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On the Method

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Abbreviations: FEM: Finite Element Modelling; CAD: Computer Aided Design; CAM: Computer Aided Manufacturing; CFD: Computer Fluid Dynamics.

Introduction

The Method: I am not an expert in History of Science. I have my background in this Science from my scientific high school. Anyway I will try to explain. I took my master degree in Politechnico di Milano many years ago. Professors often used “aula Giulio Natta” for their lectures (old and near the Rectorate). I was there. Prof. Giulio Natta was an engineer, and was a professor in Politecnico di Milano. He was an expert in chemistry. He won the Nobel Prize in 1963 for his researches on polymers. He used the scientific method. Much earlier, in 1637, René Descartes published his famous book “Discours De La Methode – pour bien conduire sa raison, et chercher la verité dans le sciences Plus la Dioptrique, les Meteores, et la Geometrie qui sont des essays de cete Methode” [1].

The scientific method: in his book he discusses all the difficulties a scientist has to struggle with in his life. One year later Galileo Galilei, in 1638, published in Leida “Discorsi e dimostrazioni matematiche intorno a due nuove scienze (Two New Sciences)” [2]. The Editor was Ludovico Elzeviro (Elsevier). Many centuries ago scientists were trying to understand our world and proposed a reliable method in support of their efforts. This was quite not simple. I translate: no internet, no computers, no smart phones, no emails, no socials on the web, no trains, no underground, no cars, no… These scientists were really alone trying to do something quite much bigger than them. I was forgetting Leonardo Da Vinci, Italian like me. Think about all his work in his life (1452-1519). Quite excellent artist and machine designer in the Renaissance. Also think about Isaac Newton (1642-1727), English Scientist, who kept in contact with Gottfried Wilhem von Leibniz (1646-1716), German scientist. No email, no internet, no…. I only wonder which might have been the results if they all were here now, in 2018, with us. Leibniz came a little bit later Descartes and Galilei stating “Omnibus ex nihilo ducendis sufficit unum” in Latin (simply, only number “1” is enough, and “0”). While discussing with Newton about differential equations and mathematics, he simply invented the binary system in which 0 and 1 are the fundamental numbers for calculators and no other number is needed. We are all using laptops, smart phones, the internet, socials tools on the web, machine controlling systems that rely on his statement and method. And so on. Surely I did not mention now a lot great scientists who did contribute to the evolution of technology and science.

Let’s come back to our days, 2018. The question is: what did change and evolve in so many centuries, till our days? Nothing is not the right answer, just because now we can use cars, airplanes, trains, underground, smart phones, laptops and so on. So, what’s new in the method? Galileo Galilei stated that the Scientific Method needs both

mathematical modelling to forecast the results and experimental procedures to confirm the results. He stated and described his method and this became the right method for every scientist later on. Notwithstanding the correctness of the method of Galilei, nowadays we have a new tool. Leibniz helped us in developing it, at the beginning. It is not within the scope of this Opinion Letter to write all the history of Computer Science. I would only like to emphasize the fact that without Informatics and Computer Science we would be in big troubles (isn't it?). I don't want to discuss about the advantages and the, unfortunately, troubles today caused by the social tools on the web. I only want to underline that the new really powerful tool for scientists is the numerical modelling via computer. This tool is in the middle between the mathematical modelling and experimental confirmation of the results. Descartes and Galilei didn't have such a powerful tool.

This means that a first confirmation of the results might come from the numerical modelling of the problem. Numerical modelling can be applied to every science, from Polymeric Science and Technology and Atomistic Simulation [3] to Machine Design (FEM – Finite Element Modelling, CAD – Computer Aided Design, CAM – Computer Aided Manufacturing) [4-6], to Magnetic and Electric simulation to CFD (Computer Fluid Dynamics) and many other applied disciplines.

The new method nowadays relies on:

a. Theoretical and Mathematical Modelling.
b. Numerical simulation via PC and Workstations - with commercial or self-made software.
c. Experimental confirmation tests.

The Theoretical and Mathematical Modelling can give a first order of magnitude of the results; Numerical simulation via PC and Workstations - with commercial or self-made software - allows to confirm, or not, the first order of magnitude of the results, with differences in theoretical vs numerical results within a limited range; Experimental Tests will allow to validate, or not, the Theoretical and Numerical results (with differences within a limited range). We simply have a new tool which is the Numerical Technique.

Scientific research is on three levels:

a. **Basic Research:** This research takes long times and is quite difficult. It might take many years and you will not probably have any good result at the end of the research process. This means that you have to take the risk. Industry often dislikes this type of research.
b. **Middle term results research:** This kind of approach can give results in middle term times. The success is not guaranteed but researchers might probably reach good results. This approach takes less than one year and industry is much more interested (it is not a basic, long-term and time consuming research).
c. **Research with immediate results:** This kind of research takes on a few weeks, or one month. Industry really loves this kind of research, just to solve problems in very short times. I think that only long term research, that is the Basic Research, can give growth opportunity to researchers and industry. But it takes time. I have many international patents: I applied the method (the new one) to each of my patents and none of them was submitted before theoretical modelling, numerical simulation of the system and, extremely important, experimental validation. But it takes time.

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