

SCIENCE AND SOCIETY

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When an ordinary caveman, 100 000 years ago, set about chipping a flint to form a tool, he was already celebrating the wedding of Science and Technology: Science, because he was using knowledge learnt from his ancestors about nature (i.e. the hardness and brittleness of silicon dioxide); and Technology since this particular utilization of scientific notion was aimed at a precise and practical purpose (to cut wood or meat, or fight an enemy).

The long story of interaction between science and human societies is precociously contained in this tiny episode. Most evolution of societies is due to a mixture of science related technological progress (of course including agriculture, medicine, navigation...) and of ethics-related behaviours (linked to religion, philosophy...). In other words, Science and Technology have always progressed hand in hand, and societies have used both for better and for worse with regards to human dignity and happiness. However entangled Science and Technology may appear in this perspective, we can separately describe their possible influence upon societies, having in mind that our understanding of both depend strongly on the scientific education which we have received as children.

1. SCIENCE, A LEARNING MODEL FOR SOCIETIES

The development of societies demands one absolute prerequisite: the intellectual and moral development of Man, and here science may play a def-

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inite role. Indeed, science is tirelessly educating us, decreasing our ignorance, and addressing not only our intelligence but also our personal and social behaviour, shaping our outlook on the world and even our character or our public spiritedness. From this viewpoint, a precocious education in science particularly along the lines of Hands-on or *La main à la pâte* approaches, should be of great help for developing this sense of civic responsibility which is highly requested in our times of hatred, racism and violence.

If we leaf through the large volume that this learning method represents for all of us and in particular for those who are not destined to practice Science, we might select some of the following chapter headings.

1.1. *The idea of freedom*

Science being par excellence a space for liberty, it constitutes a kind of humus for the spirit of freedom. How could societies develop, in the long term, with men held back by prohibitions or curbs on their thought, on their liberty to circulate, or publish? Science, its history and practice, teaches us liberty: that of a postgraduate who starts on his subject and soon frees himself from the orders of his supervisor; or that of an engineer who invents a new process, often well beyond, or in contradiction with, established ideas and his manager's directives.

Either lodged in the depths of human conscience, or expressed through visible institutions charged with preserving it (learned societies, academies, ethical committees, and so on), the spirit of freedom establishes these two virtues of mankind, *creativity* and *dignity*, two ingredients undoubtedly crucial for a development (or capacity building) of societies which will be sustainable and will escape to the deadly hold of dictatorships and various dependences, as well as to specious illusions of easy money and unbridled consumption.

1.2. *The virtue of humility*²

With Galileo, at the revolutionary time of Renaissance, Science becomes humble in that Man decides to seek the answers to his questions at the very heart of Mother Nature, by questioning her directly, via experi-

² Let us make it clear here that, while considering this virtue as consubstantial to Science, I do not pretend that scientists practice it all the time! In fact, some are arrogant, some are humble, and most lie in-between. I just claim that, whenever they flout humility, they put themselves in contradiction with their own discipline.

mentation rather than by extracting the fruits of his own thought. The law of falling bodies is no longer what Aristotle declared – however great a genius he might have been – but is rather based on what experimentation reveals: in fact, what Nature says about herself. Henceforth, the man of Science is no longer a god-like figure who decides on what is, or should be, but a simple decoder, a sort of interpreter with the job of transcribing for other men what nature unveils about herself, and in the language that she herself has chosen (“Geometry”, as Galileo put it).³

This modesty, taken on by Science, is one of the hidden forces (generally we celebrate more its power than its humility) that should influence societies. It is this patient observation, often inglorious indeed, of nature, the renouncement by Science to explain everything and its capacity to draw the demarcation line between knowledge and ignorance which should teach us to respect the facts, to test permanently our thoughts against them, to mistrust preconceived ideas, to hate arrogance and to increase our tolerance towards fellow human beings, a necessary condition to put an end to conflicts.

1.3. *The spirit of research*

By unveiling some of the great fundamental laws that govern nature, Science teaches us the immensity of what we do not know, or do not yet know. It is these *not yet*s which generate the spirit of research, and thus the endeavour for undertaking it and therefore the ability to progress. This is one of the major reasons for favouring a sound, open-minded (i.e. non dogmatic) scientific education for children.

Those for whom a scientific education has imbued both the sentiment that there is a “blank page” open in front of them and the necessity of rigorous thinking, should undoubtedly have more respect for facts than for ideas, more respect for ideas than for certainties. They should be inclined to think with honesty and resist the *more-or-less*, the *preconceived*, and also the *ready-to-wear* (including sectarian and superstitious) types of behaviour. Without a doubt, if this education has included elements of the multidisciplinary harmonics of our environment (physical and social), they will be attentive to the many different – possibly complementary – approaches we have to the world, and their minds will be tuned to sub-

³ We would now rather say “Mathematics”, the only language, together with music, being universal.

tlety. Here, Science is indubitably providing a space, a privileged theatre, for imagination, creativity, open-mindedness, and thus for a harmonious development of our societies.

2. TECHNOLOGY, A DEBATED PATH TO PROGRESS OF SOCIETIES

As previously recalled, Science and Technology are consubstantial with each other each benefiting from the advances of the other. However, we generally consider Technology (in the broad meaning of the word) as the real visible link between Science and Society.

The unbelievable and astounding progress of recent decades in well being, health, life expectancy, agricultural output, comfort, travel, communication... due to Science and Technology is so obvious that it is useless to elaborate. It also looks so normal that we have to force ourselves never to forget, or to underestimate, it. Nonetheless, hunger, extreme poverty, infectious diseases... still exist in many parts of the world, while environmental degradation, global trends in climate change, growing economic disparities, dreadful injuries inflicted to nature, not to forget more and more sophisticated weapons, may be counted at the debit of Technology.⁴

A necessary (if obviously non-sufficient) condition to tackle these dramatic questions is to invite social and human disciplines (demography, sociology...) to enter the scene. In particular, it has become clear that if Science and Technology are imposed on societies without a minimum of respect for local customs and the social, religious and moral principles that these are founded on, there is a great danger that the graft will not take. Instead of anticipated smooth development, mass rejection may occur, and even social regression, generated by migrations of populations, chaotic urbanization, feelings of frustration... This is where the reference to Ethics has become, in the last decades, more and more explicit, as a natural mediator between Technology and Societies.

2.1. *Ethics and the Golden Rule*

The purpose of Ethics is to set forth principles that can guarantee basic human right by repressing the priority instinctively given by each individual,

⁴ See, in particular, the Proceedings of the IAP Conference on Transition to Sustainability (Tokyo, 2000) and the subsequent *Statement of the World's Academies*.

group, nation, to its own interests to the detriment of all others. In a word, Ethics is an attempt to establish as much equity as possible in a society. Although morality differs from one civilization to another or from one era to another, it has universal characteristics. One cannot deny that all men rally around a few major prescriptions. One of them, the so-called Golden Rule, has the advantage of summing them all up in an expression known on all continents: "Do not do unto others a you would not like them do unto you".

Regardless of whether the reference is secular or religious, we are seeing a widening of its applicability even as the men that it commends to our sollicitude retreat from our field of vision, in space and in time. From the clan to the village, from the village to the nation, from the nation to the planet, but also from today to tomorrow, the duties given us become increasingly abstract because we are increasingly unfamiliar with the recipients of our grace. We can imagine the assistance given to the strangers in ancient societies: the foreigner, the traveller, who is protected even if he does not return the favour to his benefactor.⁵ This succour given to all and sundry is doubtless more meritorious than services rendered to our close ones. It is the sign that we bring those who are distant into our midst, that we give them the substance, attributes and privileges of true brothers.

The first duty which the Golden Rule gives to Technology is of course not to harm men of today. This is the root of so many present debates on what should be done, or nor done, in an increasing number of Technology-related problems: genetically modified crops, chemical pollution, internet-favoured pedophilia, mad cow disease (and social struggle)... But aside from this rather classical duty, new types of problems arise concerning men of tomorrow. In this case Technology helps Ethics to open a new chapter of its history: this is the signification of the Golden Rule concerning a very far future.

2.2. Problems and duties for a far tomorrow

New problems appear like those raised by greenhouse gas production, by chemical or nuclear waste accumulation, or by frenzied consumption of natural resources, which are more detrimental for future than for present generations. If we consider nuclear waste, the potentiality of the danger which we create now may last tens of millennia. In the case of some chemical waste, the period of danger has no known limitation in time.

⁵ This is well illustrated by the parabola of the Good Samaritan.

These long term harmful effects that we generate and leave as an inheritance for others prompt us to introduce not just the man from elsewhere but the man of the future in our ethical field of vision and to ensconce him there. How can one fail to recognize that this intrusion is profoundly unprecedented? The obligation just described, to provide hospitality and fraternity was less abstract than it appeared. The meeting of contemporaries, one man to another, was still possible. In this new scenario, it becomes unthinkable. No cordiality will ever reign between beings hundreds of centuries apart. Henceforth, we find ourselves confronted with this new anxiety: expanding the Golden Rule to include men of the far future obliges us to consider hopelessly faceless human beings, whereas it previously applied to outsiders who, as different as they might be, were at least contemporary and capable of communicating with us.

Not that this ethical tie that links us to our remote descendants is a new idea: doubtlessly, the carpenter or stone cutter never existed who built a bridge without somewhat vaguely meditating on his responsibility to future men who will cross this bridge, with a confident step, for centuries to come. But this ethical duty takes on a unique dimension in our time due to our increased capacity to harm, sharpening our sense of responsibility for our descendants. We have learned to regard the intensive mining of the planet's riches as pillage to our descendants' detriment, and the accumulation of waste from our industrial activities as flagrant injustice in their regard. We would be guilty of gross negligence not to heed this widening of the Ethics. With the risks that we subject them to, come the special duties of elder brothers.

Before, time frames were quantified in terms of generations: "I want to leave my great nephews an Earth where they can live in peace and well being". Now, human beings who are totally unimaginable to us enter the scene, beings whose customs, knowledge and rapport with nature we cannot even imagine. Will they be supermen, through natural or artificial evolution? Or will dreadful cataclysms return them to the caveman state? Will they be able to decipher our messages? Will they have any awareness of their distant ancestors? Does it even make sense to try to penetrate the mists of time to ponder their situation?

Given the impossibility of finding answers, what purpose is served by asking ourselves questions about future humankind? Let us instead see in the production of greenhouse gas or in the disposal of long-lived radioactive or chemical waste, an ethical command of unforeseen magnitude. It is this injunction that we must consider: we have no right to

leave behind a heritage of risks for generations in the distant future, and we cannot dodge the issue by postulating that scientific progress will protect them. At least, our contemporaries profit from the beneficial effects of our activities, which is not the case of future generations. These should not assume the responsibility for dealing with the harmful effects accompanying the benefits that we ourselves have gained. Among all the unknowns that torment us, at least one certainty remains: that our negligence will cause harm, and that our present behaviours have acquired the formidable power of exercising influence that is practically unending in time. The magnitude of the harm sets the tone for the breadth of the vigilance required and for the crucial importance of the research to be done in this field.⁶

As a conclusion

Let's be honest. Our generation would probably not have mapped out this "new ethical frontier" so unwaveringly had it not been driven by fear. Accidents such as those of Bhopal or Chernobyl have created a new mistrust of industrial operations that generate pollution and immediate or eventual fallout. Because of those accidents, ecologists have found added justification for their warnings, denouncing the wounding of nature, as much as the harmful effects to man. In this mistrust, let us salute the part that is well-founded, therefore spurring our research on safety and environmental protection, and also sort out the part that may be irrational and subjective.

In this regard, we may note that many other tangible risks – airplane crashes, smoking... – are more or less accepted because they are part of daily life and therefore commonplace. In front of the above-evoked long term and global dangers, the public's lack of familiarity with complex technical issues, the affected community's feeling of powerlessness, the quasi-infinite duration of potential harmful effects, and above all the original sin represented by Hiroshima and Nagasaki urge us to re-examine some of our assumptions about Science and Technology. We have also, in this broad field, to create a renovated dialogue between policy-makers and the

⁶ Large scale programs of research have been launched in countries like Canada, France, Germany, Sweden, Switzerland, USA, to assess the long term reliability of various types of nuclear waste repositories. In France, customers participate, via a percentage of their electricity bill, to this effort.

public.⁷ The latter must remain conscious of the immense benefits which we derive from Science, for the shaping of our minds, the intellectual stature of mankind, and the increased well being of many societies. But, at the same time, the former should be prepared to evaluate properly the dangers – those rooted in reality, not in obsessive fears – in which we live, be they natural or manmade.

To so do requires a minimum of education, understanding, judgment and solidarity.

⁷ See for instance: Sir Robert May, "Bringing Science into Governance", *Science and Governance*, Brussels, October 10, 2000.