

MATTER OF OPINION

In Memoriam: Leonardo da Vinci's Legacy, 500 Years after His Death

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The year 2019 marks the 500th anniversary of the death of Leonardo da Vinci. Many scholars regard Leonardo as the exemplar of a “universal genius.” Here, Nicola Pugno reflects on some materials and mechanics-related influence of the original Renaissance man.

The Italian artist, inventor and scientist Leonardo da Vinci (1452–1519) can probably be considered the father of bio-inspired mechanical design, as illustrated by his artificial wings and flying machines based on bird observation and dissection. Today, 500 years after his death, bio-inspired solids and structural mechanics are attracting widespread attention worldwide, both in academia and industry.

To commemorate the 500th anniversary of the death of Leonardo da Vinci occurring in 2019, I started reading the commemoration of Giuseppe Maria Pugno for the 500th anniversary of Leonardo's birth in 1952 (Figure 1)¹ and his related Italian writings on Leonardo and the Mechanics of “Matter”.^{2,3}

Leonardo demonstrated to have understood statics (Man. A sheet 47 verso), grasped the theorems at the base of the solution of hyperstatic structures (i.e., the virtual works principle and that of minimum potential energy [see respectively Cod. Atl. sheet 104 verso b, Cod. Atl. sheet 112 verso a]), anticipated Hooke's law (see Cod. Atl. sheet 110 verso b), and somehow surmised the de Saint Venant hypothesis (Cod. Atl. sheet 153 recto a). Leonardo also tried to understand the instability of

compressed columns, and he undoubtedly understood the importance of the cross-sectional area (better inertia) and length l (but providing a wrong prediction, basically the critical load as proportional to l^{-1} , and not to l^{-2} as it ap-

pears in the Euler's formula, see Cod. Atl. sheet 152 recto b). Concerning the deflection of the bent beams, Leonardo understood how this scales with the cube of the length of the beam (Cod. Atl. sheet 211 recto b). Leonardo

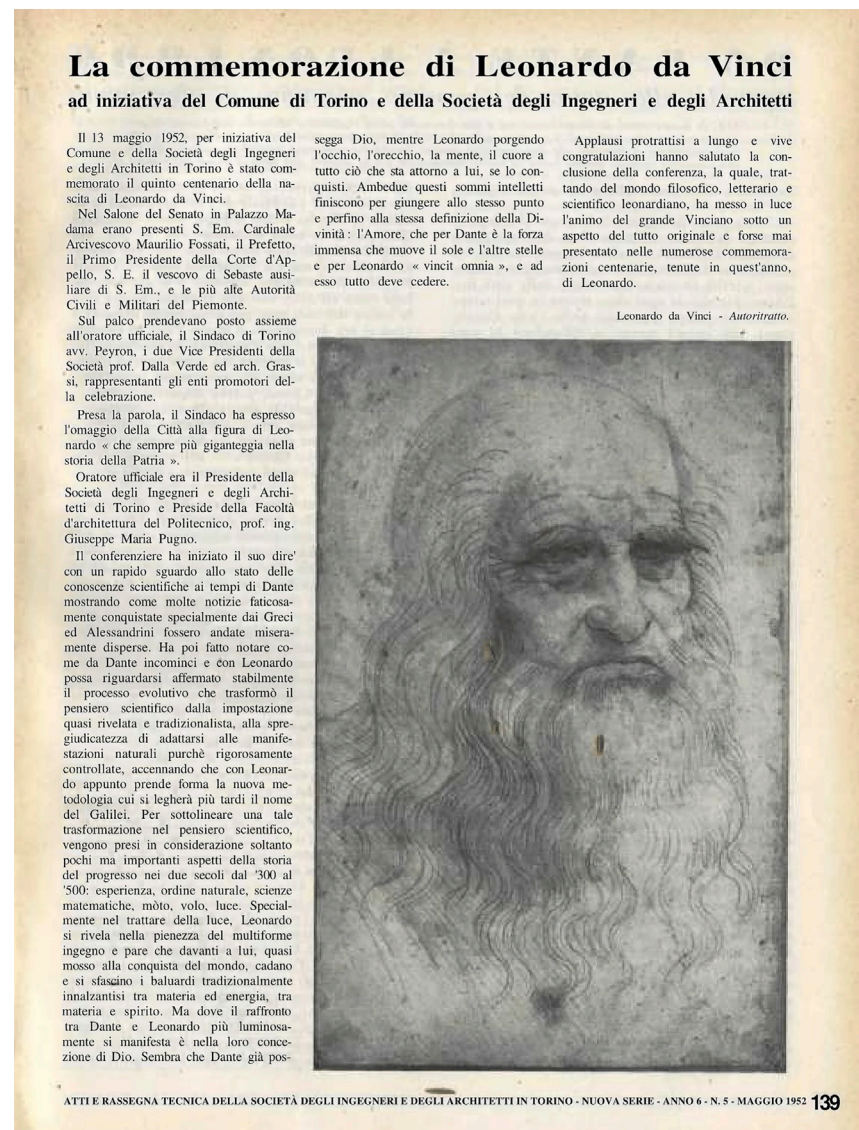


Figure 1. The Commemoration of Leonardo da Vinci for the 500 Years from His Birth, by Giuseppe Maria Pugno

The page of the “Atti e rassegna tecnica della società degli ingegneri e degli architetti in Torino”, from May 1952, which reported the news of the Commemoration of Leonardo for the 500 years from his birth by Giuseppe Maria Pugno¹ and introduced by the mayor of Turin, Amedeo Peyron.

has understood isostatic lines, e.g., that in torsion are arranged in a spiral at 45 degrees with respect to the axis of the solid (Cod. Atl. sheet 139 recto c). Leonardo, recognizing the importance of tensile tests for the characterization of the strength of materials, proposes a machine for their realization (Cod. Atl. sheet 82 recto b) and also for repeated impact tests (Cod. Atl. sheet 21 recto a).

Leonardo has also paved the way for studies inspired by nature. His flying machines are the most obvious example. Today, we have technology that he did not have access to, which allows us to observe natural materials and fabricate bio-inspired ones with nanoscopic resolution and precision. Leonardo's legacy today is indeed toward the nanoscale.

Among Leonardo's impressive and well-known machines, we find a certain number for military applications, but we must remember that Leonardo was not a man of war, but of peace. Leonardo considered war as madness, and he wrote: "And you, man, who considers in this work of mine the admirable works of nature, if you judge it to be vile to destroy it, now think it the vilest thing to take away life from man; if this creation seems to you a wonderful artifice, think it as being nothing compared to the soul that lives in such architecture." Like Dante (Alighieri), Leonardo also comes to the definition of God as love, which for the first is, "love that moves the sun and other stars" (Divine Comedy, Par. XXXIII 145) and for the latter is "amor qui omnia vincit, et nos cedamus amori", i.e., "love that conquers all, to which we must yield" (Cod. Atl. sheet 273 recto a).

This is the ultimate Leonardo da Vinci legacy.

1. Pugno G.M. Da Dante a Leonardo, sguardo alla storia del pensiero scientifico di due secoli. Atti della società degli ingegneri e degli architetti in Torino, 1956, 6, 140–150.
2. Pugno G.M. I codici vinciani e la scienza delle costruzioni. Atti del convegno nazionale per l'istruzione dei geometri e dei periti edili, 1948, 1–39.
3. Pugno G.M. Leonardo da Vinci ed Enrico Betti. Ruata, 1952, 1–9.

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<https://doi.org/10.1016/j.matt.2019.11.008>