THE ROYAL BANK OF CANADA
MONTHLY LETTER

HEAD OFFICE: MONTREAL, NOVEMBER 1954

Invention and Discovery

ALL business progress is the result of invention and discovery. The scientist in his laboratory, the traveller on his voyages, and the inventor at his workbench — these have played a vital part in developing our industrial civilization.

During the past half century science has drawn a never-ending succession of gasps from humanity. It has been told that it is wonderful, marvellous, and unbelievable. Inventors have followed hard upon the heels of the scientists, so that no sooner is a novel principle uncovered than it is embodied in capsules, gears or gadgets for popular consumption.

Lest overweening pride should seize us, however, it is well to look back over the life of mankind as Dr. Julius E. Lips does in his book *The Origin of Things*. Primitive people in all parts of the world showed their inventiveness to so good effect that Dr. Lips needs nearly 500 pages to tell what they did. Today's and tomorrow's inventions are built upon inventions that stretch in a long line from the first tool-using creatures.

No one will deny the profound effect of science, invention and discovery upon society. What we call civilization could never have come into being had we not been capable of proceeding from old to new things, and eager to make the change.

Every age has witnessed greater or smaller improvement in people's material environment, and has become accustomed to the new ways, which are, in turn, accepted by the succeeding age as old ways, crying out for change. Innovation has become revolutionary at times, as in the rise of machines to their present important place in our lives.

Consider the dynamic effects upon all of us of but six inventions: telephone, automobile, airplane, motion picture, rayon and radio. These six represent great accumulations of capital, give employment to millions of people, and have had social influences so vast in number and intensity as to be impossible to calculate.

There is, however, one area in which science has no control. In matters of morals or purposes, it has no word to say. What we do with our lives that medical science has lengthened and to which invention has given so great leisure: that is not a thing doctors and engineers can control. As John Dewey pointed out, we reason rationally about the material arts, but when it comes to institutions and society we are often ruled by prejudice and tradition.

It is a sobering thought for those who boast contentedly about our material culture that intelligence does not seem to have increased rapidly in depth during the past ten thousand years. As much intelligence was needed to invent the bow and arrow, when starting from nothing, as to invent the guided flying missile with the help of all the inventions that followed upon the bow.

Hazards in inventing

The way of the inventor is not easy. To him, his invention seems to be so obviously valuable that he loses patience with other people's scepticism. Almost all new ideas have a certain air of foolishness about them, and this may account in part for some of the incredible delays in their development.

Discoverers and inventors are not always accepted with open arms. Lavoisier, the first man to explain combustion in terms now accepted, one of the greatest men ever produced by France, was executed because the new republic had "no need for scientists". Sir Charles Lyell, illustrious Scotsman, was ostracized when he published his *Principles of Geology*, but geology has advanced to its present state by working from Lyell's axiom.

Dr. L. Austin Wright, M.E.I.C., General Secretary of The Engineering Institute of Canada, recalls the story of the man who invented the jet engine and tried to get government officials and industry to accept his design for this new power unit.

Every place he went he was turned down promptly, because of two things: he was only 22 years old, therefore he wasn't likely to know what he was talking about; and nobody took seriously to the idea of developing power by this new and novel method.

The world knows of course that eventually Frank Whittle, now Sir Frank, was successful. As Dr. Wright points out, there was never any doubt as to the person responsible for this development, and accordingly the British government at the conclusion of the war rewarded him with a grant of £100,000 tax free and a Knighthood.

Any one who doubts the difficulties that face an inventor who has a really new idea will find Sir Frank's book *Jet* revealing.

While carefulness about accepting an innovation is commendable, there are many examples of this carefulness being carried beyond reasonable limits. Franklin's report on the experiment that charged a Leyden jar by drawing electricity from the clouds was read before the Royal Society in 1752, and ten years later Galvani reported the discoveries he had made through applying electric shocks to frogs' legs: both were studiously ignored. Priestley, the discoverer of oxygen, was driven from his sacked home and came to America. A century after his death the chemists gathered around his grave and there organized the American Chemical Society. When William Murdoch proposed lighting the streets of Cornwall with gas he was ridiculed by Scott, Byron and Napoleon. Selden battled for 16 years before his invention of the gasoline-propelled car was allowed a patent, and Morse struggled for twelve years before his telegraph was tried out.

Not ridicule alone, but self-interest also, interferes between the invention and the production of something new. The use of stage-coaches was resented in every country; local authorities kept the roads in a bad state lest business go elsewhere, and travel restrictions amounted almost to persecution. When railroads came upon the scene they were opposed by turnpike companies, stage-coach proprietors, tavern keepers and farmers. The railroads and horse breeders obtained an Act of Parliament in England in 1861 which practically made it impossible for horseless vehicles to operate. The British War Ministry refused to have anything to do with airplanes even four years after Wright's first flight. Recently in Alaska the drivers of dog teams and those who sold them fish were vigorous in their opposition to air mail service.

Of course, the mote is not always in another's eye. Inventors and discoverers sometimes fail to see the possibilities in their own findings. Fessenden achieved wireless telephony in 1900, and on Christmas Eve of 1906 he put music into the air, but it was not until KDKA opened in 1920 that anything effective was accomplished. Sir James Jeans tells us in his book *The Growth of Physical Science* that Paracelsus (1493 to 1541), who initiated modern chemistry, once let vinegar act on iron filings, thus producing hydrogen, without in the least suspecting that he had uncovered the most fundamental of all chemical substances. He prepared ether, and observed its anaesthetic properties, without realizing that he had made one of mankind's most useful medical discoveries.

Patent laws

Besides all these hazards, the inventor must cope with perplexing patent laws. Social protection has been awarded the inventor from early days, ranging from the magic secrecy of early discoveries to the patent laws of modern civilized nations and to international treaties.

Many people have hazy ideas about patents. Something that is only an idea may not be patented, nor may the mere changing of material of which an object is made. The supreme court of the United States ruled against a man who wished to patent the addition of an eraser to a pencil, because, said the court, you could break the pencil in two and still write with one end and erase with the other: in other words these two did not combine to produce a new result. There are hundreds of pitfalls and winding paths in the patent laws of all countries, so that only specialists can find their way with confidence.

The patent law in Canada is designed to promote the progress of science and useful arts. Part of it provides against the possibility of anyone blocking development of any patent if to develop it would be in the public interest. A publication of the Chemical Institute of Canada remarked: "these provisions are so widely drawn that it is difficult to conceive any abuse that is not caught within their net."

The number of applications for patents in Canada has increased by one thousand annually since 1947-48, the end of the peak period following World War II, according to the *Report of the Secretary of State of Canada* in 1953. In the latest year reported on there were 16,405 applications for patents, of which 10,325 were allowed and 9,683 matured to patents.

Of the patents issued, 7,113 went to companies, 2,568 to individuals, and 19 to companies and individuals jointly. Sixty-four of the patents went to women, and 40 to men and women jointly. The total patents granted to Canadian applicants was 1,393. Revenue of the patent branch rose from $366,253 in 1943-44 to an all time high of $756,714 in 1952-53.

Common sense needed

The budding inventor needs to apply common sense to his urge to make something new. There is, for example, no crying need for a walkie-talkie that will

enable Canadians to communicate with China, because very few of us have the language or purpose to make such calls. There has been talk for years of concentrated food pills, but most of us will have nothing to do with them until a capsule is invented that will give us the taste sensation as well as the nutritional value of soup, steak, potato, mushrooms, salad, ice cream and coffee, each in turn.

There will not be a mass market for the toy invented by Donald Davies, noted for his work on a big electronic brain in Britain. He has perfected a machine that plays "naughts and crosses" with him in his spare time, and usually beats him. Dr. T. W. M. Cameron, head of the institute of parasitology at Macdonald College told facetiously four years ago about a patent issued to the inventor of a trap designed to catch tapeworms.

Not every invention must have a mass market, of course. The apparatus that controls the size, direction, and velocity of fragments of shells or bomb warheads is not likely to become widely popular, but it is welcomed in its special field. A 16-inch telescope so powerful that one may read the time on a clock fastened to the outside of an airplane flying out of sight of the ground is a specialized invention without mass appeal.

On the other hand, the fireless furnace that takes air from the rooms of a house at 70 degrees, passes it through pipes buried below frost level under the lawn, and restores it to the house at 110 degrees, need only be made economically attractive to rate a big market.

Invention follows invention

Behind every inventor there are many ghosts, some of whom made contributions without which the inventors of today could never achieve fame. Every development rests upon previous ones, so that it is literally true that there is nothing wholly new under the sun. Devices that we call new are combinations or modifications of old ones, adapted by agile minds to do some new thing or to do an old thing in a better way.

A cycle of invention begins with a group of important fundamental discoveries or inventions, then numerous additions, improvements and refinements are made. Every concept represents only a slight advance, but when taken together over several decades these advances achieve significance.

Consider jet propulsion, which we look upon as an excitingly new form of power. Its principle is as old as Newton's third law of motion: to every action there is always an equal and opposite or contrary reaction. As children, we used this principle when we blew up a toy balloon, then let go of the stem: the balloon, driven by the escaping air, darted across the room.

Dr. Raymond W. Miller, in *Take Time for Human Engineering*, goes a step farther when he says: "The successful completion of a project based upon research and study is the same as putting together the segments of a jigsaw puzzle, the original design of which has already been made."

To forecast discovery and invention is a risky undertaking, and it is even more difficult to weigh their probable influence on life, economics and government. Always there is being built up a great surge of knowledge in many fields; always we are on the verge of great discoveries. When or where the dam will break, letting loose new facts upon which the scientists and technicians will seize to advance invention, no one knows.

Vannevar Bush, president of the Carnegie Institution of Washington, told this year's graduates at Massachusetts Institute of Technology some of the possibilities. A new phase in the life of civilization, he said, may be opened by studies now being made into the cause and cure of mental illnesses; progress is being made in agriculture toward expanding the supply of food to meet the needs of the world's rapidly growing population; we may soon be on the verge of discovery of what constitutes muscles, and from there we may go on to make artificial muscles; solar energy may come into practical use sooner than atomic energy, so great have been our advances recently toward understanding ways of utilizing the sun's power; in metallurgy we have developed alloys that have a tensile strength of a million pounds per square inch.

What will be made of all these advances rests with the inventors and the innovators, men and women who will bring about a synthesis of recently found knowledge with what is already known and pass it through their minds seeking the spark of an idea.

Qualities of inventor

The qualities that make a good inventor are like the qualities that make an exceptionally good newspaperman, chemist, banker, secretary, carpenter, farmer or salesman. One of these is a distaste for unnecessary work, another is an instinctive disrespect for established methods that depend for their perpetuation on the idea that grandfather knew best, but most important is the constant curiosity that prompts the question: "I wonder what would happen if . . .".

Because planned invention is essentially a mental process in which you first think of something needed, and then combine a number of elements to produce a new result, you need to have a mind crammed with elements and informed as to what is going on in the world. He who knows only one science, or one craft, or lives in an ivory tower, is handicapped. Unless they have background and the light of present day knowledge you might fill an academy full of geniuses and reap not a single discovery.

Very often, says H. Stafford Hatfield in the useful Pelican book *The Inventor and His World*, the greatest advances are made in industry by persons who come from other fields of technical activity into work new to them. Such people see with new eyes the routines accepted as perfect by those who have been for years in close contact with them.

Adam Smith tells an illustrative story in his economic classic *The Wealth of Nations*. In the first steam-engines a boy was employed to open and shut the communication between the boiler and the cylinder. Then someone looking at the contraption thought of tying a string from the handle of the valve that opened this communication to another part of the machine. Thus an historic improvement came from an observant mind.

The inventor needs energy and enthusiasm. Seldom indeed do the fruits of technology drop ready made into our laps. Almost always the man who produces a new idea has attacked some problem with all his strength and in a spirit of fiery ardour.

There is not always a "moment of discovery" when the solution to a financial problem or the plans for a machine crackle into consciousness like a flash of lightning. True, there may be an instant when inspiration illuminates the mind, as with Johann Kepler and the first law of planetary motion, or James Watt and the steam-engine, or Archimedes and the principle of specific gravity, or Sir Robert Watson-Watt and radar, but all these men spent months of hard work laying the foundation and then verifying their ideas.

A period of calm receptivity will repay the person who is immersed in research. It will not do to allow our heads to become so filled by a problem, or one aspect of a problem, that there is no room for a new idea to get in. The mind will often produce an original thought or combination if given relaxation after a vigorous bout of work.

On being an inventor

The role of the inventor is to find applications of knowledge that are new. His success may depend in some measure upon natural ability, but he needs training, too, and a purpose. If he is content to amuse himself with ready-made toys and gadgets instead of devising some himself, he need not aspire to a career of invention.

If you want to invent something, but have no definite thought as to what, or if you wish to do something in a different way, but don't know how to change, here is a suggestion. Set aside definite periods in which to analyse your work — at your bench, at your desk, or in the kitchen — as though you were a rank outsider.

Suppose you did not already know how to do a particular job, what approaches might you make to it? If forced to work without the standard tools to which you have become accustomed, what devices could you adapt from other crafts or activities? In office, factory or home, curiosity that is let run wild will turn up ideas both within and outside your field of specialization. Then is the time to write down what your thoughts are — and the game is afoot.

The future

Without doubt the coming years will see a host of new machines and gadgets that will make the work of the world still easier to do. All that we know is still infinitely less than all that remains unknown. Every man must give his own answer to the question: "What part will you play in building that future?" but there is scope enough for all.

Science and invention are of national and world concern. Parts of the earth still slumber under ancient vegetable civilizations; others have been barely touched by the wand of modern industry and have only a thin veneer of this new way of life.

It is not too far-fetched, in view of what has already been done, to look forward to a not far distant time when we of the temperate zones will be able to live comfortably in the tropics. Already, medicine has brought under control such diseases as typhus, plague, leprosy, scurvy and rickets and technologists are steadily improving devices that condition the air. With atomic power we can dig for water in the Sahara and pump it to the surface for use in man-made oases, or we can, perhaps, introduce a miniature artificial sun to the Arctic and the Antarctic. These are optimistic vistas based upon present achievement and the probable successes of inventors.

We must not become so obsessed with the thought of work-saving and ease-giving and nature-conquering inventions that we lose sight of the basic things that make us civilized. Progress in science and invention needs to be accompanied by understanding of the part these activities play in human life. What man's mind can conceive, man's character can control.

The problem before Canadians and like-minded people today is this: are we going to despair of making the social advances that will enable us to live together in the new world that science and technology are building around us, or are we going to search for and find the social answer to happy survival?

Something like this was said in a lecture at the University of Toronto in 1950. Sir Richard Southwell, distinguished lecturer in mathematics at Cambridge and professor of engineering at Oxford put the case this way: "It argues, surely, some weakness of imagination if its wildest forecast is yet cheaper power, more abundant leisure. What has mankind done yet with power and leisure that these should seem self-evident blessings now? . . . Good faith, not technological advance, is the thing most needed in the world of today."

PRINTED IN CANADA
by The Royal Bank of Canada