Tomorrow's Bio-society

European File

Though labour troubles, unemployment and energy currently dominate the international economic scene, the coming twenty to thirty years will, it is thought, see two major changes :

- ☐ the computerization of society (telematics, new information handling technologies etc.) through the interlinking of data banks, computers, micro-processors, modern telecommunications techniques, including satellites.
- ☐ the biological revolution emanating from the boom of 'life technologies'.

Even before man had discovered the existence of microbes, he was already utilizing their ability to synthesize other compounds by a costless, non energy-consuming process, namely fermentation to produce or preserve certain foods and beverages : wine, beer, yoghurt, cheese etc. Similarly the processing of cabbage into sauerkraut resulted in an increase in the availability of vitamin C. In the twentieth century, penicillin produced from mould has enabled tuberculosis to be conquered. Now we are even beginning to produce energy by fermenting biomass (undergrowth, food-wastes etc.).

Now that man has begun to usefully understand the functioning of living cells, he can put it to good use. Firstly by using enzymes which are produced by the cells and which act as catalysts in chemical reactions such as digestion or fermentation. Secondly by manipulating the genes which are the key elements of heredity. In a simple cell weighing less than one hundred-thousandth of a milligram, there is, according to

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Nobel prize winner Christian de Duve, more chemical genius than in all our laboratories and factories put together.

This is, broadly speaking, the area covered by biological technology, a vast field as can be seen, but with one unifying objective : the industrial processing of certain substances using micro-organisms or other biological agents to obtain new products or new services.

The application of bio-technology

Within the relatively near future, bio-technology could be used in a number of sectors :

- *human health and behaviour :* we could control the development of the human embryo and — perhaps within twenty years — determine its sex. We could prevent certain malfunctions. We should be able to create new vaccines and inoffensive drugs to counter addiction to alcohol or tobacco, even to regulate moods and emotions. We could also improve the quality of life for the elderly, improve techniques for transplants and even create artificial organs and biochemical aids to cope with a failing liver or artificial kidney.

- *chemicals :* the detergents we use already countain 'glutinous enzymes'. In the future we will be using microbes or special cells in controlled conditions for tasks as varied as water purification, the production of industrial products which currently require difficult and expensive pressure and temperature facilities, the production of vitamins, hormones, anti-bodies, and immunizations for treating and preventing allergies and cancers.

- *agriculture, food :* microbes are already used for producing amino-acids which add flavour or body to numerous foods. Tomorrow, the industrial production of protein and 'vegetal meat' will help us feed the peoples of the Third World. Biological fertiliser will help plants obtain the nutritious nitrogen they currently receive naturally from soya, and should replace oil based fertilisers. Biological pesticides and genetic manipulation will afford us healthier vegetation and factors such as speed of growth will be adjusted according to use, whether for food or for energy (e.g. fast growing trees, cereals producing more straw thereby, after fermentation, combustible alcohol to replace oil). Species of animals themselves can also be improved in a number of ways ranging from the elimination of parasites to the creation of new breeds, through the use of cloning techniques enabling the production of strictly identical animals from the production of one single cell.

- *resources :* biology, as we have seen, can supply us with energy. It can also help us recycle household wastes and rationally exploit the seas by breeding fish or cultivating marine plants such as giant seaweed and algae which can provide many by-products. Certain bacteria can help us produce leather, as is already done in Japan, and also plastics. It can help us recuperate numerous minerals contained in seawater or dispersed in low-content deposits : soluble salts, copper or uranium etc. Micro-organisms mutate in the same binary rhythm used by computers and, it is thought, could be used to store and process information in 'bio-computers'.

As research progresses, biological methods will become more sophisticated. The use of bacteria present in the natural environment will be succeeded by enzyme or genetic engineering :

- ☐ enzyme engineering is based on the ability to produce, isolate, purify and immobilize cellular enzymes to utilize their capacities as catalysts, individually at first, then as a group, for extremely specific chemical reactions. We can thereby produce semi-synthetic penicillin or, using corn starch, low calory sugar. More generally, we can develop 'molecular converters' (bioreactors) capable of providing on a large scale and with the minimum energy consumption and environmental pollution, a variety of complex products whose production through traditional methods requires the use of large energy consuming and polluting machines.

- ☐ Genetic engineering will enable genes — the determinant of heredity — to be recombined in ways that do not exist under natural conditions. By working at the chromosome level, it is possible to create hybrids or to improve the productivity of micro-organisms used in enzyme engineering. We could also transfer particular properties from organisms — such as a bacterium frequently worked with in the laboratory, Escherichia coli — to another organism usable by industry and where identical reproduction can theoretically be obtained via cloning.

Economic and social implications

The economic impact of bio-technology is potentially enormous :

- ☐ *economic impact :* with new energy sources [1] and energy savings [2], as well as with information technology [3], even before the extensive exploitation of the sea whose fruits will only be available at a later date, biotechnology could establish itself as the driving force of new-found economic growth over the coming decades. Biological progress will also multiply the applications — some of which we can scarcely visualize at the moment — of bacteria, enzyme and genetic engineering. And the raw materials used are often widely found and renewable : microbe and cellular cultures, sugar, starch, oil refining residues etc. The road to economic growth is not closed, but less energy-consuming growth based on computer and biological technology, on the use of micro-processors and micro-organisms, will oblige us to reconsider how man should work, how long he should work, and the role of work in earning a living and in the distribution of available wealth, and even its impact on the development of the human personality.

- ☐ These aspects are particularly crucial for European countries. In international economic competition, we have neither low costs to compete with the low wages of some of our competitors, nor large reserves of raw materials. We can only compete

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[1] See *European file* No 2/80 'New energy sources for the Community'.
[2] See *European file* No 16/79 'Economic growth and energy conservation'.
[3] See *European file* No 3/80 'Europe and the new information technology'.

by increasing our productivity and our specialization in sectors based on the technologies of the future. Europe's raw material is its grey matter. More than any other continent, Europe is forced to innovate.

☐ *Social impact:* each of the innovations described above have considerable implications for everyday life : health, food etc. But what can we say of all these innovations taken as a whole ? Too often we hear talk of 'bio-society', a society in which whole areas of human activity will be radically transformed through recourse to biotechnology. New problems will appear, however :

- problems of acceptability as happens with all major technological changes. How will individuals react to innovation ? Automatic mistrust ? Or will they consider the needs — health, food, energy etc — which must be met ?

- safety problems, as in the case of numerous other industrial sectors such as chemicals, for example. The European biological industry shows, in general, a high awareness of safety, and the risks of microbe infection and genetic accident are probably very limited. It can even be argued that biological technologies offer more beneficial effects — reduced pollution, the treatment of certain addictions — than new risks. It is nonetheless still necessary to take all possible precautions.

☐ The answers to these problems will have bearing, quite evidently, on the speed of introduction of the new technologies. Which is to say that it is necessary to initiate a major scientific and political debate to arrive at a precise assessment of the difficulties. In addition, we should begin to examine how man will cope with his new environment, where nature and living things are increasingly controlled and manipulated. Take, for example, the social problems arising from the possibility of choosing the sex of a newborn child without disrupting the natural equilibrium.

Why European action

Despite the work undertaken for many years on bio-technology, European countries are well behind in relation to their direct competitors :

☐ Japan has a world monopoly in certain sectors such as the production of amino-acids via fermentation. According to certain sources, the exploitation of micro-organisms already accounts for 5% of Japanese gross national product (GNP);

☐ the United States has joined the race and some of its large firms, oil companies in particular, are working on large-scale investment programmes;

☐ Europe, by contrast, continues to import vegetal protein and soya. In general, its industries hold fewer patents than American or Japanese firms and a deficit is emerging in this area of trade.

Patents recorded between 1969 and 1975 (in %)

	Europe	USA	Japan	Total
Enzyme technology	20	50	30	100
Enzyme stabilization	10	21	69	100
Chemicals produced through fermentation	15	18	67	100

Amongst causes for Europe's backwardness can be mentioned :

- ☐ concern for the financial risks involved in basic research with only long-term prospects for success;
- ☐ shortage of qualified scientists, researchers and workers;
- ☐ insufficient collaboration between European firms from different countries who are too small and, effectively, disperse the research effort and duplicate what is being done elsewhere;
- ☐ barriers which can result in different safety standards from country to country and different customs and legal provisions which protect 'de facto' the traditional processes used in the market;
- ☐ and perhaps, above all, the lack of long-term strategic vision.

European cooperation is necessary to :

- ☐ reorganize the various responsibilities and pool the available human and financial resources, which are relatively scarce. Cooperation between the specialists, who are even thinner on the ground, could help us reach the threshold of profitability for industrial research and development;
- ☐ plan and coordinate work in laboratories and in industry where progress is often closely inter-related. Certain industrial objectives presuppose the availability of substances which cannot be produced unless the bottle-necks at the research end are eliminated;
- ☐ integrating protection measures for biological risks, so as to eliminate obstacles to industrial trade, whilst ensuring maximum security through common standards and, in certain cases, by concentrating risk activities in the most appropriate areas;
- ☐ facilitating the achievement of the common objectives set by Community countries in sectors such as agriculture and food, industrial progress, energy supplies, environmental protection, improvement of life in society.

Where are we today ?

The European Community is progressively extending its efforts in the field of bio-technology.

□ *The FAST programme* : first of all, the Community has given recognition to the question of biotechnology in the framework of its programme of forecasting and assessment in the field of science and technology, better known under the abbreviation of FAST, and implemented at the beginning of 1979 for an experimental five year period. This programme aims to define coherent priorities for research, based on an examination of the potentials, problems, conflicts and opportunities affecting the Community's long-term development. The Community finances and coordinates the work of multinational teams and individual researchers and tries to encourage integration into a multi-disciplinary approach. As priorities for the future, an initial evaluation has selected the problems of energy, of work and employment, of the new information technologies and, finally, of bio-technology.

□ *The FAST sub-programme 'Bio-society'* : in the framework of the FAST programme, 500 000 European units of account [1] have been devoted to a sub-programme specifically dealing with bio-society. The principal lines of research are :

- definition of a European strategy based on the systematic collection of available information as well as the identification of research and development possibilities seen over the long-term;

- evaluation of the implications of the gradual extension of bio-technology to human work and training requirements in different sectors of industry;

- examination of the social consequences of biotechnology and the psychological barriers which could hinder its introduction;

- study of the effects which the development of new technologies could have on our trading and industrial relations with the Third World (reduction of raw material imports, but also the possibilities for increased industrial trade) [2].

□ *Research and development in the energy field* : many organic materials can be transformed into gas as a substitute for oil. The Community has undertaken research specifically dealing with methods for converting wastes and exploiting the energy potential of forests and poor quality soils; in addition, it finances demonstration projects on the retrieval of methane and other types of bio-gas from linseed, manure, and other agricultural residues.

□ *Commission proposals in the field of biomolecular engineering* : on 11 January, 1980, the European Commission proposed to the Nine an initial joint programme to identify and eliminate a number of bottle-necks restricting the industrial use of biotechnology and, in particular, biomolecular engineering. This programme, which was allocated 26 million EUA from Community funds, will be undertaken on a shared-cost basis with public and private laboratories in Member States. Two

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[1] 1 EUA = about £ 0.61 or Ir. £ 0.68 (at exchange rates current on 9 June 1980).

[2] For further details see : FAST, *sub-programme C 'Bio-Society'*, document FAST-ACPM 79/14-3, published by the Directorate General for Research, Science and Education of the Commission of the European Communities.

main lines of research have been proposed : the development of a new generation of enzymes and of complex enzyme reactors to permit the synthesis of products usable by industry; the application of genetic engineering methods to certain organisms. This programme comprises six distinct projects :

- the development and evaluation of new substances incorporating immobilized, interactive multienzyme systems;
- development of biological substances to help reduce industrial pollution and to help cure individuals intoxicated through ammonia, alcohol, nicotine, certain drugs etc.;
- the transfer of genes from diverse sources to certain bacteria or micro-organisms usable for the production of hormones and thereby aid problems of physical growth, certain nervous disorders, cancer etc.;
- the development of cloning vehicles to help the transfer of genes and facilitate the reproduction of certain micro-organisms;
- the transfer of new genetic information on species important for industry or agriculture (bacteria, hybrid plants etc.) and showing good guarantees of genetic stability;
- study of the stability of particular strains and the improvement of the detection of impurities and contamination risks to increase the safety of biotechnology.

△

We are only now beginning to get an idea of the possibilities which biotechnology holds in store. One thing is clear, however : the new technologies are tantamount to revolutions which over the coming decades could affect the everyday life of each one of us, while at the same time giving new opportunities to European industry. In this area, as in others, the Community should help us prepare for the future ■

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