A plea for the reconciliation of science and culture

Why we need to reconcile science and culture

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Why are we publishing a plea for science culture? As President of Universcience[1], I feel vested with an enthralling mission, one that carries great responsibility. Bringing together the two great science education centres in Paris, the Palais de la Découverte and the Cité des Sciences et de l'Industrie, Universcience has the potential to play a decisive role in the development of science culture today. Moreover, as head of this new national institution, I wish to act as a spokesperson for all the people involved in science culture across France, for our network of partners in the provinces – the cultural centres for science, technology and industry (CCSTI), – and for all those who have the same educational mission, whether they are working in non-profit-making associations, community arts centres, libraries or other institutions. Together we are facing one of the key challenges of the new century, that of science culture and education.

To gauge the extent of this challenge, let us begin by acknowledging that for many of our contemporaries and fellow citizens, science and technology do not belong to "culture". The very expression "science culture" should be enough to confirm this. Why is it necessary to add "science" as a prefix to underline that the sciences are an integral part of our cultural heritage? When we speak of "culture", we invariably think of literature, the arts, perhaps history and social sciences… But do we think of science?

Yet today every aspect of our daily lives is reliant on science and technology. Our lifestyles, our housing, our creature comforts, our ways of communicating, learning, getting around – all these facets of our "culture" – in the general sense of the word – incorporate the benefits of advances in science. In everything that makes up our ways of living, our very ways of existing, science and technology are now inextricably intertwined with traditional "culture".

My humble ambition is to help our science museums and centres – and all members of the science education community – to reverse this situation, to convince our fellow citizens that science is neither incomprehensible nor out of bounds, nor reserved for a happy few. On the contrary, it is accessible to all – and it is fascinating. Not only is a basic knowledge of science necessary for us to understand the world we live in and play our full part as responsible citizens, it can also open up wonderful new horizons and lead to exciting discoveries. Drawing on the skills and experience of both the Cité des Sciences and the Palais de la Découverte, and all those who share my ambition, I intend to lead the drive to integrate science in our common culture.

Preparing and inspiring

Central to our plea is the question of education. Science museums have led the way with innovative educational practices. Their exhibitions, especially those designed for children,

[1] Created on 1st January 2010, this new state-owned enterprise is overseen by the French Ministries of Culture and Research.

have served as laboratories for new educational tools and methods. The use of scientific explainers has been a considerable success. Today we must take this initiative to a new level with 21st-century resources.

In a report on education in science and technology[2] that was recently submitted to President Obama, an interesting distinction is made between education that "prepares" students and education that "inspires" them.

In the plainest terms, I would say that while our schools are responsible for providing much of the education that "prepares" – the three Rs and other essentials –, organizations like ours, unencumbered with the need to adhere to curriculums and teach the core skills, are freer to offer education that "inspires". This is admittedly an oversimplification, as the two types of education are unquestionably linked. Far from being in competition, they are complementary and must interact. Each will then enrich the other.

Science museums nevertheless offer something that schools cannot. Our young visitors are encouraged to explore, question, enthuse, share, handle, experiment… But how do we preserve and develop the enthusiasm and curiosity that most children display at an early age and all too often lose as they go through school? Science museums can devise new "learning environments" that stimulate investigation, original approaches and information sharing. They can encourage the development of communities where knowledge is exchanged in a dynamic way. They can experiment with highly varied forms of scientific outreach. And they can create leading-edge content by using the new technologies that are revolutionizing our information media.

More specifically, we can appeal to the multiple intelligences[3] of our young visitors. The different forms of intelligence have been much discussed in recent years, but are still largely uncatered for in schools.

By focusing on these spheres often neglected by the school system, we make every young person feel that they are involved and their potential is recognized, whatever that potential may be and whether or not it has been identified at school. I will feel I have accomplished part of my mission if we can rekindle a thirst for knowledge among some youngsters, even more so if we manage to ensure the knowledge they acquire is not imposed from above but is obtained voluntarily and independently, as a factor in their personal development and empowerment.

I like the concept of *empowerment*. Not only have empowered persons acquired something that gives them a certain legitimacy, they have become more capable, they have developed their potential and increased their independence and responsibility. My aim is to help our young visitors achieve this personal development.

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[2] President's Council of Advisors on Science and Technology, *Report to the President. Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America's Future*, September 2010, pre-publication version. In an introductory letter to President Obama, advisors John P. Oldren and Eric Lander state "We must *prepare* students so they have a strong foundation in STEM subjects […]", and "we must *inspire* students so that all are motivated to study STEM subjects […]".

[3] See Howard Gardner, *Intelligence Reframed: Multiple Intelligences for the 21st Century*, New York, Basic Books, 2000. Gardner distinguishes eight forms of intelligence: spatial, linguistic, logical-mathematical, bodily-kinesthetic, musical, interpersonal, intrapersonal, and naturalistic. Emotional intelligence is often added to this list today. For my part, I would add creative-inventive intelligence.

Towards a new education

The Haut Conseil de l'Éducation[4] recently published a report on school results (*Bilan des résultats de l'École - 2010*) among the 11-15 age group. Some of its findings are alarming: "Academic failure greatly affects this age group. […] This failure is also evinced in the poor results obtained in 2008 in national assessments of the abilities of 15-year-olds in mathematics: 15% of them have severe or very severe difficulties, while 25% have only shaky knowledge."

This report forces us to acknowledge that the education given to many young students no longer attracts them to science.

What is to be done?

I think that science museums and centres – and Universcience in particular – have a key role to play in this field, in research, experimentation and reflection on the education of the future. Which new digital tools can stimulate the acquisition and sharing of knowledge? Which new applications are conducive to the development of a science culture? What contribution can be made by cognitive science or research into artificial intelligence? What experiments can we develop to innovate and evaluate new findings? We still do not know enough about the learning process. This is a wonderful area of research, but we must be bold enough to throw off old habits and traditions, and we must better understand what happens when a child embarks on an exploration of the world.

Disseminating, transmitting, sharing

We now live in the age of instant access. The availability of information has undergone a huge and sudden explosion with new ICT. But this solves the problem only partly, of course, because information must be turned into knowledge. Confronted with the wealth of resources now available, people must be helped to develop ownership of what they need, to *empower* themselves. This is where our expertise in mediation and outreach comes into play. We are also there to show visitors how to learn. Learning is essential at every stage in our lives: we all need to refresh and update our knowledge on a regular basis. How much of what we learnt at school do we actually use in our work, compared with everything we have had to learn in our work environment to stay effective? Centres like ours must also give a second chance to those who did not enjoy their schooldays and now wish to expand their knowledge as adults. In general terms, the guidance we can provide is increasingly necessary in a world that is becoming more complex by the day.

But beyond dissemination and transmission of knowledge, I want to put the accent on sharing. We do not wish to be part of a purely centrifugal movement in which "the learned" disseminate knowledge to "the ignorant", but rather a two-way centrifugal-centripetal movement based on sharing. The relentless expansion of the Internet – with constant contributions from users building up bodies of knowledge and the proliferation of social networks – is an indicator of a profound societal change, a need for everyone to share

[4] A consultative body set up in 2005, the Haut Conseil de l'Éducation focuses on essential knowledge, school curriculums and assessment of exam results.

information with everyone else. The contributions from all kinds of horizons need to be organized and regulated, of course, but their potential is of incalculable value.

Our mission is also to help visitors – children and adults alike – learn to sift the huge quantity of information that reaches us, so they can identify the most accurate and authoritative sources and appreciate that facts gleaned on television are not necessarily reliable. This is an invaluable asset in our world of instant access, a fundamental skill in the face of a surfeit of information.

Rigour, uncertainty, working with others

We have much to learn from science, and not least from the scientific approach itself. We can identify three crucial components: a scientific approach teaches us rigour, it teaches us to accept uncertainty, and it teaches us to work with others.

Besides the curiosity and enthusiasm I have already mentioned, children need rigour in their education, the rigour that is the very basis of the scientific approach. It is by confronting real phenomena, meeting strict verification and experimentation requirements, and facing complexity that scientists have been able to construct sound theories and formulate laws. To do this they have had to respect the rigour of experiment protocols and more generally the criteria governing production of scientific knowledge. Scientists must also submit every stage of their research to the judgment of their peers. These are precious qualities in any quest for knowledge.

However learned he may be, a scientist is also someone who constantly assesses what he does not know. Many researchers say that the scope of what remains unknown to them seems to expand the more they learn. A scientific approach requires us to recognize our limits and specify the inherent uncertainties in what we know. A scientist is rarely dogmatic. This can sometimes be disconcerting, because we expect science to supply us with certainties and dispel our doubts. The scientific approach teaches us never to abandon the rigour of reasoning and experiment, in the certainty that our knowledge will always be incomplete. This is a satisfaction in itself, however, as it means there is more to be explored and discovered.

In science, uncertainty does not discourage, it stimulates. It encourages us to take risks and to think boldly. Imagine a school where ignorance is not penalized but instead is turned into a "search engine"…

Science also teaches us the value of working with others. This is an essential factor in today's research. Scientists long ago could perhaps aspire to vast knowledge, but this is inconceivable today. Symposiums, exchanges and collaborations have become standard components of research at every level. Scientists routinely extend their knowledge by consulting others, especially peers working in closely related disciplines. This approach can be learnt at an early age. Another facet of our mission is therefore to involve young people in collective ventures and encourage them to work on projects with others. Science clubs focusing on computing, robotics, etc. offer an ideal opportunity. We can draw inspiration from experiments run in France and other countries to set up centres where youngsters can meet, interact, learn and create together.

Landscape and responsibility

When we speak of science culture, our aim is not to make everyone an expert in all disciplines. Philosopher and science historian Michel Serres evokes the idea of a "science landscape". We can all understand a picture of a familiar landscape, and we have learnt to interpret images representing exotic landscapes. Today science shows us images – from the infinitely small to the infinitely large, from atoms to galaxies – that make up the boundless landscapes of the universe. We need scientific culture to decipher the wondrous images of the world that science reveals to us, from a single cell to an entire galaxy. This does not mean that we have to accumulate the technical knowledge used by experts in each discipline, simply that we must draw on science to make the world more intelligible.

The global vision offered by this landscape gives the disciplines it encompasses all their meaning. It allows us to view the world in another way and include it among our familar landscapes.

Armed with this knowledge, we understand our world more fully and can take responsible decisions.

This too is the challenge of science culture today. In all the issues that have preoccupied our society over the last twenty years – sustainable energy, genetically modified organisms, climate change, epidemics, to name but a few –, we have needed scientific explanations to establish our position and form an opinion. In the societal choices we face, science culture is the essential ingredient for collective intelligence. On a wider scale, if we wish to assume our responsibilities today in the eyes of future generations, a common science culture is essential. Science will not tell us what to do, because it removes neither uncertainty nor freedom of action. But it can clarify our choices considerably by helping us to anticipate their consequences.

A plea for science culture

To support this plea for science culture, I have called on scientists, philosophers and epistemologists whose thinking I have valued for many years. Their contributions form the chapters of this book, which is organized around four major themes: matter and the universe; life forms; mathematics and information; epistemology and learning.

Each contributor draws on recent research in his or her discipline to push out the boundaries of what was once the sphere of experts, showing how the challenges faced must be met with a science culture widely shared by the general public.

In the first chapter, Étienne Klein shows how a seemingly obvious concept – mass – has changed its meaning over time, and shares with us the pleasure of "thinking differently". Jean-Pierre Luminet stresses the link between science and culture, showing, for example, how the conquest of space was a key influence on mankind's growing ecological awareness because it changed our view of planet Earth. Éric Lambin likens Earth's precarious balance to a tightrope walker's balancing act, and explains the factors involved in intelligent management of our planet's ecosystem.

Drawing on recent work in developmental biology, Nicole Le Douarin shows how research into life forms affects our oldest symbols, beliefs and values. Henri Korn takes stock of the

huge advances being made in neuroscience and cognitive science, increasing our understanding of the brain and thought mechanisms.

Gilles Dowek focuses on the capacity of mathematics to describe real objects and explains why maths offers a language for modelling ideas in physics and the sciences in general. Jean-Pierre Bourguignon provides a historical overview, showing us that mathematics has produced models since its origins, and that their use has been vastly expanded today by the calculating power of computer clouds. Jean-Gabriel Ganascia extends this line of thought by observing the directions currently followed by several disciplines, as they stand at the crossroads of the real and the virtual and develop experiments *in silico*.

Echoing some of my own concerns, Pierre Léna considers the best way to reconcile secondary school children with science, mentioning in particular *La main à la pâte*, an enquiry-based method developed for French primary schools. Jean-Marc Lévy-Leblond reflects on current paradoxes in the notion of science culture, clarifying the crisis in relations between science and society. Lastly, Bernard Stiegler examines the pros and cons of our new digital civilization, dissecting the fears and identifying the benefits.

Michel Serres kindly agreed to open this book, Edgar Morin to conclude it. Reflecting with their characteristic shrewdness on the place of science in today's culture, they underline its crucial importance for the whole of mankind. They call on us to approach politics in a new and broader way. The concerns of man and the future of the planet are now inextricably linked, and science is at the core of this new code of ethics.

My warmest thanks go to all the contributors to this book. Readers will no doubt find the essays within it raise as many questions as they answer. We hope they provide food for thought, as we all share the same enthusiasm and a common commitment – a determination to make science accessible to all, to make science an open and welcoming world that anyone can enter.