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PREFACE

This Collaborative Paper is a revised version of a contribution made by George F. Ray to a Task Force Meeting on "Innovation and Industrial Strategy". The author gives a historical overview of the impact of innovations on economic growth, pointing out the development chains arising from breakthroughs in certain areas. His philosophy can be illustrated by his statement: "The single pistol shot at Sarajevo was not the unique reason for the outbreak of the Great War in 1914, nor was Waft's perfection of the primitive steam engine the unique cause of an economic upswing." The economic mechanism of long waves cannot be described in a one-dimensional way indeed. Georege F. Ray presents also an hypothesis on the content of a future upswing of world economy, including in it energy, food, environment and social institutions. In his opinion the microprocessor is only an important tool for technological changes in various fields. It is like a chamaleon, it takes on the character of whatever program has been fed to it.

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INNOVATION AND LONG-TERM ECONOMIC GROWTH

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My personal preference for a title would be 'Once again: Innovation and the long cycles' - since I have recently expressed elsewhere (1)(2) certain views on the part played by innovations in the constantly debated long cycles; it is not my intention to repeat here what has been said in considerably more detail there. Let me just mention briefly one or two points that seem to me relevant to the new material that follows.

THE LONG CYCLES

This is not the place to get involved in the argument of whether long cycles in economic activity do indeed exist or not. The controversy started immediately following the publication of Kondratiev's study in the 1920s, has been going on ever since, and will probably continue. More recently, however, as one outcome of the gloomy state of the world economy - including here East and West as well as the Third World, with the sole exclusion of some oil producers - the study of long cycles has again come to the fore and has led to the publication of some valuable views with theoretical and empirical statements by both new converts and old disciples, among them such well known names as Rostow and Forrester. (3)

My interest invariably lies not directly in the theory - or the reality - of the Kondratiev cycle but in its relevance to innovation (or vice versa) and in the manner innovative activity can influence, indeed give a push, to the whole economic system.

The three long cycles identified by Kondratiev and accepted by Schumpeter in his thesis were allied, in the most simplified form, to the dissemination of steam power, to the railway boom, and to the joint effects of the motor car and electricity. These are obviously crude generalisations, since the 'steam power' period cannot be divorced from the development of the coal and cotton industries; the railway boom could not have happened without an iron and steel industry of new dimensions; and the third upswing included - apart from the somewhat loose attribution to the motor car and electricity - the birth of the modern chemical industry, among other things. It is never a simple matter to find a unique cause of historical developments in the economic arena; the single pistol shot at Serajevo was not the unique reason for the outbreak of the Great War in 1914, nor was Watt's perfection of the primitive steam engine the unique cause of an economic upswing.

EXCURSION INTO HISTORY

If we start searching for reasons for upswings, and especially if we believe that innovation is, generally speaking, a 'Good Thing' which offers the innovator advantages over laggards, then we can find plenty of evidence pointing to its importance and to the role played by various innovations in the fortunes of the countries implementing them. The leading role of Britain in the 19th century was in no small measure due to the rapid introduction of steam, to the series of major innovations in the various phases of the cotton industry, as well as to the development of coalmining in that country. It continued with the growth of the coal-based iron and steel industry which made the railway boom possible. Britain was later overtaken by others, especially Germany - again due to the great German innovations in steel and chemicals. And finally, by taking up both electricity and the motor car before the others, the United States not only arrived on the scene, but overtook everybody else.

The industrial revolution in Britain - and the various innovations leading to it and arising from it - are too well known from economic history; to an extent, almost the same is true of the ascendence of the United States. Somewhat less is generally known - especially outside Germany - of the German developments. The German steel industry was indeed thriving on the then new Thomas process: from 1880 to 1900 its output rose tenfold, leaving Britain far behind. The cost of steelmaking in Germany dropped to one tenth of the level of the 1860s as the combined result of technological progress and scale economies. As early as 1900 Germany supplied 90 per cent of the world production of dyes. The electrical industry owed much to the systematic concentration (especially of Siemens) on invention and to the early large-scale adoption of Edison's patents.

Kondratiev paid great attention to the French economy when he constructed his statistical series supporting his long waves. However, France - certainly the leading country in 18th century Europe, with the largest population - was not among the later industrial pioneers. For a while, in the times of the revolution and the Napoleonic wars, it was cut off from the world outside and lost contact with technical progress there; the industrial advance that started in the second half of the 18th century, helped by new techniques imported from England, was halted. France remained for a long time, certainly until the middle of the 19th century, a largely agricultural country. The contribution of a few major industrial innovations was nevertheless important to French (and general) industrial progress - such as Jacquard's loom, Thimonnier's sewing machine, Berthollet's chlorine-bleacher or Girard's flax spinner. The later spread of industrialisation coincided in France with Kondratiev's second cycle characterised by the railway boom.

Among the major European powers of the time, Austria-Hungary was lagging far behind the above West-European trio. The Austrian industry was very slow in the introduction of steam power and the majority of pig iron production was exclusively charcoal-smelted until about 1870. We cannot even speak of Italy proper before its unification in 1860; by about the middle of the 19th century the leading industry in Piedmont and Lombardy was silk-throwing; most of these mills worked by water power. Up to 1860 altogether 1800 km of railways were built; lack of coal characterised the industrial scene: here too ironmaking was based on charcoal. Although railway building was speeded up, industrial progress was slow to 1880 and the real spurt followed in the period 1899-1913, in the third Kondratiev cycle only, initiated by two new products of innovation: automobiles and typewriters.

The history of the economies of smaller industrial countries also provides support to the outstanding importance of innovations. The Swiss economy not only survived British competition, which at one time jeopardised the existence of the once flourishing Swiss cotton industry, but by means of innovations - among them, some interesting organisational changes - recovered to become a serious competitor to the British, in cotton manufactures and textile machinery alike. From textiles to machinery and then onwards to dyes - this was the self-sustained way of advance of Swiss industry based on industrial and organisational innovations, great flexibility, and that special agility and managerial talent that seems to be a characteristic of the industries of some smaller countries, of which Switzerland is one typical example and Belgium another.

The local availability of coal and iron ore, plus motive power by water, were the bases of early industrialisation of the region that by 1830 had come to be called Belgium. The adoption of steam power was slow but in 1807 Huart-Chapel invented a reverbatory furnace for melting down scrap iron and introduced several major changes - such as puddling furnaces to convert pig iron into wrought iron (1821) - and built the first coke blast furnace in the Charleroi area. New type rolling mills were also added at about the same time. Coming over from England, Cockerill started making spinning machines in Verviers as early as 1799; a number of outstanding innovators helped the Ghent textile industry to prominence, as well as the metal industries in Charleroi and elsewhere. By 1840 the country was highly industrialised, comparable only to Britain, and had relatively the densest rail network in Europe.

In contrast, Holland did not have any noteworthy industries; the rise of Dutch metal industries parallelled that of the great maritime innovation: the steamship, the first of which appeared in Rotterdam in 1823.

Switzerland and Belgium have been taken as examples of small countries which industrialised early. The situation was very different for Sweden. During the first half of the last century Sweden was one of the poorest countries in Europe. The late start of industrialisation was, however, followed by rapid advance. The first Kondratiev cycle did not touch Sweden at all. Towards the end of the second - the railway boom - Sweden's industry was the fastest growing in the whole of Europe and in the third cycle Sweden was already in the forefront, especially in the area of electricity, with hydropower and particularly the pioneering work in power transmission. One of the bases of the expansion of Swedish engineering industries was an early invention, the milk separator (1870) which greatly contributed to the creation of an exporting dairy industry in the Nordic countries - apart from its important role in helping engineering to become established. It was followed later by other Swedish innovations in such varied areas as turbines, electrical machinery, gas accumulators and ball bearings.

The country that perhaps benefited most from the Swedish milk separator was Denmark: the new equipment provided a changed technical basis for dairy farming, an important part of the Danish economy, and contributed to a considerable extent to the development of the cooperative movement in Denmark. The latter was instrumental in transforming the export of pigs into the sale of packed pork, another innovation that required technical and organisational change resulting in the significant growth of another part of Danish agriculture.

As in all Nordic countries, industrialisation started late in Norway, with the development of hydroelectricity around the turn of the century. In the five years 1900 to 1905 Norwegian hydroelectric power production rose eightfold. Its beneficial effects can best be illustrated by the growth of the chemical industry: the growing production of fertilisers, calcium nitrate (based on German and American inventions but further developed by Norwegian innovators, Eyde and Birkeland) as well as carbide (by 1910 Norwegian output amounted to 20 per cent of world production).

Single major innovations can often be seen to have created the basis of whole national industries. For example, the Bessemer steelmaking process offered the opportunity for the large-scale use of Spanish iron ores and for the development of the steel industry in Spain.

Another smaller country whose history is worth studying from this angle is Hungary. Because of historical conditions, industrialisation in Hungary started even later than in Sweden. For a long time the country remained basically agricultural and its industry primarily served agriculture. It was only recently, after the Second War that industry became the largest sector. This background makes the spectacular development in a few isolated cases even more striking. Among these achievements, probably the most marked were those of two particular electrical engineering firms which acquired international reputations (Ganz and 'Tungsram') and developed very rapidly indeed, thanks to the significant innovations of a few highly gifted and successful scientists and engineers in various areas of the then fast-growing electrical industry. This example is of some significance: it underlines the importance of innovations even in a situation where the whole economic climate is not particularly favourable, external economies hardly exist, and the domestic market does not provide any great stimulus to innovatory activity.

SOME POINTS ARISING

Thus, with the benefit of hindsight, it is quite possible to find historical evidence for the importance of major innovations as generators of general or regional economic upswings. It is much more difficult - and perhaps impossible - to answer certain questions which emerge. I will try to sketch them.

-- Who was the 'basic' inventor? Whoever he was, a long chain of previous inventions helped him. Take Faraday, whose demonstration to the Royal Society in London, anno 1831, is often taken as the birthday of the much later developed electricity industry. He could not have presented his theories without the outstanding achievements of scientists like Benjamin Franklin (1749), Galvani (1791), Volta (1800), Ampère (1822) and others. It was a long way - before Faraday and after him - to the large-scale electricity industry that 'created new social benefits, new markets and new jobs' (to use the definition of a major basic innovation, coined by Mensch (4)).

-- Faraday was a scientific genius; so were some other great inventors. But Watt's simple aim was a better engine and Daimler's was a new vehicle he could sell. None of them was thinking, presumably, of his achievement as the start of a new era; nor were their immediate contemporaries thinking it. The great new opening was usually recognised somewhat later by others - such as by Henry Ford in the case of the automobile. With the benefit of hindsight it may be possible to assess the fundamental importance of some major innovation, but it is difficult - or perhaps even impossible - to classify any relatively new development in this super-class without the historical perspective.

-- Finally, whilst the significance of a major basic innovation is obvious, from the point of view of its impact on the economy it is not the innovation itself but its <u>diffusion</u>, across the economy, and the <u>speed</u> of this diffusion, that matters most.

The statements in the above paragraph may seem to many to oppose the views of Mensch - who argued (4) that one of the main reasons for the decline of the world economy is the dearth of major basic innovations in recent decades. However, I trust that my views do not contradict Mensch's theory at all: they supplement it. There are many innovations ' in the pipeline'; some of them may prove to be of major importance but only time will show which one(s) - if any. At present we cannot know - we can't see the forest for the trees.

The question is nevertheless justified: what is likely to happen? Leaving all other important aspects aside, is there anything on the horizon - in the area of innovations - that may make a marked impact on economic activity or significantly reshape the way of life? Nothing less than the divine inspiration of a prophet is required to answer questions of this kind, and I can offer no more than personal guesses.

GUESSING THE FUTURE

Let us first have the 'microprocessor revolution' out of the way. There are many who believe that this great innovation will be the redeemer of the sickly world economy, following in significance the motors of earlier upswings. The importance of micro-electronics can be seen in many areas already. The microprocessor is like a chameleon: it takes on the character of whatever program has been fed into it. It can direct a guided missile, operate a fuel injector or a coffee dispenser, or control an industrial process. It can be used almost anywhere, in metal machining and in medical diagnosis. It is conceivable that it could be a candidate to lead a technological upheaval, giving the necessary push for a swing out of Mensch's technological stalemate - if we really are in this position.

It is not belittling the significance of the microprocessor when I express the view that I consider it to be the necessary instrument for achieving a really marked change but I expect this change itself to come elsewhere. My candidates for this change are the following areas, in this order:

energy
food
environment
social institutions.

Some may miss in this short list those natural resources that are neither food nor energy; their omission is intentional. I believe that within the foreseeable future none of these will be in fundamentally scarce supply, but if, contrary to my expectation, shortages do occur, mankind will find a way to live without the scarce material or find out how to replace it. Scientific and technological advance will provide the answer in the case of such an emergency - as it so often has in the past. (8)

The above four areas represent various factors of production (or 'resources'), of which three are likely to be in a tight or disturbed position and one in uncomfortable abundance. Energy may become scarce; food supplies inadequate and land for expanding food production difficult to find; and the environment may be disturbed by pollution of various kinds. The fourth area, social institutions, concerns the factor in plentiful oversupply: people.

ENERGY

With only a very slight stretch of the imagination it can be said that the motors of earlier Kondratiev upswings, as identified by Schumpeterian analysis, were closely connected with energy developments. The first upswing had water power and the beginning of the coal era. The second was clearly based on coal; the third on coal, electricity and the early development of oil.

The last upswing (the postwar golden age to 1973) was based on oil and gas, with the birthpangs of nuclear energy.

The energy situation does not require any great analysis here. It will suffice to say that the present key, the oil situation, has already become tight. The price of oil at the producers is now some 15 times that of its 1972 level in money terms, and increased over this period something like six or seven-fold in real terms. The world's main source of oil in international trade is the Middle East, whose producers, allied to exporters in other areas, are associated within OPEC; they are - at present - in a position to keep the market tight and set the price.

The tight supply position and ever-increasing price have, however, a number of implications. On the negative side (which at present - but, hopefully, probably only temporarily - far outweighs any benefits that might come from the positive side as detailed below) are the well known influences fuelling inflation, reducing domestic output and real income of the oil consumers, and resulting in an imbalance in the international financial position to an extent that from time to time it may seem unmanageable. These are all immediate effects. There is also a positive side to the present constellation - but with effects which can only work in the uncertain future (and some would no doubt add: if at all). Scarcity and the high price are a great sitmulus to R & D efforts in three directions; these are: conserving energy, that is raising the efficiency of usage; searching for new sources of conventional fuels; and seeking sources of new types of energy.

Mankind will be pressed to progress and it is my belief that solutions will be found; indeed, there are already signs pointing in all three directions. Let me start with the first: conservation.

There are many studies related to the estimation of the price elasticity of energy use. They differ in their estimates but agree, without exception, on one point: that whilst the short-term price elasticity may be low, the long-term reaction of demand and usage to price changes is high. The long-term may be longer than we would like to see; in the present conditions of very slow growth and reduced investment activity it may indeed be very long.

The three points that have to be borne in mind are these. First, apart from the relatively easy measures that can be taken in the framework of better householding - that is, improved organisation and more careful control of energy use - any more important change that would yield higher energy efficiency requires new investment. That takes time, especially in a period of high inflation and slow growth, since there are many other objectives calling for investment and energy projects compete with others for the limited capital available. Secondly, and this is more important, apart from the once-and-for-all effect of the dramatic rise in oil prices in 1973/74, until recently the financial incentive to invest in energy saving has not been too great. Whilst the macroeconomic burden on our economies has increased substantially with the manifold rise in OPEC prices, the cost to the final consumer has risen much less. Up to the closing months of 1979 this rise in real terms was in many cases no more than 30-40 per cent in the various countries, and in the case of motor spirit even less. We cannot expect too much reaction to such a relatively minor real price change, remembering that energy costs still do not account for a very large share in total production costs (apart from some very heavy users). In this respect I expect a significant change as from about now, when the second price explosion is likely to reach the consumer. Thirdly, it is questionable to what extent elasticity estimates, which are invariably based on historical experience going back to the period of cheap energy supplies, are relevant to the future of a greatly changed energy situation. This is one of the reasons I am avoiding the use of any quantified estimates. Apart from the price, the recognition of possible scarcities may also work in the same direction - that is, to devote much more attention and allocate more resources to energy conservation.

The second effect of the present situation is the search for new sources of conventional fuels. Here we have plenty of evidence practically all over the world, but let me restrict myself to the North Sea. The second wave of oil price rises in 1979 has already induced operators to start building the equipment for the exploitation of smaller oilfields discovered earlier that would not have been touched at a lower price level. Exploration has also received a fillip from the price hike and only recently, in May 1980, both Shell and BP announced independently the finding of major new gasfields in the North Sea. Given the fact that so far only a part of that maritime area has been explored, it is not wishful thinking to believe that even more will be forthcoming; and the situation is probably similar in other areas too.

Finally, the search for new sources of energy is also seen in a different light now. In the scientific sense, these sources are not new. It is the engineering that causes problems and the difficulties of producing usable energy from these sources in large, commercial quantities. Whichever of the new sources we take - solar, biomass, sugarcane-based gasohol, oil shales, tar sands, etc. - none of them will supply energy cheaply. But whilst so far the difference between the cost of the novel type of energy and that of conventional oil has been very large, with the price-raising race that can be witnessed among OPEC producers the price of oil is coming nearer and nearer to the higher level of the new fuels, helping the latter to reach economic viability within the foreseeable future.

EARLIER ENERGY EXPERIENCE

There are, however, some other important points to be remembered. Let me go back in history in order to survey briefly what happened in the past on the energy front, taking just two examples. I will deal with the first only briefly since it has been described in some detail elsewhere (5) - what form did those developments take that helped to overcome earlier, similarly serious energy shortages? The present one is not the first in mankind's history. England was facing serious fuel scarcity in the early 18th century, having burnt up her formerly ample forests; a number of major technological breakthroughs and the following stepwise innovatory developments helped to overcome the problem by converting her economy to the use of the newcomer at that time: coal, of which there was plenty.

My second example requires a little more elaboration. It concerns the United States, the country where (among the more advanced economies) fuelwood remained the energy base for the longest time. As late as 1870, about three quarters of all the energy used in the US came from fuelwood. By then, the transition to coal was already underway and towards the end of the last century it became the dominant source. The important point in this transition was the change from a severely limited fuel resource to another, available in apparently endless quantities. Abundance paved the way for the unimpeded growth of iron and steel production which, in turn, made it possible to build a railroad network covering the whole enormous continent and to produce the machinery required for the rapidly expanding manufacturing industries. The writings of Rosenberg (6) and Schurr (7) describe how,once the fuel constraint was broken, one development led to another in the various branches of industry and services (and also in agriculture) in a dynamic sequence.

Later on, the US was in the forefront of developing a large-scale electricity generation and supply industry; this removed the limitations imposed on factory processes by the earlier mechanical energy system that used shafts and belting to transmit power from the in-house prime mover, and led to large productivity increases. The oil period, apart from generally increasing mobility, led to enormous increases in crop yields with the help of tractors and energy-based artificial fertilizers, again removing further constraints: those of the availability of natural fertilizers and animal drawing power. Geographic constraints were also removed: the railways overcame the limits formerly imposed on industrial locations by waterways required for transportation and water wheels for power. In later years, liquid fuels and the ease of transportation by trucks and cars made the limitations imposed by railways and coal disappear. And finally, air conditioning and air transport removed other limitations, those of climate and distances.

Of course, an endless number of adaptations within the economic system were needed along this long road to changed conditions but technological advance supplied the answers to the emerging problems. These fundamental changes were all-pervasive; they were caused by the transition from the relative scarcity of one form of energy to the abundance of another, then the emergence of yet newer fuels; it was a long haul from shortage to abundance and diversification. There is reason to believe that on the different way that lies ahead similar developments will occur across the board. This way is more difficult because it goes from relative abundance to a tighter situation. The instinct for survival, the 'animal spirit', is strong however, and since the energy situation will leave its mark on practically every aspect of present-day life, it is not too naive or too optimistic to expect a similar cascading of technological changes to bring answers to many future problems. We may have some vague ideas as to what these changes might be but we cannot know exactly. Nor did the Americans of 1870.

This is why I believe that major developments will emerge in the area of energy and will radiate and cascade from there. If we think of the very large capital required for a single nuclear power station or one new coalmine, not to mention the milliards invested in the North Sea, and if we also remember that new forms and sources of energy will probably require relatively even larger participation from many industries and services - then it must become clear that the impact of these developments will also be fundamental and very great.

FOOD

I will only dwell briefly on the other three areas in which - in my personal view - major developments can be expected.

All three are in some way - to a greater or lesser degree - connected with energy. It does not require too much justification to state that food production will have to be increased considerably in order to feed the rising population of the world and to secure its better nutrition. Clearly this is the difficult task of agriculture. The considerable direct and indirect requirements of agriculture (including fertilisers and many other inputs into agricultural production) provide the link to energy supplies. It seems certain that these requirements are going to increase in future, in view of the rising agricultural production.

There are, however, other aspects to be considered as well. Energy materials supply the base to make many of the synthetic, man-made materials the world's industry needs. This base material will be in short supply - hence there will be excess demand for the natural varieties. To limit myself to textile fibres and rubber only: if the present quantities of man-made fibres and synthetic rubber were to be replaced by natural products, the area now serving the production of cotton, wool and rubber ought to be at least doubled and possibly trebled. Because of climatic conditions the possibilities of cultivation are limited to a large extent to those countries and geographic areas where every square meter of good soil is badly needed for the production of basic foods. Thus - apart from some marginal lands - industrial materials may be competing with food for the limited area of land. Given the dual objective, considerable developments will be needed in the technical and the organisational sense to achieve both goals.

ENVIRONMENT

My third point was the environment. This is a vexed subject nowadays, and is further complicated by its association with energy. The production, transformation and consumption of energy are activities which probably cause most of the pollution in the environment. Insofar as one can judge, some new sources and forms of energy may be relatively less polluting (e.g. solar) but others - such as shale oil - may add markedly to environmental problems in the future. For the present, we have been witnessing the emergence of public opinion against the dangers that nuclear power stations may present to the environment, resulting in demonstration campaigns, which have led in some cases to very powerful intervention.

Without going into great detail, I am expecting significant advances to fight the pollution of air and water, since otherwise the emergence of unforeseeable dangers is likely, or at least possible. However, the chances that these developments will become generators of additional economic activity are much less than in the case of the two previous sectors, energy and food.

PEOPLE

My fourth candidate, changes in the social field, directly concerns people. It is mentioned not so much as a possible source of growth, rather as a necessity. Unemployment is a general problem, indicated both by the high level of registered unemployed, a figure that has refused to return to more normal levels ever since the great recession of 1975, and also by the recent low growth of productivity pointing to overmanning and unemployment within the factory gates. Energy scarcity will hardly help; in all probability it will make the situation more difficult by retarding further economic growth.

Coupled with this is the alienation generally experienced by the worker from his work in an assembly line or other organisational form of modern industry. Technological advance has helped to reduce labour requirements of production and other activities but it has not helped to solve the ensuing problems of the society and those of the individual. With our present institutions the likelihood is of rising difficulties in keeping the increasing number of people in employment that is useful and also satisfies them. Social innovators have so far been much less productive and successful than scientists and technologists.

It is a basic truth that man does not live by bread alone. Whether our present social set-up - both the Western and Eastern types - will be able to provide 'bread' for the future population now seems doubtful; but it is almost certain that the majority of mankind will not find non-bread, non-material satisfaction, let alone happiness. This is not the right place to go any further in this matter, which is in any case more in the line of disciplines other than economics; whether we need a shorter working week, earlier retirement, some clever reorganisation of industrial and other types of work, the return of the craftsman or something else that cannot even be guessed at - all this would exceed the scope of this paper. But the need for some basic social change will soon be generally felt.

CONCLUDING THOUGHTS

The naturally emerging question is one that asks this: if - as it appears - a 'next round' is due to begin soon, where is it likely to start? A question obviously impossible to answer; some speculation may, however, not be out of place.

Kindleberger (9) has put forward the elegantly formulated view of the 'ageing economy' - contrasting the 'young countries' with the British climacteric, a condition which may be diagnosed as a kind of general arteriosclerosis attacking the whole system in an advanced period of maturity. This makes the ageing economy lose out 'in a field full of innovations'. It is an attractive theory, one of its attractions being that (as the author admits with some hesitation) although the past is not easily discarded, 'bygones are bygones' and a new start could be made at any time.

Economic history supplies many examples of the rejuvenation of economies which, at various points in time, could legitimately have been considered 'ageing'. France has emerged dynamically from her long inter-war stagnation; so did Germany from war destruction; Belgium and Holland have successfully recovered from the loss of their colonial empires, as did Austria after her less happy experience in the decades following the exit of the Habsburgs; and the United States gave evidence of their vigour by the lively recovery in 1976-78 from the deepest recession since the war. Industrialisation, and developments in many sectors outside industry, have reached a stage that is highly developed as compared with the past in the USSR and in the area that has come to be called Eastern Europe. And some of the less developed countries have already progressed rapidly enough to be called 'newly industrialised' ones.

One noteworthy experiment in the sociology of industrial work has been undertaken in one of the smaller industrial countries, Sweden (in the Volvo works). A successful new solution for easing energy problems comes from Brazil (in the form of the sugarcane-based 'gasohol'). Thus, size or position on the development ladder does not seem to be an absolute requirement for discovering and developing new avenues of departure.

The natural and human endowments of various countries are different; it remains true - to some extent - to say that whilst their chances are about equal, they are more equal for some than for others. The differences, however, are relatively much smaller than they used to be in the past. It is not a 'handicap' race par excellence any more - it seems to be fairly open.

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