PRELIMINARY SURVEY OF THE ECONOMIC

AND

SOCIAL IMPLICATIONS OF AUTOMATION

PARLIAMENTARY AND INDUSTRIAL COMMITTEE

OF THE ECONOMIC RESEARCH COUNCIL

TWO SHILLINGS

55, Park Lane,
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Preliminary Survey of the Economic and Social implications of Automation

Introduction

On May 2nd, 1956, the Parliamentary and Industrial Committee of the Economic Research Council agreed to initiate an investigation into economic and other implications of automation. A Special Committee was appointed to take the initial steps, and has now drawn up this preliminary survey which has been accepted by the Council.

It is intended only as a guide to the scope and intention of the main inquiry; it is not intended to limit them. It is felt that, if as a result of further investigations, satisfactory answers can be given to some of the questions here posed, then a useful service will have been rendered.

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PRELIMINARY SURVEY OF THE ECONOMIC AND SOCIAL ASPECTS OF AUTOMATION

1. GENERAL CONSIDERATIONS

From earliest times, examples can be found of devices which have been used to replace human labour or to render it more effective, but for long ages the use of machinery was exceptional, and extended only at a snail's pace.

Then came a quickening of the tempo, and in the 18th and 19th centuries there occurred a series of inventions of far-reaching import. These gave rise, first in England and then elsewhere, to the industrial revolution and to the present type and organisation of society.

Scientific invention and technological advances have since continued at an increasing rate. For a long time machines have performed the functions of the human hand and have done things which the human hand could not do. Now they are beginning, in effect, to perform some of the functions of the human brain, and some of the things which the human brain cannot do.

We are entering the age of automation, of the robot, the computer and the automatic factory. We have the increased resources from the development of new materials. There will soon be a new and abundant source of power from atomic energy. Provided that peace can be preserved, there is every reason to believe that in due course these developments will lead to the establishment in most parts of the world of a state of society which differs as much from that of the present day, as does that of the present day from the society of the 17th century.

On the other side of the picture there are also the new means of mutual destruction on a continental scale, and there are ominous indications of new and sinister means of influencing and controlling the human mind. But if this dark side can be discounted, we stand at the threshold of an era of most notable achievement, so coloured by opportunity and adventure, that it seems almost unimportant to note that it can also be an age of vastly increased wealth and leisure.

2. NEED FOR MODIFICATIONS OF ECONOMIC AND SOCIAL STRUCTURE

A degree of historical sense is necessary, and a degree of imagination must be exercised if we are to see the problems of today and the immediate future in perspective. We have to be

conscious of our place in history before the scientific and industrial developments of the past fifty years can be evaluated.

Our knowledge of the historical effects of the introduction of the blast furnace, the spinning jenny, macadamised roads, railways, and latterly the internal combustion engine, shows clearly that innovations of this kind cannot be regarded solely as ingenious inventions: they can turn the world upside down. And while ultimately, they may lead to a new society and a general increase in creature comforts and in the standard of living, their introduction can also lead to havoc and chaos in the economy, widespread unemployment and human distress. If these results are to be avoided, scientific and technical advances must be met by appropriate modifications of the economic and social structure.

3. SECOND INDUSTRIAL REVOLUTION

Little evidence will be necessary to persuade most people that we have entered upon a new period of revolutionary change, and that we are at a stage in many ways comparable with the beginning of the industrial revolution.

It is true that industry has so far been little affected by the more extreme forms of automation. In the whole world there are no more than a handful of fully automatic factories. In vast sections of productive industry automation is unknown. It is also true that in some types of production, automation will probably never play a very large part.

But the signs are there. First, experience shows that technical developments which offer greatly increased production for reduced cost rarely go long unexploited. Second, we can actually see, from day to day, the extension of the process at home and abroad. Third, and most important, the possibilities of automation have fired the imagination of mankind.

4. D.S.I.R. REPORT

It is fortunate that automation has been widely recognised as a new and important force. H.M. Government has issued a valuable report by the Department of Scientific and Industrial Research. An American Congressional Committee has conducted an inquiry into automation over a wide field. The Soviet Government has gone to the length of appointing a Minister of Automation. There has been a vast amount of research into various problems arising out of automation, to digest all of which would be a most formidable task.

5. EFFECTS ON THE ECONOMY

There is one field of inquiry, however, which has scarcely been touched by the research already conducted. As the British D.S.I.R. Report concludes:—

"One truth stands out from this Report—the imperfections of present knowledge of the economic and social aspects of automation, when compared with the knowledge of the technical possibilities."

Much is known about the possibilities of introducing automated processes into various industries. Much is also known about the cost of plants and apparatus already in existence, and the labour requirements and productive capacity of them, and about the difficulties which have been encountered and what has been achieved in particular cases. But very little is known of the probable effects on the economy, and particularly the British economy of the introduction of automation into the home and foreign industry. Very little is known of the nature and quality of the stresses and strains which the introduction of automation is likely to induce.

This concentration of research upon technical aspects is understandable. Such research can be directed to concrete problems of immediate interest and importance. Resources are readily available for it, and results can be obtained relatively quickly. The relative paucity of research into the economic and social aspects of automation is, in our view, attributable to further considerations, not all of them immediately obvious.

One reason is the somewhat diffuse and uncertain state of economic and social science. Any inquiry into matters in these spheres is likely to be of more than usual difficulty; and a problem which often arises, and certainly would arise in this case, is to keep the inquiry within bounds.

Another reason, no doubt, is the heavy pre-occupation of the authorities with our present financial difficulties. The solution of our present grave problems requires a large concentration of effort, and until inflation and external trade problems have been brought under control, it may seem a diversion of energy to study which has not yet arisen to any marked degree.

But a further reason why the impact of automation on the economy has not been adequately investigated, is very likely that such an inquiry, unless very carefully directed in the first instance, may readily depart altogether from the sphere of research and go off into realms of prophecy.

Yet the effects of automation on the economy must be far-reaching. The potential impact of the new technologies has been summed up by David Sarnoff, Chairman of the Radio Corporation of America in the following words:—

"The very fact that electronics and atomics are unfolding simultaneously is a portent of amazing changes ahead. Never before have two such mighty forces been unleashed at the same time. Together they are certain to dwarf the industrial revolutions brought about by steam and electricity."

In the view of this Committee there is urgent need to anticipate the problems which will arise before they are upon us.

6. QUESTIONS WHICH ARISE

Some of the questions which will arise in such a study are as follows:—

(a) Is automation to be introduced as and when private firms and individuals think fit, and can command the resources to introduce it, irrespective of its effect on the economy as a whole and particular sections of it; or should its introduction be regulated in some way? If so, by what means, to what extent, and with what object?

(b) Is the existing credit mechanism adequate to ensure, assuming that some effort should be made to ensure it, that the capital required for automation will be available to the appropriate sections of the economy at the right times, and in the right quantities.

(c) Are any, and if so, what further measures necessary to protect the economy in the event of foreign producers offering goods upon the British market at greatly reduced prices, made possible by the introduction of automated processes, at a time when home producers have not yet automated? Has the British Government sufficient latitude under existing trade agreements to enable it to meet such contingencies? If not, what modifications, if any, should be sought?

(d) Should there be any restriction on the right of foreign producers to establish automation factories on British soil in view of the possible effect on the trade of British producers who have not yet automated?

(e) While the heavy capital expenditure involved in automation may initially have an inflationary effect, this may later be more than offset by the greatly increased production made possible by automation.

Is the financial control adequate, on the one hand to contain inflation at times when that is the most pressing problem, and on the other to ensure that the public has sufficient funds to enable the goods produced to move readily into consumption, at times when the main need is to keep up consumption?

(f) The introduction of automation frequently creates redundancy and temporary unemployment in the industries into which it is introduced.

What steps should be taken locally and in an industry before the introduction of automation? What should be the respective responsibilities of the Government, employers, workers and their trades union? What should be done to reduce personal hardship to the greatest possible extent?

(g) What is to happen in the more difficult case where the introduction of automation in one industry causes redundancy and unemployment in another?

(h) What problems will arise from the pronounced disparity which must often exist between the cost of products produced by automation and the cost of goods and services produced by industries where automation is not a technical possibility?

How far should the benefits of automation be spread over the whole population through the lowering of prices?

(i) What effect is automation likely to have on hours of work? If it is likely to cause a short week in automated industries, is this likely to cause a sympathetic demand for shorter hours in other industries, and how is this to be met?

(j) How, in the light of these problems and the new technical possibilities, can Britain best find stability and achieve expansion in a trading world overshadowed by the dollar and rouble blocs and by low cost competition from Japan and elsewhere?

7. SOCIAL CONSIDERATIONS

There are also important social issues which need consideration. For example:—

(i) Is there not a case for a complete review of existing training and re-training facilities for those who will have to change their jobs?

(ii) What is the case for a fresh approach to the whole question of social security benefits (unemployment, sickness, pensions and so forth) in the light of these developments?

We are convinced that it would be criminal folly to allow these questions to be solved only as a result of hard and bitter experience.

In the first industrial revolution, Britain led the way. The new challenge is not so much to Britain as to the whole sterling area. On the alacrity of our response to it, and the foresight and industry with which it is met, depend, ultimately, the whole national existence of this country and the nations associated with it.

SOME TECHNICAL CONSIDERATIONS CONCERNING HIGH OUTPUT MACHINERY AND AUTOMATION—'HOMA'

1. WIDELY DIFFERING VIEWS CONCERNING 'HOMA'

It is evident that there are widely differing conceptions of 'HOMA,' each conception being determined by the individual's immediate circumstances:—

The City thinks in terms of huge capital expenditure, and with available finance so scarce, 'HOMA" can only be introduced slowly.

The wage earner, with the threat of redundancy facing him, regards 'HOMA' as a new hell to struggle against, and will look to his Union and the Government to protect him.

The engineer who invents, designs and makes 'HOMA,' and is perfectly clear as to what his equipment will do, is frustrated when his equipment is not acceptable, or effectively used, because of fear of redundancy.

The industrialist sees foreign competitors taking advantage of 'HOMA' and realises his company must do the same—or else!

Those engaged in certain kinds of factories, where 'HOMA' was introduced from the beginning, and the problem of redundancy never arose, wonder what all the fuss is about and say there is no problem.

Some public men state openly that 'HOMA' *will come so* gradually that there is no problem.

2. CLARIFICATION OF MAIN ISSUES ESSENTIAL

It is essential to be clear as to the main varieties of 'HOMA.' One of its simplest forms is the automatic traffic light, which take the place of human traffic police, and at the other end of the scale is the highly automated motor car works, representing an investment of, say, £15 million.

It can be argued that, if there are 10,000 sets of traffic lights, *costing £1,800 per set of four, the total capital involved is com-*parable with that of the motor car works, and the number of

police released for other duties is, say, 20,000, assuming two "beats" a day.

*In the field of high output machinery, the latest coal-getting machine enables five men to achieve the same output as 40,000 miners using modern conventional means.

Nearly every kind of 'HOMA' is involved between this triangle of examples, and a fundamental examination of the technical, human and economic aspects of certain main groups of machine would be very illuminating.

3. SOME MAIN EXAMPLES OF 'HOMA'

It is first necessary to set down some of the main examples of 'HOMA,' and then examine the fundamental aspects of each case:—

(a) J. Lyons & Co., U.K. (from D.S.I.R. Report, page 40).
(b) The automatic traffic light.
(c) Latest coal machinery.
(d) The modern electric power station.
(e) Battery of knitting machines.
(f) Machine with electronic memory.
(g) Bank computer calculates interest.
(h) Automatic assembly of radar sets.
(j) Santa Fe Railroad electronic system to handle reservations.

} From U.S.A. evidence

(k) Russian ball bearing plant in Moscow.

4. HUMAN ASPECTS

The human aspects applying to any example might well be considered under the following headings:—

(a) Does direct redundancy arise?

(b) Does indirect redundancy arise? For example, in another industry, or even in another country? Automated synthetic rubber production in sufficient volume, for example in the U.S.A., clearly affects the natural rubber grower in Malaya.

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* See footnote on Page 15.

(c) Is it necessary for a man to change his job, even though no special training is required?

(d) If so, does it mean a change of locality for living?

(e) To what extent do questions of different pay and relative skill arise? There is no doubt that there is, even now, a shortage of skill and technical ability.

5. ECONOMIC ASPECTS

The economic aspects should be examined under certain main headings, including:—

(a) What is the capital investment, both in money and human effort?

(b) What is the operating effort or cost?

(c) What is the relative productivity of 'HOMA' as against existing conventional means?

(d) What is the net increase or multiplication factor of the ability to produce?

(e) As salaries and wages are the largest channel of consuming capacity, how does the ability to consume due to 'HOMA' compare with that of conventional means?

(f) If the potential capacity to produce is greatly increased due to 'HOMA,' can increased output be realised UNLESS potential ability to consume is made effective by increased purchasing power?

(g) In certain industries the natural expansion of consumption is such that the reduced amount of Labour per unit of production still necessitates an increased number of persons. As, for example, the following percentage figures of an engineering company show for 1955, as compared with 1947, the latter being taken as 100:—

Output	677%
Number employed	238%
Price of product	131%
Productivity per individual ...	218%

If demand remains static, and hence output does not increase, as in the case of the non-expanding industries such as the railways, then redundancy will arise, and probably bar an increase in productivity.

6. EXAMINATION OF EXAMPLES REFERRED TO IN 3

In a full report, each example should be examined in the light of the main considerations set out under 4. Human Aspects, and, 5. Economic Aspects. But for this preliminary report only a few points will be considered as under:—

(b) THE AUTOMATIC TRAFFIC LIGHT

4. (a) and (b). Redundancy does not arise, either direct or indirect, and it may well be that there is still a shortage of police.

4. (c) No change of job arises.

4. (d) No change of locality as regards living.

4. (e) Change of pay does not arise, but the saving of expenditure enables the existing force to enjoy higher remuneration for a given expenditure on the police force.

5. (a) At approximately £1,800 for the purchase and installation of a set of four traffic lights at an intersection, the capital effort represents just under three man years (i.e. three men working for one year each).

5. (b) The operating cost is mainly for electric light and maintenance but, in addition, interest and amortisation have to be added. The figure given by a London Borough Authority for these items is £125 a year.

5. (c) To achieve the same service with traffic police, based on 16 hours of two "beats" a day instead of 24 hours of three "beats," would require two men at, say, £10 a week—£1,000 a year.

5. (d) The net improvement or multiplication factor is $\frac{1000}{125} - 8 : 1.$

5. (e) This aspect hardly arises, as the installation of traffic lights simply releases two constables for other duties, and does not cause them to be redundant. Their purchasing power, therefore, is not eliminated.

5. (f) Does not arise.

5. (g) Does not arise.

* (c) LATEST COAL MACHINERY

4. (a) No direct redundancy arises because the pit in question is entirely new, work having started in late 1955.

4. (b) With a commercial cost as low as 1/8d. a ton, the coal will be very competitive, either with home or overseas producers, whose costs are perhaps 20 to 40 times as high. Indirect redundancy may well arise.

4. (c) Does not arise.

4. (d) Does not arise, except that higher cost coal mines elsewhere may have to close down.

4. (e) It is probable that the few operators employed will be highly paid, if only because of the high value of the machine employed.

5. (a) The capital investment is £1,600,000, equivalent to 2,400 man years of effort, covering design, construction and raw materials.

5. (b) The machine has a crew of 5 men per shift, and if paid £1 per hour, the labour cost per ton is less than 1/4d. If interest and amortisation is based on 10%, this works out at 1½d. per ton. If overhead and maintenance is as high as 1,000% the commercial cost per ton is about 1/8d. (An American machine has recently been installed having the same output, costing 2,600,000 dollars, and operated by a crew of three. The aggregate power of the driving motors is 2,900 h.p. at 1d. per kilowatt hour, the consumption of electrical power per ton of coal will be less than 1/2d.).

5. (c) To produce the same amount of coal in the U.K. with deep mined coal requires 40,000 men.

5. (d) At a pithead price of 65/- per ton †, as compared with a selling price of, say, 6/- a ton, the multiplication factor is nearly 11 : 1 in favour of 'HOMA.'

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* These figures relate to the Rheinische A/G für Braunkohlenbergbau und Brikettfabrikation near Cologne. (See footnote on page 15).

† The average price for coal paid by the C.E.A. for the year ending 31-3-56, was 65/- per ton.

On a manpower basis, the comparison is much greater, and possibly it would be right to take the figure of 1/8d. a ton as representing all of the salaries and wages involved in capital investment and operation costs; in which the multiplication factor is 65/-

$$\frac{}{1/8d.} - 39 : 1$$

5. (e) As regards the vital aspect of the ability to consume as distributed by salaries and wages, the comparison is even more remarkable. The weekly purchasing power of 40,000 persons employed in U.K. mining is approximately £500,000. At £1 an hour with a 40 hour week, the five 'HOMA' operators have a purchasing power of £200 a week. Those employed on making the machine do not come into the consumer capacity account, because they have already been paid all that they will receive as regards this particular affair.

Obviously, the salaries and wages represented by the maintenance and administrative personnel have to be accounted for, but no figures are available.

5. (f) It is probable that an additional output of, say, 10 to 15% could readily be absorbed in an industry like coal, where there is a shortage, provided the purchasing power exists. An additional 10 to 15% of motor car production could not be absorbed when the industry is working four days a week. It might be argued that if the price of cars were cut to one-tenth, as in the case of this coal example, the additional volume of output could be absorbed. It remains to be considered what the other producers do when a substantial competitor can produce at one-tenth of their cost!

5. (g) One thing is sure, that if total labour costs can be reduced to 10%, unless the demand of the industry can be increased to 1,000%, there is bound to be a REDUNDANCY of labour in that industry. Nor is it likely that world demand for coal will increase substantially, due to the higher efficiency of oil burning machinery, as, for example, in ships, locomotives, aircraft, etc.

There are other main examples which need similar examination, but it is not proposed to consider these at this preliminary stage. It should be clear that much more economic investigation

is essential if a satisfactory solution is to be found to the two main problems:—

(1) How is the increased production due to 'HOMA' to be absorbed?

(2) How is the decreasing need for human effort, due to 'HOMA' to be satisfactorily dealt with, bearing in mind its unequal incidence?

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* 6. (c) LATEST COAL MACHINERY

The figures relate to the Rheinische A/G für Braunkohlenbergbau und Brikettfabrikation near Cologne. The coal seam is much thicker than anything in the U.K., and the type of machine being used would not suit U.K. conditions. The economic impact can be very severe in export markets, in the reduction of electrical generating costs where fuel is about 50% of the total, and there can be a major impact in the German coal industry itself.

In Australia, similar methods with German machines are being used at Yallourn, where there are two 90 ft. seams of brown coal, separated by only a few feet.

In the U.S.A., the M. A. Hanna Coal Company of Cleveland has recently started a large shovel with an output of 7,000 tons of overburden per hour, operated by three men. In this case the seam is only 4½ ft. thick.

APPENDIX

HIGH OUTPUT MACHINERY AND AUTOMATION

In any comprehensive or fundamental investigation of Automation or high output machinery, it is essential to bear in mind that it is useless to produce unless there is the ability or purchasing power to buy.

The following figures have been prepared by Mr. Antony Vickers, to show the relationship between capital investment, production cost, purchasing power distributed through wages and redundancy for three kinds of plant with outputs of 100, 200 and 300% normal.

The three kinds of plant are:—

Conventional = Normal production practice.

'Semi-HOMA' = Semi-high Output Machinery and/or Part Automation.

'HOMA' = Maximum High Output Machinery and/or Full Automation.

	Capital Investment in Terms of Man Years, not Money	Number of Production Operatives	Number of Maintenance Men	Ratio of Investment to Operatives
Conventional	200 (£120,000)	120	10	1.67 : 1
'Semi-HOMA'	1,000 (£600,000)	10	20	100 : 1
'HOMA'	2,500 (£1,500,000)	5	30	500 : 1

The following assumptions are made:—

(1) The cost of materials will be the same for each class of production and hence, for simplicity, will be omitted.

(2) The cost of sales and administration will likewise be the same for the three classes of production, and will also be omitted from the basic factory production cost.

(3) Amortisation and interest become increasingly important with high capital investment, and a factor of 10% a year will be taken.

For the purpose of this consideration, Factory Cost will be taken as proportional to the number of men employed as regards:—

$$\frac{\text{Capital Investment}}{10} + \text{Direct Production} + \text{Maintenance.}$$

The ability to purchase will largely be proportional to those employed in:—

Direct Production + Maintenance.

	Conventional			'Semi-HOMA'			'HOMA'		
	Output			Output			Output		
	100%	200%	300%	100%	200%	300%	100%	200%	300%
Factory Cost in terms of manpower	150	280	410	130	160	190	285	320	355
Ability to purchase in terms of those currently employed	130	260	390	30	60	90	35	70	105
Manpower available for other production due to 'Semi-HOMA' and 'HOMA'	—	—	—	100	200	300	95	190	285

For example, the Factory Cost with 'Semi-HOMA' Production, working two shifts to give double output, would be proportional to:—

$$\frac{1000}{10} + 20 + 40 = 160 \text{ men.}$$

The ability to purchase, however, is proportional to:—

$$20 + 40 = 60 \text{ men.}$$

In setting out the above representative figures, the author has in mind actual cases where, for example, the latest coal winning machine in Germany costs £1,600,000, equivalent to 2,500 man years, has an output of 7,000 tons an hour and is operated by five

men. It would, however, be quite simple to take actual figures from industry, which would show the following:—

(a) The distribution of purchasing power through wages is considerably less under 'Semi-HOMA' and 'HOMA' than in conventional production.

(b) Wages can only be increased a comparatively small amount without increasing cost above the cost of conventional production, and not sufficient to make good the decreased purchasing power.

(c) As it is useless to produce unless there is the ability to buy, additional purchasing power will have to be introduced elsewhere into the nation's economic system.

(d) The manpower available for other production is clearly shown, but it cannot be usefully employed unless additional purchasing power is provided.

(e) Under the present economic system, in the nationalised or State supported industries, there is the natural tendency for redundant labour (as well as capital) to restrict output to the effective demand. In free enterprise, redundant labour cannot be indefinitely retained and, therefore, a severe problem is created which is not satisfactorily solved by a four-day week. (How are men to be exhorted to produce more if they are to work a shorter week?).

(f) The solution necessitates an economic system which continually maintains a balance of effective demand with the capacity to produce, based on a stable price level. The creation and issue of the additional purchasing power required to balance increasing production should be a main responsibility of Government. Such purchasing power can be introduced via contracts for defence, railway modernisation, roads, housing, slum clearance, etc., and is, in fact, the proper means of effecting the required mobility of manpower and production. It could well be the proper fund out of which temporary redundancy compensation could be paid.

STOP PRESS!

In Chicago on the 10th August, 1956, Mr. George Meany, President of AFL – CIO, in asking the Platform Committee of the Democratic National Convention to endorse a wide range of economic and social welfare proposals, urged the adoption of measures that will increase purchasing power. "Labour," he said, "believes that the fundamental key to new prosperity is re-development of a broad consumer base." It is significant that automation is progressing faster in the U.S.A. than in any other country.

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