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The Post-Industrial Age of Science and Technology

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Tough decisions must be taken regarding the future of science and technology despite great uncertainty—above all, we cannot know what we don't know. Growing public awareness of the potential perils (pollution, unemployment, ethical and cultural issues) could undermine essential public support for science. To ensure that science brings real benefits to all sections of the global society and does not simply widen the gap between the "haves" and "have-nots", we must pool our considerable intellectual and economic resources—which will require not just knowledge, but wisdom.

Keywords: science and technology, social change, uncertainty

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Not so very long ago, most people had a touching faith in science and technology. They hoped that scientific progress would provide answers to many of the world's most intractable problems, just as it had provided them with a far better standard of living than their parents and grandparents: better health, cheaper and more plentiful food, less physically strenuous work, easier transport and communications, amusing gadgets to fill their increasing leisure time...

True, science and technology had also created terrible weapons of mass destruction, but many believed that at least the threat of nuclear warfare had stopped the Cold War from turning into anything worse.

Today, attitudes to science and technology are much more ambivalent. Certainly the benefits are there for almost everyone to see, unless they live in some exceptionally remote place. Certainly in the last 50 years scientists have a remarkable record of tackling and solving seemingly impossible challenges. Eradicating smallpox, TB and polio. Developing new species of crops that have allowed Asia to feed itself. Putting men on the Moon-but more importantly putting satellites into orbit that give global phenomena a new reality. Because now it is possible to monitor global climate and environmental change, as well as to develop truly global communications networks.

And there is no doubt that scientists will continue to make astonishing advances on the basis of what they have recently learned or are just now beginning to understand. You do not have to be a specialist to see that progress is constantly speeding up, and the practical applications come hard on the heels of theoretical breakthroughs.

So far, so good.

On the other hand, the destructive effects of progress in science and technology are now being perceived far from any war zone: in factories and offices, in cities and the countryside. Machines can still be marvellous things. But they can also destroy people's jobs and utterly devalue their skills. Machines can pollute not just their immediate environment but the air and water hundreds of miles away.

Machines and new techniques are affecting every aspect of our lives from cradle to grave; they raise fundamental questions about ethics and about the kind of world we want for ourselves and our children.

Indeed the positive side of all this is that more and more people feel concerned about the impact of science and technology—for good or for evil—on their own and other people's lives. And they have a much greater chance of making their views heard than ever before.

For one thing, in purely practical terms, science is no longer a matter for scientists alone. Of course progress depends on their expertise, but scientific research is now conducted on such a vast scale that scientists need ever greater resources to continue their work. The money to pay for it ultimately comes out of our pockets, whether as taxes or as payments for the goods and services produced as a result of scientific progress. So, if the bandwagon is to go on rolling, public approval is essential. And, thanks to the growth and success of grass-roots movements in many countries, ordinary men and women no longer feel that they are powerless to influence the decisions of governments and large corporations, especially in matters affecting the environment and health.

The problem, of course, in making decisions about science and technology, is that there is a huge factor of uncertainty, even for the most well-informed scientists, politicians and business leaders. And as technical change speeds up and our world becomes more complex and interdependent, the uncertainties increase rather than decrease.

Some things are known for certain. Some are the subject of lively debate, like global warming, where eminent scientists hold opposing views. Yet others are known to be still unknown—for instance, how to achieve nuclear fusion or eradicate the common cold. But the biggest unknown is what we cannot know that we don't know. Who 50 years ago could foresee the impact of the microchip, or developments in fields like microbiology or chaos theory, which did not even exist? What discovery yet to be made will have transformed human life in 2050 in ways we cannot imagine today?

Yet in spite of this uncertainty and ignorance, decisions must be made about the resources to be allocated to science and technology,

and the areas of research to be encouraged or discouraged. The public should be involved in those decisions because the consequences will be felt by everybody in one way or another.

For, in the midst of this uncertainty, one thing at least is clear: science and technology have an enormous potential to widen the great divide between the world's haves and the have-nots. If present trends continue, those who have access to the benefits will receive an enviable education thanks to computers, CD-ROMs and the like. They will be able to go on to stimulating and well-paid jobs. If they fall ill or have an accident, they will enjoy the best high-tech medical care, with scanners and lasers and the latest drugs. And they will live long comfortable lives, with whatever improvements the 21st century brings to entertainment, sports, travel, and so on.

At the other end of the spectrum, those who have none of these things will be left further and further behind, probably without even the comfort of ignorance of their misfortune. Because this divide will be more social than geographical. We are already seeing the growing gap in the industrialised countries between the unemployed and the rest of the new underclass on one side, and the lucky ones who have jobs and holidays and personal computers on the other. I'm sure I don't have to press the point to anyone who has taken a cab a few blocks across Washington DC from Capitol Hill.

In developing countries, the contrasts are often even more flagrant, between the elite who enjoy the same advantages and living standards as the most affluent Westerners, and the poor who do not even have access to clean water, let alone schooling or basic medicines.

Yet if the will to change this state of affairs were there, science and technology could do a great deal to provide a way—at least to give those at the bottom of the ladder more of the advantages taken for granted by those at the top. Poor people have already benefited from scientific progress, through such things as disease control, new crop varieties, better telecommunications. And more could be done.

Money is an inevitable factor, as it is with regard to the environment. Some compromise has to be worked out between making the

polluter pay and making those who care about the pollution pay. Especially when the polluters are Third World countries desperate to raise incomes and unable to afford expensive imported technologies that would cut pollution levels.

Similarly, in most Western countries until recently everything had to be plentiful and cheap, especially food, energy and consumer goods, and nobody asked searching questions about how this was achieved. Now those questions are being asked, and the public are not very happy about the answers-but how much are they prepared to pay for industry, agriculture, public utilities to clean up their act?

It is a sad reflection on our societies that the biggest share of R&D budgets in many so-called advanced countries is spent on defence, and that many of the world's poorest countries squander money on buying imported high-tech weaponry rather than on primary schools and clinics.

Western governments are reluctant to cut these expenditures because the armaments business, shamefully, is a major source of both highly skilled employment and export earnings. With almost 20 million people out of work in the European Union alone, these jobs cannot be thrown away lightly, even at the expense of world peace.

Yet economic security is now a far more serious problem than conventional security for both governments and individuals. It is not just a matter of trying to find jobs for those currently unemployed, in itself a gigantic task, but of dreaming up jobs for the young people who will leave schools and colleges in the next few years, as well as for those likely to be made redundant at 35,40, or 45... Today's New Deal will have to be extremely imaginative, because today's unemployed are so diverse and have higher expectations. Some are well educated, with long but now useless experience; many are half educated, with little aptitude for the jobs available. All are, in one way or another, a potential charge on the community.

Science and technology are inevitably blamed for creating the machines that run tirelessly around the clock, replacing the work of many fallible human beings. For a while it was hoped that they

would create other, more agreeable and interesting jobs. To some extent they did, especially working with computers and software. But few believe today that new technologies will generate more jobs than they displace. Again, we cannot know what cannot be known, and perhaps some miraculous discovery will change the scenario. What is certain is that we face a period of tremendous structural change that is likely to last for several decades. And in the meantime, the productivity race goes on, spurring science to create yet more labour-saving technologies.

Human ingenuity has been wonderfully successful in understanding how our physical world functions and inventing ways to exploit all its possibilities. Or how our bodies function and repairing the deficiencies. That ingenuity is now going to have to come up with a radically new approach to how human beings spend their time and receive an income. Work has structured the existence of most of the human race since our distant ancestors made the first primitive tools. Work filled a major part of people's lives, and gave them not just the means to live but their social identity.

Now we face the real prospect of too little work for too many people, with far-reaching consequences for the way our societies are organised and wealth is distributed. Again, money is the crux. Because there are plenty of things that need to be done, that benefit the community, but that are not profitable in the conventional sense. They involve support for those who cannot take care of all their own needs through age or illness. Or cleaning up or conserving the environment. Or providing entertainment. There are many people who would like to do these jobs, or to spend more time studying, or engage in other activities that are not normally remunerated. Increasingly the world is divided into the overworked, who would be delighted to have more free time, and the unemployed, who would give anything to have a job. A social revolution is required to share the work and the free time more evenly. We need to think in terms of "activity" rather than "work". Some of it would be paid, at least a living wage; and the rest highly valued but unpaid.

In any case, a revolution is already under way that is changing

the whole notion of "going to work" in a factory or office or school or even clinic. Thanks to information technologies, more and more tasks can be done at a distance: so-called telework. This started with basic information processing (secretarial work, accounting, computer software design), but it is now almost limitless. Designers can be thousands of miles from the plant that makes the final product, yet be immediately "available" to sort out problems. Computerised machines can be supervised from another city or another country. Doctors can "see" patients or professors teach students without ever being in the same room with them.

Similar changes are affecting other activities like shopping and banking, as you know better in the United States than we do in Europe, where these services are only now beginning.

Automation has brought about a fundamental shift in the role of women in many societies, releasing them from old chores and opening up new careers in production, distribution and management. The social consequences in industrialised countries are already considerable, and they are likely to be even greater in Third World countries, where empowerment of women through education and paid employment can be the key to mastering population increase and achieving development goals.

So the problem of how to distribute employment and income is bound up with these other upheavals in the nature of work and society itself. The solutions may come in ways we cannot foresee, but the potential for even greater social cleavages is all too obvious and they must be minimised. In future, a home with a phone line may be a necessity not a luxury, and those without these basics will be excluded from huge areas of employment, education, healthcare and other services.

These technical and social changes are of course anathema to certain fundamentalist creeds and societies. At the least, this will add to the disparities between those who enjoy the full benefits of technical progress and those who are excluded from them. It will also add to the cultural tensions between different visions of the ideal society.

But even in the most sophisticated and tolerant societies, the new technologies are raising questions about cultural values that are not easily resolved. The technologies may be in themselves neutral: the difficulties arise from the way they are used. What do we do when satellite TV and the Internet are used to disseminate pornography, especially involving children, which even the most broadminded find abhorrent? And if we do not like this use, how do we control it?

The information superhighway is a gift to criminals on every continent. Computer fraud is very lucrative and, like all the intangibles created by the Information Revolution, it is hard to police. So people who would never have dreamed of robbing a bank when it involved using a gun are silently stealing millions by pressing a few keys. Of course, we hear only about those who are caught. How many more are getting away with it?

Another, very different issue is how to protect minority cultures and languages from the onslaught of the majority, above all English. Cultural and linguistic diversity—despite its problems and the bloody conflicts that it sometimes generates—is part of the rich heritage of humankind. To lose it to a few dominant cultures would impoverish us all. The optimists will reply that the new technologies offer wonderful opportunities to reach a larger audience with TV programmes from small countries, or to record, teach and use minority languages on a far greater scale than ever before. But the reality is that if you want your programme or your e-mail message understood, you virtually have to use English.

From the practical viewpoint it is perhaps no bad thing if the global society has a lingua franca in which to communicate. But from the cultural viewpoint, it would be a tragedy if it has only that language and set of cultural references.

Given these threats, promises and above all uncertainties, it is hardly surprising if attitudes to science and technology are ambivalent. Individuals and governments wonder how they are going to cope with these changes, which will affect them whether they like it or not. Which side of the divide will they or their countries find

themselves as the global society emerges? With the haves or the have-nots? If they end up with the have-nots, what chances are there of catching up with the haves? If among the fortunate haves, how secure is their position? What must they do to stay there?

The decisions taken now may be crucial for the future of our societies and our world, yet we must take them on the basis of very incomplete information. Which lines of scientific research will lead to beneficial results and which to useless or harmful ones? Which technologies should be promoted, and which discouraged? How can advanced countries best help developing countries in the area of science and technology? Where should developing countries invest their own much scarcer human and financial resources? How should education and training be adapted to prepare the rising generation to meet the challenges ahead? Or to help older people to train for jobs that did not exist when they left school?

Since resources are limited, some of the decisions will be tough. Which should have priority: research into saving premature babies or into Alzheimer's? Is it better to aim for maximum productivity and competitiveness, or to try to start adapting now to a new kind of economy and society, with the risks that each option carries of unemployment and social dislocation? Should armaments industries be scaled down and the job losses accepted, or should they be maintained in spite of the consequences for world peace? Should the richer countries tackle first the problem of their own poor, or invest in helping the poor of the developing world to earn a decent wage at home rather than migrate in the hopes of a better life in the rich countries? Should development aid be given for clean water or for girls' education?

These and all the other questions raised by progress in science and technology are not going to be easy to answer. On the other hand, human beings have always been good at problem-solving. Furthermore, we are well placed to tackle these issues, because we know more, and we have better resources at our disposal than ever before in human history. As we move towards a global society, we have extraordinary opportunities to pool our intellectual and eco-

conomic resources to tackle common problems, instead of either duplicating our efforts or, worse, using them against one another. Everyone recognises that it makes more sense for Russian, American and European scientists to collaborate, as they are now doing, rather than compete in space. We need similar co-operation and solidarity here on Earth: if we put all our heads together, we stand a better chance of solving the problems we now find baffling. For that to happen, we need not just knowledge, but wisdom.