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SCIENCE, SOCIETY AND CIVILIZATION IN THE HISTORY OF SCIENCE

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Dear Readers,

What about science, society and education in the history? In the 19th century Europe the figure of the scientific engineer is emerging.[1] In Paris the *Grandes Écoles* were founded, where the most distinguished mathematicians of the time taught to students and drew up treaties. and Joseph–Louis Lagrange (1736–1813) and Gaspard Monge (1746–1818) were among the first professors of mathematics at *École Polytechnique* (1794), a military school for the training of engineers. In 1794 the *École Normal* of Paris was also born, in 1808, the *École normale supérieure Paris* was founded, a school that had as its goal the training of teachers of both science and humanities. On this model, with a Napoleonic decree of 1813, it was established the first foundation of the *Scuola Normale* in Pisa. The attention of the French mathematicians toward applications was therefore, at least in part, due to the need of educational institutions to train technicians for the new state. Such an attitude is not found in Germany, the country that in the nineteenth century was with France at the forefront of European mathematics. On the one hand, great importance was attributed to purely theoretical disciplines, such as number theory and abstract algebra, on the other hand the *natural philosophy* aim to frame in the same theory at all the physical disciplines. In Germany a great engineering school eventually developed which become dominant in Europe. But interaction between scientists and engineers has existed since ancient times: e.g., for the study of prototypes and machines for the society. Questions might be: *when, why and how the tension between mathematics, physics, astronomy, gave rise to a new scientific discipline, the modern engineering? What is the conceptual bridge between sciences researches and the organization of technological researches in the development of the industry?* Generally speaking a discussion concerning history of science and technique/ technology within society and its civilization is presented such as a discipline within the history of science for understanding eventual relationship between science and the development of art crafts produced by non–recognized scientists in a certain historical time. The relationship between science and science & society and consequent civilizing by science is centred on the possibility that the society effetely developed a fundamental organization in capacity to *absorb* science and produce technologies (i.e., water and electrical supply, transportation systems etc.) of course and technically that lacked in the past. Subsequently, *a development civilization was necessary parallel to development of the science within society? Is effetely happened that? Did scientific works develop as a response to the needs of society?*

Alexandre Koyré (1892–1964) strongly stressed the relationship between sciences *activa* and *practical* concerning *continuity* and *discontinuity*[2] topics in the history of scientific thought. Through the intuition that the fundamentals of scientific theories contain two basic choices, Koyré' intellectual matrix has been cleared up.

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> The new science, we are told sometimes, is the science of craftsman and engineer, of the working, enterprising and calculating tradesman, in fact, the science of rising bourgeois classes of modern society. There is certainly some truth in these descriptions and explanations […]. I do not see what the *scientia activa* has ever had to do with the development of the calculus, nor the rise of the bourgeoisie with that of the Copernican, or Keplerian, astronomy theories. […] I am convinced that the rise and the growth of experimental science is not the source but, on the contrary, the result of the new *theoretical*, that is, the new *metaphysical* approach to nature that forms the content of the scientific revolution of the seventeenth century, a content which we have to understand before we can attempt an explanation (whatever this may be) of its historical occurrence.[3]
>
> [...] I shall therefore characterize this revolution [the birth of the modern science] by two closely connected and even complementary features: *(a)* the destruction of the cosmos and therefore the disappearance from science – at least in principle, if not always in fact – of all considerations based on this concept, and *(b)* the geometrization of space, that is, the substitution of the homogeneous and abstract – however now considered as real – dimension space of the Euclidean geometry for the concrete and differentiated place–continuum of pre–Galilean Physics and Astronomy.[4]

According to Russian historian[5] one consider that: 1) the history of scientific thought is never have been entirely separated by philosophical thought. 2) the most important scientific revolutions are always state determinate by a replacement of philosophical speculations. Thus, i.e., the history of scientific thought (i.e. for physical Descartesian and Newtonian sciences[6]) has not developed by *vacuum*, but it moves in a set of ideas, foundational principles, or axiomatic evidences. In particular, he grasped that the birth of modern science cannot be explained just through the human works, but conceptual–revolutionary factors are needed, including discontinuity in history. *Thus, what about science in the society & education?* I think that a larger cooperation among scientists from different disciplines involved in the study of history and epistemology of science, science education, nature of science, science and society, philosophy and epistemology of mind and cognitive modelling in education research would be appreciated. The overall objective would produce an integrated approach to problems of connection education with the contemporary knowledge from the mentioned area and to:

- Develop the new paradigms and strategies of teaching/learning especially connected with modern technologies and intelligent systems,
- New pedagogies and didactic for science teaching/learning based in a multidisciplinary approach
- Exchange experience and knowledge.

A possible road? The distinction between experimental science and mathematics–arithmetical interpretations[7] would be (among many others) an index of conscience and the ability to draw shapes and recognize properties.[8] Since the dawn of civilization, every primitive culture has also developed a mathematical–reasoning culture. This also applies to the *natural sciences* with differences in the interpretation interpretive use of mathematics and geometry giving it a sort of *special status*. This status shall require validation by methods[9], numbers, tests and inspections, analysis of error, the statistical risk, standards of rationality, full coherence with other knowledge scientists, shared and well–controlled. In this respect, science provides a reassuring image of itself: it proceeds methodically expanding its own domain, reduces the space of *mystery*. In this sense it seems that science (and its teaching) is a sort of *linear* and progressive *amount*, sometime monotonous, in order to proceed from certainty to certainty by rigorous and/

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or ideal/mental proofs; on the other hand, *an tolerable control would it be a mistake?* In a certain secondary literature contemporary science is indeed based on an compromise–ethical–standard that would rejects the idea that the world is knowable *a priori*. That probably is due to the fact that the most interesting objects of science are aware of what is not yet scientifically measured–calculated–proved. Science cannot, in any case have, by its very nature, the characteristics of a activity that produces *monotonically* by simple iteration: i.e., principles, conceptual tools, procedures, control criteria, etc.. This is to address issues related to the history of science and teaching in comparative terms, i.e. science education (teaching), scientific civilization (society) and history of science (culture of foundations). One can think:

- A historical and epistemological approach (past)
- A new approach to science education, taking into account both mediation and communication sciences (Present) and new modes of creation and use of scientific knowledge (future).

The history of science might produce answers to *why* and *how* with assumptions/reasoning study approach and epistemological critique of science:

- The structure of a specific scientific theory and its historical conflict/similarities with others.
- The use the foundations of science, which in past centuries formed first by technical (i.e., ruler and compass).
- The role played by machines and artisans practices in the history of science with respect nowadays.

What about science, society and technologies? The science and technology are increasingly linked to issues and political, economic, social, cultural and ethical.[10] This is reinforced by the emergence of information technology and communications which interaction with the world of research remains largely underestimated. Some observations can be made. a) The speed of information transfer enables the emergence of new paradigms from the confrontation of sparse data. b) Conversely, the mass and diversity of information too often lead to the creation of networks of individuals sharing the same ideas and mutually reinforcing, leading to reinforce ideas, not necessarily related to reality, or partial vision–partial reality and societal issues. c) Finally, the tools (i.e., search algorithms data) providing access to information weights may change the data produced or to create bias. These phenomena are amplified by an international competition organized by states, national institutions or international or large companies. These structures direct the search either by calls for proposals or by direct funding of research, which often leads to a science whose goals are set in advance. Worse, some deviations appear when searches lead to undesirable results or when research deemed obsolete or unwanted are abandoned (*Ibidem*). An integration to combine basic and applied sciences of nature and humanities (history of science, epistemology and education) would be proposed. This is to strengthen the interaction with civil society (social solidarity, political think tanks), associations and non–governmental organizations, and interactions less developed than those established with the business world, but just as important to society:

- Scientific training.
- Assess the impact of their research in society, with society, far beyond the disciplinary framework in which they evolve.
- To operate an interdisciplinary critical thinking

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What about science, society, cognitive science and modelling? From a cognitive–epistemological[11] point of view people do not naturally reason by means of deductive/ inductive processes only. In this regard, scientific reasoning is not a part of our common knowledge, although we often intuitively compare events, tables etc. Instead, is we consider reasoning such as associations of ideas within resonance dynamics, some concepts are far from the scientific ones and need to put in resonance with them on dialectic between of scientific and everyday concepts. The result will be pedagogy according to which science education essentially means *setting and solving problems* and teaching means re–evaluating the between theory and experience and between history and foundations. They could come together with well–structured and practical interdisciplinary work by means of the history of science. The interdisciplinary is in philosophy, epistemology, logic and the foundations of physical and mathematical sciences At school, science education need a strong effort for an interdisciplinary approach to *teach* and *learn* the relationship physics–mathematics as a discipline of study. The education needs to revaluate scientific reasoning as an integral part of human (humanistic and scientific mixed) culture that could build up an autonomous scientific cultural trend in schools. It would be useful to pay particular attention to the elaboration of the *teaching–learning* process and modelling[12] based on the reality observed by students (inductively), by a continuing critical reflection. Therefore, turning from *teaching based on principles* to *teaching (also) based on broad and historical–cultural themes* would be crucial. In this way, both a student is the *protagonist,* and schools training experts teacher (*teach*, *work* and *publish*) to provide a setting on teaching research aimed at the critical re–construction of scientific meanings along with ideas and contents. Focusing on sciences and their inter–relationships, a larger base of analysis should be adopted: history, historical epistemology, logics and foundations of sciences. Thus, a multidisciplinary teaching based on large themes–problems toward a scientific education, science & society studies, based on different formulations of the same theory would be appreciated. The relationship between sciences, strategies, methods is taken into account to try to define a re–thinking on the problem of *theorization* and of modelling within educational problems.[13] In this context, the correlated relationship between science, society, education and institutions will be discussed. Thus, *how science and its recreational modelling can work in order to present science and correlated technologies in an exciting manner? A popular science addressed to a large audience exploring the fascinating world of pure and applied sciences, really exists?*

What about science, society and communications? The university aims to encourage greater cultural orientation. It also aims to offer reflections on the shaping the history of science understood as an emerging discipline of the twentieth century.[14] This is to promote interest young people to science and the history of science, education and research of the latter. These aspects are part a wider range of analysis that includes history, epistemology and philosophy, and psychology and sociology. Indeed, today it is unthinkable to learn and understand the meaning of a scientific discipline without studying its intellectual and cultural aspects. The debate on teaching and learning issues for school education. Based on historical and epistemological reflections that could meet in university history courses epistemology and philosophy of science, seems tired compared to the attention shown towards the weak number of topics considered crucial. It should also highlight the interest of giving, for example, historic dignity of the physics and mathematics of the twentieth century to understand specifically what kind of revolution. *Only basic? Also cultural?* Although methodological in terms of national academic research, when young researchers are initiators of projects over a frame disciplinary narrow, they may feel door overhang compared to the academic discipline pursued by their laboratory attachment. They can be an expression and interdisciplinary research applicants be able to satisfy their scientific requirements. The study of the foundations and science education, which is rooted in the analysis disciplines varied, unfortunately, is not sufficiently taken into account. A proposal might be to rethink basic and higher education focusing on historical foundations

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of science. An intellectual revolution starting from science (first) to investigate, i.e., historical development of physics, astronomy, foundations of science, engineering with technology. Each argument will be developed under historical and epistemological standpoints in a unique book. It emphasizes the need both to establish the role played by theoretical and conceptual frameworks by means of the bridge between applied *science & society & technologies*. Scholars from different traditions discuss on the emergency style thinking in methodology and theoretical perspectives.

In Europe some few centres are currently working on practices related to mediation and to science and techniques (*Ibidem*). A deficiency in this area is therefore, all the more glaring deficiency in the current context of changing missions of universities, the diversification of research actors, changes in society and its expectations. Indeed, we observed a rapid diversification as places of production and exchange of knowledge that the values, motivations and skills of many partners. The context of education, *communication* (or mediation) is wildly complex and evolving due to diversity, complementarily (or contradictions) of all actions in the field of science technologies and companies to establish links between them. He seems crucial to have a synthetic study of the different current actions in these areas in order to identify best practices and to focus and identify opportunities improvement and mutual enrichment. Note that if all the shares are of the same project sciences & societies, they require dependent specific discipline practices. This highlights the need to have. Researchers from these disciplines that address these issues without clearly exclude association with researchers from the humanities and social sciences. The fact is rooted in the disciplines to open the humanities and social constitutes the originality and strength because the process is often quite opposite. Researchers from both countries participating in the project and will develop methods of research, education, communication and mediation original. All actions are characterized by the fact that they leave the scientific and technical problems and developed to serve different audiences. Finally an empirical and scientific combination of approaches, to develop a dedicated line to the study of education, mediation and communication science and an analytical strength of actions would be appropriate along synergy of skills and diversity of actions. For example:

- Analyze the different actions and conduct in terms of interactions between science, technology and society Provide resources and tools optimized with this analysis.
- Provide free digitized essays and books
- To provide the benefit of greater number results of the research on the dissemination of technical knowledge and scientists.
- Mediation and making social provision, all the actions mentioned may be mutually reinforcing and contribute significantly radiation Universities.

What about science, society and scientific civilization in the history? The social and civilization environment in which a scientist lives has profound influences on the way how his scientific results and methods are framed. This is specifically true for the 17th century, the epoch of the scientific revolution and a century of deep social and political transformations. Nevertheless, the influence of the social–political situation on the work of a scientist has to be deduced directly from the analysis of his scientific works. In other terms: an analysis of the society in a certain period can be useful to understand the general direction taken by the science in that period, but, in itself, it is not enough to understand the specific work and results of a certain scientist. This kind of general analysis risks to become a sort of an *a priori passepartout* (Bussotti, Pisano, 2013) through which the scientific work is analysed and risks to induce serious misunderstandings on the way in which a certain scientist presented the results of his researches. It is always necessary to begin a historical research – also a research concerning the relations between science and society in a determined period – from the alive, both theoreti-

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cal and technical work of the scientists. If, in the analysis of the whole work of a scientist, the historian of science reveals some unclearness or internal inconsistencies or a lack of coherence between the methods used by this scientist in different works of his and if all these questions cannot be explained either with technical problems (for example the lack or the misunderstanding of certain mathematical methods) or with the general methodological and epistemological convictions of the scientist himself, then it is necessary to think of the general structure of the society in that period. Therefore technical analysis of the results and methods used by the scientist is a priori considered and then evaluated within civilization.

Endnotes

1 Pisano, R., Capecchi D., (2013–*forthcoming*). Conceptual and mathematical structures of mechanical science between 18th and 19th centuries. *Almagest;* see also: Pisano, R, (2013). Reflections on the Scientific Conceptual Streams in Leonardo da Vinci and his Relationship with Luca Pacioli. *Advances in Historical Studies* 2 (2), 32–45.

2 Pisano, R., Gaudiello I., (2009). Continuity and discontinuity. An epistemological inquiry based on the use of categories in history of science, *Organon, 41*, 245–265. See also: Pisano, R., (2008). A history of chemistry à la koyré? Introduction and setting of an epistemological problem, *Khimiya*, *17* (2), 143–161.

3 Koyré, A., (1965). *Newtonian Studies*. Cambridge–MA: The Harvard University Press, p. 5–6.

4 *Ivi*, p. 6–7. In the following explaining of Alexandre Koyré' choice for the history of science: "*The destruction of the cosmos*" that is a replacement of the finite world, as it had been hierarchically classified by Aristotle, with the infinite universe. "*The geometrization of space*": that is a replacement of Aristotle' physical (concrete) space with the abstract space of the Euclidean geometry.

5 A conference (1954, Boston) of American Association for the Advancement of Science. Cfr.: The scientific Monthly, 1955; Koyré, A, (1971). Études d'Histoire de la pensée philosophique. Paris: Gallimard.

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8 For the sake of brevity, a profile and outline of a larger current research are only presented. It concerns studies at the Centre *Sciences, Sociétés, Cultures dans leurs Évolutions*–SCité (University of Lille 1, France) headed by Bertrand Bocquet and a coming project, *History of Sciences & Society, Epistemology of Mind And Cognitive Modelling in Science Education* between above French centre and *Department of Technical Education*–DTE (University of Maribor, Slovenia) headed by Boris Aberšek.

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13 Pisano, R., (2013–*forthcoming*). Notes on the Historical Conceptual Streams for Mathematics and Physics Teaching. *The International Proceedings of the 53 mathematical Society Congress*, Lithuanian Vilnius University, The Lithuanian Vilnius University Press.

14 From Centre Sciences, Sociétés, Cultures dans leurs Évolutions–SCité (University of Lille 1, France) project.

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