Science and Its Demons

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Borges, in *Pierre Menard, Author of the Quixote,* writes "truth, whose mother is history, emulator of time, repository of actions, witness of the past, example and notice for the present, and warning of the future". History is much more than the sequential narrative of events and personalities that they teach us in school. As the mother of truth, history comes down to being indispensable for obtaining knowledge, and if we accept that one of the purposes of science is precisely this task of learning, then the study and understanding of historical facts becomes obligatory homework for scientists.

The idea of conceiving history as a series of processes subject to causes and effects is part of the legacy that the monumental work of Karl Marx and Friedrich Engels has left to us. One of the phrases that best illustrates this was written by Marx in 1852, in *The Eighteenth Brumare of Louis Bonaparte,* and it has been cited on multiple occasions in political literature. "Hegel said somewhere that all the grand deeds and personages of universal history appear twice. But he forgot to add: the first time as tragedy, the other as farce."

Marx set up a parallel between the coup that allowed Louis Napoleon Bonaparte to convert himself into emperor of France under the name of Napoleon III, and another similar one that permitted his uncle- Napoleon Bonaparte- to attain the throne of the same nation some decades earlier, in the time just after the French Revolution. Marx attributed to Hegel the affirmation that history has a cyclical character. Evidently, no one would be able to accept a strict periodicity in history; if it were so, we would be condemned to observing the unfolding of a drama totally determined and predestined. For this reason, Marx uses a metaphor to underscore that in history it can be acknowledged that certain deeds are apparently repeated ("The first as tragedy, the other as farce"), since they have characteristics that can seem similar, but whose particular circumstances are different.

For some time the historians of science have identified a swaying, an apparent periodicity, that is to say, an alternation between rationalism and romanticism. This conflict, out in the open or beneath the surface, has dominated the development of science practically since its origins. Right now science reflects the crisis of Western society, which indicates that we are entering into one of those agonizing transitions mentioned earlier. If indeed times of crisis are times of risk and danger, they are also the opportunity for innovative ideas and for revolutionary change.

NaturPhilosophie

In Western societies -American and European- at the dawn of the XIX Century, an important movement arose, in art as well as science, of thinkers who were dissatisfied with the social disquiet and the ethics in the atmosphere of strict classicism which was dominant in the intellectual world of the times.
In the face of the prevailing cold rationalism, this current surged as a movement exalting the human being, nature, and beauty, but it was also a social expression of rebellion, liberty, and independence. Consciously or unconsciously it was seeking a way out that privileged the individual, the "I" over the

collective. This Utopian yearning in pursuit of an ideal world, without more of a basis than will or fervor, is called romanticism.

European romanticism emphasized the individual over the collective, and it is a reaction against the laws of neoclassical art, in which creativity found itself restricted by academic rules; therefore it is a direct expression of the emotions that often seeks its sources of inspiration in the past or in mythologies.
In the sciences, romanticism postulates that the natural world can't be explained rationally and can only be apprehended in an intuitive manner. As a consequence, there is no unique description of the universe since it is dependent on the individual, his environment and circumstances; the subjective, irrational, and imaginative lead the way. The philosophers Fichte and Schelling gave this point of view substance as a form of thought under the name of *NaturPhilosophie.*

This was radically opposed to the empirico-mathematical tradition of the preceding centuries, and above all, to the rationalist current which dominated since the Century of Light, known as the Enlightenment. The rationalists, strongly influenced by the success of the mechanics of Newton, thought that the world could be understood and explained completely based on these laws. In 1705 Edmund Halley predicted that the comet that now bears his name, and that had passed close to the Earth in the solar system in 1607 and 1682, would return in 1758. The exactness of his prediction produced enthusiasm for and gave rise to great confidence in the power of mathematical methods in order to go further in the description of the universe, which opened the possibility of predicting the future. Nature was now perceived as an open book, disposed to reveal its secrets to whomever knows its language: mathematics, according to Galileo.

The basis of rationalism was confidence in the unlimited power of reason. This was the method that humans should use as the only instrument to come to the truth, the comprehension of the universe, and search for its own happiness. They followed an analytical method as a strategy of study, which brought them to decompose nature into parts. Moreover, they sought diligently a detailed description of the same; a good example is the classification of living beings by Carl Linnaeus in a system that would follow, in his words, “the order dictated by nature”.

Another swing of the pendulum

At the end of the XIXth Century and the beginning of the XXth there was another alternation in the feelings-reason struggle. Various philosophical movements devoted to rationalism followed after romanticism, in the sciences as well as the arts, among which is found “realism”, that had many followers in France, cradle of the renowned encyclopedias. In the arts, as its name indicates, it intends to draw an exact portrait of nature and society. The paradigmatic example is *The Human Comedy* of Honoré de Balzac; it is an ambitious and erudite portrait of society with its passions, virtues, and defects.

At bottom, the clashes between the currents to which we are drawing attention form part of a more ancient conflict which is still present. Ever since humans learned to question themselves and to interrogate nature, there exists the antagonism “idealism” *versus* “materialism”. Moreover, these terms are confused since commonly idealism has a positive connotation in that it refers to the capacity of individuals to live out their lives guided by very high moral principles. Nevertheless, what characterizes philosophical idealism is that its advocates opine that the world and its phenomena don't have an existence of their own which is independent of the observer, and, therefore, there does not exist an objective reality external to the individual and independent of his or her consciousness.

On the other hand, in today's popular language, someone is “materialist” when he shows an exaggerated interest in money and worldly possessions.
Nevertheless, philosophical materialism considers that the universe and nature have an objective existence, even when we are not present. That is to say, that the ratio of the circumference of a circle to its diameter is 3.141592... even if there had been no mathematician to formulate it, and that a tree makes noise upon falling in the middle of a forest, in spite of the fact that nobody is there to listen.

During the time that the new rationalism was influential, confidence returns that science has the capacity to explain all natural phenomena, social included. Moreover, these are subsumed within physics and should be studied as such. Today not all theoretical biologists- who *are* physicists for the most part- are convinced that Darwin's theory of biological evolution by natural selection is the explanation of evolutionary phenomena, even though at the end of the XIXth Century Darwinism fit perfectly well, the same as Marxism into materialistic rationalism. The neo-Romanticism of the XIXth Century is not the same as that of the preceding, given that, on the one hand, it had been influenced by realism, and on the other, history is not mere repetition, as was mentioned previously. This has grave consequences, since its nature is more negative and its rejection of rationalism is more violent.
In 1918, the year the First World War ended, Ostwald Spengler -a German philosopher- publishes *The Decline of the West.* The central argument of the book is that civilizations, the same as organisms, are born, grow, mature, and terminate in an irreversible degradation. Spengler opines that western culture exhausted its creative phase, being situated in an epoch close to its intellectual death. This process is due, to a good extent, to the preponderance of materialism over spiritual forms, whereby affirming that rationalism and science are responsible for this spiritual degradation. (“After two centuries of orgies of science, we have gotten our fill”). Spengler initiated a line of thought that has a great influence in some contemporary currents that discredit science and they start a crusade against what are called “absolute truths”. Another phrase very illustrative of the same author is: “Nature is always a function of culture”, which doesn't say that *science* is a function of culture (which would be acceptable), but rather *nature* itself; that is, that it doesn't have its own existence in the absence of humans.

If indeed the arts and sciences encountered an environment notably favorable to growth during the Weimar Republic, the political instability and the great economic crisis provoked in the average citizen a feeling of hopelessness and fear before an uncertain future, which spawned the necessity of seeking out the guilty, whether real or fictitious, and to look for skewed solutions, in order to buy some hope, no matter such a way out is lacking any basis. It is in this environment where superstitions and myths are re-born along with the charlatans who exploit them with nefarious consequences. Adolf Hitler and Hermann Goering tried to make a disturbance in Munich in 1924, but later on they convinced themselves that it was more productive, politically speaking, to blame the Jews for the precarious economic situation, to revive the myth of a grandiose German past, and to convince the poor and uninformed that each one of them was potentially a superman with a splendid future, if given the opportunity. Finally, the Weimar Republic died with the rise to power of the Nazi party in 1933.

The world of today [June 2002]

The profound changes that the world experienced in the last decade of the XXth Century and that were associated with the fall of the Soviet Union and the end of the so-called “socialist bloc” led to the world-wide seizure of the political and economic scene by the United States and its neo-liberal capitalism.

Analysts, communicators, and personalities of the Western world congratulated themselves on this

change and augured a future of unprecedented happiness, in which humanity would share the American [meaning here the United States] values of liberty, morals and democracy. One might mention that this idyllic scenario collapsed before the twin towers of New York did. One does not have to be especially wise to perceive that not everyone wants a homogenization imposed by force, given that "globalization" does not mean that all of the peoples of the Earth take the best of the others and can incorporate it into its style of life in a fruitful and enriching interchange; rather, it means the accepting, without appeal, of the standards and values of the United States. The rejection of the homogenizing imposition that is shown by the peak in global-phobic movements is towards the "McDonaldization" of the economy, of customs, and of values (including gastronomic ones).

The transition from a bipolar world to a unipolar world, far from alleviating the tensions that were generated by the Cold War, has brought with it aberrations in the relations between nations, societies, and individuals. The world finds itself immersed in a generalized crisis, with multiple facets, that are recognized by the following signs: war, the method foolishly chosen to resolve conflicts between States, nations, or ethnic groups; terrorism, which includes the desperate action of minority groups as well as illegal abuse by the State which has sufficient power to exercise it with impunity; the global economic disorder which makes the well-being of a reduced wealthy class fall back on the shoulders of the majority.

The world is divided into two parts: one is excluded from whatever benefit of development, lacking the conditions which permit human life with a minimum of dignity. In this part are concentrated the countries of the so-called Third World.

Hopelessness leads to a loss of faith in progress, the quest for immediate personal solutions,, so the majority turns to mysticism, falls in the arms of religion, traditional or emergent, and given the privatization of health services to the people, entrusts its health to pseudo-scientific practices (when not charlatanistic).

In an analogous situation as mentioned earlier and similar to the atmosphere of the Weimar Republic, the picture here described edges the people to seek out and persecute the ones at fault, be they real or figurative: we are in another transition from rationalism to romanticism. This time science is accused, perhaps with reason, to be part of the apparatus of inequality and injustice.

The demons of science

In the alternation back and forth between rationalism and romanticism, at the present time, it is the first that stands in the docket of the accused. A poet, most notable for his political activity (president of Czechoslovakia since 1989 and afterward of the Czech Republic until our days) expresses his point of view in the following manner: "The fall of communism can be interpreted as a sign that modern thought- based on the premise that the world is objectively discernible and that the knowledge thus acquired is susceptible to generalization- has fallen in an ultimate crisis."

This phrase of Václav Havel describes what we are trying to get at: the crisis of values not only generates a loss of confidence in rationality, but moreover produces confusion among the intellectuals, conducive to methodological errors like that of Havel, that of confusing Marxism with the Soviet bureaucracy, to the gross absurdity of the conclusion, based on this false assumption, that the world is not objectively discernible.

These ideas find an echo nowadays in the schools of post-modernism and cultural relativism. The point

of view that the values of a culture are not absolute goods, but rather depend on the historical development of each culture- doctrine known as cultural relativism- is undeniable from the perspective of anthropology (moral principles may be different in different cultures without having to decide which one is good and which on bad; the human sacrifices in old Tenochtitlan horrified the Spanish who, in turn, saw it as natural that some people should die at the stake.

We think that the universe can be discerned objectively and that the knowledge thus acquired is susceptible of generalization, but we cannot close our eyes to the the diversity of criticisms and attacks upon science which are legitimate have have real bases. Science has been at the side of the most perverse interests and burdens itself with sins and demons that are necessary to exorcise.

Among these demons is found the relation of science with the technology of warfare. Pablo González Casanova says that "we have to realize that globalization is piloted by an managerial-financial-techno-scientific-political and military complex which has reached high levels of structuralization, articulation, and organization of the parts which integrate into this complex, many of which are state enterprises or institutions complex in themselves. Thus, the dominant mega-complex, or the complex of the dominant complexes, possesses great enterprises at its disposal such as banks for its financing, research establishments for its technologies, publishing houses to spread the virtues of its products, of its politicians and military for the opening and expansion of its "input markets" or of its production and sales markets, or of its recruitment of skilled and unskilled workers".

The association of scientists with war is not new: among the notable is Archimedes of Syracuse in the IIIrd Century B.C. , who invented machines of war during the war of his city of birth against the Romans. Since then, it becomes very difficult to find an instrument of death that doesn't depend on a technological development based in scientific work. In fact, if we accept that technology is applied science then perhaps one can affirm that all modern instruments of extermination are "children" of science.

As mentioned by González Casanova, science forms part of a managerial-financial-techno-scientific-political and military complex. This fact severely restricts the scientific capacity of deciding the lines of research, since the supporting financing of this complex isn't concerned with science as an intellectual delight nor as a means of attending to the problems of the majorities, but rather that it forms part of the apparatus of domination. In this world, globalized and dominated by neo-liberalism, the nation States have been letting go , gradually , of their role of being the principal source of the financing of scientific activity. The guidelines for research in biotechnology, bio-medicine, science of materials, information technology and many other areas obey the interests of large companies that, in turn, pursue the interest of immediate profit.

Even if we were sufficiently indulgent to skip over the association of science with the means of war, there are also negative aspects in the terrain of ethics. The quixotic image that society has, of the scientist as an absent-minded individual in his tower, inhabiting a dreamworld and absorbed in his work, often spread by the same scientists as a means of shunning responsibility, is simply and completely false. Scientists, being educated people, with academic preparation spanning many years, would be capable of, if not obligated to, knowing what it is that happens in their environment. Under these circumstances, it's difficult to find a reason why there don't exist more than a handful of them who raise their voice against the mentioned complicity and against the disinterest in our world and its poor.

If indeed it is certain that science has generated well-being for humanity (or better said, for part of

humanity), so also has it abandoned morals and ethics. That is to say, that it has not preoccupied itself with searching for satisfactory responses to the questions the people have concerning the meaning, value, and purpose of life. Science has converted itself into a secular religion of "truths" revealed to mortals only by means of priests that are the exclusive owners of the universal knowledge: science is the base of modern technology and thus of present-day capitalism.

Wonder and skepticism

What, then should science be? Let us go to its foundations, to that still-uncontaminated kernel and which will eventually allow the rescue of its ethical foundation.

Science is made up of various elements; we can say, perhaps superficially, the most important are wonder and skepticism. The first leads us to marvelling before the universe and asking ourselves as to its origin, development, and evolution. The religions have this also; to live in the "fear of God" is understood nowadays, erroneously, as the constant and continuous fear of the deity. In this expression, "fear" should be taken as synonymous with awe, amazement or astonishment (as in the English phrase *awe of God* or German *Ehrfurt vor Gott*). Nevertheless, in contrast to the religions, science has an exclusive interest in the physical world and its manifestations, and leaves spirituality to personal fancy. So the second element is the ingredient that distinguishes science from religion.

Skepticism implies a critical attitude towards facts and phenomena, be they natural or social. In science theories and explanations are not accepted without discussion and convincing; explanations of the type "because it's so" or "it's the will of God" are not admitted. Thus, a scientist ought to be part of the conscience of society (beginning in the professional associations), ought to have a commitment to his or her people, and fight to banish superstitions and charlatanism. In print and electronic communications media there is a scarcity of space dedicated to science, and an abundance which, in one way or another, foment prejudices, stereotypes, pseudosciences, and superstitions. Behind all this is a powerful industry which earns enormous profits exploiting the credibility and good faith of the people. Astrology, New Age, and modern religions are a formidable business, which would break up immediately if education successfully fomented a skeptical attitude among the citizenry.

We cannot fool ourselves with the ingenuous notion that by pure will we can change a structure with such colossal economic and political interests. Still, to remain doing nothing is to validate the situation.

Education is a field in which the spirit is formed, which has repercussions on society, making it a place where you can act to change the status quo, and which may lead to the founding of a school of thought and work that is purposeful and, furthermore, whose proposals will convince the people. In our special case the emphasis would be situated in higher education.

Questions

There exist a good quantity of studies and diagnostics of the problems of higher education in Mexico, in which there have been formulated a series of questions, and among those that stand out are the following:

Diversity or Homogeneity? For some time public higher education have found itself under pressure to

uniformize curricula and homogenize methods of evaluation, for professors as well as students. Examples include departmental exams and teaching evaluations to assign bonuses.

It is curious that this trend gathers strength even in academia, when recent scientific advances point in the opposite direction. The physics and mathematics of complex systems show that diversity helps those systems increase their capacity of adaptation when faced with novel situations. Rigid curricula and syllabi don't leave room for diversity to maneuver, and they are an assurance of future problems. In the Faculty of Sciences at UNAM [National Autonomous University at Mexico City], half of the courses for a major in mathematics are optional; the students can choose from a sufficiently ample set and in this way decide their professional formation in a flexible manner. Additionally, each professor chooses a focus and orientation that he or she will give to their courses. The result is that this faculty produces very diverse mathematicians and all of them with large possibilities of placing themselves in the workforce or in the academic world. This case illustrates a forceful example that can confront the policy of uniformization followed by the educational authorities of Mexico. One must defend academic freedom and fight in order that they implant nothing like departmental exams. Homogenization of persons and human activities is characteristic of totalitarian regimes.

Elite or Masses? Also, we have to oppose the fashionable tendency of hindering the acceptance and retention of students who, for personal reasons or, in the majority of cases, because of their socio-economic level, cannot be full-time students or have the same rate of completion that some others do; they have to be convinced that a student who doesn't complete his program is useful to society and is not a "wasted investment"; the one who drops out halfway through his or her program still raises the average level of culture in society, and that's a good thing. Still better it would be if that individual could retake her studies when her situation permitted it.

So we reject the absolutism of the dichotomies, just as the intimidation "you are with the United States or you are with the terrorists", recently [2001] proffered by George W. Bush, seems aberrant to us, and we are equally against having to choose between the extremes of "quality elitist education" *versus* "mediocre education for the masses". Who can claim that they have a rigorous proof that it isn't possible to have massive quality education? Normally, phrases like those in quotes represent common positions that, by force of repetition, wind up being accepted without reservation; and it's uncharacteristic of scientists, who almost by definition ought not to accept forceful affirmations without evidence that sustains them, who willingly swallow myths, like those propagated by an academic "big-shot", which assert that with age "the ability of professors to generate new knowledge decreases", and "a professor of over 60 years (sic) cannot compete in productivity with young professors". Somebody once said that a lie repeated a thousand times turns into truth.

Specialization or Generalization? Public university or Private university?

Premature specialization leads to the formation of professionals with a high grade of competency but in ever more narrow fields, which brings about the isolation of scientists. Communication, now let us not say between physicists and biologists, to mention one case, but between biologists of different specialties, is now almost impossible: a field ecologist and a molecular geneticist can confront difficulties in finding a common topic for scientific communication. Such overspecialization has its analog in biological evolution; we have all been taught that a highly specialized organism can be very efficient in exploiting its environment, but extremely fragile to changes in the same. The ant bear has an anatomy very adequate for the seeking out, hunting, and ingestion of ants but those only; what happens if the ants run out? A overspecialized professional can also run out of ants.
A graduate of a public university and a private one are different in many aspects. One of them is the

unquestionable difference in salary that they will get when they get out. This is no reflection on the quality of education that they received or of the culture acquired (as the case of the managers of Mexico Inc. shows), but rather how useful they will be to the productive apparatus. Up until now the Mexican entrepreneurs have preferred a well-trained professional to carry out specific tasks in a timely fashion. We must convince employers (public and private) that more profitable to them is someone with the capacity to adapt successfully to a rapidly changing environment. That is, we ought to persuade them that it is better to keep an employee who is adaptable to new situations than to replace a overspecialized person when their skills cease to be useful by bringing in someone new, with all the problems associated with adjusting to the workplace. In a nutshell, we believe that a public university should prepare high-quality "Swiss army knives" in place of specialists with reduced vision.

How is modern knowledge incorporated into teaching? Our lesson plans continue with the notion of presenting a compartmentalized development of science. This has be all right up until now form the "intellectual" preparation of the student, but will it be adequate in a world of rapid change? There is a modern tendency to erase the artificial boundaries between the sciences, which appears with the emergence of disciplines like mathematical biology, bio-informatics, and physical biology. In line with this tendency, our proposal would be, to give an example, to present physics in the light of biology and biology in the light of physics. But nowhere has it been analyzed what repercussions this would have in lesson plans and curricula. A common core? Multipurpose modules?

In a nutshell, which would be the best path to bring students to the point of doing productive work early on, thus breaking the social stratification of science, with its mandarins and servants? We don't know; probably, relatively small groups of professors that teach subjects in the first semester could agree among themselves how to insure that the students, independents of their academic majors, know very early on what are the contemporary controversies within science; and thus faced with a wide range of general readings that lead to a self-sustaining dynamic of study for the acquisition of tools for thought. In other words, to break with the passive acquisition of knowledge as "inert baggage" and to convince the student that the world will seem different (much nicer) if they know how to unravel the subtleties of reasoning by analogy, to describe the utility of formalism, and to learn how to let loose their imagination about the metaphysical and philosophical aspects of science.

Colophon

In epochs of crisis flourish lucid and brave minds. In the transition from rationalism to romanticism in the early XIXth Century, there existed a group of thinkers that called themselves rationalist morphologists. Goethe, D'Aubenton, Geoffroy Saint-Hilaire and Lamarck are some of the names associated with this school. At the end of the same century, and in the middle of another transitional epoch, there appeared the enormous personality of D'Arcy Wentworth Thompson. All these naturalists, up and going between the end of a stage of rationalism and the beginning of one of romanticism, synthesized the best of both worlds: the passion for detailed study, thorough and reductive, characteristic of the rationalists, and the love of the romanticists for general principles.

All of them, now ignored by the scientific *establishment*, were creative beings, rational and emotive at the same time, that within the social restrictions came to be artificers of their own lives and masters of their fate. This is in striking contrast with the present neo-liberal situation in which all aspects of human life, to be considered of value, have to represent gain or capitalist profit, and in which man is no more than the means that the goods have to produce more goods.