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**Short note**      **F. Commandino, de centro gravitatis solidorum, 1565**

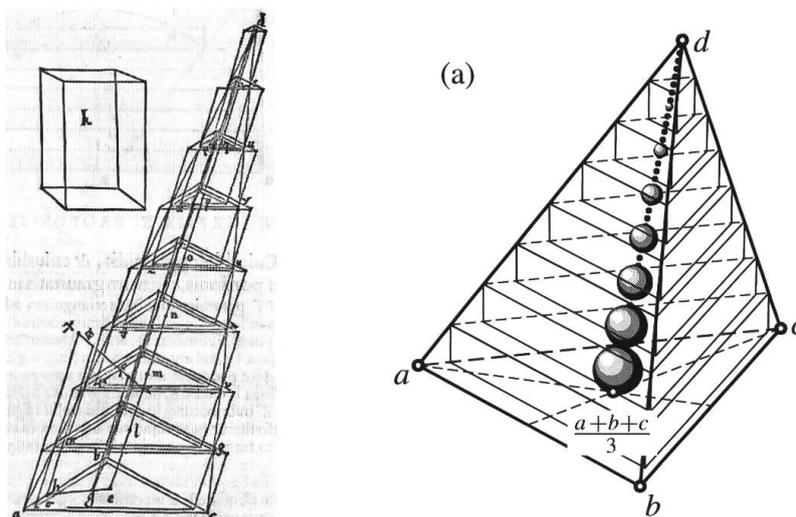
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Gerhard Wanner

The importance of Federico Commandino (1506–1575) cannot be better described than by quoting E. Rosen<sup>1</sup>: “In the sixteenth century, Western mathematics emerged swiftly from a millennial decline. This rapid ascent was assisted by Apollonius, Archimedes, Aristarchus, Euclid, Eutocius, Heron, Pappus, Ptolemy and Serenus – *as published by Commandino*”.

In addition to all this extraordinary editorial work, Commandino also developed his own research in [1] (4½ centuries ago), among which the determination of the center of gravity of the Tetrahedron led to one of the first new theorems above the Greek heritage.

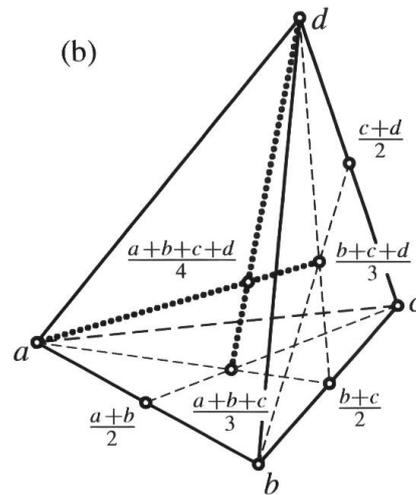
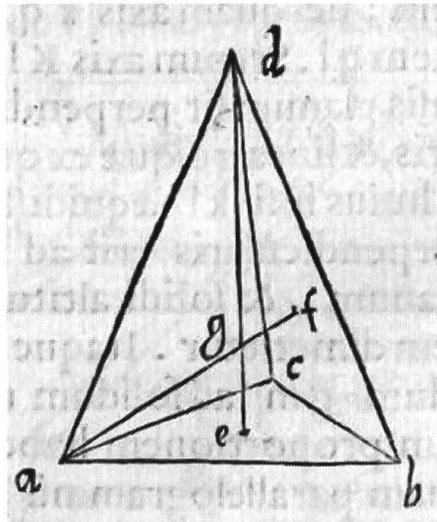


**Theorema X.** “*pyramidis ... centrum gravitatis in axe consistit*” [The barycentre of a tetrahedron lies on the median (i.e., the line connecting a vertex to the barycenter of the opposite triangle)].

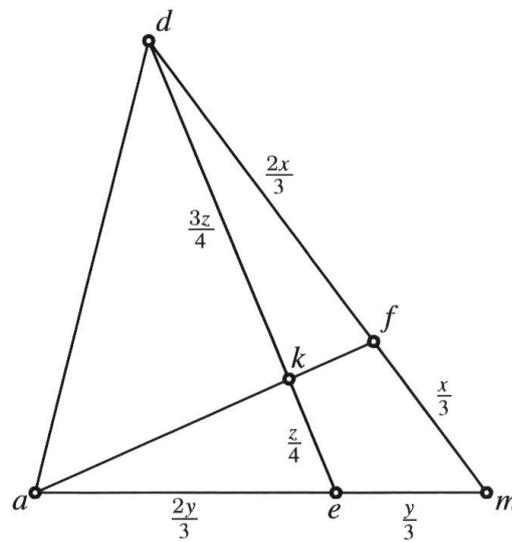
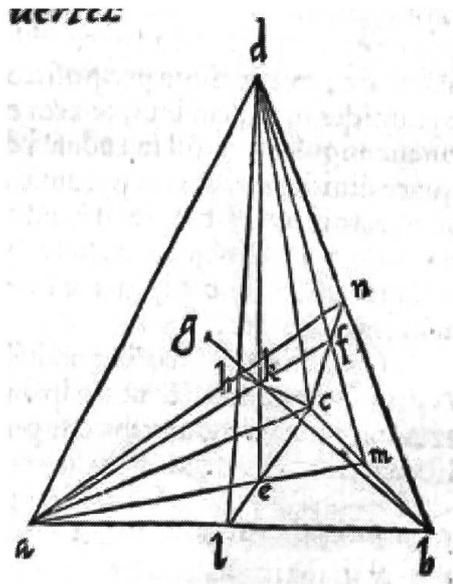
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<sup>1</sup>Biography in *Dictionary of Scientific Biography*, New York 1970–1990, also reproduced in [www-groups.dcs.st-and.ac.uk/history/Biographies/Commandino.html](http://www-groups.dcs.st-and.ac.uk/history/Biographies/Commandino.html)

*Proof* (inspired by Archimedes' *Equilibrium of planes*). Concentrate the masses of slim triangular prisms<sup>2</sup> in their centre of gravity, all lying on the median, and then concentrate *these* masses in one point, which lies on the median, too.



**Theorema XIII.** “*grauitatis centrum est in puncto, in quo ipsius axes conueniunt*” [The barycentre of a tetrahedron lies on the point where medians meet].



Sit pyramis, cuius basis triangulum a b c; axis d e; & grauitatis centrum K. Dico lineam d k ipsius K e triplam esse.

**Theorema XVIII.** “*Dico lineam dk ipsius ke triplam esse*” [The centroid divides the medians in ratio 3 : 1].

<sup>2</sup>If you look closer, you see that Commandino, like Archimedes, distinguished carefully between “upper and lower Riemann sums”. Also the method of indirect proofs, by drawing the points g, f and  $\chi$ , was adopted from Archimedes.

*Proof.* We consider Commandino's triangle  $amd$ , where  $m$  is the mid-point of  $bc$  (see Figures). We know from Archimedes that  $f$  and  $e$ , which are the barycenters of two triangular faces, cut *their* medians, of lengths  $x$  and  $y$  respectively, in ratio  $2 : 1$ .

We reduce Commandino's proof, which extends over 2 pages, to one line by applying Menelaus' Theorem for the triangle  $dem$  (see, e.g., [3, pp. 87–88])

$$\frac{ek}{kd} \cdot \frac{df}{fm} \cdot \frac{am}{ae} = 1 \quad \text{or} \quad \frac{ek}{kd} = \frac{1}{2} \cdot \frac{2}{1} = \frac{1}{3},$$

which is the stated result. □

**Remark.** Exactly the same idea, after applying a second time Menelaus' Theorem to the triangle  $dea$  and dividing the results, allowed al-Mu'taman ibn Hūd (11th century) to give the first proof of what many centuries later became known as "Ceva's Theorem" (see [2]<sup>3</sup>).

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## References

- [1] Federici Commandini Urbinatis, *Liber de centro gravitatis solidorum*, Bononiæ, Ex Officina Alexandri Benacii. MDLXV (Bologna 1565).
- [2] J.P. Hogendijk, *The lost geometrical parts of the Istikmāl of Yūsuf al-Mu'taman ibn Hūd (11th century) in the redaction of Ibn Sartaq (14th century): an analytical table of contents*, Arch. Internat. Hist. Sci. 53 (2003) 19–34.
- [3] A. Ostermann, G. Wanner, *Geometry by its history*, Springer, 2012.

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<sup>3</sup>The author is grateful to D. Paunić for this reference; see also the Proceedings of ICM 1994, Zürich, p. 1570.