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Editorial

Medicine and the machine

La medicina y las máquinas

Medicine from 'art' to 'science'

Medicine, that for centuries had qualified itself as an *art*, is considered (and considers itself) today as a *science.* If examined carefully, this does not appear as a deep change, for the old term "art" had a meaning quite different from the meaning it has assumed after the romantic turn of the nineteenth century, when art in general, and the single arts in particular, were considered eminently as activities having to do with the production of something *beautiful*. Actually, the ancient Greek term which is translated as "art" (even today) is *techne*, and by this term the ancient philosophers denoted an activity able to produce excellent results and at the same time grounded on the knowledge of the *reasons* for such an efficacy. In other words, an art consisted in a practical ability supported by theoretical knowledge, and it is not by chance that the ancient philosophers usually give, as an example of art, precisely medicine. This meaning of *techne* passed unchanged to its Latin translation as *ars*, and then to the corresponding words in modern languages.

As a consequence of the new 'aesthetic' meaning assumed by by the notion of art in the nineteenth century, and also due to the extraordinary intellectual and social prestige acquired in the same historical period by the natural sciences, medicine too began to cultivate the proposal of qualifying itself as a *science.* The realization of this proposal presented three fundamental aspects. The first was the adoption of the *results* obtained by the natural sciences as a theoretical and practical support for the medical knowledge and its application in diagnosis and therapies. The use of measuring instruments, of laboratory tests, of anatomic and physiological examinations, of bacteriological knowledge, began to replace or to help the confidence in the "clinical eye" of the doctor in the treatment of single diseases.

The second aspect was a refinement of the *empirical* side of medicine, whose first elements in the West were already present in the Hippocratic tradition and had been gradually increased and identified along the centuries, until the more formal codifications of the nosographic classifications and their criteria elaborated in the first decades of the nineteenth century.

A thirds step was accomplished in the second half of the nineteenth century when the requirement was put forwards that medicine, in order to be genuinely 'scientific', had to adopt the characteristic method of the natural sciences, that is, the *experimental method.* The work in which this additional requirement is strongly and clearly advocated is the *Introduction to Experimental Medicine* by Claude Bernard (1862). In that book the issue of what was later called 'clinical experimentation' is not yet envisaged since neither patients nor volunteering human beings are considered as objects of experimental investigation, whereas animals are. It is known that precisely this extension to humans of the medical experimentation has raised the first ethical concerns that were at origins of medical ethics. We are not interested here in considering this important consequence, but rather in examining certain intellectual frames that accompanied and affected the transformation of medicine into a scientific discipline.

The experimental medicine

The structure of Bernard's book is instructive in this respect. It begins with an accurate presentation of the experimental method in general and continues with the application of this method to the study of two different classes of "bodies", the "brute bodies" and the "living bodies", the last being the animals. In both domains an "absolute determinism" is affirmed to hold, and this is the ground for the application of the experimental method that consists in creating, through suitable manipulations of the 'natural' conditions, a certain situation from which another precise situation would causally follow with absolute necessity. The fact that such a necessary causal consequence actually occurs or not enables the scientist to accept or reject the hypothesis he is testing. The discipline in which Bernard intended to apply the experimental method is physiology, where he has brought fundamental contributions, the most famous of which is the concept of "internal environment" (*milieu intérieur*) characterized by a display of physical and chemical parameters whose values must remain stable, and whose alterations can produce pathologies. The chief procedures for testing hypothesis in the case of the living bodies are the "cadaver dissection" (basis for the pathological anatomy) and vivisection, that is,

direct experimentation on animals, that is described in details. It may be surprising that in that work no mention of something like a "patient" can be found, nor any consideration that could make reference to humans, and this simply because at the beginning experimental medicine was not conceived yet as implying experimentation on humans, probably because an implicit feeling made clear that humans beings are different from things and ethically deserve a specific respect.

But what about animals? The answer comes when, by reading that same work, we encounter the phrase "living machine" (*machine vivante*) for denoting the animal. In such a way we are put in the condition of capturing the ontological root of the project of that experimental medicine: it consisted in considering the living organisms as particular kinds of machines. This was by no means a novelty, because interpretations of the animals and even of the human body as machines had been elaborated already in the seventeenth century, and had been seen compatible with different conceptions of the human nature. From the mechanical interpretation of the human body presented in detail by Descartes (who maintained at the same time that the genuine man is his spirit capable of thinking and reasoning), to the fully materialist doctrine of the *Homme machine* (1747) advocated by La Mettrie. One can say that, along with the advancements of the modern natural sciences, their approaches and results have been used for proposing machines as models of living organisms, with applications to medicine: mechanical, chemical, thermodynamic, electromagnetic, cybernetic computational machines have been proposed according to the science that was receiving special attention at a given moment, and direct applications to medicine have even received special denominations in the history of medicine (such, e.g., as iatro-mechanics or iatro-chemistry).

The cognitive use of machines

Is there any reason which could explain this fascination of the machine in modeling the structure and functioning of living beings? Yes, there is a reason and it consists in the fact that in a machine everything is clear, nothing remains hidden, there are no mysteries, simply because a machine has been designed and constructed by assembling parts that are interconnected following a precise pattern that obliges them to causally interact according to the physical deterministic laws established in one or more of the natural sciences. Of course, one can note that such a model is a mental construction, an idealization that leaves out of consideration many aspects of the real behavior of a living organism, but this objection is not particularly strong because the proponents of the model are usually ready to admit that this provides the

'essential' features of the concrete reality investigated, while the other neglected features are accessory details that could be captured by a refinement of the model or, perhaps, by making room in it for an additional machine based on the knowledge offered by another natural science. There is, however, a different and stronger reason: a machine is something concrete, for it is true that its functioning has been designed and foreseen before its construction but it is no less true that it actually exists and functions in the concrete world and interacts with other concrete things and beings, including animals and humans. This means that a machine has an 'ontological status' different from that of a mental entity and, as a consequence, can be taken as a reliable 'simulation', or 'imitation', or 'interpretation' of the ontological structure (that is, of the way of being) of several entities.

One anecdote may clarify this point. It is reported that in the famous abbey of Port Royal (that was the intellectual center of Jansenism in France at the time of Descartes and Pascal, and where the Cartesian doctrines were greatly appreciated) there were a few watchdogs. One day a visitor came and the dogs started to bark. The porter began to control them by beating them with a stick and the yelping of the poor beasts impressed the visitor. But the porter reassured him by saying that such cries were not expressions of ache, but simply gnashing of gears that produced such a noise. We certainly remain puzzled by such a declaration, but this was simply the consequence of having taken too seriously the doctrine of the machine-animal proposed by Descartes, instead of considering it a reasonable model for representing certain partial aspects of the whole complex nature of the animals. Today we are confronted with several similar equivocations when the contributions of various sciences are taken in a *reductionist sense* as capable of offering a global interpretation of what living beings and humans really are.

Machines as product of technology

There is something more: modern machines are the emblematic expression of *technology,* understood in its most direct sense as applied science. According to this sense, the unavoidable consequence of the progressive acquisition of the status of science entailed for medicine also its becoming more and more interweaved with technology, and in such a measure that progress of medicine is often considered to consist in the availability of more advanced and sophisticated technologies. We do not want to address here the complex issue of the advantages and disadvantages that this proliferation of technologies has produced not only in medicine, but in every sector of contemporary human existence, an issue that has been debated in a very large

literature. We only want to point out that machines have become such a massive part of our environment that persons living in the so-called advanced societies are compulsory obliged to interact with machines, to 'communicate' with machines, to depend on machines for the satisfaction of even the most elementary needs of everyday life. Moreover, also the communication and interaction with other persons is very often possible only through the mediation of some machines and this can affect the person-to-person contacts and relations and in many cases produces a sense of frustration (simply remember when you phone a call center in order to have an information and you can only select to digit a number out of a list and receive recorded answers that do not correspond to your need, but you cannot speak with a human person).

Interaction between man and machine

This interposition of machines between human persons occurs also in medicine, independently of the good will of the partners concerned. It is normal, when a person consults a doctor (especially if this is not the 'family doctor' but simply a physician appointed by an institution or health structure) that the first step required for making a diagnosis is the submission to certain clinical tests that, depending on the cases, can go from laboratory analysis to radiography, ultrasound, tomography, magnetic resonance, and a variety of other controls that are possible thanks to specialized machines. Therefore, the first significant contact of a patient with medicine actually is a contact with machines. It is supposed that, once the 'results' of such submission to machines are known, the doctor will formulate his diagnosis, but this is only partially true, because these results are automatically compared with certain intervals of variability which indicate whether they are 'normal' or not. The direct intervention of the doctor should occur when a comparison and synthesis of the different kinds of test would lead to a diagnosis but here again the personal role of the doctor tends to decrease in the most advanced countries where the so-called 'expert systems' become more and more available. These systems are very complex computational machines in which a rich data base is included containing enormous information on the most probable correlations between different combinations of the various clinical tests and certain diseases. In such a way the expert system can offer a diagnosis that is often believed to be more reliable than that offered by a single doctor based on an information more restricted than that stored in the machine. Of course, a particular training and expertise is needed in order that a doctor be able to properly 'ask' the machine and obtain from it the required 'answers', but this very fact indicates that a significant part of the doctor's expertise and ability

regards his efficient interaction with the machine rather than his relation with the patient. Finally, once the diagnosis is realized and the therapy begins, the patient is often submitted again to a more or less massive treatment with machines, depending on the seriousness of the illness and also on a lot of extra-medical conditionings.

The intention of this quick survey of a few well-known aspects of modern medicine is not that of disavowing the great importance that advanced technologies have acquired in medicine but simply that of calling attention on a phenomenon of slow 'marginalization' of the patient that can be entailed in this process, in which the patient risks to be perceived (and perhaps to perceive himself) as a machine put in contact with other machines. Therefore, it is clear that this risk must be contrasted by introducing or recovering certain aspects in the medical theory and practice which should 'complement' the presence of technology. Before coming to this point, however, we think important to mention a rather recent contribution to medical technology that could give a significant impulse to the perception of the patient as a particular kind of machine. We refer to what is called 'medical simulation'.

Medical simulation

For the correct understanding of the notion of medical simulation one must first focus on the substantive, and then on the adjective. The substantive is "simulation", which denotes a very large display of technologies that today mainly depend on the articulated field of information disciplines. As such, simulation is a specialized branch of *engineering* and not of medicine, though, among the many domains where it is used, simulation has found an exponentially growing success in medicine during the last few decades. Therefore, it is correct to say that medical simulation is a *branch of simulation technology* which is *used* in medicine. But now we must ask which kind of use is appropriate for simulation and it is not difficult to see that it is different, say, from the use of laser technologies applied to obtain certain results in surgery. To put it briefly, the use of simulation is essentially that of providing a *representation* of a certain object, fact or process, by means of a device that nevertheless remains *different* from the represented object even when it is very 'faithful'. Think, for instance, of a drawing, a photo or a film faithfully representing a concrete thing or event. If this fundamental role of simulation is understood, it becomes clear its most natural use also in medicine, that is, as a precious tool for education and training in medical fields of various kinds. The great advantage of simulation over the photos or drawings we find in textbooks is that one is not limited to *see*, to look at the representation, but can *do* many things on it, can *interact* with it. Therefore,

simulation is a formidable *pedagogic tool* in medical education and training, and for this reason the most advanced schools of medicine are normally equipped with these (very expensive) apparatuses.

But now let us consider what we could call an unintended side effect. When a layman is admitted to visit a simulation department at a medical school, he is easily impressed by seeing several full scale mannequins having an amazing resemblance with human patients, and this not simply from the point of view of the 'external' appearance (like in a wax museum) but also regarding certain behaviors that we normally link with feelings (such as crying tears or expressing groans): nothing seems impossible to simulate, it is enough to install in the mannequin certain additional devices in order to obtain the desired behaviors as an *effect* of the functioning of those devices. In spite of this, though we may be astonished, our common sense is sufficient for knowing that those mannequins are *not alive*, that they are not *real patients*. Also the student who takes part in demonstrations and training based on the use of such mannequins is aware that they are not alive; nevertheless he learns more and more about their 'resemblance' with humans and, actually, they are endowed with practically all the properties and functions that he is expected to know and manage in his profession as a medical doctor. Of course, he will appreciate the advantage of learning how to practice correctly a tracheotomy on a mannequin – without the serious consequences of a possible mistake – in comparison with doing the same on a real patient but, on the other hand, he will gradually become convinced that, once he will have learned how to handle correctly the mannequin in the different situations and conditions, he will have learned all that is required for handling a patient. If this were to become the internal unconscious conviction of the doctor, this would amount to considering the patient as a machine: the *simulation* would have converted itself into an *ontological interpretation*.

The indispensable complements

Speaking of Claude Bernard, we have seen that he had confined the application of his experimental method in medicine to the treatment of animals as "living machines", leaving open for other approaches (in particular for philosophy) the investigation of other deeper issues, among which the issue of the nature and dignity of the human being is certainly included. Today this recognition of the human dignity, the autonomy of the patient, the delicate nature of the doctor-patient relation are among the central issues of the ethical and bioethical discussions, and this requires that not only in the abstract debates, but concretely in the education and formation of the doctors

and of the different operators of the health professions, more be present than the contribution of the natural sciences and technologies. If we want – as we want – that the patients are not perceived and treated as the watchdogs of Port Royal, that is as disguised machines, we must include philosophy and humanities among the constituents of medical education, and the training in psychological approaches to persons and in interpersonal relations as part of the training of operators in health professions. This is obviously not an easy task, especially in our time in which high specialization and ability to work with sophisticated machines and technologies are the most appreciated qualities in medicine, but this is an indispensable goal to attain if we want to avoid that 'scientific' medicine be felt as alien and not friendly to humans, as is happening little by little in several of our 'civilized' societies.

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