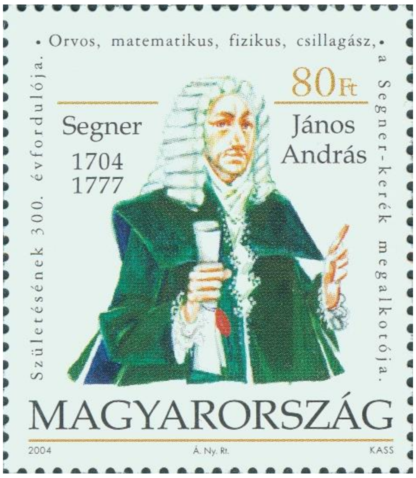
JÁNOS ANDRÁS SEGNER (October 9, 1704 – October 5, 1777)

by HEINZ KLAUS STRICK, Germany



With the decision to found a university in the small town of Göttingen in Lower Saxony in 1732, the minister GERLACH ADOLPH FREIHERR VON MÜNCHHAUSEN, who resided in Hanover, pursued an ambitious goal: a new type of university was to be established there, where research would be conducted entirely in the spirit of the Enlightenment – and without the patronising censorship of the theological faculty.

Contrary to the usual practice, students were also to be allowed to use the university's library, and when professors were appointed, their ability to teach academically was to be given special consideration.

The choice for the first chair in mathematics fell on JOHANN ANDREAS SEGNER, a 31-year-old lecturer at the University of Jena. He had already made a name for himself in scientific circles through various publications. In addition to lecturing in mathematics and physics, he also occasionally gave experimental lectures in chemistry. In 1743 he was commissioned to establish an observatory.

SEGNER's appointment marked the beginning of the successful history of the mathematics faculty at Göttingen University, which was to become the most important in the world.

JOHANN ANDREAS SEGNER was born as SEGNER JÁNOS ANDRÁS in Pozsony, the capital of the Kingdom of Hungary (today: Bratislava, the capital of Slovakia). The son of an influential family of German origin, he successfully attended the local grammar school as well as a school in Győr. After a year at the university in Debrecen (Eastern Hungary), he moved to Jena in 1725 to study medicine. During his studies he had already written articles on various topics from mathematics, philosophy, physics, astronomy (*csillagászat*), chemistry and medicine. After passing his medical exams, he first worked as a doctor (*orvos*) in Debrecen, but returned to Jena as early as 1732 to pursue an academic career.

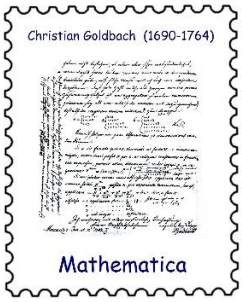
In Jena, SEGNER was appointed associate professor of mathematics and medicine through the sponsorship of his former professor of medicine and physics and future father-in-law HERMANN FRIEDRICH TEICHMEYER. One year later (1735) he was appointed to Göttingen as described above. In 1738, SEGNER became a member of the *Royal Society* in London.

From 1741 onwards, a lively correspondence developed with LEONHARD EULER, who, after 14 years in St Petersburg, now worked at the *Royal Prussian Academy of Sciences* in Berlin. Over the course of the next three decades, the two exchanged more than 200 letters.

Several of these letters dealt with a horizontally mounted water wheel that SEGNER developed. The water flowing in from above left the apparatus at the bottom via two outlets mounted in opposite directions. The exiting water jets acted like nozzles, so that the movably mounted lower part was set into rotation by the recoil.

EULER was so taken with SEGNER's waterwheel that he made a number of suggestions for improvement before publishing a contribution to the theory of turbines himself, without questioning SEGNER's authorship (*Recherches sur l'effet d'une machine hydraulique proposée par M. SEGNER, professeur à Göttingue*). The invention was soon successfully used in an oil mill and today the idea is employed in sprinkler systems.

At the suggestion of EULER, SEGNER, who is still referred to today as the "father of the turbine", was accepted as a member of the *Academy of Sciences* in Berlin (1746) and in St Petersburg (1754).



Another topic of the correspondence with EULER was a combinatorial problem that he first communicated to his friend CHRISTIAN GOLDBACH in a letter in 1751:

- *In how many ways can a convex polygon be divided into triangles by the diagonals?*

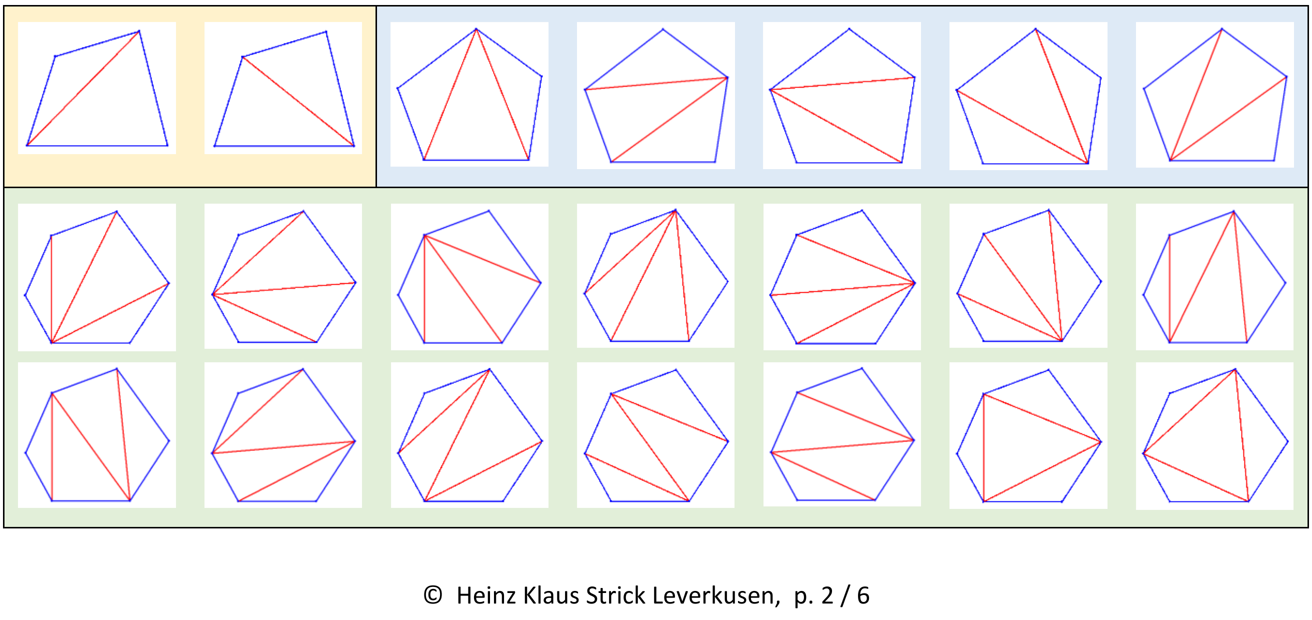
(A polygon is called *convex* if every connecting line of two points of the polygon lies inside the polygon).

EULER wrote to SEGNER that he had found the decomposition numbers

1, 2, 5, 14, 42, 132, 429 for 3-, 4-, 5-, ..., 9-gons and that they could be calculated with the help of

$$C_m = \frac{2 \cdot 6 \cdot 10 \cdot \ldots \cdot (4m-2)}{2 \cdot 3 \cdot 4 \cdot \ldots \cdot (m+1)} \text{ with } m = n-2,$$

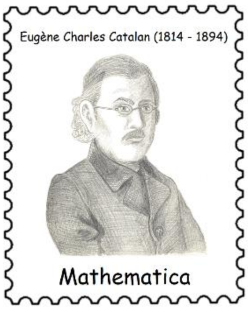
i.e. $C_2 = \frac{2 \cdot 6}{2 \cdot 3} = 2$ (tetragon or quadrilateral); $C_3 = \frac{2 \cdot 6 \cdot 10}{2 \cdot 3 \cdot 4} = 5$ (pentagon), etc.

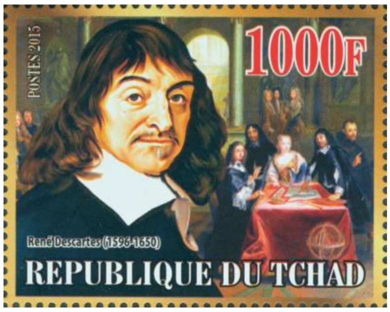


Segner proved that these numbers could also be determined iteratively:

$$C_{m+1} = \sum_{k=0}^{m} C_k \cdot C_{m-k} \text{, e.g. } C_3 = C_0 \cdot C_2 + C_1 \cdot C_1 + C_2 \cdot C_0 = 1 \cdot 2 + 1 \cdot 1 + 2 \cdot 1 = 5,$$

with the initial members C_0 (2-gon), C_1 (3-gon or triangle). Today, the sequence C_m is called the *Catalan sequence* (after Eugène Charles Catalan).

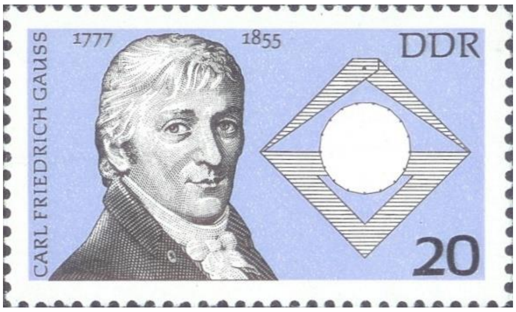


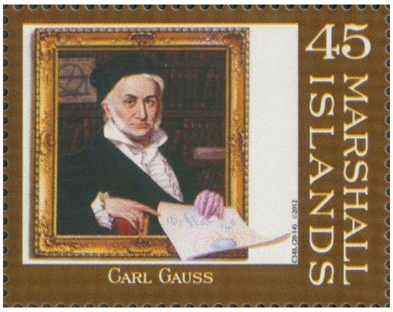


As early as 1728, Segner had ventured a first attempt at proving Descartes' rule of signs, which had been unproven until then:

- *The number of positive zeros of a polynomial is equal to the number of changes of sign in the numerical sequence of the coefficients or less by an even number*.

In 1756 he submitted an improved (though still incomplete) proof to the *Berlin Academy*; only Gauss succeeded in giving the final proof.

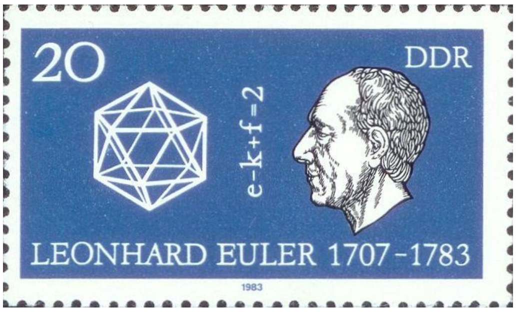




In his lectures, Segner endeavoured to prepare an understandable and systematic approach to the fundamentals of physics and mathematics for his inquisitive audience. In 1746, the first edition of his 586-page *Introduction to Natural Theory* appeared, a summary of the physical knowledge of his time. Among other things, it contained an astonishingly accurate estimate of the speed of light, from which he calculated the time it takes for light to travel from the sun to the earth (8 minutes 7 seconds; the correct value is 8 minutes 20 seconds) and from the nearest fixed star to the earth (more than 6 years).

In 1747 he published a first elaboration of his mathematics lectures: *Clear and complete lectures on arithmetic and geometry: for the use of those who want to practise these sciences by their own diligence*. In 782 pages he explained the contents and methods of elementary mathematics: from simple arithmetic with whole numbers and *decimal fractions* (= decimal numbers) to trigonometric calculations.

When the mathematician and philosopher Christian Wolff died in Halle in 1754, King Frederick the Great commissioned the director of the *Mathematical Class of the Berlin Academy of Sciences*, Leonhard Euler, to find a suitable successor.



EULER proposed SEGNER for the chair of mathematics and physics, who, as he wrote, *was almost the only one who had excelled in physics and mathematics in Germany*.

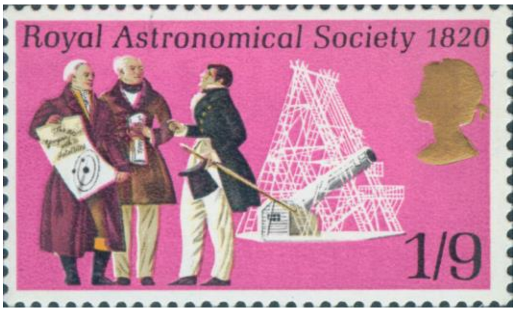
SEGNER seized the opportunity and demanded, in addition to a higher salary, the title of *Privy Councillor* as well as the renewal of a Hungarian noble patent of his family, so that he could call himself *VON* SEGNER in future. He did not regret leaving his previous place of work in Göttingen for long because of recent disputes over competence.

Shortly before completion of the observatory, not he, but the Nuremberg astronomer and mapmaker TOBIAS MAYER had been appointed director of the observatory.

The background of this surprising appointment by GEORG AUGUST, Elector of Hanover, who was at the same time also King GEORGE II of Great Britain, was a proposal of the British Parliament from 1714, by which the supremacy of the *Royal Navy* on the world's oceans was to be secured.

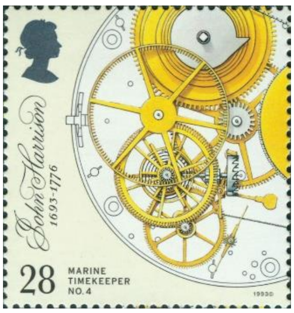
A prize of £20,000 was promised to the person who solved the *longitude problem*:

- *How can one determine the correct position of a ship at sea?*



TOBIAS MAYER seemed to have found a useful method: With the help of his lunar tables, which he created through extraordinarily precise measurements and clever calculations, the position of the moon could be predicted to within 5′′.

Conversely, the longitude of the position of a ship at sea could be determined to within 0.5° by comparison with the lunar tables. (After the untimely death of TOBIAS MAYER, his widow still received a share of £3,000 of the prize money and almost the entire remaining amount went to the inventor of the chronometer, JOHN HARRISON).

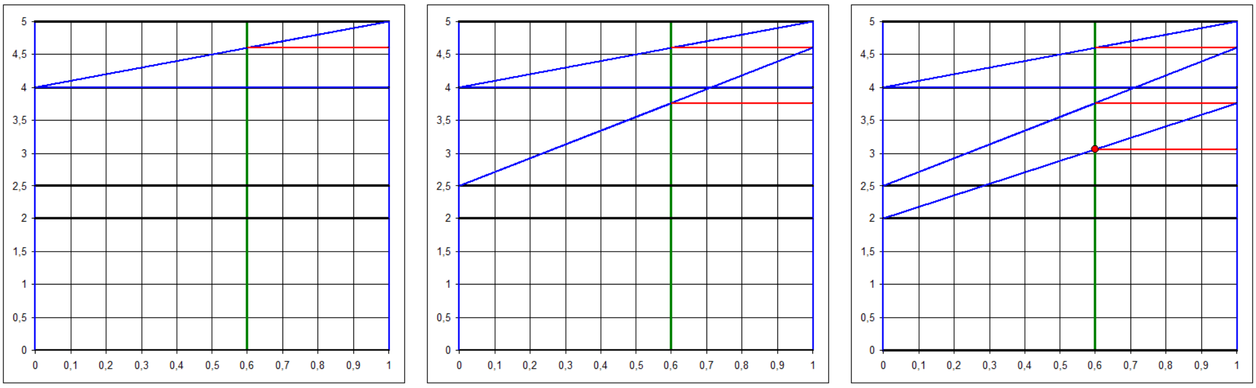


In Halle SEGNER published elaborations of his mathematics lectures (*Cursus mathematici*): *Elementa Arithmeticae Geometriae et Calculi Geometrici* (1756). They were translated by his son JOHANN WILHELM as *Anfangsgründe der Arithmetick, Geometrie und der geometrischen Berechnungen (Beginnings of arithmetic, geometry and geometric calculations,* 1764). The subsequent volumes (*Elementa analyseos finitorum*, 1758, *Elementorum analyseos infinitorum*, *pars* I *et* II, 1761, *Elementorum calculi integralis*, 1768) proved that SEGNER was up to date with regard to mathematical developments.

In 1758 SEGNER wrote a paper which was published by the *St Petersburg Academy*. In it he showed how one can construct function values of a polynomial. The idea behind this is none other than the calculation method published 50 years later by WILLIAM GEORGE HORNER and named after him.

SEGNER stated that in principle the constructions could probably also be carried out with the help of a mechanical device, but considered the realisation to be technically problematic. Only a few years later (1770), a paper by JOHN ROWNING appeared at the *Royal Society* in London, in which he presented such a machine (probably developed independently of SEGNER).

Example of a construction according to SEGNER:
The function value $f(0.6)$ is to be constructed for the polynomial $f(x) = x^3 + 1.5x^2 + 0.5x + 2$.
First, four rectangles of width 1 are drawn on top of each other; their height is determined by the coefficients: $a_0 = 2; a_1 = 0.5; a_2 = 1.5; a_3 = 1$.
Then, one after the other, the values $a_3 \cdot 0.6$ (Fig. left), $(a_3 \cdot 0.6 + a_2) \cdot 0.6$ (Fig. centre) and $((a_3 \cdot 0.6 + a_2) \cdot 0.6 + a_1) \cdot 0.6$ (Fig. right) are constructed at the point (according to the proportionality theorem).
Finally, the figure $f(0.6) = ((a_3 \cdot 0.6 + a_2) \cdot 0.6 + a_1) \cdot 0.6 = 3.056$ on the right can be read off.



In addition, SEGNER published popular articles in the *Wöchentlichen Hallischen Anzeigen* (Halle Weekly Journal) such as instructions on how to build a lamp for students or a cork belt to protect against drowning.

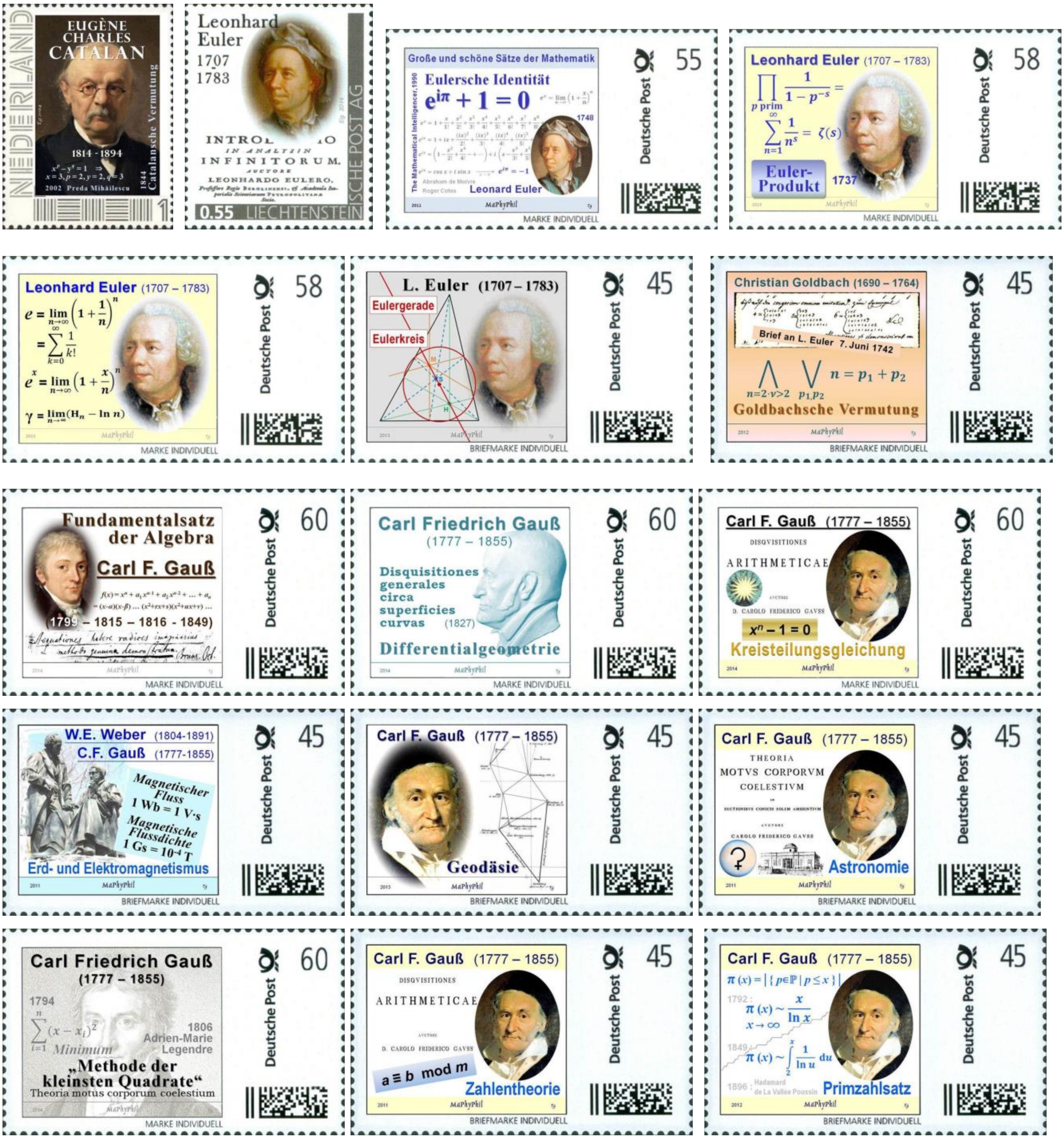
In 1777 SEGNER died as a respected citizen of the city and was buried in a tomb on the city graveyard.

First published 2014 by Spektrum der Wissenschaft Verlagsgesellschaft Heidelberg

https://www.spektrum.de/wissen/janos-andras-segner-1704-1777/1308878

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

Here an important hint for philatelists who also like individual (not officially issued) stamps.
Enquiries at europablocks@web.de with the note: "Mathstamps".



… and from Arthur Palyan …