

The disillusionment of Science
conférence à l'Imagination Week BBA
2 septembre 2016,
ESSEC business school

After graduating in agronomy and biology, Jacques Testart carried out research on artificial procreation in animals and human beings between 1964 and 2007. After developing gestational surrogacy for cows to accelerate artificial selection, he was instrumental in the first test-tube baby in France (Amandine, 1982), as well as with various infertility treatment methods. In 1986, in *L'oeuf transparent* [The Transparent Egg], he revealed, but only so as to denounce, the possible abuses of eugenics deriving from medically assisted procreation and the genetic selection of embryos. An Emeritus Research Director for Inserm, Jacques Testart has written over 300 scientific papers, many articles aimed at the general public, and 25 books on assisted reproduction, biotechnology and the relationship between techno-science and society. He describes himself as a science critic, and is committed to the democratization of science through the association "*Sciences Citoyennes*". In his address for iMagination Week, he offered students a reflection on the disillusion of science, and an optimistic and empowering view on how we can re-enchant science.

The death of science

Science is dead. This is the ominous conclusion I reached after 43 years as a researcher. I was not born a science critic. As a child, I was a naturalist. I was fascinated by insects, by mice and by the beauty of science in general. However, my career as a researcher taught me that science has gradually been dead and has been replaced by techno-science. Techno-science is a discipline whereby fundamental knowledge is applied with a view to creating a technological result. It capitalizes on the tools offered by science to do more science, which, in turn, will lead to the defining of better tools, and so on and so forth. This cycle has become an important element of the economy, but it is incompatible with making new discoveries. Today, innovation takes precedence over discoveries. When you hear about the great achievements of genetics, the invention of CRISPR-Cas9 to edit the genome, etc., these are all technological achievements, but they offer no understanding of how the human organism works.

Techno-science also hinders the freedom of researchers. Today, scientists are mere contractors. There is about one chance in ten of being awarded a research contract, and then researchers are tied for several years to producing something designed to be useful to the economy. This means that it is the market which governs innovation. As such, it is an economic tool rather than a cultural one. The Science philosophers talked about is dead. Today's techno-science takes advantage of the prestige of this Science, but only to favor patentability over truth. This has taken such proportions that today, reputable international journals have openly admitted that over half the papers submitted to them are falsified. The message the author(s) try to get across may be accurate, but charts, figures or results are edited so as to

reach the desired result. This goes against the very principle of fundamental research, in its quest for knowledge, and is an extremely alarming trend. Young students and researchers are exposed to these practices and forced to do the same if they want to survive in the world of research.

Techno-science is in no way democratic. It takes advantage of how the people worship techno-science thinking it is science, but has no regard for the population which finances research. Who chooses what topics should be researched? How are they aligned with the common good?

The birth of IVF

In 1964, I was hired by INRA as an Agricultural Engineer to find ways to improve milk production. There had already been some attempts with gonadotropin therapy, i.e., ovarian stimulation thanks to a gonadotropin-releasing hormone in order to increase ovule production. Because in vitro fertilization was not available, we had to use in vivo fertilization. This method, however, proved unsuitable, for two reasons. Multiple births are dangerous in cattle, and they lead to freemartinism, which causes infertility in female cattle born with a male twin. These outcomes were not compatible with the desired economic outcome of increasing milk production. I therefore developed a technique based on the same principle, i.e., ovarian hyper-stimulation, after which we inseminated the females with the semen of major milk breed bulls. A few days later, we retrieved the embryos by means of a uterine wash, and re-injected the embryos into desirable heifers, thereby developing gestational surrogacy for cows. The first calves were born from this technique in 1972. That same year, the European Union implemented milk quotas. While I was working on a way to increase milk production, the European Union, who had funded my contract, was also implementing commercial methods to prevent the overproduction of milk. I started questioning the organization and most importantly the legitimacy of science and research in Europe and in France. When I brought this up with the Director of INRA, he remonstrated with me, telling me that it was not simply a matter of increasing milk production but also a matter of having more competitive cows.

I felt increasingly guilty, and this was my first disillusion. During my research I had met and worked with farmers, cattle ranchers, etc. Some of them expressed concerns that the results of my work could be a threat to their livelihood. This made me realize how my scientific work was destroying the place of farmers, an issue which is still relevant today. It became evident to me that the so-called research industry was not acting on behalf of society. Had anybody thought of the impact my work would have on these men and women? Had anybody even asked consumers if they needed more milk or if they preferred more local and varied production?

After this experience, and by the end of the 70s, I felt the need to move on to something new. I had acquired unique skills in reproductive research and hormonology, and had made a name for myself in the field. In 1977, Dr Emile Papiernik, the head of the maternity unit of the Antoine-Béclère Hospital, suggested we set up a research laboratory in his service to work on human infertility. After my first experience, I felt that helping people build a family and bringing them happiness was a noble cause, all the more so that our goal was not so much to

create assisted procreative technology, i.e., to produce tools or techniques, but rather to understand the underlying mechanisms of human reproduction. One year later, a British team of researchers announced the birth of Louise Brown, the world's first test-tube baby. After the success of the British team, French gynecologists were putting a lot of pressure on me to achieve the same, which I was not opposed to. For me, this project the opportunity to help more couples, in ways we had been unable to until then.

IVF is a twofold undertaking. There are, on the one hand, obstetricians, who deal with the patients, prescribe the hormones; and then there are the labs, in which the gametes are fertilized. In the 1980s, there were two laboratories in Paris working on IVF, mine and another in Necker. Colleagues at Necker hospital were able to achieve IVF. I had succeeded in fertilizing the ovules, but when I transplanted the embryo it never led to a pregnancy. There was a lot of competition between gynecologists to "catch up" and to be the first in the country to achieve the same as the British team. Gynecologist Jean Kohen came to me and proposed a scientific protocol to identify why we were failing. This protocol consisted in harvesting eggs in both hospitals, transporting them by taxi to the two laboratories which were doing IVF, and then returning the embryos, if there were any, back to the initial hospital so the patients could receive their embryos. To our great surprise, the first attempt succeeded. It was terrible for the gynecologist I worked with, Rene Frydman, who had not been involved in this process, and who was suddenly at the head of the first test tube pregnancy. This experience gave me the opportunity to get a behind-the-scenes look at the medical world, which is driven by personal interests and competitiveness.

It took us two more years to conceive our first test tube baby, Amandine, who was born in 1982. This achievement attracted significant media attention, to an extent that made me uncomfortable. This success also triggered exacerbated competition among gynecologists and biologists, who fought to receive the praise for this achievement. Not only was I not interested in this race for fame and glory, but I suddenly became aware that medical research and the medicine "industry" was no longer at the service of patients, but rather at the service of those who practice it. This scientific achievement sparked numerous debates, and led to the establishment of a national ethics committee. But most importantly, from that point forward I started questioning our success, and the possible abuses of medically assisted reproduction. At that point, I met a group people from social sciences with whom I worked for about ten years: philosophers, sociologists, psychoanalysts. We met regularly for discussions, and this was a breath of fresh air. Researchers are surprisingly narrow-minded. There is an undeniable intellectual poverty in the scientific field, which is terrible when you consider the responsibilities entrusted to them. This was the opportunity for me to broaden my horizons, and to think beyond statistical results and scientific findings.

The media attention the birth of Amandine attracted was not a revolutionary scientific feat, our success came four years after the first test-tube baby. The Church and psychiatrists said we had separated sex from reproduction. But sex had long been separated from reproduction, ever since people started practicing *coitus interruptus*. We already had a number of very efficient birth control methods. I then understood that what we had done was actually bring about the conditions for the potential "lift the veil" on reproduction. When the embryo is under the microscope, it is in the spotlight, and we can therefore analyze it and foresee what type of embryo it is going to become. There are always multiple embryos with medically assisted procreation techniques. Therefore what these new methods were offering was in fact

the potential selection of specific embryos based on specific, genetic criteria. When I first raised this concern, gynecologists and geneticists thought it was ludicrous.

From building families to eugenic determinism

Four years later, in 1990, a team in the UK developed a technique called Pre-Implantation Diagnostics (PID). This method consists in harvesting one or two cells from the embryo in order to determine certain of their genetic characteristics, so as to choose the embryo which best suits the parents' project or health requirements. I felt the contribution I had made to helping infertile was already being abused. It was no longer a matter of helping couples who could not procreate to have a child, but to programme a child for potentially fertile couples who desired a child which met specific, non-medical criteria. The difference between prenatal diagnosis and PID is that whereas the former gives a couple the opportunity to avoid the worst, based on their own personal ethics, the latter is applied to find the "best", without this being motivated by sound medical reasons. I grew increasingly concerned that this would turn children into a manufactured product, and that society would gradually move towards a more and more pronounced refusal of differences between people based on arbitrary, genetic criteria. I also feared that children born from this type of process would live a life of immense pressure, having to live up to the expectations their parents had placed on them.

I refused to take part in this and, of course, I was dismissed from the lab. I simply could not contribute to the development of research enabling the manufacturing of calibrated children. The media misinterpreted this refusal; one newspaper headlined its story: "Jacques Testart, at the threshold of the sacred". As a fervent agnostic, this title baffled me. The article said that I had chosen to retire permanently from research. Of course, this statement was unfounded, because I had clearly expressed my intention of continuing to find solutions to help infertile couples have a pregnancy that would lead to a naturally "random" child. And this is exactly what I did. In 1986, I developed a method for freezing embryos. This enabled couples to freeze the embryos they did not use for their initial IVF should they want to use them again at a later stage, thereby saving them the trauma of having to go through the entire treatment all over again. In 1994, we obtained the first baby from a new, revolutionary method developed by Belgian researchers: intracytoplasmic sperm injection (ICSI). Instead of having thousands of spermatozooids to enable the strongest to fertilize, the sperm is injected directly in the ovule, thereby enhancing the chances of success.

At this stage, I published extensively on the abuses of IVF. Today, IVF counts for 3% of all births in France. In one third of these, IVF is used with no medical justification, and in two thirds of these births, the embryos are fertilized with the ICSI method, even when it is not medically necessary. This method is most widespread because it is easier to have the same process applied to all, even when this process is not necessary. I personally believe this is a mistake. We do not yet have enough hindsight to be sure this method does not lead to epigenetic diseases, but it is too lucrative a business for clinics and hospitals to give up on. Assisted reproduction has opened up a very lucrative business opportunity. This also explains its success and the support it receives, as well as the extent to which it complies with societal criteria, which are neither medical, nor well-founded. Moreover, the abuses of PID

Liberating research and making Science noble again

These two experiences led me to the conclusion that there is always somebody pulling the strings behind research. Researchers have no independence in this business-driven environment. I felt the need to reconnect with Science and to rekindle my passion for it. At that point, I was in charge of the research laboratory at the American hospital of Neuilly, with younger gynecologists. I wanted to do real scientific experiments, engage in selfless science, the science which elevates people, the poetic science. I was interested in studying how human gametes recognized each other. All species have a mechanism enabling them to recognize gametes from their own species thanks to dedicated proteins which can be found in the ovule and the spermatozoid. The scientific commissions authorized to issue research licenses and credits asked me what financial or medical benefits could be expected. This meant that for them the knowledge I was offering had no intrinsic. The second question they asked me was why I wanted to conduct this research, since a technique which I had myself developed rendered this knowledge unnecessary. This criticism was fair, but still a little difficult to hear. It meant that the technology I had contributed to develop was hindering the development of knowledge. I applied a second time, but this time round, I had defined a technological project which would “justify” the research in the eyes of the commission. Given that the proteins on spermatozoids and ovules I wanted to study enabled fertilization, understanding the underlying mechanisms would enable us to develop a vaccine to inhibit these proteins, thereby creating a form of immune contraception. This would have been particularly relevant for third-world countries because it is very cost-effective solution. They accepted the principle I was defending, but they then asked me who my industrial partner would be. This meant that in order to be judged worthy, a research project has to serve economic growth. Of course, I was unable to find a partner for this project. The pill and other contraceptive methods are too lucrative a business to jeopardize it! Because the project had no commercial outcome, the commission did not authorize the project.

All these professional setbacks and scientific disillusion led me to become what I call a science critic. In 2002, I founded with fellow researchers *Sciences Citoyennes* [Citizen Science], an association designed to democratize and rehabilitate Science. We apply for recurring credits for fundamental research, which are disappearing today. In the past, half of the budget of a research lab was dedicated to producing a contractual outcome, and the other to what we called “free research”, i.e., on topics which researchers were curious about and which they themselves chose. I believe we should bring this back, even if only in the interest of those who want to commercialize the product of scientific research. Today we are building only on the heritage of past knowledge. Our failure to renew this knowledge base can only lead to the exhaustion of investment possibilities in the future. From a less financial point of view, it is paramount we continue developing our understanding of the human organism. Should we fail to do so, this would leave us exposed to the consequences of changes in our environment and climate.

I also believe that targeted research should be based on the needs and desires of the population, and no longer dictated solely by economic interests. With that in mind our association has developed a system to enable the general population to give their point of view. A group of people is picked at random, and is given contrasting information on the research proposals. They are then invited to discuss the issue in question, and decide whether or not the research project we have offered is worthy of interest, is something that should be

done, and whether or not it serves the greater good. In doing so, we are putting “humanity” back at the heart of research. We also work on the protection of whistleblowers, reforming expertise and the idea of re-enchanting research. Today, the research situation is quite bleak. Other scientists, just as I do, feel disenchanting or disillusioned with their work as scientists. Bringing back the pleasure and enchantment of science, by offering projects which are requested by or supported by society, would give researchers a renewed sense of purpose, and that is what we need if we are to preserve the future of research.

The environmental disasters which await us in years to come make it all the more vital for the future of humanity to mobilize the vital forces of science and technology to ensure the survival of the species. Climate change will present threats we cannot yet imagine. Not just because of climate change itself, but most importantly because of the parasites and bacteria that this will bring about. This could happen as early as within the next 30 years, leaving us biologically and medically powerless. I believe a different science is possible, but this can only emerge in a new political economic context, freed from mercantile concerns.

Discussion

What position should we have in a society which favors media attention over factual discoveries, and personal gratification over scientific progress?

I do not know what can be done about this, because it is an integral part of the system.... I always feel I am somewhat of an alien when I say that competitiveness irks me. This is a perfectly common and acceptable notion for many, it is the lifeblood of business, and therefore of innovation. Those who want to be in the limelight by shoving others aside are perfectly integrated within the system, a system which is promoted by people like Friedman, our politicians and industrialists, who pretend to be interested in the fate of others and of the third world but are in fact serving economic and competitive interests. People like me are what is left of an archaic society, with outdated values and ideas. I, however, like to think that people like me are at the avant-garde of a new society. The way society works today is not only criminal, but also counter-productive, and most importantly, it is not forward-looking. The *conventions de citoyens* are a veritable scientific and maybe even political proposal.

My fight against eugenics is a fight for the survival of our species. Eugenics is a perfidious, selfish activity. In the past it was practiced on people who were deemed unfit to have a family. Today it is worse, it is a selfish desire, which people choose. Today it has become something pleasing, people are offered a ‘high-quality’ child. But this is particularly dangerous. Above and beyond simply preventing diseases we know about, people are now using it to choose the gender of their child. If we select embryos, we also select the individuals which will make up the society of the future, based on genetic and arbitrary criteria. The proliferation of made to measure babies will lead to the emergence of a sub-species selected in laboratories who could become the majority in only a few centuries. From an evolutionary point of view, society will thus be greatly weakened because these selected humans will not have the diversity which can normally be found in nature. We need this diversity in order to fight diseases against which we have no resistance. But if we take away what we think we do not need or simply what we do not understand, we are increasing the risks of extinction through the development of diseases.

Very quickly, you identified the need to set limits. Were you overtaken by the discoveries you made or did you feel guilty that you should not have gone this far?

I have no regrets as to my work on IVF. If I were to do it all over again, I would definitely not undo that. The only thing I would do slightly differently is ensure that greater precautions are taken. Back then there was no ethics committee. The very notion of ethics was strictly limited to philosophy or religion; it was a very foreign concept in science. Our only concern as researchers was whether or not the research we were conducting could have an adverse effect on the people, and that patients were duly informed. What enabled me to “sound the alarm” at a very early stage was that I had the opportunity to meet and work with people from a wide range of fields, who showed me how to approach problems differently. They taught me to see further than the tip of microscope. It really helped me gain a more comprehensive and long term analysis of the situation.

Are there any international organizations which can help support or bring about science and research which is not driven by economic interests?

This is the case in the field of agriculture, where there are converging efforts against GM products and pesticides. The medical field, however, is very peculiar, because surprisingly, what stands between research which resists the sirens of new technology and discoveries, is patients. Patients need medical support, and would do anything, whether or not this goes through eugenics. They do not care, what they want is results. Another barrier to achieving a knowledge-driven research is researchers themselves. Most consider that their role is to do research to find results, and they consider that what society will make of these findings is not their concern. In every country there are associations which promote this message. We have met them, but this only represents a minority and we have no joint course of action. Unfortunately, at present I do not have many allies in my battle. Let us hope that this will change over time.

What are the issues inherent to the development of transhumanism and what type of framework should be implemented in order to regulate it? Should it be legal, scientific or civil? Or maybe a bit of all three?

I am currently writing a book on transhumanism. It is a very complex and quite hopeless issue. I nearly abandoned this book because I felt that the concerns I was raising would only fall on deaf ears. The younger generations are much more receptive to the promises of transhumanism. A young man once asked me why I was against our becoming immortal. The entire discourse of transhumanism is built on very ancient myths which play on human fears. The greatest problem I see with transhumanism is that it is not driven by biologists, and yet it pertains to the human body. Scientists are reproducing what is possible with machines, but applied to humans, based on the principle that the human brain is mechanical. What I reject here is the notion that we have become machines. Just like eugenics, transhumanism focuses on ways to enhance humanity, to make it more efficient. I think it will be very complicated to regulate at this stage, the sum of possibilities is so vast that no ethics commission could every cover every possible scenario. I think that future world developments will leave us in such a situation of shortages, that being competitive will be grotesque, and aspiring to economic growth will be ludicrous when society as a whole will be struggling to survive diseases, starvation or wars. In all of this mix, transhumanism, and everything this notion conveys, will seem absurd. I do not think anybody would want to become immortal when their children are dying of starvation. I do not think the future looks bright, but at the same time, this may be the only way to avoid such developments.

Researchers are under the constant pressure of the ‘Publish or Perish’ system. Do you think we should reform the research publication system to leave more room for fundamental science, and how?

This is an on-going issue. The development of computer technologies is particularly useful. Researchers can now share their work with the entire world very quickly and easily. The problem with the publication system is that researchers do not only publish for the pleasure of advancing knowledge. They also publish because it is necessary to advance their career. Therefore, publications must be credible for the institution to which researchers belong, and publications shared via non-traditional channels always lead to the findings of the paper being questioned. There are groups of researchers who come together to form a reading committee to approve or disprove publications which can be found online. I think this is the way forward. It still needs to be perfected, but it is definitely a valid approach. Research institutions are generally wary of what is published via non-traditional channels. And yet, studies have shown that nearly all those which do go through traditional channels are falsified. The solution might be to publish less in general, publish more failures, and less false successes. Journal editors, researchers, institutions, rankings, all feed competitiveness, but not science per se. Therefore, if we are to make the scientific publication system more ethical, it is the scientific system as a whole we must question.

Who finances research in France today? How can we ensure that these investments are diversified and not simply dominated by economic interests?

This is a major question. When you get a European contract, a lot of money is at stake, but you do not always know where the money comes from. It can come from European institutions, public funding, and some private funding also. In France, institutions receive subsidies from industrial partners, a system to which I am totally opposed. Maybe it would be a good idea to ensure diversity is to create a “black box” system, where private, public and international organizations could place money for science in general. The real issue then would be how this money was distributed. Our *conventions citoyennes* for example, would be a wonderful way to achieve this with transparency and fairness. They could define how this money should be distributed. We do not presume that citizens should carry out the work of researchers and decide in which direction research should go, but rather define a general distribution of available funding, which laboratories and research institutes could then dispose of as they saw fit. This is the most democratic approach I can think of, and the one which is most in line with common law.

When these groups of people from all walks of life, different backgrounds, different levels of education come together to discuss an issue, they develop a wonderful ability which I called “humanitude”. They develop a collective intelligence and a genuine sense of selflessness. They have no vested interests, they are not thinking in terms of their family, their country, or on behalf of a lobby group. They genuinely think in terms of the common good of humanity and future generations. Sociologists are surprised to see how fifteen random citizens put in an appropriate environment, who are told they are defining the future of the world, that what they decide could actually make a difference, they develop wonderful human qualities. A system along these lines could tell us how money should be shared out, and what share of the budget can be allocated to fundamental research, which is often viewed as research for the good of humanity. These people are less biased and more inventive. They are bolder and have more integrity. They genuinely think in terms of the common good, and the wellbeing of future generations, with a human intelligence from which politicians worldwide could learn.