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The Ethics of engineers in front of the challenges of the 21st century

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Résumé

En 1999, la faculté des sciences sociales de l'Institut de Technologie de Harbin, en Mandchourie, l'un des instituts techniques prestigieux de la Chine, dépendant du Ministère de la défense et des affaires spatiales a demandé à Pierre Calame de faire une conférence sur l'éthique des ingénieurs. Il le fait en partant de son expérience, a commencer par sa formation à l'école polytechnique dont la devise était, de manière significative (pour la patrie, les sciences et la gloire). Cette devise lui permet d'expliquer ce qu'a été l'idéologie des ingénieurs à partir du 19ème siècle. Le lien entre la technique et la guerre. Le lien entre la raison et l'Etat. La tentation de la simplicité. L'espérance que les sciences sociales ressembleraient aux sciences de la nature. La difficulté à développer des relations humaines complexes et à s'interroger sur des finalités réelles de l'action. Une certaine vision de la linéarité du progrès. Le lien entre la liberté de la science et la liberté tout court. La tentation d'une compréhension mécaniste du monde vivant. La prédilection pour les phénomènes mesurables.

En réponse à ces dérives, Pierre Calame plaide pour un nouveau profil de l'ingénieur du 21ème siècle à partir d'une éthique commune fondée sur la Charte des responsabilités humaines. La nécessité d'une rupture profonde est, en fin de conférence illustrée par la question de l'énergie : longtemps le développement humain a été associé avec la croissance de consommation en énergie et toutes les ressources techniques ont été orientées vers le développement de l'offre. Aller vers un monde plus sobre implique un changement radical d'approche.

Mots-clés thématiques : ETHIQUE; CONTRAT SOCIAL; RESPONSABILITÉ; HISTOIRE; RELATIONS SCIENCE SOCIETE

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I will present here my personal insights, visions, hopes and concerns about the challenges of the 21st century and about the ethics of engineers facing these challenges.

I will do it in three parts :

- 1. My personal experience and the reasons why I came to question the dominant ideology of engineers ;
- 2. The presentation of the dominant ideology seen from a historical viewpoint ;
- 3. The challenges of humanity for the 21st century and the role and responsibilities of the role of engineers ;

My personnal convictions that the main challenges in the coming centuries are not at first technical. However, engineers and technical innovation played a critical role in the evolution of our society. Then, their values, their ideology and their mindset will be essential in the evolution of our societies. The influence of engineers and technical change determine their peersonnal and productive responsibilities towards the society.

The questions I talked about are not from any academic field. It is not as much a disciplinary field as a matter of existencial experience.

1. My personal experience and the reasons why I came to question the dominant ideology of engineers

I am a former student from the Ecole Polytechnique in France. I think the French Ecole Polytechnique was the first set up in the world and some kind of a model for the others. Trained in mathematics and natural sciences I got specialised in civil engineering and urban planning. In France at the beginning of the sixties, we were facing a relatively high rate of urban growth (maybe rather low for the Chinese but important for the Europeans) and we were putting in thoses matters a lot of engineers' rationality. Very soon, I got convinced that although building, utilities, and roads were important, the main urban problems were not merely technical and had to do with the evolution of the society and the relationships between techniques, politics and the society. And my statement at that time was that we, engineers from the Politechnical Institute, were not really trained to recognize the importance of those non technical factors. Instead of getting involved in the public services when I graduated, I decided to devote myself to social economic research in order to better understand the evolution of the urban societies. And I was surprised how my colleagues would assume the responsibilities related to the field, in the name of the government and central administration, without any proper training and experience in the field.

After five years researches and applied studies where I had the chance to learn about the real functioning of local societies ineterrelating historical, cultural, economic, political and trechnical factors, i had the opportunity to become director of the services of the Ministry of Equipment (which at that time was in charge of housing, physical planning, transportation and urban planning) in a region of four hundred thousands inhabitants in the North of France. This region was entering an industrial crisis which would lead to some demographic decline, very far from what was foreseen in our adminsitrative procedures of city planning which had much to see with urban growth. Then once again, I found that the main questions were not technical but how this local society facing an economic and cultural crisis would be able to ovecome it. So, in a way, I

had chosen between what I would qualify of bureaucratic loyalty, to apply rigidly the central procedures, or society loyalty which meant that I had to adapt the procedures and the administrative approach to the real issues of society. Of course I chose society loyalty. On that occasion, I also learnt how important it was to manage an adminsitrative service through sharing a common vision of our commitment towards the society and not through mere adminsitrative and hierarchical approach.

After a while I became a Deputy Director in the urban planning service at the central level. Then, I got involved in international affairs and had to think out how the same urban problems must be tackle in different regions of the world and there again, I understood that if was only by trying to understand the society that you could have any relevant technical actions.

After having been for a short time, an Executive Officer in a large state-owned steel company, I decided in 1987 to move from the civil service and become Chief Executive Officer of the Foundation Charles Leopold Mayer for the Progress of Humankind, and I still assume this responsibility today on. Why would a high ranking civil servant decide to move to the Third sector ? To understand it, you must keep in mind the difference between the Chinese foundations and the European foundations. Our foundation has been set up from the endowment of its founder Charles Leopold Mayer and it achieves its goals with the revenue of the foundation : we do not raise money from the public sector and we are totally independent from states, companies or any other social actors and, thanks to our endowment we can think and act on the long term. Being the Chair of the foundation, I have found a very relevant, institutionnal and financial tool at a moment when the major challenges of Humanity were no more of a national nature but implied international, extensive exchanges experiences. The exchanges, even if technical matters are not of secondary importance, imply mutual understanding, intercultural exchanges and the acknowledgement that any technique is embodied in a culture and specific society.

2. The ethics of engineer on the 21st century presentation of the dominant ideology seen from a historical viewpoint

I have spent two years in Paris at the Ecole Polytechnique. The motto was : For motherland, science and glory.

To understand this motto which is still displayed in the wall of the school, you should understand the context when this first Institute was set up. It was during the French Revolution in 1789 and the core idea behind the creation of the School was to mobilize all scientific knowledge at the service of the motherland when the Revolution was alone to face the kingdoms of the rest of Europe.

The idea that the victory will lie on the ability to mobilize scientific knowledge a the service of the Revolution was very much in the philosophical mood of what they call the « Enlightment period » . What were the major features of this period ? You can find them out of some great figure of intellectual leaders of that time. I will mention first Condorcet who gave a global vision of human progress as a progressive liberation from superstition thanks to rationality ; another great figure was Monge, the mathematicien who first managed the School and was deeply convinced of the mobilization of scientific knowledge at the service of Humanity ; a third one was Carnot, a parent of the Carnot who discovered the second principle of thermo dynamics. He organised the resources of the nation during the time of the Napoleon wars.

These histories have deeply marked the very history and the ideology of the engineers. You must remember how people were thinking during this period, even the philosophical and social thinking was influenced by the Newtonian and the Lagrangian mechanics. You must also keep in mind how the discovery of the gravitation laws by Newton gave a deep impression. And then the Newtonian mechanics were characterized by some kind of simplicism and determinism.

These scientific theories aim at finding as few principles as possible explaining as many facts as possible, hence assuring an ability to anticipate a large bridge of phenomena. These relationships with simplicism and determinism will shape profpundly the mentality of the engineers. I will describe from that historical point of view some features of this ideology.

2.1 Engineers and the social sciences

As the Newtonian laws of gravitation could explain as well, the fall of an apple from the apple tree and the movement of the planet around the sun, that is micro phenomenon and macro phenomenon, it was very attractive to try and find in the field of the society itself such a simple law giving understanding of micro and micro phenomenon. And for a whole nineteen century, the search of social laws, equivalent to gravitational laws has been very clear. I will give three examples. The deduction of classic economics was that a very simple law, supply and demand and a balance between both could explain everything from the behaviour of the individual consummer to the macro economic evolution of the society.

As such, the Darwinism Law of evolution would at a sudden, in a consistent way with the fascination for competition in the economic field, give an explanation for animal and human evolution.

And, last but not least, the Hegelian and Marxism vision of history would give a simple and general law of evolutionof the society. In my opinion, the evolution of complex systems as society or even ecosystems cannot be reduced at such a simple and elementary numbers of laws. Then, the attemps to find these laws would very hearten engineers to some simplicism in the approach of social issues.

2.2 Engineers and the war

We should not be surpised to feel so deeply between engineers and the war. The thing is , at the first place, historical. Engineers, in the Greek times were military engineers, designing defence devices for the cities or machines for the siege of the cities.

The link between engineers and the war is not only a historical matter, it is also a current matter. It is not surprising if modern war is related that much to techniques and engineering as we have seen it recently the case of the Kosovo War with some illusion from the NATO that through techniques you could conduct a so-called clean war, which means in fact without any casualty for the NATO forces thanks to the use of sophisticated techniques.

One you carefully look at what it means to prepare a technical project or a modern war, you are surprised that it is exactly the same approach which is used. And, by the way, the Manhattan project which brought the Americans to get the nuclear bomb in 1945 has been a model for any complex technical projects.

In fact, the engineers and the war share the same logics. It is a technical sophistication at the service of a simple objective.

Deep links can also be found in the difficulty of converting armament industry to civil activities as it can be seen in the case of the former Soviet Union. The foundation has launched for the last five years an international network of exchange of experience about the conversion of armament industry. Through this network it was found that the main difficulties in converting amament industry has much to see with the psychology of the engineers. Through sophisticated arms industry case in the former Soviet Union, and the engineers had a chance to get means to carry on very sophisticated technical project . It was intellectually very stimulating and it was quite rewarding in terms of prestige. Now, getting involved with them in civil activities really useful at that stage of the development of the Russian society was a completely different matter. What is needed is not so much the product of sophisticated techniques than the result of a better understanding of the practical need of the population but for those engineers, to get involved in civil activities would mean the use of much less sophisticated techniques and a great loss of prestige.

You can see that peace has quite different logics than modern war. To put it simply, I would say that if war is the search of a simple objective through technical sophistication, peace means to manage complex compromises among partially interests but through often simple technical means.

It is often said that the military research is a great source of technical innovation in our society. I think it is right that it is not always very clear whether it doesn't push mainly in favour of sophisticated technical innovation, which might not be the most important needs.

2.3 Engineers, the rationality and the State

Remember the Ecole Polytechnique's motto « For motherland, sciences and glory » . In the French tradition inherited from the Enlightment period, rationality and the State go hand to hand. This rationality places engineer and science and the State in a way outside and above the society. The society is perceived as subjective, emotional, irrational. The engineers as a State bring rationality in it. Hence the propension of engineers and progress to think in the place of the society. Hence the frequent seduction of engineers for etatism and authoritarism.

At the rational logics of the engineers is found to be the only real rationality, it produces a difficulty for many engineers to understand the logics of the other social actors.

I, sometimes, qualify engineers as social autists. Autism is precisely mental disease which brings you to live in your own world not perceiving the external world. It is sometimes the case for the engineers, maily when they are involved in the civil service or in large companies. Along with this autism, the deterministic ideology of engineers makes them fond of plannification. Whereas the modern management of complexity means an ability to adapt to an unforeseen evolution. They do prefer plannification.

2.4 Engineers an the temptation of simplicity

There seems to be some paradox to speak about temptation for simplicity for engineers who spend many years to learn about very sophisticated knowledge. But one must introduce the critical difference between sophistication and complexity. Sophistication means that you use the

sophisticated, intellectual means. Complexity on the other hand means an effort to comprehend that is to say to understand as the whole the relationships inside a system which is not on a technical but also ecological social economic, politic and so on and so forth. The present tendancy, because of the sophistication of the means to train more and more specialised engineers increases their propension to avoid complexity that means internal sophistication absorbs the best of the and very few is left for the understanding of external complexity.

2.5 Engineers and human relationships

(Harbin 2 debut face b) that engineers do not feel very comfortable with human relationships. Of course, many investments have been intellectual and technical not human. I mentioned the tendancy for social autism and it is also frightened by the illusion of the unique best way which is one determined by the application of their own rationality.

In the recent years, the extensive use of computers and internet have even increased that propension. I remember discussing last year with teachers in engineers' school in France. They were concerned with the tendancy of their students to spend most of their time in front of their personnal computer instead of discussing with their fellow students.

2.6 Engineers : the « how » and the « what for »

Let me get back to the parallel between engineers and the war. All the training of engineers is linked to how to do things. It doesn't really prepare to discuss the « what for » . « What for » is always supposed to be given by the outside world : from political decision or from the rationality of technical progress and economic development seen as the very definition of human progress. Many engineers feel much more comfortable to discuss about means than to discuss about ends. Also for the very reason that discussing about ends means discussing about collective ends, which involves social and political dialogue.

2.7 Engineers and materialism

Most engineers are deeply disisinterested They don't work basically for money. The prestige from the corporation does not go, most of the time, for those who became businessmen and have made a lot of money for their own sake. Many of them, on a personnal basis have real spiritual life. But as professionnal, because they are so much involved in technical innovation, they contribute to the general belief that human progress can be assimilated to material development. That is why even if they are not on a personnal basis, they are mainly materialist in terms of their professionnal activity.

2.8 Engineers and the linearity of progress

Most engineers share the belief that there is a human progress defined in material terms. As mentioned, the roots in the enlightement period increase that feeling in the human progress defined in material terms and in a way predictable. Recently, with the increasing importance of economic measures in our perception of reality, this measure of progress has often been reduced to very material terms : increase of the GNP per capita.

2.9 Science, techniques and freedom

One must remember that science has been at the beginning of its development and seen as a fantastic tool of liberation for mankind and it has consequently been actually such a factor of liberation.

More recently, if you look at the Charter of UNESCO, you will find that science and freedom, research are seen as direct results of human rights and of freedom of opinion.

But nowadays, is science still to be assimilated to the increase of personnal freedom ? I do not think so. A famous French expert in prospective, Jean-Jacques Salomon, has very recently published a book entitled « Shall we survive to science ? » . Isn't that a strange question ? Double sounds theoretical for the scientific corporation ? In fact, I do think that it is on the contrary very profound. Technoscience nowadays is driven by the search for power from the different nations and by the search for profit by large companies. Our societies are clearly technically pushed much more than demand would. The need for technical innovation, for licenses, to create new technological secured income derived from the management needs rather than from social real needs. And, in that new situation, the orientation of science and technical innovation and technical innovation become out of the field of democratic debate. We can argue then that instead of the best democracy, science and technical innovation have turned in a way against democracy.

2.10 Engineers, the mechanics and life

Do the engineers prefer mechanics and the things to life and the living beings ? I am afraid that it is often the case. I take the example of agriculture. It happens that our foundation processes a lot agricultural domains in France and is looking at transforming it into organic farming then the managers of the farms turned to agricultural research to get the from them on how to do the things but on very few advices. They wanted to know what kind of med to , how to associate different types of grass of such med but the French agriculture research institution was unable to give sound advices because « with more than two varieties of grass it was impossible to modelize the behaviousr of the med ! » . It can be often seen that engineers do not like the situations which they do not control. For them, a scientific approach means the control of the different factors and this control can only be reached in a laboratory controlled experiment. This is of course, easy to conceive as long as you deal with atoms, molecules or bateria. But it is of course impossible when you deal with concrete social situation. Because the sciences even in many cases, social sciences have been influenced by natural sciences ; clinical approaches are hardly taught in engineering schools.

2.11 Engineers, the measures and the reality

May I tell you about a story ? There was a drunk man looking under city lights walking around and around, looking on the soil. Another man was passing by and asked him if he had lost something. The drunk man answered : yes I lost my keys. Then the other answered : did you loose your key under the city lights ? The drunk man answered no but I have to look for them here because there is light here.

This is a good metaphor for some propension of engineers to overvalue what can be measured. Maybe, the most important human question cannot be measured and since you cannot measure it, you neglect it.

3. The fundamentals of engineer ethics;

The fundamentals of engineer ethics can be derived from what has just been described : attention to human patience ; ability to listen at others logics ; articulation between (milieu face A N°3) ; opening to complexity ; looking for the ends as well as for the means.

But I would like to put them in a more systematic approach, which is the one of the Earth Charter.

What is the Earth Charter ? It is in the context of interdependence of different people in the world and of interdependence between humanity and biosphere which I will mention in the last part of the section., an attempt to formulate on a universal basis the rights and responsibilities of the individuals and humanity for the next century.

We have contributed to search through the *Alliance for a responsible and united world* : a citizen's movement to overcome the powerlessness feeling and to link together to cope with the main challenges of humanity for the next century. From that process on, we have identified five core principles for modern ethics which I will here applied to engineers.

Principle 1 : Always have to cope together with unity and diversity. Our world is unique, our world is interdependent and the very fabric of life on the Earth means the huge number of relationships between the diverse components.

What does it mean for an engineer ?

On the side of unity, it means to pay attention to complexity, always look for the unity of science and the articulation between disciplines, to build links between natural sciences and human sciences. Coping with diversity means the respect of the diversity of logics, the understanding of the diversity of cultures and of course the will to repect this diversity.

Principle 2 : It can be simply stated as what is called the golden rules in the interreligious dialogue. It is the rule which can be found in every religion and philosophy : « do not do what you would not want to be done to you » . Consider the other « at the same level as myself » means in particular, for the engineers once again to be listening to other logics and to pay attention to human patience, to care for the dignity of the workers, to recognize the legitimacy for the population to give its own point of view on matters which have an influence of it, etc.

Principle 3 : Knowledge brings responsibility. For an engineer, it means that there is a responsibility related to the scientific findings and technological breakthrough and because of the responsibility you have to contribute to the evaluation of this impact. You cannot consider that this impact is the business of others just because you did not take the personnal responsibility to apply these technological breakthrough to real fields. It also means a particular responsibility of engineers to feed the democratic debate on technical choices and on the impact of technical innovation.

The case of GMOs (Genetically Modified Organisms) in Europe is a perfect illustration of that question. GMOs for plants and animals were presented by laboratories and by the companies as a breakthrough which would allow to feed the world better, and so on and so forth. Neither the scientist nor the companies which decided to implement them had asked the population what they thought of such a manipulation of life. For the scientists and companies, any resistance to the generalization of the GMOs in food producing was irrational. The people's when asked to give their opinion, answered that they perfectly understand the benefits that scientists and companies can draw from the dissemination of the GMOs. However, the benefits for themselves are not at all clear. Although the GMOs innovation was largely supported by the governments which wanted to promote their leading companies, the reactions of the consumers was so strong that at the end, companies had to accept to make clear which products were issued from GMOs, after a period when they pretended that it was technically impossible and many GMOs products were withdrawn from the market.

Principle 4 : It is about being and having and it has much to do with the links between the engineers and materialism. We have to acknowledge that the only human progress is a progress in being, and not in having. I will not restrict my point to the Chinese population facing huge poverty and say that material well-being has no importance. It would be insane since I come from a developing country. But it becomes clearer and clearer that material well-being in the world is by no means a guarantee of a real development. At the end, engineers have to devote themselves to real human development.

Principle 5 : A balance must be found between stability and evolution. One could not oppose stability to evolution. Life being, can evolve and this capacity of evolution is a very condition for their survival and for their remaining the same. Hence, technical innovation cannot been seen for its own sake as if it was always good by nature. It has sense only from the fact that it brings society to be adaptable and to preserve its own major characteristics. That means for an engineer that innovation should never been opposed to respect of cultures, societies. It brings the means for society to adapt not to deny its former self.

4. The challenges of humanity for the 21st century and the role and responsibilities of the role of engineers

4.1 Are the main tomorrow's challenges technical or scientific ?

I do not think they are. Scientific innovation can be looked from the point of view of Esope. Aesope was a Greek philosopher and poet. He was a slave of a rich Roman. His master, to illustrate in front of his guests, the cleverness of his slave, asked him one day to prepare for dinner the best and for supper the worse. In both cases, Aesope prepared a dish made with tongues. His master thought he was laughing at him and wanted to whip him. But Aesope answered the tongues are actually the best and the worse of the things because they are used to speak and with a word you can bring war or peace. Well, science and technical innovation are the modern tongue. With it we can do the best and the worse.The choice is not embodied in science and innovation themselves.

We have entered a strange state of humanitywhere we have never been so clever and we have never accumulated so much knowledge and wealth, we have never felt so unable to face the major challenges of humanity development and even survive. Science and techniques have

brought many improvements and have created many problems. Scientist would believe that all the problems created by science and tecghniques will be solved by more science and more techniques. Thgis is a typically and ideologically belief and there is no historical reason to think they are right.

Let me take the case of energy.

A history of humanity has much to see with the energy management. In all the traditionnal societies and scientist society, the best example, the sound management of the renewable energy either from biomass, from human energy, was a matter of survival. Passing from the Hunting society to the agro-pastoral society have reflected a deepening in the art managing the natural ressouces then, after the agricultural revolution with a more systematic approach of the regeneration of the natural ressources came the industrial revolution which opened a new story. By replacing human energy by fossil energy, called then oil, we were passing from close ecosystem to open ecosystem bringing inputs, specially energy, from outside and sending back waste to the outside. For more than a century, our development grew, specially in the western world, could be identified with the growth of energy consumption. And it paved the way to what Suren Erckman called , by reference to natural ecosystem, immature industrial system, that is a system in which internal relationships are weak because the system reproduces itself by taking out external sources of inputs and energy. Now, at the end of the twentieth century, this process has come to an end. The planet is full of people and they are all looking to develop and then to consume more energy. From open ecosystem, we have to move to closed ecosystem to keep on our western way of living. Should we rely on new technological breakthrough, the mobilization of new sources of fossil energy, like uranium, of new ressources from outside like solar energy to special station, or Principally look for a change in our ways of living ? We have launched through the Alliance for a responsible and united world an international workshop on those questions and we think that it is much more liable to look for a new kind of modernity much more tha energy efficiency.

Most of the energy consumption goes to housing, transportation of persons and goods and for industrial processing. We can clearly reorient the mangement of our cities and the consumption of our houses in the direction of a much better use of energy. In Europe, at least, we begin to understand that there is no human cities relying on the extensive use of cars neither real comfortable houses without a better use of the sunshine, of isolation and of all the knowledge based on ecological architecture. The best example of poor energy efficiency is the former Soviet Union. Mega works can bring prestige to engineers, specialized approaches can give way to technological techniques but it is only a good global conception and maintenance which drives us to eco efficiency. The Soviet Union is an almost unique case of low standard of living and huge consumption of energy. A friend of mine was telling me recently : to improve energy efficiency, in Moscow, it is not ground technicians which are needed but one engineer and a thousand numbers ! One of the reasons why most choices are made in favour of developing new sources of energy nbetter than to develop energy efficiency is the power of the companies and corporations linked with energy supplied. On the contrary, the side of energy demand is scattered among milliosn of users. And the energy suppliers are in the mainstream of technological push and supply side push, namely in favour in mega structures.

One of the aspects, along with immature industrial structures while our present economic is highly anthropic, to speak in termodynamic terms.

4.2 The need for a global transition

Let me tell you briefly about the history of the platform for a United and Responsible World. In 1996, we have started a small international french speaking group of academics called « Le groupe de Vezelay » . We wanted to put together our knowledge, experiences and insights to try and understand what was happening to the world. For several years we worked intensively having understood the huge diversity of situations, visions and agendas in the world, we took a lot of time to listen to people from different backgrounds and different cultures. In this context, June 1993, a meeting in the new town of Cantho in Southern China, with 20 intellectual chinese. They got convinced that it was