MAY 1998

THE UNESCO COURIER

Progress, risk and responsibility

INTERVIEW WITH **MARCEL MARCEAU**

ENVIRONMENT
RENEWABLE ENERGY: WINDS OF CHANGE

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The Leap. São Paulo (Brazil).
Photo by Lorry Salcedo-Mitrani (Peru).

**Presumed by his family to have been killed in the war,
Papa is greeted by his younger brother as he returns to his new home (Liberia).
Photo by Rip Hopkins (United Kingdom).**

THE UNESCO COURIER

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Consultant: *Georges B. Kutukdjian*

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Oil painting by the American artist Theo Rudnak.

Science and social responsibility

BY GEORGES B. KUTUKDJIAN

The ethical implications of scientific progress concern everyone

Today there is a certain degree of disillusionment about science, especially in the industrially developed countries. Science and scientific progress are indeed raising urgent questions, for example in the field of genetics. Who should determine the priorities and choices of science and technologies and on the basis of which social goals? How can we define democratically the risks which can be considered as "acceptable"? What is the level of responsibility and solidarity which can be expected from individuals and groups in relation to both present and future generations?

The answers to these questions go beyond the narrow confines of professional practice and national borders. In a multipolar world characterized by an unprecedented splintering of perceptions, it is more than ever necessary to strive for the emergence of values which will make our common existence technologically, ecologically and socially viable.

Such ethical reflection calls for a free and open exchange of experience and ideas among decision-makers, specialists and representatives of the civil society, in all its diversity, in order to identify the issues, set points of reference and advocate a range of forward-looking alternatives.

The development of science must henceforth be examined in a new framework. At the end of the twentieth century, the "battlefield" has become primarily one of economic warfare, and economies are increasingly being dominated by scientific knowledge, technologies and information. What has to be done is to develop new forms of knowledge and share them. Sharing knowledge goes together with sharing responsibilities. Science needs to be perceived as a liberating force.

At the same time, we cannot overlook the gap between the state of science in the developed and developing countries. Some of the devel-

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This model at a research centre in Faridpur (Bangladesh) is used to study flood patterns. The results will be helpful in designing and building flood-control barrages.

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Digital composite image showing a biochemist using a virtual reality system to investigate molecular interactions.

oping countries are facing crucial choices. Should the State devote its resources to science or should it tackle more urgent problems such as access to drinking water, for example? It should be recalled that industrial research is non-existent in the developing countries and that some of them do not allocate even one per cent of their gross national product (GNP) to science. For example, there is no research centre for industrial chemistry in any developing country. Meanwhile, the industrially developed countries seem to be suffering the consequences of the lack of flexibility that characterizes their unwieldy research institutions. It is as if the ability of science to create wealth were a burden on its own organization. These cumbersome and administration-oriented structures are discouraging investment by the industrial sector.

This is why there is a need to work out new strategies of scientific development. It is necessary to establish flexible structures of international co-operation and to turn science into an "international undertaking", for example through partnership programmes and by tightening the links between research work in all countries through conferences, publications, networks, the use of new information and communication technologies.

It can be seen today that there is a profound failure of understanding between laboratory science and the general public. This failure often stems from a lack of knowledge and is based on mistrust and fear: research workers sometimes have a dehumanizing and reductionist view of the public and, at the same time, the public is becoming increasingly wary of science. ▶

Scarcity of resources forces some developing countries to make the painful choice between investing in research and tackling more pressing problems. Right, a genetics-microbiology laboratory in Harare (Zimbabwe).

© David Reed/Panos Pictures, London

The public increasingly expects that major engineering works, in particular those involving technological hazards, should be preceded by comprehensive, stringent and independent technology assessment studies. These studies should take into account unavoidable technological risks, which cannot be altogether eliminated but must be reduced to a minimum, and should also address the question of hazard management. Their results should be made public in accessible form.

Transparency, truth and trust

The three Ts in this exercise are: transparency, truth and trust. Of course, transparency is time-consuming, but it is an essential ingredient of trust. This is also the case of truth. Misinformation or half-truths fuel rumours, induce fears and discredit those responsible for public information.

Accumulated experience illustrates that information provided in an impartial way is generally rewarded by responsible behaviour by the population concerned. This is particularly true in the case of the prevention and management of natural disasters, where UNESCO has acquired some expertise.

Surveys show that this is also true in the medical field, in particular in genetics. In fact, such a trustful relationship can stimulate the creativity of a population in response to a new and unexpected situation. Of course, a number of international guidelines and directives adopted by intergovernmental bodies, addressing these issues, exist; for instance in experimentation on human subjects or clinical trials, not to mention national Parliamentary legislation.

The safety issue is closely linked to the principle of precaution. (See article page 23.) More specifically, there is a felt need for education and information of the public at large, starting with the populations directly concerned. Mechanisms that guarantee the informed participation of the public should be devised. To be effective, these mechanisms must rely on the local authorities and involve leading figures of the civil society, as well as associations, consumer groups and other non-governmental organizations which have a key role to play in this area provided they are involved from the inception of the project.

Public debate can only enhance a democratic process very much needed in this area. The road lies before us, and if there is still a long way to go, we know the indispensable provisions needed for the journey. One such provision is a strategy of communication, in order to ascertain comprehensive information and a sense of solidarity.

Appropriate communication can only be based on accurate information, including that concerning uncertainties when these exist. Nevertheless, it would be illusory to think that irrationality can be completely eliminated; it can only be reduced. As a matter of fact, irrationality, nurtured by ill-understanding, can

Training farmers in Togo.

© F. Nouvelli/Ask Images, Paris

be built into a rational argument. This is an element which has often been overlooked.

The most topical example of the need for ethical safeguards in regard to scientific progress lies in the field of genetics. This example reminds us of the ambiguity of science, which is one of the most powerful ingredients of societies. Today we can no longer close our eyes to the ethical issues implicit in science. It is no longer possible to envisage an ethical neutrality of knowledge that would be independent of its subsequent applications. Thus, the General Conference of UNESCO, on 11 November 1997, adopted a Universal Declaration on the Human Genome and Human Rights. This Universal Declaration provides a consistent and comprehensive set of ethical principles which should guide both research and applications of research findings in biology and medicine. (See page 34.)

We also need to be able to think out the conditions of ethical control over discovery. Scientific institutions have a responsibility with regard to the environment of research workers and must ensure that research is governed not solely by the lure of gain but also by the desire to protect life and cater to the welfare of human beings.

Finally, science can no longer be regarded as the repository of truth. Science does not state mere certainties. It constantly challenges itself. It is in the balance between doubt and certainty that the ethics of science places its role.

Scientific knowledge no longer depends on the genius of human beings, it calls for gigantic resources, both human and technological. Hence scientists themselves recognize the importance of the social acceptability of their undertakings. The level of acceptability relies heavily upon a balance of measured risks and unwarranted risks. And present societies have a clear perception of the need to establish priorities, even when the alternatives are not always clearly defined.

This situation places new responsibilities upon the scientist, the engineer, private and public decision-makers (in particular in the industrial sector) and the citizen. These responsibilities can only be assumed through discussion and the construction of common values. ■

NASA scientists set up equipment to measure gases that will be given off during the burning of a deforested area in the Amazon (Brazil).

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Energy: a fair deal for all

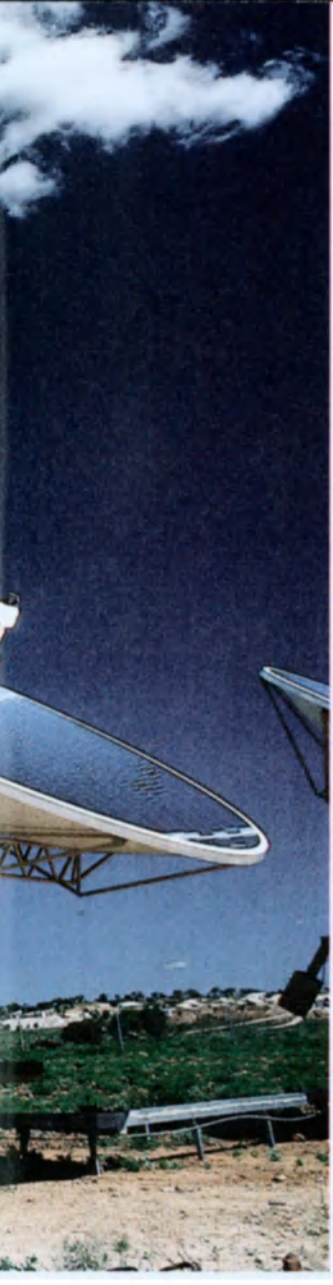
BY JEAN AUDOUZE

Both the supply of energy and the demand for it have spiralled in modern societies, where everyday life and changes to the environment, global as well as local, are conditioned by energy production and use. At the same time, there are more than a billion people in the world with an income of less than a dollar a day, and more than two billion rely on firewood as their sole source—if any—of energy. There is a crying need for a fairer share-out of material goods, energy and economic resources.

Energy comes in three forms: so-called "fossil" fuels (coal, oil and natural gas); nuclear power; and "renewable" energies (hydroelectric power, thermal or photovoltaic solar energy, wind and tide power, wood, etc.). Each of these has its own undeniable advantages and drawbacks.

Fossil fuels

Fossil fuels are abundant and very simple to use. Oil, for example, can be very easily transported and processed, and is relatively cheap. The technology for producing its many derivatives is highly developed. What's more, it is particularly well suited for use in all forms of land, sea and air transport. Its handy fluid form and its price make it appropriate to the



Above, White Cliffs solar power plant, New South Wales (Australia).

Right, gathering firewood near Lake Abaya in southwestern Ethiopia.

World energy resources are inequitably distributed. The author of a UNESCO report on the ethics of energy suggests ways of righting the balance.

needs of poor communities or those that are unable to invest in capital goods.

Fossil fuels account at present for 77 per cent of all the energy produced and will, according to the most realistic projections, still account for 73 per cent in 2020. Worldwide annual consumption of coal, natural gas and oil stands, respectively, at 2.3, 1.7 and 2.7 GTOE.[1] Proven reserves at 1990 consumption levels stand at 200 years for coal, 40 for oil and 60 for natural gas. These figures may be multiplied by between two and five if improvements in productivity and efficiency and the exploitation of the last remaining deposits, such as those of oil shales, are taken into account. The resources will be strictly limited geographically as well as in duration, being restricted to certain regions such as the Gulf and the Caspian Sea. This state of affairs is fraught with the risk of tensions and even conflicts, owing to the strategic importance of energy supplies.

Fossil fuels are, furthermore, responsible for the man-made increase in the carbon dioxide content of the earth's atmosphere, with the associated danger of an increase in the greenhouse effect and, as a direct result, global warming of the order of 1^0 to 4^0 C in the next twenty years, which would adversely affect the climate and the environment. Though much uncertainty remains as to the scale of these effects, the risk is great enough to mean that every effort should be made to slow down the increasing "carbonization" of the atmosphere due to the intensive use of fossil fuels.

Nuclear power

The main advantage of nuclear power is that it has no effect on the carbon dioxide content of the atmosphere. As it is also cheaper (per energy unit) than hydroelectric or thermal energy, some countries, France for instance, have opted strongly for this way of producing electricity. ▶

© Edgar Cleijne/Lineair Arnhem

1 TOE or "tonne oil equivalent" is the energy supplied by the combustion of one tonne of oil. G stands for giga = one billion, 10^9.

Nuclear power is, however, far from being unanimously accepted. Public opinion is very conscious of the lack of candid information and of the safety of nuclear plants, two aspects that have not always been treated, in some countries, with all the necessary care and clarity by the authorities and the operators. The public is also worried about the disposal of long-lasting radioactive wastes, an acute problem to which the experts seem confident that a long-term solution can be found. It would also be a mistake to underestimate the danger of the spread of nuclear arms, even though the main powers are now significantly reducing their arsenals of these weapons. A final point is that only those countries which can afford to make the huge investments required can put nuclear plants into operation. The investment is offset by the low cost of the fuel but is recouped only in the medium and long term.

Renewable energy sources

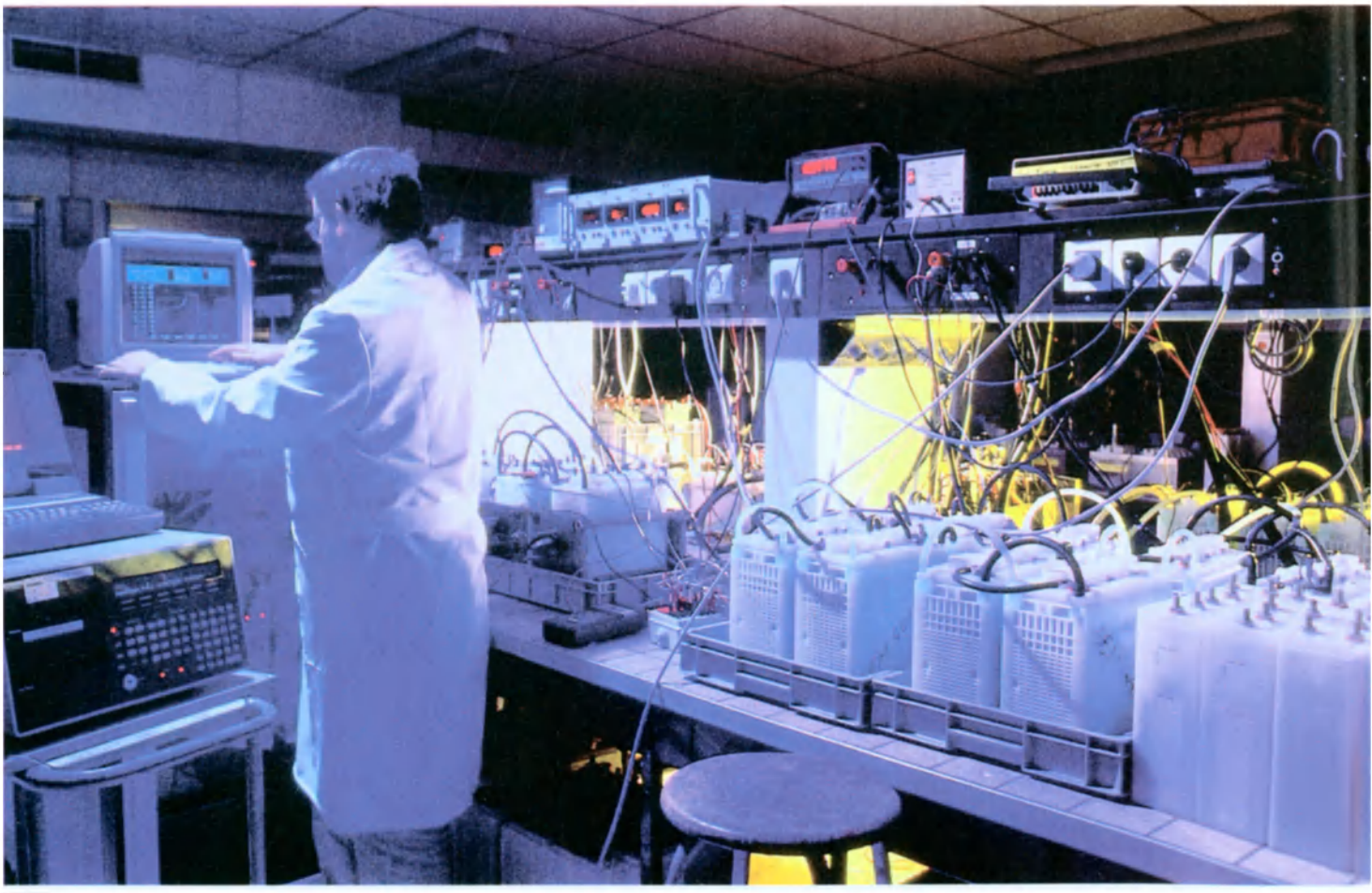
The ecological movements, which are worried both by global warming and by the real or imagined dangers of nuclear power, would like renewable energy sources to be developed faster than is now the case. These forms of energy at present supply some 18 per cent of total demand, which puts them well ahead of nuclear power.

Technology is moving rapidly forward in this field. Thanks to technical improvements, the price of energy produced by photovoltaic cells, for instance, is due to fall from $5 per kilowatt-hour in 1990 to $0.5-0.8 by 2010.

These forms of energy are capable of meeting the needs of communities that it would be too expensive to connect to a central grid supply, but despite improved productivity and falling costs, they remain on the whole dearer than the two previous forms. It will be a long time before they can constitute the main source of supply. Other problems that remain to be solved include the major investments required for hydroelectric power stations and the environmental damage caused by the building of dams and wind farms.

We must face the fact that as of now there is no "miracle" energy that is risk-free for humans and their environment and is also cheap and inexhaustible. There is no such thing as absolute security as regards power generation and use, and it will not be possible in the future to do without any of the above-men-

Making batteries for electric cars in Bordeaux (France).



© R. Bossu/Sygma, Paris

Demonstrators protest against the shipment of nuclear waste to Gorleben (Germany) in 1997.

tioned sources. Energy demand will continue to grow as a result of irreversible technological advances, of the justified demands of the non-industrialized countries, and of population growth that is in any case set to continue for at least the next fifty years.

Some ethical principles

A number of imperatives must thus be borne in mind by every individual, every nation and, in particular, the citizens of the industrialized countries. These are: the right of each individual to sufficient sources of energy; our responsibility towards our children and our children's children; protection of the environment; prevention of the potential major risks from the production of energy on a massive scale; the control of costs and the need to carry on with research in all these fields.

Some of these obligations—those relating to population growth, climate change or the disposal of nuclear wastes, for example—are of a very long-term nature, while others—efforts to deal with pollution caused by road transport or chemical waste disposal—are short-term. These differences of time-scale and the various possible interactions between the quantitative and qualitative aspects of the question have to be taken into account in observations of an ethical character such as the following:

☛ The present situation, whereby nearly one person in four in the world is without access to the energy resources he or she requires, cannot be accepted with resignation. Those with an active role in world energy policy—decision-makers, industrialists, research workers and so forth—must ultimately ensure that there exist, and continue to exist, sufficient resources of sufficiently cheap energy for all countries to have access to them, regardless of their geographical or economic situation. It is accordingly essential that genuine co-operation in energy matters be established on a sound basis between the countries of North and South.

☛ There should be no pretext for unnecessarily keeping the countries of the South, which urgently need proper infrastructures, on short commons as regards energy use. This is one area where, more than in any other, people ▸

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A solar dryer in Ghana.

need to be informed, so that they can take part in discussion and decision-making on subjects where scientific and technological knowledge is essential.

☛ Our duty to future generations enjoins us to use energy resources as sparingly and rationally as possible, especially as we know that a major part of these resources may be exhausted in a century or two. We must also take collective action to avoid creating irreversible situations with regard to the environment and energy management. We must take particular care to apply the "precautionary principle" so as to avoid causing too great an increase in atmospheric carbon dioxide, to be careful and economical in our output and use of energy, and to do all we can to prevent any event with irreparable consequences from occurring.

☛ Even though rapid progress is being made in the exploration of space, we must acknowledge the obvious fact that we have only one Earth and must therefore preserve and protect it. Since energy production and use may jeopardize our environment, there is an urgent need for appropriate measures to be taken as rapidly and as effectively as possible. The management of nuclear waste and campaigns to combat all forms of pollution arising from energy use constitute unconditional obligations in this connection.

☛ Whenever massive quantities of nuclear or other forms of energy are produced or transported, e.g. when oil is transported by sea or big dams are built, major risks to life and health ensue. Absolute safety is unattainable, but the various energy authorities are nevertheless under an obligation to issue and enforce appropriate safety regulations. These precautions should be applied to the two risk situations just mentioned and should also cover everyone working in the power-generating industry, especially those employed at nuclear and major hydroelectric plants.

☛ Unit cost will continue to be the main factor influencing the choice between different forms of energy. Production costs must be controlled and savings constantly sought if energy supplies are to be available to all. In the case of nuclear power, the costs arising from safety procedures and the decommissioning of plants should be taken into account.

☛ Research sometimes seems to have been neglected in work on energy production and consumption, but it is an indispensable duty. Efforts to find new sources of energy and

more economical ways of using it must continue. One example is the use of natural gas, which is in itself a vast field for research. Other priority areas for research include technologies for producing nuclear power—fast breeder reactors, energy-boosting systems, thermonuclear plants, etc.—and waste disposal systems. Efforts must also be made to reduce the cost of renewables. The industrialized countries must give effective support to research in the developing countries and show them how to maintain their energy facilities.

Further recommendations

We must keep our eyes open for the early warning signs of potentially dangerous or irreversible situations, and react quickly to them.

Application of the "precautionary principle" remains an unconditional obligation. We must take economic and fiscal measures designed to avert the risks of tension between producers and consumers and to encourage proper control of the resource in question. The tax instrument should be used to redistribute resources between privileged and less privileged groups of the population.

The man and woman in the street and their elected representatives must be informed about everything relating to the production and consumption of every kind of energy. Parliaments should have their own scientific and technological evaluation services, as is the case in certain countries such as France. Projections made on the basis of different economic and demographic hypotheses ought to be regularly updated.

Last but not least, systems must be created to enable internationally enforceable measures to be taken. The environmental balance sheet drawn up by the United Nations five years after the Rio Summit was, inevitably, an admission of failure and reflected the deep disappointment aroused by governments' inability to engage in dialogue and undertake joint action.

Now it is realized that no form of energy can replace any other form, we must endeavour to preserve the balance between producers and consumers, between rich and poor countries, and between those that are spendthrift and those that are thrifty. ■

Indigenous people of the Amazon at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro (Brazil).

© J.L. Atlan/Sygma, Paris

The right to know

BY NICHOLAS A. ASHFORD

What are the legal and ethical responsibilities of industrial enterprises when communities and workers are at risk from the sudden and accidental releases of toxic and/or radioactive substances into the atmosphere?

Well-known examples of such incidents occurred at Seveso (Italy) in 1973, at Bhopal in India in 1984, at the Three Mile Island (Pennsylvania) nuclear power plant in 1979, at Chernobyl in Ukraine in 1985, off Alaska in 1989 and the French coast in 1978 due to oil spills from the supertankers *Exxon Valdez* and *Amoco Cadiz*, as well as a large number of chemical production and petroleum refining catastrophes.

Such events sometimes engender legislative responses. The passage of the U.S. Emergency Planning and Community Right-to-Know Act (1986) and the so-called first and second Seveso Directives of the European Union (1982) are examples. In the United States, the Clean Air Act Amendments of 1990 require increased attention to the risks of sudden and accidental releases, placing obligations on both government and on industrial firms.

Democratic risk management

Right-to-know, the mandatory sharing of information between management, workers, and the community, embodies a democratization of risk management decisions.

Early right-to-know legislation in the

Alaska (U.S.A.), May 1989: the battle against the oil slick discharged after the supertanker *Exxon Valdez* ran aground.

United States and elsewhere addressed workers' and communities' right to know *scientific information* about the ingredients in chemicals and materials used in production, waste content, actual chemical releases to the environment, and information about exposure to gradual, expected pollution. But *technological information* about potential system failures, unexpected chemical reactions and releases, and ameliorative control technology is also needed, and here, right-to-know legislation is more recent and less adequate. While risk management plans requiring "worst case scenarios" to be explored by firms are increasingly common, obligations to identify superior, inherently safer technologies are notably absent. In addition, much of the important information is held closely by industrial firms and is not shared with either workers or the community.

The relevant rights and obligations under right-to-know fall into three categories.

☛ The *duty to generate and/or retain information*, i.e. a firm's obligation to compile and retain a record of certain facility-based events such as near misses or system failures.

☛ The *right of access* (and the corresponding duty to disclose upon request), i.e. the right of a worker, union, community member or agency to request information and access to information held by a manufacturer or employer.

☛ The *duty to inform*, i.e. the firm's obligation to disclose, without request, information needed by government, workers, and communities to understand the potential risks of sudden and accidental releases; to assess the adequacy of in-place technology and human resources that can prevent, minimize or address the consequences of those risks; and to identify the technological options that could have been adopted but were not.

Conflict analysis

The law establishes legal rights and provides remedies to correct their violation. But it also recognizes that conflicts of legitimate interests, conflicts of legal duties, and differences in perception of what is right or wrong, fair or unfair, require an appropriate balancing in the fashioning of remedies. Indeed, there are both legal ▸

Hydraulic engineering class in a Chinese university.

© Trygve Bolstad/Panos Pictures London

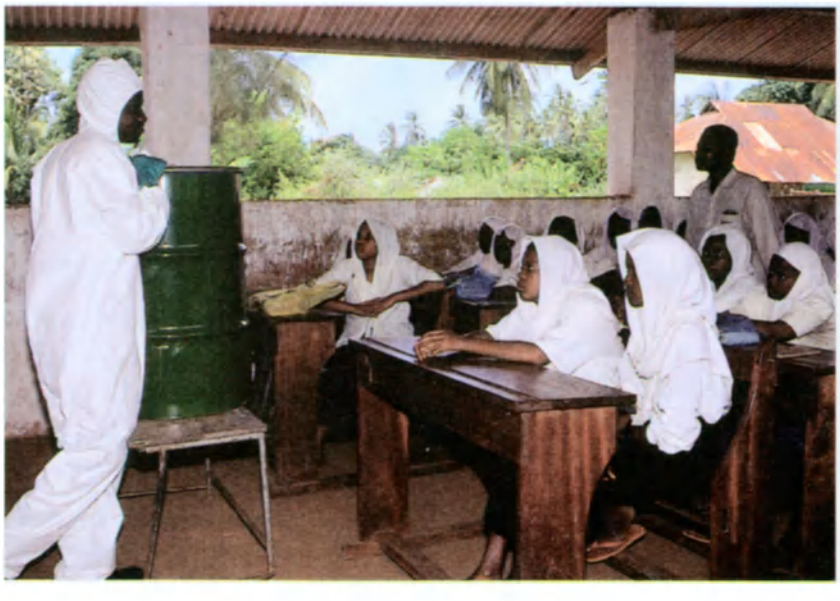
Chemical spillage training (Malaysia).

remedies (usually of statutory origin) and equitable remedies that give great discretionary power to the courts or adjudicating institutions. In examining questions of conflict, the law views behaviour in the context of relationships, and will sometimes find a duty when none was intended by original legal arrangements, because it was reasonable that workers or the community expected certain behaviour on the part of an industrial enterprise.

The law does not, however, always serve the ethical interests of society so nobly. Legislation and legal institutions can be compromised by powerful special interests. In addition, if there is a lack of societal consensus or interest about a moral issue, the law may either not address that issue or fail to give helpful guidance concerning the boundaries of fair or equitable behaviour. Thus, it is important to engage in both a legal and ethical enquiry concerning human and institutional behaviour.

In the context of the risk management of low probability, high catastrophic events, legal and ethical norms are in a state of considerable flux. Conflicts of interest and conflicts of duty (for example, for the corporate or government official in charge of protecting the community and workers) abound. Just how much should workers and the community be told? Given the arguable scientific uncertainty of constructing worst-case scenarios for sudden and accidental releases, questions of what risk communication activities and preventive actions to take or not to take may reflect differences in perceptions of fairness and risk-averseness. In possible contrast, a duty on the part of industrial firms to identify and implement superior, inherently safer technology that would both reduce the risks of sudden and accidental releases and bestow cost savings on the firms themselves, would seem to be morally irrefutable.

Students in Zanzibar are taught how to dispose of agricultural chemicals as part of a Netherlands Council of World Development project.



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Internal conflicts among the duties of various stakeholders (firm and government officials, workers, community residents) can lead to psychological distress and sometimes to unethical behaviour. Community residents may feel torn between a duty to be well informed (so as to anticipate and respond appropriately to danger) and a duty to maintain their own peace of mind (which is conducive to rational thought) and present a calm exterior for the benefit of their families.

Environmental and public health professionals have experienced conflicts between their duties to prevent panic in the community and to inform the public of potential danger, as well as between the duties associated with their roles as scientists, wage earners, public servants and employees of a particular branch of government. Other individuals who work for governmental agencies have experienced conflicts as a result of their multiple roles as promoters and regulators of a particular industry, such as nuclear energy.

Conflicts arise from the relative significance of "subjective" versus "objective" information and from the nature and degree of uncertainty, error, and/or risk that is tolerable. Community residents, workers, and agency professionals may disagree about priorities: residents and workers worry about experts' ability to assess and control risk, while "experts" fret about citizens' and workers' "unreasonable demands" for certainty. All the members of a group will not necessarily share the same views on these matters. Conflicts occur between those trained and socialized in a technical field and those who identify more closely with humanistic traditions.

Anxiety and stress affect key figures who are faced with unprecedented situations, scientific uncertainty, and a need to make decisions quickly. Since the catastrophic incidents mentioned above, professionals have acquired experience and received specialized training. Nevertheless, in the political controversies that develop and the continuing scientific uncertainty surrounding sudden and accidental releases of toxic substances, government officials and professionals still find their personal moral integrity threatened. Workers or residents of communities where a dramatic accident has recently occurred, are generally not well prepared to cope and can be expected to respond emotionally and with confusion. They need to be treated in a non-patronizing way like any other victims of natural disasters, with understanding, patience and counselling.

As risks become more uncertain and serious, the case for fuller partnerships between industrial firms and their workers or communities concerning risk management options becomes stronger and more ethically imperative.

Shared decision making

Participation by members of the affected communities is an essential element in constructing ethically-sound risk management decisions. This can be facilitated in a number of ways, notably including the utilization of advisory panels.

A variety of possible technical and legal interventions is available, from minor to major changes to plant and production, from training existing personnel to hiring new professionals, from adopting specific legal requirements to suggesting administrative processes. Both new laws and institutions and informal ad hoc mechanisms are needed to involve the affected public and other key actors more fully in risk management involving sudden and accidental releases of toxic and radioactive substances. In general, the earlier that people are involved, the more effectively adverse effects and loss of trust are likely to be avoided or minimized. Firms, government, communities and workers have begun to explore ways to address the problems. Law provides little structure at this time, but the ethical and moral imperatives remain. ■

1. The natural world

BY GORDON BENNETT AND NIKITA LOPOUKHINE

The creation of protected natural areas raises a host of dilemmas

© Yann Arthus-Bertrand/*Earth from Above*/UNESCO

Nature is in a state of constant flux. It is shaped over time by dynamic natural processes such as flooding, fire, wind, volcanoes and climate, and in response to these forces some physiographic features, species and ecosystems have disappeared and others have evolved. People, of course, have also played an integral part in this process, and in recent times modern technology has dramatically increased the scope of human influence.

Change is inevitable, but how should we respond to it? There are generally three options. First, a "laissez-faire" or natural regulation approach to the management of natural resources. A more commonly exercised option is to channel or even arrest change by "active management", an option frequently associated with wildlife, water and forest managers who are chiefly concerned with the extraction of resources, although it may also be used to compensate for damage to natural processes or for extirpated species. A third option, also a form of active management, is to try to restore conditions which once existed or even create new assemblages of plants, animals and physiographic features, e.g. creating wetlands where none previously existed. The ethical choices facing managers of protected areas are intricately linked with all three options.

Systems of protected areas are usually established to embody a country's varied landscape in accordance with a bioregional framework. For various reasons representation of a bioregion's full variety is not always a realistic objective within a protected area. The size of protected areas, their configuration, and the lack of

© Yann Arthus-Bertrand/*Earth from Above*/UNESCO

Air view of a tourist complex in Lanzarote, one of the Canary Islands (Spain). Lanzarote has been the site of a UNESCO biosphere reserve since 1993.

Hinchinbrook Island National Park (Australia).

linkage to other protected areas all add to the difficulty of maintaining representation over time. Nevertheless, it is often possible to approach representation by choosing sites that are relatively undisturbed or that have the necessary potential. An important aspect of this approach is to write a goal or purpose statement that declares the level of desired representation.

Islands in an unfriendly environment

Most of the world's protected areas are surrounded by land that is used in ways inimical to them and are subject to long-range as well as local influences. The trajectory of a protected area's ecosystems is likely to be deflected away from the originally defined representation values, and in response the park manager is faced with choosing either to ignore the changes or to address them through one of the options noted above. The "laissez-faire" option—abandoning the area to the vagaries of influences within and outside it—is, in effect, an acceptance of change. The ethical dimension of a "laissez-faire" approach is to determine whether the original intention to achieve bioregional representation and the biodiversity associated with this goal are placed in jeopardy and whether the outcome is appropriate. For example, to permit a forest or prairie fire to burn or to have ungulates proliferate unchecked has significant consequences on the biodiversity of a protected area.

It is not our intention here to judge whether the consequences are good or bad but to point out that change will occur even when the decision not to intervene is made. Ethics here require the manager to be forthright in ▸

providing information on the consequences of a decision, even a "laissez-faire" decision. The notion that natural regulation will manage the protected area does not absolve the manager from the responsibility of setting objectives. It is impossible to determine the success of a particular management regime unless the changes are forecast in advance, debated, agreed upon by stakeholders and finally set as objectives.

The second option—attempting to minimize change by setting fires, culling, mowing, girdling, or modifying water flow regimes—raises more fundamental ethical questions: what right do we have to alter nature to meet our objectives? Does the manager of a protected area, of all places, have the right to dominate nature? Are the objectives of conserving the genetic values, structures and functions of ecosystems a good enough reason to intervene? Even if one answers in the affirmative, the question immediately arises of deciding which genetic values, structure and functions are appropriate. The matter becomes a debate between biocentric and anthropocentric values—between what might be called "deep ecology" and utilitarianism.

Open discussions

In the past century, the rationale for establishing protected areas has moved steadily away from the utilitarian to the biocentric. The initial motivation was to create places which people could enjoy. Later, protected areas grew in number as societies wished to absolve themselves from guilt over destroying the environment while also responding to economic opportunities. Today, the ideas of ecological integrity, biodiversity conservation and bioregional representation are the driving forces behind the establishment of protected areas. These goals provide a framework within which appropriate ecosystem structures and functions can be defined. Nevertheless, to be assured of continued support, open discussions on management objectives must take place. In these discussions, it may very well be that the best way of defending proposed objectives and goals is to present the alternatives to them. In simple terms, would it be acceptable to consciously decide to have biodiversity values decline, lose ecological integrity, and witness the decline of ecosystem health?

The third option for managing protected areas, centred on restoration, raises another ethical issue. Restored sites are seldom, if ever, replicas of the targeted state. Extirpated species and genetic stock, modified natural processes and landscapes, and altered physiographic conditions make it impossible to recreate what may have once existed. Substituting close representatives is not the real thing.

A more fruitful debate arises from the question of whether it is appropriate to reconstitute the functions and structure of an ecosystem, particularly in a protected area. If the protected area contains degraded sites and altered natural processes, and species have been extirpated from it, should these be restored? The debate over biocentric and utilitarian objectives is to be expected in this context as well.

A fundamental question which arises in all restoration projects is that of the historical model which the project seeks to reconstitute. A wilderness model (prior to European settlement) is commonly put forward as the appropriate target in many North American sites. This is a questionable objective if the model rejects human influences. Clear evidence exists that humans have played a significant role in influencing ecosystems within North America for thousands of years, as they have elsewhere in the world. To be ethical, then, exclusion of human influences is inappropriate. Instead, the objective should focus on the restoration of a social fabric where the practices of humans sustain the ecosystem and vice versa. ■

A ranger in Kluane National Park, southwest Yukon (Canada), a UNESCO World Heritage site.

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A Canadian approach to cultural resource management

The ethics of conservation

2. The cultural heritage

BY GORDON BENNETT AND NIKITA LOPOUKHINE

Louisbourg (above), on the Saint Lawrence River (Nova Scotia), was a key French fortress in Canada and a major trading centre. Part of this historic landmark is being rebuilt following the original plans.

In the late 1980s, Parks Canada, the agency responsible for the conservation of Canada's cultural and natural heritage, began to develop a cultural resource management policy, partly to synthesize good work that had been done elsewhere, but also to help to cope with apparently conflicting expressions of conservation ethics. The Parks Canada Cultural Resource Management (CRM) policy drew upon a wide range of policy and ethical formulations developed by other national and international conservation organizations, and in 1994, after several years of development and public consultation, it was approved by the Minister of Canadian Heritage, who tabled it in the Canadian Parliament.

The CRM policy takes into account that ethical issues operate at at least three levels:

- ethics of intent or purpose (why?);
- ethics of means (how? and often who?);
- ethics of results (what?).

The levels or categories are not mutually exclusive, but neither are they necessarily mutually reinforcing. Ethical means may not always lead to the desired ethical result, and an ethical result may be achieved by means that might not have been the first choice in terms of the second category. The CRM policy attempts to ensure an alignment of all three.

The policy consists of three parts: principles, practice and activities. A training programme designed to facilitate its implementation emphasizes that ethical decision-making requires that all parts of the policy be used. In other words, the policy is not a menu from which you pick and choose. One of its key features is that it does not distinguish between various types of cultural resources and establish different management approaches for each, as is the case with most other cultural resource management policies and international charters. Another is that it does not focus only on conservation.

Three Canadian examples may help to demonstrate how the ethic inherent in CRM ▸

has led to better decision-making and to enhanced respect for cultural resources. Two of the examples call into question some practices of professional conservationists, whereas the third deals with a site facing serious financial challenges and a series of development proposals that divided people into pro-development and pro-conservation camps.

Critical to all three was the application of a concept developed by Parks Canada called commemorative integrity, which is used to describe the health and wholeness of a national historic site. A site possesses commemorative integrity when:

- the resources (including the place) that symbolize or represent its importance are not impaired or under threat;
- the reasons for the site's national historic significance are effectively communicated to the public;
- the site's heritage values (including those not related to national significance) are respected by all whose decisions or actions affect the site.

Lower Fort Garry Walls (Manitoba)

Lower Fort Garry National Historic Site, which is located north of Winnipeg, Manitoba, was an important 18th-century fur trade establishment operated by the Hudson's Bay Company. Technical experts advised that if action were not taken, the then 130-year-old perimeter stone walls would collapse. Consequently, an approach was developed that led to the reconstruction of two of the walls. The action was highly controversial, but proceeded with the blessing of senior conservation specialists. Following the development of the Cultural Resource Management Policy, this approach was called into question on the grounds that the action did not respect the historic value of the walls and violated the commemorative integrity of the site. The reconstruction approach was abandoned and the surviving walls have been stabilized.

Fire protection for wooden buildings

This illustrates a case of conservation ethics gone awry. For at least a generation many conservationists were opposed to the opening of certain historic wooden buildings to the public on the grounds that a requirement to provide fire suppression facilities for buildings accessible to the public was incompatible with the preservation of the buildings' authenticity. Professional conservationists should have recognized that in the case of wooden buildings, fire suppression was not a threat to conservation, but rather an indispensable instrument in its attainment.

Fort Henry, Kingston (Ontario)

Confronted with significant reductions in government funding, the agency responsible for operating Fort Henry, a site located in Kingston, Ontario, developed a business plan that proposed several initiatives to raise revenues. The proposals divided the community, various stakeholders, and agency staff into pro-development and pro-conservation camps. A decision was made to develop a Commemorative Integrity Statement for the site with the participation of the various competing interests. The statement led the persons who had initially advocated controversial development proposals to conclude that the proposals were inappropriate. ■

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Fort Garry, north of Winnipeg (Manitoba), below left, was a major 18th-century Hudson Bay Company fur trading post.

Below right, re-enactment of 18th-century daily life in the fort.

How predictable is nature?

BY JENS ERIK FENSTAD

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In spite of progress in mathematical modeling, natural phenomena still defy precise forecasting

Above, a man outside his home in flood-ravaged Grand Forks, North Dakota (U.S.A.) in April 1997.

The future of science is not what it used to be. The optimistic public perception that scientific insights and technological advances would provide a better future has suffered a severe setback. Such "benefits" of scientific progress as atomic power, new chemical compounds and foodstuffs produced by genetic manipulation now generate uncertainty, even fear, as to what the future holds in store for man and nature.

The post-war period was a good time for modern science-driven technology: it had played a decisive part in the allied victory and now it was to be harnessed to the tasks of post-war reconstruction, promoting increased welfare, better health and improved security. Few were troubled if at times scientists and engineers showed little concern for the preservation of nature—after all, the aim of technology has always been to transform nature for the benefit of humanity. There may, however, be limits to what nature can tolerate.

Relatively few doubts were raised until the United Nations World Commission on Environment and Development issued its report, *Our Common Future*, in 1987. By that time there was growing concern about the environmental problems progress was bringing in its wake: the fossil fuels used in industrial development were increasing the carbon dioxide content in the atmosphere, threatening to create a greenhouse effect; urbanization was eating into agricultural land and woodlands; industrial expansion was causing increased pollution and loss of fresh water resources. Further ahead loomed the threat of the loss of biodiversity. Addressing these problems, the Commission's report, often referred to as the Brundtland Report, advocated a policy of sustainable development, whereby current demands could be met without prejudice to the legitimate demands of future generations.

The Brundtland Report became the charter ▶

Destruction of rain forest for housing development (shown on hoarding in foreground) east of Ipoh, Malaysia.

document for the "Earth Summit", the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992. One of the most important things to come out of this conference was the Rio Declaration, which set forth guidelines for the future environmental policy of United Nations Member States. One key element in this was the recommendation that, in order to protect the environment, nations should apply the "precautionary principle", which may be summarized as follows: *Whenever there is a threat of serious or irreversible damage, lack of absolute scientific certainty shall not be used as an argument for delaying cost-effective measures to prevent the destruction or degradation of the environment.* Never precisely defined, this principle is open to different legal interpretations and raises problems about uncertainty and actual risks.

The Brent Spar controversy

The story of the Brent Spar oil rig provides an object lesson in the complexities of applying the precautionary principle in practice. The Shell oil company wanted to get rid of this platform, which had served its useful life in the North Sea oilfields, by sinking it at a suitable spot in the Atlantic. The environmentalist movement Greenpeace successfully campaigned to persuade the public—and hence the politicians—that this would present an unacceptable environmental risk. Shell claimed the opposite but was not believed, and the platform was towed to a Norwegian fjord, where it still awaits its fate.

With the benefit of hindsight, it seems that the risk analysis carried out by Shell was correct and that the Greenpeace assessment was based on inaccurate data. This does not necessarily mean, however, that the platform can safely be disposed of at sea. Scientific risk analysis is only part of the story: there are strongly held emotional convictions about the purity of the sea and opposition to its becoming a rubbish dump. As a basis for action, risk analysis needs to take account of all aspects of a case.

In the Brent Spar case, the decisive issue was whether sinking the platform at sea would lead to serious or irreversible environmental

damage. As in many environmental conflicts, the debate was adversarial in form, which is usual in normative and legal contexts but has hitherto been unusual in scientific arguments over issues of "scientific certainty". Does this mean that in environmental issues we are confusing questions of fact with matters of opinion? Should Shell and Greenpeace have got together to conduct a dispassionate enquiry about scientific laws and facts before embarking, if necessary, on a discussion of the pros and cons of possible action? Can factual knowledge be separated from the question of how that knowledge is used?

A positive answer to the latter question presupposes that scientific laws exist and that scientific certainty can be established, at least within acceptable error limits, which has been the received view of science and technology. From Newton's classical mechanics to Einstein's relativity and up to the time of Bohr's quantum mechanics, the laws of nature were expressed in the language of linear mathematics, and the future was computable.

The relationship between mathematics and the laws of nature has, however, become more complex, and in a way that has implications for our understanding of the precautionary principle. The fact that those laws are still written in the language of mathematics no longer means that the future is necessarily predictable. To explain this issue, let us see how the mathematical modelling of nature works.

The blue and green circles are computer-generated theoretical models of how the distribution of galaxies evolved. Gold circle at bottom shows the real distribution as observed from Earth.

Models of nature

There are three stages in mathematical modelling: first, the specific scientific and/or technological problem is analysed; next, a mathematical model is created and analysed; and lastly, efficient algorithms—problem-solving procedures which can be run on a computer—are developed for use, in the scientific context, in making predictions and, in the industrial context, in construction tasks. With the rapid development of computer technology, the range of applications is vast, testifying to the central role of mathematics in today's "knowledge society".

Successful application depends, however, on the "correct" choice of mathematical model. One class of models is particularly relevant to a proper understanding of the precautionary principle. We often need to understand the behaviour of a system or a population of individuals over a certain period of time, e.g. the flow of oil and gas in the North Sea fields, or plant and animal populations in areas with a high concentration of acid precipitation. The models used for this purpose can be divided into three main classes, according to the dynamics that governs their behaviour.

Nature as a machine

Models of nature as a machine represent our inheritance from Newton and Descartes. They are defined by the forces acting upon the body or bodies involved in the system, and the laws that determine the system are expressed by a linear equation. To take as a typical example the laws governing the trajectories of planets, once the proper parameter values—in this case the position in space and time and the initial acting force—have been established, the future development of the system is completely determined. To use mathematicians' terminology, the system is defined by a "unitary group", with time as the independent variable.

This is the kind of mathematics used in numerical calculations and industrial applications. Assuming that our equations faithfully describe a slice of reality, we extract algorithms from them, and the computer then goes to ▸

work, either to predict the future state of a physical system or to produce a set of specifications for an industrial task. Our confidence in the equation is sometimes so great that the results of the corresponding calculations are presented as true facts of nature.

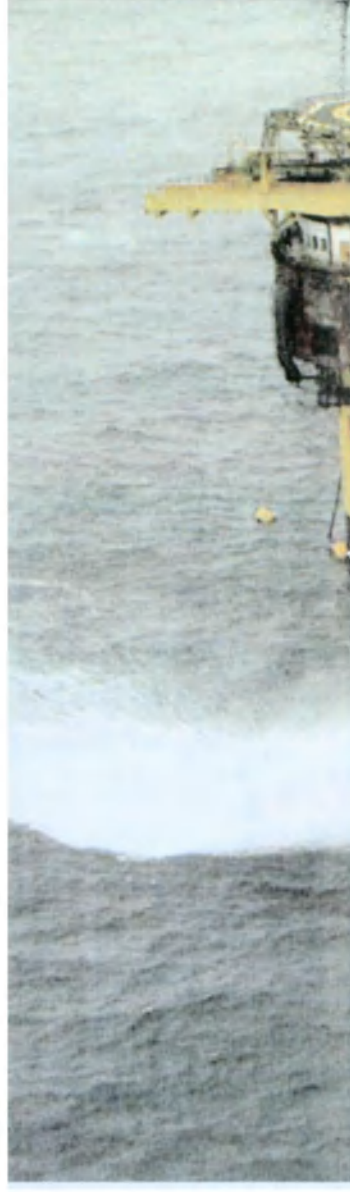
Computer simulations can be used for many purposes. In science, measurements can be extended to values beyond those obtainable from experiments and observations, e.g. to study systems under extreme temperature conditions, and the development of a physical system can be speeded up, e.g. in studies of the early universe. In industry, simulation can replace the use of prototypes—it is faster and cheaper to simulate collisions on a computer than to crash real cars—and can be used in the design of new pharmaceutical products. The presupposition underlying all this is that our models correspond with reality—and that the future is determined by our equations.

Chance and uncertainties

So far we have assumed that the law is deterministic and that, in principle, the results of experiments and observations can be measured with absolute precision, but this is in most cases too much to ask: we may be in a situation characterized by chance and uncertainties. Mathematical modelling knows, however, how to deal with such situations.

Where parameter values cannot be precisely measured for technical reasons, there are established theories for measurement techniques and many statistical methods are available for controlling errors. Where uncertainty is inherent in the fundamental theory, however, new issues arise, especially in the case of quantum mechanics, where the development of a system is governed by a probability distribution. In this case too, the process is nevertheless still determined by a unitary group. The new feature is the use of a transformation of probability distributions where the Newtonians used point transformations. The latter allow us to follow closely the planets in their trajectories, but not quantum particles.

Another form of uncertainty arises when the dynamical law is no longer deterministic but may include a stochastic or random element. This marks a shift from ordinary to stochastic equations, which are now widely used in mathematical modelling. The applications are sometimes opportunistic: in the absence of complete knowledge, a random term is added in the hope of obtaining a better fit with nature. In most cases, however, our knowledge of nature and observed fluctuations is sufficiently precise to



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Children, the elderly and people with heart and lung disorders are particularly vulnerable to the effects of air pollution.

The Brent Spar oil rig is prepared for towing into the Atlantic, June 1995.

provide "faithful" models for phenomena ranging all the way from the flow of oil and water in porous geological structures to speculation on the stock exchange.

Common to the models examined so far is a belief in numbers and measurements. There has been a strong tradition in physics according to which theory is driven by measurements, i.e. by exact numbers. It has been held that good theories yield numbers, explain numbers, help design good apparatus, and allow us to control and manipulate the objects they describe. But are all theories of nature equally amenable to numbers and control?

Chaos and catastrophes

The unitary group thus encapsulates the notion of linearity and the associated possibility of exact prediction, but despite several hundred years of progress in physics and technology we must conclude that only a few of nature's phenomena can be modelled in this way. One solution to the problem is to introduce chance and uncertainties, as described above. Another is to keep to deterministic equations but to proceed beyond the well-known domain of linear equations into the new and largely unexplored territory of non-linear phenomena.

Physical theory has always acknowledged the existence of non-linearity, which typically occurs where small variations may have large effects on the future evolution of a system, but only now is the outline of a reasonably complete science of non-linear dynamic processes beginning to emerge. The first really convincing application of non-linear theory to a natural phenomenon came in 1963, when the meteorologist E. Lorenz published a paper entitled "Deterministic nonperiodic flow", which had basically all the "correct" mathematics. His equations were a simplified form of those used in modern numerical weather forecasting, but they were sufficiently complex to capture the unpredictable—even chaotic—behaviour inherent in the long-term development of the weather. ▶

"Chaos" and "non-linear science" have become fashionable terms but, unlike many other fashions, there is substance behind them. The transition to non-linearity marks a change of paradigm in the modelling of natural phenomena, but with non-linearity there is no longer a guarantee for long-term prediction. This is the lesson we learned from Lorenz in 1963.

Instead of computing a single given future, we can, however, simulate various possible future scenarios. The computer can be taught to serve another master: there has been a change-over from "hard" science based on computable predictions to a broader perspective with greater emphasis on insight and a critical attitude. Hence, though we cannot predict the occurrence of the next avalanche, we can use our models to gain a better insight into such phenomena and to develop strategies for warding off their adverse effects.

Earthquakes are also impossible to "predict", in the sense of giving the time, place and strength of a future occurrence within acceptable error limits. Such an operation presupposes a system governed by a unitary group, but the earth as a geophysical system is far more complex than Earth as a planet. Planets are predictable in their trajectories; they form a deterministic system. The earth as a geological system is in what the experts call "a state of critical self-organization", where there is a positive probability of even the smallest earthquake developing into a major disaster. Many attempts have been made to devise a warning system for earthquakes, but they have all failed.[1]

The global processes that drive earthquakes are typical of the very many global processes in nature. These processes need to be seen in conjunction with a social and economic system committed to a high per capita consumption of natural resources. It is in this context that the precautionary principle becomes urgent: we are dealing with natural processes that we know to be non-linear, where the dynamics of the system is poorly understood and where our interference may have irreversible consequences. Unlike a standard industrial process, nature is not a mechanical system that can be controlled by ingenuity and engineering skills alone. Instead of relying on our ability to fix and restore, we must therefore adopt a strategy of prevention. In these circumstances, the precautionary principle is more than political rhetoric. It is the best advice that science can offer. ■

1 See the *UNESCO Courier*, October 1997: *Natural disasters: Be Prepared*. Editor

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"Spiralunar 3D", a fractal landscape based on the mathematics of chaos theory, which is used to analyse turbulent (non-linear) dynamic systems.

© Peter Menzel/Cosmos Paris

The development of genetic testing confronts humanity with urgent challenges

Genetic testing and discrimination

BY MICHAEL KIRBY

At the heart of adverse discrimination lies difference. Many people only feel comfortable with others who appear exactly the same as themselves. Inject an element of differentiation and such people may feel entitled to act in prejudicial and even cruel ways.

Sometimes making distinctions may be justified. A person with a highly contagious disease may need to be isolated for the protection of society and the proper treatment of the individual. But the history of the century now drawing to its close has been one of irrational and unwarranted discrimination. It is still going on. The grounds have included the victim's race, skin colour, gender, disability and sexual orientation. All of these are wholly or partly genetic in origin.

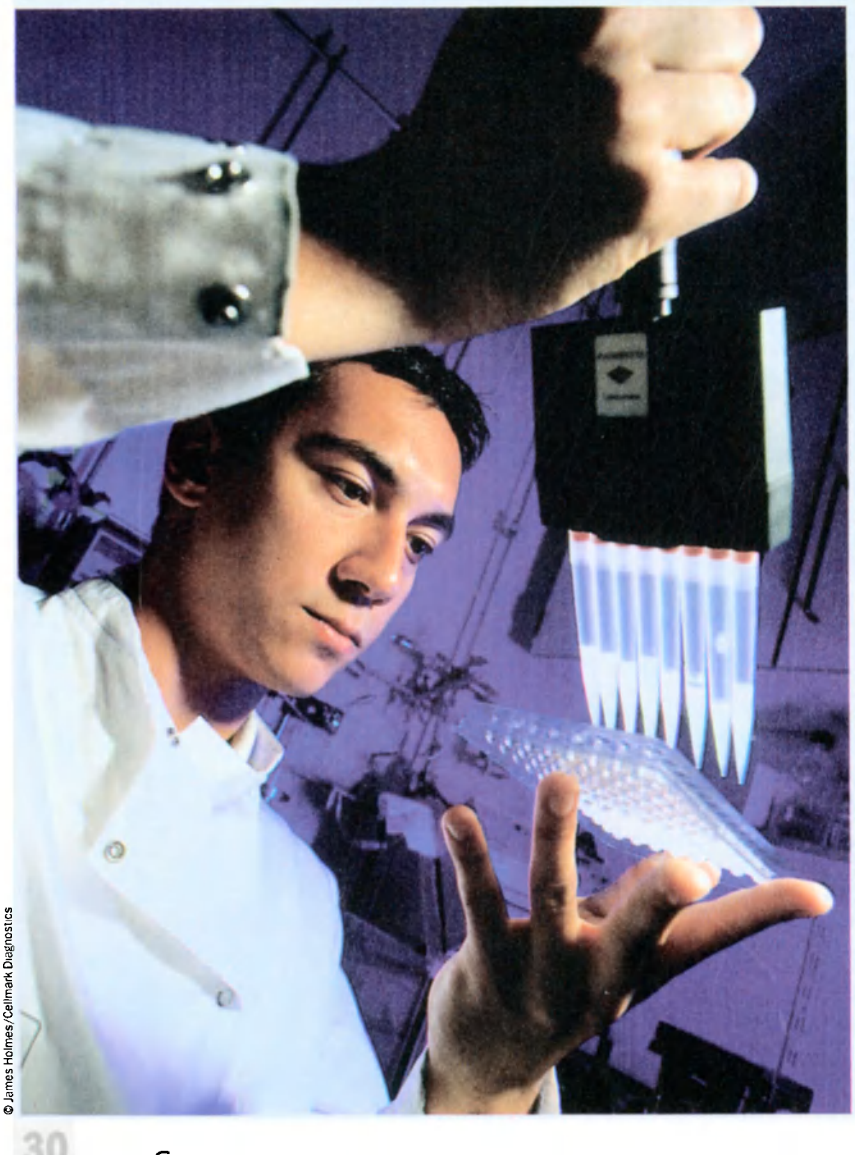
For some people, the fact that an individual did not choose to be different does not matter. Even if the difference is completely irrelevant, it can sometimes affect most seriously the individual and the society concerned. ▶

Above, symbol of the Human Genome Project. The baby's silhouette stands out against a karyotype (chromosome set).

The Universal Declaration of Human Rights, proclaimed fifty years ago, has offered the world a beacon of hope to guide us away from irrational and irrelevant acts of adverse discrimination. But whilst much progress has been made, the abiding challenge of discrimination, grounded in the fear of the unknown and the unfamiliar, remains. Now, at the end of the century, new potentialities for discrimination are presented. They arise from the rapid development of genetic testing which promises to identify more indelible elements of human differentiation upon which adverse discrimination could be based.

Genetic testing

Testing human beings for genetic conditions is not entirely new. Pregnant women in many countries have for years been able to undergo amniocentesis to detect the presence in the foetus of genetic abnormalities such as Down's Syndrome. For years, physicians have been able to test patients for Tay Sachs disease (an inherited and ordinarily fatal nerve disorder), sickle cell anaemia and other inherited conditions. But the progress made over the past decade in the Human Genome Project will ultimately ensure that genetic causes of human differences are identified. Many that are responsible for inherited cancers and other serious diseases have already been isolated. Amongst those discovered are the genes causing several late onset disorders such as cystic fibrosis, muscular dystrophy, Huntington's disease and, most widespread of all, Alzheimer's disease.



This British researcher belongs to a team that has engineered a molecule which "switches off" a gene causing leukaemia.

© James Holmes/Cellmark Diagnostics

Mistakes can occur in the performance of tests to identify the presence of genetic disorders. As with the well-known tests for HIV (human immunodeficiency virus), there can be false positives and false negatives. But apart from this problem, current tests cannot predict, with accuracy, precisely when a genetic condition will manifest itself. The genetic test for Huntington's disease (an inherited condition which manifests abnormal movements and mental deterioration, generally occurring in middle age) has a 99 per cent accuracy rate. But there is enormous variation in the age of onset and in the range of symptoms that will appear in a given individual. In the past, family members would often know generally about inherited conditions which might manifest themselves in succeeding generations.

Now there is the potential to remove the uncertainty and to diagnose with near perfect accuracy the presence of the gene which, in due course, will manifest itself and, in some conditions, lead on to profound disabilities or certain death. Here, clearly, are new foundations for differentiation between individuals by reference to a wider category of distinctions that mark them off from most people in society. Is this a problem? In these enlightened and scientific times, need we really be worried about threats of discrimination on genetic grounds?

Foundations of discrimination

Unfortunately, despite progress in education and in domestic and international human rights law, the past teaches us that we should be concerned. Millions of people this century have lost their lives, or have suffered profoundly, because of obvious genetic distinctions. When new distinctions, previously hidden, are added to the list, we should be alert to provide effective social responses.

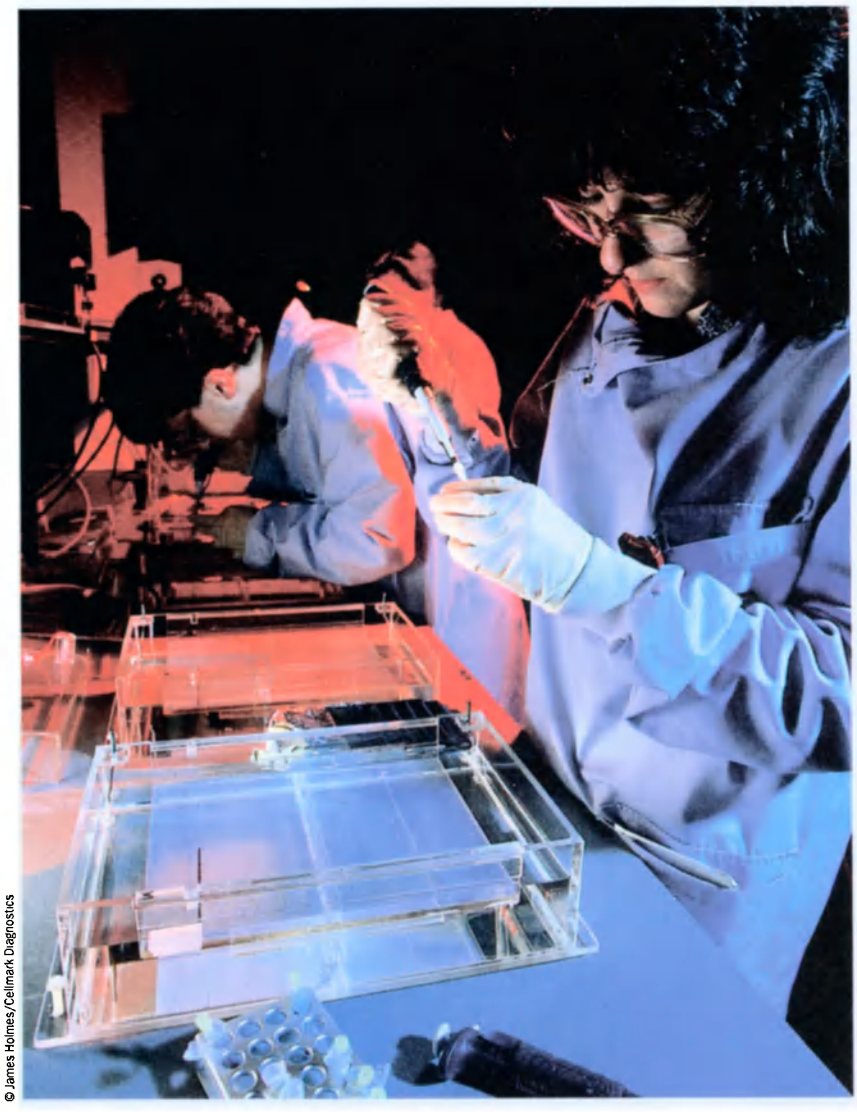
As a result of learning the outcome of a genetic test, an individual's life may be profoundly changed. A patient learning of the presence of a fatal and untreatable disorder may undergo profound psychological disturbance. Some may choose not to submit to the test

A scientist points out a defect on a human karyotype: an extra copy of chromosome 8 which is commonly found in some forms of leukaemia.

because of the effect which knowledge of a negative result could have for the subject's well-being and that of the immediate family.

The greatest dangers from adverse discrimination lie principally in the context of social arrangements which may be affected by knowledge, or access to knowledge, about an individual's genetic makeup. Take insurance. In the past, the availability of insurance, and the rates of premiums, were ordinarily fixed by reference to a sharing of the risks of the onset of a multitude of genetic disorders amongst all members of the insuring public. Now that it is possible to subject a proponent for insurance to genetic tests, the sharing of risks may disappear or be substantially reduced. If the presence of inherited disorders can be ascertained with near perfect accuracy, the cards may be stacked in favour of the insurance company. There may be no risk of the onset of defined disorders. Or it may be absolutely certain.

Insurers argue that they are merely substituting the latest scientific information for the old-fashioned medical check-ups and replacing generalized data of life expectancy with accurate predictive data of genetic disorders. If insurers can offer policies at lower premiums to non-smokers, should they not be able to ▶



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DNA fingerprinting in a British laboratory. Fragments extracted from an individual's tissue are processed to produce a kind of genetic "identity card". DNA fingerprints are used to prove whether people are related and to identify criminals from tissues left at the scene of a crime.

do so to those who, genetic testing reveals, are unlikely to manifest a range of life-threatening inherited conditions? These are some of the dilemmas we face.

Employers may wish to subject certain employees to genetic testing. They may argue that training, the provision of disability benefits and the costs of sick leave and replacement justify having access to genetic information concerning members of their workforce. The problem with this is the same as with insurance. Will the individual with "negative" genetic results be refused employment? In the relationship between the individual proponent for insurance or the individual applicant for employment and the potential insurer or employer, will the former be sufficiently empowered to refuse access to his or her genetic data?

Unless the law intervenes to prevent threats of adverse discrimination, will the practical consequence be that insurers, employers and possibly the State itself will be empowered to require individuals to discover the range of long-term genetic disabilities which, left alone, the individual might prefer not to know?

Some scientists believe that sexual orientation is, at least partly, genetically determined. If this were scientifically established, would it help or hinder the world-wide efforts to reduce discrimination against people on the ground of their sexuality? It might help by proving that something so innate is determined naturally and is not defiantly chosen to flout society's moral rules. But out of fear or hatred of difference, it might lead to demands for destruction of foetuses showing this propensity.

The diversity of the human gene pool has been one of the principal causes of humanity's strength and survival. The ultimate threat of discrimination would arise from demands to eradicate all inherited conditions conceived of as "intolerable". The advance of genetic testing will therefore present fundamental challenges to humanity. How do we alleviate unnecessary suffering and eradicate the scourge of premature death from inherited disorders whilst at the same time retaining the precious variety of humanity and the diversity of its gene pool?

Social management

On 11 November 1997, the UNESCO General Conference unanimously adopted the Universal Declaration on the Human Genome and Human Rights (see page 34). This path-breaking charter proclaims, in its first article, that the human genome underlies the fundamental unity of all members of the human family as

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well as the recognition of their inherent dignity and diversity. The Declaration addresses itself to the problem of adverse discrimination and says: "No one shall be subjected to discrimination based on genetic characteristics that is intended to infringe or has the effect of infringing human rights, fundamental freedoms and human dignity".

Translating these principles into effective protection of vulnerable people against threats of adverse discrimination is a major challenge which now faces the international community, the nation states and the professional and commercial organizations that are involved in genetic testing.

The international community is to establish machines for monitoring the implementation of UNESCO's Universal Declaration. Already an ad hoc group has met in Paris to consider the ways in which the principles of the Declaration can be implemented.

Nation states must introduce laws and policies to give effect to the principle of non-discrimination. Several countries have already enacted laws to govern the use of genetic testing in particular fields. But so far, comprehensive laws dealing with the threats of discrimination have been slow in coming. The Council of Europe in 1997 adopted a Convention for the Protection of Human Rights and Dignity of the Human Being with regard to the application of biology and medicine. But in most societies, the advances in genetic testing have outstripped the lawmaking process. Protection of vulnerable individuals, and society, against the threats of discrimination are mostly left to depend, if on anything, upon the ethics of the healthcare professions and such general laws and policies forbidding unwarranted discrimination on health grounds as were adopted years before genetic testing became possible.

© Katherine Arion/SIS, Paris

"The diversity of the human gene pool has been one of the principal causes of humanity's strength and survival." Above, *Silhouettes in the Sun* by the American artist Katherine Arion.

British researchers cloned a lamb, Dolly (right), from a single cell of a ewe in 1997.

Professional bodies such as the Human Genome Organization, supported by its Ethics Committee, devise guidelines which are recommended to scientists in the field for their guidance. Industry bodies, such as those representing insurers and employers, may adopt rules of self-regulation to limit demands for genetic test results to circumstances where they can clearly be justified. But the hard work of preparing enforceable laws and policies to address a multitude of issues presented by genetic testing, lies ahead.

Education in the risks and dangers will have a part to play. So will the development of enforceable laws which balance the demands of those who claim that knowledge of genetic data is relevant to their decisions against the demand of the individual to maintain the privacy of such data and control over its use. In every country, lawmakers should have the assistance of expert and multi-disciplinary bodies to give guidance on the way in which the right balance is to be struck. To refrain from providing protection against discrimination is to condone the dangers of the discrimination which will follow. To do nothing is to make a decision. ■

FACT FILE

THE UNIVERSAL DECLARATION ON THE HUMAN GENOME AND HUMAN RIGHTS

PREFACE

The Universal Declaration on the Human Genome and Human Rights, which was adopted unanimously and by acclamation by the General Conference of UNESCO at its 29th session on 11 November 1997, is the first universal instrument in the field of biology. The uncontested merit of this text resides in the balance it strikes between safeguarding respect for human rights and fundamental freedoms and the need to ensure freedom of research.

Together with the Declaration, UNESCO's General Conference adopted a resolution for its implementation, which commits States to taking appropriate measures to promote the principles set out in the Declaration and encourage their implementation.

The moral commitment entered into by States in adopting the Universal Declaration on the Human Genome and Human Rights is a starting point, the beginning of international awareness of the need for ethical issues to be addressed in science and technology. It is now up to States, through the measures they decide to adopt, to put the Declaration into practice and thus ensure its continued existence.

FEDERICO MAYOR
3 December 1997

THE UNIVERSAL DECLARATION ON THE HUMAN GENOME AND HUMAN RIGHTS

A. HUMAN DIGNITY AND THE HUMAN GENOME

Article 1

The human genome underlies the fundamental unity of all members of the human family, as well as the recognition of their inherent dignity and diversity. In a symbolic sense, it is the heritage of humanity.

Article 2

a) Everyone has a right to respect for their dignity and for their rights regardless of their genetic characteristics.

b) That dignity makes it imperative not to reduce individuals to their genetic characteristics and to respect their uniqueness and diversity.

Article 3

The human genome, which by its nature evolves, is subject to mutations. It contains potentialities that are expressed differently according to each individual's natural and social environment including the individual's state of health, living conditions, nutrition and education.

Article 4

The human genome in its natural state shall not give rise to financial gains.

B. RIGHTS OF THE PERSONS CONCERNED

Article 5

a) Research, treatment or diagnosis affecting an individual's genome shall be undertaken only after rigorous and prior assessment of the potential risks and benefits pertaining thereto and in accordance with any other requirement of national law.

b) In all cases , the prior, free and informed consent of the person concerned shall be obtained. If the latter is not in a position to consent, consent or authorization shall be obtained in the manner prescribed by law, guided by the person's best interest.

c) The right of each individual to decide whether or not to be informed of the results of genetic examination and the resulting consequences should be respected.

d) In the case of research, protocols shall, in addition, be submitted for prior review in accordance with relevant national and international research standards or guidelines.

e) If according to the law a person does not have the capacity to consent, research affecting his or her genome may only be carried out for his or her direct health benefit, subject to the authorization and the protective conditions prescribed by law. Research which does not have an expected direct health benefit may only be undertaken by way of exception, with the utmost restraint, exposing the person only to a minimal risk and minimal burden and if the research is intended to contribute to the health benefit of other persons in the same age category or with the same genetic condition, subject to the conditions prescribed by law, and provided such research is compatible with the protection of the individual's human rights.

Article 6

No one shall be subjected to discrimination based on genetic characteristics that is intended to infringe or has the effect of infringing human rights, fundamental freedoms and human dignity.

Article 7

Genetic data associated with an identifiable person and stored or processed for the purposes of research or any other purpose must be held confidential in the conditions set by law.

Article 8

Every individual shall have the right, according to international and national law, to just reparation for any damage sustained as a direct and determining result of an intervention affecting his or her genome.

Article 9

In order to protect human rights and fundamental freedoms, limitations to the principles of consent and confidentiality may only be prescribed by law, for compelling reasons within the bounds of public international law and the international law of human rights.

C. RESEARCH ON THE HUMAN GENOME

Article 10

No research or research applications concerning the human genome, in particular in the fields of biology, genetics and medicine, should prevail over respect for the human rights, fundamental freedoms and human dignity of individuals or, where applicable, of groups of people.

Article 11

Practices which are contrary to human dignity, such as reproductive cloning of human beings, shall not be permitted. States and competent international organizations are invited to co-operate in identifying such practices and in taking, at national or international level, the measures necessary to ensure that the principles set out in this Declaration are respected.

Article 12

a) Benefits from advances in biology, genetics and medicine, concerning the human genome, shall be made available to all, with due regard for the dignity and human rights of each individual.

b) Freedom of research, which is necessary for the progress of knowledge, is part of freedom of thought. The applications of research, including applications in biology, genetics and medicine, concerning the human genome, shall seek to offer relief from suffering and improve the health of individuals and humankind as a whole.

D. CONDITIONS FOR THE EXERCISE OF SCIENTIFIC ACTIVITY

Article 13

The responsibilities inherent in the activities of researchers, including meticulousness, caution, intellectual honesty and integrity in carrying out their research as well as in the presentation and utilization of their findings, should be the subject of particular attention in the framework of research on the human genome, because of its ethical and social implications. Public and private science policy-makers also have particular responsibilities in this respect.

Article 14

States should take appropriate measures to foster the intellectual and material conditions favourable to freedom in the conduct of research on the human genome and to consider the ethical, legal, social and economic implications of such research, on the basis of the principles set out in this Declaration.

Article 15

States should take appropriate steps to provide the framework for the free exercise of research on the human genome with due regard for the principles set out in this Declaration, in order to safeguard respect for human rights, fundamental freedoms and human dignity and to protect public health. They should seek to ensure that research results are not used for non-peaceful purposes.

Article 16

States should recognize the value of promoting, at various levels, as appropriate, the establishment of independent, multidisciplinary and pluralist ethics committees to assess the ethical, legal and social issues raised by research on the human genome and its applications.

E. SOLIDARITY AND INTERNATIONAL CO-OPERATION

Article 17

States should respect and promote the practice of solidarity towards individuals, families and population groups who are particularly vulnerable to or affected by disease or disability of a genetic character. They should foster, inter alia, research on the identification, prevention and treatment of genetically-based and genetically-influenced diseases, in particular rare as well as endemic diseases which affect large numbers of the world's population.

Article 18

States should make every effort, with due and appropriate regard for the principles set out in this Declaration, to continue fostering the international dissemination of scientific knowledge concerning the human genome, human diversity and genetic research and, in that regard, to foster scientific and cultural co-operation, particularly between industrialized and developing countries.

Article 19

a) In the framework of international co-operation with developing countries, States should seek to encourage measures enabling:

i) assessment of the risks and benefits pertaining to research on the human genome to be carried out and abuse to be prevented;

ii) the capacity of developing countries to carry out research on human biology and genetics, taking into consideration their specific problems, to be developed and strengthened;

iii) developing countries to benefit from the achievements of scientific and technological research so that their use in favour of economic and social progress can be to the benefit of all;

iv) the free exchange of scientific knowledge and information in the areas of biology, genetics and medicine to be promoted.

b) Relevant international organizations should support and promote the initiatives taken by States for the above-mentioned purposes.

F. PROMOTION OF THE PRINCIPLES SET OUT IN THE DECLARATION

Article 20

States should take appropriate measures to promote the principles set out in the Declaration, through education and relevant means, *inter alia* through the conduct of research and training in interdisciplinary fields and through the promotion of education in bioethics, at all levels, in particular for those responsible for science policies.

Article 21

States should take appropriate measures to encourage other forms of research, training and information dissemination conducive to raising the awareness of society and all of its members of their responsibilities regarding the fundamental issues relating to the defence of human dignity which may be raised by research in biology, in genetics and in medicine, and its applications. They should also undertake to facilitate on this subject an open international discussion, ensuring the free expression of various socio-cultural, religious and philosophical opinions.

G. IMPLEMENTATION OF THE DECLARATION

Article 22

States should make every effort to promote the principles set out in this Declaration and should, by means of all appropriate measures, promote their implementation.

Article 23

States should take appropriate measures to promote, through education, training and information dissemination, respect for the above-mentioned principles and to foster their recognition and effective application. States should also encourage exchanges and networks among independent ethics committees, as they are established, to foster full collaboration.

Article 24

The International Bioethics Committee of UNESCO should contribute to the dissemination of the principles set out in this Declaration and to the further examination of issues raised by their applications and by the evolution of the technologies in question. It should organize appropriate consultations with parties concerned, such as vulnerable groups. It should make recommendations, in accordance with UNESCO's statutory procedures, addressed to the General Conference and give advice concerning the follow-up of this Declaration, in particular regarding the identification of practices that could be contrary to human dignity, such as germ-line interventions.

Article 25

Nothing in this Declaration may be interpreted as implying for any State, group or person any claim to engage in any activity or to perform any act contrary to human rights and fundamental freedoms, including the principles set out in this Declaration. ■

COMMENTARY

Federico Mayor

A shared future

Day by day our planet is shrinking. Today it is smaller and more fragile than yesterday. And yet are we really any "closer" to each other?

The interdependence of the peoples and nations making up our world has become self-evident. No country, however powerful in terms of its economy or population, can any longer get by completely on its own. Transnational problems—whether they be environmental, cultural or economic—can no longer be solved at the national level. It is through international strategies, through concerted action between states and between regions that such problems can be addressed. Poverty, Aids, pollution, climate change, drugs and violence know no boundaries, whether national, ethnic, natural or political.

Globalization also means that the issues are interconnected. The sectoral, specialized, discipline-specific approach has shown its limitations, and these are becoming more and more of a constraint as real life, or at least our awareness of it, grows in complexity. Bioethics is an obvious example of a domain that "cuts across" several disciplines. If we wish to influence reality, we must adopt a transdisciplinary approach that makes use of all available expertise and skills.

This awareness of the interdependence of human beings and of the interconnectedness of the issues they face has become clearly apparent in recent years at the highest levels of political action and in global forums. Within the United Nations system, a series of major conferences has highlighted the connections between the various challenges we must take up—between environment and development, for example, and between education and population. Jomtien, New Delhi, Vienna, Cairo, Copenhagen and Beijing are among the cities that have hosted these global summits.

Too long overlooked or neglected, the human dimension is once again compelling recognition as

'Compare the hundreds of billions of dollars siphoned off by the arms or drug trade with national education budgets. What a shameful disparity!'

'We must multiply our bonds of allegiance, build more bridges between the individual and communities of various kinds and sizes, strengthen "community citizenship" while at the same time promoting the idea of "world citizenship".'

or no future

the measure of all things. In the United Nations system, the approach to social development, to human development has become broader, more diverse and more flexible. Human beings, with all their unfathomable qualities, their strengths and weaknesses, are again moving to the centre of the economic stage.

And yet . . . compare the hundreds of billions of dollars siphoned off by the arms or drug trade with national education budgets! What a shameful disparity! Is not education a fundamental human right?

"*Ecce homo*. Behold the man!" exclaimed Pope John Paul II at UNESCO's Paris Headquarters eighteen years ago in an address that left its mark on all of us. "Behold the man! . . . the rich creativity of the human mind" which makes "untiring efforts to fathom and affirm the identity of man . . . always present in every form of culture".

For human beings to be worthy of the name, they must "belong" to the human species and experience that sense of belonging. If they know and feel themselves to be members of the human family, they will have no difficulty in assisting their fellow beings without ranking people close to them any higher than those who are far away. We must multiply our bonds of allegiance, that is to say, build more bridges between the individual and communities of different kinds and sizes, strengthen "community citizenship" while at the same time promoting the idea of "world citizenship", and think globally while acting locally, so that human solidarity may flourish.

The "intellectual and moral solidarity of mankind", seen by UNESCO's Constitution as the basis of lasting peace, is a form of solidarity targeted at social disparities, one which strives against intolerance, jolts indifference and builds bridges between haves and have-nots, between Muslim and Jew, between prince and pauper. It is an active kind of solidarity between individuals who may be poles apart in many ways, a sense of community in diversity. And it is that solidarity, which grows up between different languages and cultures, beliefs and customs, ways of being and of thinking, and soon becomes indestructible, that makes people accept the idea of sharing, and indeed want to share.

Share their riches, resources and knowledge, and also their doubts. It is this universal imperative which must underpin our individual and collective thoughts and actions. Though we now know—and have known for several decades—that we, as civilizations, are mortal, it is only right that we should also know, as human beings, that the future will be one of sharing or there will be no future at all. ■

Renewable energy: winds of change

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BY FRANCE BEQUETTE

While the planet is being stifled by atmospheric pollution from the gases given off by fossil fuels such as oil—64 million barrels of which are consumed every day—and coal, alternative sources of "clean", renewable energy are there for the using. But looking around the world, even those places where sources such as water, sun, wind, plant residues or volcanoes are plentifully available, we see how little use is actually being made of them. The reason lies both in the cost of the necessary capital goods, which remains high because they cannot be mass-produced, and in the lack of information and training.

UNESCO recognized that renewable energies are one of the keys to sustainable development as long ago as the 1950s, when they were still seen as a bee in the bonnet of woolly-minded conservationists. A number of factors—growing environmental awareness, the realization of the impact of the greenhouse effect on world climate, the catastrophic accidents that have occurred in the very nuclear plants that promised clean power, and the progress made concurrently in the technology of renewable energy use—have, however, drawn increasing attention to the potential they represent.

Rocketing oil prices in the early 1970s reinforced this interest still further, but when prices fell, fifteen years later or thereabouts, interest again waned and research programmes went on to the back burner. Today's very low oil prices ($16 a barrel) are no inducement to economy, nor do they encourage investment in new energy technologies, especially since they are mainly intended for the developing countries, which are either insolvent or getting on that way. They are, furthermore, complicated to put into operation, requiring an interdisciplinary approach, which is why UNESCO's Engineering and Technology Division co-operates with other institutions of the United Nations system, with many non-governmental organizations and with bilateral and multilateral aid agencies.

AN URGENT NEED

In 1993, UNESCO hosted the World Solar Summit, at which, for the first time, the international community examined the problem of renewable energy sources. As explained by Elie Absi, a member of the secretariat of the World Solar Commission which was set up in 1993, the generic term "solar" is used because all sources of energy, with the exception of nuclear and geothermal energy, are linked with the sun. The choice of the most suitable of these energy sources depends on local circumstances, available resources and level of consumption.

Demographic pressure is making the use of renewables a matter of even greater urgency. The planet's population is now increasing at the rate of nearly 250,000 a day. Agriculture is incapable of feeding the developing countries' four-and-a-half billion rural inhabitants (700 million households) scattered about the relatively isolated regions of Africa, Latin America, India and China. To keep these people on the land and restrict migration both from countryside to towns and from one country to another, it is essential to launch cost-effective craft, industrial or agro-food activities, on however modest a scale, and this cannot be achieved without energy supplies.

Output of electricity by conventional means has increased by leaps and bounds over the last thirty years but the main consumers have been city-dwellers. The World Bank spends $3.3 billion a year in the energy sector but only 7% of this goes to renewable energy in the developing countries. Out of the total of $8 billion similarly provided by multilateral aid agencies, only $1.5 billion is spent on rural electrification. Electricity supplies to the rural population are no better than thirty years ago. The reason is that maintenance and repairs are

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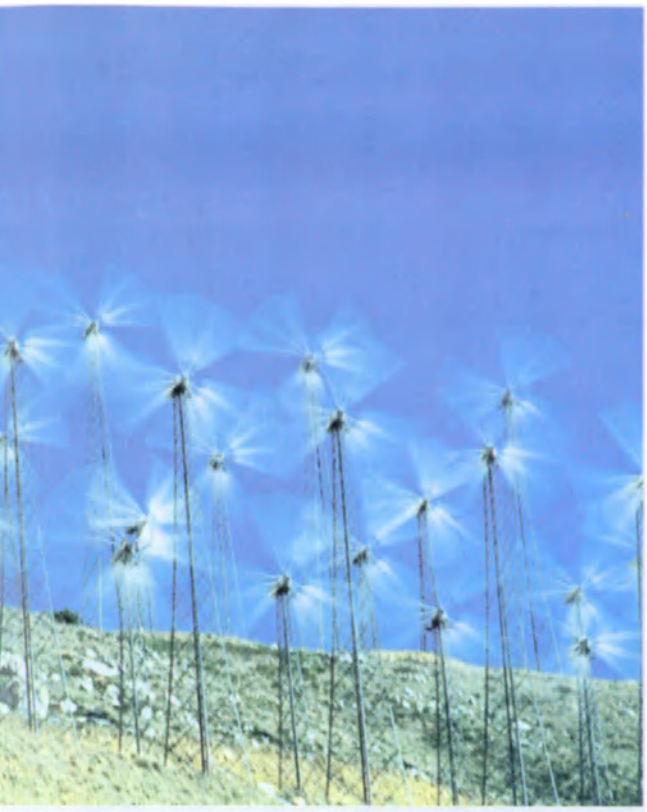
Svartsengi geothermal plant, which supplies Reykjavik (Iceland) with hot water.



Wind turbines in the Mojave desert, California (U.S.A.)

Inside the hub of a 100-metre tall wind turbine, Brusbuttel (Germany)

© Regis Bossu/Sigma Paris

difficult, connection to the mains supply is costly, human settlements are widely scattered, access to isolated areas is difficult and consumption is often low (less than one kWh a day).

BIOGAS, GEOTHERMAL ENERGY AND WIND POWER

A few examples will suffice to show what can be done with renewable energy sources. In Guatemala, for instance, there is an ongoing shortage of oil and gas, and only 36% of the population, mainly in the towns, are connected to the electricity supply. This being the case, the main source of energy is firewood, leading to 900 sq.km. of woodland being deforested yearly—far exceeding the forest's regeneration capacity. The national agency responsible for the management of renewable energy, set up in 1983, employs locally-based technicians throughout the country. With the assistance of an anthropologist who helps persuade the local inhabitants to accept the new technologies, these technicians have the job of promoting and monitoring the use of solar installations (biodigesters and photovoltaic systems).

A geothermal unit and two small-scale hydroelectric power stations are planned. Backed by $2 million from the United Nations Industrial Development Organization (UNIDO), a three-year (1996-1999) plan will provide dispensaries, schools and food shops with photovoltaic installations. In the village of Xetzé, for example, where one of these systems has been installed, electric light now enables the womenfolk to carry on with their weaving in the evenings and, as their output of cloth has thus been put on a more regular basis, they have been able to set up long-term deals with foreign buyers.

Biogas is one of the cheapest sources of renewable energy, obtained by fermenting animal or vegetable waste products in a special container, the biodigester. Rich in methane and carbon dioxide, it is used for lighting, cooking and other purposes (see "A waste-free farm", *Unesco Courier*, September 1997).

Geothermal energy makes use of underground heat, which increases with depth (a drill can go down to a maximum of 5,000 metres), allowing a turbine to be driven by water or steam and produce electricity. Another technique consists in injecting water into fissures in rock, and retrieving it when it has been naturally heated. Heating for 85% of the population in Iceland comes from geothermal sources. A score of countries, mostly developing, use geothermal energy, and there are 250 geothermal power stations in operation in various parts of the world, but cost restricts their further development.

Wind power is the most promising of all the renewable energies and the one that has undergone the most spectacular development. Germany, India and Denmark are the three countries best equipped in this respect. Spain, which comes fourth, is the first country in the European Union to enact legislation incorporating the recommendations made in the European Commission's White Paper on renewable energy sources; wind generators are in wide use in the Canaries, for sea-water desalination among other purposes. Over a hundred wind pumps are already operating in Mauritania, where a non-governmental organization, the *Groupement de recherches et d'échanges technologiques* (Technological Research and Exchanges Group), working in partnership with the Mauritanian energy authority, has installed wind-powered battery-charging stations in fifteen villages in the Tzarza region, a south-eastern area where there is plenty of wind. These batteries supply electricity to houses or nomads' tents. A $5-a-month subscription buys the use of an individual battery that can be recharged when flat by the wind generator. Wind generators power pumps supplying villages with drinking water in the remotest regions of the Adrar.

THE WORLD SOLAR PROGRAMME

The sun is an immense renewable energy source equivalent to about 10,000 times the total world demand for power. It is ever-present—albeit varying in intensity—throughout the world. It can be harnessed directly, in the form of heat, or converted into electricity. In the former case, all that is needed in the developing countries is a black-backed sheet of glass or plastic to make a cheap drying rack for fruit, vegetables or fish. The latter method—the photovoltaic system—requires panels, a battery and a device for converting direct current to alternating but also needs an operator who has to be trained to use and maintain it. ▶

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A house in Nepal. Left, the fermentation tank, or biodigester, used for producing biogas. Right, cooking with biogas.

"Solar technology", explains French researcher Michel Rodot, "represents a major potential, but development runs up against real financial problems, firstly because installation costs are fairly high but mainly because village people and rural extension workers need to be committed to the idea of solar power. It also requires political will on the part of the State and support from the banks. Consumers will have to learn that the supply of solar electricity is a service they must pay for, however modest the price."

Conscious of the part renewable energies can play, UNESCO has devised a ten-year (1996-2005) World Solar Programme, which aims "to develop and implement 300-odd top-priority renewable energy projects of national, regional and international value... in order to demonstrate the technical feasibility, economic viability and social and political acceptability of solar energy." The Organization is also offering an extremely well-stocked database, available both in printed form and on computer, and a summer school for French-speaking engineers, instructors, academics, researchers and economists. ■

FOR FURTHER INFORMATION:

World Solar Programme:
Internet:
http://www./unesco.org/general/fre/programmes/science/wssp
Summer school:
Mr O. Benchikh, UNESCO
Tel: (33) (0)1 45 68 39 16
Fax: (33) (0)1 45 68 58 20

Books:
✔ *Renewable Energy. Sources for Fuels and Electricity*, Earthscan Publications, London, 1993 (an excellent collective work of over 1,000 pages)
✔ *Le solaire thermique au service du développement durable, Guide de l'énergie solaire*, a guide to the application of solar energy to sustainable development, published by the Réseau international énergie solaire, Canada, and containing some remarkable case studies
✔ *Energie et environnement en Méditerranée, Enjeux et prospectives* (Energy and environment in the Mediterranean, Issues and prospects), by Michel Grenon et al., Economica, Paris, 1993

CD-ROM:
UNESCO/ISEEK Energy Database, 3rd edition, 1997 (Database of the International System of Energy Expertise and Knowledge)
On sale from UNESCO Publishing, 1 rue Miollis, 75732 Paris Cedex 15, France
Tel: (33) (0)1 45 68 43 00
Fax: (33) (0)1 45 68 57 41
Internet: http://ww.unesco.org./publishing

initiatives

'ENERGIES FOR THE WORLD'

On the initiative of the French renewable energy body *Observatoire français des énergies renouvelables*, twelve public and private partners, ministries and major companies, came together to set up, in Paris, the *Fondation Energies pour le monde* (Energies for the World Foundation). Established and granted State-approved status in 1990, it carries out renewable-energy-based electrification projects to help the development of the local economy and improve living conditions in impoverished rural areas.

Its activities, international in scope, include:

Africa: electrification of ten or so youth clubs (Mandé region, Mali) and thirty dispensaries (Casamance, south Senegal); practical and theoretical instruction in the technology and maintenance of photovoltaic pumps at a school for rural engineers in Ougadougou (Burkina Faso); installation of a solar generator for recharging ten batteries a day in the *douar* (nomad encampment) of Igoudar Jebel (Atlas Mountains, Morocco).

Asia: in Bangladesh, the Foundation is advising the Rural Electricity Development Board on the electrification of isolated villages. In Viet Nam, in the Mekong Delta and many southern islands, it has electrified some forty community centres, which now have television sets, video players and battery chargers. In Cambodia, ten or so dispensaries have electric light and refrigerators for vaccines.

The Pacific: in Vanuatu, nearly twenty schools now have a power supply.

The Foundation's activities extend to many other countries, including Georgia, Togo, Madagascar, the United Republic of Tanzania, India, Nepal, Haiti and China.

In addition to its own small staff, it has a network of field officers who carry out its projects in liaison with the local authorities. It works in partnership with UNESCO, the World Health Organization and the United Nations Development Programme. The Foundation publishes many simple, practical documents on renewable energy sources, and a bimonthly review, *Systèmes solaires, Energies-Environnement-Développement*, 146 rue de l'Université, 75007 Paris. Tel: (33) (0)1 44 18 00 88; Fax: (33) (0)1 44 18 00 36. ■

CAULERPA: DOING WELL—AND DOING DAMAGE

Caulerpa taxifolia algae, which appeared twelve years ago in the Mediterranean, pose a threat to the beds of Posidonia (a marine plant similar to the eelgrass) and to the fauna that lives in them. Three thousand hectares of the coastal waters of France and Italy are already infested with this "green plague". It reproduces at a great rate by putting out suckers, and its proliferation has been further speeded by the anchors of pleasure craft, fishing nets and the dumping of the contents of ballast tanks. The French Academy of Sciences has recommended that pleasure-boat owners and fishermen be given more information about the danger it presents and, in particular, that in-depth research should be carried out into its method of propagation and ways of halting the invasion.

A WORLD COMMISSION ON DAMS

Establishment of this new body was announced in February 1998 by Kader Asmal, South Africa's Minister of Water Affairs and Forestry, who chairs the Commission. He will be assisted by ten commissioners, drawn from widely varying backgrounds—academics, industrialists or ecologists. The Commission's aim will be to bring about a more reponsible approach to the building of large dams by conducting a global review of their costs and benefits.

UNITED STATES INVADED BY CANADA (GEESE)

When an animal species has been too well protected, as has happened with the resident population of Canada geese (*Branta canadensis*) introduced into the eastern United States by wildlife managers in the 1960s, drastic measures may be called for. These birds, about a million of them, gobble up grass, foul reservoirs, and present a safety hazard for airports. After an attempt had been made to relocate them, shortage of space made it necessary to cull several thousand before the arrival of the 300,000 migratory geese, who have priority!

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PLASTICS MAKE GOOD FUEL

Barely 4% of the three million tonnes of plastics thrown away every year in France is recycled. The Association of Plastics Manufacturers in Europe has demonstrated that 1.4 tonnes of coal would be saved for every tonne of plastic waste products burned as fuel in an energy-guzzling cement works. If this practice was generally applied in Europe, which accounts for 25% of the world's cement output, 3.8 million tonnes of coal could be saved, an especially environment-friendly outcome since coal pollutes the atmosphere but plastics leave no solid residues or ash and burning them would not lead to any increase in atmospheric emissions.

THREAT FROM OBSOLETE PESTICIDE STOCKS

The United Nations Food and Agriculture Organization (FAO) has drawn attention to the fact that over 100,000 tonnes of obsolete and unused pesticides continue to pose a threat to health and the environment in the developing countries. In town and countryside alike, thousands of barrels are rusting away and leaking their toxic contents, sometimes contaminating irrigation and drinking water. The best way to get rid of them would be high-temperature incineration, but most of the countries concerned lack the necessary installations. In Africa alone, the disposal cost is reckoned at $80 million, but the agro-chemical industry is proposing to put up only 30% of the disposal costs.

ETHNO-DEVELOPMENT IN ECUADOR

The World Bank has approved an "ethnodevelopment" project in Ecuador. Backed by a $25 million Bank loan, it aims to develop, in indigenous and Afro-Ecuadorian communities and villages, activities such as improving schools, managing community forestry, farming activities, fisheries or water services. There are 2,500,000 hectares of land yet to be titled in Ecuador and, against this background, the project helps the indigenous peoples to obtain title to their ancestral lands.

BORNEO: THE ORANGUTAN IN RETREAT

Seventy orangutans have been taken into care at the Wanariset research centre, a sanctuary in the forests of East Kalimantan, the Indonesian part of the island of Borneo. Most of them are young orphans whose mothers have fled to escape the forest fires or have been killed or kidnapped by poachers. Though protected as one of the world's most endangered species, these great apes are hunted for their meat or sold into captivity. Their numbers have declined by 50% in the last ten years in Borneo and Sumatra, and there are now thought to be less than 20,000 left.

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The monastery of HAGHPAT

by Elisabeth Baudourian

A masterpiece of religious architecture and a major centre of learning in the Middle Ages, Armenia's Haghpat Monastery was placed on UNESCO's World Heritage List in 1996.

Tradition has it that two of Christ's apostles, St. Thaddeus and St. Bartholomew, introduced Christianity into Armenia at a very early date. Later, at the beginning of the fourth century, Armenia became the first country to adopt Christianity as an official religion. Against a backdrop of theological disputes, but above all motivated by political reasons, the Armenian church soon began to elect its own archbishop. Since it rejected the dogma of the two natures of Christ (human and divine), the church came into conflict with Byzantium. But this theological dispute masked a political concern: Armenia wanted to set itself apart from both Byzantium and Persia, two rival empires which often clashed on its territory. The break with Byzantium was completed in 609.

The determination to be independent also resulted in the creation of an Armenian alphabet in about 405. Written Armenian replaced liturgical Greek and became one of the church's main instruments for unifying the Armenian people. Drawing strength from their specific religious and linguistic identity, the Armenians managed to survive in a hostile environment and thwart repeated attempts by other nations to assimilate them.

Towards the middle of the seventh century, the Arabs conquered Byzantine Armenia. People converted in increasing numbers to Islam, especially among the nobility. Only two princely families on the outer reaches of Armenia remained Christian: the Bagratids in the north, and the Artsrunis in the south. But in 862 the Caliph appointed Ashot Bagratuni "Prince of Princes", and made him "King of Armenia" twenty years later. Armenia regained its independence shortly thereafter.

THE RENAISSANCE OF ARMENIAN ART

Ashot, who had become Ashot I after being crowned by the *Catholicos* (the spiritual head of the church), ushered in a period of peace and prosperity that was

Bas-relief on the east gable of Surb Nshan church, below, shows Princes Smbat and Kurike, sons of the church's founder, holding a model of the building.

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© Bruno Morandy/DIAF, Paris

The monastery roofs. Left, Surb Nshan (Holy Cross) church.

to last 120 years. Armenian art enjoyed a renaissance. In about 961, the Bagratid family founded a new capital at Ani, now part of Turkey. At that time a mere fortified village, Ani was transformed into a wondrous city "with forty gates, 100 palaces and 1,000 churches", according to chroniclers of the time.

Armenian architecture blossomed with the construction of the church of the Holy Cross, on Aghtamar Island, and of Ani cathedral. Philosophy, theology and literature faculties were set up within the precincts of monasteries. The neighbouring monasteries of Haghpat and Sanahin were restored and enlarged and became cultural and educational centres by the end of the tenth century. The period's leading architect, Trdat, restored Hagia Sophia cathedral in Constantinople, built Ani cathedral and was responsible for the expansion of Haghpat monastery.

The Haghpat monastery complex overlooks the Pambak River in northern Armenia's Lori region. It was built, not on a peak, but halfway up a hillside on a site chosen to afford protection and concealment from prying eyes and also in response to a kind of monastic humility. It is built on a verdant promontory located in the middle of a mountain cirque, which is often wreathed in clouds. A peak on the opposite side of the river is over 2,500 metres high.

The monasteries of northern Armenia are not isolated, unlike their counterparts in the country's arid regions. They were built in a village environment. Haghpat, for example, is surrounded by many hamlets, and Sanahin's domes rise from the centre of a village.

THE ORIGINAL CHURCH

The little church of Surb Nshan (the Holy Cross) is Haghpat's earliest building. Begun in 966-67, it was later enlarged and embellished by the architect Trdat and his team. Like many other churches and monasteries, it was endowed by prominent feudal families. A typical example of tenth-century Armenian architecture, its central dome rests on the four imposing pillars of the lateral walls. The outside walls are dotted with triangular recesses. A fresco in the apse depicts Christ Pantocrator. Its donor, the Armenian Prince Khutulukhaga, is depicted in the south transept (a transversal nave intersecting the main nave). The sons of the church's founder, Princes Smbat and Kurike, are shown with Queen Khosravanuche in a bas-relief on the east gable. Apart from one or two minor restorations carried out in the eleventh and twelfth centuries, the church has retained its original character. ▶

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The monastery seen from the northeast. At left, the 13th-century bell tower.

© K. Hibbs, Paris

A *khatchkar*, a stone slab engraved with a cross and intricate designs.

A local noble family, the Kiurikians, made the church their spiritual centre and the monastery grew spectacularly. Two new buildings were added to it—St. Gregory's church (1005-25) and the chapel of the Virgin Mary—along with several circular defence walls with two fortified gates.

Armenia's golden age came to an end in the mid-eleventh century. Ani was taken by the Byzantines. The last Bagratid king abdicated. At the end of the century, Turkish-Mongol Seljuks completed their conquest of Armenia. In about 1130, an earthquake damaged Haghpat, which was not restored until fifty years later. But those eventful years did not in any way impair the monastery's spiritual influence.

A WIDENING SPHERE OF INFLUENCE

At the beginning of the thirteenth century, the monastery acquired a *gavit*, a large construction resembling a narthex (an entrance hall between the porch and nave of a church) which shows this feature of ecclesiastical architecture in its most fully developed form. The *gavit* was used for meetings, teaching and funerals. In line with the principles of vernacular wooden architecture, its roof rests on four central pillars. Above the arches of the square central area, intersecting arches divide the building into nine parts. Light streams into the building through a lantern crowning the highest central section (the *yerdik*). The floor is partly paved by tombstones of the Kiurikan family.

At that time, several hundred monks lived in Haghpat monastery. They could eat in a refectory, but there was no dormitory because they had formed the habit of lodging in villages in the valley. They produced the *Haghpat Gospels* (1211), an illuminated manuscript renowned for miniatures in which secular features blend into religious scenes. One illumination shows a man and a woman in Armenian dress welcoming Jesus before the gates of Jerusalem.

The fortress of Kaian was built nearby in 1233 to protect Haghpat and Sanahin from invading Mongols. Although the monastery was captured and destroyed a few years later, its life did not come to a halt.

In the mid-thirteenth century, three important buildings were added to the site. One of them was the campanile, or *zangakatun*, which stands apart from the church at the highest point of the site. An elongated construction topped by a short octagonal spire, it has three floors, each containing recesses and apses with one or more altars. The library, or *matenadaran* (1258-68), is a square, compact building directly connected to the church by what is known as the "Saviour's Passage". The great *jamatun* or chapter-house which the monks used for assemblies is also connected to the church by a vaulted arcade. Built in the same style as the *gavit*, it is the work of the father superior, Hamazasp. Outside the monastery walls, the monks also built the Holy Zion chapel (1268) in a village farther down the hill.

But the Mongol incursions resumed. Tamerlane's invasions (1387-1405) put an end to further attempts to reconstitute a Greater Armenia. Between the fourteenth and seventeenth centuries, Haghpat was frequently damaged, and on two occasions, in 1651 and 1677, the Armenian apostolic church undertook restoration work.

On the eve of the Second World War, the Soviet Socialist Republic of Armenia's Committee for the Preservation of Monuments made plans for a comprehensive restoration of the site. At the end of 1991, Armenia again became independent. The town council of Tumanian is now responsible for the upkeep of Haghpat, which still belongs to the church of Armenia, while the culture ministry is responsible for its restoration. A long-term approach to the preservation of Armenia's historic and spiritual heritage can finally be adopted. ■

© K. Hibbs, Paris

A *khatchkar* set in the monastery wall.

NINE CENTURIES OF INFLUENCE

966-991:
Construction of Surb Nshan church

1105:
Destruction of the church by the Seljuks

13th century:
Northern Armenia's main spiritual and educational centre; construction of new buildings

Mid-17th century:
Restoration of the site

1688:
A destructive earthquake

1940-1960-1980:
Plans for restoring the site during the Soviet period

1996:
Inclusion on the World Heritage List

DIZZY GILLESPIE, A JAZZ GIANT

BY ISABELLE LEYMARIE

© P. Renault/Gamma, Paris

Pioneer of bebop, Afro-Cuban and Brazilian jazz, Dizzy Gillespie (1917-1993) was a colourful figure and, with Louis Armstrong and Miles Davis, one of jazz's trinity of great trumpet-players.

John Birks Gillespie was born in Cheraw, a small town in South Carolina. Neither his father, a builder who led a dance-band at weekends, nor his mother took much interest in his education. But young John was bright and curious about everything, especially music. Unbeknown to his father, he practised on the various band instruments stored in the house and learned to play the trumpet with a neighbour's son.

As a teenager, he worked for a time on one of the public-works projects set up by the Roosevelt Administration under the New Deal. But manual labour was not to his liking, and he soon obtained a scholarship to the Laurinburg Technical Institute, an agricultural college for Blacks in North Carolina. He played trombone and then trumpet in the college band, and started studying musical theory and trying his hand at the piano. At weekends he performed with a small group of teenage musicians. The cornetist King Oliver, who was giving a concert locally, heard him play and offered him a job, but Dizzy preferred to stay with his friends.

In 1935, he left high school to move with his mother to Philadelphia, where he sat in on innumerable jam sessions and, at eighteen, joined the Frankie Fairfax band. His first role model was Roy Eldridge, six years his senior, who was regarded as the fastest and most innovative trumpeter then playing and who was at that time with Teddy Hill's band. When not rehearsing or performing, Dizzy spent all his time studying harmony on the piano, a grounding to which he later attributed his ability to play in any key. It was about this time that his fellow trumpeter Palmer Davis, impressed both by his virtuosity and his non-stop fooling about, nicknamed him "Dizzy".

The birth of bebop

In 1937, Dizzy moved in with his brother in Harlem, where he hung around the Savoy Ballroom and jammed with the Savoy Sultans, Fess Williams, Claude Hopkins, Willie Bryant and Chick Webb. Webb, who had just discovered a young singer named Ella Fitzgerald, realized that his was an exceptional talent and often called him in as replacement solo trumpet. When Dizzy started his first big band in 1946, he toured the southern states with Ella and encouraged her to take up scat-singing.

Dizzy became friendly with Mario Bauzá, one of Webb's trumpeters, and, at the Cotton Club, with the flautist Alberto Socarrás, who between them introduced him to Cuban music. A few months later, he met the sax and clarinet player Teddy Hill, who was just about to set off on a European tour and was looking for a trumpeter. Dizzy talked him into giviug him a break and, in a career move that went beyond his wildest dreams, took over from his mentor Roy Eldridge in the band. He impressed audiences with his embouchure and perfected his high-register playing, his soaring riffs and a harmonic concept that was far ahead of its time (so far that the singer Cab Calloway, who hired him in 1939, forbade him to ▶

play what—unable to understand it—he called his "Chinese" music).

After the commercially-oriented swing era with its mainly White big bands (Benny Goodman, Jimmy and Tommy Dorsey), Black jazzmen were gripped by a fever of creativity. The most innovative of them, guitarist Charlie Christian, Thelonious Monk, drummer Kenny Clarke and Charlie Parker, the latter fresh from Kansas City, met for jam sessions in the clubs of Harlem, including the famous Minton's Playhouse. That was where, according to Miles Davis, musicians really cut their teeth; they had to have played at Minton's to earn a reputation among jazzmen. Dizzy and his friends experimented there with unfamiliar harmonies and frenzied tempo, and created numbers with jokey titles. It was from these experiments that bebop was to emerge, soon to take definite shape in the clubs of Fifty-second Street, jazz's new centre of gravity.

The elder statesman of jazz

In 1941, Dizzy was accused by Cab Calloway of throwing a spitball at him during a gig and was thrown out of the band. He played with various groups, including the one led by pianist Earl Hines for which he wrote *Night in Tunisia*, and then formed a revolutionary little group with bass-player Oscar Pettiford, performing at the Onyx Club on Fifty-second Street, As he tells it, they played lots of untitled original numbers, with Dizzy chanting "Dee-ba-pa-n-bebop" as the lead-in. When the fans wanted to hear one of these unnamed pieces they would call out for "bebop". The press soon got hold of the term and started to call their music bebop.

Dizzy next joined Billy Eckstine's big band, the first to be inspired by bebop, at the same time pursuing a career as an arranger. In 1945, a year that was to be decisive for him, he teamed up with Charlie Parker, his musical alter ego, and recorded the historic bebop tracks *Groovin' high*, *All the Things You Are*, *Salt Peanuts* and *Hot House* with various groups of musicians. It was at this time that he began to blow out his cheeks like a hamster when playing and to sport a beret, a goatee and wire-framed glasses, a look that all his fans hastened to copy.

In 1946, Dizzy formed a big band that was joined, the following year, by the remarkable Cuban conga player Chano Pozo, who could speak no English. When asked how they managed to communicate, Pozo would reply: "Dechee no peek pani, me no peek Angli, bo peek African". This was the first time drums played with the hands rather than with drumsticks entered the jazz world—in the slavery period, Whites had systematically destroyed African-style drums.

Together, Dizzy and Pozo wrote *Manteca*, *Tin Tin Deo* and *Cubana Be Cubana Bop*, compositions that led the way for "Latin jazz". A concert they gave at the Salle Pleyel, Paris, in 1948 had a stunning effect on all French jazzmen, coming as a revelation both of bebop and of the red-hot rhythms of Afro-Cuban music. On 2 December that same year, at the age of thirty-three, Pozo was murdered in a Harlem bar.

On 6 January 1953, at a party in a club, an actor accidentally fell on Dizzy's trumpet, bending the mouth and giving it the famous upturned shape. "My instrument, when you hit a note, Bam! You hear it right then, instead of waiting," he said. In 1956, Dizzy, then at the height of his powers, was sponsored by the State Department to tour the Middle East and Latin America with his new big band. Refusing to act as an official spokesman for the United States, he made friends among the locals in the various countries he visited and gave free invitations to his concerts to children and poor people. In Brazil, he discovered the samba and the bossa nova, which he popularized in the United States, and in Buenos Aires he met the young pianist Lalo Schifrin, signing him up for his band a few years later.

In 1964, he ran for the presidency of the United States on a platform of abolishing racism and uniting all the peoples of the world. He suggested that the White House be renamed the Blues House, and that Miles Davis be appointed head of the CIA and Max Roach Minister of Defense. In the late 1960s, he converted to Baha'ism, a faith of Persian origin that preaches tolerance and universal love.

Dizzy performed until the end of his life in many different venues, including the White House, where, with President Jimmy Carter, he played *Salt Peanuts*, the anthem of bebop. "I like playing. I like people. I love making people laugh, and I do just as I please", he said. Decorated by the American and French Governments, proclaimed *bashere* (a Yoruba princely title) of Iperu, Nigeria, he became towards the end of his days an elder statesman of jazz.

Somebody once asked Dizzy what legacy he would like to leave behind. "I would like people to know how to pronounce my name: Dizzy, D-I-Z-Z-Y!", he answered. ■

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Marcel Marceau

The art of silence

© Hervé St Heiler/HPSH/Sygma Paris

The world-famous French mime Marcel Marceau breaks his silence and talks about the secrets of his craft and the highlights of a career spanning five decades. Interview by Michel Fargeon.

■ **You have been appearing on stage all over the world for more than fifty years. Why is it that you are more popular abroad than at home in France?**

Marcel Marceau: I have performed a great deal in France. It was here, in 1947, that I created the character of Bip, the dreamy little poet who appears in all my shows. After performing in Jean Louis-Barrault's troupe, I set up my own company in 1948, and between then and 1964 I staged twenty-six mime plays, or "mimodramas" as I prefer to call them. Since pure mimodrama was not recognized as a theatrical art form I received no subsidy, so I had to raise the funds for my productions by international tours. I have given performances on all five continents, with particular success in the United States and Japan, and appeared many times on television. But my financial difficulties, particularly after the only partial success of *Don Juan*, a mimodrama adapted from the play by Tirso de Molina, produced in 1964, forced me to disband my troupe that year and begin appearing alone on stage.

I became a solo mime, but unlike singers, who can be listened to at any time on records or on the radio, mimes are masters of silence, soon forgotten if they don't appear on stage regularly.

■ **Mime is a universal language that doesn't require translation. Perhaps that is another explanation of your success?**

M.M.: Yes, that's true, but French audiences seem to me rather conservative, despite the fact that France has a great tradition of mime and has produced many famous exponents of the art. UNESCO asked me to be one of its goodwill ambassadors but unfortunately, as I am always on tour, I didn't think I could be very effective in that role, though I did work with that splendid Organization on a film defending copyright and authors' rights.

Eventually I asked the French authorities to help me prevent the art of mime from disappearing. As a result I was able to set up the Marcel Marceau International School of Mimodrama in Paris, which receives a subsidy from the City of Paris. It provides courses of training in several subjects (dance, fencing, acrobatics, drama) and is attended by students from all over the world. Some former students are working with me on the preparation of a show, *The Bowler Hat*, a tribute to Chaplin that will be performed internationally in several theatres.

■ **Do you feel when you are on stage that you are delivering a text, even though you don't say a word?**

M.M.: Yes indeed, I feel that I am both an author and an actor at the same time. Although my performance is silent, I am not acting by means of gesture alone. I am using the power of thought. I communicate with the audience by means of the thought that goes into every movement and every pose. Writers make contact with their readers by means of words and ▸

the way they give form to words through a story. Mimes are always, by definition, wordless, but they present the fable of human life on stage by means of an art that transcends words. I often make use of themes that transcend language, such as *The Heart Eater*, *The Cage*, or *The Mask-Maker*, which are the titles of some of my sketches. They are actually parables that express deep thoughts. Dancers do this by movement, but the mime does it by remaining motionless, by simply being there.

© Jean Pierre Amet/Sygma, Paris

■ Could it be said that the spectators recreate within themselves what you are doing on stage?

M.M.: Yes, exactly. Unless the audience is drawn into the action, the mime has failed to get his message across the footlights, his performance is closer to mimesis than to the true art of mime. He has not succeeded in radiating the poetical aura that evokes in the spectator what I would describe as a "zen" identification with the character portrayed. Laughter is aroused by what appear to us as distortions or discrepancies in relation to what is "normal", but the laughing stops when the outcome is tragic, when death intervenes. The great Charlie Chaplin's films illustrate this very well. Although the cinema audience go along to laugh at Chaplin's antics, at some point they stop laughing, they succumb to emotion and suddenly see the character he plays in a different light. Comedy and tragedy disrupt the rules established by society.

■ What influence have Chaplin's films had on your work?

M.M.: The character of Bip was entirely inspired by Chaplin. He was very popular when I was a child, and by the age of ten I was already imitating his funny walk. He and my teacher, Etienne Decroux, who invented the grammar of mime, its rigorous control of the body, inspired me to opt for the art of silence. I also studied under Charles Dullin, who taught me about lyrical rhythm and the inspiring power of the spoken word. Chaplin in fact started out by performing in music halls, as a singer, dancer and acrobat. His performance in silent films was pure mime and he was so affected by that experience that, long after the talkies had come in, he was still turning down speaking roles.

■ You could have been a dancer...

M.M.: No, I might have had a talent for movement, but dancing involves pirouettes and leaps whereas mime, an art of bodily expression, of what my mentor Etienne Ducroux called "moving statuary", borrows its postures from Graeco-Roman statues, giving it scope for beauty and virtuosity. Immobility is a very important part of it, but so are acrobatics and the visual element. Since it can be abstract, surrealist or melodramatic at will, it has an explosive impact on the feelings. There is in the theatre of mime a kind of inner respiration that renders visible the invisible, sculpts forms out

© F Damigny/Sygma, Paris

of space and lends wings to the characters' thoughts. Whereas the dancer is more ethereal and tends to fly away like a balloon, the mime artist is held down by his body movements.

■ **Do you also find inspiration in art forms like Japanese *kabuki, nô* or *butho,* or African dances?**

M.M.: Yes, mime naturally borrows from the other arts: the Japanese theatre, as you rightly say, including *bunraku*, the traditional puppet theatre, from which I learned a great deal—I've toured Japan twenty or so times—and the Italian commedia dell'arte, the British music-hall, Indian and Cambodian dancing and contemporary Western dance. Not needing words to express itself, mime is in touch with all cultures

■ **You both design and perform your own pieces, and recreate and reinvent them with every performance. Do you have a favourite audience, one that is more receptive, more knowledgeable than others?**

M.M.: Mime has a grammar of its own that needs to be respected, an insistence upon classical perfection that has to be constantly upheld and renewed. As to spectators, children are the most receptive; they make a marvellous audience. In the silent ceremony of mime, which demands intense concentration, they are in perfect communication with the performer. They are totally responsive; unbeknown to themselves, they are telling the story. When I play an angel, for instance, they identify so fully with the character that they become that angel themselves, thanks to a power of imagination that no adult possesses to the same degree. Like fairy stories, mime reinstates that imaginative faculty of theirs. Even though they sometimes become fidgety, they are spellbound. They think they are magicians, and so do I.

■ **Why are there so few female mimes?**

M.M.: That was true a few years ago, but more and more women now want to take it up. In nineteenth-century mime theatre, women played frivolous creatures or great men's muses, seductresses or unfaithful wives. They were always a foil to the male characters. In her mime play *La mémoire des femmes*, Anne Sicco, my former wife, gave women a more important role than they had in my productions, where they only played so-called female parts, as flower-sellers for instance. There are more and more parts now for women. Dozens of them are studying mime in my school.

■ **Why doesn't the cinema show much interest in mime?**

M.M.: Charlie Chaplin and Harry Langdon were brilliant mimes. Films like *Modern Times* (1936), which Chaplin directed and in which he showed his incomparable mime artistry, have kept the world laughing for generations, but it is true that mime does not interest modern directors. I am sure film-makers in the next century will take an interest in it.

■ **How do you manage to stay so young?**

M.M.: Although I am over seventy, I still find time to enjoy life. I also stick to a healthy diet, not eating much and not drinking alcohol. I have several projects on the go. As an illustrator I am working on a book for bibliophiles entitled *La ballade de Paris et du monde*. As an author, I have written a book about Bip that has been translated into five languages, and another, entitled *Pimporello*, a poetical story about an Italian mime and a young orphan girl that I would like to adapt for the screen. Age means different things to different people, that's all there is to it! (*He mimes an old man who suddenly becomes a child.*) ■

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At the crossroads of science and ethics

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The ethics of life

edited by Denis Noble and Jean-Didier Vincent. 1998, 238 pp. 135 French francs.

AUTHORS

GEORGES B. KUTUKDJIAN, a philosopher and anthropologist, is director of UNESCO's Bioethics Unit. He is the author of several published works, and was co-editor, with Antonio Papisca, of a collective work on the rights of peoples published by CEDAM, Padua, 1991.

JEAN AUDOUZE, a French astrophysicist, is a research supervisor at his country's National Centre of Scientific Research (CNRS). He has written several science books intended for the general public, including *Regards sur le visible* ("Looking at the Visible", with Jean-Claude Carrière, Plon publishers, Paris, 1996) and *L'Univers* ("The Universe", "Que-sais je?" series, Presses Universitaires de France, 1997). He is the author of a report for UNESCO preparatory to the creation of a World Commission on the Ethics of Scientific Knowledge and Technology.

NICHOLAS A. ASHFORD, of the United States, is professor of technology and policy at the Massachusetts Institute of Technology (MIT), where he teaches environmental law and policy. He is the author of *Crisis in the Workplace: Occupational Disease and Injury* (MIT Press, 1976) and co-author of *Chemical Exposures: Low Levels and High Stakes* (John Wiley Press, second edition, 1998).

GORDON BENNETT, a Canadian public servant, is chief of policy and strategic planning at the National Historic Sites Directorate, Parks Canada. He is the author of *Yukon Transportation: A History* (1978) and of many articles on cultural heritage policy.

NIKITA LOPOUCHKINE, a Canadian public servant, is acting director of his country's Natural Resources Branch at the National Parks Directorate. He is the author of many works on ecology and the restoration of ecosystems.

JENS ERIK FENSTAD, of Norway, is professor of mathematical logic at the University of Oslo and a member of the Norwegian Academy of Letters and Sciences. He is chairman of the Standing Committee for the Physical and Engineering Sciences of the European Science Foundation.

MICHAEL KIRBY, an Australian High Court justice, is a member of UNESCO's International Bioethics Committee and of the Ethics, Law and Social Issues Committee of the Human Genome Organization.

FRANCE BEQUETTE is a Franco-American journalist specializing in environmental questions.

ELISABETH BAUDOURIAN, an Armenian-born French journalist, is general co-ordinator of *Nouvelles d'Arménie* magazine.

MICHEL FARGEON is a French journalist specializing in the performing arts.

ISABELLE LEYMARIE, a Franco-American musicologist, has recently published *La musique sud-américaine, Rythmes et danses d'un continent* ("South American Music: A Continent's Rhythms and Dances", Gallimard, Paris, 1997).

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Illustrations: Ariane Bailey (Tel (33) (0) 1.45 68 46 90)
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