

## TO FRANCESCO DELL'ISOLA

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We are very pleased to dedicate this Special Issue of *Mathematics and Mechanics of Solids* to Francesco dell'Isola for celebrating his 60th birthday. This Special Issue represents a tribute to a Scholar whose work had and still has an outstanding influence on the development of Mechanics of Generalized Materials. His research covered several important aspects of Theoretical and Applied Mechanics, to which he contributed with original, fertile, and rigorously developed ideas.

In his rich and diverse scientific production, Francesco dell'Isola touched on several topics, from the foundations of Continuum Mechanics to Generalized Continuum theories, from discrete models for mechanical complex systems to homogenization, to mention only some significant ones. His polyhedral approach to research has been indeed one of the prominent marks of his scientific work. In this short note, the Editors want to summarize some relevant aspects of his large scientific production and remark on the multifaceted attitude which characterizes most of it.

Francesco dell'Isola's academic formation can be ascribed to a double matrix: the primary Italian one, for which it is even possible to draw up a genealogy, and the French one, mediated by his numerous collaborations with French scientists and inspired by his fruitful contact, as a young scholar, with Paul Germain.

With regard to the academic *genealogy*, one can trace his training back to Gabrio Piola (1794–1850), who several times in his works declared that he considered himself a pupil of Lagrange, see [Piola \(1848\)](#). Specifically, Francesco dell'Isola was a pupil of Antonio Romano, in Naples; the latter was a pupil of Carlo Tolotti (1913–1991), who was himself a pupil of Tullio Levi-Civita (1873–1941). Levi-Civita's genealogy is well known: indeed, he was a pupil of Gregorio Ricci-Curbastro (1853–1925), who was a disciple of Eugenio Beltrami (1835–1900), trained in turn by Francesco Brioschi (1824–1897). It is well-known that Francesco Brioschi had an intense mentoring relationship with Gabrio Piola, and published his posthumous works.

Thus, the Italian roots of Francesco dell'Isola's background cross about two centuries in a continuous way and travel through the entire Italian peninsula. They can be conducted, through Piola, directly to Lagrange, so meeting back his other matrix, the French one.

The French roots, indeed, go back to his first experiences as visiting professor (i.e. *maître de conférence invité*) in Toulon, where he was invited in 1992 by Pierre Seppecher. With Seppecher and others, we only mention Jean-Jaques Alibert for concision, he developed models in the field of second gradient theories. The collaborative work [dell'Isola and Seppecher \(1997\)](#); [Alibert et al. \(2003\)](#); [Seppecher et al. \(2011\)](#) led to the development of the so-called *pantographic* metamaterial which practically realizes a material described by a second gradient continuum. In 1994, he was invited by Gerard Maugin and his research group to Jussieu (Paris) to hold a seminar. It was with Maugin that Francesco dell'Isola met Paul Germain for the first time. Germain had read his work on second gradient models and appreciated it: he would support the publication of dell'Isola's papers in the *Comptes*

*Rendus de l'Académie des Sciences dell'Isola and Seppecher (1995); dell'Isola and Hutter (1997).*

Familiarity with Seppecher first, and then with Maugin and Germain, is only the starting point of numerous fruitful collaborations that continue to this day with some of the most prominent French scholars. For brevity's sake, we mention only the most recent collaboration, with François Hild (ENS Paris-Saclay), with whom a fruitful line of research concerning the application of Digital Image Correlation to metamaterials is still under development (some results are already available [Turco et al. \(2018\)](#); [Barchiesi et al. \(2020\)](#)).

The interest also in merely experimental aspects [dell'Isola et al. \(2019\)](#); [Auger et al. \(2021\)](#), and not only in the theoretical and modeling ones, is completely in line with dell'Isola's conception of research: there is unity and indissolubility between theory and practice. Being aware of his passion and respect for classical culture, we believe it would be pleasing to him to use the words of St. Thomas Aquinas: *Intellectus speculativus extensione fit practicus* (i.e., "Theory by simple extension becomes practice"). This particular aspect is nowadays rather actual. It is, indeed, a pivotal point of his thought, and puts dell'Isola clearly in favor of the so-called *theory-driven* approach in the debate between the *inductivism* and *falsificationism* perspectives, nowadays also referred to as *data-driven* versus *theory-driven* approaches. One of his favorite sayings in this regard is: *Theory is Practice!* Indeed, the data-driven approach is quite useless, for it is possible to fit a large quantity of data with whatever "trend" one chooses, simply by increasing the number of degrees of freedom. Therefore, predictions made with this approach are worthless because (almost) everything can be predicted. On the contrary, predictions based on a solid theoretical foundation are always helpful because they are the fruit of rigorous speculation based on some hypotheses which are judiciously based on observations of a natural phenomenon. They represent a firm guide that is safely verified if the assumptions are of such kind.

This view is clearly expressed in his recent book on the evaluation of scientific sources, [Spagnuolo et al. \(2020\)](#). In the same context of rediscovering scientific sources, in order to be able to formulate new theories without repeating the mistakes of the past, other works can be framed, such as [dell'Isola et al. \(2015, 2017\)](#); [Eugster and dell'Isola \(2017, 2018a,b\)](#).

His basic education, in the school that, through Piola, considers Lagrange as its founder, and his numerous worldwide scientific collaborations allowed dell'Isola to understand that the strategy on which every robust and firm formulation should be based in Mechanics is to be traced back to Variational and Energy Methods. All his scientific production is based on this belief. This approach is founded at the dawn of Western culture, with the first formulation of the Virtual Work Principle dating back to Archytas of Tarentum in the 3rd century BC, [Winter \(2007\)](#).

As a matter of fact, he has many concerns about the methods based on the balance of forces and moments of forces simply because they are less general than those methods based on variational arguments and are much more challenging to use since they might produce ill-posed problems from a mathematical viewpoint, due to a possible lack of coherence in the hypotheses. Indeed, following the words of William of Ockham: *Frustra fit per plura quod fieri potest per pauciora*<sup>1</sup> (i.e. "It is pointless to do with more [things] what can be done with less"), it is safe to say that it is always better, when it is possible, to reduce the number of unnecessary assumptions and this circumstance always occur when a variational approach is instead used. Not only the approach by means of Variational Principles is more general than that based on the balance of forces and moments of forces, but it is part of a layout that, with few modifications, can be applied to other fields besides Mechanics. It is in

<sup>1</sup>William of Ockham, Summa Logicae, 1323.

this perspective that some of dell'Isola's works in the field of Economics, such as dell'Isola and del Monte (1995) or his recent book dell'Isola (2019), should be framed.

It has to be remarked that the type of approach here described has been a distinctive signature in his production through many different topics: flow in deformable porous media, Quiligotti et al. (2003); Sciarra et al. (2007), mechanics of living tissues, especially related to bone remodeling, Lekszycki and dell'Isola (2012); Giorgio et al. (2019); smart materials and piezoelectric transducers oriented to vibration control, Rosi et al. (2010); Darleux et al. (2022); theory of beams under large displacement and deformations, dell'Isola et al. (2016); Della Corte et al. (2017); second gradient materials including metamaterials, Carcaterra et al. (2015); dell'Isola et al. (2015); Turco et al. (2016); Eugster et al. (2019); Giorgio et al. (2021); fiber-reinforced composites, Steigmann and dell'Isola (2015); Giorgio et al. (2018). It is worth remarking that his interest in enhanced models of continua resulted also in a corresponding interest in enhanced mathematics, such as, for instance, anisotropic Sobolev spaces, Eremeyev et al. (2018); Eremeyev and dell'Isola (2022).

In addition to his scientific achievements he spent a lot of time as a co-editor of many books, see, e.g. Sofonea et al. (2017); dell'Isola et al. (2019); Abali et al. (2019); dell'Isola and Steigmann (2020); dell'Isola and Igumnov (2021); dell'Isola et al. (2022).

It is worth also to mention a recent volume in Springer series *Advanced Structured Materials*, Giorgio et al. (2022) devoted to professor dell'Isola.

Finally, his long and fruitful teaching experience has to be recalled, and is characterized by remarkable clarity and passion in his approach. Francesco dell'Isola has been the mentor of many skilled researchers and scholars, a great Mathematician and Mechanician who is still spending his scientific life addressing new and challenging problems and proposing compelling and highly original ideas to solve them.

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