Automation—Some Social Aspects

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Since the advent of automation many questions have been raised concerning its possible repercussions on labour.[1] *These questions, which are of wide interest, since numerous applications of automation in industry and commerce have already been reported from a great many countries, are discussed in the following article.*

The author first explains the meaning attached to the term " automation " and discusses the problems raised by automation in the light of the experience of countries in which it has begun to develop. Much of the documentation on which the article is based comes from the United States, where the major developments have taken place.

AMONG the ideas that have gained popular currency since the war few have given rise to such conflicting opinions as " automation ".

Some hail it as the main hope for the increased productivity on which the future growth of national income must depend and forecast a rising income for everyone and more leisure time as well. Others fear its implications, for to them automation means the widespread displacement of people from their present jobs, with a resulting unemployment problem of catastrophic proportions. These conflicting attitudes are hardly surprising, for the implications of automation are uncertain, but there exists a widespread awareness that the world has entered on a new phase of technological development that is bound to affect the economy of nearly every country.

The active preoccupation in business and industry, trade union circles and university research centres in the more industrially developed countries with the changes that are becoming

[1] For a discussion of similar questions concerning the social implications of the industrial use of atomic energy, see *International Labour Review*, Vol. LXXII, No. 1, July 1955.

daily more evident in ever wider sectors of industry and commerce has spilled over into the public press, where periodicals and the daily papers report current developments and future prospects, frequently in sensational terms.

Even qualified commentators tend to describe automation as " a second industrial revolution ". They argue that, while the first industrial revolution replaced manual labour by machines, the second will replace manual control by machine control; this new industrial revolution, they say, will turn over to instruments tasks that formerly had to be performed by men's hands and minds; and they conclude that men will be eliminated from the industrial process or, on the contrary, that men will gain new stature, and work will become a more " human " activity, since it will require higher levels of skill; the new tasks will make larger claims on man's unique abilities with which the machine cannot compete; knowledge, judgment, responsibility in supervising more complex mechanical operations and processes will replace the dull, routine duties typical of so many industrial and office jobs of today.

Other equally competent observers both in management and in trade unions insist that the complex developments in industry to which the term " automation " is applied do not constitute a revolution, but represent the continuation of a long-term trend, which had its inception when James Watt developed the governor for his steam engine. Since then, they argue, as one element in an almost constant stream of technological advances automatic controls and devices have been developed and applied in an ever more complex form and to an ever wider range of industrial operations.

Whatever may prove to be the case, there is general agreement that automation raises vast problems for modern industrial society, even while it holds the promise, if its development can be wisely guided, of higher standards of living and leisure time for all.

It is important to recognise at the outset that automation cannot be considered in isolation. Its future is closely bound up with that of nuclear energy and its manifold applications in research and industry, such as the use of radio-active isotopes in measuring and controlling a multitude of industrial processes—the very development of atomic reaction was dependent on certain techniques of automation.[1] It will also affect, and in turn be affected

[1] It is well known, for instance, that the need to protect workers from the effects of radiation requires the shielding of all processes involving atomic reactions behind great thicknesses of lead and concrete and the use of other protective devices, which completely isolate the attendants from the operations they control. The accurate control of these lethal processes through remotely operated devices is only possible by the use of equipment that is at the very heart of automation.

by, the important transformations taking place in management's conception of its functions and of its relationship with the various factors of production.

In consequence, it is important that every member of society (since everyone will be affected in some way), and especially the industrial community most directly concerned with these developments, should gain a sound understanding of what automation really means. In particular, industrial and trade union leaders and governments will need to show flexibility in their approach to the problems involved if the present generation is to avoid the social mistakes of the Industrial Revolution and is to make the best use of the opportunities for change that automation will create.

WHAT IS AUTOMATION ?

The word " automation " is reported to have been conceived independently and at about the same time by John Diebold, then a student at the Harvard Graduate School of Business Administration [1], and Dell Harder, vice-president in charge of manufacturing of the Ford Motor Company.

Harder may have been the first to use the word in 1947 in describing improved methods for handling parts in process without the delays involved in manual operation.[2] In contrast to this conception of automation, which lays stress on reducing the costly idle time between machining operations on high-speed production tools resulting from the manual handling of each part into and out of the machine, Diebold has emphasised from the outset the view, shared by many, that automation represents a new way of thinking about the total process of production : that it denotes both automatic operation and the process of making operations automatic, with a resultant emphasis on self-regulation of the entire production process.

Although the term automation has come to mean many diff-

[1] Diebold led a research team in developing the theoretical background of automation and in working out a model for the automatic production of automobile pistons. See Harvard University, Graduate School of Business Administration : *Making the Automatic Factory a Reality...* Prepared under the leadership of John T. DIEBOLD (Harvard, 1951).

[2] Harder has more recently expanded this definition, stating that in his view automation was in fact " a philosophy of manufacturing " and that its meaning should be broadened to include design of parts, methods for their manufacture and production-tool control systems. Another engineer has defined it as "... the art of applying mechanical devices to manipulate work pieces into and out of equipment, turn parts between operations, remove scrap, and to perform these tasks in timed sequence with the production equipment so that the line can be wholly or partially under push-button control at strategic stations " (quoted by Ashburn ANDERSON in *The Developments of Automation in Metal-Working*, Paper No. 55-SA-62 (New York, American Society of Mechanical Engineers, May 1955)).

erent things in various quarters, it should not be regarded simply as a synonym for technological change. Thousands of technological advances are constantly being made in industry that have nothing to do with automation. While it may be easiest to describe automation in terms of a family of different technological developments, it is not solely a technological phenomenon.

Automation is a particular kind of development combining a number of well-established engineering principles and certain recently developed theories of communication [1], which had their beginnings during the Second World War under the pressure of the urgent need to develop automatic and self-correcting devices such as those used on radar-guided aircraft, electronically controlled anti-aircraft guns, etc. In contrast to most forms of technological change—such as the development of automatic bottle-blowing machines or coal-cutting machinery, which are specific to a single industry—its principal characteristic is that it represents a generalised form of thinking about technological processes, one potentially applicable over a wide range of manual and clerical operations in a great many industries.

In practical application three basic forms of automation are generally recognised.

Integration

The first type is usually referred to by technicians as " integration " or " advanced mechanisation ", and the ideas leading to its development reflect the thinking of specialists in the metal-working industries, where this form of automation has made a fairly recent and spectacular entry. It is also often referred to as " Detroit automation ", since some of its most publicised applications have been made in the automobile industry in the United States. This type of automation consists essentially of linking together conventionally separate manufacturing operations into lines of continuous production, through which the product moves " untouched by human hands ". It is largely the outcome of mechanical engi-

[1] Specialists in many scientific and technical disciplines—physicists, psychologists, physiologists, mathematicians, statisticians, engineers and others—working together on a great variety of inter-related problems of communication, of transmitting, receiving and interpreting " messages ", of the use of " information " and its mathematical expression, experienced the need for a common technical language. This area of research and development was named " cybernetics " (from the Greek word for steersman, in the sense of to govern or to control) by Norbert Wiener, a professor of mathematics at the Massachusetts Institute of Technology and one of the principal architects of the new theory. The term is intended to cover the general theory of control and communication systems applied both to living organisms and to mechanical systems ; one of its basic elements is the concept of self-regulation, the engineering term for which is " feed-back " or " closed-loop circuit ".

neering thinking and represents the ingenious application of well-established mechanical methods for loading, unloading, transporting and positioning identical parts through a series of separate but closely integrated machine tools.

The process of developing this type of operation and the thinking that went into it are vividly described by R. H. Sullivan, another vice-president of the Ford Motor Company:

> ... I don't mean that our factories had no automatic machines. In one sense we were too automatic—we had *too many unrelated machines.* We found, for example, that it was fast becoming impossible to utilise the full capacity of up-to-date machine tools, because *men couldn't load and unload them fast enough by hand.* The trouble with our manufacturing methods was that, like Topsy, they " just grew ", and nobody had taken time out for a long view. What we needed was a complete rethinking of the problem—*a whole new philosophy of manufacturing* .... In place of the old, complicated maze of machinery, we visualised long, clean production lines along which our *parts and materials would flow evenly and smoothly*—just as fast as modern machine tools could handle them. The processes of automatic lubrication, scrap removal and, to some extent, quality testing would be integrated into the lines. The new lines would be equipped with various control devices to assure effective preventive maintenance. The achievement of that dream over the span of a few short years involved a lot of work and headaches ... we had to fit together the products of dozens of different manufacturers into a smooth-running system. The result was what has come to be called Automation.[1]

It is clear that this form of automation is, in fact, the latest step in a long chain of inventions and improvements in existing production methods. The earliest example of automatic machinery is probably the mechanical loom for weaving figured patterns in silk textiles, constructed in 1741 by a French inventor, Jacques de Vaucanson, the pedals of which were automatically controlled by means of a drum pierced with holes. Some 60 years later Joseph Jacquard improved on this device, perfecting the loom which bears his name and whose operations are controlled by a punched paper roll. In the United States, Oliver Evans in 1782 built a continuous-process flour mill, using an ingenious combination of belt conveyors, screw conveyors and endless chain buckets, that required no human labour from the time the grain was unloaded from the wagon until the flour was run into barrels ready for shipment. Many other developments in manufacturing processes, such as the constant refining of the accuracy of metal-working machines, the improvement in standards of measurement, the notion of the assembly line (as developed by Henry Ford in 1913), the transfer machine (of which an early example was built at the Morris automobile plant in Coventry (England) in 1924), had to be perfected before integration in its present form could be achieved.

[1] *Automation* (New York), Vol. 2, No. 10, Oct. 1955, p. 4.

Even the key principle of integration—continuous automatic operation or " flow production "—has been a characteristic for many years of industries handling liquids, gases or powdered goods, such as the oil and chemical industries. The important step, however, was to apply this principle to the manufacture of the hard and heavy components and products of the engineering industries and to the manufacturing operations of other industries whose products are solid, identical units, and which had all until then used, and mostly still use, the intermittent or " batch " process of production.

Feed-back Control

The principle on which the second form of automation is based is not new either. Briefly, the principle is that while a mechanism is working information is " fed back " to it, so that any divergence from the desired performance of the mechanism is automatically corrected.

The flyball governor invented by Watt to regulate the speed of his steam engine is generally regarded as the first example of true feed-back control. The governor consisted of two independent balls each hanging freely from one end of a short rod, the two rods being connected at their other ends to a collar, which was free to slide along a vertical shaft while being rotated by the shaft's motion. The shaft was driven by the engine, and its speed varied in consequence with that of the engine. As the engine speeded up, the balls would tend to fly apart and upward, while any slowing of the engine would permit the balls to swing inward and downward. This motion of the balls was in turn transmitted to a link mechanism, which controlled the throttle valve of the main steam intake of the engine. As the balls went higher the valve closed and the engine slowed down. As they dropped below their normal position the throttle valve was opened and the engine speeded up. The operator of the engine had then merely to set the governor so that when it reached a certain number of revolutions per minute the throttle valve would tend to close, thus reducing the volume of steam admitted to the engine, and the machine would maintain a more or less uniform speed automatically.

Another well-known form of a feed-back system, which more nearly corresponds to the complex forms applied in industrial production, is the thermostatic control in the hot air or hot water heating systems in many homes. This is a relatively simple self-correcting device which, through a mechanical contrivance, opens and closes an electrical circuit powerful enough to operate the control valve on the heating unit, which is thus able to maintain a desired condition—the temperature of the room—fairly close to the desired average.

In most modern industrial applications, however, the system is considerably more complex and provides a much more refined and accurate control of the operation. The essential aspect of this type of control, however, is the same : it functions by comparing actual with expected performance. That is, the particular automatic mechanism is equipped with an electric device that compares the way in which the work is being done with the way in which it is intended to be done ; using electronic circuits to amplify the minute original currents sent out by the directing mechanism (signals), the device can automatically make any necessary adjustments in the work process through another device that is operated by the amplified current, the latter being powerful enough to open and close switches on the motors that control the working parts of the mechanism or other parts of the production process. These controls are called " servomechanisms ". They may be operated by electricity or by hydraulic power or compressed air and may be said to function as a type of governor. These controls have been highly developed in the chemical and oil-refining industries to open and close the thousands of valves and operate the multitude of other mechanisms involved in these industrial processes. In contrast to the first form of automation, which embodies predominantly mechanical engineering thinking, this form of control depends primarily on electrical engineering knowledge and techniques.

Computer Technology

The third form of automation involves another application of the generalised type of mathematical and engineering thinking about communication and control referred to earlier. This is the computer. A computer is an electronically operated machine capable of recording and listing information (generally in the form of numbers) and of performing both simple and complex operations on the basis of this information. Various types are now being produced. Some operate by comparing dimensions, such as lengths, weights or other quantities, and are called analogue (or analogy) computers ; others operate with figures or digits and are called digital computers. Computers are capable of solving highly complicated problems of the kind that arise particularly in research work. A whole range of special computers of more limited capacity are being produced for use in industry and offices. This type of automation is generally referred to as " computer technology ".

Even computer technology did not spring full-fledged from war-stimulated developments—although it is stated that some nuclear fission and guided missile developments might have been well-nigh impossible without the use of the electronic computer. As early as the mid-1600s Blaise Pascal had built some half-dozen " arithmetic machines ", and other forms of computer appeared in the 1700s. A much closer approximation to the modern computer is the machine developed in 1823 by the English mathematician Charles Babbage, who was prevented from building his calculator by technical difficulties, including the inferior machining methods of the time. More than 50 years ago electrical calculators, keyboard and card-punching machines had begun to eliminate routine computations in research and office work. In the late 1920s, a group of United States scientists developed a differential analyser, which was the first of the large-scale computing machines. Recent developments in electrical and electronic engineering have given a tremendous impulse to the maturing of computer technology.

The extraordinary performance of computers in solving various complex mathematical problems has led many people to speak of electronic " brains " and to refer to their operation as " thinking ". Computers can and do, in fact, perform operations so complicated and tedious as to be beyond human patience to carry out, but they function only in so far as they have been given suitable " instructions " to deal with every problem or " original situation " that may arise in the course of their computations. Should an unforeseen problem occur, the machine, being without instructions as to how to handle it, will stop. This brings out the basic limitation of the computer—its capacity to perform operations only on instruction—and emphasises the basic difference between the computer's action and man's ability to reason, to think through original problems, to deal on the spot with unexpected situations and to make value judgments.[1]

Nevertheless these machines have already proved of great value in solving difficult mathematical problems presented by scientific

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[1] The abilities and limitations of computers are summarised as follows in a recent engineering analysis of developments in the field of electronic computing:

" Computers *can* *(a)* learn what you tell them ; *(b)* apply the instructions when needed ; *(c)* read and remember numbers ; *(d)* add, subtract, multiply, divide and round off numbers ; *(e)* look up numbers in tables ; *(f)* look at a result and make a choice ; *(g)* do long chains of these operations one after another ; *(h)* write out an answer ; *(i)* make sure the answer is right ; *(j)* know that one problem is finished and turn to another ; *(k)* determine *most* of their own instructions ; *(l)* work unattended.

" On the other hand, computers *cannot* *(a)* think intuitively ; *(b)* make bright guesses and leap to conclusions ; *(c)* determine *all* their own instructions ; *(d)* perceive and interpret complex situations outside themselves." (*Electronics and Everyman*, Urwick, Orr and Partners, Ltd., London, 1955, p. 7.)

and engineering research, and their usefulness in other fields is being constantly demonstrated, such as their ability to handle numerous routine office operations performed by banks, insurance companies, pay-roll departments and the like.

Some Examples

These three types of automation, alone or in combination, have made possible a growing number of startling applications in a wide variety of industries and in nearly every industrialised country.

Some of the most notable applications of integration may be found in the newer automobile plants. In the Cleveland Engine Plant of the Ford Motor Company, one of the many interesting engineering features is the extensive and ingenious use of various automatic conveyor systems, which move the work from station to station through highly complex combinations of standard machine tools, called transfer machines, or from machine to machine, and which load and unload the parts in process without human intervention. For example, in one part of the engine block line, 25 men now perform the work formerly done by 117 men, principally because the present group of operators no longer have to stand before each machine and accurately position the work before the cutting tools can perform their task. Another combination of machine tools, tended by nine men, drills the necessary holes in the crankshaft, whereas this was formerly done by 39 men working on 29 separate machines. Although electronic equipment is extensively used in a wide variety of automatic controls, for instance to time the sequence of operations, few of the production machines in this plant employ the feed-back principle in their operation. Instead they are " programmed " to perform a predetermined sequence of operations a certain number of times (determined chiefly by tool wear). At the end of this time a man must still come and change the tool; but no man need watch the machine while it operates.

Similar applications have been made and new developments announced by other automobile manufacturers in the United States and other countries. The machining of automobile parts in the Ford and Volkswagen plant in the Federal Republic of Germany is being turned over to automated production lines. The Renault works in France have for 12 years made increasing use of transfer machines for a wide variety of machining operations in the production of automobile components. The U.S.S.R. is reported to have a factory in which nine men per shift produce 3,500 piston heads a day, enough for the entire Soviet light car industry.[1] In the United Kingdom a recent announcement concerning the Standard Motor Company's plans to modernise their tooling for the production of motor vehicles and tractors describes the performance of an electro-hydraulic transfer miller capable of performing electrically all six machining operations on a cylinder head. This machine, manufactured by the Heller Company in Germany, will give a much higher output with the direct labour of only two men—a loader (unloading is automatic) and a supervisor—than 22 men now achieve with conventional machine tools. Four other men will be required—electricians, maintenance men and tool setters, with a final saving of about 16 men. Another automatic device used by the Standard Motor Company is an inter-connected line, 80 yards long, of three Archdale " Unimatic " machines served by six men (one to load and one to unload each machine). The plant produces 21 finished cylinder blocks an hour, which pass automatically through 53 stations. The machines do all the drilling, tapping, rough-boring and counter-boring on all the faces of the cylinder block. This operation on conventional machines required 36 men for the production of 16 cylinder blocks an hour.[2]

Automatic operations of this type have many possible applications in the mass production industries, and it seems probable that it will be this type of automation that will make the most marked impact on manufacturing methods within the next few years. Its greatest limitations are the relative inflexibility and high first cost of the installations ; its application is therefore only economically justified where long runs of identical products with little or no change in design are normal.[3]

Equally remarkable performances are reported from many other industries. To take only one example, electrical circuits for the radio industry are now " printed " instead of being laboriously assembled by soldering individual wires and other components. The printed circuit eliminates any chance of faulty connections, and the assembly of components is greatly speeded up. One case has been cited of a unit that assembles in little more than a minute the same number of multiple-part electronic units that a worker assembles in a full day. It requires only two workers and a super-

[1] See " Towards the Automatic Factory ", in *Planning* (London, P.E.P.), Vol. 21, No. 380, 13 June 1955, p. 71.

[2] *The Times*, 22 June 1955.

[3] A United States technical journal has stated that, in contrast to traditional type metal-working plants, where the cost of machinery and equipment per worker averages $9,200, the Ford Cleveland plant costs $28,750 per worker. See " Spot News of Metal Working ", in *American Machinist*, 14 Sep. 1955, p. 105.

visor, and has a capacity of more than 200,000 assemblies a month.[1]

Some of the most remarkable adaptations to almost fully automatic operation have been made in the last 20 years, with little notice in the general press, by the oil and chemical industries. Oil experts claim that a modern refinery is at present 80 to 90 per cent. automatic. In one of the latest refineries constructed, the Esso Petroleum Company plant at Fawley (England), six men on any one shift operate distillation units processing 5½ million gallons of crude oil a day. The through-put of this half-dozen men is enough (in weight) to meet nearly one-third of Britain's inland consumption of oil products. At the catalytic cracking plant only eight men are needed for each shift.[2] The plant employs nearly twice as many maintenance engineers as operators. Control of operations in a plant of this type involves the processing of the raw materials by regulating four variables—flow, temperature, pressure and level—and automation means the automatic control by instruments of these variables. Almost every instrument in the control room of a modern refinery provides both communication and control on the feed-back principle.[3]

In another field, the transformation of metals by machining, a number of successful attempts have been made to build fully automatic machine tools that perform their work on the basis of " instructions " fed into electronic equipment, which ensures the correct performance of the machine. An example of this type of application is the numerically controlled milling machine developed at the Servomechanisms Laboratory of the Massachusetts Institute of Technology. This is a standard type of milling machine whose normal controls have been replaced by servomotors, which drive the vertical and horizontal motions of the rotating head of the machine and the motion of the table holding the workpiece. The servomotors are in turn controlled through a series of electronic devices. The machine is able to cut out irregularly shaped metal parts by following instructions " programmed " into it by means of holes punched into a paper tape. The punching of the holes is done by another machine, which " codes " the holes in such a way that they can be " read " by a special type of computer called a director ; this instrument in turn guides the milling machine through its intricate motions by means of electronic signals sent out to the servomotors. A separate feed-back system built into

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[1] See James B. CAREY : " Labor's Stake ", in *The Challenge of Automation,* Papers delivered at the National C.I.O. Conference on Automation (Washington, D.C., Public Affairs Press, 1955), p. 64.

[2] *Planning,* loc. cit., p. 69.

[3] Ibid., p. 70.

the machine ensures that its every motion corresponds exactly to the original programme.

A somewhat different type of machine tool has been reported under development by the General Electric Company. In this the first part is produced in the traditional method by a skilled operator who guides the tool over the workpiece. Every motion of the machine is recorded on a tape and this tape, after any necessary corrections have been made on it—simply by cutting out any unnecessary or undesired motions and splicing the tape—can be used repeatedly as a master control to run the machine automatically in the production of any number of additional pieces. This type of operation is called " record-playback " control.

The transformation of a standard machine tool to this type of fully automatic operation naturally increases its cost several times. However, tests at the Massachusetts Institute of Technology on the electronically controlled milling machine have shown that intricate metal parts such as aircraft fittings produced by this method can be substantially cheaper—how much cheaper depends on the number of parts to be produced—than the same parts produced by conventional methods. Engineers foresee the day when simpler types of control will make such machines practicable for the smaller firm operating normally on short runs of identical parts. It is this type of automation that appears to open up the greatest opportunities to all types of firm, both large and small.

However, automation may well make its largest contribution in the routine handling of information in offices. Repetitive office work in sufficient bulk, such as calculations for pay-rolls, inventories, cost control and budgetary analysis, dividend and interest payments, tax deductions and the preparation of customers' bills can be put at least on a partially automatic basis through computers and a variety of specialised office equipment, much of which represents adaptations of equipment at present in use. A number of cases of such applications have already been described in the technical press. One such is " Leo ", the electronic office of the restaurant firm of J. Lyons and Co., which works out the weekly wage packets of 7,000 of their London employees, makes a daily analysis of the trend of bakery orders in Lyons' teashops and is rented in its spare time by a number of outside bodies.[1]

Another example is the " magnetronic reservisor " used by American Airlines in their New York Office. This electronic " memory " can instantly answer an inquiry by any of the company's sales offices in the New York area as to whether seats are available on any scheduled flight. If the customer makes the

[1] *Planning*, loc. cit., p. 73.

reservation, the clerk informs the computer by using a key system, and the number of available seats for the flight is decreased by the number of seats sold to the customer. The reservisor is interrogated on the average 35,000 times a day.[1] Among its many advantages is its quicker response to inquiries and its flexibility, which permits a far higher number of reservations to be completed than through the methods currently in use. However, its high cost makes it economically impracticable except at centres where a very large volume of daily passenger traffic is the rule.

Advantages of Automation

Automation has several economic advantages. John Diebold has summarised them as follows.[2] It reduces production costs. It brings about safer working conditions and improved operations, and this in turn means higher output and less waste. It improves methods and makes it possible to do new things (e.g. the production of fissionable material). It has created a new industry (concerned with the design, manufacture, installation and maintenance of automatic control equipment) and new professions. It makes for greatly increased productivity of capital equipment and the labour force.

Briefly, automation represents a trend in man's continuing search for greatest results with least expenditure of human and material resources.

Sectors Likely To Be Affected

With respect to the sectors of economic activity likely to be affected by automation, it may be noted in the first place that manufacturing industry—one area immediately concerned—accounts for a minority of the gainfully employed population, even in highly industrialised countries, and even in this area automation may be possible only in some types of manufacturing.

Preliminary attempts have been made to estimate the parts of the economy most likely to be affected by the new control technology and the extent of the changes that it may bring about. One study undertaken by an authority on industrial planning and economic

[1] Congress of Industrial Organisations, Committee on Economic Policy: *Automation,* Pamphlet No. 270 (Washington D.C., C.I.O. Department of Education and Research, 1955), p. 9.

[2] *Management Record* (National Industrial Conference Board, United States), Sep. 1955, pp. 356-359.

development [1] suggests that in the United States the industries most directly affected or likely to be directly affected by automation employ less than 10 per cent. of the total labour force and that it is highly unlikely, even in these industries, that employment in any one industry could be reduced by as much as 50 per cent. over a 20-year span, on the assumption that no increase in the demand for these products occurred during that time. Industries where a high degree of automatic production has already been or is likely to be achieved include chemicals and liquid fuels, cement and brick, beverages, fibre and textile products, paper products, glass and ceramic products, machinery and machine-tool production, mining, communications and some areas of retail trade. Industries considered likely to be only incidentally affected, although able to use some automatic machines, include agriculture, transport, construction, forestry and wood products, the garment industry and shipbuilding.

Outside of the manufacturing sector, the service industries will unquestionably make extensive use of automatic and semi-automatic machines. Proprietors will certainly have better records and control systems for their shops ; and professional men will be able to save time and develop higher quality services through the use of new machines.

Past experience and current developments suggest furthermore that many new industries may grow from the impact of automation and its technical requirements. Already, for example, automation has given tremendous impetus to the growth of one new industry—electronics, which in the United States not only doubled its output of industrial recording and controlling instruments between 1950 and 1951 but has continued to expand at a rapid pace. The use of record and control instruments in industry is one indicator of the rate of installation of automatic production machinery.

With respect to the areas of the world likely to be affected, the safest prediction is that no area will remain unaffected. So far as the pace of economic development is concerned, it has been suggested that automation may well help to short-circuit the slow, costly process of industrialisation in the underdeveloped countries. The argument runs that, in their efforts to industrialise rapidly, these countries are handicapped by a shortage of capital and a shortage of trained labour. The capital and labour force require-

[1] Richard L. MEIER : " Automatism in the American Society ", quoted by John DIEBOLD in " Automation—The New Technology ", in *Harvard Business Review* (Boston, Mass.), Vol. 31, No. 6, Nov.-Dec. 1953, p. 70. See also Martin PACKMAN : " Automation of Industry ", in *Editorial Research Reports* (Washington, D.C.) Vol. 1, No. 1, 5 Jan. 1955, p. 6 ; Walter S. BUCKINGHAM, Jr. : " Industrial Significance ", in *The Challenge of Automation*, op. cit., p. 40.

ments of an automatic factory are relatively low per unit of output compared with those of more traditional plants. In certain circumstances automated plants may present another important advantage in underdeveloped countries : the fact that fewer workers are required diminishes the problems involved in shifting large numbers of workers to new industrial locations, particularly, for example, those connected with providing the housing and community services needed. By building a few large up-to-date automatic plants turning out a carefully selected group of products, therefore, the less developed countries might take rapid strides forward in their industrial development. Examples of such plants can already be found in the oil refineries in the Middle East, the new Brazilian fully integrated steel mill and the large fertiliser plant recently put into operation in India.

However, opportunities for short cuts in the less developed countries turn on many financial and technical factors as well as on the employment situation, and the possibilities tend to vary from one country to another. In any particular country there would have to be careful selection from the point of view of national economic and social policy of the industries to be developed along these lines rather than on the more traditional lines. Automated plants would, in any case, be exceptional, and the selection would be decided primarily by the need to provide specified types of goods with a maximum economy of resources.

Clearly any attempt to predict the impact of automation on the various national economies or the technical effects of automation in particular industries comes up against very great difficulties. The impact can hardly be divorced from that of other technological developments and other factors affecting economic and social progress. Moreover, much depends on the rate of its adoption in different industries and countries. This last, perhaps, is an all-important factor in attempting to weigh the economic and social effects of automation.

Although references to the " automatic factory " evoke the picture of a plant operating without any workers and controlled from one central point by a small group of men—and such a factory is technologically possible—the likelihood of one being built in the foreseeable future appears remote. In the first place, this mirage ignores the presence of maintenance workers, whose number, importance and skill requirements tend to increase in proportion with the degree of automation of a particular process. In the second place, the very intricate controls that would be required would make such a plant economically impracticable.

It is this consideration, perhaps more than any other, that encourages qualified observers to state that automation will not invade business and industry as a tidal wave but gradually, affecting first one industrial sector and then another.

Another important factor is the relatively limited area of the economy, particularly from the standpoint of employment, on which automation is likely to have an important and direct influence in the foreseeable future.

Also, individual company managements are faced with a number of problems—not the least of which is to grasp fully the potentialities and limitations of automation in respect of their particular needs. They must weigh such advantages as are clearly ascertainable against the costs of installing the new process, and this involves not only the direct cost of equipment but also the costs and uncertainties involved in redesigning the production process or the product itself, retraining and reorganising the work force, as well as allowing for the uncertainties of the market in a dynamic economy.

It is true that some observers of the process of automation take the view that developments are likely to come fast and go far. They argue that once the possibilities are fully appreciated by management, its advantages will far outweigh other considerations, and obstacles can be overcome rapidly. On balance, however, it would appear that most experts insist that developments in automation will expand in a relatively slow and orderly way.

Other forces at work in the economy may also be expected to cushion the impact of automation, whatever the rate of application in particular countries and industries.

Technical Problems of Management

Clearly, whatever the industries affected and whatever the rate of application of automation, the change to automatic production processes raises many technical problems that can only be resolved through considerable thought and effort on the part of management.

For management, many of the difficulties are concerned with grasping the true meaning and possibilities of automation. Automation does indeed require a new philosophy. Moreover, in order to derive the greatest benefits from it management will need to revise and modify many of its established methods of technical organisation. This will require general acceptance by industry of a fundamental rethinking of the entire production process, including the redesign of the product itself in order to adapt it to automatic production methods rather than the search for automatic production methods adapted to existing product designs. Plants will also need to be redesigned, and machines will be grouped around the concept of related production processes rather than in terms of the product itself. However, much engineering development and cost analysis will be required before general agreement is reached regarding the most effective way in which feed-back control technology can best be applied to existing manufacturing equipment.[1]

One of management's stumbling blocks in many countries is a tendency to look upon automation as a possible means of reducing labour costs exclusively. Automation may indeed reduce costs, but not so much by reducing labour costs as by making possible a higher output per unit investment through more accurate, faster production, with reduced spoilage, fuller utilisation of machine capacity, greater economy in floor space and reduced accident hazards—all of which are important in the final cost of the product.

This point is illustrated by the case of a United States chemical plant that had some 1,000 employees in 1948, when the management decided on modernisation involving also a 50 per cent. expansion in capacity.[2] In 1953 the plant had, instead of 700 production workers and 300 maintenance men, about 550 production workers and 450 maintenance men—i.e., about the same number of workers. Despite far more complicated processes, machinery and controls, the number of maintenance man-hours per unit of product remained almost constant, and production increased by 60 per cent. Maintenance now accounted for 45 per cent. of total wages instead of the previous 30 per cent. and, despite a 35 per cent. rise in real wages and a 50 per cent. increase in raw material costs, the unit cost in 1953 was substantially lower than it was in 1948:

> A little quick arithmetic would disclose that the total man-hours per unit dropped only about one-third. That is not enough to offset the jump in real wage rates plus increased material costs. And that is precisely the point. The company figures that for every dollar saved by reducing the man-hour content of each unit, it saved at least three dollars through less production of substandard material, fewer customer complaints, better utilisation of equipment and elimination of overhead on " non-saleable " production.

Social Effects

Structural Problems for Trade Unions

Trade unions, as well as management, will have to think about automation and adjust their structure to the changes likely to take place. This point was emphasised by delegates to the last session

[1] See, for instance, John Diebold: " Automation—The New Technology ", loc. cit., pp. 65-67.

[2] H. L. Waddell: " Progress in Automatic Production ", in *Mechanical Engineering* (New York), Vol. 75, No. 3, Mar. 1953, p. 208.

of the British Trades Union Congress. One delegate noted that many of the demarcation problems that now confronted the trade unions would be " blown sky high " because many of the jobs existing today would disappear. Another said that the movement would have to look again at many of its cherished traditional beliefs and be willing to change its attitude towards demarcation, classification and industrial unionism.[1]

Changes in skill requirements may also require new organisational efforts among groups in which trade unionism has so far made little progress in most countries.

Some Effects on Employment

Fears have been expressed regarding the impact of automation on employment. In the first place there is the question of what is likely to be the extent of reduction in employment opportunities in the industries where the trend to automation is accelerated. One observer has suggested that, fully automated, the automobile industry in the United States, which today employs over 1 million workers, could achieve the same production with 200,000. While this kind of development will certainly not occur for many years, it is a contingency that must be faced.

It is natural that anxiety and fear should be voiced by workers faced with uncertainty regarding their future employment, particularly the less skilled and older workers who, if displaced from their present jobs, have limited possibilities of fitting themselves for or obtaining new employment.

However, the problem of the displacement and re-employment of individual workers must not be confused with the impact of automation on the trend of total employment. The general employment situation is dependent on many forces, and automation may be or become one of these, but there is no reason to suppose that it is likely to become a negative influence in that situation. In fact, every historical indication points in the opposite direction. The growth of new employment opportunities and the continuous redistribution of manpower in relation to these changing opportunities are characteristic of the industrial era. There is no intrinsic reason to associate shifting opportunity with unemployment. But there is every reason to reinforce the measures taken to promote and to achieve full employment in each economy and to continue to make this a dominant aim of public policy.

Even in the industries likely to be most directly affected by

[1] *Labour* (London, T.U.C.), Oct. 1955, p. 220.

automation, the employment situation may differ from one industry to another. There may be a drop in total employment in many of these industries but in others there may be simply a shift of opportunity.

Moreover a number of other factors may tend to diminish the impact of automation on employment. One is the long-term tendency for living levels to rise and for more goods to be consumed per person. This can make for a market physically capable of absorbing a greatly increased output of goods and services, particularly if lower production costs attained through automation are passed on to consumers in the form of lower prices. Another factor is the steady long-term trend towards the reduction of working hours, a trend likely to gather force with the progress of automation, where shorter shifts, with continuous machine operation, may well be a characteristic method of organising work. There may also be a fall in the ratio of the working population to the total population in a number of countries as a result of population trends and social policies, such as longer schooling and the spread of leisure. Finally, a gradual rate of advance towards more automatic production processes would also limit the impact of automation on employment.

None the less, in spite of these various mitigating factors, there will be labour displacement, and this raises a general social problem, which must be met through co-ordinated planning and effective measures to facilitate the individual job changes that become necessary.

Indeed, it is in this area that automation presents an immediate challenge, for the average worker is bound to look at automation in terms of its effects not on jobs in general but on his job. He may know that automation may rid the world of much dull, arduous or hazardous work, and offer better and safer working conditions and more interesting and responsible duties, but his main question will still remain : " How will it affect my job ? " And for those displaced by automation—and there will be many—the vital question will be : " How can I find other useful and satisfying work ? "

In this area of policy, much thought needs to be given to finding the most effective means of providing social protection and financial assistance to workers forced to change jobs and of avoiding the individual hardships often associated with periods of rapid and far-reaching technical change. Particularly difficult problems arise in the adaptation and re-employment of older workers ; and the demand for more highly skilled workers may make it harder than in the past to find useful work for the unskilled.

Changes in the Composition of the Labour Force

In the employment field, however, one consequence of automation is becoming quite clear : there will be a substantial change in the relative numbers of skilled, semi-skilled and unskilled workers. Some existing skills will become obsolete ; some may be diluted by a further division of labour ; but there will be especially a demand for new skills, usually of a higher order. This means that while industry will require fewer and fewer unskilled workers, increasing opportunities will be open to workers with higher skills and to technicians and engineers. Because of the increased demand for higher degrees of skill for many of the new jobs and for greater versatility on the job, training and retraining will need to be developed considerably beyond their present levels.

The installation of complex and expensive equipment, the main function of which is to perform repetitive jobs more rapidly and accurately than can human labour, will tend to eliminate many unskilled and semi-skilled jobs. On the other hand the routine supervision of these machines will place a premium on the ability of workers to grasp the more complex operations under their control and to show initiative and resourcefulness in meeting the occasional emergencies that are likely to occur despite the elaborate controls built into the machines.

More important, perhaps, will be the need for maintenance workers, whose skills will of necessity vary from those of the traditional maintenance mechanic. The proportion of these workers has increased already in automated plants, and in the case of electronic feedback and computer technologies a relatively new occupation is gaining in importance, that of electronics technician. The importance of these workers in the new type of plant is evident, since the economic advantage obtained by the use of this equipment depends primarily on " keeping the process going ", and stoppages therefore become increasingly costly.

New skills will be required in the manual, technical and professional categories alike. What these new skills will be is still far from clear, since the new technology is in a state of rapid evolution. Guidance will largely have to be sought among the companies with experience. Alertness to the new requirements, and to the opportunities they represent for vocational training and technical education, will be required of all those with responsibilities in this field. Flexibility in thinking will also be necessary, and a willingness to revise existing programmes and methods.

A large responsibility for training will necessarily rest with individual companies. Managements will be best qualified to indicate the needs and to provide at least a share of the training.

They can save time and money by sharing experience and in some cases training facilities.

More people will have to be trained in some of the traditional skilled manual occupations, since the experience of many companies with automation shows a need for more skilled workers, especially in maintenance, than before. In this connection, a careful study of the ways in which people acquire the necessary skills will be needed. Although apprenticeship and formal training programmes will no doubt have to be strengthened, as well as adapted to new needs, experience in industry suggests that more informal methods —such as on-the-job training—produce a substantial number of skilled workers.

It seems clear already that the spread of automation will considerably alter and increase the demand for technological education. More and improved facilities will be needed, and their links with industry will have to be strengthened if they are to meet the new skill requirements. The facilities for training engineers and other professional and technical personnel will also have to be expanded. A review of existing facilities in the light of the increasing demands of industry for technicians and professional staff, and particularly for the in-between categories of semi-technical and semi-professional personnel, will be an important step in planning the adaptation of training services.

There is also the important problem of training management in the leadership and other skills required to cope with the new demands of automation. The increase in the number and skill content of jobs as well as in the ratio of managers to employees (because of the increased value of equipment and the increase in the scope of the work process under a manager's control), changes in plant organisation and the pace and complexity of operations and in the decision-making process are all factors that involve changes in management's responsibilities and attitudes and in the types of leadership it must provide.

> In the automatic factory, managers will of necessity have to become more co-operative and more imaginative in their co-operation. There will be a need for closer team-work both up and down the executive and across the functional lines of the organisation. The gift of prophecy will be a near essential, for it will be important that all possible difficulties shall be foreseen. Management will have to be more communicative, instructions will need to be more fully considered, less tentative, more explicit and positive than hitherto. Transmission of communications will need to be quicker....[1]

Many companies have already found it essential to expand their " management development plans " to take account of these

[1] Frank G. Woollard: " What Automation Means ", in *Personnel Management & Industrial Equipment* (London), Sep. 1955, p. 145.

increasingly important skill requirements for effective performance by their managerial teams.

Supervisors and foremen will also be required to develop their leadership skills. Attitudes towards supervision may need considerable modification, and new forms of training may be needed. The growing emphasis now being placed on adapting supervisory training to the changing human and technical needs of industry is encouraging.

Labour-Management Relations

Automation also raises a variety of problems in the area of labour-management relations. Many of these concern wages, hours, safety and other conditions of work; others relate to seniority and job security; still others bear on the methods and techniques of consultation and co-operation.

It seems clear that one consequence of automation will be a substantial improvement in working conditions and, above all, greater safety. However, new safety problems will arise, and these will have to be analysed in advance and appropriate forms of training introduced within industry in order to develop the new types of safety consciousness that will be needed to profit fully from the possibilities for greater safety.

It is also predicted that automation will improve working conditions by eliminating much arduous physical labour and much " dirty " work in industry. Automation offers opportunities for cleaner and safer work and also for making the plant environment far more attractive than in the past.

The changes in the work content of jobs will call for an extensive re-examination of existing wage administration policy and practice. One area where past developments have tended to emphasise narrow and rigid demarcation lines—job classification—will need to be re-examined by both managements and trade unions in the light of new conditions. For instance, in plants where automatic operations have replaced a number of narrowly classified jobs—for example, where a number of workers on separately classified grinding jobs have been replaced by a single operator controlling an integrated grinding line—experience shows a logical tendency to establish a single new category requiring a generalised knowledge of the job family, in this particular case, grinding. A natural consequence is for the union to claim for this new post a higher rate of pay based on greater versatility and more responsibility for the operation of complex and expensive equipment.

Related industrial concepts and practices will need to be carefully re-examined, such as time study—which, many observers argue, will be outmoded in its present form, since the pace of production will be set by the machine—and job evaluation, where new difficulties will be presented by changing job content. Existing incentive systems, particularly individual forms of piecework, are also certain to undergo important changes, and much thinking will be needed in order to revise them.

As for seniority, existing contract clauses and plant customs may be found unsatisfactory in the light of the new conditions brought about by automation. Both management and union in a particular plant will unquestionably be brought to reconsider the existing rules, which have generally developed from relatively stable operations with long-established and clearly defined occupational groups. Under the new conditions, broader seniority provisions—plant-wide or even extending to all the plants of a company—should facilitate the transfer of workers and provide them with a larger degree of protection in continued employment.

In the same general connection, provisions governing layoffs, rehiring, transfers and promotions will call for re-examination by management and union with an appreciation of the problems of the individual workers concerned as well as of the needs of the undertaking. New means must be found to combine increased adaptability with increased job security.

Finally, there will be continuing problems of labour-management co-operation arising out of the need for consultation on changes in technology, plant organisation and work assignments. Existing methods and techniques will have to be examined to ensure that they are adequate to bear the heavier burden that will be imposed on them, particularly in meeting the short-term problems of transition. Changes in the organisation and content of work will raise new problems of group and social relationships. These will affect not only the organisation of supervision but also the approach to many other aspects of in-plant relationships, including communications and information practices and channels for in-plant consultation.

Automation is also likely to give fresh impetus to the movement for shorter hours of work (both annual and weekly hours). The consequent increase in leisure time raises many problems of its own, not the least of which relate to the nature of the educational system and of recreational activities.

Implications for Social Policy

In this brief review of some of the major technical and human problems of automation that can be discerned, passing reference has been made to a number of areas of industrial relations and social policy that will undoubtedly feel its impact.

It is not the purpose of this article to suggest, on the basis of current experience, detailed specific solutions to the problems raised by automation. This is not yet possible. What is urgently needed is a measure of coherent planning, based on consideration of the problems involved and of their implications for social policy, and a sustained sense of responsibility for future developments on the part of industry, labour and government and of educational bodies and research groups.

It is true that each of these areas has had its problems in the past. Much study has been devoted to some, and solutions have been worked out either through collective bargaining or through action by the State. But continuous and careful consideration is needed, not only to meet but also to anticipate the new problems and to bring to their solution the new twists necessary to facilitate the change-over to automation.

The speed with which automation comes to a particular industry will naturally substantially affect the degree of intensity of these problems. Since it is generally agreed that changes are likely to develop gradually, it will no doubt be possible to make adjustments over time that would not be possible if they had to be done overnight—such as retraining key employees or letting time work off surplus labour.

Despite some diversity of opinion as to the extent and speed at which automation is developing and the social impact that it is likely to have, there is widespread consensus on one important point : the need for an extensive study of all aspects of the problems associated with automation as a basis for the early and co-ordinated action required to ensure an orderly transition with a minimum of social dislocation and the greatest possible benefit to all sectors of the community. This is emphasised by management, labour and government services in all the countries in which automation is making an appearance.

It is appreciated that a wide range of studies will be required : general studies of the progress of automation in the economy as a whole, studies of the rate of introduction of automation and its effects in each industry, of the changes in the size and composition of manpower requirements, of changes in levels of productivity and of modifications in piecework and incentive pay systems and in hours (including shift work) and other working conditions. Case studies will need to be made on a factory basis. Attention will have to be paid to the psychological consequences of new working conditions, such as " perceptual fatigue " on monitoring jobs or work in isolated stations, to changed social relationships inside the workplace and to new problems of supervision, and changes in plant organisation and in line and staff relationships. Special analysis will be needed of the experience of displaced workers in order to probe the difficulties and find the most effective remedies.

There is equally widespread recognition that, in the light of the findings of these studies, a series of inter-related measures will be needed to reinforce those already applied by industry and government to protect the labour force.

Measures already suggested refer either to means of protecting workers from unemployment during job shifts or to means of ensuring that adequate purchasing power is put into the hands of workers—who constitute a dominant sector of the consuming public—in order to ensure the high and rising level of effective demand in the mass of the population necessary to support increased production and productivity. Specific measures include the extension of dismissal compensation, widened opportunities for transfer, upgrading training and promotion, broadened seniority provisions to assure better protection to workers and to encourage inter-department and inter-plant transfers based on seniority, revision of job classification, with appropriate wage increases to take account of greater skills and new responsibilities and to ensure to the worker a fair share of the increased productivity of the equipment they control, and a wider application of guaranteed annual wage provisions as an essential element of security for the worker and as a stabilising influence in industry. The last-mentioned measure, together with adequate wage increases and a reduced working week, is considered by many trade unions as the best means of providing " a more secure basis for mass consumption throughout the year " and " of spreading the benefits of mass consumption to the great mass of . . . families ".[1]

Considerable emphasis is naturally placed on the extension and improvement of vocational training facilities and on the respective responsibilities of industry and government in the retraining of displaced workers. Special attention is devoted to the problems of skilled and older workers. Improved employment services are regarded as essential. An expansion of social security provisions, with earlier retirement for displaced older workers unable to find new jobs and an improvement in unemployment compensation also figure prominently among the measures suggested to cushion the shock of technological displacement.

It is significant that each of the groups primarily affected—management, labour and government—has given consideration to these questions and is alert to the need for study and action on the various specific problems arising or likely to arise in consequence of the spread of automation. In the United Kingdom, for instance,

[1] C.I.O. Committee on Economic Policy, op. cit., p. 12.

commenting on the plans of the British Institution of Production Engineers to hold a conference in 1955 on " The Implications of the Automatic Factory ", *Scope* observed—

> The implications are upsetting ... to traditional standards of management, administration, product design and manufacturing methods as much as to the prevailing ideas on employment and wages. All the more reason, then, for frank discussion.[1]

In an article in the *Commercial and Financial Chronicle,* John Diebold stated—

> Fundamental to the successful integration of Automation into our mechanised society is the recognition by all parties concerned—unions, management, and government—that they have a common interest. No one, least of all the American businessman, wants to see increased unemployment. All of us stand to gain by Automation as long as we stand together.[2]

In a recent pamphlet the United States National Association of Manufacturers emphasised that automation would bring new responsibilities to industry, including greater responsibility for the reallocation of manpower to dry up temporary pools of unemployment.[3]

Industry spokesmen generally hold the view that automation will prove an unquestioned boon and that any expanding and full employment economy will easily absorb an increased industrial output without serious dislocation. They agree with labour, however, on the need for studies and for measures to meet the problems of workers who will be displaced.

The trade union movement, both nationally and internationally, does not dispute the promise of automation but is more apprehensive of the short-term consequences and has given particular consideration to the social problems raised. In the United States no part of the trade union movement opposes technological change —such change is welcomed. But many union leaders are deeply concerned with the transitional problems. For example, the President of the United Automobile Workers, Walter Reuther, has declared—

> Now we enter the second phase of the industrial revolution, and the impact of automation—for good or for evil—is magnified a thousandfold. The need for enlightened social policies becomes imperative.[4]

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[1] *Scope* (London), Dec. 1954, pp. 31-33.

[2] " Automation and Its Uses ", in *Commercial and Financial Chronicle* (New York), Vol. 181, No. 5424, p. 20.

[3] National Association of Manufacturers : *Calling All Jobs : An Introduction to the Automatic Machine Age* (New York, 1954), pp. 20-21.

[4] *Automation* (Detroit, U.A.W./C.I.O. Education Department, 1955), p. 4.

The C.I.O. Committee on Economic Policy, in a research pamphlet on automation[1], raised a host of technical and human problems requiring study and consideration, and stresses the need for combined efforts by labour, management and government to smooth the transition to the new technological era.

The President of the American Federation of Labor, George Meany, also stated that the answer to technological change lies in smoothing its transitions and cushioning the shocks that attend it.

> This means, in the immediate sense, the establishment of severance pay, retraining of skills, reorganisation of work schedules. These are social costs that industry will have to bear in order to avoid the wasting of human resources and to avoid our calling on government to bear these costs if industry fails to do so.[2]

From the beginning, the United States unions have tried to draw the attention of their members to the implications of automation. The C.I.O. adopted a first resolution on the subject at its 1953 Convention and a second in 1955. It also convened a conference on automation in 1955 in order to focus attention on the problems arising from developments in this field and to discuss the measures required to cushion their impact.

In the United Kingdom, the President of the Trades Union Congress stated at the 87th Annual Congress in September 1955 :

> We can visualise the time when there will be an abundance of consumer goods which will meet the requirements of every man, woman and child on the face of the earth. We can welcome it for this reason, or we can fear it because we may believe that it will rob us of our individuality, of our skills and perhaps of our livelihood.... To fear automation would be the cowardly approach ; it could arise only from a sense of weakness. If we are confident in our strength as workers and our workers' organisations—and we should be—we have no need to fear. We should immediately set ourselves to the task of controlling these developments, not restricting them ; of turning them to our advantage and not our disadvantage.[3]

After discussion of the question, the T.U.C. adopted a resolution welcoming the opportunities for higher living standards presented by technological advances generally and, foreseeing that these opportunities would be attended by complex human, social and economic problems whose solution would depend on a larger measure of workers' participation in industry through joint consultation, urged continued study of the problems in order that the whole movement might be efficiently equipped to deal with the subject.

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[1] Op. cit.

[2] George MEANY : " What Labor Means by More ", in *Fortune* (Chicago), Mar. 1955.

[3] " The President's Point of View ", in *Labour*, Sep. 1955, p. 188.

Although their proposals differ in detail and in relative emphasis, unions on both sides of the Atlantic are substantially in agreement on the measures they consider should be taken in order that the advent of automation may in fact herald a new and a better life for all members of society and not new, terrifying prospects of economic and social upheaval and disaster. Their particular emphasis is on upgrading, retraining and transfer within the plant, protection for displaced persons, reduction of hours, and maintenance of income and purchasing power.

Governments are equally alert to the urgency of studying and taking measures to deal with the problems connected with automation. In the United States the Subcommittee on Economic Stabilisation of the Joint Congressional Committee on the Economic Report is making a study of automation to determine what social policies are necessary to ensure that the long-run benefit to be derived from increased productivity does not produce serious or undue short-term unemployment and dislocations. In the United Kingdom the Department of Scientific and Industrial Research is undertaking a survey of automation developments and will sponsor research into these and related problems. In Europe the European Productivity Agency is sponsoring surveys to ascertain the extent to which the new techniques of automation have already been applied in various sectors of industry and the possibilities of future development ; these surveys are to provide the basis for detailed consideration of the technical and human problems of automation.

At the individual plant level, too, much is already being done to dissipate the fears of the workers and to facilitate change to new production methods. As always, what is essential is a willingness on the part of management to share its plans with the workers, to keep them informed of all phases of the new techniques that affect their prospects of continued employment—the need for dismissals, transfers and training, and the opportunities for promotion and to plan ways of making the changes. It is here, particularly, that the time element can be turned to good use :

> ... For one outstanding characteristic of automation is that it takes time to install. Even after an exploratory stage has been completed, equipment must be designed and manufactured, men must be hired or trained for new occupations, physical installation and transition problems must be faced. All of this takes time—not days or weeks, but months or even years, and with problems like displacement and personal adjustment, time, of course, presents a major opportunity that alert and socially responsible companies and unions can use to good advantage.[1]

[1] George P. Schultz and George B. Baldwin : *Automation—A New Dimension to Old Problems* (Washington, D.C., Public Affairs Press, 1955). See also " The Effect of Automation on Industrial Relations ", by the same authors, in *Monthly Labor Review* (U.S. Department of Labor), Vol. 78, No. 2, Feb. 1955.

Conclusion

There is evidence that automation is beginning to receive the attention it merits. Recognition of the need to analyse the problems and to reinforce measures of social protection in certain areas of policy are two steps forward. Recognition that automation and other technological developments are placing a heavy strain on the labour-management structure and that increased consultation within industry is a necessity is a third step in the direction of preparing for the future.

However, recognition of the problems is not enough. Much has to be done to meet the problems ahead, and it is probable that attention will centre in the near future on action. Here there is an evident need for continuing and intensified co-operation on the part of those more directly concerned—co-operation that can only come about through conscious effort and thought about the more far-reaching social implications of automation. Above all, there is a need to keep automation in its place—that is, as a group of related concepts and technological developments offering great possibilities for the raising of levels of living and welfare—and not to assign to it an inexorable and over-riding role to which social policy must be subordinated for many years to come.

In the words of one of the principal speakers at the Conference on the Automatic Factory organised by the Institution of Production Engineers in the United Kingdom, Mr. F. G. Woollard, for many years engaged in the development of flow production methods in the British automobile industry—

> We must always remember that automation is not a device with which to outlaw, displace or dispense with man. It is not a contrivance nor an invention to deprive man of his heritage—his right to work and to enjoy the fruits of his labours. It is a means of increasing man's stature and for extending his ability to do more and more useful work; to produce in greater volume with less physical effort or mental strain—a means whereby he can bring to his fellows the fulfilment of their lawful desires and, to their homes, comfort and leisure. We must always remember that men were not made for machines, but that machines were made for men. Whatever device or emblem we may adopt to typify " automation " the motto must be... " Machines in the Service of Man ".[1]

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[1] Quoted by L. W. Bailey, in his report on the Conference: " The Automatic Factory—What Does It Mean ? ", in *Mechanical Handling* (London), Vol. 42, No. 8, Aug. 1955, p. 482.