

Big Data: Optimal Design of Woven Composite Materials

Joseph ZARKA

MZ Intelligent Systems

19 bis Boulevard de Lozère, 91120 Palaiseau, France

Jose.zarka@gmail.com

In 1989, at Ecole Polytechnique (France) with a little team, we started to explore the domain of Artificial Intelligence of Machine Learning as I knew that I don't know even if many areas I was an expert. Most of the people were thinking that was a return to the past: horror "data treatments" !!

But, Big Data is now at fashion. There is no way to escape from a session fully dedicated on this subject in any conference.

In this lecture, we shall explain again our approach, based on the special application of optimal design of woven composite materials with the hope that at last, you would use it in your future works.

The composite materials have enormous uses in the mechanical engineering, the civil engineering, the automotive, the aeronautical and the naval industries. Composite materials are particular aggregates since they have a periodic microstructure. Textile composite materials with woven fabrics are more complex materials: different fibers are used to make bundles that are then intertwined according several types. It is necessary to reduce their acquisition cost while improving the life cycle and safety of the structures: **low cost, high quality !**

The challenge is thus the following one: how to design the optimal woven composite (i.e. to give the composition and the process) that will satisfy the requirements for the mechanical properties (elastic and ultimate) and the electromagnetic properties (permittivity and tangent of loss) at the lowest cost. In this problem, there are more than 50 design parameters. Numerical simulations are not valid (more than 1000 % of errors based on experimental results). Only 16 materials were manufactured and tested with our limited budget.

Two steps will be particularly underlined:

- i) how to make fusion of data coming from different sources or different cases with different formats with the help of INTELLIGENT DESCRIPTORS
- ii) how to make the reduction of the number of these intelligent descriptors as even if we have "big data", they are not enough.



Personnal Resume :

Prof. Joseph ZARKA

MZ Intelligent Systems, 21 Boulevard de Lozère

91120 Palaiseau, France

Cellular: + 33 6 20 37 51 93 ; Email: jose.zarka@gmail.com

He holds a Dr. es sciences degree from University of Paris (1968) and a Civil-Mechanical Engineering diploma from Ecole Polytechnique (1962). He is now the Scientific Director of MZ Intelligent Systems. He was Directeur de Recherches au CNRS, Ecole Polytechnique, France, 1964-2004. He was Professor and Chairman of the Materials-Structures Departement at Ecole Nationale Supérieure des Techniques Avancées (ENSTA), 1976-1981; Associate Professor at Ecole Polytechnique, 1981-1983; Scientific Director of Centre Etudes Techniques des Industries Mécaniques (CETIM), 1981-1986.; He was a part-time visiting scientist at the Center of Excellence for Advanced Materials at University of San Diego California (USA) and a part-time visiting professor at Mc Gill University at Montréal (Canada). Since 1986, he participated to the creation of some consultant companies such as MECALOG (now ALTAIR) and since 1989, CADLM (which is a transfert and research center for mechanical, civil-engineering, transportation, off-shore, military industries) in which he was the Scientific Director 1986-2010. He was appointed a fellow of ASME in 1999.

During his fifty years as a researcher, he was able to cover all the problems in high technology: His previous interests were in micromechanical constitutive modellings, numerical analysis of structures, new formulations and simplified analysis of inelastic structures, non-destructive tests. His current research interests are towards a new approach for Advanced Intelligent optimal Design of materials and Structures, control of fabrication, survey of structures (that he started in 1986) i.e. into the important problems where we know that we do not know the full answer and where however an answer has to be proposed. This approach is based on automatic learnings and optimization techniques but mainly it implies a real expertise in the description of the data base. Within MZ Intelligent Systems, that he created in 2008, he is now working also on the applications into Medical and Pharmaceutical problems as well as banking problems.

He has co-edited two important books in english:

1. **MODELLING SMALL DEFORMATIONS OF POLYCRYSTALS** with Dr. John GITTUS (Elsevier Applied Sciences Publishers 1980)
2. **MODELLING LARGE DEFORMATIONS OF AGGREGATES** with Dr John GITTUS and Prof Sia NEMAT-NASSER (Elsevier Applied Sciences Publishers 1982).

He is the author of some books:

3. **A NEW APPROACH OF INELASTIC ANALYSIS OF STRUCTURES** with Dr J. Frelat, Prof G. Inglebert and Dr P. Navidi (CADLM 1990).
4. **INTELLIGENT OPTIMAL DESIGN OF MATERIALS AND STRUCTURES** with Dr P. Navidi (CADLM 2000)

He is the authors of more than 100 Papers.

He holds some patents:

1. Non destructive measurements of residual stresses within a structure ; S.K.F/ ANVAR., 1974.
2. Non destructive measurements of mechanical properties within a structures ; S.K.F/ANVAR., 1974.
3. New system of seismic protection for existing building ; C.B.C /ARMINES 1993.(Co-author with P. HABIB and M. LUONG)
4. Procédé de grenailage pour formage précis de panneaux métalliques de grande taille ; MZ Intelligent Systems ; 2015