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Where is Science Going?
The Main Road Overlaps Disciplines and Crosses Reductionism

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Guest editors

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The special issue *Where is Science Going? Scenarios and Perspectives of Contemporary Technoscience* features a specific multidisciplinary approach. The call's topic was developed according to the modern tripartite pattern of knowledge: humanities/social sciences, life-sciences, and physical-sciences. In fact, the papers in this issue display a large overlap and interplay between scientific branches while highlighting several problems that were suggested in the call. Such an original and fruitful path toward a future, sound knowledge addresses both the practice and the debate of technosciences.

The problem of scientific truth and reliability of research are faced by Baker and Bardi *et al.* Both these papers quote the same statement by H. Poincaré, "An accumulation of facts is no more science than a pile of bricks is a house."

Starting from the perspective of biological sciences, Baker's commentary, inspired by a recent opinion piece by renowned biologist Paul Nurse, highlights the problem of the giant amount of data currently available, and still growing, in contemporary scientific enterprises. This theme is developed, with suitable examples, underlining that true knowledge is not just a matter of collecting data. Rather, it is about understanding and predicting—an articulated process where data, theories, and errors play a key role. In this sense, epistemological and methodological questions belong to a broader panorama where they should be understood and resolved, calling into question the role of scientists as subjects aware of the implications of their work. These, for example, directly affect research programs funded by states and enterprises, sometimes generating perverse results such as the "Machiavelli effect".

The perspective of Bardi *et al.* refers to scientific communications, i.e. the domain of knowledge and public debate on technoscience, for which the scientific discourse and its applications become valuable if clearly understandable by the general public. In this vein, scientific communication should become a duty of scientists; but this requires, *inter alia*, the scientific community to undergo suitable changes. To this end, the authors propose a tool inspired by Seymour Papert's book *Mindstorms* expanding his concept of "mind-size learning" to match the current scientific enterprise. Employing the metaphor of science as one of the dragons of Western mythology, described as sitting on their hoard of gold but not using it for any useful purpose, Bardi *et al.* note that a broad paradigm shift is also needed from a social and cultural point of view. We should thus encourage scientific communication and the redistribution of the scientific treasure of knowledge in the form of "mind-sized" memes.

This theme refers, clearly, also to the problem of the "social structure" of contemporary democratic societies in relations with science, a crucial question already addressed by Robert Merton around the first half of the 20th century. Here, Parravicini stresses how the current conditions and role of the scientific community in democratic societies are embodying a sinister social scenario, predicted by K. Popper decades ago: the joining of relativism in knowledge and authoritarianism in research, which leads to a compression of political and intellectual freedoms.

On the other hand, Bicocchi focuses on issues relating to the sphere of law. She recalls the need for still-lacking efficient legal regulations concerning technoscience in neurology and underlies the potential misuses of scientific

discoveries. Bicocchi warns that, in this regulatory vacuum, new and potentially dangerous market niches have been created for invasive devices dedicated to our mental activities. The possible negative consequences are attested by the growth of neurotechnological means of social control and surveillance. This calls for establishing independent ethics committees about "neurorights."

On the epistemological level, the contributors focus on the inadequacy of reductionism and on the correlated topic of complexity.

Strumia gives a comprehensive review of several issues correlated to complexity in natural sciences. He emphasizes how information plays a determinant role in generating order and organization in complex systems, recalling the ancient Aristotelian-Thomistic logic/ontology and *form*. The holistic approach is shown to be mandatory in the field of fractal geometry, whose implications in many branches of nature, spanning from the shape of galaxies to the anatomy of biological organ in a living system, like a human heart, are given.

The same topic consideration of the natural universe as a whole, the so-called *holistic approach*, is also dealt with in three physical science works, facing the foundations of quantum mechanical theory. Interestingly, the two papers by Silvestrini and the contribution by Carati & Galgani propose almost opposite interpretations of this charming topic.

Silvestrini starts with the concepts correlated to the "local realism," on which A. Einstein based his criticisms of quantum mechanics. After recalling the experiments on Bell's inequality violation, which demonstrate that Einstein's assumptions are not satisfied, Silvestrini proposes an interpretation, entirely based on quantum mechanics, where all physical systems in the universe should be considered as synchronically correlated.

On the contrary, the work by Carati & Galgani aims at explicitly recovering Einstein's program to explain microscopic systems within a classical mechanical framework. The authors note that this can be done if and only if in classical electrodynamic equations both temporal retarded and anticipated terms are considered. This requirement introduces the innovative concept that also classical mechanics can predict a sort of general correlation among physical systems in the universe.

Finally, the investigation of biological systems can be seen as a field where all the previous issues come together. This is the topic of the works by Erenpreisa *et al.* and Gambacorti-Passerini & Aroldi. The first considers some features of cancer cells, where complexity and chaotic behavior play a key evolutionary role, which is relevant for treatment resistance. Here, paradoxically, the potential mechanism of "explorative adaptation" is initiated in cancer cells only, "on the brink" of catastrophic damage. The paper eschews a reductionist framework and proposes, in this specific field, an application of the epistemology deriving from the thermodynamics of unstable open systems discovered by Ilya Prigogine. Erenpreisa and colleagues stress that the described regulation does not conform to the expected linearity between the severity of an applied drug and the final effect on cancer.

Gambacorti-Passerini & Aroldi shed light on the unknown side-effects of vaccines based on nucleic acids, particularly in the mid and long term. Their production was expedited based on urgency, and authors warn that such an approach risks becoming an excuse to omit a much needed surveillance activity. They conclude referring to the wider problem of the relationship between science and society and claiming, on one hand, that genuine knowledge is possible only by protecting scientific work from extra-scientific interests and pressures; and on the other, that transparency, reliability, and science-based opinions win people's trust much more than coercion.

All the papers, according to their specific disciplinary approaches, but with an interdisciplinary and conscious vision of the social role of science, demonstrate that global society is questioning the boundary between an internal and an external domain of the technoscientific "machine." This is reflected at every level of scientific enterprise: theoretical, imaginary, discursive, operational, applicative, and technological. The immeasurable expansion of the skills and effects of technoscience extends from the level of representation to that of practice, seamlessly and with no obstacles, to reach social totality. Therefore, a sort of redefinition or rather a re-foundation of society emerges from a technoscientific lexicon, which is still heavily mortgaged by a reductionist and neo-positivistic epistemology. Moreover, further and more serious problems emerge, including, not least, that of politics and financen that arrogantly use the scientific practice for their own purposes.

Such an open issue has serious implications for democratic societies. The scientific community must face and solve it even through a though, critical, but always open and democratically oriented dialogue and discussion.