Design+Analysis
VISITING LECTURE

"Data-driven" or "Theory-driven"?
An epistemological reflexion motivated by the need of designing exotic metamaterials

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Thursday the 7th of December 2017 at 3 pm
Lecture hall R2, Rakentajanaukio 4 A, Otaniemi, Espoo

Visitor. Professor dell'Isola is a highly-cited researcher having research activities in many different areas of science and engineering: metamaterials, flows in deformable porous media, theoretical continuum mechanics, Saint-Venant problems, capillarity surface phenomena and phase transition, piezoelectromechanical structures etc. For more information, see http://www.fdellisola.it/.

Abstract. One of the most advanced frontiers in modern technology concerns the design and the realization of materials which have innovative performances and are not yet observed in nature. The invention and diffusion of 3D printers made possible the construction of (meta)materials with very complex and highly organized internal microstructures. Even if such microstructures are built by using an isotropic and homogeneous material with perfectly standard behaviour, the resulting metamaterial may have exotic overall performances.

The scientific problem of a greater interest in this context is the problem of synthesis of a metamaterial with physical characteristics chosen "a priori". But how can one predetermine the properties of a metamaterial? To answer to this question one can decide to choose evolution equations which should govern the behaviour of the metamaterial to be invented and only as a second step one tries to synthesize the microstructure constituting it.

This procedure is not new: in the forties of XX century, this procedure was used for synthesizing analogical computers and it had a great impact in the technologies of that époque. Indeed, a whole research group (whose leader was Kron) in General Electric for more than 20 years was completely devoted to this kind of research. The part of the theory of circuits developed by Kron has often been considered as obsolete and actually has been nearly forgotten: however, it is being nowadays revived in a completely different context.

In the theory of the synthesis of metamaterials, we are not looking for the equations needed to describe the phenomena occurring to a given physical system. Instead, we look for a physical system whose phenomenology is described by the equations which we have chosen "a priori".

A suitably deep and careful analysis of the epistemological questions implied by such a change of paradigm seems now necessary. It seems to us that these questions have not yet been addressed with sufficient systematic generality. We, however, are confident that once again the ancient and powerful vision presented by Archimedes of Syracuse, and developed in more recent times by Popper and Kuhn, will supply us a strong guidance not only in our scientific understanding of reality but also towards outbreaking technological progresses.

We wish you welcome – coffee at 3 pm sharp, the presentation a quarter after the first dose!

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Design+Analysis VISITING LECTURES target for presenting and discussing a diverse collection of topics related to C*omputational Structural Engineering* and *Structural Mechanics* from the perspective of *Structural Analysis* and in the context of *Architectural, Industrial and Structural Design,* with a special emphasis on *Theoretical and Applied Mechanics of Solids and Structures.* Accordingly, term *design* – besides architectural, industrial and structural design – refers to designing models and methods, whereas term *analysis* refers to analyzing models and methods – besides structural analysis.