the mother and thus acknowledged his paternity. Despite the parents' marriage, the boy remained in a foster family in a small town near Metz.

It was not until he was fifteen that JEAN-VICTOR moved to Metz and attended a *lycée* there, where he was successfully prepared for the entrance examination to the *École Polytechnique* in Paris.

There he was fortunate to be taught by outstanding teachers, including GASPARD MONGE, LAZARE CARNOT, CHARLES BRIANCHON and ANDRÉ-MARIE AMPÈRE.


Despite a prolonged illness, he completed the first part of his studies in 1810. He then decided on a military career, so he was seconded to the *École d'Application* in Metz for the practically oriented phase of his studies.


In March 1812, the newly graduated engineer and lieutenant in the French army received the order to expand the fortifications of Fort Rammekens (near Vlissingen in Zeeland province). But then in June of that year, after NAPOLEON declared war on Russia, he received the order to join the *Grande Armée*, which consisted of 600,000 soldiers.

The young engineer was ordered to build a bridge over the Dnieper at Smolensk, which he succeeded in doing despite heavy shelling, as he simultaneously faked the construction at another location. After the battle of Borodino which resulted in heavy losses (over 30,000 casualties on both sides) for both armies, the way to Moscow was clear for the French army.

In the burnt-out ruins of Moscow, NAPOLEON waited in vain for four weeks with his remaining army, now reduced to 100,000 men, for negotiators from the Russian Tsar and then he gave the order to retreat. In a battle near Smolensk, in November 1812, PONCELET's superior was killed and he himself fell from his horse. But since his own soldiers thought he was dead, they left him lying there, and so he ended up as a Russian prisoner of war. He survived only because, as a French officer, he was considered an important "bargaining chip" in the event of peace negotiations. For five months he was taken from one camp to the next until he finally arrived in Saratov on the Volga. After a peace agreement in June 1814, he could finally return home.

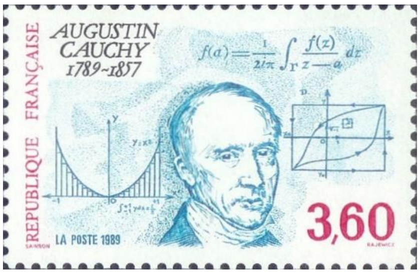
To pass the time in captivity, he occupied himself in particular with geometry; and since he had no literature at his disposal and also no longer remembered all the details from his earlier lectures, he inevitably had to develop everything anew. He published his *Cahiers de Saratov* as a book fifty years later (*Applications d'analyse et de géometrie*).

From 1815 to 1825, as captain of the pioneer battalion in Metz, he was responsible for maintenance work on fortifications in the region and for new constructions. During this time he constructed, among other things, a new type of drawbridge. Although he also taught mechanics at the *École d'application*, he had enough time to deepen the ideas he had developed in Saratov.

From 1817 onwards, he published several articles in the journal *Annales de mathématiques pures et appliquées*, edited by JOSEPH DIEZ GERGONNE. In 1820, he submitted to the *Académie des Sciences* the paper *Essai sur les propriétés projectives des sections conique*, in which he outlined the main features of projective geometry.

AUGUSTIN CAUCHY, who was commissioned by the *Académie* to examine the paper, did not like PONCELET's approach very much and even saw the danger of misconceptions. CAUCHY's authority initially prevented a broader discussion of PONCELET's reflections.

Nevertheless, PONCELET wrote further texts and published the book *Traité des propriétés projectives des figures* in 1822.





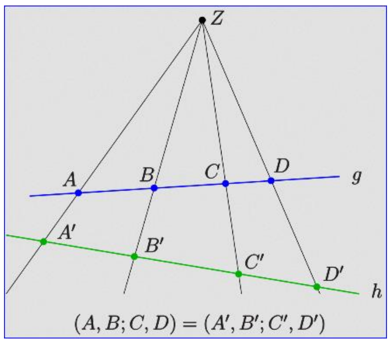
In 1639, GIRARD DESARGUES had already recognised in his investigations into perspective representations that it makes sense to supplement the objects of ordinary Euclidean geometry, i.e. points, straight lines and planes, with "non-actual" elements:

From the property that parallel straight lines "intersect at infinity", distant points, corresponding to distant straight lines, result from the "intersection" of planes that are parallel to each other. By adding these non-actual elements, some theorems of geometry can be formulated more elegantly, because the case of parallel lines or planes then no longer represents a special case.

DESARGUES had also already discovered that it is sufficient to prove certain propositions about conic sections only for the special case of a circle, since all conic sections arise by projection of a circle. DESARGUES' insights had almost been forgotten in the meantime.

Through PONCELET's investigation of the *projective properties of figures* these insights re-entered the consciousness of mathematics.

PONCELET called properties *projective* that are invariant in a central projective mapping. This includes, for example, the *cross-ratio* of four points lying on a straight line, cf. fig. right.

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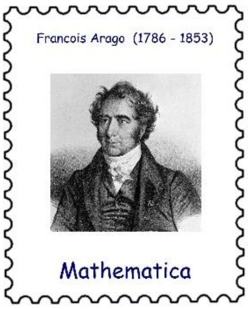
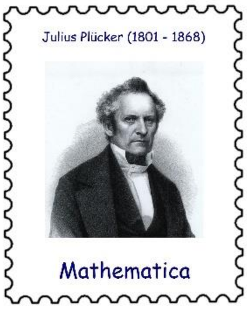
One of the most important principles of *Projective Geometry* is the *duality principle* (called the *reciprocity law* by PONCELET): In the plane, for example, points and straight lines are dual objects to each other. For a proposition about points and straight lines, one obtains the corresponding dual proposition by interchanging the terms.

*Example*: "Two points *A* and B lie on exactly one straight line *g*." is dual to "Two straight lines *a* and *b* intersect at exactly one point *G*."

FRANÇOIS ARAGO, an influential member of the *Académie*, persuaded PONCELET to take over the chair of *Applied Mechanics* at the *École d'application* in 1824. In the following years, PONCELET worked intensively in the new field of work and only rarely dealt with problems of *Projective Geometry*. On the one hand, this was due to CAUCHY's lingering criticism, which delayed the publication of new contributions; on the other hand, he got into an unpleasant priority dispute with GERGONNE and with the young German mathematician JULIUS PLÜCKER.






PONCELET took the challenges of his new job very seriously, and was extremely successful. After just one year in office, he received a prize from the *Académie des Sciences* for his idea of curved blades for turbines and waterwheels, for this invention considerably increased the efficiency of water mills. In the years to come, the transcripts and elaborations of his lectures on theoretical, experimental and practical mechanics were rapidly distributed throughout the country. The two books that two of his students compiled on his behalf were reprinted several times.


In 1834, a special professorship in mechanics was established for PONCELET at the *Sorbonne*; due to his outstanding physical-technical contributions, he was elected as a member of the *Académie des Sciences*. His military career also continued upwards – until he was appointed Brigadier General (1848).

In the same year, he was appointed director of the *École polytechnique* - with the task of reforming this institution.


Although he had retired in 1850, he took charge of the commission coordinating the French contribution to the *Great Exhibition* in London; he then participated in the preparation of the first *Universal Exhibition* in Paris in 1855.

In 1857, he published a two-volume work on the development of mechanisation and industrial manufacturing methods.

From 1862 onwards, he compiled in four extensive volumes the contributions to *Projective Geometry* that he had written, some of which had not been published (beginning with the *Cahiers de Saratov*) and did not spare polemical comments on the reception of his theories.

While working on a compilation of his contributions to applied mechanics, he died. Only a small part of his papers was later published by one of his students; the rest was lost during the chaos of war in 1914-18.

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Translated 2022 by John O’Connor, University of St Andrews

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