euro spectra

SCIENTIFIC AND TECHNICAL REVIEW OF THE EUROPEAN COMMUNITIES

MARCH 1971
VOL. X
NO. 1

Contents

The world is poisoned with pesticides ; they have permeated the water, plants, animals and foodstuffs. Man, the prime cause of all this, is contaminated too, and must now find some way of freeing himself and the environment of them *(see p. 2).*

spectra

Coal and oil are the familiar, classical sources of primary energy, which have recently been joined by natural gas.

In the last 25 years uranium has won itself a place in the list, although it has experienced some ups and downs, notably the large drop in demand for military purposes and, later on, the disappointing setbacks encountered in other fields of development.

Under its policy of ensuring a dependable energy supply system for the six Member States, the Commission of the European Communities has devoted an enormous effort to its task in this sector over a number of years. How necessary this action was has again been demonstrated by the recent disputes between the oil-supplying and oil-consuming countries.

The agreement reached in 1970 by the European uranium producers, under the Commission's auspices — one of the most enthusiastic and active promoters of which was Jacques Mabile, Director of Production at the French Atomic Energy Commission, tragically killed in an air disaster in France last January — has yielded more than promising results, which amply justify a resolute pursuit of the policy of developing uranium as an energy source and encouraging its use, so as to relieve the Community of at least a part of its energy supply problems.

Scientific and
Technical Review
of the European
Communities
(ex-Euratom-Review)

1971 1

Pesticides - a problem for present-day society

The large-scale application of pesticides, such as it is known today, is gradually polluting our planet. At the same time we cannot do without pest controls. How should modern society face this dilemma?

BRUNO VERSINO

ACCELERATED industrial activity, the ever-increasing spread of intensive farming, the achieving of an ever more comfortable, secure way of life, have all helped to flood the environment with myriads of inorganic and organic chemicals, a large proportion of which consist of pesticides [1].

Pesticides are employed for many purposes, apart from their main use in connection with food production, e.g. preventive measures against epidemic diseases (malaria), production of antiseptic fibres, forest protection and highway maintenance (weed prevention). Consequently, not only do these substances enter man's environment in ever-mounting quantities, but the number and variety of the pollutants is constantly increasing.

A few years ago the leading aim was to procure substances that would do their job with the maximum efficiency. However, undesirable side effects were discovered shortly afterwards, including some serious ecological effects, due occasionally to wrong use, but more often to wholly correct use of the products. This, joined to the fact that some of the more persistent pesticides (e.g. organochlorine insecticides, organomercury fungicides) have become universal pollutants, i.e. present in various organisms and all over the world (including the oceans and polar regions!), gave rise to a growing stream of disturbing questions.

Do the concentrations found in man, living organisms and the environment have a significant value and hence biological consequences?

By what pathways are the pesticides spreading out so quickly and so uniformly?

Naturally this form of environmental pollution is not due merely to the fact that the compounds employed are synthetic. Many chemicals create no problem; but it is vitally important to know how to choose suitable substances, compounds which, even if they are fated to enter the food chain of man or of other organisms, can be rapidly broken down so as to avoid a build-up to dangerous levels.

What happens to pesticides

Some pesticides, in soil or water, are destroyed, rendered harmless or removed from the place where they were applied, by a whole range of non-biological processes. These processes include adsorption by colloidal substances, volatilisation, solubilisation and transport by rainwater, lixiviation and other chemical reactions.

Too often, however, the vanishing of a pesticide from a given locality only creates an illusion of safety. It has been amply demonstrated that usually the pesticide has not been finally extirpated from the natural environment but simply moved from one place to another where the potential danger may be just as great or even greater.

Pesticides do not stay put: they move on the air, are adsorbed by dust, and travel, dissolved or suspended, through the world's water systems (Fig. 1); they take part, with parallel cycles, in the natural biochemical cycles such as that of the forest ecosystem (Fig. 2).

Certainly the processes which give the best assurance of radical decontamination of the environment are the partially or totally biological processes. The breakdown of organic compounds by enzymes is highly desirable in that the end products are nearly always entirely inorganic, CO_2, H_2O, Cl_2. Contrariwise, in nature the photochemical or chemical processes do not generally lead to complete mineralisation of organic substances, so that even if the original compound undergoes some degradation, intermediate products of unknown toxicity may be formed which, in their turn, are liable to persist for some time.

Unfortunately the insecticides based on chlorinated hydrocarbons mostly persist intact in the soil, even years after all application of them has ceased. Today, although it is difficult to say whether these substances are absolutely resistant to biodegradation, the number of micro-organisms that have proved capable of destroying them completely is extremely limited. Furthermore, it is well known that sometimes only a minute change in the structure of a substance normally destroyed by micro-organisms is sufficient to render it absolutely insensitive to their attacks; and the fact is that large acreages of soil contain, and absolutely fail to destroy rapidly, pesticides which are closely akin in structure to easily biodegradable compounds.

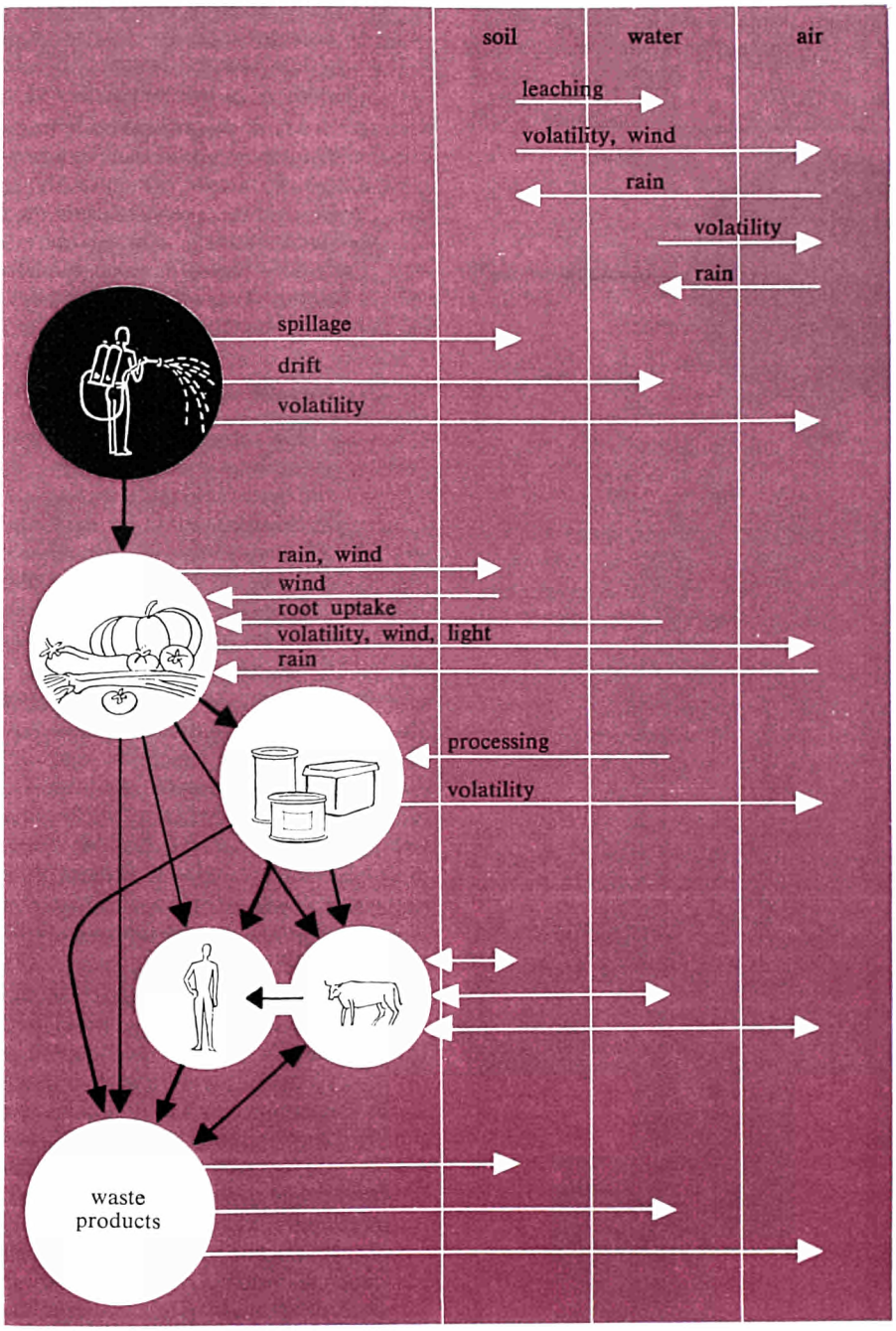
BRUNO VERSINO is on the staff of the Ispra Establishment of the *Joint Research Centre*.

[1] The term "pesticides" is taken to mean all the chemical substances capable of antiparasitic activity and defined and classified, according to their action, as insecticides, fungicides, herbicides, acaricides, etc.

Man and the food chain

At the moment, as regards human contamination through the food chain, the situation can be considered neither satisfactory nor really alarming. On the one hand, analysis of food samples taken in the United States and Europe shows the remarkable coincidence of the pesticides found, witnessing to the universality of contamination (Table I); on the other, *today's "acceptable daily intake"* of each individual pesticide (expressed in mg per kg body weight)

Figure 1: *Propagation of pesticides to the environment.*



is in general considerably higher than the levels found in various balanced-diet samples (Table II), that is to say, there is still a certain margin of safety which, however, must not be over-estimated. It should be remembered that the acceptable daily intakes were laid down in 1967 when, for instance, only the harmful effects of DDT on the nervous system were known and not its recently discovered powers of profoundly altering the hormone balance by stimulating enzyme production.

Again, prof. Göran Löfroth (*New Scientist*, 5 December 1968) has shown that, because human milk in Sweden contains 0.117 ppm of DDT, a baby can easily ingest 0.017 mg of DDT per kg weight every day, thus exceeding by 70 % the maximum acceptable dose (0.01 mg/kg wt). And similar conclusions can be drawn quite easily from examination of a few analysis results such as those we obtained from some food samples taken in the vicinity of the Ispra Establishment of the *Joint Research Centre* (Table III).

In the light of this kind of information, proposals have already been put forward from many sides to lower the acceptable daily intake figure, thus narrowing the margin of safety which is thought to be available today.

Man himself is already unequivocally contaminated in nearly every country in the world (Table IV) and, even though the present levels are regarded as absolutely danger-free from the strictly toxicological point of view, too little is known about the long-term biological effects.

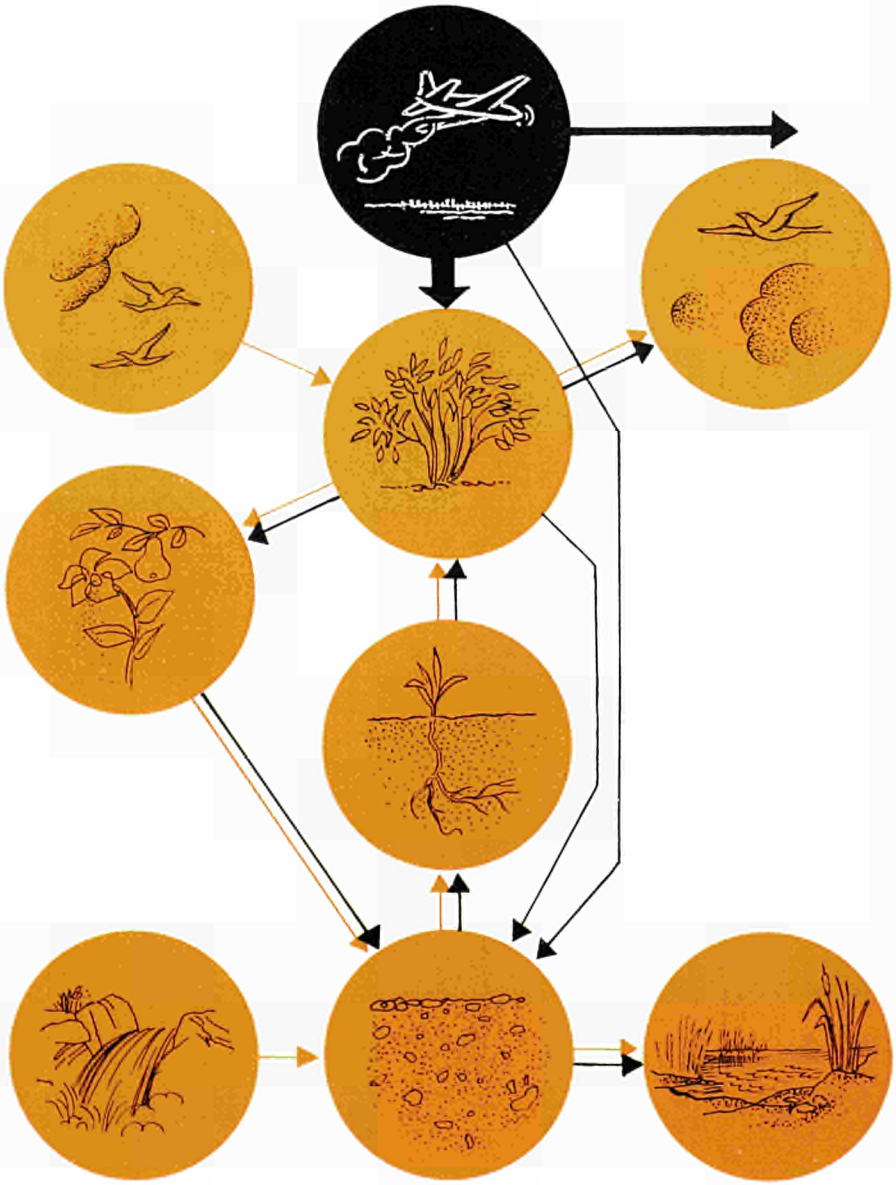


Figure 2: *A forest can be regarded as an ecosystem of plants, animals, micro-organisms and their physical environment, through which energy flows in a single direction and matter moves in obedience to biogeochemical cycles. DDT goes along too, with parallel cycles (black lines).*

Natural environment

The situation in the natural environment is a good deal more precarious, for here relatively low levels can cause, in addition to immediate toxicological effects, long-term ecological effects capable of permanently altering the balance of nature.

DDT, for instance. has been found in the Antartic in penguins and gulls and it is well known that relatively low concentrations can inhibit reproduction by altering balances, such as those responsible for the calcium metabolism. Birds affected by DDT produce eggs with either thicker or thinner shells than normal; the former do not open, the latter break easily, and thus in a short time a species can find itself on the road to extinction.

Pesticide residues, initially sparse, can later go through actual concentration processes through chemical and biological cycles. DDT, which is practically insoluble in water (water is saturated with DDT when it contains 0.0012 parts per million), is fairly readily soluble in fats, so that the DDT present in soil, rivers or oceans quickly "attaches" itself to the nearest biological material, thus starting an obvious enrichment process (Fig. 3). For ex-

ample, in a Long Island, USA, estuary it was found that the plankton contained 0.04 ppm of DDT; the small fish 2-3 ppm: the birds (which feed on fish) 30-75 ppm. In Lake Maggiore, Italy, we found that the water contained less than 0.000003 ppm of DDT; the aquatic plants 0.03 ppm; mussels 0.07 ppm; and the fish 1.5-2.5 ppm.

Another danger to the natural environment is the risk of accidents during the transportation of large amounts of pesticides from one place to another, or of accidental discharge into rivers by industrial plants using pesticides. An exceptional example of the latter case occurred in West Germany in June 1969, when the Rhine was accidentally polluted with the organochlorine insecticide Thiodan. Owing to its extreme toxicity for fish (even at 0.00002 ppm it is lethal to them), millions of fish died and, since the Rhine flows through several European countries, the question assumed an international dimension which showed up the urgent need for cooperative action to secure genuinely effective control at least on a European scale.

The general picture becomes still more complicated if we consider the industrial type of organochlorine products—the polychorinated biphenyls or PCB's. For years the environment was polluted, unknown to anyone, by these waste products of the plastics, lubricant, cosmetic and other industries until the methods developed meanwhile for the analysis of pesticide residues enabled them to be identified. Although less toxic than DDT, the PCB's appear to be capable of greater hormonal alterations, chiefly in the steroid hormones. The Swedes, to whom we owe the identification of PCB's, demonstrated by analysing birds from a museum that specimens dating 1944 had already been contaminated. Recent investigations have confirmed that this contamination is absolutely universal by now, and it is easy to foresee that in the coming years, if the present trend prevails of cutting down the use of organochlorine pesticides or of banning them (as has been done in Sweden, Denmark and Canada), it is the PCB's that will take first place as environmental pollutants.

Pesticides found in dairy products (listed in descending order of frequency)	
U.S.A.	Europe
DDT	DDT
DDE	DDE
DDD	DDD
Heptachlorine epoxide	BHC
Lindane	Lindane
BHC	Aldrin
Endrin	Keltan
Aldrin	Heptachlorine epoxide
Toxaphene	Endrin

Table I: *Significant coincidence of pesticides found in American and European food samples, testifying to the universality of contamination.*

In further confirmation of the general situation outlined above, there recently appeared details submitted by ten countries in the context of a survey promoted by the *Organisation for Economic Coordination and Development (OECD)* on unintentional pollution of the environment with organochlorine pesticides and PCB. The Ispra Establishment of the *Joint Research Centre* was invited to take part in that programme, which called for (after a set of ring analyses to check up on methods) the analysis of fish, mollusc and bird samples taken in place where pesticides had not been directly applied.

Table II: *There is a sufficient margin of safety between the acceptable intake and the amount found in samples of balanced (adult) diets.*

Pesticides	Acceptable daily intake	Balanced diet samples
	(mg/kg body wt.)	
DDT	0.01	0.0005
Lindane	0.0125	0.00006
Malathion	0.02	0.009
Carbaryl	0.02	0.0012
Dieldrin	0.001	0.0009

Daily intake of DDT + metabolites (DDD, DDE) through some of the foods normally eaten by small children

Samples	DDT (mg)	Acceptable daily intake 0.01 mg/kg body weight
1 egg	0.005	
5 g cod liver oil	0.005	
400 g milk	0.01	A child weighing 10 kg may have a daily intake of
2 oranges	0.001	
Total	0.021	0.10 mg

Table III: *With babies the acceptable maximum intake is approached relatively easily. As the present acceptable values are regarded as too high, then the need for serious checks is obvious.*

The upshot was that all the samples, including those from the sea (and, of course, those taken from the Ispra area) proved to be contaminated, thus confirming for the n-th time that pollution is now world-wide.

At present the government laboratories in the various countries, working in some cases hand in hand with the industrial laboratories, are engaged upon the following lines of research:

a) *lethal and sublethal toxicology studies:* from these findings can be established the tolerance limits and the acceptable daily intakes for human and other organisms;

b) *ecological* studies to ascertain the long-term effects of pollution by pesticides and the *synergistic effects* associated with the simultaneous presence of different pesticides;

c) *sampling and monitoring*, to determine the present level of deliberate and unintentional pollution of the natural environment and of the food chain;

d) development of *analytical methods* with special reference to *specific* methods capable of the *simultaneous detection of various pesticides (known as multidetection methods);* the present pattern of analysis for pesticides residues is roughly as shown in Fig. 4: the problem here is to select, out of many, the best mode of extraction and clean-up; the best separation technique (generally one of the chromatography techniques); and the most suitable detectors (specific and sensitive) for a qualitatively unequivocal and quantitatively exact analysis;

e) *information* contributing to proper use of pesticides; promotion of *complementary antiparasite techniques* that will reduce the use of pesticides; search for *new types of pesticide*, with the object of steering the industry towards the production of less poisonous and persistent substances.

Table IV: *Man, too, is now definitely contaminated with pesticides.*

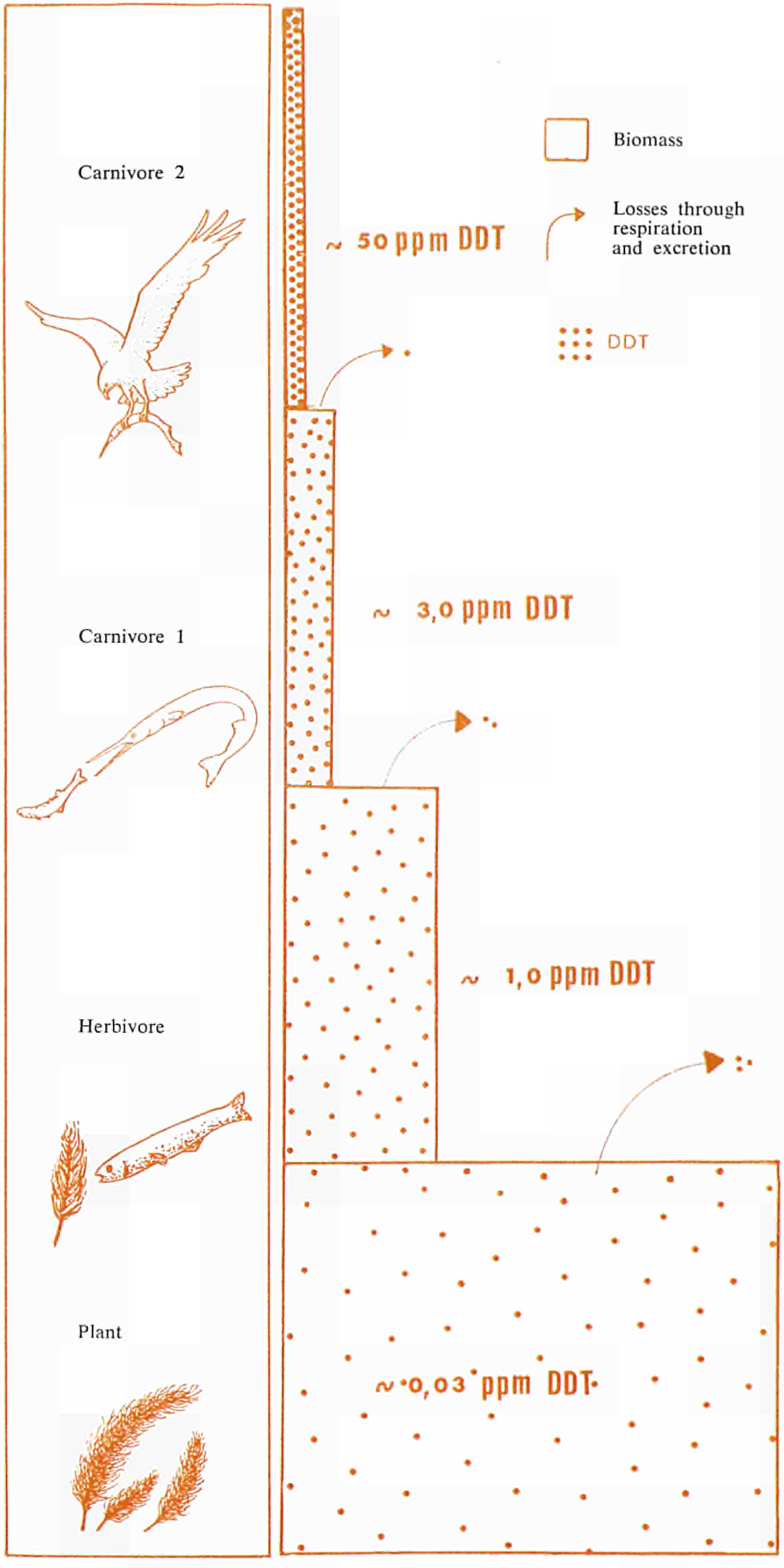
Residues to DDT + metabolites (DDE, DDD) in Man (ppm, referred to fat)	
United States (average)	11.0
Alaska (Eskimo)	2.8
United Kingdom	2.2
West Germany	2.3
France	5.2
Canada	5.3
Sweden	7.0
Hungary	12.4
Israel	19.2
India	12.8 - 31.0

International cooperation

Although the problem is regarded from different angles in the various countries, in recent years there has been a definite trend towards the promotion of joint international research aimed on the one hand, at establishing sound, internationally recognised tolerance limits and methods of analysis and, on the other, at encouraging coordinated use of the knowledge and skills already available today.

Whilst the analysis of pesticide residues is not concerned exclusively with the food chain, it is in this quarter that the main interest lies.

The *Codex Alimentarius Commission*, a body set up to keep watch on activities in the foodstuffs field, the *Food and Agriculture Organisation (FAO)* and the *World Health Organisation (WHO)*, operating through *Pesticide Residues Committees* who work hand in hand, have laid down a number



of internationally-based tolerance limits and analysis methods, and are continuing to do so.

The Council of Europe contributed substantially to the standardising of the pesticides registration schemes by publishing, in 1962, a pamphlet entitled "Agricultural Pesticides"; this pamphlet was completely revised and brought up to date in 1969 by the *European Committee for the Conservation of Nature and Natural Resources*.

The Commission of the European Economic Community (EEC), through its Directorate-General for Agriculture, in 1964 set up two Committees to deal respectively with tolerance limits and analyses of pesticide residues in plant crops. These committees, which are still functioning, avail themselves of the technical assistance of experts of the Community countries under the chairmanship of the Commission. The purpose of their work is to issue tolerance limits and methods of analysis that will be regarded as official, and therefore as having full legal effect, in the European Community so that uniform standards can be put forward for trade in agricultural produce.

In 1967 the *Ispra Establishment* was invited, on account if its equipment, analytical knowhow and experience acquired from participation in the *OECD* programme, to take part in devising and developing analysis methods.

In 1965 the *Council of the International Union of Pure and Applied*

Figure 3: *Concentration of DDT residues being passed along a simple food chain is indicated schematically in this diagram. As "biomass" or living material, is transferred from one link to another along such a chain, usually more than half of it is consumed in respiration or is excreted (arrows); the remainder forms a new biomass. The losses of DDT residues along the chain, on the other hand, are small in proportion to the amount that is transferred from one link to the next. For this reason high concentration occurs in the carnivores (Copyright © 1970, Scientific American).*

Chemistry (IUPAC) agreed to assist the international agencies (e.g. *FAO, WHO, OECD)* in the standardising of analysis methods by setting up a pesticides section.

Turning to the natural environment, contributions came from both the *OECD*, which in 1966 launched the already-mentioned programme of research on accidental contamination of the natural environment, and from the *European Community's "pollution" project (PREST Group)*, later extended to non-Community countries *(COST Group)*, which is to promote experimental work in the field of pollution in general and pesticides in particular.

All that we have briefly described above goes to show very clearly that something is being done, even though sometimes, with the best of intentions, one organisation does not know what the other is doing and different organisations labour simultaneously on the same type of problem, thus wasting effort to no good purpose. Most of them, moreover, having no laboratories and being therefore unable to conduct their own research, have to depend on help from the various national laboratories which, though excellent, is often affected by economic and political factors that hold up the work. Furthermore, the end result of these international studies is usually a set of recommendations with little compulsory force as regards their application by the various countries, which, owing to their different economic development, are liable to set different values on the various aspects of the problem.

It is highly desirable that the present trend towards coordination of the various activities should continue, so that by combining the efforts of different organisations and channelling them all in the same direction, we may at least obtain a more responsible application of such standards as are already available today.

As regards the strictly European environment, the European Community could act as a powerful coordinating and stimulating agent if, in addition to pursuing its present projects, it were authorised to carry out experimental work employing some of the abilities knowledge and equipment available at its research establishments.

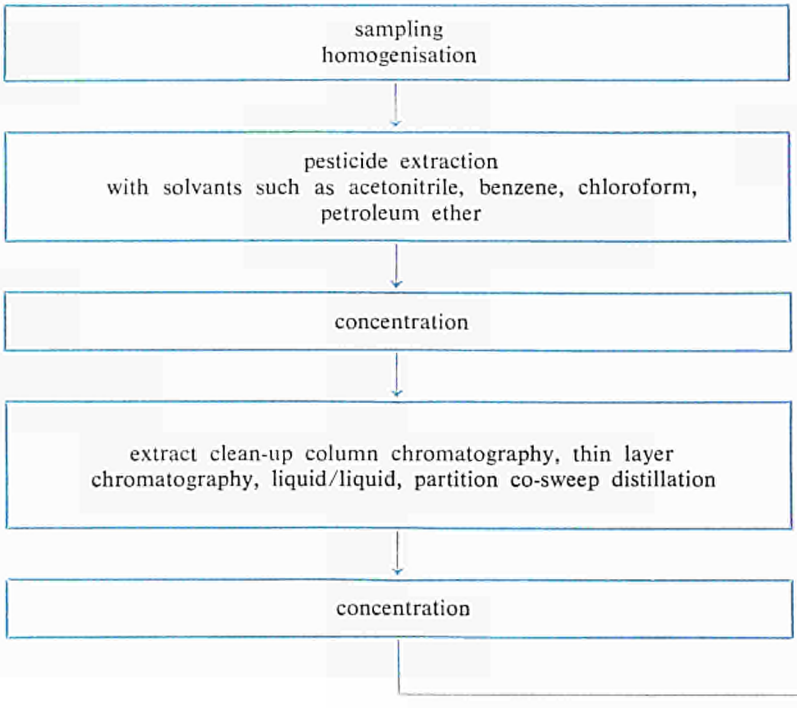


Figure 4: *Analysis flowchart for pesticide residues. (To make comparison of the detectors easier, the approximate limits of sensitivity are given in grams instead of the more correct gram/second.)*

Future developments

Undoubtedly pesticides are the most efficient and cheapest antiparasite weapon known today, which is why, although it is unanimously considered that their use must continue in the coming years, efforts are nonetheless being made to develop products with more specific action, easily biodegradable and even better if employed in combination with other control methods.

The pesticides developed to date have created two intractable problems:

a) their broad-range effects have hit useful insects which no-one intended to destroy, and by persisting in the environment they have built up to levels that imperil other forms of life, and

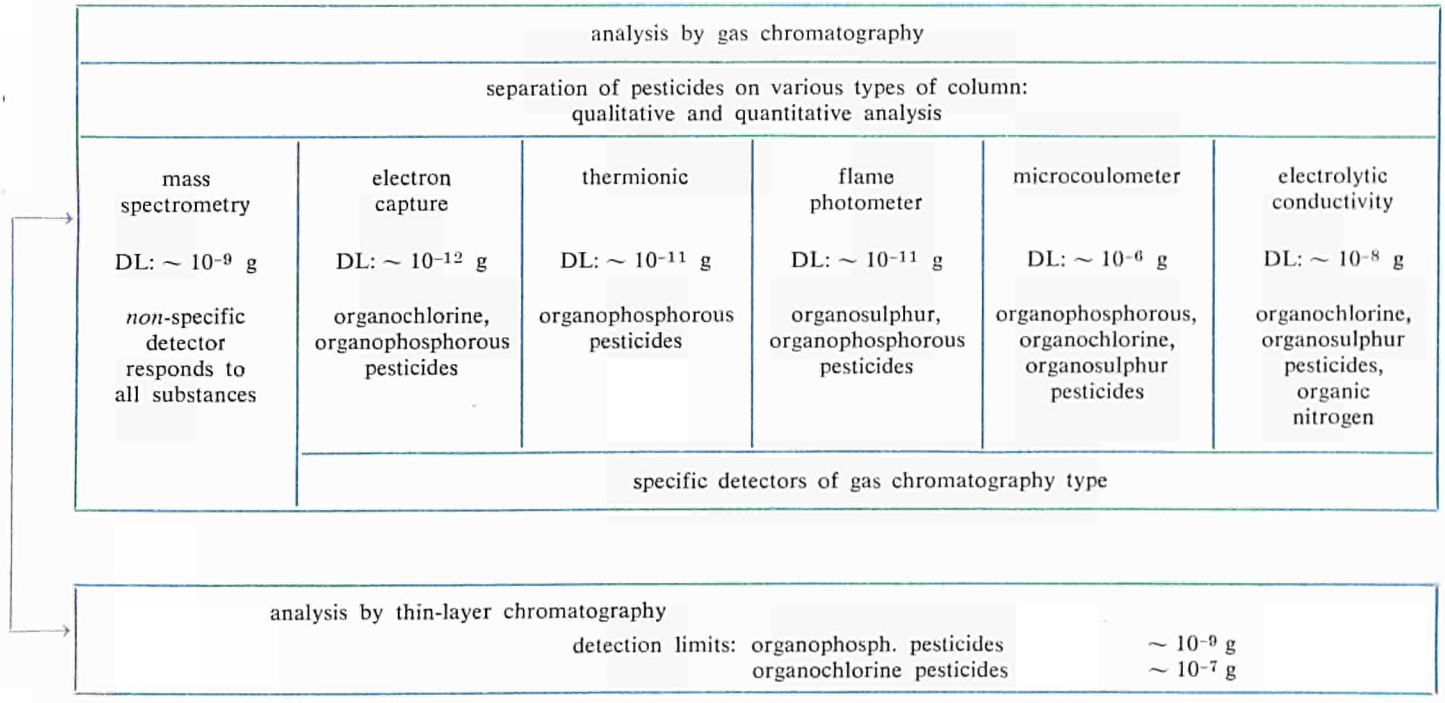
b) the insects have displayed a remarkable ability to develop defences against the pesticides.

In order to get around these difficulties, scientists turned towards a search for compounds that would be highly specific in their action, would attack the target parasites exclusively, and would not allow the insects to acquire defences or insensitivity in a short time.

Recent results have shown that the idea of operating along these lines is less of a pipe-dream than it looked only a few years ago. The concept underlying the research is that the insects might be attacked through their own hormones. Thus was launched the *"third generation"* of pesticides (the first one being exemplified by lead arsenate, the second by DDT) based on the *"growth hormones"* such as the *"juvenile hormone"*, which all insects secrete at certain stages of their life. This is one of the secretions used by insects to regulate their growth and metamorphosis from larva to pupa to adult. At certain stages the hormone must be secreted, at others it must be completely absent, if abnormal development is to be avoided. The stages when it must be absent are the Achilles' heel of insects; for if they come in contact with an artificially applied hormone, lethal changes quickly take place in their life cycle. "Juvenile hormone" is an insect product and, as far as is known today, does not affect plants or animals. Even to insects it is not a poison in the classical sense of the term: in does not kill directly, but by altering normal development brings the insects to self-destruction. There is a further obvious advantage: insects cannot develop defences against their own hormone without automatically committing suicide. Some of these hormones have been extracted, isolated and identified, and laboratories are now working on the synthesis of equivalent substances.

Another recent line of study deals with the *"sex-attractants"*. It has been observed that special substances, even in minute quantities, act as a sexual advertisement for particular species of insects (sometimes their action is helped on by the presence of colours or sounds): by this means the insects can be "steered" into closed areas or traps previously treated with pesticides, with the advantage that one need not resort to wide-scale and hence relatively uncontrolled application of pesticides.

Lastly, a very up-to-date technique now being studied is one which aims at inducing *genetic changes* in insects so as to prevent their normal development. This can be done by releasing insects with radiation-induced *defects* into the environment, taking care that the defects do not affect their general behaviour and competitiveness, in order



to generate a whole population of genetically deficient and therefore gradually less active insects.

These three new weapons in the fight against insects—hormones, sex attractants and genetic changes—have already provided brilliant specimen results, although naturally they cannot yet be said to be in practical everyday use.

Another method worth mentioning, because though discovered some time ago it has been widely used of late, is that of *sterilisation*, which in most cases consists in breeding huge numbers of insects, sterilising them with gamma radiation, and then releasing them into the environment to compete with the natural population, whose numbers soon fall off because of the drop in successful matings. There are certain conditions attached to this method: one must be able to breed a large number of insects easily; the sterilising must not alter the insects' natural behaviour in any way; the technique has proved successful where the target insect population is not very numerous, or rather where the sterile insects can compete in numbers with the natural ones which, incidentally, can be reduced by a preventive application of pesticides.

And this brings us to the so-called *"integrated pest control methods"*, considered by many to be safest and most useful in the war against pests until the day when the latest discoveries can be put to practical use. This method consists in employing, in proper sequence and at due intervals, the various techniques developed to date (e.g. using more highly pest-resistant seed, applying pesticides, releasing sterile insects, introducing insect parasites or predators), so as to wipe out the insects in a given place, or reduce them to economic levels, with the least risk to man and the environment. To adopt this method one must obviously have full, precise data on the area to be treated (insect species, numbers, habits, varieties of crops, food sources, distribution of population, etc.), which predictably means considerably higher costs. Hitherto industry has shown little interest in developing integrated control methods, on account of the low profits involved, so that the perfecting of this technique, which suits man and the environment, will mainly depend on the involvement, ability and determination of the national and international organisations.

The pesticide problem is clearly a question of compromise; modern society cannot do without pest controls, nor can it continue to afford the price it has paid up to now. It is a matter of finding more rational ways of employing them, using less toxic, less persistent substances; of changing and standardising the regulations in force today, even if it means introducing uneconomic measures; of looking squarely, without further procrastination of any kind, at the present peril so as to avoid the blind alley of an irreversible situation.

EUSPA 10-1

"That's what I call a palate. He can identify the château, the year, and the pesticides."

Uranium : prospects and problems

The European Community has suddenly become a self-supporting uranium producer. A recent symposium has focussed attention on the implications of this event, especially with respect to short-term marketing and long-term development of reserves.

JOHAN BRINCK

EUROPEAN URANIUM PRODUCERS were convened by the Commission on 18 and 19 June 1970 at Ispra (Italy) to discuss the prospects and problems of the uranium mining industry.

From the resulting exchange of views there already emerge the broad lines along which uranium supply could develop as part of a European joint energy policy.

The Community's energy policy

The Commission's energy policy can be viewed as the instrument for achieving the aims set out as early as 1964 by the governments of the Member States and the three European Executives with regard to the Community's energy supply, i.e. the provision of energy at the most favourable prices, combined with maximum security of supply.

This energy policy will have to evolve as a function of the conditions prevailing on the energy market. The main trend of the past few decades has been a progressive change in the supply pattern due to competition between the various primary sources of energy and the advent of new sources.

Thus, from being 90 % self-sufficient by virtue of its own coal production, the Community has become over 50 % dependent on overseas supplies, particularly in the form of oil, to satisfy its primary energy requirements.

In addition to the regional problems due to these changes, the Member States have been faced for the first time in their history with the problem of security of supply for this most vital branch of industry.

The increasingly massive consumption of natural gas, of which there are large reserves on Community territory, does little to relieve anxiety on this score.

With the growth in energy consumption, electricity is likely to be the favourite form in which energy is used and will therefore continue to expand at the relatively highest rate.

The role of nuclear energy

The Commission therefore sees the development of nuclear energy as one of the ways of keeping the uncertainties in supply within reasonable bounds in the longer term.

Uranium, the basic raw material of nuclear energy, has some very attractive qualities from the security of supply angle, namely a wide geographical spread of deposits, negligible transport costs and ease and relative cheapness of storage.

The use of nuclear power stations will also put a brake on the ever-increasing level of air pollution.

Dr JOHAN BRINCK is a member of the Directorate-General for Energy of the Commission of the European Communities.

The uranium supply problem

In view of the above developments, the Commission considers that one of its tasks in the field of energy policy is to establish conditions in which an independent European mining industry can contribute to the Community's uranium supply and be internationally competitive.

In the course of the symposium, three main requirements emerged clearly, namely:

a) the development of a free market;

b) the necessity for initial support to exploration by public funds, and

c) the great importance of a dialogue between producers and consumers on marketing.

The new indicative programme for nuclear energy in the Community now being prepared will be an important aid to the further refinement of energy policy in this field. The figures given at Ispra should be considered as preliminary and may be slightly adapted in the course of the establishment of the new target programme.

The programme is based on an extrapolation of the historical growth of electricity consumption, which for some time past has doubled every ten years. The forecast share of nuclear energy in this growth until the year 2000 is a carefully weighed strategic choice in the context of overall supply possibilities (Fig. 1). Fig. 2 shows the growth of nuclear power in five Community countries up to 1985.

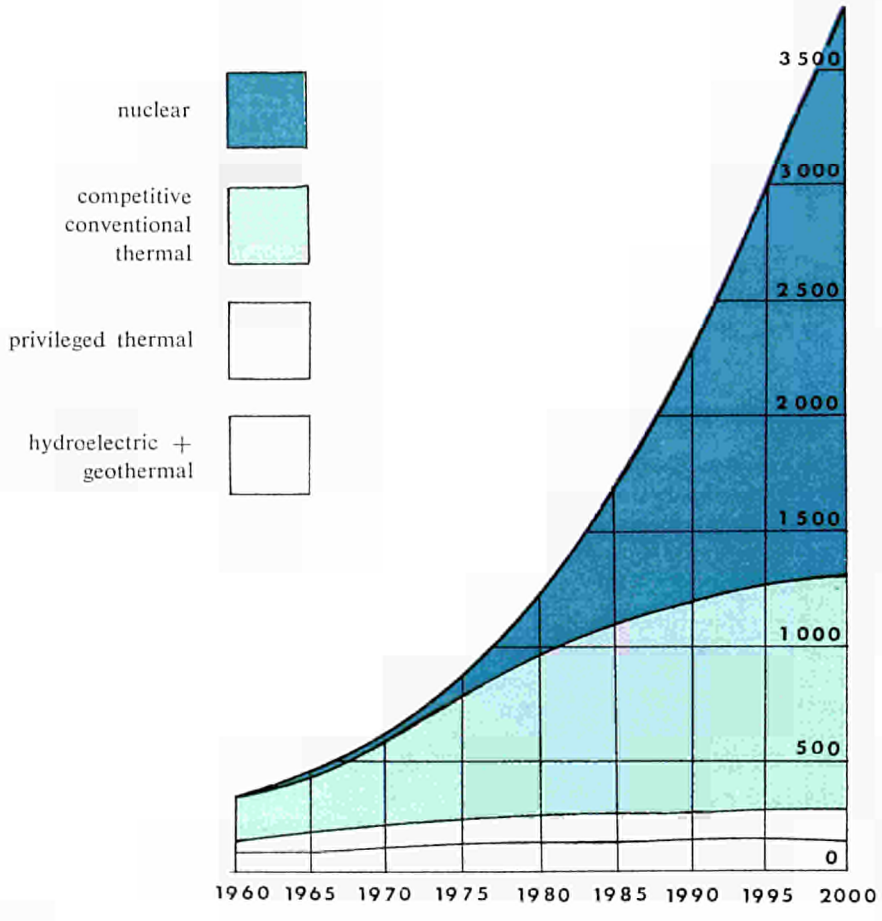
The uranium requirements flowing from these developments depend on the breakdown, by type of installed reactor plant, which is still uncertain. Since the reactors commissioned up to 1985 will be predominantly of light-water-cooled design, total uranium requirements up to 1980 can be estimated at some 40 000 metric tons. By 1985 they should exceed 100 000 tons. This is considerably more than the uranium reserves discovered so far in the Community, estimated at 55 000 tons of uranium and located mainly in France.

It is apparent that the Community's requirements will have to be largely

met by imports. This also applies to the Community's neighbours, Sweden, the United Kingdom and Spain, all of which, in view of the anticipated growth of nuclear energy, have insufficient low-cost home reserves to meet the forecast uranium requirements. The whole of Western Europe will therefore be largely dependent on imported uranium.

In the case of the Community, however, in the short and medium term a large proportion of its import requirements could be *met by production from deposits controlled by its mining industry in non-member countries*, particularly in Africa.

Figure 1: *Breakdown according to production sector of gross electricity output in the Community 1960-2000 (in 10^9 kWh).*



The *Commissariat à l'énergie atomique (CEA)* and French industry have reasonably assured reserves in these countries amounting to some 42 000 tons of uranium and possible supplementary reserves of 43 000 tons.

This puts the French uranium mining industry in fourth position, after the United States, Canada and South Africa (Table I), with about 10 % of known world [1] reserves and existing production capacity. It must be noted, however, that the size of the reserves under European control is estimated on the basis of the present market situation (\$ 6-6.50/lb U_3O_8), whereas the Western World's resources are estimated in the light of deposits that can be extracted at a cost up to \$ 10.00/lb U_3O_8. It can be shown both for the Western World and the Community that available uranium reserves and the production capacity based on them should be adequate for the period up to 1977-78, though a gradual rise can be expected from the present price to the generally accepted target price of \$ 8/lb [2].

Developing new reserves

Thereafter, new, still undiscovered reserves must become available if the growing demand is to be met.

Since, on average, eight to ten years are needed before a prospecting programme delivers the goods in the form of uranium concentrate production, the industry is bound at all times to have sufficient reserves to cover the demand expected during this period. Then from the forecast growth in requirements, it is possible to calculate the amount of new reserves needing to be discovered each year and the attendant development costs.

It appears at the moment that the rate of discovery of new reserves, both

[1] Excluding USSR, People's Republic of China and the East European countries

[2] Actually, the recent uranium discoveries in the Northern territories of Australia may delay this gradual rise until the late seventies.

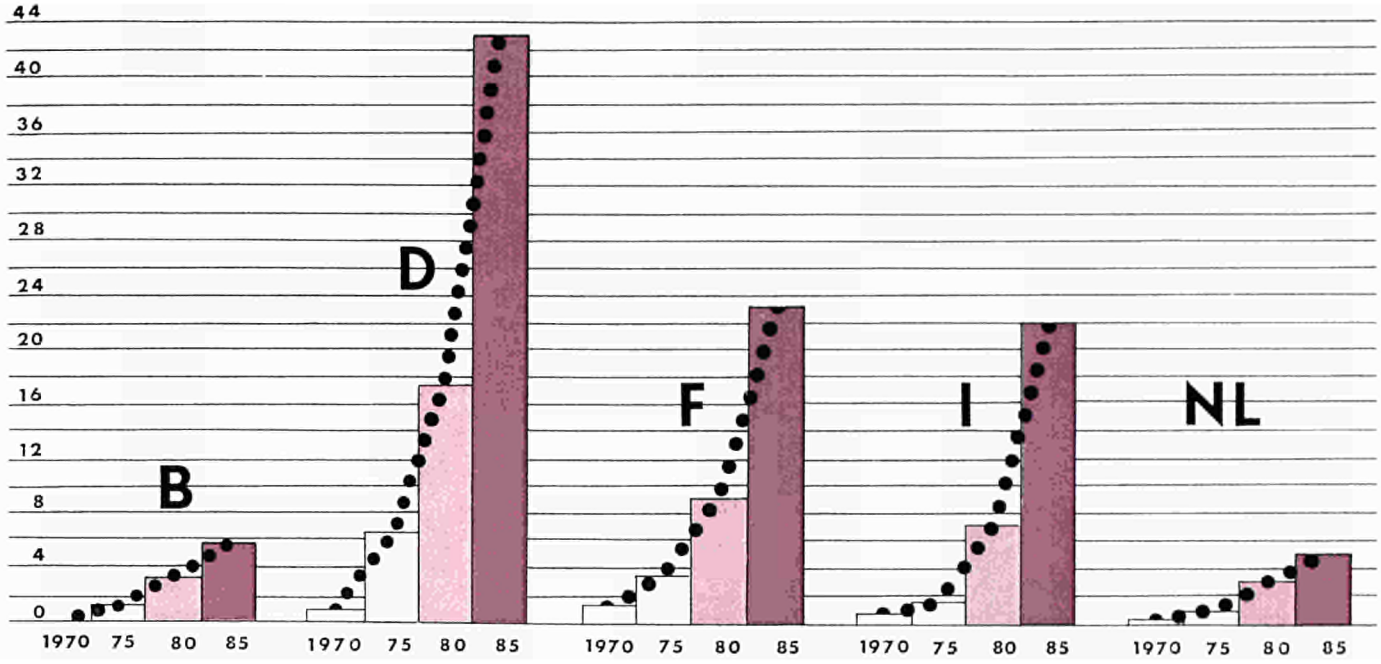


Figure 2: *Breakdown of nuclear power by country, 1970-85 (in 10^3 MWe).*

for the Western World as a whole and the Community in particular, is roughly in balance with the forecast rise in requirements. In the future this rate of discovery will have to be gradually raised, as will the required investments (see Figs. 3 and 4).

This cost estimate assumes the historical trend observed with other metals, namely declining unit exploration costs resulting from economies of scale, due, in turn, to the fall in the average assay and an increase in the size of the ore deposits worked. Prospecting costs of \$ 0.80/lb U_3O_8 were assumed, for an average find of 4 000 tons of uranium, as the basis for the calculation, and an average ore assay of 0.165 %. These calculations show that the investments required to establish and maintain an independent European uranium industry certainly cannot be entirely derived from the cash flow of the firms themselves, certainly for the first 10-15 years.

The financial launching aid currently granted by the governments of various Member States to their national industries is thus an essential "greasing of the wheels" aimed at facilitating the effort that Europe must put into the search for uranium.

While the French effort has been sufficient to build up adequate reserves for the whole Community, at least for short term requirements, the activities of the Germans and Italians have recently been intensified and should contribute to maintaining this favourable reserve position and help give the Community an export potential.

Although there are occasional examples of cooperation, e.g. in Niger, where French, Italian and German interests have embarked on joint uranium exploration and mining ventures, European firms have largely tended to work separately in this sphere. The increasing proportion of private capital employed in the industry tends to promote unrestricted competition. As these undertakings become increasingly successful, their character should change; from being tailored mainly to the meeting of national requirements they will come more and more to look to the world market.

Developing a market

Here the pattern is set by the French uranium industry and the *CEA*, which have established a joint sales organisation, *Uranex*, for the planned selling of the French production surplus.

As pointed out at Ispra, the development of a free international market must be seen as a matter of great potential benefit to these expectations, but this is precisely the area in which the most pressing problems are now to be found.

With a world production capacity of 18 000 tons and requirements of 9 000 tons in 1970, the uranium market will

Table I:

Uranium reserves, in 10^3 metric tons uranium content (April 1970).

Country	< $10/lb U_3O_8			$10-15/lb U_3O_8	
	Reasonably dependable reserves	Possible additional reserves	Estimated content ‰ U	Reasonably dependable reserves	Possible additional reserves
USA	192	390	1.44	105	228
Canada	178	177	~ 1.00	99	129
South Africa	154	11.5	by-product (0.2)	49	27
France	35	19	1.85	7	12
Italy	1.2				
Niger	20	30	2.8	10	10
CAR	8	8			
Gabon	14	5			6.5
Australia	16.7	5.1	0.6-7.6	7	5
Spain	8.5		1.7	8	
Argentina	7.7	17	0.9-1.3	8	25
Portugal Europe	7.4	6	1.7		11
Portugal Angola					11
Japan	2.1			3.4	
Mexico	1.0			1.2	
Brazil	0.8	0.8	8.5		
Sweden				266	38
Denmark				4	
India				2.3	0.8
Round total	645			570	

From:

"Uranium: reserves, supply and demand" *ENEA-IAEA*, 1970.

display a large excess of supply over demand in the next four or five years. This situation will probably persist for a further few years owing to the premature commissioning of new production facilities.

As it happens, this same difficult period will see the construction of about 60 % of the world's nuclear generating capacity in the United States, whereas US mines account today for 50 % of the world production capacity.

In a free market economy the United States might thus be expected to import about 20 % of its uranium requirements, but in fact the reverse is the case: American producers compete with those outside the United States for the remaining 40 % of the world market.

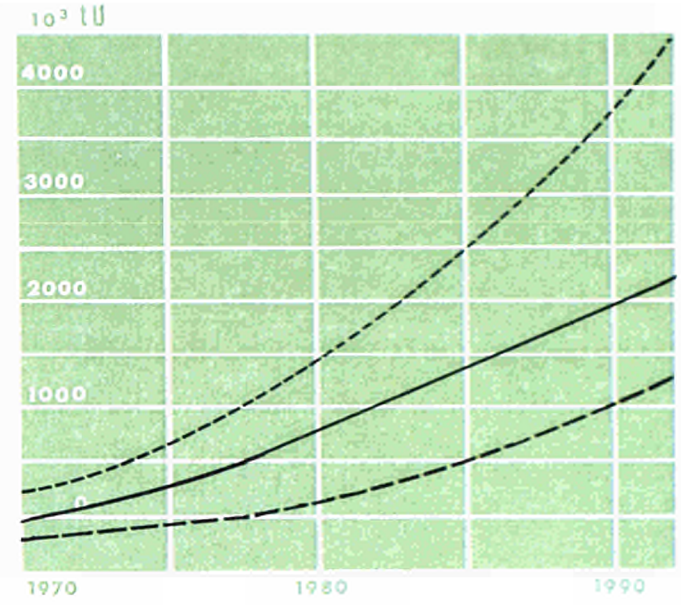
The reason for this situation is that the *USAEC*, by virtue of the powers conferred by the Atomic Energy Act, accepts uranium for toll enrichment from outside the United States only if it is to be re-exported afterwards. In principle, this ruling might remain in force only till 1973, after which a partial raising of the ban is planned, combined with import quotas in its place.

The outcome of this discriminatory measure has been the establishment of two uranium markets in the Western World, with the protected American uranium mining industry cornering its home market, which accounts for 60% of world demand. Stable and relatively high prices have fostered steady growth in this industry, which can also sell any surplus production at marginal prices on the remaining 40 % of the world market.

In contrast, the non-US uranium producers are in genuine competition both with each other and with their American counterparts to supply this 40 % of world uranium requirements. The possibility that, in the process, the generally recognized need for continuing prospection for and development of reserves might suffer neglect is a source of concern about the supply capabilities in the early 1980's, when the United States, too, will probably need to tap international reserves. Indeed, this could cause serious fluctuations in uranium prices, which would not help the nuclear industry—either inside or outside the United States.

Proposed joint measures

The development of a free uranium market must also be considered to serve the general interest, for it offers the only context in which the steady long term build-up of uranium supplies at favourable prices can be guaranteed. In this connection, an approach by the Commission to the American author-



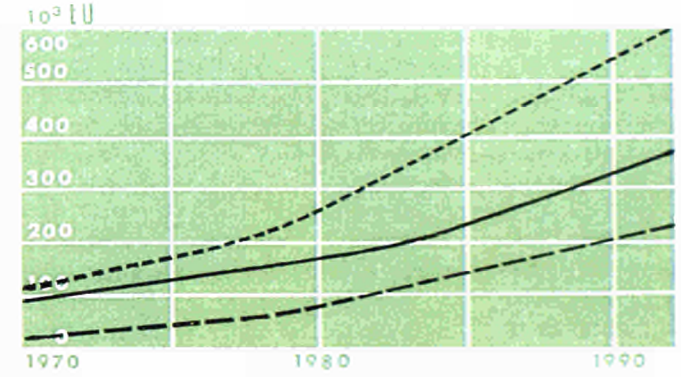
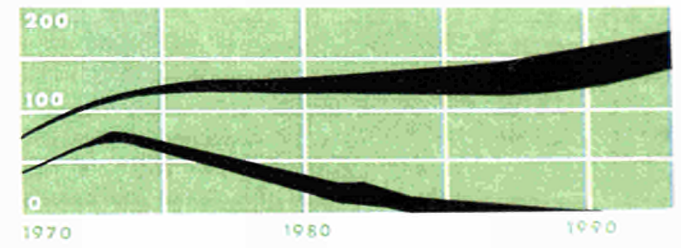


Figure 3: *Development of uranium reserves in the period 1970-1993 as a function of predicted requirements (top graph: Western World; bottom graph: European Community). The top lines on both graphs represent reserves + previous production, the middle lines reserves as a function of forward requirements and the bottom lines cumulative requirements.*



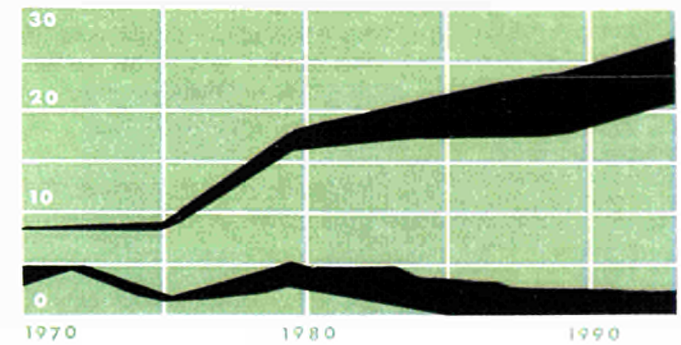


Figure 4: *Annual exploration investments (top graph: Western World; bottom graph: European Community). Top lines represent total investments required to develop reserves shown in Fig. 3. The second line represents the proportion of the investments which cannot be covered by cash flow of the mining industry and for which capital from outside the industry must be attracted.*

ities aimed at securing a timely revision of their supply policy as far as the ban is concerned would be seen by the industry as a desirable step. At the same time the Commission would have to study the possibility of putting European producers on an equal footing with their foreign competitors, by supporting production, e.g. through special tax allowances and grants. It should also envisage giving assistance, in the form of development aid, to associated countries in which European firms mine or prospect for uranium.

Another important task which the symposium participants proposed the Commission should tackle is the establishment and maintenance of a permanent dialogue between the producers and their customers and help in understanding each other's problems, by means of broadly-based meetings between parties, with smaller groups discussing specialist matters. EUSPA 10-2

Quantitative research in Benelux

The main results of a study on the penetration of quantitative research methods in Benelux firms and the extent to which such methods are being used as an aid in decision-making.

ROGER VANDENBORRE and JACQUES VANDENBULCKE

QUANTITATIVE research methods relate to the operations of an organisation. If economic optimisation problems with respect to these operations arise and an attempt is made to solve them by using mathematical models, then the approach used is called the quantitative methods approach. For example, a steel firm might want an answer to the question: "What is the minimum cost composition of a furnace load, given that some requirements with respect to various elements must be met?". Or a firm might want to know the level of inventories that should be kept on hand to guarantee a certain service to clients and, under that proviso, minimises combined production and inventory costs.

The principal components of quantitative research methods are operations research and econometrics. Whereas operations research is directly concerned with the study of the optimal behaviour of an operation or system, the object of econometric study is the measurement of the relationships underlying economic behaviour. Results of such measurements can then be used in operations research models. Econometric research could, for instance, lead to knowlegde of the demand response to price variations for a certain product. This information could then be used in an inventory-production model.

ROGER VANDENBORRE and JACQUES VANDENBULCKE are respectively Professor and Research Assistant at the *Institute of Applied Economics, Katholieke Universiteit Leuven* and are also associated with the *Centre for Operations Research and Econometrics.*

This article is based on a pilot study, by R. Vandenborre, J. Vandenbulcke, D. Vanwijnsberghe, "The Process of Introduction and Diffusion of Quantitative Research Methods in Benelux Firms", *Katholieke Universiteit Leuven*, 1969, sponsored by the Commission of the European Communities. The authors thank J.P. Abraham for his suggestions on an earlier draft of this article.

The sample

Twenty of the larger enterprises in Benelux were contacted and nineteen agreed to collaborate. Their annual sales range from two to twenty thousand million Belgian francs with two exceeding the latter figure. An effort was made to cover a wide range of industries, while at the same time including at least two firms per branch.

The necessary information was gathered by means of personal interviews. Persons in charge of Q.R.[1]-methods and if possible top management were interviewd at length once and sometimes twice by a two- or three-man team. The majority of the interviews took place during the first half of 1969. The sample was heavily biased towards Belgian firms (14 out of 19 firms cooperating).

Birth of Q.R.-methods in Benelux firms

Sixteen of the firms interviewed are using Q.R.-methods now. The times at which they started using them spread out over fifteen years (1955-1969), with a high frequency of introduction in the years 1963-1965. The introduction took place earlier in the Netherlands than in Belgium and Luxembourg, but in Benelux firms generally it occurred five to ten years later than in U.S. firms (for a chronological survey of the birth of Q.R.-methods in the United States, the United Kingdom and Benelux, see table I, pp. 18-19).

Who took the initiative?

Early introductions in Benelux (before 1960) occurred through interested individuals, mostly scientists and science-oriented people, who started Q.R.-work before the local business circles and institutions with business connections (e.g. some university departments) had become thoroughly aware of these modern methods. Managers took the initiative after they had been confronted with Q.R.-methods through reading, contacts in conferences, meetings, etc.

At the time Q.R.-methods were introduced, several of the firms visited possessed an economic research unit. The work done by these groups was of a non-quantitative nature. It is somewhat astonishing, however, that there were so few efforts made to integrate the Q.R.-group with the economic research unit.

Organisational aspects

The people initially recruited to constitute the Q.R.-team were engineers or mathematicians. The rationale behind the recruitment of people with such qualifications was that they had greater mathematical skill and were more familiar with the technical aspects of production.

In two-thirds of the firms interviewed the Q.R.-team belonged to a particular division, while in the remaining third the team enjoyed a staff position, normally as a part of a larger group.

[1] From here on Q.R. stands for quantitative research.

Generally, little attention was granted to the organisational location of the team. This was equally true in the initial stages of introduction.

The present state of the art in Benelux

Preparation of decisions

Q.R.-methods are employed for decision-making purposes. It is therefore worth-while to look more closely at the kind of decisions that have been taken on the basis of Q.R.-studies.

More than two-thirds of the studies were successful, i.e. led to decisions. In order to refine and qualify this picture we shall divide decisions into three categories: those of restricted importance, those of intermediate importance and those of top importance. Decisions of restricted importance are those which, although made with the aim of improving the efficiency of some process, have no influence on firm policies. An example would be the application of linear programming to solve a mix or a blending problem. Decisions of intermediate importance are those that do influence firm policies, although not to a major extent. An example of this category would be a revision of inventory policies so as to improve service. Decisions of top importance are those that could have a major effect on firm policies. An example here would be the selection of investment alternatives with the aid of programming methods.

Sixty-seven percent of the decisions taken in Benelux on the basis of Q.R.-methods were of the restricted importance type, 24 percent of the intermediate importance category and only 9 percent of the top category.

Techniques used

It is of interest to know what Q.R.-techniques have been used in the various fields of application (see boxed in "Definitions of principal Q.R.-methods" pp. 20-25).

Linear programming is an approach frequently used for optimising the production process. Other programming algorhythms can be used in the presence of non-linearities in the objective function, in the constraints or in both.

The *PERT and CPM techniques* can be used whenever a project can be subdivided into components for the completion of which times and possibly costs can be defined and when there exists a problem of optimal planning of these different components. These techniques (commonly referred to as network-planning) may be useful for production scheduling, maintenance and revision of machines, planning of technical processes, planning the introduction of a new product, etc.

It is evident that *inventory models* are applicable to situations where optimal inventories must be calculated. From such models are then derived optimum ordering policies.

The purpose of the formulation and subsequent solution of *sequencing models* is to optimise the utilisation of the capacity of a certain system in which several tasks consisting of several operations have to be carried out but with a certain choice as to the order in which these operations can be performed.

Simulation and heuristic programming can be applied with profit to treat problem situations that cannot be formulated into an analytical model because of a high degree of complexity or a tremendous number of possibilities (e.g. heuristic programming for combinatorial problems).

Applications of *decision theory* can be found where uncertainty is a major ingredient of the decision process (should a product be marketed or not?) while *gaming* can be used in bargaining situations, price making, etc.

Econometric studies within a company context can deliver information that can be used together with optimisation models or by itself, both for short-run and long-run decision problems.

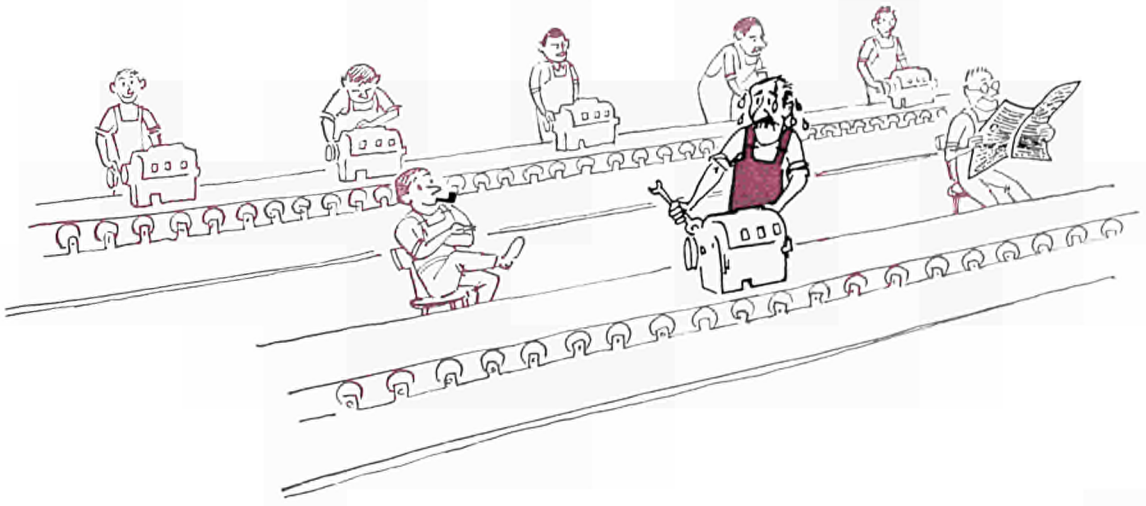
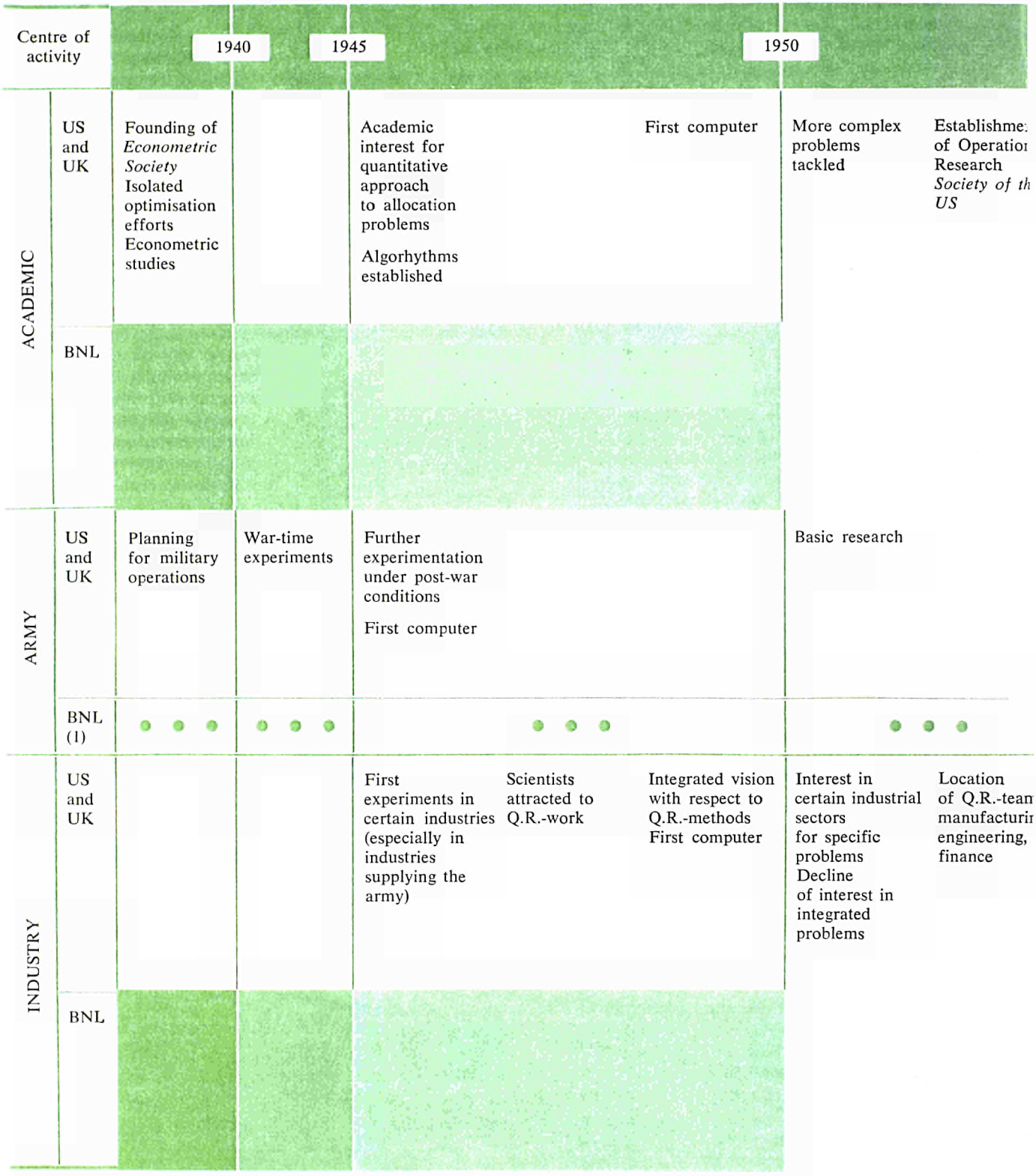


Table I: *Chronological survey of the birth of Q.R.-methods in the US, UK and Benelux.*



(1) No information is available on Q.R.-activities in Benelux armies.

1955	1960	1965	1969
Development of specific algorhythms for mathematical programming and development of analytical models Academic training in Operations Research International meetings and contacts Second generation computer - simulation studies	Further development of basic research plus applications Abundant literature	Third computer generation - expansion of pratical possibilities	O.R. becomes academic discipline
	Interest at universities	First optional courses in Q.R.-methods	Extension of interest in Q.R.-methods Introduction in certain curricula Research efforts start
Basic research and applications Extensive computer applications	Basic research plus applications Extensive computer applications		Basic research plus applications Extensive computer applications
• • •	• • •		(1)
More branches of industry introducing Q.R.-methods First failures and disbandments of teams O.R./M.S. specialists in firms Second generation computer - simulation studies	Management aware of Q.R. situation Changes in localisation, personnel and applications	Expansion of Q.R.-methods to more firms Large-scale data collection via third generation computer	Q.R.-methods fully introduced in firms Applications become of a more integrated character and are also used to prepare high level decisions
Managers in technological sectors get interested via international contacts Solution of classical problems First applications, mainly by scientists Effects are small	More widespread introduction of Q.R.-methods Solution of problems, especially production problems	Teams consist primarily of engineers Collection of internal data Third generation computer	Further introductions Applications are still mainly restricted to production

Our empirical observations indicate that Q.R.-applications have been most numerous in the fields of scheduling, technical control of production processes and production and inventory analysis. The techniques most used are: *PERT/CPM*, linear programming, simulation and production and inventory analysis models.

These results may be compared with those of an American study made in 1964 by C.C. Schumacker and B.E. Smith[2] (see table II). Although comparisons must be made with care, the table suggests that in 1969, Benelux firms employed Q.R.-methods on a smaller scale than did their American counterparts in 1964 but on a larger scale than did the latter in 1958[3].

Depth of applications

With respect to the depth of the applications it is useful to divide the fields into two broad categories.

First there are those in which problems can be relatively neatly formulated and where the results of problem solving can be directly observed. Typical of this group are the areas "productions scheduling" and "technical problems in production" . "Production scheduling" covers problems like the routing of a product through the factory. Under "technical problems in production" are classified those which bear a direct connection to the production process (mix problems, cutting problems, etc.). Problems in these fields were generally solved well, on condichemical, power generation and petrotion however that they were relatively simple[4].

The second category refers to areas where the problems are naturally of a more integrated character, where it is often difficult to observe the results directly and where the dangers of suboptimisation or of tackling the wrong problem with the wrong data are very real. Typical of this group are areas such as "inventory and production control" and "advertising, sales and market research". Applications in these fields were much more superficial and consisted often of a rather preliminary investigation.

The process of penetration of Q.R.-methods within the organisations

1. Phases in the evolution

The importance of Q.R.-studies is directly tied to that of the firm's operations of significance to the firm normally affect several functions, so

Table II: *Areas of application of Q.R.-techniques (Benelux and United States survey).*

Areas of application	Percent of companies reporting activities		
	U.S. survey		Benelux survey
	1958	1964	1969
Forecasting	57	73	0
Production scheduling	47	90	87
Inventory control	45	90	68
Transportation	26	54	43
Advertising, sales and market research	20	27	43
Replacement, maintenance	16	32	13
Plant location	15	32	6
Capital budgeting	11	39	19

[2] C.C. Schumacker and B.E. Smith: A sample survey of industrial operations research activities, *Operations Research* 13, 1965. The 1958 data for the United States are from a study by R.W. Hovey and H.M. Wagner, which Schumacker and Smith qualify as comparable with theirs.

[3] The results for forecasting and advertising, sales and market research are astonishing. But, first of all, Benelux firms often called in the help of consulting agencies for maket studies and, secondly, it is quite possible that with respect to U.S. data, some market research work was brought under the heading "forecasting".

[4] If e.g. in cutting paper, film or glass, only the width of the rolls was a factor, then the cutting problem was solved with linear programming. However if not only width but also thickness of the rolls was to be taken into account, then the procedure was quite often to investigate a number of possible combinations that led to a reduction in waste.

that the relevance of Q.R.-studies then depends upon how well the integrated structure has been analysed and quantified. In practice, it is only after acquiring considerable experience that problems of an integrated nature can gradually be tackled.

Consequently, a distinction was made between four phases: the preliminary phase, the individual operational phase, the revision phase and the integrated operational phase.

The preliminary phase

Main characteristics of this phase are that the Q.R.-team brings a selected problem to a successful conclusion and that management recognises that Q.R. is a valid approach. We observed that Q.R.-teams generally chose an initial problem with limited scope that led to fast results.

The individual operational phase

After a first successful application, the efforts of Q.R.-workers are directed towards the solution of several isolated problems, not necessarily covering different areas. Characteristics of this phase are: top management accepts Q.R.-methods as a useful way of analysis for at least some decision problems; many isolated applications are made; there is further development of the Q.R.-team, the data system and the network of communications.

The revision phase and integrated operational phase

A restricted number of firms indicated that they were thinking of revising completed studies in the sense of bringing them together into a more general framework. In our opinion, Q.R.-methods cannot be considered as having reached the stage of adulthood in the firm unless there is an organisational set-up insuring Q.R.-operations in the divisions and an overall Q.R.-team attached in a staff function to top management. At this stage management relies heavily on the results of Q.R.-work for the preparation of decisions at all levels.

2. Factors determining the penetration process

The economic literature generally indicates that in the process of transforming a discovery into an innovation, the following factors are involved: nature of the industry; availability and costs of required resources; awareness of the new technology, surrounding uncertainty and relative profitability; managerial ability. These factors will be discussed here under the following more concrete determinants: nature of the industry; availability of resources; managerial attitudes; organisation of Q.R.-work.

Nature of the industry

Our empirical findings indicate a greater use of Q.R.-methods in industry branches where technical problems in production and production scheduling can be more easily found, delineated and formulated although these studies remain of a limited scope. This is generally the case e.g. for the steel, leum industries. Progress is more difficult in industries like metal construction, distribution, banking and finance.

Availability of resources

The availability of hardware (especially the third generation computer) has made practical Q.R.-work possible. It was observed that firms depend for their Q.R.-software on outside help and that they only reluctantly take the step of writing programmes themselves. Some firms indicated that in the intermediate future they expected up to 30 % of their computer time to be absorbed by Q.R.-studies, as opposed to about 2.5 % today.

Leaders of Q.R.-teams in Benelux are mostly engineers or mathematicians who became O.R./M.S.[5] specialists after entering industry. In the United

[5] Operations Research/Management Systems.

States, these leaders are more of the management specialist type. The tendency in the United States to appoint O.R./M.S. specialists and management specialists as leaders stems from the impression that these types see the problems more realistically and have less friction with people in the divisions whom they have to serve. In Benelux the teams themselves, as pointed out earlier, have a strong technical slant; this might help to explain the emphasis given to production problems. There is however a growing interest in quantitative economists, econometricians and quantitatively trained business school graduates.

Empirical data are the necessary raw materials of Q.R.-work. Quite often, penetration has been hampered simply by a lack of data caused by organisational, psychological and administrative difficulties.

Attitudes of top management

Managers, once they become aware of Q.R.-methods, have generally supported their introduction. However, this support has in most cases not been followed through sufficiently. Management has by and large recognised the usefulness of Q.R.-methods for insuring greater efficiency in production and has been less enthusiastic in supporting work outside this area.

Organisation of Q.R.-work

As to the influence of a firm's organisation on Q.R.-work, it was found that relatively more problems of high importance were studied (by the Q.R.-team) in firms with a considerable number of staff functions above the divisions. With respect to the specific location of the Q.R.-team, it is our judgement that it should occupy a staff function reporting directly to top management or perhaps be part of the financial-administrative division, thus having easy access to data and computing facilities. Although the first applications made by Q.R.-teams located in production, research and development and financial-administrative divisions were of low importance, teams in the latter location started faster in dealing with problems of a higher order. An interesting picture of the relationship between location of the Q.R.-teams and importance of problems studied in American firms is provided by the graphs published by Radner, Rubenstein and Bean (Fig. 1).

It will be noticed from the graph on "all locations" that the number of " major studies" declined from its peak in the middle fifties. The reason is a change in the approach from a "total integrated approach" to one that was based on moving more slowly by first tackling more isolated problems. One observes however that this decline occurred in major proportions in research and development and in manufacturing. Radner, Rubenstein and Bean expect an increase of major problems studied by Q.R.-groups located in financial divisions. The "top management" graph speaks for itself.

Communication is a necessary ingredient of the penetration process. The larger part of the firms visited mentioned communication difficulties with top management as well as with staff groups and divisions. Among the several reasons responsible for this state of affairs, the prevalent ones are probably unfavourable location of the Q.R.-team (location in the production division, for instance) and sheer difficulties in mutual comprehension.

Conclusions

If one accepts the definition of adulthood given above, then one cannot but conclude that Benelux firms have only reached a preliminary stage in the use of Q.R.-methods. Considerably more could be accomplished with existing models and methods. This does not imply that the latter are perfect or that all theoretical difficulties have been solved. Indeed, for many important problems facing management, Q.R.-methods, even if competently applied, do not give definite solutions. But at least, and here lies probably their greatest payoff, their use forces one to look into situations on a rational basis. We are convinced that greater use of quantitative research methods in market activities, integrated activities and longer term planning

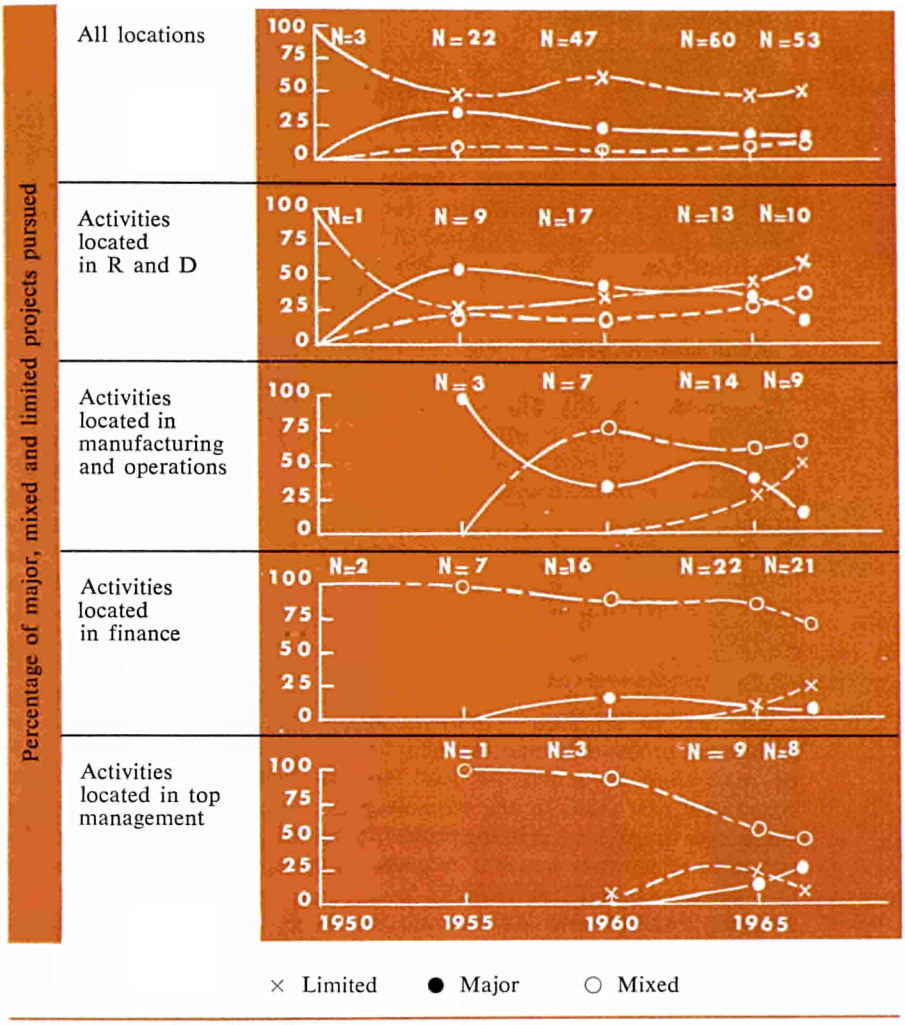


Figure 1: *Changes in project missions by activity locations. (M. Radner, A.H. Rubenstein, A.S. Bean: Integration and utilisation of management science activities in organisations. "Operational Research Quarterly" 19 No. 2, 129).*

would contribute more to the improvement of a firm's position.

What measures can be taken to improve the situation? Top management should actively support sound Q.R.-work. It should not limit the activities of the Q.R.-team to the production area but encourage applications in all sectors.

The composition of the team should be more diversified. This implies the recruitment of quantitative economists, econometricians and quantitative business school graduates in the team in addition to engineers and mathematicians.

Penetration is hampered by a lack of knowledge of Q.R.-methods in the several departments or divisions. Ultimately, Q.R.-specialists should be present in each of these. As a first step, one should consider a system whereby able persons belonging to the different divisions go through a training period as part of the Q.R.-team.

Finally, although it may be presumptious to state that there is a best organisational location for the Q.R.-team, some locations are definitely better than others. Efforts should also be made to remove administrative and psychological obstacles in the gathering of data. Perhaps psychological obstacles are at the present time the more difficult to remove. It should be pointed out to anyone involved that it is not the task of the quantitative researcher to take decisions, only to improve on the advice that is to be given to the decision-maker.

Definitions of principal Q.R.-methods

a) **Operations research** (1), (2)

Operations research is a science which deals with the characteristics and variables of economic systems; its purpose is to indicate the optimal behaviour of such systems, thereby heavily relying on mathematical formulation. The main operations research techniques can be classified as follows:

1) **Mathematical programming**

The techniques of mathematical programming are used to solve optimisation problems; a function of variables is optimised subject to inequality constraints. Depending on the form of the function, a distinction can be drawn between linear programming, non-linear programming and dynamic programming.

— *Linear programming* (3), (4)

One has to do with a linear programming problem if the function to be maximised or minimised and the constraints are linear in the variables. An integer linear programming problem is one in which it is however required that some or all of the variables take on integer values only. An example is the maximisation of net revenue from the manufacture of a given series of products subject to limitations of machine capacity.

— *Non-linear programming* (5), (6)

We have a non-linear programming problem where non-linearities appear either in the objective function or in the constraints or in both. There are many types of non-linear programming problems, depending on the exact form of the non-linearities and the combination of non-linearities in the objective function and the constraints. The name quadratic programming is used for programming problems which involve the minimisation of a convex or the maximisation of a concave quadratic expression while the constraints are linear. In the case of stochastic programming one generally deals with a non-linear programming problem (the objective function is non-linear) where some of the parameters (requirements or technical coefficients) are random variables.

— *Dynamic programming* (7), (8)

This is a computational technique to solve programming problems which are characterised by recurrence relations, i.e. where a sequence of interrelated decisions is to be made. Applications can be divided into two classes: those in which a sequence of decisions is to be taken in time and those which, although the time element is absent, can still be presented as involving essentially a sequence of decisions. A typical example of the former category is the "production smoothing" problem. A manufacturer has available capacity for producing an item for several periods in the future. For each period the demand is known. The problem is to determine the production programme for each period so that total production costs, storage costs and out-of-stock costs are a minimum and the demands are satisfied.

2) **Analytical models**

These models seek to determine, in an analytical way, the optimum of a certain function when that function is not subject to inequality constraints. Such models are: waiting time (or queuing) models, replacement models, inventory models, *PERT/CPM*, sequencing theory.

— *Waiting time models* (9), (10)

Waiting time models are used for determining the optimum length of a queue for a system providing one or more service facilities. They can be applied every time one has a system, e.g. a flow of incoming telephone calls, where the availability of a limited number of service facilities leads to the possibility of formation of queues.

— *Replacement models* (11)

Replacement theory is the study of the economically optimal policy for the replacement of durable capital goods. It is part of the general subject of investment theory. Applications fall into two classes, covering items that deteriorate or become obsolete because of technical and/or economic conditions (e.g. machines) and items subject to sudden failure (e.g. light bulbs).

— *Inventory models* (12), (13)

Inventory theory is the study of the optimal amount of stock to be kept so as to minimise the costs of the inventory function.

— *Network planning* (14)

PERT and *CPM* are techniques aimed at optimal planning of the different processes or steps necessary for the realisation of a project. The *PERT* system is even-oriented and focuses attention on the beginning and end of tasks. The *CPM* system is job-oriented and emphasises the tasks themselves.

— *Sequencing theory* (15)

Sequencing does not refer so much to a certain technique but rather to a group of specific problems where several techniques can be used to find solutions. Sequencing problems exist whenever there is a choice as to the order or sequence in which a number of tasks can be performed. Assembly-line problems are typical, where jobs at an assembly-line have to be assigned to the different posts or stations in such a sequence that the times spent at each and all posts are equal.

3) **Non-analytical models**

These techniques involve the use of a number of test phases without insuring that an optimal solution of the problem has been reached. Specific techniques are simulation and heuristic programming.

— *Simulation* (16), (17)

When a problem is so complex that analytical models cannot provide a solution, we can make several experiments with respect to a model of that complex situation in order to imitate the situation and thereby discover its characteristics and/or the consequences to which it may lead. An example would be the simulation of the consequences of the reactions to the introduction of a new product. Whereas in analytical models one tries to catch the causal relationships that underly the process and its behaviour, in simulation models it is only a description of the process that is given.

— *Heuristic programming* (17)

A heuristic method is a rule of thumb, strategy, trick, simplification or any other kind of device which drastically limits search for solutions in large problem spaces. Heuristic programming usually combines several heuristic methods with the aim of solving a problem in a "satisfying" (if not optimal, perhaps) way.

b) **Econometrics** (18), (19)

The purpose of econometrics is to arrive at "good" quantitative estimates of the parameters belonging to micro- or macroeconomic relationships. These estimates can be the basis for direct decision making, or they can be used in other models. For example, empirically known demand response functions can be used in inventory models. Also, knowledge of demand and supply relationship is necessary for an intelligent price policy in the short-run as well as in the long-run. EUSPA 10-3

Literature: (1) C.W. CHURCHMAN, R.L. ACKOFF, E.L. ARNOFF: Introduction to operations research. *John Wiley and Sons, Inc. N.Y.*, 1961. (2) F.S. HILLIER, G.J. LIEBERMAN: Introduction to operations research. *Holden-Day Inc., San Francisco*, 1967. (3) G. HADLEY: Linear programming. *Addison Wesley Publishing Company*, 1962. (4) A. CHARNES, W.W. COOPER: An introduction to linear programming. *John Wiley and Sons, N.Y.*, 1953. (5) W.I. ZANGWILL: Non-linear programming, a unified approach. *Prentice Hall, Englewood Cliffs, New Jersey*, 1969. (6) G. HADLEY: Non-linear and dynamic programming. *Addison Wesley Publishing Company*, 1964. (7) G. NEMHAUSER: Introduction to dynamic programming. *John Wiley and Sons, New York*, 1966. (8) R. BELLMAN: Dynamic programming. *Princeton University Press, Princeton, New Jersey*, 1957. (9) A. KAUFMANN, R. CRUON: Les phénomènes d'attente - théorie et applications. *Dunod, Paris*, 1961. (10) D.R. COX, W.L. SMITH: Queues. *Methuen's monographs on applied probability and statistics, N.Y.*, 1961. (11) D.W. JORGENSON, J.J. McCALL, R. RADNER: Optimal replacement policy. *North Holland Publishing Company, Amsterdam*, 1967. (12) E. NADDOR: Inventory systems. *John Wiley and Sons, N.Y.*, 1966. (13) G. HADLEY, T. WHITIN: Analysis of inventory systems. *Prentice Hall, Englewood Cliffs, New Jersey*, 1963. (14) R.R. ARCHIBALD, R.L. VILLORIA: Network based management systems. *John Wiley and Sons, N.Y.*, 1967. (15) R.W. CONWAY, W.L. MAXWELL, L.W. MILLER: Theory of scheduling. *Addison Wesley Publishing Company, Massachusetts*, 1967. (16) T.H. NAYLOR, J.L. BALINTFY, D.S. BURDICK, KONG CHU: Computer simulation techniques. *John Wiley and Sons, N.Y.*, 1968. (17) J.S. ARONOFSKY: Progress in operations research. *John Wiley and Sons, N.Y.*, Vol. 3, 1969. (18) J. JOHNSTON: Econometric methods. *Mc.Graw-Hill, N.Y.*, 1963. (19) C.F. CHRIST: Econometric models and methods. *John Wiley and Sons, N.Y.*, 1966.

Technical Notes

The Commission's *technical notes* give descriptions of original results obtained under the Euratom research programmes. Their purpose is to enable firms to decide whether they should consider industrialising these results.

On the basis of article 12 of the Euratom Treaty, a non-exclusive licence may be granted on the results covered by patents, in so far as the licensee is in a position to make effective use of these results. The conditions of the licence, as well as the royalties for technical assistance, will, for each individual case, be fixed after joint consultation.

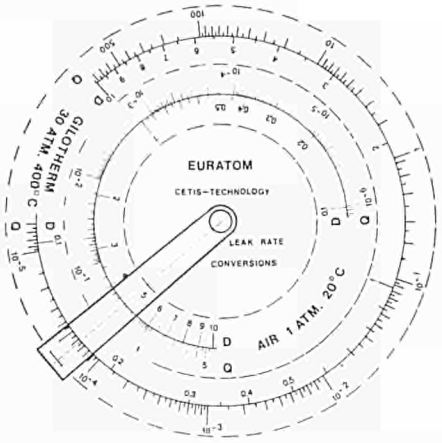
Requests for additional information should be sent to: Commission of the European Communities, D.G. XIII-A, 29, rue Aldringer, Luxembourg.

— 9/C: Computer-generated calculator discs for leak rate conversions

The leak-testing of process and similar plant is often carried out in conditions which are not representative of actual operations.

Since there is a relationship between (a) the length and diameter of a capillary tube and (b) the loss due to leakage of gas or liquid for diameters in the range $10^{-2} < D < 10^{2}$ μ graphs and discs can be used to convert the test results to reflect actual operating conditions.

The *JCR*'s computer centre at Ispra has developed a program for automatically plotting and drawing such conversion discs and graphs for various gases and liquids, at various temperatures and pressures.



The disc shown opposite is an example: it can be used to work out the leakage of Gilotherm at 400 °C and 30 atm from leaks measured *in vacuo* at laboratory temperature.

The Ispra computer centre *(CETIS)* can, on request, prepare graphs and conversion discs for specific leak rate calculations.

— 17/C: Logic unit

This unit, known as logic unit model CL2, was developed at the *JRC* Ispra. It is in the form of a single *ESONE* module and consists of two independent parts:

(a) *Coincidence-anticoincidence circuit*

A double coincidence can work alone or in anticoincidence with a third input. The input differentiating time constant is 1 ms obtained with μF and 1 kOhm.

Output pulse width is from 0.5 to 25 μs in six steps.

Fan-out *(ESONE)*: 4.

(b) *Pulse shaper*

It accepts rectangular negative pulses. Input differentiating time constant is 1 ms obtained with 1 μF and 1 kOhm.

Trigger: on the leading or trailing edge.

Output pulse width from 0.5 to 25 μs in six steps.

Fan-out *(ESONE)*: 4.

If the shaper is triggered on the trailing edge of the input pulse, a delay is obtained at the output equal to the input pulse width.

— 18/C: Threshold discriminator

This discriminator, known as the threshold discriminator model DS6-B, was developed at the *JRC* Ispra. It is in the form of a single *ESONE* module and consists of two identical variable threshold discriminators.

It accepts negative pulses from 0.1 to 10.1 V.

Input differentiating time constant is 1 ms obtained with 1 μF and 1 kOhm.

Output pulse width is 0.5 to 25 μs in six steps.

Fan-out *(ESONE)*: 4.

Threshold drift from 0 to 55 °C less than 1.5 mV/°C.

— 19/C: Scaler

This counter, known as scaler model CT6, was developed at the *JRC* Ispra. It is in the form of a double *ESONE* module and accepts statistical or recurrent pulses.

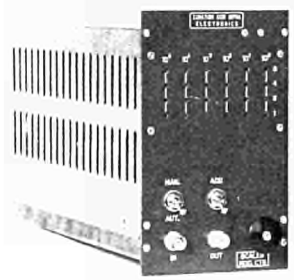
The capacity is 10^{-6} counts. The operation can be manually or automatically controlled.

Dead time measured with a double pulse is 500 ns.

Maximum recurrent frequency is 3 MHz.

Input impedance 1 kOhm.

Minimum pulse width 10 ns at half amplitude for 6 V pulses.



The display is binary coded decimal and obtained by filament lamps.

A front panel switch allows the content to be reset at the beginning of a cycle if desired.

An internal memory allows preceding data to be read off and printed out even while a new counting cycle is in operation.

— 20/C: Scaler

This counter, known as the scaler model CT6A, was developed at the *JRC* Ispra. It is in the form of a single *ESONE* module and is an improved version of counter model CT6.

The electrical characteristics are the same as those of the CT6 model.

The capacity is 10^6 counts. The operation can be manually or automatically controlled.

Dead time measured with a double pulse is 500 ns.

Maximum recurrent frequency is 3 MHz.

Input impedance 1 kOhm.

The display is binary coded decimal and obtained by filament lamps.

A front panel switch allows the content to be reset at the beginning of a cycle if desired.

An internal memory allows preceding data to be read off and printed out even while a new counting cycle is in operation.

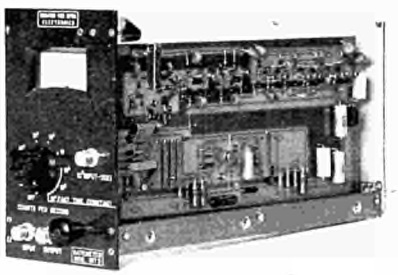
— 21/C Ratemeter

This ratemeter, known as model INT5, was developed at the *JRC* Ispra. It is in the form of a double *ESONE* module.

Six measuring ranges from 10 to 10^6 pulses per second are provided, with a decreasing time constant for increasing counting rate. The normal time constant ranges between 10 and 1 s. The upper three ranges can operate with 0.01 s time constant for recording variable phenomena.

The 10^6 cps range has a 50 Ohm input and a 100 MHz decimal divider.

Dead time losses are negligible in the lower ranges and less than 0.4 and 1 % respectively in the ranges 10^5 and 10^6.



The accuracy is 1 % in the temperature range 10-45 °C.

Data are displayed on a front panel or stored on an external recorder. The output of the recorder is 10 mV on a 10 Ohm resistor.

— 22/C: Multiple time-of-flight converter

This device, known as the multiple time-of-flight converter model CTV1, was developed at the *JRC* Ispra. It is in the form of a quadruple *ESONE* module. The converter is designed for use with up to 12 detectors. It operates in connection with a PDP-8 computer and there is a special program for the accumulation, print-out and display of data.

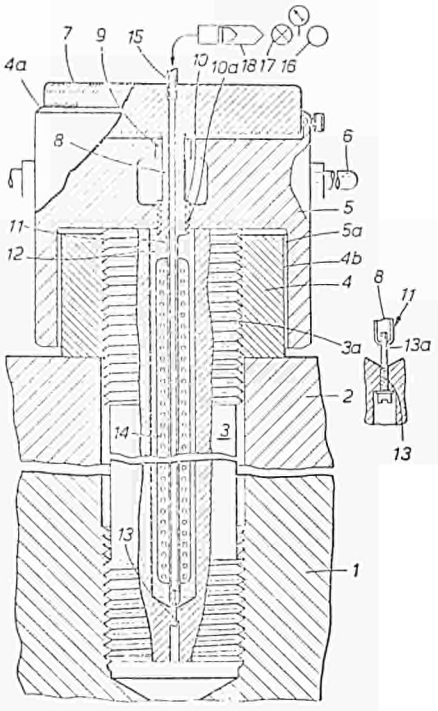
As the components are integrated circuits, some simple adaptors for matching *ESONE* signals and interface signals with the computer are used.

A single 12-bit word identifies both the channel and the detector numbers. All the operations are synchronized by a 4 MHz quartz-controlled clock.

— 65: Technique for obtaining the adjustable extension of tensioned bolts

Under the *OECD Dragon* Reactor project a technique has been developed for obtaining the adjustable extension of tensioned bolts, which is particularly useful for the studs of a reactor pressure vessel. In this technique a thin reference tube (11) with negligible longitudinal thermal expansion is inserted in an axial hole in the bolt (3). At the bottom end of the bolt this

tube rests on a conical valve (13a), while at the top it is connected by a fine thread (10) with the bolt head (5). The tube is surrounded by a heating coil along the whole length of the bolt.

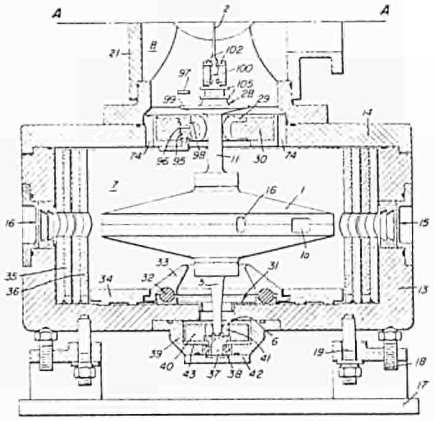


The measuring technique is pneumatic: pressurized air is blown from above into the tube and at the same time the volumetric flow is recorded. This flow depends solely upon the position of the bottom end of the tube relative to the conical valve. Initially the bolt is untensioned and a defined amount of heat is used to produce a defined change in the volumetric flow; the pressurized air flowing through the interior of the bolt past the heater coil ensures uniform convection heating. After cooling down, the same elongation as that previously obtained by heating is produced by cold pretensioning of the bolt. The tube can be adjusted against the bolt head by a micrometer screw (7) and the fine thread (10), so that the measurements can always be carried out with the same initial volumetric flow.

(German patent No. 1 295 238, French patent No. 1 323 166 or British patent No. 946 409.)

— 609: Chopper

The chopper developed in the Ispra *Joint Research Centre* can pulse a neutron beam with energies of 1-80 meV at frequencies of 200-1 250 c/s. It



consists of a motor, a synchronization device, a vertical elastic coupling shaft and the chopper rotor itself. The rotor is suspended on one side of the shaft and is guided only loosely at the bottom with a lug. The rotating parts are all enclosed in a casing which can be evacuated down to 10^{-4} mm Hg in operation.

Special precautions were taken to ensure that in the event of a fracture of the elastic shaft (2), which is only 3 mm thick, the rotor energy of about 100 m/tons can not run wild. In such an event a safety plate (99) attached to the shaft locks onto a coaxial soft metal funnel (29), the lug (5) onto a rotating supported shell (37) and the rotor itself onto an elastic ring (33). The rotor casing is also armoured with steel plates (35, 36) circumferentially.

(German patent No. 1 296 716, French patent No. 1 476 064 or US patent No. 3 427 455.)

— 699: Supplementary lock

In a hot laboratory handling alpha, beta and gamma activities (1 000 curies 1 MeV), containers are transferred from one area to another by means of locks.

In order to protect the transfer mechanisms installed in a lock against the

ambient radioactivity or corrosive agents in a containment, a supplementary lock has been developed which can be inserted between this lock and the containment.

In addition, it can be used, if desired, to place the object to be transferred under a controlled atmosphere.

This supplementary lock includes two horizontally-sliding doors and a platform on which the container is placed by means of the transfer mechanism or of a telemanipulator situated in the working containment.

The supplementary lock is connected to the first lock by a flexible PVC sleeve.

In the present version, the transfer mechanism consists of a telescopic table which can be deployed horizontally in the following three positions:

(1) in the containment from which it is desired to make the transfer;

(2) in the shielded lock;

(3) in the supplementary lock.

The container is transferred from the telescopic table to the platform by a vertical movement of the platform.

(French patent No. 1 458 968 and British patent No. 1 148 597.)

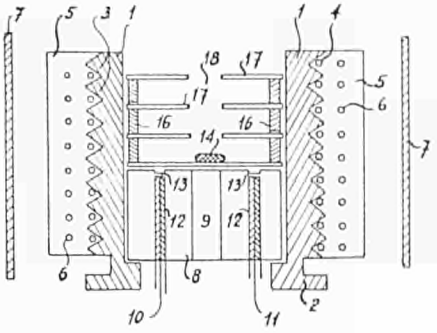
— 842: Float

The depth of immersion of a float depends greatly upon the density, and this in turn upon the temperature of the fluid to be measured. The float developed at the Ispra *Joint Research Centre* compensates for this dependency. In one design there are several bimetallic strips (Fig. 1) inside the float, their individual effects being designed to be additive. These strips cause a relative movement between the body of the float proper (7) and a part indicating the level (e.g., a magnetic indicator) (6). In an alternative design the bimetallic strips are replaced by an expansion vessel (15) with a suitable fluid (Fig. 2).

(German patent application No. 1 548 944, British patent No. 1 165 451 or French patent No. 1 517 278.)

— 1004: Furnace for the specimen table of a microscope

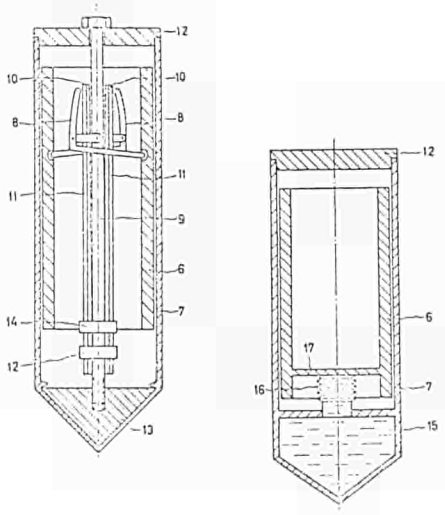
The Petten *Joint Research Centre* had developed a furnace for the specimen table of a microscope in which it is specially important that there shall be small temperature gradients in the specimen to be studied (14) and that the temperature shall be capable of accurate determination. The furnace consists of a vertical cylindrical ceramic tube (2), resistance-heated from the outside. In the inside is a sample-holder (8) of platinum and several radiation shields (17) with a central observation hole (18). For temperature measurement a multiple thermocouple (10, 11) is passed to the sample-holder surface from below and welded to it. The termal stresses arising at the welding spots (13) distributed over the surface provide information both on the



mean temperature and also on the local temperature distribution over the surface.

The furnace was designed for a temperature range up to 1 500 °C in an atmosphere adjustable between an underpressure of 10^{-2} mm Hg and an overpressure of 1 atm. At 1 200 °C operating temperature a maximum temperature differential of 0.2 °C was noted between the centre and the edge of the sample holder.

(US patent No. 3 501 580, French patent No. 1 556 143 or Swiss patent No. 476 316.)



NEWS FROM THE EUROPEAN COMMUNITIES

THE Ministers of Science of the six countries met in Council at Brussels on 16-17 December 1970, and in the presence of the Commission of the European Communities approved the **expected reorganisation of its Joint Research Centre,** granting extensive autonomy to the Director-General of the Centre, who will be assisted by a Consultative Committee composed of eighteen members (three for each Member State—one civil servant, one scientist and one industrialist).

This step towards modernisation will necessitate changes in the financial regulations, which will be the subject of proposals by the Commission. They will be accompanied, once a new multiannual research programme has been adopted, by a revision of the service regulations in consultation with the personnel, with regard to acquired rights and aimed at greater mobility of staff.

The reorganisation recently decided by the Commission, and the Council's expressed intention of no longer drawing up research programmes except in very general terms, will make it possible for the Community to act methodically and resolutely with a view to initiating a policy of research and technological development.

This body of decisions will enable the *Joint Research Centre* to develop its new role and to emerge from the stagnation from which it has suffered in recent years.

As regards the Community's *new multiannual research programme* (it is known that for 1971 the *Joint Research Centre* is working on the basis of an annual programme), the Council has asked the Commission to examine the question of creating a *Community Bureau of Standards* against the background of its work and the studies which it is conducting with a view to selecting non-nuclear projects suitable for implementation in the *Joint Research Centre*.

In addition, five delegations have approved in principle the study proposed by the Commission with the aim of ascertaining the factors governing the decision as to whether to build the *SORA* pulsed reactor; the Council has also agreed to continue its work on the Commission's proposals concerning *thermonuclear fusion and biology*.

On a more general plane, the new—and overall— approach to the problems of scientific and technical research within the Community proposed by the Commission is the subject of an intensive exchange of views, at the conclusion of which the ministers have instructed their experts to continue to study this proposal in cooperation with the Commission, each agreeing to recognise the *desirability of a regrouping of the various bodies* within which European scientific policy is at present being discussed.

Lastly, the Council has instructed an ad hoc Group of the *Consultative Committee on Nuclear Research* (this Committee is presided over by the Commission of the European Communities and is made up of delegates from the Member States) to evaluate the various possible techniques with a view to the creation of a *European uranium enrichment capability,* in conformity with the Commission's proposal.

MR. PIETRO CAPRIOGLIO, the new Director-General of the Community's Joint Research Centre, which comprises the four establishments at Ispra in Italy, Geel in Belgium, Karlsruhe in Germany and Petten in the Netherlands, took office on 15 February 1971.

He will enjoy a large measure of autonomy, and his first task will be to decide the part to be played by the *Joint Research Centre* in the Community's new multiannual research programme, which will probably include both nuclear and non-nuclear activities.

THE automated nuclear documentation system of the *Centre for Information and Documentation (CID)* of the Commission of the European Communities at Luxembourg has processed over 3 400 queries for document retrieval since 1967 and is at present supplying 650 research workers or industrialists with selective periodical information.

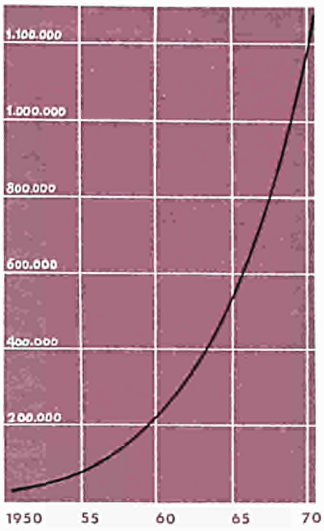
Of the users of the system, 21 % are German, 18 % Belgian, 16 % French, 5 % Dutch, 3.8 % Italian and 36.2 % from other countries.

The *CID* regularly scans 50 abstract journals for summaries of publications of nuclear interest, which are analysed and stored in the computer memory in accordance with a system which permits the subsequent rapid retrieval of the documents containing information on a given subject. Roughly 1 100 000 documents published since 1947 have been stored in this way to date.

No charge is made for retrieval at present; users are asked, however, to send in their comments on the searches effected on their behalf.

The *CID* can carry out several types of computer search, including:

(*a*) *retrospective search,* a search through the whole memory-stored collection of documents; to obtain this, one need simply send the *CID* a form (specimen appended to this issue) filled in with due care. (When asking for additional forms, please state preferred language; the forms are available in Dutch, French, German, Italian and English). The question is then processed by experts in various scientific or technical branches (physicists, chemists, metallurgists, biologists) and the results are sent in the form of photocopies of abstracts and bibliographical data;



The rise in the number of documents of nuclear interest published since 1950 and stored in the CID computer memory.

(*b*) *preliminary guide search:* to give the user an initial view of a subject with he is unfamiliar, so that he can then formulate his question more specifically;

(*c*) *selective dissemination of information,* monthly retrieval which regularly notifies the user of recent papers that have appeared on a given subject.

In addition, the *CID* can supply copies of certain originals or else tell the user where he can obtain them.

Persons wishing to receive further details or a description of the scientific fields covered by the system are invited to write to the *Centre d'Information et de Documentation (CID),* European Communities, 29, rue Aldringer, Luxembourg.

THE Commission of the European Communities plans to place an order with a Community firm or consortium for the **design of a SORA pulsed reactor and, possibly, its construction** at the *JRC* Ispra Establishment, as part of the Community's research programme into condensed state physics. The Commission was also issuing invitations to interested firms for whom a briefing was held at Ispra on 2-4 February 1971.

THE corosion of nuclear graphite in a pressurised carbon dioxide atmosphere was the subject of a working meeting organised in Brussels on 19 January 1971 by the Commission of the European Communities at which a report was given of the results of a major research programme financed by the Community since 1963. The tests made during this programme in a very high-flux loop of the *BR-2* reactor at Mol have made it possible for the first time to measure the behaviour of the graphite moderator under irradiation doses equivalent to the total residence time of the graphite in a power reactor.

THE health aspects of the irradiation of foodstuffs for preservation purposes were the subject of a colloquium held in Luxembourg on 27-28 October 1970 at the invitation of the Commission of the European Communities and attended by experts from the six Community countries. The colloquium provided an opportunity for a broad exchange of views on the experience gained and on the research in progress in the various laboratories; five of these have been conducting a Community research programme under contract to the Commission since 1967.

THE Eurisotop Office has undertaken the promotion of studies on the technical and economic implications of various **techniques involving the use of isotopes for industrial analysis purposes** (neutron activation, X-ray fluorescence, activation by gamma rays and charged particles) in the industrial exploitation of precious metals and their compounds (see also *euro-spectra* Vol. IV (1970) No. 4, p. 128a). The aim of these studies is to define the analytical problems which arise in the industrial utilisation of precious metals, to assess the potentialities of nuclear methods and to create a basis for cooperation in the improvement of analysis techniques.

The Commission of the European Communities has just authorised the award of three study contracts on this subject.

FOR its research requirements, the **Community has leased enriched uranium** to a total value of about $ 31 100 101 (figure as at 31 December 1970) from the *US Atomic Energy Commission;* the total value of the *plutonium* supplied to the Community by Great Britain and the *USAEC* is about $ 286 042.

As regards power reactors, the value of the enriched uranium imported under the 24 toll enrichment contracts concluded, implementation of which began on 1 January 1969, was $ 15 900 000 in 1970 (as against $ 19 907 028.51 in 1969). All these deliveries were arranged by the Community's supply Agency.

THE Commission of the European Communities has just approved the conclusion of a **toll enrichment contract** between the Supply Agency and the *United States Atomic Energy Commission* for the *Hamburgische Elektrizitätswerke (HEW)* for a total net quantity of 8 500 kg of U-235, to be delivered between 1972 and 1990.

NEWS FROM THE EUROPEAN COMMUNITIES

TELECOMMUNICATIONS requirements up to 1985 will be the subject of a study to be carried out by the *European Conference on Posts and Telecommunications (ECPT),* for which the fifteen countries at present seeking to cooperate in the scientific and technical field are to provide financial backing. It will be recalled that the "Fifteen" include the six Community countries, the four applicant countries and Austria, Portugal, Spain, Sweden and Switzerland (see the article on "Telecommunications 1985", *euro-spectra* Vol. VIII (1969) No. 4, p. 98).

UNDER the terms of the **agreement on nuclear cooperation between the European Community and the United States,** the *US Atomic Energy Commission* has agreed to a considerable relaxation of the terms governing the supply of plutonium to Community users. Customers can henceforth buy plutonium from US private producers at freely-negotiated prices. The supply contracts will be awarded through the Community Supply Agency and the plutonium supplied will be subject to the Community's system of safeguards and controls.

THE European Atomic Energy Community has been invited to take part in the fourth **International Conference on the Use of Atomic Energy for Peaceful Purposes.** The Commission has accepted this invitation and has promised an active contribution, in the form of papers on certain items on the agenda.

THE Commission has decide to hold a major **conference on the Community's industrial policy,** to which all the interested circles will be invited—government administrations, industrial companies, trade unions, etc. Rapid, continuous industrial growth is necessary to ensure a rising standard of living, but it goes hand in hand with a rise in the amount of damage done to nature (e.g., pollution) and to society (overpopulation, regional underdevelopment). One of the main objectives of the conference will therefore be to define an overall concept which will not make industry an end in itself but will place it at the service of mankind.

CONFERENCES

"Professional rehabilitation and employment of handicapped persons" is the subject of a colloquium which the Commission of the European Communities is holding in Luxembourg on 24-26 May. Enquiries should be addressed to "Colloquium on Handicapped Persons", Commission of the European Communities, Directorate-General XIII, 29, rue Aldringer, Luxembourg.

"Information meeting on precipitation-hardening steels", to be held by the Commission of the European Communities in Luxembourg on 14 June 1971. The aim of this meeting is to review the present situation with regard to weldable steels, the mechanical properties of which are enhanced by the solution and precipitation of particles such as carbides, nitrides and carbonitrides. Applications should be addressed to Commission of the European Communities, Directorate-General XIII, 29, rue Aldringer, Luxembourg.

"Interdisciplinary training course in molecular biology and radiobiology" for young research workers. The University of Leiden in the Netherlands proposes to hold this course at Rijswijk on 15 August - 3 September 1971 under the sponsorship of the European Communities and jointly with the *Medisch Biologisch Laboratorium TNO,* Rijswijk, and the *Faculty of Medicine,* Rotterdam. Applications for enrolment must reach the Molecular Biology and Radiobiology Course Secretariat, Commission of the European Communities, Directorate-General XV, rue de la Loi 200, 1040 Brussels, before 5 April 1971. The application should include a curriculum vitae of the applicant, with details of his knowledge of languages, a list of his scientific publications and a testimonial from the head of his institution.

"Radioecology applied to the protection of man and his environment"—a symposium which is being organised by the Commission of the European Communities in cooperation with the *Comitato Nazionale dell'Energia Nucleare* in Rome on 14-17 September 1971. Radioecology is defined in this context as the study of the relationship between nuclear energy and the environment.

The aim of the Symposium is to determine to what extent our present knowledge of radioecology can be used for the protection of man and his environment in order to assist the orientation of future research and improve the organisation and efficiency of the fight against pollution. For further information and enrolment, please apply to the Secretariat of the Symposium: Directorate for Health Protection, Commission of the European Communities, 29, rue Aldringer, Luxembourg.

"Transplantation Genetics of Primates"—an international workshop and symposium under the chairmanship of H. Balner and J.J. van Rood which will be held at the *Primate Center TNO,* Rijswijk (the Netherlands), from 6 September to 21 September 1971. (Workshop September 6-17, symposium September 20-21.)

Participation in the workshop is restricted to established tissue typers of sub-human primates. Registration forms and a provisional programme plus detailed information for the symposium can be obtained from H. Balner, *Radiobiological Institute TNO,* Lange Kleiweg 151, Rijswijk (the Netherlands).

JUST PUBLISHED

- **Kernkraftwerk Obrigheim,** Jahresbericht 1969. *EUR 4565 d.*
- **Centrale nucléaire des Ardennes,** Rapport annuel 1969. *EUR 4566 f.*
- **Centrale elettronucleare di Latina,** Relazione annuale 1969. *EUR 4596 i.*
- **Kernkraftwerk Lingen GmbH,** Jahresbericht 1969. *EUR 4616 d.*
- **Convenzione EUREX Euratom - C.N.E.N.,** Relazione annuale 1969. *EUR 4604 i.*
- **Radiation protection problems relating to transuranium elements** - Proceedings. *EUR 4612 d,f,e.*
- **Niveau de contamination radioactive du milieu ambiant et de la chaîne alimentaire.** *EUR 4546 f.*
- **New methods and developments in the field of coke production.** *EUR 4520 d,f,e.* (The French and German versions were already available).

These publications can be obtained at the *Sales office for official publications of the European Communities,* 37, rue Glesener, Luxembourg.

- **The Joint Research Centre of the European Community** is the title of a booklet brought out by the Scientific and Technological Information Service of the Commission (rue de la Loi 200, 1040 Brussels). It is available in Dutch, French, German, Italian and English.
- Proceedings of the International Colloquium organised by the *European Research and Documentation Centre* of Grenoble and the *Committee for the Study of the European Communities on the subject:* **"Research, development and competition in the European Communities",** Grenoble, 16-17 April 1970.

This colloquium is a sequel to those organised at Aix-en-Provence in 1967 and at Nice in 1968 on "The legal background to international cooperation on scientific matters and the European problem".

There was a remarkably large attendance, including both economists and lawyers, since the subjet of the colloquium was related at one and the same time to economics, private law, public law, and in a wider sense to scientific policy and competitive policy at national and international level.

Research and development together constitute a force which is disrupting the economic and social structures of a number of countries; industrial sectors have been transformed by the creation of large companies and increasing collaboration between firms, and we have witnessed the birth of new forms of competition firstly between companies and secondly between countries.

All these phenomena have inevitably raised problems which call for review at various levels. It is also necessary to consider how and to what extent the public authorities should intervene to regulate competition either at national level (i.e. at the level of production units, e.g. by restructuring the allocation of subsidies to various sectors), or in the wider context of an international joint scientific policy designed to avoid jeopardising or excessively retarding the creation of a large unified market.

The proceedings of the colloquium, of which a limited number of copies are available (persons interested are invited to apply to the Editorial Office), contain a discussion of all these problems together with a review of the background against which solutions must be sought.