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MACHINERY, TOOL OF PRODUCTION

THE four material factors most important in the economic well-being of a nation are invention, population, natural resources and economic organization. This article is about the machines we invent in order to mould natural resources into usable products for our people, and to distribute the commodities.

With a world population so large that economists tell us we must strain our resources to feed all the people, we are under increasing compulsion to expand productivity. We can do so only by using machinery.

For a dramatic contrast between the efficiency of human labour and that performed by machines directed by men, look at the Great Pyramid and Boulder Dam. The pyramid contains 2,300,000 blocks of stone, each weighing 2½ tons. Dr. W. M. White, a consulting engineer of Milwaukee, has figured out that it took 100,000 men over a period of 30 years to build it. Boulder Dam has 3½ million cubic yards of concrete, requiring the handling of ten million cubic yards of material. A power line 220 miles long brought electricity which was applied through machines by 5,000 men. The pyramid was built by slaves under the taskmasters' lash in 30 years: the dam was built by machines under the direction of skilled workmen in 5 years.

What has brought about the change from a slave society to one in which every worker may be the master of manufactured power equal to that of hundreds of men? Imagination; the power to visualize what would result if this and that were put together; progressive skill in applying the forces of the six basic principles of machines: the lever, the wheel, the pulley, the wedge, the screw and the inclined plane. The wooden scoop of untutored races developed through the ordinary spade to one with a pneumatic attachment, and finally to a huge shovel with steel teeth that can gobble up a cartload of earth at one mouthful.

The Industrial Revolution

The Industrial Revolution, which was simply the substitution of gigantic non-human forces for our puny human physical powers, took us out of the backward economy of the spade, the hand loom, and the human back as a burden bearer. It altered the character of life from the old indignity of harsh toil to mastery over resources.

Economically, the effect was to take industry out of small family establishments and concentrate it in factories. Cities in Britain were booming industrial centres while the scattered farmers of Canada still used tools the Egyptians had invented, and still carried grain long miles on their shoulders to have it ground at a water mill.

Opposition to Machines

Machines met strong opposition, but it is nothing new to find progress obstructed. The art of selling new ideas is often as dangerous as it is difficult.

Ancient beliefs and frivolous ideas were used to resist mechanical advancement. English farmers drove out with violence the man who suggested using drilling machines to plant grain. Vienna police forbade the use of a carriage driven by a benzene motor because it made too much noise. Railways were opposed on the grounds that they would prevent cows from grazing and hens from laying. In the United States, small-town bankers refused for many years to lend money on tractors because they were a menace to farmers. And in that same country in the 1840's the bathtub was denounced as an innovation designed to corrupt the democratic simplicity of the Republic.

In spite of all these, and the propaganda effect of Samuel Butler's utopia in which no machines were allowed, not even clocks to keep time, machinery has come. We plant and cultivate and harvest by machines; we have survived the noise of the horseless carriages, and our streets are cluttered with them; there are

single counties on this continent with more cows than there were in all of pre-railway England; and bathtubs are made in thousands by machines, to the great increase of cleanliness and improvement of health.

Improvement in Factories

Early complaints about the factory system were undoubtedly justified. The coal, iron and textile industries in England were swept too suddenly into mechanization. Factory buildings were improvised, and people crowded in from rural hamlets to build bleak and grimy towns.

In explanation, it might be said that no one had the foresight to know what was coming; indeed, we are in the same fix today in our ignorance of what is meant to the world by atomic energy, international rivalries and the uses that will be made of inventions flooding the patent offices of the nations.

Public opinion brought about improvements through enlightened legislation, through raising the age at which children might be made to work by their parents, and through rigorous factory inspection. Management, too, has become more intelligent and has accepted extended responsibility toward working people. In fact, although there are some industries still backward, and some employers who fail to measure up to the general standards of their colleagues, the Western countries have progressed a long way on the road toward industrial democracy.

Machines Increase Employment

One of the great fears of workmen always has been that installation of a new machine will result in unemployment. As a matter of fact, technology has not in the long run resulted in a decrease of the number employed, but has decreased the hours of labour.

Few occupations have been affected more by intensive mechanization than those in the manufacturing and mechanical industries. Yet employment in these industries increased 414 per cent in the United States between 1870 and 1930, while the population went up only 218 per cent.

Millions of people are now employed in industries that would never have existed had it not been for science and mechanization. They produce a variety of goods and services quite unthought of in a time of primitive handicrafts, and make them available at prices within the reach of all who want them enough to exchange their work for them.

There is a long term increase in employment: the index of leading industries in Canada has risen from 99.4 in 1939 to 183.4 in July 1951, based on employment as it was in 1939. In June this year there were 5,247,000 persons with jobs in Canada, of whom 920,000 were in manufacturing and mechanical pursuits.

New Industries

One of the fascinating aspects of the new era is the birth of new jobs in new industries. While old occu-

pations have been made obsolete, the net change has been an increase in employment opportunities.

We need only look around us to see the tremendous multiplication of labour opportunities which machines have brought about. In 1881 there were only 1,391,000 persons gainfully employed in Canada; in mid-1951 more than five million.

Our census lists many industries which did not exist at the beginning of the century, some of which employed the following numbers in July this year: electrical apparatus and supplies 66,714; motor vehicles 33,020; aircraft and parts 19,070; rayon and allied products 18,193. Figures are not to be had for earlier years, but since 1933 the monthly production of domestic electric refrigerators in Canada has gone up from 1,260 to 32,948 in May 1951, and washing machines from 8,350 in 1929 to 27,236 in May 1951. In 1937 there were 24,100 radio receiving sets manufactured monthly; in 1949 the production was at the rate of 66,700 a month.

Social Effect of Machines

When he wrote *Man The Unknown* Alexis Carrel put his finger on a truth which worries all who seek the good of mankind; "In learning the secret of the constitution and of the properties of matter, we have gained the mastery of almost everything which exists on the surface of the earth, excepting ourselves."

To what degree is human disappointment with the influence of the machine upon the well-being of the individual traceable to better education, widened interests and greater opportunities for pleasure? Humans will start their tomorrow's quest for contentment where they left off today, and today's level is considerably higher than yesterday's; consequently their demands are greater.

Today's young lady at the spinning frame of a great factory probably suffers fewer discomforts than her ancestor of colonial times at the spinning wheel in her kitchen. She likely works under less pressure, because in those days it took every ounce of energy people had just to keep themselves alive. But wide reading, the romance of the movies, and the insistent voice of radio dramas combine to create dissatisfaction and lure her to search for some lotus land.

Standard of Living

Inventions and the products of machines have made themselves part and parcel of our lives. Without the help of machinery there could not be that vast outpouring of goods upon which our high standard of living is based. The very hardest toil by everyone in the world, without machines, would not provide anything but a scant life for anyone. It is the margin of labour-saving provided by the machine that makes possible the extras, the new necessities of life, which add brightness to living.

W.F. Ogburn wrote a book called *You and Machines* in which he showed the machine advantage in this way: "Many workmen today live in steam-heated houses with bathtubs, and hot and cold running water,

and indoor toilets. More than a few of them have automobiles. In Queen Marie Antoinette's apartments in the Palace of Versailles in France, the stove used to heat the big rooms was very inferior to our modern furnace. . . . Her bowl and pitcher were not as convenient as the modern wash basin with its drain pipe and running water. Very probably the girl behind the counter at Woolworth's has more silk stockings than had this queen. She never had a radio, nor a telephone. She never went to a moving picture show. Her food was cooked over an open hearth in the cellar of the palace, not on an electric or a gas range."

Not only on the level of physical well-being are the workers of today better off than the queens and kings of not so long ago, but on the higher levels of individual culture. Magazines and books broaden their horizons, and art treasures belong to the people, not in guarded castles. Our life-span has grown longer. We have more leisure, though we have not yet learned fully how to use it in satisfying self-expression.

There is in Canada a great educational equipment, universities, schools, libraries, night schools, trade schools, study groups and farm forums. There is, literally, no excuse for boredom. Society needs socially literate persons who will turn their hands to advancement of community life, and in this type of participation everyone can find as great satisfaction as the most eminent statesman does in working for his country.

Opportunity for Advancement

Now that the handicraftsman of past centuries has been split up into parts, how can he find happiness in his work? The physical energy he used to contribute is provided by manufactured power; his individual operative skill has been replaced by the precision of mechanism; and his craft knowledge has developed into the technician's specialized knowledge of the reactions between the factors with which he works.

We see many a workman who is visibly proud of operating a powerful machine with full responsibility for its control. That is not a depressing, monotonous job, but one that expands a man's ego and establishes self-confidence.

The farmer, like the city factory worker, must know far more than his ancestors. His work with tractors, harvesters, milkers and the other machines that ease work on the modern farm is not soul-destroying or deadening. It gives him new horizons, and far from making him a robot develops him into a king.

Some persons, of course, are happy in ruts. As the psychologists say, they "fixate" at a certain level. They become content to throw a switch, tighten a bolt, press a button or pull a lever. They survive in the Machine Age with far fewer skills than the most primitive savage in his jungle.

These are the robots, because they are content to be. There are not among them any George Stephenson, climbing from mining drudgery to change the world with their ideas; nor Isaac Newtons, glass grinders and makers of spectacles, seeing through space to a new idea of the universe; nor George

Westinghouses, bucking opposition from the highest quarters for the sake of a life-saving idea. But their backwardness is not the fault of the machine. There have been such people in all ages.

The Use of Capital

Over the long run, national prosperity will hinge on our ability to generate a sufficient rate of capital expenditures to provide the machinery for new, different and increased quantities of products. The maintenance and advancement of material wellbeing require that funds be made available from savings to finance research, to perfect inventions, and to apply the processes which translate new ideas into practical uses.

There is no way in which a self-sustaining production job can be created except by some people spending their savings to buy tools that men may use to produce the marketable goods from the sale of which comes the money to pay their wages. "Even the lowly job of digging," said Voorhees in *The Uncommon Man*, "requires the employer to spend savings for a shovel. For steel production — from mine to market — at least \$20,000 would nowadays be required to create one new job."

Capital is one essential ingredient in production. If we wish to state the value of a machine in a lump sum, we can do so only by calculating what sum of money would be needed at the current rate of interest to give an income equal to the value of the product of the machine.

This brings up the thought that if the machine does not produce all expected of it the man who provided it loses money. There are big hazards in investing capital.

It is often taken for granted that capital invested is perpetual. This is very far from the fact, because all equipment in which capital is invested begins to depreciate the moment it is produced.

A study of the obsolescence of metal-working equipment revealed that it was as a rule obsolete if not produced within the past 10 years. This suggests the magnitude of the need for renewed capital. Neglect has a secondary but very important effect: when plant is in a bad state, requiring a heavy programme of repairs, this tends to irritate the worker, reducing his output even below that caused by run down machinery.

A principal safeguard, and the main assurance of growth and progress, is the practice common in Canadian industry of plowing earnings back into the business. By retaining a portion of net income for future needs, successful enterprises of all sizes have strengthened their financial positions. This is one of the best features of the Canadian system, because it gives an assurance of continuity to a business, and at the same time provides for development to meet changing needs.

Making Machines

Given capital, the next thing is to get the machines.

Publications of the Dominion Bureau of Statistics show the interesting growth of Canada's machinery industry. These figures cover only the operations of

firms occupied chiefly in making industrial, household, office and business machinery, and do not include farm implements and electrical machinery. Between 1925 and 1949 the number of plants grew from 151 to 366; the number of employees from 8,313 to 30,070; the wages paid from \$10 $\frac{3}{4}$ million to \$74 million; and the gross selling value of products from \$30 $\frac{1}{2}$ million to \$241 million. In addition, there were 546 machine shops in 1949, with 6,027 employees, wages of \$12,840,000 and a gross value of work amounting to \$28 million.

Power

No matter how good our machine may be, it is useless by itself. It needs power to give life to its moving parts. The really important thing about the Industrial Revolution was the substitution of other powers for physical human effort as the working energy of production.

We of today have the same biological limitations as ancient people. We have little physical strength. It has been calculated that we cannot for any sustained period put forth more than 1/10th horse power. With that kind of power the production of commodities would be on a small scale and very slow.

To increase production and take the load off our shoulders we were inventive enough to use wind and running water to turn mills, and then we went on to other devices. Through the work of many ingenious men there are today five kinds of power-developing engines which provide 95 per cent of the world's energy: the reciprocating steam engine, the steam turbine, the water turbine, the gasoline engine, and the diesel engine.

Chief among these for industrial purposes is electricity developed by water power. The first hydro-electric plant in Canada was installed in the 1880's. The developed hydraulic turbine horse-power in Canada today is 12 $\frac{1}{2}$ million. This, on the commonly accepted basis of one horse-power being the equivalent of the work of ten men, furnishes energy equal to that of more than 125,000,000 workers, yet the whole labour force in Canada today is only about 5,200,000.

Production

Canada is committed to a steadily rising standard of living for all her people, continuing the trend of the past century. We are committed to a programme of social services, certain of which cost so much as to require an increase in the national income. More consumer goods and services are needed to meet the wants of a population whose income from wages and salaries is 289 per cent higher than before the war. There are, in addition, responsibilities in the way of defence and contributions to world recovery.

All of these add up to a requirement for production far above that of 1939.

History and economic investigation show that high productivity is the key to a high standard of living. Low productivity can mean only fewer and fewer goods at higher and higher costs for fewer and fewer people. We have Aladdin's lamp in our hands, but we have to rub it.

The objective should be to get as much work out of every machine as we possibly can.

The deeper we explore beneath the surface of today's confused world situation, the more evidence accumulates that higher productivity is one of the most urgent requirements for a reasonably stable economy, both in Canada and internationally.

Machinery can enable us, if we use it fully, to secure the same amount of commodities for half as much work, or twice as many commodities for the same amount of work. We just can't live as high if we spend the same hours per day at machines and produce only half what we could make.

The human body has ceased to be the burden bearer. The hard work has been passed along to the machine and to generated power. But human service remains the sole creator of output, because it is the workman who keeps the power flowing and the machine running.

Good production is a matter of men, management and machines. It is the responsibility of management to increase the productivity of machines by fostering research and development of new engineering and manufacturing techniques. It is the function of workers to make every machine yield its utmost in products. This does not mean setting a killing pace or restoring any of the abuses of the old "speed-up" days, but the exchange of an honest day's work for a fair day's pay.

Such a programme would have a tonic effect upon all our economy.

The Future

While our universities and schools are well supplied with teachers of history, not one has a professorship for the study of the future. It would be a good thing, suggests W.F. Ogburn in *Machines and Tomorrow's World*, if we had a group of thinkers who would devote all their time to a study of trends. These men would not be lulled by wishful thinking and loose optimism. Looking at the whole field, they would see a great variety of changes approaching, but they would see no innovation that will eliminate man's responsibility to do a good job, or sanction his producing less than a reasonable output.

If there is difficulty in building bridges to a bright future it is not because of lack of materials; natural resources, inventiveness, skills, and so on. These are all at our finger tips. It is because of the lack of something that would assemble all these and make them stick together.

When an ancient Greek dramatist had entangled his plot beyond human solution, an actor dressed as a god was lowered over the stage by a crane. He, the "god in the machine", got the playwright out of his mixup by solving the problem along supernatural lines. No "god from the machine" can be counted upon to get human beings out of any tangle they create. It would be good business to apply common sense and honest endeavour to prevent the need arising.