The Mirrored Spectrum

The Mirrored Spectrum

A collection of reports for the non-scientist and non-engineer about achievements in Canadian Science and Technology.

Canada
Ministry of State for Science and Technology

Ministère d'État Sciences et Technologie

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Introduction

This book is a sampling of a few Canadian achievements in science and technology, written with the non-scientist or non-engineer in mind. It makes no pretence to being comprehensive or to presenting a selection of achievements that outrank those not included. There are many of the latter and, from time to time, it may be possible to add to the accounts already written by the young people who participated in this program — or the appearance of this book may inspire others to seek out and collect further accounts of achievements.

The items here are only a small part of more than 1,000 suggested by scientists, engineers, professional associations, industrial groups, universities and government departments and agencies. These suggestions formed the basis from which a group of young people from across Canada, mainly selected by the university and community college journalism schools, researched and wrote under the supervision of Professor Marvin Schiff of Carleton University's school of journalism.

Their work is testimony to the belief that achievements have taken place in this country of which its citizens can be proud. The rationale for undertaking to write about them in the language of the lay audience rests in part upon a certain attitude toward science, information and democracy. This attitude is at the root of the kind of statement on information policy published by Canada and other members of the Organization for Economic Cooperation and Development in 1971:

"A national information policy must . . . foster a well informed electorate. Effective access to the scientific and technological information base by the general public is a prerequisite of this objective. The educational process itself is a major vehicle for its accomplishment. And governments will wish to ensure that the public is well aware of the scientific and technical facts on which government policy is based. But the public must also have access to these same basic data in order to participate in informed debates on these policy issues, through which social goals and priorities are set."

Dissemination to the public of information about Canadian scientific and technological achievements was not the sole benefit looked for. Hon. Alastair Gillespie, Canada's first Minister of State for Science and Technology, referred to another:

"Among the 15 young men and women, who come from as far apart as Vancouver and Charlottetown, we hope will be found science writers of the future. We hope that in four months of concentrated effort, they will be inspired to say to themselves, 'here is an interesting way to earn my living.' If we succeed, they will be the beneficiaries and so will society. But above all, so will science and scientists."

The program owes much to the support of Mr. Gillespie as well as to the editorial activities of Professor Schiff and Mr. Ken Kelly, director of information services of the Ministry of State for Science and Technology.

The Ministry is indebted to those public-spirited scientists, engineers and writers who served on an advisory committee on publication. They are in no way to be held responsible for any shortcomings of this publication. That is entirely the responsibility of the editor, Mr. Kelly. But their names deserve to be recorded here:

Professor D.G. Andrews, professor of nuclear engineering, University of Toronto; Dr. D.M. Baird, director, National Museum of Science and Technology, Ottawa, and staff; Dr. Louis Berlinguet, vice-rector, University of Quebec; John Bird, public information branch, National Research Council; Dr. Fraser N. Gurd, associate secretary, Royal College of Physicians and Surgeons of Canada, Ottawa; Dr. Martin Johns, chairman, department of physics, McMaster University; Dr. James Morrison, director, materials research institute, McMaster University; Dr. J. Gordon Parr, deputy minister of Colleges and Universities, Province of Ontario; Dr. Louis Siminovitch, professor and chairman, department of medical cell biology, University of Toronto; and David Spurgeon, associate director, scientific publications, International Development Research Centre, Ottawa.

A special thanks needs to be said to all those individuals and groups who furnished ideas and helped to guide the young writers' efforts.

One final word. Many inquiries have been received about the ultimate fate of the source material and suggestions collected during the program. After use in the next stage of the program, these will be deposited with the National Science Library, whose officers and staff furnished important help to the Ministry of State for Science and Technology and to the young writers involved in this program.

Mme Jeanne Sauvé

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Stress

GEORGE PORKOLAB

George Porkolab, 24, from Vancouver, has had considerable experience in radio, television production and theatre, and has had several poems published in Canada, the U.S. and England. He received his MA from the University of British Columbia in 1972.

Stress is "the salt of life" which accompanies all our activities. But prolonged stress can cause irreparable and irreversible damage to body parts. The cumulative effect of stress is the process of ageing. Prolonged stress results in death. Yet the absence of stress means death.

A body can come under stress from physical damage, noise, overcrowding, death of someone close, strikes, boredom, frustration, failure, censure — or just from metabolism, the life process itself.

This entire concept of stress was conceived and evolved by Dr. Hans Selye, director of the Institute of Experimental Medicine and Surgery at the University of Montreal and the world's foremost authority on the subject.

Stress is the body's stereotyped biochemical response to all demands made upon it by changes in the external and internal environment.

Dr. Selye explained: "It's just the same as if you have a very large battery of electric power and you use it for lighting or for heating or for making a bell ring. The specific end results will be very different, but it's always electricity you're using up."

That is, when there is a demand made on a person to adjust to the fact that he has just won the Irish Sweepstakes or lost his brother, the specific aspects, namely the cold, the heat, the pain, the pleasure are different. But the nonspecific biochemical reaction is always the same, like the electricity.

Dr. Selye's work can be put into perspective by noting that in life there are two major objectives from the biological point of view: reproduction and self-preservation. Dr. Selye has devoted his entire career to elucidating the biochemical mechanism of self-preservation or the defense system of the body.

Stress is part of the defense system.

In 1926, as a second-year medical student, Dr. Selye noticed when people are ill, they have a stereotyped response. Whereas his teachers were emphasizing the differences, he perceived the similarities. It wasn't until 10 years later, in 1936, that he came across laboratory evidence of this stereotyped response in test animals. It was then that he identified and labelled as

Dr. Hans Selye, Director of the Institute of Experimental Medicine and Surgery at the University of Montreal.

such the stereotyped response and elaborated it into a theory.

He postulated that the body has a single characteristic basic response to all demands made on it, whether the demand is physical or psychological. He called this reaction pattern the general adaptation syndrome (G.A.S.).

G.A.S. is the sum of all nonspecific reactions that occur when an organism comes under stress, that is, when a demand is made on the organism to which it must adapt.

There are three stages to G.A.S. First, there is an alarm reaction, a general call to arms of the body's defensive forces. Second, there is a period of resistance, reestablishment of normalcy at a great cost of energy and resources. Third, there is a stage of exhaustion when all energy and resources are depleted if the noxious situation lasts too long and the defense system collapses.

Dr. Selye's elucidation of the stress concept opened up many new avenues of research, influenced clinical medicine and the pharmaceutical industry.

Most of Dr. Selye's current research is concerned with the treatment of cardiovascular diseases and a group of hormones which he calls "catatoxic steroids." Catatoxic steroids are part of the defense system of the body and hence still related to stress.

In simplified terms, this is what happens at the biochemical level during stress:

Whether the demand or stressor is physical or psychological, a chemical message goes directly from the stressed area to an area of the brain called the hypothalamus just above the pituitary gland. The stressed area can be a single point, as a burn on the knee, or the entire body, as in the case of mental excitement.

The hypothalamus produces chemical messengers called releasing factors, which go down to the pituitary by way of the blood stream. They tell the pituitary to produce hormones. A hormone is a chemical substance that carries a message to another part of the body.

The pituitary then produces hormones, among which the most important with regard to stress is ACTH, adrenal corticotrophic hormone. Although ACTH is carried to all organs by way of the blood stream, it apparently affects only the adrenal glands located just above the kidneys.

In the adrenals it causes the cortical part, the outside part, to produce certain hormones, which Dr. Selye calls "corticoids."

These corticoids are steroid hormones, steroid being the label for their particular chemical structure. Steroid hormones are the largest class of hormones. Dr. Selye has limited himself to the study of the part these steroid hormones play in the body's defensive reactions.

Some of them carry the message not to fight, to just put up with things, to co-exist with the disease-producing agent. These are called syntoxic hormones, or syntoxic steroids.

Others carry the message to fight, to destroy the disease-causing substances. These are called catatoxic hormones or catatoxic steroids and they help the body rid itself of toxic substances by stepping up the production of drug-metabolizing enzymes especially in the liver. That is enzymes that take apart any pathogen.

These enzymes produced in the liver have the function of being able to destroy a very large number of damaging substances.

Whereas syntoxic hormones were known in 1936, the entire concept of catatoxic hormones was not elucidated until 1971 when Dr. Selye's book, Hormones and Defense, was published.

Dr. Selye feels that these steroids may one day be used to treat patients poisoned by endogenous toxicants, that is, metabolic products of the body itself, or exogenous chemicals, such as insecticides and other environmental poisons.

Dr. Selye's greatest hopes are pinned on PCN (pregnenolone-16-carbonitrile), the purest and most active catatoxic steroid found to date. PCN has a broad spectrum of activity against many different substances and seems to be virtually nontoxic.

Hence in perspective, catatoxic compounds are one of two main groups of adaptive steroids that help man to cope with internal and external stressors. The other, syntoxic compounds, improve tissue tolerance by permitting a symbiotic type of coexistence with the pathogen, that is, by suppressing nonspecific inflammatory or allergic reactions against it.

Dr. Selye is best known for his general stress concept which opened up new approaches of research, for establishing the link between psychological stress and the biochemical changes in the body and much extensive biochemical research, most notably the discovery of catatoxic steroids. He is also regarded as a brilliant educator.

Dr. Selye was born on January 26, 1907, in Vienna. He is the author of 26 books and more than 1400 publications in technical journals. He holds earned doctorates in medicine, philosophy and science, as well as 14 honorary degrees conferred on him by universities in Argentina, Austria, Canada, Chile, Czechoslovakia, Germany, Guatemala, Italy, Japan, Uruguay and the U.S.A. He is a Fellow of the Royal Society of Canada and an Honorary Fellow of 42 other scientific societies throughout the world. A recipient of numerous medals and honorary citizenships, he has been made a Companion of the Order of Canada, the highest decoration awarded by his country.

Sea Battery

DAVID JAMES

David James, 23, is from Cumberland, Ontario. He received his BA from Trent University in Peterborough in 1971. In 1972, he received his diploma in journalism from the University of Western Ontario in London, where he also won an award for journalism. He has travelled fairly widely and freelances for the CBC.

An estimated $4 million worth of silver chloride, tossed into the sea annually in the name of national defence, need no longer be drained from the world's dwindling silver reserves.

Two Canadian scientists, working independently in centres about 1,000 miles apart have substituted lead chloride — previously a useless byproduct of bismuth extraction — for silver chloride in sea water-activated batteries.

These batteries are used, among other things, to power submarine detection devices known as sonobuoys, thousands of which are dumped into oceans and waterways each year, never to be retrieved. On impact, the floating sonobuoys drop microphones into the sea which pick up all subsurface noises. These sounds are transmitted to aircraft which carry instruments capable of sorting out the noise of a submarine.

Since their introduction by the British during the Second World War, scientists had been looking for a way of substituting a less valuable substance for silver chloride in sonobuoy cathodes.

An indicator of the significance of the quest was the fact that as many as 2,000 sonobuoys might be salted into the ocean in a single naval exercise. About 100 tons of silver were lost each year around the world in this manner, about 40 tons of it off North America.

The use of lead chloride, of which Canada alone stockpiled about 200 tons a year, could virtually eliminate this loss.

Working at Shirley's Bay near Ottawa, Dr. J.R. Coleman, a Defence Research Board physical chemist, developed a low-drain, lead chloride battery primarily for the sonobuoy.

In Halifax, Dr. T.J. Gray, a chemical physicist and Director of the Atlantic Industrial Research Institute at the Nova Scotia Technical College, also developed a lead chloride battery, but with slightly different capabilities. His was a heavier-drain, higher-energy battery for heavier duty than powering just sonobuoys.

The joint economic potential of these developments was great. It was believed that since a Canadian lead chloride battery was ready for marketing by mid-1972, Canada was a year to 18 months ahead of other nations working on the problem. That gave this country a considerable advantage in bidding for the valuable U.S. defence market, among others.

The United States, the world's largest consumer of sonobuoys, buys 75 per cent of all production and represents a silver chloride market valued at about $3 million a year. They were expected to buy at least 300,000 of the submarine detection devices between 1972 and 1976.

Of course the relative values of silver and lead chloride mean that the value of the sonobuoy and sea water-activated battery markets would be greatly reduced. The price of lead chloride in 1972 was about 50 cents a pound. The price of silver chloride fluctuated, but was generally about $35 a pound and rising.

But lead chloride batteries ultimately would have other than just defence uses. For example, construction workers underwater could use them to power drills, lights, and other tools, even underwater vehicles.

Further, because the battery did not weaken after long periods of storage and could be activated by a variety of salty fluids, including urine, it could be used in emergency equipment for commercial and light plane operators.

To make lead chloride batteries feasible several problems had to be overcome.

Lead chloride has a tendency to dust or flake with the result that particles from a lead chloride cathode would land on the magnesium anode and corrode it. The corrosion delayed activation of the battery and shortened its life.

Sonobuoy batteries also had to stand up to being slammed into the water at 46 miles per hour, an impact which could disintegrate the lead chloride cathode. In addition the battery had to endure storage for up to 90 days at 90 degrees Fahrenheit in 90 per cent humidity.

Dr. Coleman began his work in 1969. Later the same year Ray-O-Vac Canada Ltd., of Winnipeg received the first of two government development contracts worth a total of $35,000.

Initially, Dr. Coleman and John Armstrong, a Ray-O-Vac project engineer, mixed the lead chloride with a binder or glue. The fabrication process took three days but was not successful. Dusting still occurred.

By 1972 a successful method was found. Lead powder, with the dual role of binder and conductor, was mixed with the lead chloride. The mixture, when heated and pressed in a shallow mould, formed a hard, shiny surface in only a few minutes. The cathode was capable of withstanding the physical abuse and extreme temperatures.

Meanwhile, Dr. Gray had also begun his work in Halifax in 1969 and two years later had success. To increase the battery's power output, he replaced the carbon current collector of the cathode with a metallic gauze, a more efficient conductor. This gauze was placed in a mould and molten lead chloride was poured in to form the cathode by fusion casting. This process took less than half a minute and resulted in a cathode that did not dust.

Dr. Gray further safeguarded against anode corrosion by replacing the magnesium with an aluminum alloy which was cheaper and non-corroding. Since there was no corrosion, the battery could be reused indefinitely, filled up when needed and emptied for storage.

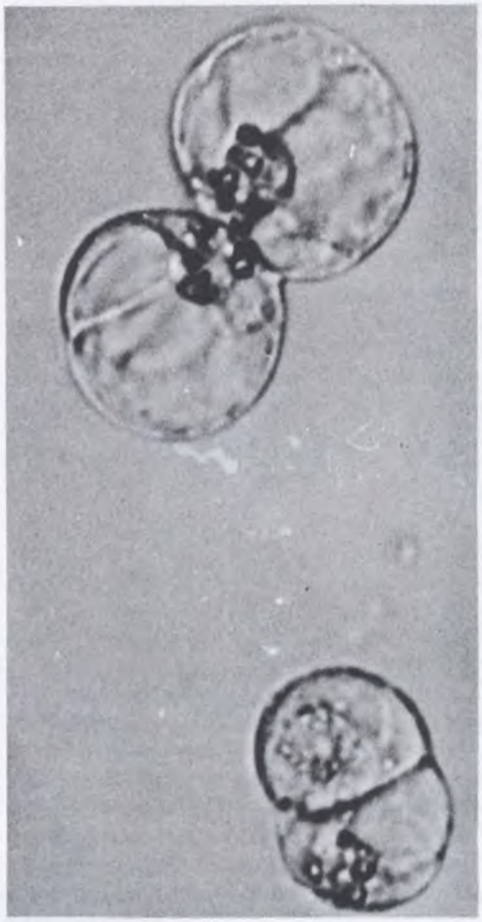
In the summer of 1972, Ray-O-Vac started seeking world markets for Dr. Coleman's battery. The U.S. Navy had expressed interest and British government and manufacturing representatives came to Canada to find out more about the battery.

The Canadian Armed Forces' Air Combatant Services considered their first tender for sonobuoys powered by non-silver chloride batteries from Hermes Electronics Ltd. of Dartmouth, Nova Scotia. The batteries for the Hermes sonobuoys were to be provided by Ray-O-Vac, the only suppliers of the battery in Canada, who had to set up full production facilities.

Cell fusion

LISA MARTEL

Lisa Martel, 21, is a recent journalism graduate of Calgary's Southern Alberta Institute of Technology. She has published several poems, reviews and general articles in the campus newspaper and has been active in art and drama during her high school years. She is currently assisting in research on the role of the mass media in the presentation of science news.



Two cells (protoplasts) in the process of fusion

An increased protein supply for a nutrition-hungry world may result from the efforts of Prairie scientists to produce new plant species.

Known as parasexual cell hybridization, the technique involves fusing cells from related or even unrelated plant species to form hybrids.

By 1972, cell hybridization was still in the developmental stages. However, work had progressed to the point where its developers saw in it great possibilities for several major crop improvements — such as creating unique grains which would require little or no artificial fertilizer, crossing various fruits or increasing the nutritional value of many foods.

As Dr. Oluf Gamborg, one of the leading researchers in cell hybridization, put it: "The results of cell hybridization, when perfected, would affect the populace as a whole. Plant breeding would be revolutionized; the quality and quantity of food production could be increased; protein quality could be improved and desirable traits of one species could be successfully transferred to another."

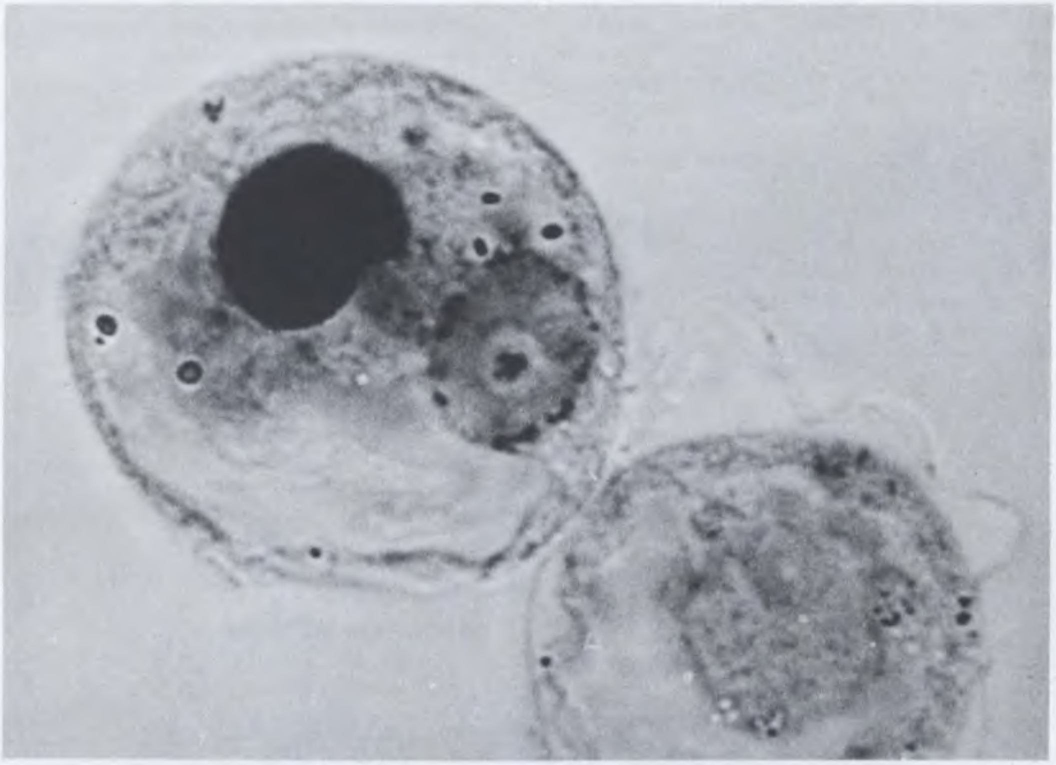
The developers of the cell hybridization process were: Dr. Gamborg, Dr. K.N. Kao, Dr. Friedrich Constabel and, until early 1972, Dr. R.A. Miller. Dr. Tage Eriksson, Sweden's leading expert in cell hybridization, joined the group as a visiting scientist while on sabbatical leave from the University of Uppsala. The research team was working at the Prairie Regional Laboratory of the National Research Council in Saskatoon.

It was in this period between 1969 and 1972 that the research group took the first steps toward cell hybridization. Each step was a significant achievement that, in itself, won the Prairie Regional Laboratory international recognition.

The Saskatoon team was the first in the world to report laboratory regeneration of groups of naked cells or protoplasts — cells from which the walls have been removed. They were also the first to grow wheat and barley cells as suspensions in a liquid medium, a particularly noteworthy achievement.

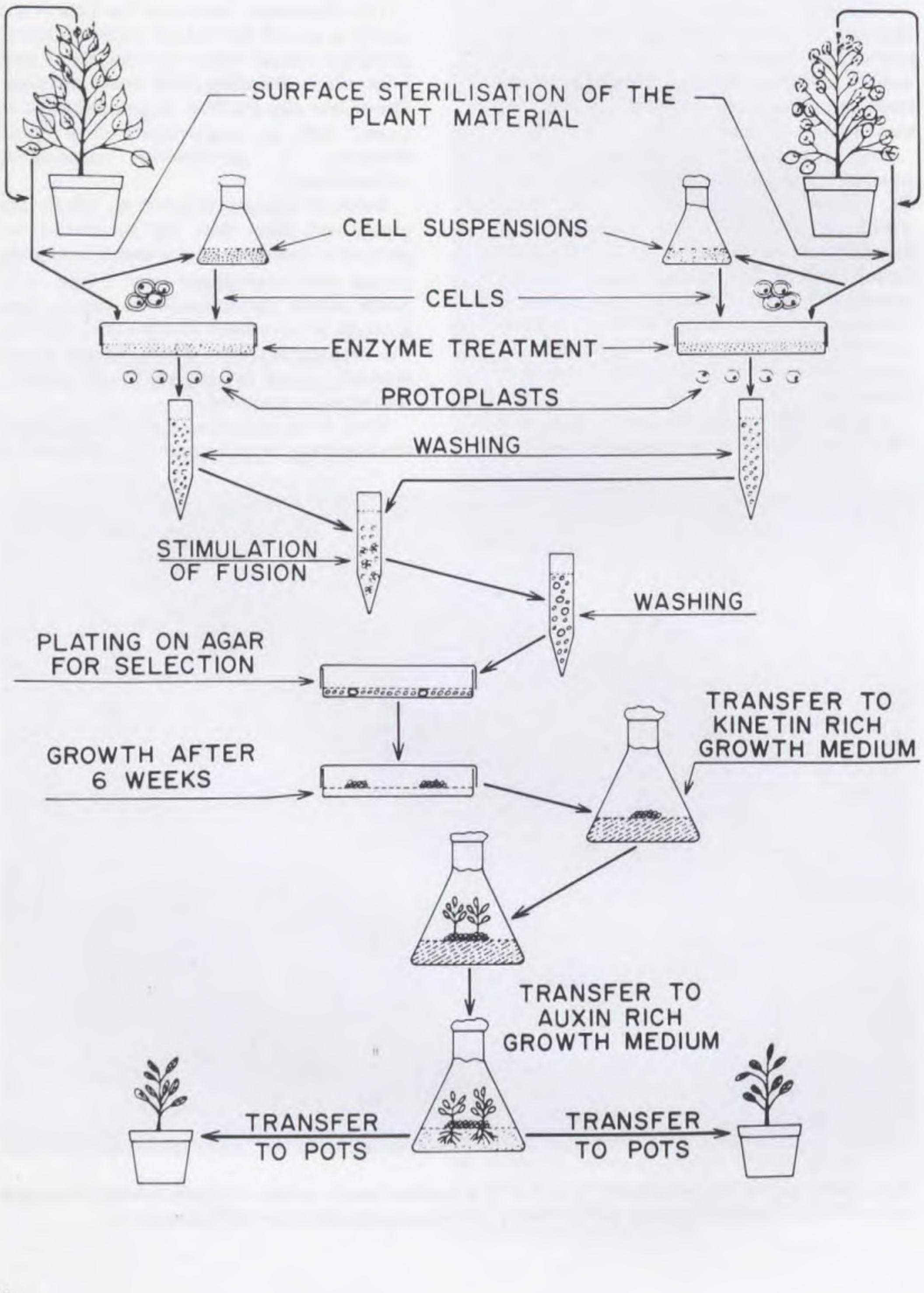
Another accomplishment to which the group laid claim was the successful regrowth of complete carrot and bromegrass plants from protoplasts and single cells. Since whole plants could be grown from protoplasts and cells of the same species, the researchers concluded, hybrid plants similarly could be grown if cell hybridization were achieved.

With these preliminary steps completed, the Gamborg team turned their attention to



A cell with two nuclei produced by fusion of a soybean and a wheat cell (protoplast). The dark colour is the result of staining being used to distinguish nuclei from different plants.

SCHEME OF SOMATIC HYBRIDIZATION



actual hybridization, beginning with protoplasts as the raw material from which they hoped to develop new breeds of plants.

To obtain the protoplasts, they took cells from sections of two different plant species and cultured them separately in liquids containing nutrients and sugar. The walls of the cells were then dissolved with enzymes, leaving protoplasts, each of which contained in its nucleus the genetic code of its species.

The hope of the research team was that protoplasts of two different species could be induced to fuse and give rise to hybrid cells from which a plant of a new species would be produced.

By mid-1972, the group could demonstrate that protoplasts of distinct species — for example, soybean and wheat or wheat and rice — would fuse, even though the nuclei remained separate. Some of the cells produced in their work may have been hybrids — that is, with the two nuclei themselves fused into one.

However, there were few tests to demonstrate that true hybridization had occurred. Development of better techniques to identify and select fused cells was, therefore, one of the next projects of the Saskatoon group.

Once such tests were developed and true hybrid cells were identified, theoretically the way would be open for the development of a broad variety of hitherto unknown plants to answer a world demand for rugged, high-yield, nutritional crops. The final proof, of course, would be in the growing.

Meanwhile, the Prairie researchers were investigating other methods of investing one plant with useful properties of other plants. For example, they were working on the transfer of DNA — the substance in cells that contains a species genetic information — from one plant to another.

Using the results of their hybridization experiments, they also were exploring the possibility of transferring from one species to another the capability of nitrogen fixation — the conversion of nitrogen from the air into organic compounds.

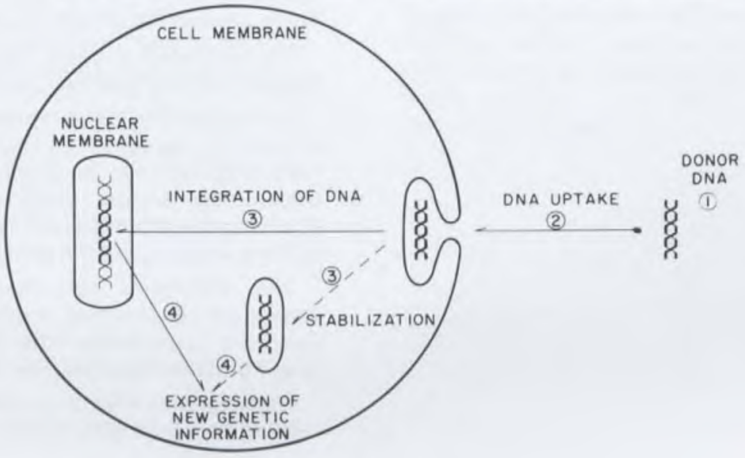
This ability, which is characteristic of legumes such as peas and beans, if transferred to cereal crops with the aid of cell hybridization, would reduce the requirements for nitrogen fertilizers.

Cell hybridization research was not confined solely to the Prairie Regional Laboratory but was a subject of interest to scientists around the world.

Other countries, such as England, Germany, France, Japan, the United States and Sweden also were leading contenders in the race to grow a hybrid plant from individual plant cells.

"As far as culturing of the protoplasts is concerned, the group at the Prairie Regional Laboratory is the most advanced of any research group, and at the moment our prospects for success in other areas of the process are as good as anywhere in the world," Dr. Gamborg said.

A MODEL OF PLANT CELL TRANSFORMATION



Computerized Braille

HEATHER BUCHAN

Heather Buchan, 23 obtained her BA degree from the University of Saskatchewan in 1971. She completed one year of journalism at the Southern Alberta Institute of Technology in Calgary, then became a reporter with the Hudson Bay Post Review in her home town of Hudson Bay, Sask. She is an information officer for the Saskatchewan Department of the Environment.

The blind and visually handicapped everywhere may one day find whole new fields of study and recreation available to them because Roland Galarneau is an impatient and determined man.

When Mr. Galarneau set out in 1966 to develop a computerized method of transposing printed texts into braille, the American Printing House for the Blind in Louisville, Kentucky, already had a four-year jump on him. They had begun working toward a similar end in 1962 but still had not achieved it.

So, the impatient Mr. Galarneau, working in the basement of his home in Hull, Quebec, began building his own computer out of old wires, telephone relays and whatever materials he could scrounge.

By 1972 the computer was finished and ready to produce highly abbreviated French braille from a perforated tape produced by a teletype keyboard.

Why was Mr. Galarneau so unwilling to wait for others to master this complex task? Because Roland Galarneau had been himself nearly blind since birth. He knew at first-hand about the frustrating shortage of braille texts.

And how could a man who has only two per cent vision master the complexities of computer construction? With a profound conviction about the importance of his work, a powerful microscope, considerable help from his friends and a lot of determination.

He explained, "I wanted to build a machine that could accept input that required no knowledge of braille to prepare. Then, anyone could help the blind."

He succeeded in doing just that. But he may have accomplished much more.

It was possible that a network of modern computers, based on the Galarneau prototype, might one day be sharing information transmitted almost instantaneously by sophisticated electronic equipment via telephone links around the world.

The Galarneau computer might also inspire the construction of other computers designed to transpose other languages, or music and mathematics, into braille text.

Starting with efforts to match standard typewriter letters with braille symbols, Mr.

Galarneau's project evolved into the assembling of a highly complex computer with a permanently wired-in program.

A machinist with the Ottawa Department of Public Works, he spent virtually every spare moment for six years designing and redesigning the machine, scrounging materials, soliciting financial support and coaxing friends and family into a few hours' work on parts of the computer he was unable to assemble himself.

In late 1966, Robert Dormer, an electrical engineer with Bell Canada Ltd., was attracted to Mr. Galarneau's project. He spent many hours of his free time drawing a plan to Mr. Galarneau's specifications and providing him with technical information and advice.

Through his efforts and those of Jack Reid of Northern Electric Co. Ltd., Mr. Galarneau was able to obtain a number of telephone relays, electrical switches that constitute the basic components of the computer.

The computer consisted of over 3,500 of these relays, each keyed to recognize individual letters or combinations of letters and produce the corresponding braille symbols. It even could accomodate contracted abbreviations. In the braille system, frequently recurring letter patterns — such as t-i-o-n in action, redemption or retention — are abbreviated to one symbol to facilitate reading.

The computer was designed to scan each word, determine if it contained a pattern that could be contracted, and respond accordingly.

Despite the complexity of the machine, operating it was relatively simple.

The text to be transposed was typed on a teletype keyboard, which produced a perforated tape. This tape was fed to the computer where it was transposed into braille on another tape. This tape was run through a "flexowriter," a machine equipped to produce a printout of the tape for correction purposes.

When corrections had been made, the flexowriter produced a third tape which was cut into strips, each containing the equivalent of about 25 pages of text. The strips were then fed into an electrical reader.

The reader, a component of a teletype machine, conveyed the text in the form of electrical impulses to specially adapted braille typewriters which produced a braille printout at approximately 60 words a minute. Several braillers were utilized to accommodate several tapes at once.

In addition to braille tapes, the computer could be adapted to accept compositors' tapes prepared by inkprint publishers for typesetting on linotype machines.

Financial support for Mr. Galarneau came mainly from a blind resident of Montreal who donated $12,000 to the project. A blind resident of Hull also donated $1,500 and the Canadian National Institute for the Blind contributed $1,200.

In 1970 a group of contributors and friends formed a nonprofit company, the Cyphihot-Galarneau Converto-Braille Service, to promote the computer and solicit financial support. Mr. Galarneau assigned all rights to the computer to the company.

A Local Initiatives grant in February, 1972, enabled Mr. Galarneau to hire four full-time employees to complete the computer.

Although the computer was built to augment the production of French braille in Canada, models based on the prototype may one day be fulfilling the demands of braille readers in many languages throughout the world.

Blood Vessel Stapler

MARLENE SIMMONS

Marlene Simmons, 21, was born in Chatham, Ontario, and studied journalism at Carleton University, Ottawa. She works on a weekly newspaper and hopes later to work in television.

A pen-sized, stainless steel stapler may virtually eliminate the surgical hazard created by the imperceptible shaking of even the steadiest surgeon's hands in joining delicate blood vessels.

The device, called a vascular suturing instrument, was being clinically tested in hospitals throughout the world during 1972. It was conceived by Dr. I.J. Vogelfanger, surgical research chief at Ottawa's Civic Hospital and developed in co-operation with National Research Council engineers.

Formal reports on clinical trials were being assessed at the end of the year. However, Dr. Vogelfanger said the stapler had been used in thousands of operations, mostly on experimental animals and,on a trial basis, on humans.

He said it had been at least 95 per cent effective in joining blood vessels as small as one millimeter across and had cut the time for some operations by more than half.

Without the benefit of a stapler, surgeons had to sew even the smallest blood vessels together by hand under an operating microscope, a delicate and often slow procedure.

The slightest trembling of a surgeon's hand could cause delicate vessel walls to bleed, possibly resulting in blood clots that might block the vessels and cause medical complications. The hazards also mounted as the time required for suturing increased.

According to Dr. Vogelfanger, the stapler proved to be of particular value in organ transplant operations. From 1968 to 1972 the instrument was used regularly in Ottawa Civic and Ottawa General Hospitals during kidney transplants for suturing the ureter, the tube linking the kidney and the bladder.

Using the stapler, surgeons in the Department of Experimental Surgery at the Civic Hospital had done liver transplants in which they managed to cut to 12 minutes the time the recipient had to be without a functioning liver.

Suturing by even the most experienced hands requires 25 or 30 minutes, the point beyond which it is fatal for a patient to be without a functioning liver.

Dr. Vogelfanger also stressed the value of the instrument in repairing vessels of accident victims and saving the limbs of war casualties.

In 1956 Dr. Vogelfanger, with the support of Dr. W. Gordon Beattie, chairman of the Division of Surgery at the Ottawa Civic Hospital, first envisaged an instrument that would join the ends of blood vessels with a ring of minute staples.

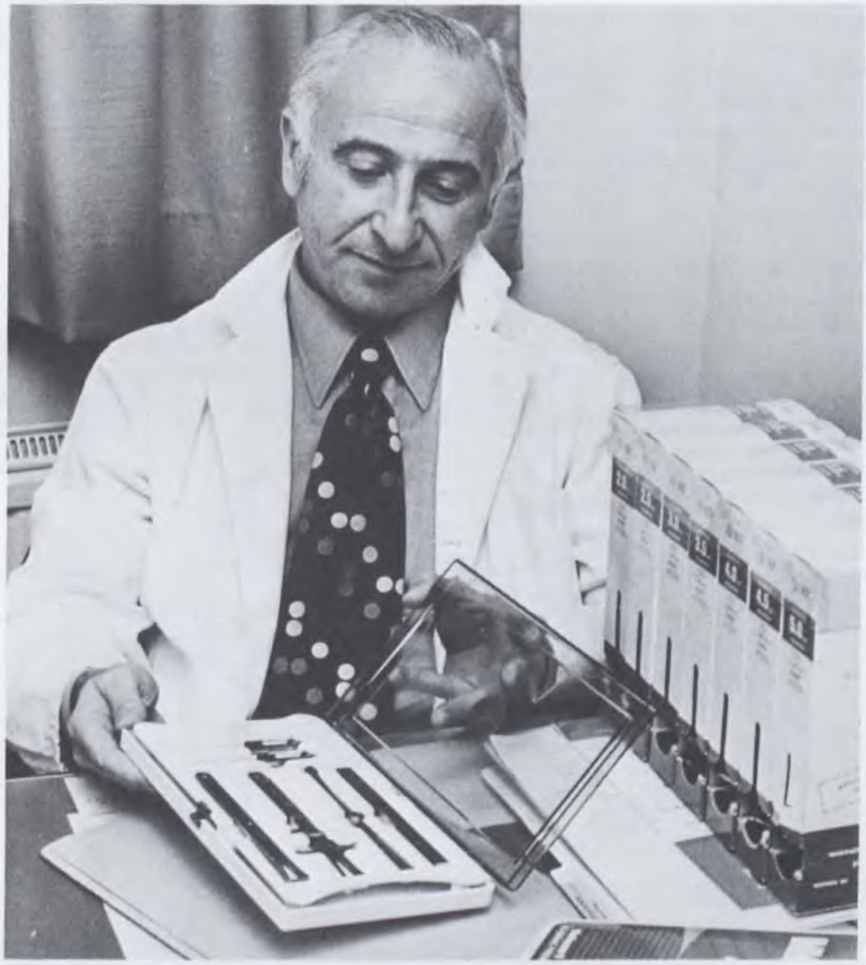
They approached the National Research Council with Dr. Vogelfanger's basic design and the Instrument Laboratory of the NRC's Division of Mechanical Engineering collaborated with them on the actual construction.

Sixteen years of research and $2 million later, the staplers were about to go on the market for $1,000 each. Dr. Vogelfanger donated his share of any profits to the University of Ottawa Surgical Fund.

"We took our time," said Dr. Vogelfanger. "The Russians, Americans and Japanese rushed to get their instruments on the market. We may not be the first, but we're the best."

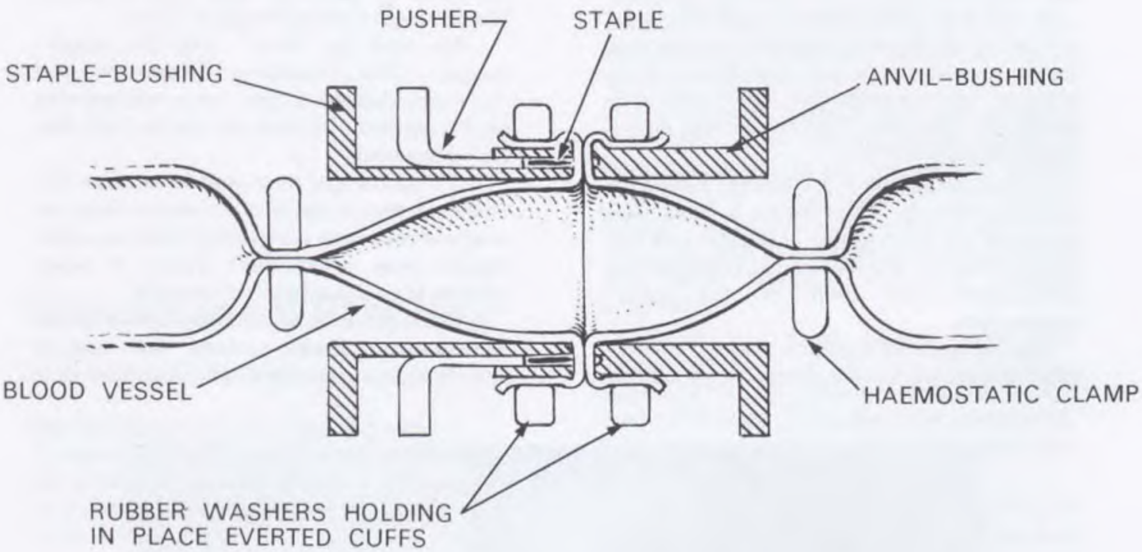
Dr. Vogelfanger hesitated to criticize the other staplers in detail but stressed that the extreme precision with which the Canadian stapler was engineered made it more reliable than the other instruments.

He said the lack of precision of the other instruments caused sutures that leaked and disastrous failures during operations.

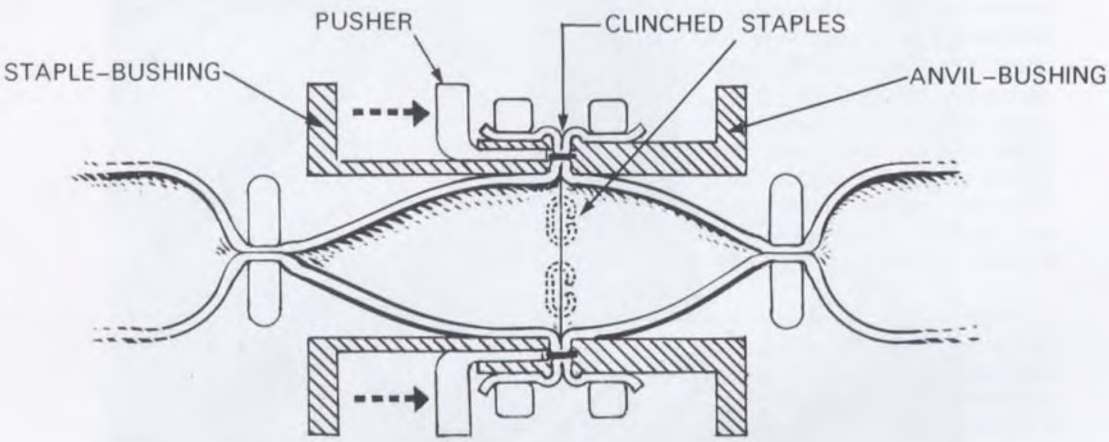


A tiny stapler, which does the suturing a surgeon now does with his hands, is shown by Dr. I. J. Vogelfanger of Ottawa, who conceived the idea.

VASCULAR SUTURING INSTRUMENT
DIAGRAMMATIC REPRESENTATION OF BUSHING ARRANGEMENT
FOR STAPLING OPERATION



(a) CUFFS EVERTED; BUSHINGS APPROXIMATED



(b) STAPLES DRIVEN

Dr. Adrien G. Bouchard, a surgeon at Ottawa General Hospital, was equally enthusiastic about the suturing instrument. He was practising with it on NRC laboratory animals twice a week and was impressed with its ease of handling and accuracy.

The vice-president and general manager of a company which did the initial manufacturing of the stapler said this model was equipped to join only vessels one to five millimeters in diameter in half-millimeter gradations. Eventually, though, it would be refined to suture any vessel in the human body.

Dr. Beattie said the vascular suturing instrument could not yet be used on hardened arteries because they were too thick and tough for the staples, which are smaller than the head of a pin. He said, however, further research probably would overcome this limitation.

A smaller stapler incorporating new refinements had, in fact, been developed to handle vessels ranging from one to two millimeters in diameter in quarter-millimeter gradations. It was being used experimentally in 1972.

Dr. Vogelfanger said the next stapler on the market would handle vessels between six and 12 millimeters in diameter through gradations of one millimeter.

When the vascular suturing instrument is assembled and ready for use it resembles two slender pincers. To suture a blood vessel with it, each end of a severed vessel is threaded through one of two bushings, tiny plastic cylinders in the heads of the "pincers."

Before stapling, the vessel is folded back over its bushing to make a cuff, so the inner surfaces of the stapled section will touch, a necessary condition for healing. Each cuff is held in place by a rubber ring.

The handles of the two halves of the instrument are then aligned and snapped together in a manoeuvre that also aligns the cuffs perfectly. When the handles are squeezed, one bushing pushes out the U-shaped staples while the other acts as the anvil against which the staples are bent.

When the pressure is released, the handles spring apart and the bushings fall off. They are picked up, one cuff is folded over the other, and the suture is finished.

In 1965 the company which would ultimately manufacture the instrument joined in the development work and, after seven years, produced disposable, preloaded plastic bushings to eliminate stapling failures.

The company spokesman said no estimates of potential sales of the instrument could be made until reports of its clinical trials were in. However, Dr. Vogelfanger predicted, "I think it will become as common as the needle is now in the operating room."

Scale

PETER MILLS

Peter Mills, 21, is in third year journalism at Carleton University, Ottawa, where he has had considerable experience with television and journalism production.

An electrical weigh scale designed in Montreal has eliminated "boxcar bounce" and other phenomena that once frustrated efforts of railroads to weigh freight in motion. It also has allowed them to save millions of dollars in the bargain.

The scale, capable of highly-accurate measurement in seconds, consists of a platform set into a regular railway line. The platform is equipped with weight-sensitive, electronic cells that feed data about a moving freight car to a computer centre where it is analyzed and the weight of the car's load is computed.

The scale can weigh objects up to 500,000 pounds that are moving up to 15 miles an hour with only a 15 percent margin of error. For example, if a loaded freight car weighed 130 tons and the car was travelling at 15 miles an hour, the scale could compute the weight of the cargo within 400 pounds.

By 1972, its use at the five major Canadian National Railways yards of Montreal, Edmonton, Winnipeg, Moncton, and Toronto had meant an annual saving of up to $2 or $3 million for CN, whose engineers developed the scale.

The savings could be effected because the company no longer had to remove freight cars individually to sidings for static weighing, a procedure that costs $10 a car. The cost of weighing fully-loaded freight cars in 1971 was about $10.5 million. If the cost of handling partially-loaded cars was included, the total was at least two or three times higher.

Other applications of the scale may include weighing on conveyor belts or weighing other transport vehicles in motion.

The scale results from three years of work begun in 1963 by a team of engineers, headed by Dr. Robert Cass and Pierre Berthiaume, at CN's Technical Research Centre in Montreal. CN now holds patents on the scale in Canada, the United States, Japan and most major industrial countries in Western Europe.

When CN began its research, it was looking for a scale capable of fast, accurate, in-motion weighing. The scales available in 1963 either were not capable of in-motion weighing or could not meet federal standards of accuracy.

CN tried to adapt existing scales to give accurate measurements of moving cars, but conditions at hump yards, where freight trains are categorized and assembled, made this impossible.

In hump yards, cars are moved from giant loading and storage sidings down a "hump", or hill, in the order in which they are to be joined in a train. CN wanted a scale that could be used at the bottom of the hump. Existing scales capable of in-motion weighing suffered from "boxcar bounce," a phenomenon caused by the hump. Cars would gather speed as they reached the bottom of the hump and bounce as they hit the scale. This, combined with winds, wear on wheels and rails, and differences in the dynamics of each car, resulted in seriously inaccurate and inconsistent measurements.

The CN electronic weigh scale compensates for all these problems.

Load cells, sensitive to weight, are attached to the scale to operate in combination with a small computer. Readings from the load cells, which include the unwanted boxcar bounce, are fed to the computer.

Previously programmed with all available information on all CN freight cars, the computer is able to analyze the incoming information from the scale and compare it with stored information. It then eliminates the effects of the bounce and other variables so that the virtually true static weight of the car is determined and the weight of the load is produced.

The readings are printed out at the scale and at a second location for billing purposes. The whole process takes approximately three seconds.

The first scale was built in CN's Montreal hump yard, where it underwent tests for three years before receiving final approval in 1965 from the division of weights and measures of the Department of Industry, Trade and Commerce.

Ramsey REC Ltd., of Richmond Hill, Ontario, an affiliate of the international Ramsey family of companies, holds worldwide rights for manufacturing and marketing the scale.

As of mid-1972, the only other companies besides CN known to be using the scale were the Steel Co., of Canada Ltd.; International Nickel Co., of Canada Ltd.; and Algoma Steel Co. However, world marketing of the scale had just begun and Ramsey had several inquiries from companies in the United States and overseas.

The cost of the scale depends upon the length and size of the track and platform required. It has varied from $40,000 for a unit 12 1/2 feet to about $100,000 for a unit 82 to 85 feet long.

Crash Indicator

BRIDGET MADILL

Bridget Madill, 20, a journalism student at Carleton University, Ottawa, was born in Kapuskasing, Ont., where she worked part-time for the weekly newspaper. She hopes to work in public relations.

If every aircraft in Canada were equipped with one of Harry Stevinson's "automatic pigeons" between 1972 and 1982, an inestimable number of lives and over $28 million could be saved.

That, at least, was Mr. Stevinson's assessment of the potential value of his "pigeon," a device he designed and formally named the airfoil crash position indicator (CPI).

The CPI is carried by an aircraft and, in the event of a crash, is automatically released to broadcast a signal that rescuers can "home" in on.

This type of CPI uses a very specially designed airfoil as the main component of an escape system capable of performing in a fraction of a second, and very short flying space which may be all that is available during an airplane crash. This escape device can carry a small payload such as a distress radio beacon and still preserve enough performance to escape the fury of a large percentage of crashes.

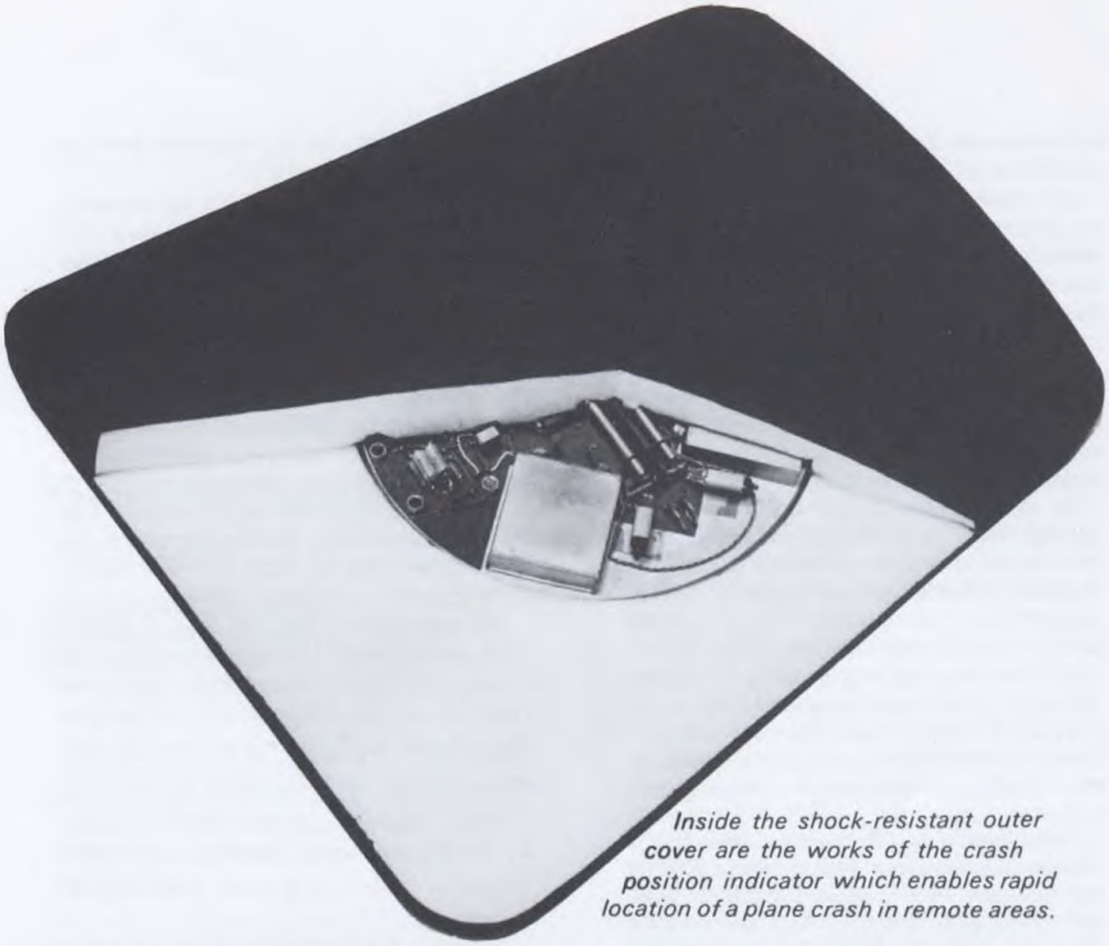
It must do more than escape and land softly. It must support the needs of the radio transmitter and its essential antenna almost anywhere on earth for up to several days until search aircraft have accurately located the crash site and/or survivors.

The first commercial aircraft was fitted with an Airfoil CPI in 1960. By 1969, 14 planes carrying airfoils were known to have crashed. The ability of the system to perform in ocean crashes was proven off the coast of South Vietnam in April, 1967, when a large plane crashed offshore. The airfoil deployed, floated clear and permitted a long range signal from its transmitter to alert rescue planes. As a result of the rapid rescue made possible, the CPI is credited with saving at least one life.

The ability to perform in severe crashes like flying into a mountain was demonstrated in the Northwest Territories in April, 1969.

A small aircraft crashed into the side of a deep valley, the airfoil deployed and signalled for 79 hours before the crash was pinpointed in the dark by radio. This location was confirmed in daylight and only then was it known that there were no survivors.

In 9 of the 14 cases the crash was severe enough to deploy the airfoil. Three levels of



Inside the shock-resistant outer cover are the works of the crash position indicator which enables rapid location of a plane crash in remote areas.

crash detection are provided: a) Crashes too gentle to cause injuries — manual deployment feasible. b) Moderate crashes — automatic crash detection and deployment. c) Severe crashes — aircraft tears to pieces, airfoil torn off whether crash detector works or not.

In 4 of the 14 cases conditions warranted calling out search and rescue aircraft. In 3 cases the missing planes were found so quickly that 90 to 95 percent of the normal flying time was eliminated.

In the remaining case the aircraft was extremely far off course, and had a faulty installation interfering with the normal CPI battery-charging system. These no doubt were factors contributing to abandonment of the search after 234 flying hours. The aircraft was found 58 days later by accident. Extreme cold weather also had been a factor.

The relevant statistics also seemed to justify Mr. Stevinson's assessment of the CPI's potential value. In Canada, 98 planes crashed in 1971.

There was no indication of how many lives might have been saved if CPIs had drawn rescuers to these downed aircraft sooner. However, to indicate potential financial savings, authorities pointed out that Canadian Armed Forces search-and-rescue teams spent 8,628 flying hours looking for them at a total cost of over $7 million.

Despite the proven capabilities of the CPI, though, no world airline had opted for the device by 1972. They still used a less expensive, manually-operated personal locator beacon, carried within the aircraft. Small aircraft still used a beacon fixed inside the plane.

Unlike the CPI, the contained beacon goes down with its aircraft in the crash, often to be destroyed or at least severely damaged by the impact. Nicknamed the cannonball by aviation authorities, the fixed beacon frequently is sent shooting through a plane upon impact, adding to its own chances of damage and creating an additional hazard for passengers.

CPI airfoil units are roughly saucer-shaped, about 20 inches across, 4-1/2 inches deep and weigh about six pounds. But there are many variations of the device, depending on the aircraft to be fitted.

They are rectangular or round, flat or curved on the underside, designed for subsonic or supersonic aircraft, with rounded edges or very sharp ones. Some contain only a radio beacon; others carry a flight data recorder as well.

In good line of sight conditions, the beacon has a range of 40 to 60 miles and the battery lasts about 60 to 80 hours. Antenna orientation has some effect on transmission but the flat shape greatly favours proper orientation either side up.

Work on developing a device to locate missing aircraft was begun in 1954 at the National Research Council under the direction of Mr. Stevinson, a project engineer at the NRC's National Aeronautical Establishment.

Tests began in 1956 at the NAE Flight Research Laboratory and in May, 1960, the first commercial aircraft was fitted with an airfoil CPI. Shortly after, the federal Department of Northern Affairs and the former Department of Mines and Technical Surveys made it mandatory to use CPIs on all planes they chartered. Mr. Stevinson said he thought they were necessary on all aircraft.

CPIs are manufactured by Leigh Instruments Ltd., of Carleton Place near Ottawa. Very simple ones for large aircraft cost about $2,000 to $2,500 each, and more complex CPIs for military use cost $5,000 to $8,000. With a flight data recorder included in the airfoil, the average CPI might be priced from $15,000 to $40,000, depending on customer specifications. The Dapi, for light aircraft such as bush planes, sells for $671.

Douglas Granger of Leigh Instruments said that by 1972 the company had sold almost 3,000 CPIs in many countries including the United States, Peru, West Germany, and New Zealand as well as Canada. The main market was military.

Meanwhile, though, there were no regulations requiring the use of CPIs on civil aircraft and the International Civil Aviation Organization had made no recommendations to commercial airlines for their use.

The Ministry of Transport indicated that emergency locator transmitters will be made mandatory for most Canadian registered aircraft by January, 1974.

Development of the CPI was a multidisciplinary affair. Massive assistance was obtained from the Department of National Defence and the Department of Transport and a team, led by Mr. D.M. Makow from NRC's Radio and Electrical Engineering Division helped to develop the CPI's radio. In 1959 they were awarded the British Brabazon Award for a paper published on their work.

In 1965, the Canadian Aeronautics and Space Institute presented Mr. Stevinson with the J.A.D. McCurdy Award for his contribution to air safety.

In 1972, Mr. Stevinson was still heavily involved with CPI research, doing preliminary tests on a device for helicopters, and developing a theory for future satellite locations of radio distress signals. D.A. Baker assisted Mr. Stevinson throughout this project and is a co-inventor in some of the CPI patents. G.O.C. Paynter, who was part of the team for 10 years, is also co-inventor on two of the CPI patents.

Genetic Engineering

OREST DUBAS

Orest Dubas, 28, an astronomer turned science writer, obtained his B.Sc. from McGill and his M.Sc. from the University of Toronto. His interest in the sciences, coupled with the work towards his Diploma in Journalism at the University of Western Ontario in 1972, spurred him into the field of scientific communication research. He is co-ordinating a survey on the impact of science and technology on the public.

Both farmers' barley crops and brewers' beer were richer by the 1970s as a result of more than three decades of genetic improvements in barley engineered by a Canadian agricultural researcher, Walter H. Johnston.

According to conservative estimates in 1969, barley research under Mr. Johnston's supervision "added an accumulative total of $140 million to the income of Western farmers".

Meanwhile, the Canadian brewing industry had never translated its debt to Mr. Johnston into dollars and cents, but spokesmen acknowledged that the malting barleys his research teams developed were almost ideally tailored to the beermaker's needs.

Of the 655 million bushels produced in the 1971-2 Canadian barley harvest, half were of varieties developed by Mr. Johnston and his associates in the cereal crops section of the Canada Department of Agriculture experimental station at Brandon, Manitoba.

Their research led to the introduction of barleys ideally suited to the climatic conditions in the Canadian west. Among the characteristics of the strains they bred were better yield capabilities, greater disease resistance, and higher malting quality.

From the time of its introduction in 1965, Mr. Johnston's most successful variety, Conquest, outyielded earlier malting barley by almost 25 per cent. By 1972, it had become the most popular type of barley in Manitoba and Saskatchewan, and the second most popular in Alberta.

It also was particularly satisfactory to brewers, who, in 1972, were producing Canadian beer from malt containing 70 to 80 per cent Conquest.

Although considered his most important achievement, Conquest was not the only major breed developed under Mr. Johnston's direction during his 36 years as head cerealist of the Brandon station. In that time he secured licences for eight different varieties of barley, more than any barley breeder in North America.

Each represented more than a decade of work for the researchers.

"The development of barley is an ongoing thing, just as is the breeding of animals," according to Mr. Johnston. "You take the best varieties of the past and cross these selections with others to get improved barley."

This cross-breeding, based on the painstaking tracing of barley parentage, has been the key to Mr. Johnston's breeding program.

In cross-breeding, the anther, or male part of the barley, is pulled out of the plant before it releases the pollen from its pollen sac. Then pollen from another barley variety is transferred onto the stigma, or female part. This hybrid plant is then tagged and catalogued.

Within five to six days after such a cross has been made, some 30 seeds of hybrid barley are produced in each head of barley. Then, after four to five harvests, a true strain of this barley results.

By using this technique, the breeder can control the reproduction of barley, and can produce hybrid progeny with desirable genetic characteristics — better yield, better malting quality, or a combination of several traits — from existing varieties.

"Even with latest methods, such as using greenhouses and getting two crops a year, or sending material south for another crop, it takes at least seven years, and more like a decade, to get a variety to the farmers," said Mr. Johnston.

When Mr. Johnston became the cerealist at Brandon in 1936, he took over a breeding program that had begun in the early 1900s. Within three years, Brandon licensed their first variety, Plush.

Unlike earlier barley, Plush did not lose its kernels in high wind or storms. It soon dominated about two-thirds of the barley acreage sown in the eastern Prairies. Its introduction is estimated to have saved Western farmers about $30 million through crop losses.

In the next two decades, Walter Johnston worked constantly on the elimination of various barley diseases through selective breeding. His 1947 variety, Vantage, was resistant to stem rust, the epidemic responsible for total crop losses by Western farmers in the late 1930s.

By 1961, he had developed his last feed

Mr. Walter Johnston, Canadian pioneer in agricultural research, looking over one of the barley varieties he helped develop.

variety, a high-yield grain called Keystone, which was highly resistant to rust diseases.

Much of Mr. Johnston's work in the 1950s and 1960s was devoted to developing breeds of barley especially for malting purposes.

Malting barley required several qualities. Its kernels had to be high in starch content and the enzyme activity which converts these starches into water-soluble sugars also had to be high.

In addition, the economics of the malting operation required the barley kernels to be plump and uniform in size.

Mr. Johnston's research was intended to produce these qualities in a barley crop without loss of yield.

Mr. Johnston's first successful malting barley, Parkland, licensed in 1956, fulfilled these requirements, and, by 1965, half the acreage of Manitoba and one of every five acres in Western Canada were devoted to this variety. Its dominance was challenged only after nine years by Conquest, which Mr. Johnston developed with his Brandon associate, Dr. Richard Metcalf.

Because Brandon's latest varieties — Paragon, introduced in 1968, and Bonanza, introduced in 1970 — matured earlier, more farmers preferred to devote their acreage to them than even to the best feed wheats. They could be sown not only in the northern areas of the Prairies, but wherever farmers experienced early frosts.

The research leading to the malting varieties was part of an overall barley-breeding program organized in 1949 for the eastern Prairies. Mr. Johnston coordinated this joint project of government and industry from its inception until his retirement from Brandon in 1971.

During the period from the '30s to the '70s, Western farmers devoted more than 40 million acres of Prairie farmland to the growing of Johnston barleys.

In addition to the eight licensed varieties, Mr. Johnston left for his successors several new varieties with excellent prospects for government licensing.

One variety, tested in 1972 for the first time, appeared to have the best malting quality ever to come from the Brandon station. Another advance line was yielding better than Bonanza, and was earlier-maturing and shorter-strawed than Conquest.

Walter Johnston received many awards for his barley research, among them an honorary Doctor of Science degree from the University of Manitoba in 1968. The following year, the federal government accorded him the highest Merit Award given by the Public Service in Canada.

In 1972, a Walter H. Johnston scholarship was set up by the Canadian Malting and Brewing Research Institute at the University of Manitoba for research in areas related to barley improvement.

Earth Core

BRUCE SMITH

Bruce Smith, 24, received his BA degree in 1971 from the University of Calgary. In 1972, he received his Honours Bachelor of Journalism degree from Carleton University, Ottawa. He is presently working at I.P. Sharp Associates, a Canadian-owned firm specializing in computer systems and service.

The earth is a sort of heat engine, the internal workings of which created the conditions that made life possible and continued to influence its evolution.

This theory, the first to link the convulsions within the earth's core to the origins and evolution of life on its surface, was advanced in 1963 by Dr. Robert J. Uffen, then geophysics professor at the University of Western Ontario.

The mysterious inner workings of the earth had long intrigued the scientific community, but there had been precious little discussion of their biological consequences until the Uffen theory.

Dr. Uffen theorized, as have other scientists, that the earth began as a whirling cloud of gasses and dust some 4.5 billion years ago. Eventually the centre of this cloud condensed to a molten mass. For the next two billion years the molten interior of the earth bubbled with activity, culminating in the formation of a surface environment suitable for life.

As the earth compacted into a sphere with an essentially iron core, it was bombarded by electrically charged particles blown from the sun. Dr. Uffen believed that this solar wind produced a weak magnetic field which exists in the core.

All the while, the metallic core grew hotter and hotter. Like the action in a pot of boiling porridge, the hot metals near the core were churned upward, only to fall back once more as they cooled.

The transfer of heat by actual movement of the fluid — a process called convection — followed circular or elliptical paths. The flow of molten metal thus formed "convection cells." This motion within the earth's core produced what Dr. Uffen called a self-generating dynamo.

When a coil of a man-made dynamo moves across a magnetic field, an electrical current flows through the wire of the coil. Similarly, the motion of the convection cells across the earth's weak primary magnetic field produced ring-shaped flows of electrical current within the core.

The converse is also true. Just as magnetism gives rise to an electric current in a dynamo, electric current, in turn, produces a magnetic force. Consequently the electrical ring currents within the earth's fluid core produced magnetic fields. These gradually increased in strength, producing a powerful envelope of magnetic force around the planet.

Dr. Uffen suggested that the origin of life on earth was not possible until this magnetic field was formed to ward off some of the life-damaging ions reaching the earth in solar radiation. This was a novel approach, for it had previously been held that natural radiation had little effect on the evolution of life.

According to Dr. Uffen, a weak, multipolar magnetic field began to offer some protection about 2.5 billion years ago. By this time the earth had taken shape, complete with continents, oceans and a primitive atmosphere.

But, Dr. Uffen theorized, the life process from which man eventually evolved probably did not begin until about 1.5 billion years ago. By then a solid inner core had developed and the large convection cells in the outer core and mantle had produced powerful magnetic fields around the earth.

With the planet thus protected from the influx of damaging and sterilizing radiation, the growth of living organisms from organic molecules in the oceans became possible. The first tiny, primitive organisms appeared. Perhaps the oceans were the first source because water acted as a shield against radiation.

After the formation of the earth's magnetic field, its strength and polarity did not remain constant. Significant changes occurred from time to time which, Dr. Uffen believed, profoundly affected life on the planet.

The magnetic field was periodically reversed so that north would register as south on a compass. Little was known about the causes of these reversals, but Dr. Uffen again drew on the analogy with a man-made dynamo to explain them.

If a dynamo is turned off and started again, he explained, it is conceivable that the polarity of the magnetic field it creates would be reversed. He therefore supposed that the reversals in the earth's magnetic field were due to interruptions in the motion of convection cells within the earth's core.

The time required for a reversal to occur was between 5,000 and 10,000 years. During this interval, the strength of the earth's magnetic field was greatly reduced, probably passing through zero.

In the absence of the strong, protective magnetic shield, Dr. Uffen suggested, the solar wind showered the earth with charged particles. The accumulated effect of this radiation bombardment over several generations was the extinction of some primitive organisms and the evolution of others.

Dr. Uffen's theory of the influence of the earth's core on the origin and evolution of life still had not been proven almost a decade after he advanced it. But discoveries had been made since 1963 which tended to support his argument.

Study of the magnetic qualities and fossil content in rock core samples, for example, had confirmed that some species had died and others had appeared at the same time as magnetic field reversals.

Still, some things remain unexplained. The chief criticism was that the theory did not offer an adequate explanation of how radiation penetrated the earth's thick atmosphere.

Dr. Uffen said further research also was needed in genetics, especially in regard to the effects of radiation. He proposed that experiments be carried out from orbiting space stations, in which living organisms could be exposed to radiation outside the atmosphere and the genetic mutation effect could be measured.

Valid or not, Dr. Uffen's theory inspired a great deal of scientific research. While his ideas might one day be rendered obsolete, their value remains unchanged.

Electric Hands

DON WIGHT

Don Wight received his BA in English from Saint Dunstan's University, Charlottetown, in 1969. In 1972 he received his diploma in journalism from the University of Western Ontario.

A 10-year-old child, her arms deformed since birth because her mother took thalidomide during pregnancy, contracts a muscle in her stunted arm.

Electrical impulses, generated by her own body, flow from the muscle to an artificial hand. The fingers, fashioned by technicians in a workshop, pick up coins, grasp a fork, offer a pencil.

It is unlikely medical science ever will be able to make her whole. However, because of the work of the Rehabilitation Institute of Montreal, under the direction of Dr. Gustave Gingras, many of Canada's 125 thalidomide children, as well as amputees and others with limb deformities, can lead comparatively normal and useful lives.

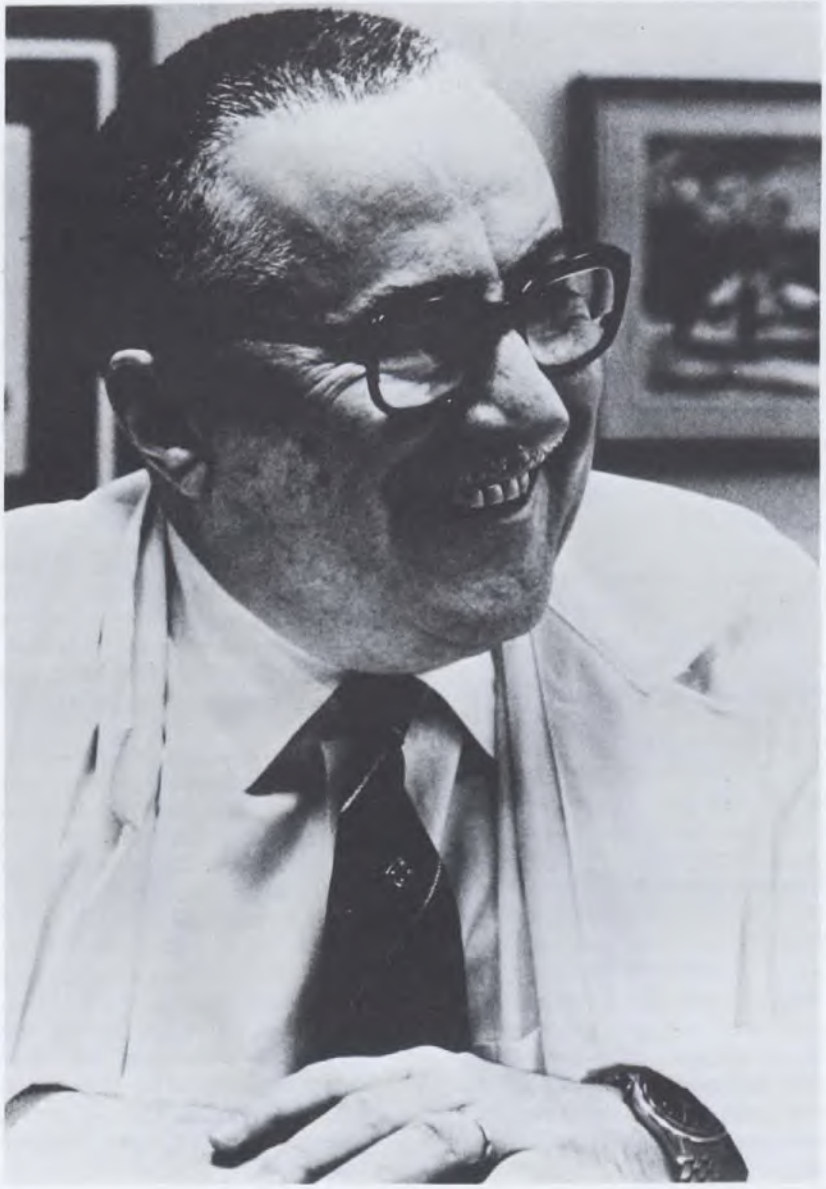
Since 1964, Dr. Gingras, a world-renowned figure in physical medicine and rehabilitation, the institute staff, and researchers at Northern Electric Company in Ottawa have been refining an artificial hand activated by the body's own electrical currents. They succeeded in improving the original Soviet-designed hand, known technically as a "myoelectric upper extremity prosthesis."

When brought to Canada for study at the Institute, the device was already an improvement over conventional artificial limbs. Its operation required no muscular effort; nor did support equipment have to be harnessed to the body.

However, the hand, as the Russians had designed it, was limited to use by adult males, primarily amputees. Dr. Gingras sought to adapt the myoelectric principle to devices for females and particularly for children.

To this end, the Institute engaged the assistance of engineers at the Northern Electric Research and Development Laboratories in Ottawa. Northern Electric also received grants totalling $67,000 for the period 1966 to 1971 from the National Research Council of Canada to support this research on improving the prototype electric arm. Components were miniaturized, almost all wiring was made internal, and a wrist unit was added. This wrist, though not controlled myoelectrically, could be rotated by the wearer turning it with his other hand.

The greatest improvement, however, was to build into the hand a system of



Dr. Gustave Gingras, Executive Director of the Rehabilitation Institute of Montreal, and winner of the $50,000 Royal Bank Award for 1972.

"proportional control" which gave it a grip force proportional to the muscle electricity activating it. The control system also gave the hand a "pinch force," a "sense of feeling" which, for instance, allows the hand to pick up a cigaret without crushing it.

The hand can pick up objects varying in diameter from one-quarter to 3 3/4 inches. A cosmetic glove encasing the hand increases the friction between the hand and the object grasped. The increased friction enhances the grip, making it firm enough to hold a knife and cut a steak.

The electric hand functions through surface electrodes attached to a muscle which pick up the electrical signal involved in muscle contraction. An amplifier, which the Institute developed and built into the device, increases the strength of the signal and turns it into a direct current.

When the current is strong enough, a motor is switched on to run in the direction dictated by the muscle impulse. Another electrode picks up the signal to run the motor in the opposite direction. The hand can thus open and close.

While the myoelectric system is here to stay, it may not completely replace conventional devices which are controlled pneumatically, by compressed carbon dioxide, and activated manually.

As Dr. Gingras said: "Each human's problems are unique. This probably precludes the development of any standard device to serve all cases."

The absence of a harness or vest encasing the torso is one advantage of the myoelectric system, for it allows greater freedom of movement. In addition, activation of the myoelectric device does not require muscular exertion.

And, unlike most conventional devices, the appendage is a "hand" rather than a hook, an improvement in cosmetic appearance that may be psychologically important to the wearer.

However, myoelectrically-controlled limbs are heavy. Bilateral amputees — persons whose arms are both deformed — may experience difficulty in putting them on. In addition, the electrical signals sometimes get mixed up, closing the hand when it should open or opening the hand when it should close.

In future prosthesis, Institute researchers hoped to see even smaller, more compact electronic devices. All the wiring was to be built into the artificial limb and the electrodes possibly imbedded beneath the surface of the skin. The myoelectric system also was to be further applied to paraplegics and others with limb paralysis.

Camille Corriveau, a consultant in prosthetics and orthotics at the Institute, called Dr. Gingras "the father of rehabilitation of the physically handicapped in Canada." However, Dr. Gingras' contributions to physical medicine and rehabilitation have been international.

From 1953 to 1959 he worked with the United Nations in establishing a national rehabilitation centre in Venezuela. Similar projects were initiated in seven other South American countries.

In 1969 he opened a rehabilitation centre in Qui Nhon, South Vietnam. In the same year he co-ordinated an International Red Cross program that resulted in 8,000 of 10,000 Moroccans being totally cured of paralysis caused by contaminated cooking oil.

Dr. Gingras teaches physical medicine and rehabilitation at the University of Montreal, is a member of more than 20 national and international societies, has published over 145 articles and, in 1972, was elected president of the Canadian Medical Association.

On June 8, 1972, he was awarded the $50,000 Royal Bank Award for his contribution to human welfare. In announcing the award, Dr. Roger Gaudry, Rector of the University of Montreal, said it was largely due to the work of Dr. Gringras that "those without legs, walk . . . without hands, grasp . . . without spines, stand erect . . . in pain, endure."

Anti-pollution Cars

JOHN FORSYTHE

John Forsythe, 26, is from Winnipeg where he attended the University of Manitoba to obtain his BA degree. From 1968-1971, he worked with the Winnipeg Tribune.

Ten town cars, designed to prove automobiles need be neither killers nor polluters, took shape in 1972 under the hands of Canadian college students and the eyes of federal transportation authorities.

The immediate inspiration for the student undertaking was a U.S.-Canadian competition for "a better urban vehicle". The competition, held in August, 1972, was jointly sponsored by the Transportation Development Agency of the Ministry of Transport and four major U.S. institutes of technology.

Of 63 cars in the finals of this competition, two Canadian cars received prizes for their design.

A sporty-looking avocado vehicle with an internal combustion engine, designed and built at the University of British Columbia, received the top award for over-all excellence. It was judged best-in-show for safety and style, and scored high on almost all the tests, which included emission of pollutants, estimated cost of production, space utilization, drivability, fuel-efficiency, bumper effectiveness, and a variety of performance tests.

The award for the best electric vehicle was won by an entry designed by teams from the University of Western Ontario and Fanshaw College of Applied Arts and Technology in London, Ontario. This car also received the most points for student innovation.

In the long run, though, transportation agency officials hoped student-designed safety or anti-pollution features would be taken up by the auto industry. The industry was made directly aware of the students' designs because the cars were judged at the General Motors testing ground near Detroit, Michigan, by experts from the major U.S. car companies.

There was also the possibility that the industry would be forced by stiffer safety and pollution legislation expected in the 1970's to adopt similar features.

C.B. Lewis, head of planning for the Transportation Development Agency, even suggested that "if a car were sufficiently promising, it would lead to all sorts of opportunities for Canada to get into the car business . . . to work with something other than American designs."

Mr. Lewis said his agency would work

The winning vehicle was designed and built by students from the University of British Columbia.

with the Department of Industry, Trade and Commerce to encourage Canadian manufacture of a promising design.

Underlining the value of the student efforts was the fact that conventional cars are major polluters and killers. For example, motor vehicles were responsible for nearly half the 11,378 accidental deaths in Canada in 1970. Nearly 180,000 Canadians were injured in vehicle accidents in the same year, most of which involved cars.

Meanwhile, officials of the New York State Department of Environmental Conservation estimated that automobiles were responsible for 40 per cent by tonnage of urban pollution by the early 1970's. For example, in the heavily populated and polluted Erie County surrounding Buffalo, N.Y., state environment officials estimated about one million tons of all pollutants were emitted into the air in 1970.

Students at eight universities and two colleges in Canada began working on their town cars in 1971. One of the most important criteria for judging cars in the contest was safety.

The cars had to have bumpers that could withstand low-speed crashes; brakes and handling were to be highly effective; and the bodies were to have sufficient structural support to withstand serious damage in high-speed collisions and rolls.

The cars had to be less than 10 feet long, 5 feet shorter than most conventional autos. They had to be able to carry two passengers, travel 50 miles on a single stock of fuel and go 22 miles in half an hour. In addition, the cars were to be as inexpensive and quiet as possible.

Most of the 10 cars had internal combustion engines. In all but two of these engines, gasoline was replaced by fuels such as propane, natural gas, liquified natural gas and diesel fuel. The University of Toronto and the University of Western Ontario teams built cars with electrical motors.

To control engine exhaust emission, most cars employed an exhaust system that either burned off excess carbon monoxide, hydrocarbons and nitrogen oxides or converted these harmful emissions by chemical reactions.

For example, the University of British Columbia team used a platinum catalytic muffler that acted on carbon monoxide to turn it into relatively harmless carbon dioxide. The University of Manitoba car had a "thermo-reactor" muffler to burn off emissions.

The demand for crash-resistant bumpers resulted in a number of design innovations. For example, the University of Toronto's electrical car had a bumper filled with silicone fluid. The fluid enabled the bumper to compress on impact and return slowly to its original shape. The bumper thus acted as a shock absorber.

A hydraulic drive was used by many of the contestants, replacing the conventional crankshaft. The McGill University car had a 20-horsepower, propane-fuelled engine hooked to a hydraulic pump. This pump pushed oil into an "accumulator," a cylinder containing air in a rubber bag. The oil compressed the air, creating stored energy. When power was required, oil was pushed from the accumulator by air pressure in the bag to drive a hydraulic motor attached to the differential.

The main advantage of the hydraulic drive was that it allowed the engine to operate constantly at optimum speed regardless of the speed of the car itself. This cut down exhaust emissions since an internal combustion engine running at optimum speed burns its fuel more completely.

The use of the hydraulic drive also eliminated the hump in the floors of most cars which have conventional crankshafts and rear-wheel drive.

The cars were kept to a comparatively small wheel base, usually about 80 inches, to cut down on cost.

Although the students were aiming at general excellence in design and performance, in some cases special effort was spent in developing convenience features. For example, the University of British Columbia team developed an instant read-off system for rapid checking of routine items like tire pressure, brake wear and wheel alignment.

They installed instruments at a number of points in the car and connected them by wires to the mouth of the fuel pipe in the side of the car. When a "plug" or reading instrument was inserted in the pipe mouth, the instrument circuits were activated and readings given.

The larger Canadian schools designed and built their cars from the ground up. Some of the smaller schools, such as St. Clair College near Windsor, Ontario, and Humber College near Toronto, purchased stock cars and modified them.

Most entrants spent more than $20,000 on their projects. However, the team leader at St. Clair College said only about $4,250 had been spent on his team's car by June, 1972.

An initial grant, ranging from $1,000 to $8,000 was given to each team by the transportation agency. In addition, four teams — from McGill University and the Universities of Montreal, Manitoba and British Columbia — secured Opportunities for Youth grants for summer salaries for student workers.

Further funds were solicited from the institutions themselves and from professional associations and private industry. The total cost of the project to the schools, government and private business was estimated by the transportation agency to be more than $200,000.

The Canadian teams were from the Universities of Montreal, Manitoba, Western Ontario, Toronto and British Columbia; McGill, Queen's and Sir George Williams Universities; Humber College and St. Clair College.

Sub-Igloo

SUSAN BOYD

Susan Boyd, 23, is from Toronto. She received her honors BA from the University of Toronto in 1971. In 1972, she received a diploma in journalism from the University of Western Ontario, London. She has been a reporter for the University of Western Ontario Gazette and now is an information officer with the University.

A transparent plastic diving station called Sub-Igloo is Canada's latest contribution to the exploration of the 11,500,000 square miles of the earth which is covered with water.

The creator of this eight-foot sphere is Dr. Joseph MacInnis of Toronto, one of the world's foremost undersea scientists and an M.D. who specializes in the study of the physiological responses of humans exposed to the deep-sea environment.

In 1969 Dr. MacInnis conceived the idea of an undersea refuge which would combine the advantages of free-swimming with the protection of a submarine or habitat.

"The sphere is an ideal structure," says Dr. MacInnis. "Made of acrylic it is strong, it has transparent walls which give 360 degree visibility and is resistant to the corrosive effects of seawater."

Sub-Igloo is formed from two hemispheres joined at their equator. The hemispheres nest for easy shipping and are easily connected on land or underwater by oversize bolts. When submerged, air is pumped into the structure so that its internal gas pressure is equal to the ambient water pressure. This means that Sub-Igloo can withstand the pressure of depths of 1000 feet or more.

The structure will comfortably hold four or five divers who enter by popping in through an open hatch. Air pressure inside keeps water from entirely filling the sphere. Divers leave their scuba gear outside when they enter and only mesh grating covering the hatch on the floor separates them from the water outside.

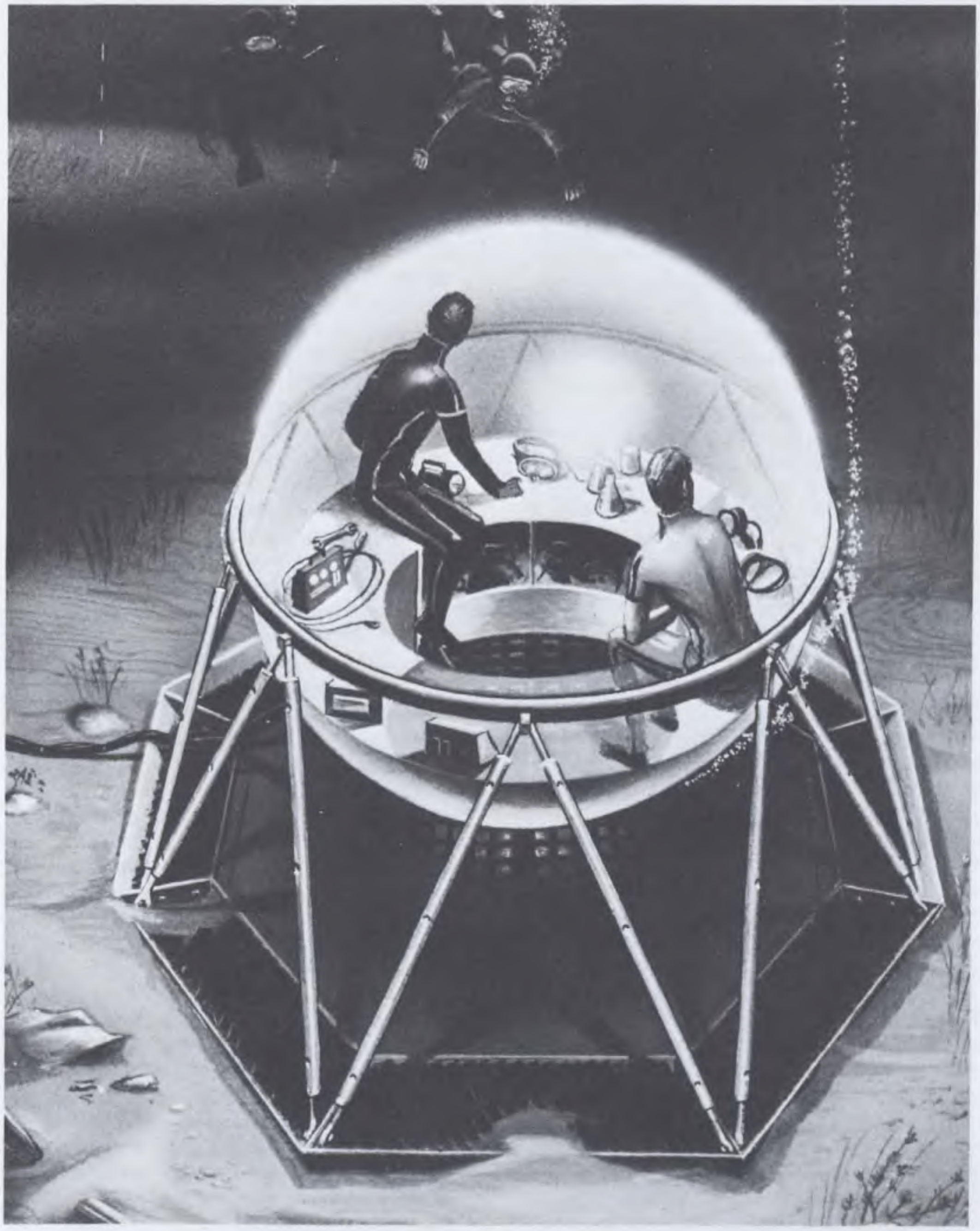
Funds for the project came from the James Allister MacInnis Foundation, a non-profit organization created by MacInnis and named for his father. The foundation studies man and his relationship to the underwater environment.

Five Canadian companies, headed by King Plastics Ltd., of Toronto, contributed to the project. Since much of the technical labor and advice was donated, Don King, Sr., president of King Plastics, says that it is impossible to estimate precisely how much the prototype of Sub-Igloo cost.

"The price for the design, labor and materials would probably be somewhere around $50,000," says Mr. King. "Dr.

MacInnis is doing his own testing which otherwise would add another $25,000 to the total cost."

Existing materials were used for the project since there were no funds for research. The technology involved is es-



The Sub-Igloo, a transparent plastic diving station, created by Dr. Joseph MacInnis of Toronto.

sentially not new but the components of Sub-Igloo have never been assembled in such a unique step as placing men in an undersea environment.

The edges of the two plastic hemispheres are set in aluminum rings. Sixteen adjustable support struts are attached to the ring on the lower hemisphere. The structure is anchored by eight aluminum trays, each designed to hold one ton of ballast in the form of 60 to 90 pound lead bars.

King Plastics Ltd., the company largely responsible for the design and manufacture of Sub-Igloo, encountered problems in blowing the two hemispheres. They had never produced a bubble as thick as the 3/4 inches required for Sub-Igloo.

An electric oven was especially built with precise temperature controls and a moisture-free air supply. The acrylic sheets were heated to 312 degrees Fahrenheit.

"The acrylic is heated to a rubber-like consistency," explains Don King Sr. "Air is blown into the sheet like bubble gum. Engaging or gripping the edges of the spheres required tremendous pressures."

A special blowing platform or rigid table was created to fill the need.

The aluminum connection rings on each half of the sphere were open channels into which a sealer made by Dow-Corning Silicones Inter-America Ltd., of Toronto, was placed in liquid state and hardened under heat.

In 1972, three years after Dr. MacInnis first sketched Sub-Igloo, production was completed. The structure proved satisfactory to Dr. MacInnis and his group during tests carried out in July at Georgian Bay off Tobermory, Ontario. By November, the Sub-Igloo was flown north and tested a half-mile offshore at Resolute Bay, 600 miles inside the Arctic circle — the first time a manned station has ever been put under the Arctic ice.

Among the subjects studied by the underwater workshop were the geology and biology of Resolute Bay, the performance of divers in freezing water and reliability of various support systems for divers. The researchers were particularly interested in testing four small underwater refuge stations, called Sea Shell, developed by the MacInnis group and also tested earlier in the warmer Georgian Bay waters. These stations, placed in the area of diver work, were designed to provide temporary refuge and points of communication with the surface for divers in trouble.

"It was designed for use in the Great Lakes," says Dr. MacInnis. "But in the long interval from conception to realization I made two diving expeditions in the Arctic and I got excited about the structure's potential there."

Sub-Igloo will be especially useful in the freezing waters. "Sub-Igloo serves the same function as an explorer's tent," explains Dr. MacInnis. "In it the divers can rest and communicate with one another allowing them to spend more effective time in the sea."

A circular acrylic bench is the only concession to comfort inside Sub-Igloo. Dr. MacInnis does not plan to heat Sub-Igloo in Arctic waters. During experiments in Resolute Bay he found that heated diving suits seriously disturbed the marine environment. The animals and plants living in this water require constant cold temperatures and perish if the water temperature is raised even a few degrees.

A transparent structure is particularly valuable in Arctic waters. Dr. MacInnis and his associates found the visibility in the water to be 200 feet, the clearest any of them had ever seen.

Dr. MacInnis describes what it's like inside Sub-Igloo: "It's like sitting in a suspended bubble. There is no distortion. Entering Sub-Igloo is like coming to the surface. I was overwhelmed by the fact that I was unable to tell where air ended and water began. It's frightening because it looks so fragile."

Don King, Sr., feels that its recreation use may far surpass its scientific value. Mr. King estimates that he could build another Sub-Igloo for somewhere around $40,000, which would make it economically feasible for large resort hotels catering to divers. While Canada does not yet have a full-fledged "Man-in-Sea" program, it is only a matter of time before Canada's commitment to arctic sovereignty will make Sub-Igloo and technology like it vital to the understanding of the arctic marine environment.

Sonar

JOE CASSAR

Joe Cassar, 23, is from Toronto where he is in 3rd year journalism at Ryerson Polytechnical Institute.

The most sophisticated underwater detection gear in the world is doing multiple duty around the globe — patrolling for submarines, tracking fish, sniffing for oil and locating sunken ships.

The Variable Depth Sonar (VDS), developed by Canadian defence authorities in the early 1950s, determines the presence and location of submerged objects by bouncing sound waves off them and analyzing the "echoes."

The VDS was designed originally to penetrate strata of varying temperature in the ocean that refracted or resisted sonar penetration and shielded submarines from detection by devices mounted in the keels of surface vessels.

In order to eliminate the tactical advantage afforded a submarine by these thermal layers, Canadian technologists developed a sonar set that could be lowered to varying depths and towed by destroyers.

Today most Canadian naval escort destroyers are equipped with VDS systems.

Eventually though, as military VDS equipment became more sophisticated, models based on the military VDS were developed in Canada for commercial application.

A major oil company, Canadian fishing vessels, and non-military search and rescue operations adapted them for their own underwater purposes.

The oil company was patrolling the Gulf of Mexico and the Alaskan coast for oil reserves during 1972, using VDS towing equipment integrated into a unit that searched out and then sucked up water samples near the ocean floor in an attempt to detect oil leakage from cracks in the continental shelf.

This 4 1/2-foot, torpedo-shaped pumping unit, developed by Fantom Oceanology Ltd., of Port Credit, Ont., enabled the patrols to collect water samples from which analysts could ascertain — on the basis of hydrocarbons in the water — whether or not the point from which the sample was taken was a suitable drilling site.

Meanwhile, the waters of Lake Ontario around Port Dalhousie were being scoured by Fantom Oceanology for two vessels sunk during the War of 1812.

The VDS would establish the presence

and position of hulking objects that might be the sunken ships and a magnetometer built into the towed VDS unit would scan them for the 50 tons of steel believed to have been contained in the two vessels.

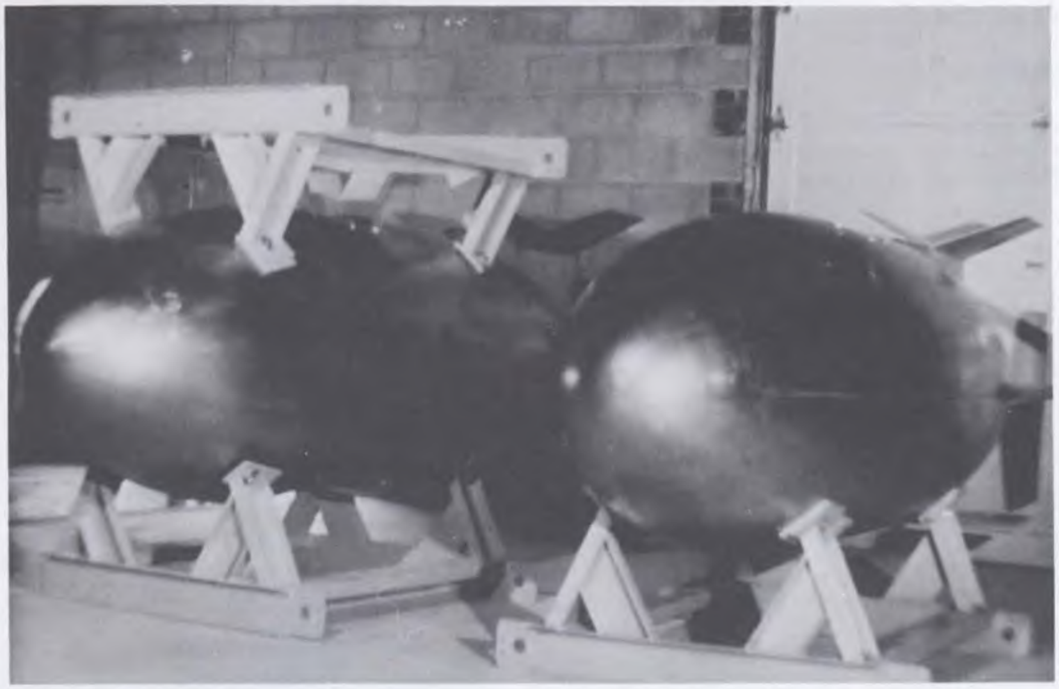
In addition, the tracking of schools of fish by Canadian and Japanese fishing fleets was carried on with keel-mounted versions of the VDS.

But the original motives for the VDS research were defensive and defence needs continued to be the primary inspiration for its further development.

Working together, Defence Research Board scientists and Royal Canadian Navy anti-submarine specialists launched VDS development in 1950. Their goal was to create a system that could penetrate thermal layers by dropping a sound source, known as a transducer, into or below the layers.

The VDS system that eventually evolved from these efforts is carried in the stern of a ship along with a hydraulically powered towing winch and boom. Main, auxiliary and emergency electric motors lift and lower the VDS to optimum sonar operating depths. Exactly how deep is classified information.

When the sound waves emitted from the transducers strike an object, an "echo" travels back to a receiver aboard the ship. On the basis of an analysis of the echo, the object is identified and its bearing and range are worked out. This information is then conveyed to a computer in the sonar control room for attack purposes, if necessary.



The Variable Depth Sonar (VDS), underwater detection gear developed by Canadian defence authorities in the 1950's.

Two critical tasks faced the Defence Research Establishment in Halifax, in the development of the VDS.

The first was increasing the power capability of the transducers so they would work effectively even several hundred feet down.

The second was overcoming the tendency of the equipment's towing cable to drag and vibrate when the sonar ship was proceeding at even moderate speeds of 10 to 15 knots.

The power capability of the transducer was multiplied 500 times by constructing the transducer casing of piezo electric ceramic, an acoustically permeable material developed by the Department of Energy, Mines, and Resources.

The problem of cable drag and vibration was overcome by the attachment of fairings to the cable. These fin-shaped objects, manufactured by the Fleet Manufacturing Co., of Fort Erie, Ontario, were strung bead-like along the towing cable so that it resembled the spinal column of a dinosaur. This served to streamline the cable and significantly reduce water resistance and vibration.

The coastal escort HMCS New Liskeard, on loan to DRB, was the first ship used in experimental trials during the mid-1950s. Repeated testing, evaluation and minor modifications resulted in improvement in the equipment's performance.

A slightly larger version was built by Canadian firms, installed in the destroyer escort HMCS Crusader and commenced testing on April 1, 1958, in the North and South Atlantic and the Mediterranean Sea.

The purpose was to determine if the VDS could meet operational requirements in all types of seas and weather, manned by ordinary seamen. The equipment substantially met the challenge.

In 1961 production of VDS equipment to outfit nine St. Laurent-class destroyers began.

A much larger VDS was developed in Canada during the early 1960s. This version employed omni-directional sonar, which could scan 360 degrees at one time. The smaller version had used the search light system wherein a 15 degree area was searched before the sonar rotated to another 15 degree area.

A prototype was installed aboard HMCS Terra Nova and evaluated from the spring of 1966 to the spring of 1971.

The success of the prototype led to production and installation in eight destroyers, four of the Restigouche class and four of the new DDH 280 class.

Smaller, less sophisticated VDS sets have been marketed in other countries such as Sweden and West Germany. The Belgian and Netherlands navies purchased hull-mounted versions of the more recently developed, solid-state sonar equipment.

Synthesis

GEORGE PORKOLAB

Within 100 years man will be able to create himself in his own image.

The first steps in synthesizing the blueprint for life, the DNA molecule, were taken in Canada. DNA is the large molecule, contained in the chromosomes inside the nuclei of all cells, that determines the hereditary characteristics of an organism.

Guidelines for synthesis of DNA were established in 1953 when James D. Watson and Francis Crick at Cambridge University in England determined the structure of the DNA molecule. They found it to be a double helix; that is, two spiral strands--made up of alternating sugar and phosphate molecules--with pairs of nitrogenous-base molecules running like rungs between the spirals.

Then Dr. Har Gobind Khorana, while head of organic chemistry with the British Columbia Research Council from 1952 to 1960, developed methods for chemically synthesizing the building blocks of DNA. These building blocks, called nucleotides, are groupings of the three complex molecules of sugar, phosphate and nitrogenous base.

Dr. Khorana also linked these building blocks or nucleotides into a short DNA chain. The first steps in creating life in a test tube had been taken.

One of the future applications of DNA synthesis could be the cure of genetically caused diseases. For example, many forms of cancer are caused by a malfunctioning section of DNA. That is, a "stop-growing" order has failed to activate and excess cells proliferate unchecked.

With genetic engineering it will be possible to identify the malfunctioning section of DNA, synthesize a healthy segment and replace the malfunctioning piece with a healthy section. Scientists at the National Research Council in Ottawa are now engaged in the development of methods for the synthesis of the natural gene.

The task is monumental. A DNA molecule in a single human chromosome is a chain of many billions of nucleotides and there are 46 chromosomes in a human cell. The immediate problems are to develop methods for reading the exact sequence of these nucleotides, to decipher precisely what the sequences mean and to synthesize DNA according to a predetermined sequence.

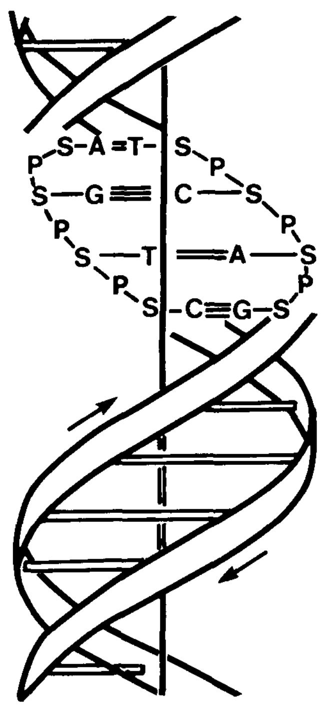
In a nucleotide the sugar and phosphate molecules form the two spiral strands of the DNA double helix. The nitrogenous base molecule can be one of four different kinds: adenine (A), cytosine (C), guanine (G), and thymine (T). Hence, there are four different nucleotides as determined by the bases.

These four nucleotides, more specifically the four bases--A, C, G, T--are the "letters" of the genetic "alphabet." The order and sequence of these letters directs the formation and growth of an organism. As a result of Dr. Khorana's work, all four nucleotides are commercially available.

While with B.C. Research, Dr. Khorana also made an extensive study of coenzymes and succeeded in synthesizing many of them. Coenzymes, although not directly related to DNA synthesis, play an important role in the modification of proteins and DNA spells out the manufacture of proteins.

Dr. Khorana received the Merck Award from the Chemical Institute of Canada in 1958 and the Gold Medal for 1960 from the Professional Institute of Public Service of Canada. In 1960 he went to the University of Wisconsin where he continued his work, begun in Canada, and synthesized larger and larger molecules of DNA.

In 1968 he shared the Nobel Prize for Medicine for his work in synthetic organic chemistry. He is currently at the Massachusetts Institute of Technology.



The DNA chain. It's a double helix.

Agrifoam

MARLENE SIMMONS

Tomato plants breaking through dispersing foam, about 24 hours after application.

Whenever frost was expected in the fall of 1967, one of the tomato fields at the Central Experimental Farm in Ottawa looked as though it had been sprayed with a giant can of shaving cream.

Although it looked strange, that two-inch layer of "shaving cream" — actually a substance called Agrifoam — insulated the tomatoes from frost damage for up to 18 hours, even if the temperature fell to 18 degrees Farenheit.

These tests and subsequent use of Agrifoam by commercial growers indicated that, wherever frosts present a problem, it could extend the growing season by two to three weeks at the beginning and the end of the season and save a wide range of crops from frost damage.

Approved by the federal Food and Drug Directorate as completely non-toxic, Agrifoam was developed jointly by the Department of Agriculture and Laurentian Concentrates Ltd., of Ottawa.

"It's ideal for climatic conditions like ours because we often have two frosts in quick succession," said Dr. David Siminovitch, a research scientist at the Cell Biology Research Institute of the Department of Agriculture.

Dr. Siminovitch, who worked on Agrifoam development with J.W. Butler, the director of research at Laurentian Concentrates, did concede that Agrifoam still was too high-cost an item for most Canadian farms.

Using Agrifoam, it would cost approximately $900 to protect 25 acres of spring tomatoes or $1,500 to cover 25 acres of strawberries. The more rows of crops to be sprayed, the more expensive it would be to protect them with Agrifoam.

But even if Agrifoam use in Canada was not yet economically feasible, by 1972 experience with it elsewhere indicated its value as a Canadian-made export, feasible for major farm enterprises of a size and value found in other countries.

"In the United States, especially in Florida where they have a heavy investment in agriculture, Agrifoam is used extensively," said Dr. Siminovitch. "The interest comes mainly from tomato, strawberry and watermelon growers."

Agrifoam is also used in Japan to protect their 200,000-acre tea crop, valued at $86.4 million, from frost damage. Frost is prevalent there because tea is planted on terraced mountain sides as high as 3,500 feet above sea level where climatic conditions are much like Canada's.

The idea for Agrifoam occurred to Dr. Siminovitch, an expert on the effects of frost on plants, when he was leafing through a magazine in 1957 and saw an ad for a fire extinguisher that used foam.

"I was wondering at the time what I could use to insulate plants, so I decided to try some kind of foam." He believed the tiny air bubbles in foam would create an insulating barrier between the plant and the cold air.

After experimenting unsuccessfully with several different kinds of foam, he approached Laurentian Concentrates in 1965 with the idea of experimenting with their

Application of agrifoam to tomato plants.

fire-fighting foam. It was a chemical concentrate manufactured from animal products, mainly animal meal.

The first field tests at the Central Experimental Farm proved the foam would insulate well, was non-toxic, light enough not to crush the most fragile plants or blossoms, and easily dispersed.

However, it collapsed four to five hours after application. If an early morning frost was expected, the foam would have to be applied late in the night; if the frost continued for many hours, the foam would not last long enough.

To further develop Agrifoam and its applicators, a grant of $49,250 was given to Laurentian Concentrates by the Department of Industry, Trade and Commerce.

By October, 1969, Laurentian Concentrates had created a marketable foam by adding a stabilizing chemical to their fire-fighting foam. As a result, Agrifoam could be applied in the late afternoon and still give all-night frost protection, even in winds as high as 15 miles an hour.

Agrifoam comes in concentrate form and looks like maple syrup. It is mixed with water — five parts concentrate to 95 parts water — in a compressed-air applicator. It is then applied either in a continuous strip or blanket or in a heavy, snow-like spray, depending upon the type of crop to be protected.

"Agrifoam forms a tenacious canopy around the plant it is protecting because it tends to adhere to the leaves of the plant," Dr. Siminovitch said.

"Occasionally the outer layers of the foam freeze, but this tends to better trap the warmth radiating from the earth, creating even more protection for the plant," he added.

Strong winds, bright sunlight or rain break the foam down in a matter of hours, and any residue can easily be washed off the plants.

Since there is nitrogen in Agrifoam, it has the added benefit of fertilizing the crop. Two years of testing on strawberries and tomatoes at the Central Experimental Farm followed the development of the 1969 version of Agrifoam to make sure it was safe and effective. This time was also devoted to refining applicating machines.

"We built the prototype machine, a tractor-drawn, 200-gallon tank trailer; it was fitted with an air blower and fluid pump, each powered by a separate gas motor," D.O. Crabtree, vice-president of Laurentian Concentrates, said.

"Air coming from the blowers was mixed in chambers with the solution that was ejected from the tank by the pump. Then the mixture was sprayed through nozzle outlets suspended from the rear of the trailer."

Using the latest applicating machines, which produce 1,500 gallons of foam a minute, a farmer could cover a 25-acre field in two to four hours.

Mr. Crabtree said the applicators still tended to spread the foam unevenly, occasionally causing gaps that left plants unprotected, but efforts to correct this flaw were continuing.

Dr. Siminovitch said Agrifoam also had a pungent, unpleasant odor but Laurentian Concentrates was confident they could eliminate it. He pointed out that every chemical put on the field has an odor.

Initially, Agrifoam and its applicators were adaptable only to low-lying crops such as peppers, melons and tomatoes. But experiments were conducted on citrus trees in Florida in 1972 with the hope of adapting it to protect fruit trees from frost.

Negotiations were completed in the summer of 1972 to distribute Agrifoam in the United States under the trade name of Thermofoam. France, Bulgaria and 25 other countries had shown interest in Agrifoam.

"I estimate our sales to be somewhere around $50,000 in 1972 because our product is so new," Mr. Crabtree said. "I'm confident, however, that they will rise once Agrifoam gains general acceptance."

Brain Surgery

OREST DUBAS

A young girl describes, with considerable emotion, an experience she had while running through a meadow; a middle-aged housewife exclaims in surpise that she seemed to be having her baby all over again; a businessman suddenly finds himself reliving a moment of his childhood.

These aren't patients recalling their experiences at some seance or to a psychiatrist. They are epileptics undergoing brain surgery, describing their feelings in response to the delicate touch of an electric probe in the hands of Canada's foremost neurosurgeon, Dr. Wilder Penfield.

Under Penfield's leadership, numerous teams of neurosurgeons at the Montreal Neurological Institute have performed more than 1,800 such operations for epilepsy — the largest series in the world.

As a founder of the MNI in 1934, and as its director until his retirement in 1960 at the age of 69, Penfield devoted much of his life to conquering brain disease. Once he and his associates diagnosed the commonest form of epilepsy as caused by damage to localized regions of the brain, Penfield pioneered the surgical techniques to cut out these areas and effect a cure.

Through his efforts, more than half of the 50 to 60 patients who undergo such operations each year at the MNI are totally cured. In another 25 per cent of the cases, the operation lowers the number and severity of epileptic seizures to the point where they can be controlled by drugs.

From his investigations, Penfield was able to explore many uncharted areas of the human brain, and to link specific brain areas with movement, the different forms of sensation, and certain activities of the mind. Much of his work centred on the outer portions of the brain — the convoluted matter known as the cerebral cortex, containing some 10 billion nerve cells.

As these cells conduct the minute electrical impulses within the brain, they make possible man's behavior. In epileptics, certain regions of this cortex become damaged, either through disease, pressure, or lack of oxygen to the brain.

As a result of this damage, the electric charge increases and occasional electrical explosions produce epileptic fits. A fit may consist in unconsciousness and generalized

Dr. Wilder Penfield, one of the world's foremost authorities on the human brain.

convulsive movement, or it may consist in small movement. The epileptic may feel various sensations, dream sudden dreams or experience simple lapses of memory.

Penfield's explorations made it possible to map the functional areas of the cortex: the motor, the sensory and the psychical. They also made it possible to pinpoint the irritable area responsible for epileptic attacks in each case.

In the 1930s, Penfield developed a surgical procedure for removing the sources of these fits. During the operation, a trapdoor opening is made in the skull to expose the brain and to allow the cortex to be probed by an electrode and by an electron encephalograph, an instrument on which epilepsy-producing discharges are recorded.

Unlike patients who undergo other brain operations, Penfield's patients were conscious and alert during the entire operation. They were kept from feeling pain by an injection of a local anesthetic. While their brain was being explored, they could tell the operator what they felt or what they were caused to remember. When the electrode made a hand or foot move, the patients were even aware that they had not willed the movement.

Penfield probed and listened, tagged the areas for motion, sensation, or speech, meanwhile mapping out the contours of the damaged tissue. He then cut out only this damaged region — without fear of harming a vital area such as the speech centre within the brain.

In the course of research for a surgical cure of epilepsy, Penfield uncovered more than 70 cases of "psychic" responses with his stimulator. Hitherto, neurologists had been unable to assign any functions to these temporal lobe areas of the brain.

The responses from his patients — about one patient in every 8 explored electrically — were varied and unexpected. Some patients suddenly experienced a flashback of past experience. Others felt a sudden strange sensation of having been in this situation before.

One woman, who felt she was reliving the birth of her child, was able to describe the sights and sounds of the delivery room, vividly and exactly in detail, as if the events were taking place before her eyes.

All of these responses were given with such clarity that Penfield realized that they could not have occurred spontaneously, but were the result of activations of a normal mechanism in the brain, resulting from stimulation of brain cells. Such activation may be due to electrode stimulus or epileptic discharge at the beginning of a fit. Penfield found, moreover, that each man's previous conscious experience is recorded as in a tape recorder.

The brain, said Penfield, keeps track of every bit of conscious information it receives, without making a record of what was ignored. His patients, therefore, could summon this record normally for automatic recognition and perception, or they could summon the record voluntarily with decreasing accuracy.

From hundreds of maps of the human cortex, Penfield proposed a more concrete picture of the cerebral cortex. He suggested that the cortex develops in stages. Some parts are committed from birth to the control of motor activity and some for appreciation of sensation. Other areas must be programmed gradually during life.

One large area of the temporal cortex — for which Penfield coined the term "uncommitted cortex" — was especially reserved for speech and perception. Here, a speech centre is normally established by the time an individual is 10 or 12 years of age, and only additions can be made through life.

A large portion of this temporal cortex, though, is continually processed through life. This area, containing the permanent records of sight and sound of a person's conscious life, can be activated electrically or by epileptic irritation.

In this uncommitted cortex, there also is a mechanism for subconscious interpretation and recognition of present experience, and this, suggested Penfield, is a part of man's process of perception.

Penfield received numerous accolades for his contributions to the science of the mind, among them, the 1961 Lister Medal of the Royal College of Surgeons (England), Fellowship in the Royal Society of London, and membership in the Scientific Academies of the U.S.S.R., U.S.A., and France.

He is a Companion of the Order of Canada and holder of Britain's highest tribute the Order of Merit, an award limited to 25 members. Past recipients of this last award have been Lester B. Pearson, Winston Churchill and Dwight D. Eisenhower.

Penfield also holds membership in more than 40 international medical and scientific societies, and has published a dozen books and over 300 technical articles.

Potatoes

LISA MARTEL

Virus-free potatoes soon may prove to be the key with which Canadian potato growers open the door to multi-million-dollar European markets from which they thus far have been barred.

Although potato viruses are no proven danger to humans, several European governments had for years maintained quarantines against Canadian potato imports for fear of infecting their own domestic crops.

In 1967, however, a Vancouver agricultural research team developed a process for growing potatoes which were free of the two particular viruses that, until then, had infected virtually all commercial North American seed stocks. These viruses had reduced some potato yields in Western Canada by up to 38 per cent.

In the eyes of many agricultural authorities, the development of the virus-free potato would rank with the development of high-yield cereal grains in terms of its importance to the Canadian economy.

By 1972 the federal Department of Agriculture was forecasting that access to European markets afforded by virus-free potatoes could mean $6 million to $10 million in additional revenues per year for seed growers. Table stock growers were expected to reap up to $10 million in expanded export earnings.

Dr. D.S. MacLachlan, director of plant protection at the department's Central Experimental Farm in Ottawa, said many European nations, even some members of the European Economic Community, were potential buyers.

In fact, a major breakthrough for virus-free potatoes already had occurred in 1970 when the Canadian product finally met ultra-rigid Dutch standards and a 30-ton shipment of seed potatoes was sent to the Netherlands.

Domestically, the impact of the development was not to be as great. But Canadian consumers could anticipate being able to keep potatoes longer since virus-free varieties had shown added resistance to other diseases caused by fungi and bacteria.

The first virus-free potato plant in North America was grown by a team of plant pathologists, headed by Dr. N.S. Wright, at the agricultural department research station in Vancouver. Working with him were Dr. Richard Stace-Smith and Miss F.C. Mellor.

Viruses are submicroscopic organisms that cause various diseases in animals or plants. In potatoes, as in other vegetables, they invade the entire plant — shoots, roots, and tubers.

The spread of viruses that cause visible symptoms can be controlled by carefully removing infected plants from a crop as soon as symptoms are observed.

However, Dr. Wright explained: "What is unique about the viruses we eliminated, commonly known as the latent viruses S and X, is that there are no visible symptoms."

By 1972 the Vancouver researchers could report that they had managed to apply their anti-virus process to about 60 varieties of potato, nearly all those grown in North America.

The process used in producing virus-free potatoes is known as thermotherapy, a heat treatment that involves subjecting plants to high temperatures to inhibit the virus without killing the plant.

Dr. Wright was introduced to the technique in 1957, in the Netherlands and England, where it was being used to develop virus-free carnations and chrysanthemums.

"The method had been used for woody plants, but treating softer, herbacious plants with elevated temperatures was a tricky business," Dr. Wright explained.

Nonetheless, Miss Mellor managed to get processed strawberry plants to survive for several weeks and, in 1966, the researchers decided to try the same technique with the potatoes.

Potato plants were grown in a chamber where the temperature ranged from 91 to 99 degrees Fahrenheit. During the heat treatment, small auxiliary buds that grew between the leaves and the stem were removed, sterilized and placed in chemical nutrient solutions under fluorescent light. When the shoots had grown to about two inches they were planted in sterilized soil.

By 1967, success. A few plants were grown in which no evidence of viruses could be detected. The Vancouver team had grown the first virus-free potato plants in North America. By the spring of that year, several thousand plants were ready for planting.

The Pemberton Valley in British Columbia was chosen to grow the virus-free seed potatoes that would be used by commercial growers to produce table stock potatoes.

"Recontamination had to be guarded against," said Dr. Wright. "Once the potatoes were free of virus, they had to be kept isolated from all sources of infection."

"To ensure that recontamination did not occur, solutions of Virus S and X were injected into rabbits which reacted by producing antiserum," explained Dr. Wright. "Leaf samples from the potato plants were ground up and the juice was mixed with the antiserum. If a virus was present, a reaction took place."

Although Viruses S and X cannot be transmitted from the soil, crops had been rotated the previous year to remove all infected tubers from the Pemberton Valley fields.

By 1969, 130 tons of virus-free seed potatoes were exported from the valley.

Dr. Wright said it would take several years before the entire Canadian potato industry was converted to virus-free potatoes. But all provinces had set up programs to grow virus-free seed stock, with the exception of Ontario and Saskatchewan which import most of their seed potatoes from other provinces.

In recognition of their outstanding research, the Vancouver team received a $2,500 award from the federal government, the highest public service award of its kind possible in Canada.

STOL

PETER MILLS

If the people can't come to the airport, the airport must go to the people.

That was the principle guiding Canadian air transportation authorities and aviation technologists as they worked at refining Canada's answer to growing airport congestion — the short take-off and landing (STOL) aircraft.

Because of the space required, the noise they generate and the safety hazard they represent to populated areas, conventional airports have been situated at a distance from major urban concentrations.

But this, in turn, has created problems of increasing congestion — congestion of airport access roads, terminal facilities and landing strips. By the late 1960s, congestion already was a problem of critical proportions.

For travellers whose trips were 500 miles or less — a group who made up half of the 9.4 million Canadian air travellers in 1971 — the problem was particularly acute.

To a traveller on a long haul, the hours spent going to, sitting in and going from airports was bothersome but represented a relatively small portion of total time. But short-haul passengers frequently spent considerably more time being shunted around on the ground than flying, especially with the introduction of faster aircraft.

To Ministry of Transport (MOT) officials, the likeliest answer to the problem of the short-haul passenger seemed to be a STOL transportation system with STOL aircraft landing in and taking off from populous living and working areas without disturbing the environment.

To test, and prove, the feasibility of such a system, the MOT planned demonstration service between Ottawa and Montreal to begin in mid-1974.

MOT officials hoped the demonstration service would help them to define and develop a STOL system, determine passenger and community reaction and test the economic viability of such a system. They also hoped to stimulate an international market for STOL aircraft to provide a much-needed boost to Canada's aircraft industry.

MOT officials felt Canada was in a good position to pioneer a system since it was the leader among fewer than a dozen countries concentrating on the technology required to put together a complete STOL service.

In 1972 there was no firm working definition of STOL aricraft, but the MOT was studying several standards it felt STOL aircraft should meet.

First of all, STOL aircraft would have to be powered by at least four turbine, rather than jet, engines. MOT officials felt four engines would better enable the aircraft to meet international safety requirements, and turbine engines would better meet noise specifications.

Secondly, STOL aircraft would have to be much quieter than existing commercial aircraft. The allowable noise level would be such that a STOL aircraft operating 500 feet from a listener would seem no louder than a freight train passing an equal distance from the listener.

This would allow the STOL aircraft to operate in populated areas without unduly disturbing the surroundings. Officials hoped to see even this noise level lowered by 8 to 10 per cent to make it even more acceptable to the public.

Proposed STOL noise levels would be about one-quarter those of commercial jet aircraft. According to the mathematics of sound, if the level 8 to 10 per cent lower were reached, they would be about one-eighth those of commercial jets.

A third standard which STOL aircraft might have to meet would require them to be capable of taking off and landing at angles of six to ten degrees, twice those of conventional jetliners. If this were achieved, the STOL "noise print" — the total land area over which the sound of take-off or landing can be heard — would be no more than 1 1/2 square miles, compared with between 28 and 34 square miles for regular jet aircraft.

Finally, STOL aircraft and STOLports would have to meet stringent safety and equipment standards for commercial operations. For example, the aircraft would have to be able to take off and land on a 2,000-foot runway with its critical engine non-operational. This would mean performing at peak safety under much less than ideal conditions.

STOLports would have to maintain special equipment such as radar particularly

The DHC-7 'Quiet STOL Airliner' designed by de Havilland Canada for short hauls.

geared to facilitate landings in an area surrounded by skyscrapers.

Even the de Havilland Aircraft of Canada Twin Otter, to be used for the 1973 demonstration service, did not fully meet MOT requirements. The only aircraft expected to meet the requirements was the de Havilland DHC-7, scheduled to come off the production line in 1974 or 1975.

The DHC-7 would be powered by a Pratt & Whitney PT6A-50 free-turbine engine, developed jointly by de Havilland, United Aircraft of Canada and Hamilton Standard.

The STOL take-off capability and low noise level of the DHC-7 would be achieved by coupling the powerful free-turbine engine with a large, slowspeed, four blade propeller.

In conventional propeller-driven aircraft, the engine and propellers both must be running at maximum revolutions to propel the aircraft with enough speed to create the proper air currents for lift-off. This produces a great amount of noise and requires a long take-off run.

The DHC-7 engine, on the other hand, is a two shafted engine, with one shaft turning the compressors that power the engine and one turning the propellers. This allows different propeller and engine speeds without any loss of overall power.

The propeller, specially adapted to fit the new engine, was designed to allow adequate propulsion at lift-off despite a relatively slow propeller speed.

Another factor contributing to the low noise level of the aircraft is a new suspension system which reduces noisy engine vibrations. In addition, exhaust outlets at the top and rear of the engines divert noise away from the ground.

The DHC-7 is designed to carry 48 passengers at a cruising speed of 276 miles per hour. It is to be about the same size as the old Viscount aircraft.

A fully developed STOL system would provide three types of air transportation services.

The first would be a downtown-to-downtown, inter-city service, similar to the Ottawa-Montreal demonstration route, linking major metropolitan areas.

The second service would be a feeder line from smaller centres to already existing airports.

Finally, STOL aircraft would be used as regional carriers. This would mean dividing Canada into geographical regions within which local services would be provided by one or more competing STOL airlines. All the regions would be connected by conventional long-range air transport facilities.

Airport development costs would be cut with the construction of STOLports, according to MOT officials. They felt existing conventional facilities would easily be adequate for 25 years if a STOL system were developed.

MOT officials estimated a downtown STOLport, excluding land, could be built for less than $2 million, compared with the $200 to $400 million usually required for more elaborate airports. The need for extra facilities such as major access roads would be eliminated with STOLports, adding further savings.

The feasibility and benefits of STOL service were proved to a degree in a "race" between Chicago and St. Louis in March, 1972. Two men left a downtown Chicago hotel at the same time, one to use conventional air transportation and the other to use a STOL service flying the de Havilland Twin Otter.

The man using the STOL service reached St. Louis first by an hour and 12 minutes even though the Twin Otter had only about half the cruising speed of the commercial jet.

It was this type of convenience and service the MOT was trying to demonstrate in the Ottawa-Montreal route.

Periwinkle vs. Cancer

BRUCE SMITH

The unexpected death of laboratory rats in experiments to test the alleged antidiabetic qualities of a Jamaican folk remedy led medical researchers to the discovery of vinblastine, a drug for cancer therapy.

Dr. Robert L. Noble and his associates in the University of Western Ontario's medical research department initially were interested in the tea which many Jamaicans made from the obscure, flowering periwinkle plant to treat diabetes mellitus.

Dr. Noble and his researchers could not find anything in the potion that was effective against diabetes. But they were led into other, more promising research when experimental rats they injected with the periwinkle brew died.

Microscopic tests indicated that the cause of death was widespread infection due to a marked reduction of their white blood cells, which are key body infection fighters.

This unexpected finding suggested that the substance might play a part in the treatment of leukemia, a form of cancer characterized by an excess of white cells in the blood.

Continued research was climaxed in 1958, when Dr. Noble and his colleagues, Dr. C.T. Beer and Dr. J.H. Cutts, isolated the active compound vinblastine from the leaves of the periwinkle plant.

Subsequently laboratory studies showed that vinblastine was effective in the treatment of some cancers in animals. This favourable response then justified the trial use of the drug in humans.

Since its introduction in 1960, vinblastine has passed a number of clinical tests and, although found to be of only slight use against leukemia, it is now used every day in other forms of cancer chemotherapy. Several malignant disorders respond to the drug but its success is most pronounced in the treatment of Hodgkin's disease.

The chain of events leading to the production of vinblastine for cancer therapy began when Dr. C.D. Johnston of Black River, Jamaica, became curious about the reputed benefits of the periwinkle tea. In 1949 he sent a supply of the local periwinkle, Vinca rosea, to the medical research department at the University of Western Ontario.

Intrigued by the plant's reputation as a folk medicine, Dr. Noble, then professor of medical research at the university, ran some tests on diabetic rats. When the animals failed to respond to orally-administered periwinkle water extracts, the material was injected directly into their blood streams.

This had no effect on the diabetes, but the consequences were, nevertheless, dramatic. The rats died within a few days. Autopsies showed the cause of death to be massive infection, particularly in the liver and kidneys.

Further studies indicated that the infection was linked to a destruction of the bone marrow and a sharp reduction of white blood cells.

The primary purpose of the white blood cells is to destroy bacteria and other foreign matter. The periwinkle extracts evidently weakened this defense mechanism in the rats, reducing their resistance to infection.

In view of the effect that periwinkle extracts had on white blood cells, it seemed possible that the plant could be used in treating leukemia, the disease in which white blood cells proliferate excessively. The investigation then was continued in the field of cancer research.

The researchers decided their first step should be to isolate the essential active substance in the periwinkle plant for use in further experiments. However, it was not until Dr. C.T. Beer, a British Empire Cancer Exchange Fellow, joined the research team in 1954 that intensive chemical experiments were undertaken.

Finally, in 1958, Dr. Beer isolated a white crystalline substance, minute doses of which caused very marked white blood cell and bone marrow destruction. This active extract was given the name vincaleukoblastine or VLB, later to become known as vinblastine.

Dr. Noble and his associates tested the new drug on rats that had been inoculated with experimental leukemia and a number of other tumors. Vinblastine prolonged the lives of some animals and, in some cases, apparently cured them.

Consequently, the trial use of vinblastine in the treatment of advanced malignant tumors in humans began in 1960.

Following its introduction, vinblastine gained wide acceptance as a useful chemotherapeutic agent — but not as originally hoped. The response to vinblastine in leukemia therapy was generally poor and other drugs now are considered more effective.

However, vinblastine was found to be capable of effecting worthwhile remissions in other tumors such as cancers of the lung, breast, ovary, kidney, cervix, stomach, testes, and rectum. Hodgkin's disease, a progressive and eventually fatal enlargement of the lymph nodes, lymphoid tissue and the spleen, was especially responsive to the drug.

Vinblastine's mode of action is not fully understood. About all that can be said is that it produces temporary reduction in the size or temporary disappearance of some tumors. It also relieves pain and allows some patients to gain weight.

The duration of vinblastine-induced remissions varied considerably, but was never permanent. The disease eventually recurs.

Nevertheless, medical researchers have not lost faith in this periwinkle derivative. Significant progress will be made, they feel, by combining vinblastine with other chemotherapeutic agents for which the periwinkle plant could well prove to be the source.

Since the discovery and isolation of vinblastine, three other active extracts and at least 12 related compounds have been isolated from the plant.

One of these, vincristine, was clinically tested and found to prolong the life of children with acute leukemia. Laboratory experiments with other extracts indicated that the powers of periwinkle in cancer chemotherapy would be increased.

Mechanized Farming

LISA MARTEL

To the conservative Upper Canadian farmer of 1830, the enormous bull thresher that stood in Daniel Massey's yard was clearly a laughing matter.

Many members of the farming community, which still labored away with virtually primitive implements, considered the American-made thresher and other farm machinery "too slightly got up for Canadian conditions."

But despite their laughter, this first venture by Daniel Massey into mechanized farming was to be the basis for the development of a world-wide industrial enterprise that would help open the Canadian west and revolutionize much of Canadian agriculture.

Out of this venture has come the Massey-Ferguson Company, today one of the world's largest manufacturers of farm implements and machinery. And among that company's virtually countless innovations in farm machinery design and construction, perhaps the self-propelled combine, developed in 1938, was the most significant.

The celebrated self-propelled combine owes its beginning to a Massey-Harris engineer, Tom Carroll, whose 50 years with the company included development of farm machinery in Canada, Australia and Argentina. For his development of the combine, he was hailed as the father of a new era in farm mechanization.

Eliminating the use of either tractor or horses, and requiring only one man to operate it, the motor-powered, self-propelled combine brought together in one machine the complete operation of harvesting. But the first model proved to be too large and expensive for the average farmer. By 1940 the self-propelled combine had been reduced by 3,200 pounds and a considerable number of dollars to become the world's first such combine that was commercially-practical. Without a doubt, a milestone in agriculture had been passed.

The impact of the self-propelled combine on agriculture was felt world-wide during the wartime summer of 1944. In the United States alone, more than 5,000 American farmers had their crops harvested by the combines. Becoming famous as the "Harvest Brigade," the combines

The largest combine produced in North America has been introduced by Massey-Ferguson.

swept across a million acres to pile up 25 million bushels of grain in 10 states at a saving of a third of a million man-hours and half a million gallons of scarce fuel.

In Britain, 6,000,000 additional acres were cultivated. That year, the British Ministry of Agriculture wrote to the company's president: "Our farmers rely on your machinery and your self-propelled combines are the leaders in what is truly a revolution in harvesting methods."

For the development of the self-propelled combine, Tom Carroll was awarded the Cyrus Hall McCormick gold medal by the American Society of Agricultural Engineers in 1958. He was the first engineer outside the United States to be so honoured.

But the combine was not the only nor the first major Massey mark on agriculture. A decision by the company in 1883 to manufacture the Toronto Light Binder, which incorporated the best features of American design with Canadian improvements, enabled the individual farmer to more than double his present production.

When displayed at the International Exhibition in Antwerp, Belgium, in 1885, it received a special gold medal for its speed and lightness of draft.

Introduction of the Toronto Light Binder played a large part in the evolution of Canada's export trade in manufactured products and in the new impression on world markets of Canadian-made machinery.

In 1910 came the Massey-Harris reaper-thresher, which resembled a streetsweeper of the 1940s, and which once more placed Massey-Harris in the vanguard of technical development.

After three solid years of commuting between Australia and Canada, Massey-Harris engineers finally came up with a machine which performed the functions of threshing, reaping and separating in an automatic continuous operation, simultaneously reducing the human labor by more than two-thirds. Prior to the reaper-thresher, these operations had required three complicated, expensive machines — a binder, a threshing machine and a tractor. It was this machine which was to serve as the progenitor for the modern combine.

Beginning in 1847 at Newcastle, Ontario, from a modest enterprise which manufactured solely American-designed machinery, the company early in its career acquired a distinct Canadianism in both its advertising and the patenting of original inventions.

In 1878, the company completed its first machine of wholly Canadian design, the instantly-popular Massey Harvester, a conventional reel-rake reaper.

In 1851, Daniel Massey's son, Hart, joined him in the management of the Newcastle foundry, and a succession of "firsts" for Canadian machinery followed.

The American-designed Manny's Hand Rake Reaper as manufactured at the foundry in 1852 was the first machine to embody Canadian improvements on American machinery, principally in the use of stronger materials.

In 1866, the Newcastle works was accorded the highest honors that had yet been received in the Canadian implement industry. That year, Massey harvesting machinery was chosen to represent Canadian manufacturing at the Paris International Exposition of 1867 where two Grand Gold Medals were presented to Hart Massey.

A move to Toronto in 1879, home of the present company headquarters, was contemplated, and plans for the "largest and best equipped factory ever built in Canada" were blueprinted and effected.

The merger with a leading competitor, A. Harris and Son, in 1890, established the firm of Massey-Harris as the largest of its kind in the British Empire by 1892.

Other technological advancements followed, and soon after the turn of the century, the company had redesigned virtually its entire line of cultivating and harvesting machinery, and developed a number of new and more efficient types.

Since the merger with the Harris Company, the enterprise absorbed numerous firms, one of the most important of which came in 1953 when the company merged with the Harry Ferguson Companies of Coventry, England.

In 1971, a gold medal was presented to the company by the Royal Agricultural Society of England honoring the Ferguson contribution to agriculture.

From its conception in 1847 as a modest farm implement foundry, the Massey-Ferguson Company grew to be the world's largest manufacturer of tractors, combine harvesters, loaders and backhoes, and diesel engines. By 1972, these and other products were being made or assembled in 22 countries and distributed in virtually every country of the world.

Disintegrating Plastics

MARLENE SIMMONS

A refuse-strewn beach in the Bahamas shocked a vacationing University of Toronto chemist into using his knowledge about the disintegration of plastic in a practical campaign against plastic pollution.

Prior to his 1970 trip, Dr. James Guillet and his research team at the University of Toronto already had made a plastic that, unlike existing plastics, would disintegrate when exposed to unfiltered sunlight. But the discovery had remained a laboratory oddity, research valued for its own sake.

It was not until he saw the beauty of the Bahamas spoiled by waste carried down from Florida by Gulf Stream currents that Dr. Guillet was inspired to put his new plastics into commercial production.

For several years ecologists had been pointing out the environmental hazard represented by plastics. Conventional plastics are virtually indestructible. They can be cut up, crushed or burned, but they cannot be destroyed.

According to Terry Cox, education co-ordinator for Pollution Probe in Toronto, "Plastic pollution is not bad right now; it makes up only two per cent of our solid wastes."

"But, it will become a serious problem if people indiscriminately start throwing away plastic containers."

Since the uses of plastic abound and multiply, accumulations of it in our garbage dumps mount steadily.

For eight years Dr. Guillet and a research team at the University of Toronto had been working on the effects of light on the resins used in the manufacture of plastics. They found that by introducing light-sensitive molecules, plastics could be made to disintegrate at a controlled rate.

"We were the first to successfully use this method to break down plastics, "Dr. Guillet said.

Dr. Guillet said conventional plastics are virtually indestructible because they are made up of long chains of molecules that intertwine and fold back on themselves like a big knot in a fishing line.

"You can pull the knot and cut it in one or two places but that doesn't mean it's going to fall apart," he explained.

Dr. Guillet and his researchers found they could add light-sensitive molecules

Dr. James Guillet, University of Toronto, holds a cup made from the plastic that disintegrates when exposed to unfiltered sunlight.

intermittently along the molecular chains. These molecules absorbed extra energy from the ultra-violet light in sunlight. This made them vibrate in an agitated manner that broke the chemical bonds between them and the molecules from which plastics are made.

Consequently, when plastic made in this manner was put into direct sunlight, it became brittle and broke into tiny fragments that would be bio-degradable, that is, subject to destruction by micro-organisms, in soil.

The rate at which the plastics disintegrated depended on the intensity of the ultraviolet light to which they were exposed. The type and number of light-sensitive molecules added to the plastic, and the thickness and the type of plastic used also helped determine the rate of disintegration.

Disintegration could be controlled to occur over a period ranging from days to months, depending on the intended use of the plastics.

VanLeer EcoPlastics Ltd., a Toronto-based company owned jointly by Royal Packaging Industries, VanLeer N.V. of the Netherlands and EcoPlastics of Toronto, was to market the plastic resin by mid-1973 under the trade name Ecolyte.

According to Paul Wright, president of both EcoPlastics Ltd. and VanLeer EcoPlastics Ltd., a new plant was to be built in Canada in 1973. This plant would have an annual capacity of more than four million pounds of Ecolyte.

Although this plant would initially produce only polystyrene resin, used in the making of such plastic items as foam cups, picnic trays and egg cartons, such biodegradable products as plastic milk jugs and bottles could be made with Dr. Guillet's process.

The cost of light-sensitive plastics would be a few cents a pound higher than conventional plastics. However, Dr. Guillet said, "It would stop us from polluting with these things we use once and then throw away."

The practicality of Dr. Guillet's plastic was not undisputed. Critics pointed out that plastic dumped in landfill sites would not get enough sunlight to disintegrate. They also said certain plastics were poisonous when disintegrated and, if washed into water supplies from landfill sites, could cause a health hazard.

Dr. Guillet agreed his process was not universally applicable. However, he said in reply to critics that polystyrene plastic could be treated to disintegrate in one day and would easily get enough sunlight to degrade before it got to the landfill site. He said the process would not be used on poisonous plastics.

Dr. Guillet said over 400 companies from 30 countries were interested in his process, but Canadians were not as interested as many other countries.

"They don't seem to believe they can produce first-rate things themselves and prefer to wait for the Americans or Japanese to come out with something," he said.

Dr. Guillet said the research for the project cost $250,000, of which the National Research Council paid $100,000. The rest came from private industry and other granting agencies.

A cup made of Ecolyte Polystyrene and "straw" made of ordinary plastic before exposure to sunlight.

The same cup and "straw" 5 weeks after exposure outdoors.

Velvet Glove

JOE CASSAR

A later version of the Velvet Glove, with its own booster, is ready for a flight trial at the Defence Research Board's Picton Range late in 1954.

An air-to-air guided missile that never saw military use was the first stage in a missile development program that rocketed Canada into a prominent position in space technology.

Known as the Velvet Glove, the seven-foot subsonic missile was abandoned in 1954 with the advent of supersonic aircraft.

But surviving its demise was the expertise and technology for launching the Alouette and ISIS weather and communications satellites as well as the Black Brant scientific research rockets.

Technicians and aerodynamicists from the Velvet Glove program applied their experience in launching Canadian space probes and satellites from 16-inch hypervelocity guns in the Barbados in the early 1960's. Others helped develop the

CF-105 jet interceptor aircraft.

The groundwork for this development of Canadian rocketry and space technology was laid in 1950. In view of projected Canadian needs for special air defence weapons, Defence Research Board (DRB) authorities began then to concentrate on a line of air-to-air missiles as part of a tripartite arrangement with Britain and the United States.

Canada's guided missile program began with a team of only four or five DRB scientists, but within four years of cabinet approval in 1950, it had grown to about 600 specialists working with the board, the RCAF and industry.

Within that same period, nearly $7,-000,000 of the $24,000,000 spent on the project were employed for permanent DRB and RCAF facilities such as aerody-namics test ranges and laboratory facilities.

Canadair Ltd. was the general contractor for the project and was responsible for the overall assembly of the weapon system. The entire project was co-ordinated from the Defence Research Establishment at Valcartier, Que.

The two subsonic fighter aircraft chosen to be armed with the Velvet Glove were the Canadian-designed, twin-engine CF-100, built by A.V. Roe Canada Ltd., and the American-designed, single engine F-86, built by Canadair Ltd.

With launchers added under their wings, the F-86 could carry two missiles and the CF-100 was able to handle four.

Canadian Westinghouse Ltd., of Hamil-ton, Ont., designed and manufactured parts of the missile. The Canadian National Aeronautical Establishment concentrated on the aerodynamics of the two aircraft with the missile installed. Modifications were made to the two interceptors to accommodate them when the missiles were tucked under their wings.

The Defence Research Telecommunica-tions Establishment (DRTE) was responsi-ble for the telemetry equipment that monitored performance and transmitted the information back to the receiver. The DRTE also designed some parts of the missile and modified the radar systems of the jet interceptors to make both systems work in concert to track the target aircraft.

The Velvet Glove was eight inches in diameter, seven feet long and weighed 350 pounds. Its four rectangular wings had a 32-inch span. Approximate range of this subsonic bomber-seeker was 5,000 yards.

The missile was propelled by a rocket motor that burned solid fuel and was launched by one blast. The missile's flight was guided by a radar system tuned to the same frequency as the tracker aircraft by using the reflected radar energy from the target to home in on the target.

A radar proximity fuse developed by the DRB and DRTE measured the distance to the target and activated the missile's frag-mentation warhead when the distance between the seeker and the target began to increase instead of decrease.

Within eight months of approval the first prototype was launched in the spring of 1951 from the ground over Lake Ontario from the Canadian Army test range at Picton, Ont. The missile's telemetry equip-ment transmitted favourable reports on its performance.

During the subsequent four years more than 300 missiles were manufactured and fired, most of the latter series from inter-ceptors over the new test site at Cold Lake, Alta.

The introduction in 1954 of supersonic bombers and A.V. Roe's supersonic air-craft, the CF-105, for defence against the new bomber threat spelled the end of the Velvet Glove. The CF-105 was assigned a higher priority than the Velvet Glove and the missile team and resources were di-rected to other projects.

Although it never entered military service, the Velvet Glove was the catalyst for the creation in Canada of an electronics industry oriented to the space age.

As a missile, it was only a technical success; but as a vehicle for training engineers, designers, and technicians, both in the military and civilian field, it was an achievement of great importance.

Cobalt Bomb

BRIDGET MADILL

Dr. Harold Johns

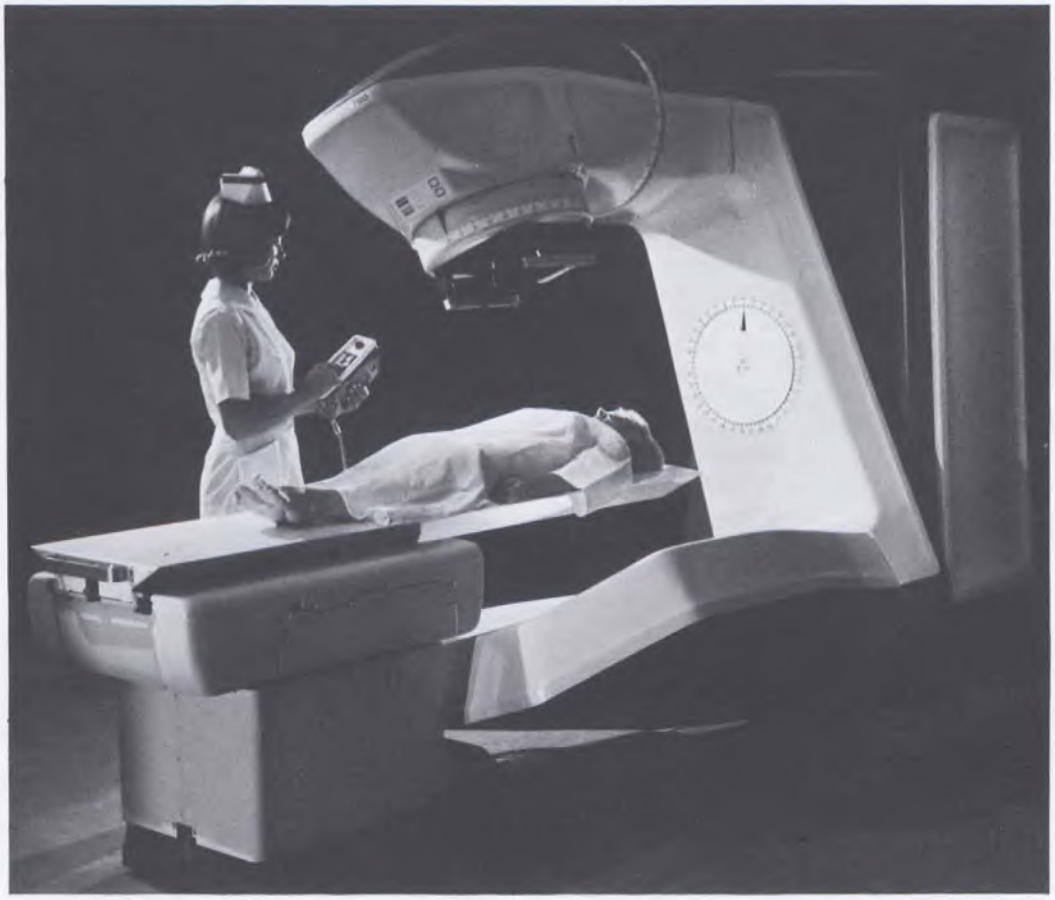
The lives of 18,000 Canadians each year are prolonged by a bomb developed in Canada in 1951.

Officially called the Cobalt-60 Beam Therapy Unit, the cobalt bomb is used extensively in clinics throughout the world for the treatment of cancer.

At least half of the 18,000 patients treated with cobalt in Canada annually have survived three years or longer, despite the fact that, in many cases, the prognosis was much shorter. In the context of cancer, a three-to five-year survivor is termed a "cure," although the disease may recur after that time.

In 1951, Dr. Harold Johns, a physicist at the University of Saskatchewan in Saskatoon, was the key figure in the development of the cobalt machine. Encouraged by the Saskatchewan Cancer Commission with which he was working, Dr. Johns tested an idea that radioactive cobalt could be used to treat the disease.

The suggestion for using radioactive cobalt on cancer was made in 1946 by Dr. W.V. Mayneard, head of the physics di-



The cancer therapy machine developed by Dr. Johns.

vision of the Royal Cancer Hospital in England. He was studying the biological effects of radiation at the Chalk River atomic energy plant.

In 1947 Dr. Johns sought the materials for his work from Chalk River. Reports from that period indicate that Chalk River authorities doubted that Saskatoon, only Canada's eighteenth largest city, was the right place for the work.

Finally, it was agreed that the cobalt would be sent, but only on the condition that Dr. Johns could work out a safe and efficient container for the radioactive cobalt discs. Before the radioactive cobalt would be produced for him, he also had to design and construct a suitable sourcehead to regulate the amount of radiation received by the patient and to protect those giving the therapy.

In addition, his machine had to be equipped with a remote-control mechanism to raise and lower the head, to position it on ceiling tracks, to aim the outlet and to turn the live cobalt within foot-thick walls of lead.

He and his associates did it and it worked.

Two batches of the radioactive cobalt were produced at the Chalk River plant in 1951, four years before any other country could do so.

One was sent to Dr. Johns at the University of Saskatchewan; the second to the late Dr. Ivan Smith at the Victoria Hospital in London, Ont.

The development was largely unheralded at the time. Medical authorities attribute this to the fact that many people thought the cobalt bomb was just an extension of X-ray treatment. However, cobalt is 300 times more powerful than radium, 6,000 times cheaper, and much safer. It replaced X-ray treatment of many cancers.

The machine to hold the Saskatchewan source was built by John Mackay of the Acme Machine and Electric Co., Ltd., in Saskatoon. Atomic Energy of Canada Ltd., then built the first commercial cobalt unit which housed the cobalt radiation source in London.

The radiation source in the first machines was a half-inch stock of cobalt discs, each about the diameter of a 25-cent piece. The cobalt metal was first saturated with radioactivity in a nuclear reactor and then taken, in lead containers, to be placed in the therapy unit.

The radiation penetrates into the tumor and the cancer cell is rendered incapable of performing like a living, growing cell. After a sufficient number of cancer cells have become ionized in this way, the healthy cells exert control over the cancerous tissue and repair the damage.

For treatment, the patient is carefully positioned on a couch or table. An indelible target is painted on his skin in the area of the tumor. The patient is positioned so that the beam of radiation is concentrated on the target. This minimizes the damage to healthy tissue. In some cancers, like cancer of the bowel, healthy tissue is too susceptible to radiation destruction to employ the beam therapy unit.

Patients may undergo beam treatments five times a week for a period of two to six weeks. Each treatment may take only three to 10 minutes.

The two Canadian units went into operation in 1951 and became the models for succeeding machines around the world.

Atomic Energy of Canada Ltd., makes more than half the cobalt beam therapy units in the world. By 1972, they had sold more than 1,000 units to 53 different countries. Only five of these units had been retired from use.

Dr. Johns had become professor and head of the medical biophysics department at the University of Toronto by 1972, but his work with cancer was continuing in the physics department of the Ontario Cancer Institute and at the Princess Margaret Cancer Lodge in Toronto.

Slicklicker

MARLENE SIMMONS

When the tanker Torrey Canyon foundered off the coast of Britain in 1969, alert harbour officials at Esquimalt, B.C. scrambled to prepare against the eventuality of a similar oil spill in Victoria Harbor.

Their quest for an effective and economical way to clean up major oil spills was answered by Richard Sewell, a chemist with the Defence Research Board of the Department of National Defence. His answer was an awkward-looking device, formally known as an Oilevator, but commonly called slicklicker.

The slicklicker got its first major test in February, 1970, when the tanker Arrow broke open and spilled two million gallons of Bunker C fuel oil, into Chedabucto Bay in northern Nova Scotia. But the Torrey Canyon disaster was not repeated, largely because of the slicklicker.

"It's the best machine for oil clean-up in the world," said Dr. P.D. McTaggart-Cowan, head of the federal government task force which conducted the clean-up of the Chedabucto Bay. "I should know. I tried them all."

Four slicklickers were built for clean-up of the Arrow spill. They lifted 200,000 gallons of oil in 10 weeks despite often rough seas. The task force was so impressed with their performance that it recommended every Canadian port install one for harbor clean-up.

The slicklicker has several advantages over other methods of fighting oil pollution at sea. It salvages much of the oil for re-use; it is relatively cheap, compact and light; it doesn't harm the environment it works in; it is portable and works well even in fairly rough seas.

The slicklicker, which costs around $7,500 each, can lift up to 43,200 gallons of oil off the water in 24 hours.

The machine itself is very simple. An inflatable plastic boom with a five-foot skirt traps surface oil near the slicklicker, which is mounted on a barge or boat. The slicklicker's tongue is an oil-soaked conveyor belt of canvas and terrycloth three feet wide. Soaking it with oil makes it repel water and attract oil.

The belt, powered by a three-horsepower motor, conveys the oil to a heavy wringer where it is squeezed into 45-gallon drums. The whole unit weighs approximately 900 pounds.

Mr. Sewell said he envisaged two basic problems when he designed the device.

"First I had to find something that oil would stick to, but which wouldn't attract water too. Then that material had to be made continuous so the oil would be constantly drawn off the water."

The first stage, he said, was fairly simple. He used the principle that likes attract, opposites repel. An oil soaked cloth attracted oil and repelled water.

The second stage, making the cloth continuous, was more difficult, but the conveyor belt idea soon came and the slicklicker was born.

"I was reasonably optimistic after trials at Esquimalt that the slicklicker would work," Mr. Sewell said. "However, I was impressed how well it did work with the very viscous oil of the (Chedabucto) spill," he added.

By mid-1972, approximately 45 slicklickers had been sold, 30 of them to the federal government for use in Canadian harbors. The other 15 went to the United States Navy and the governments of England, Japan, Israel and Okinawa. Arrangements were being made for its manufacture in France, Singapore and Australia.

Mr. Sewell and his brother have set up a company, R.B.H. Cybernetics, Patents and Processes Ltd., to manufacture slicklickers. Dominion Welding Engineering of Toronto is producing models for the eastern Canadian market.

The slicklicker in action in 1970 cleaning up the major oil spill caused by the tanker Arrow in Chedabucto Bay, Nova Soctia.

Sensory Deprivation

LISA MARTEL

For six days, three men lay in an almost sound-proof chamber, wearing translucent goggles and listening to nothing but a constant hum that blotted out all other sounds.

While inside the chamber and for some time after, the men had hallucinations, were unable to think or perceive clearly and experienced heightened susceptibility to suggestions.

It seemed like a scene from a prisoner-of-war film. However, the setting was not a prison camp but a psychological research laboratory at McGill University in Montreal during the 1950s.

Within the next two decades, information gained from this research was being applied to wean heavy smokers from cigarettes, to treat mental patients, to make personnel selection for jobs in remote areas more effective, and to select astronauts for space travel.

The clinical trials at McGill were inspired by the terrifying technique known as brainwashing. Their purpose was to test the psychological effects on humans of sensory deprivation and of boredom.

The people running the tests were psychology students under the direction of the world-renowned Canadian psychologist, Dr. D.O. Hebb. The "prisoners" were student volunteers paid $20 a day.

Sensory deprivation — lack of stimulation to the senses — had been recognized as an affliction peculiar to prisoners, mystics in isolation, explorers, sailors and others in secluded circumstances long before the Korean War began in 1951.

But it was not until then, when concern about brainwashing was current, that Dr. Hebb launched the first major experimental work on sensory deprivation with humans in a laboratory situation. The work was financed by the Defence Research Board of Canada.

The results of the McGill experiment were dramatic and unexpected.

For many volunteers, lying isolated and inactive with almost all sensory stimulation cut off was too much to endure for long. Despite the salary offered, out of several hundred volunteers who participated in the four-year program, only 72 were able to endure the isolation for three days and only three managed to last as much as six days.

Subject lying inside a dome-shaped isolation chamber at the University of Manitoba. Frosted goggles which allow light but eliminate pattern vision and a pair of earmuffs through which a low hissing sound (white noise) is generated are worn. The light and noise are present at all times throughout the entire 7-day period. In some experiments, darkness and silence is employed.

During isolation, subjects developed a need for stimulation of almost any kind. Before the first day was out, their capacity for maintaining a coherent train of thought had deteriorated noticeably.

Many also reported a variety of hallucinations during isolation that ranged from visions of "old men in bathtubs on wheels" to "squirrels wearing snowshoes."

In 1972 the Canadian pioneering research on sensory deprivation was the focus of considerable controversy. Interrogation methods similar to the experimental techniques of Dr. Hebb's group allegedly were being employed by the British in Northern Ireland to extract information from Irish Republican Army suspects.

But John P. Zubek, formerly one of Dr. Hebb's McGill colleagues and himself a noted researcher in the field, contended: "The purpose of our studies has certainly not been to develop new techniques for brainwashing but rather to advance the cause of science. The thing is that some of our results have been put to wrong use by certain individuals."

Dr. Zubek, as director of the University of Manitoba's sensory isolation laboratory, was head of what by 1972 had become the world's leading centre on sensory deprivation.

The applications of sensory deprivation studies are broad and useful, he explained.

For example, he said, companies selecting personnel for jobs in remote northern settlements and other secluded circumstances had minimized costs significantly by preliminary laboratory testing to determine applicants' endurance levels. Clinical psychologists or psychiatrists had used sensory isolation methods to put hospitalized mental patients in highly-suggestible states so they would readily accept therapeutic messages.

"In other areas of the world," continued Dr. Zubek, "heavy smokers are being put in isolation and given instructions which reduce or sometimes completely eliminate smoking."

Methods of minimizing the effects of isolation also had been developed. For example, less psychological impairment was reported if the volunteers in experiments performed isometric exercises while in isolation.

In the wake of the McGill group's pioneering studies in sensory deprivation, related research gradually began in such countries as the United States, Italy, Japan, Great Britain, the Netherlands, and the Soviet Union.

With the launching of Sputnik I and the dawning of the space age in 1957, studies on sensory deprivation were accelerated around the world as the problem of confinement during manned space travel became imminent. Other problems, such as the monotony and isolation of life in the far north and confinement in such quarters as prisons or submarines, also came under consideration.

In 1959, Dr. Zubek picked up where Canadian work in this field had been left in 1954, re-establishing sensory deprivation research at the University of Manitoba. Spurred by the heightened world interest in this subject, his work received financial support from the Defence Research Board of Canada.

"Canada has done the leading work and the longest continuously-operated research in the area of sensory deprivation — 17 years of Canadian research devoted to it," Dr. Zubek said.

In fact, evidence of emerging Canadian interest in the topic could be seen at least as far back as the 1940s. In 1949 Dr. Hebb published his classical work, The Organization of Behaviour, in which he laid some of the conceptual background for the studies begun at McGill in 1951.

That book, in fact, launched Dr. Hebb and McGill's psychology department into international fame among psychologists and related professionals. Dr. Hebb wrote another psychology classic, A Textbook of Psychology, and some 70 other publications.

Meanwhile, Dr. Zubek, in 1969, edited the book, Sensory Deprivation: Fifteen Years of Research, which presented a comprehensive survey of the work that had been done on sensory deprivation around the world. By 1972 he had also published approximately 50 scientific articles on sensory deprivation, among them several submissions for encyclopedias and anthologies.

New Images

PETER MILLS

Space scientists seeking better pictures from the moon went one better than Hollywood when they adapted for lunar exploration a videotape process developed by a Canadian to revolutionize movie-making.

John Lowry, a former CBC technician from Toronto, began in 1968 to work on a computerized process for transferring videotape to film that he predicted would cut the cost and time required to produce a movie by 30 per cent.

The feature film industry was Mr. Lowry's ultimate target, but he persuaded the National Aeronautical and Space Administration in the United States to preview the process in early 1972. He saw his technique as a means of clearing up the interference that caused haziness and distortion in previous television transmissions from the moon's surface.

Exactly how the computer functioned in the Lowry process was a secret closely guarded by Image Transform Inc., the company formed in 1972 by Mr. Lowry and his colleagues to market the process commercially.

However, company officials explained that the improvement is made by taking the electronic signal apart and then reconstructing it while removing physical defects and scratches. This ensures a steady image, low granularity, high definition, colour dependability, tonal accuracy and sharp edge effects.

NASA officials were so impressed with the process that they engaged the company to correct the interference during the Apollo 16 moon mission in April, 1972, and, after this initial success, to participate in the December Apollo 17 moon flight. The television transmissions from the moon were received in Houston, relayed to Los Angeles to be run through a computer, and sent back to Houston with the interference corrected. The total time lapse in the Houston-Los Angeles-Houston relay was one-fifth of a second.

The Lowry process proved to be a key component in NASA's efforts to reap maximum returns from the astronauts' limited time on the moon.

In previous lunar missions astronauts had spent much of their time manipulating cameras and objects to give scientists on earth more detailed images on their television screens. With the computerized process eliminating the need for this kind of work, the astronauts had more time for experimentation and exploration.

Company officials were highly optimistic about the possibility of future contracts with NASA and anticipated providing similar services for the Skylab project in 1973.

It was clear, however, that the functions of the computer when the process was applied to commercial film-making would differ from its function in the lunar study. Whereas the scientists used the computer to clarify otherwise faulty images, movie moguls would use it to effect the transfer of videotape feature movies to standard cine film for distribution.

A better allotment of time and money, however, was still the factor Image Transform hoped would attract movie-makers to the Lowry process.

An image Transform spokesman explained that one of the major advantages in using videotape rather than film to shoot movies was that a series of scenes could be shot at a time, replayed immediately and shot again at once if necessary.

Directors no longer would have what normally is a 24-hour wait before they could see ''rushes'' to determine whether a scene had to be shot again.

An estimated 10 days could be saved from a 30-day shooting schedule, and up to 25-30 per cent could be saved from any budget depending on a number of factors. The end result would be a picture equal in quality to pictures shot with conventional techniques.

Image Transform also planned to use the process to transfer television programs and commercials to film for easier storage.

A television transmission from the moon's surface.

Because film projection equipment was more readily available than video playback equipment, videotape industrial and educational productions also were being put on film to facilitate distribution.

Mr. Lowry completed his work on the process in 1970-71. By early 1972, a plant to transfer videotape to film and market the process had been established in California, virtually in the backyard of the Hollywood movie industry.

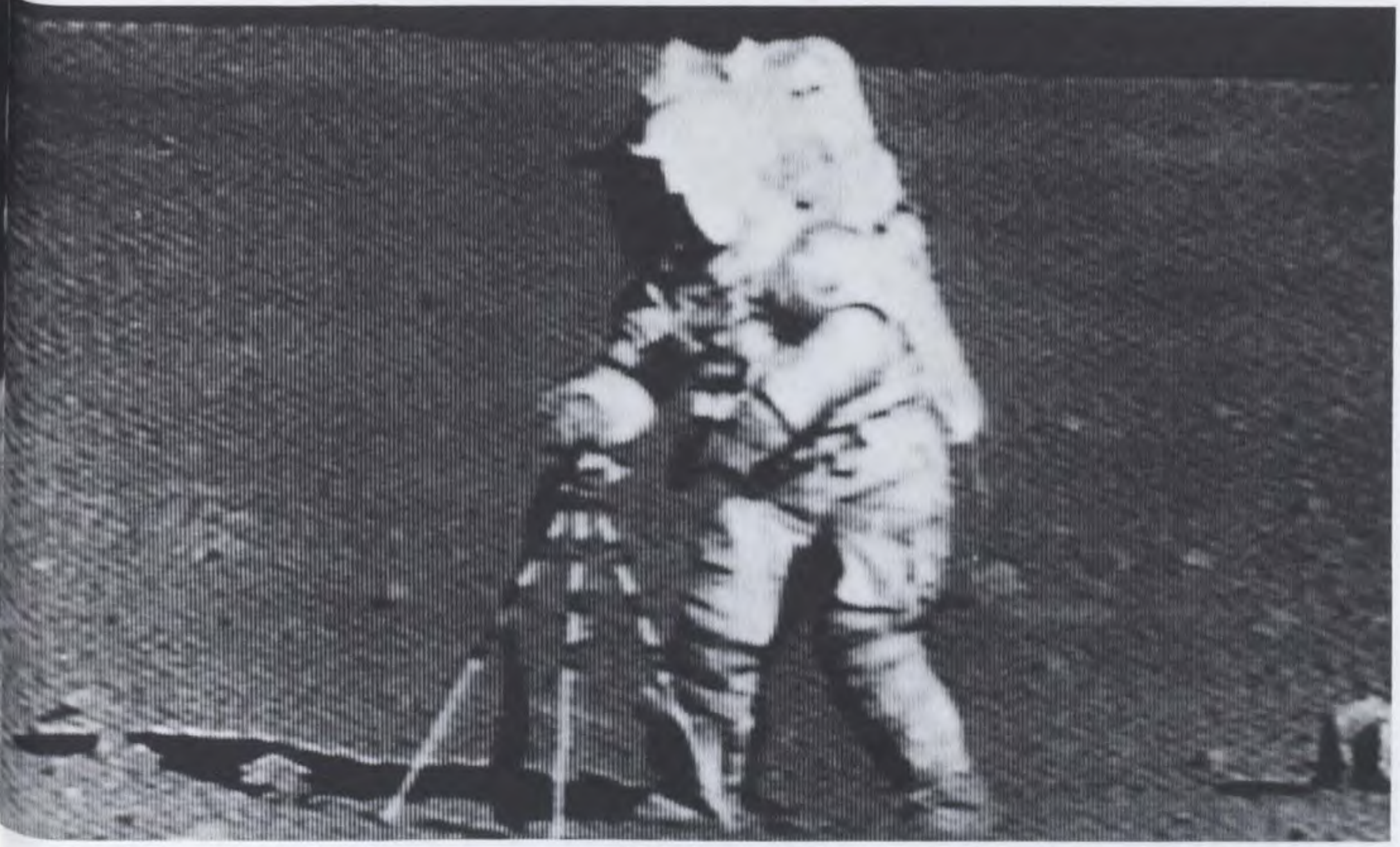
The company had talked with the three major U.S. television networks and the major Hollywood movie studios about future use of the process in the television and movie industries. Meanwhile, another company called Image Research Ltd., had been set up in Toronto to look into other applications of the Lowry process.

Financing for the initial venture came from Douglas McCutcheon, son of the late Canadian Senator M. Wallace McCutcheon, and a director of the company.

By December, 1972, John Lowry and his Image Transform company had used their process in the making of one Canadian film, and were engaged in the production of a major film for the American market.

The tape transfer technique was but one in a series of film processes and inventions pioneered by Mr. Lowry. He was involved in the early development of electronic editing and videotape techniques, as well as freelance tape and film production in New York, Hollywood and Toronto. At one time he had his own video production company, Advertel, in Toronto.

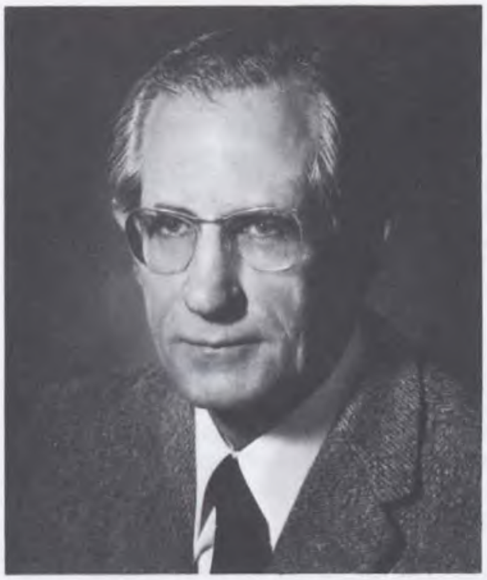
An earlier invention of Mr. Lowry, widely used in filming commercials and movies, was a platform that enables motion pictures to be taken from a moving helicopter without vibration affecting the camera.



A television transmission from the Apollo 16 moon mission in April, 1972, using the videotape process developed by John Lowry.

Drug Vulnerability

OREST DUBAS



Dr. Werner Kalow, Canadian pioneer in pharmacogenetics, the influence of heredity on drug action in the body.

She seemed normal enough — just another middle-aged woman in hospital briefly for minor surgery.

However, in one potentially dangerous respect, she was far from normal. Her genetic makeup made her one of nearly 10,000 Canadians who could suffer a reaction ranging from mild discomfort to death if given succinylcholine, a muscle-relaxant drug commonly used in surgery.

Fortunately, though, the patient's physician had followed routine case history procedure and asked her whether she knew of any drugs to which she suffered reactions. Her affirmative answer prodded him to do a simple blood test and possible tragedy during surgery was averted.

The special blood test by which doctors could predict her reaction to the drug was developed in the 1950's by a University of Toronto research team, headed by Dr. Werner Kalow.

Dr. Kalow, chairman of the University of Toronto department of pharmacology, and his colleagues found that certain persons inherited a rare gene which resulted in their bodies lacking the normal chemical capacity to break down succinylcholine. They estimated that about one Canadian in 2,000 carries such a gene.

From tests on more than 100 patients sensitive to the drug, Dr. Kalow's group also charted various family trees to indicate how this hereditary trait was passed down from one generation through later generations.

The Canadian work on succinylcholine sensitivity was a prototype study in pharmacogenetics, a field concerned with the hereditary aspects of human responses to drugs.

A leading U.S. pharmacologist, Dr. Bert La Du of the New York University School of Medicine, has said: "Everyone would agree that it is Dr. Kalow's contribution in pharmacogenetics that . . . set the stage for this field to become a real and practical science rather than almost a hobby kind of investigation."

In the wake of the Kalow group's findings, researchers uncovered about 60 different drugs — among them some barbiturates and contraceptive pills — that produce adverse reactions in persons genetically allergic to them.

For example, general anesthetics occasionally cause a condition called malignant hyperthermia. Body temperature rises rapidly, sometimes as high as 112 degrees, and some or most skeletal muscles go rigid. The result often is death from kidney or heart failure.

Because of its widespread use as a muscle relaxant in surgery and psychiatry, succinylcholine was one potentially allergenic drug that had to be fully understood in terms of its action in the body.

In many types of surgery, the drug is injected into the blood stream to prevent a patient's muscles from twitching. It allows the use of up to eight times less anesthetic to maintain the patient in the necessary pain-free and relaxed condition.

A single dose produces momentary muscle paralysis, but an enzyme present in the liver and blood of most patients usually destroys all traces of the drug within two to four minutes.

If complications develop or if continued muscle relaxation becomes essential for the surgeon to operate safely, the patient may be administered more than 20 times the normal amount over the course of an operation.

Clinical observations of abnormal reactions to succinylcholine began accumulating in the early 1950s. Certain patients were found unable to breathe on their own for more than 30 minutes after a single dose was given.

With larger doses, muscles involved in breathing were impaired for up to eight to 10 hours. Indeed, patients' lives depended on the skills of the anesthetists and on artificial respirators.

Even before the Kalow studies, several researchers had observed that the activity of the enzyme that destroys the drug in the body was especially low in sensitive patients. Then, in 1956, Dr. Kalow first demonstrated that these people had inherited an unusual or atypical form of the enzyme known as cholinesterase.

By the end of the decade the Kalow group also had devised a blood test for predicting whether a patient would react negatively to succinylcholine without having to inject the drug into the body. Several substances could be employed in the test, among them the widely-used local anesthetic dibucaine.

When dibucaine was added to a specimen of blood serum, the Kalow group found, it was chemically destroyed much more quickly if only the atypical enzyme was present. Test results could be available in a matter of hours.

To determine how severe a sensitive patient's reaction to succinylcholine would be, Dr. Kalow and his research team also calibrated the "dibucaine scale" on which the results of this routine test could be measured.

In 1962 Dr. Kalow described his work and reviewed the literature on the subject of genetic predisposition to drugs in his book, Pharmacogenetics: Heredity and the Response to Drugs. It was the first such survey of the field and, after a decade, still was the only major work in this area.

Dr. Kalow's pioneering work eventually stimulated not only individual research in pharmacogenetics, but led the World Health Organization as well to examine the hidden hazards of drugs mass produced for a society of unknown genetic composition.

Disposable Cameras

BRIDGET MADILL

Along with their popcorn, programs and soft drinks, Canadians soon may be able to buy "disposable" cameras at baseball, football and hockey games.

In June, 1972, the Lure Camera Co., of Calgary announced the development of the world's first disposable camera.

The camera is small enough to fit into a shirt pocket, weighs only 1.5 ounces, and will come with a 12-exposure, 16-millimetre colour film sealed inside.

Once the film is exposed, the entire unit will be shipped to a licensed processor who will break open and discard the camera. The 5-by-7 prints and a new film-loaded camera are to be returned to the user.

"The ultimate goal is to have a totally recyclable camera," a spokesman for the company said. By January, 1973, some parts, such as the lens, were reclaimable, but the body of the camera was not yet reusable.

Researchers were trying to develop a plastic body that would resist damage, but would be totally recyclable, biodegradable, or photodegradable, all without substantially raising the cost of the camera.

The spokesman said the camera would retail to premium contractors for about $2.00 and processing would cost the user about $3.50. He said other companies had been attempting to develop a similar camera, but thus far unsuccessfully. Lure's closest competitors had produced pocket cameras with over 100 moving parts compared to Lure's five, but in addition to being more complex, these cost about $30 and were not disposable.

The patent for the Lure camera encompassed the camera's most important features: the method of advancing the film and the lens shutter system. The spokesman said that both were of an unusually simple design.

The Lure camera has two shutter speeds, one for daylight exposures and the second for shooting in the dark, the latter set by inserting a non-battery flash cube.

The body of the camera is made of injection-moulded, high-impact styrene plastic. The lens, with its fixed opening, is made of plastic and has a range of three feet to infinity.

The camera was about 10 months in the development stage. Research costs ran to over $100,000 before the first hand-built prototype was made. The company aimed at having production moulds capable of producing 50,000 cameras monthly ready by the end of February, 1973. The cameras were being cast by Monitron Industries of Huntington Beach, California. A second set of moulds to produce a million cameras a month was to be ready by May 31, 1973. The increased production and assembly of the cameras was projected for June.

R.B. Colborne, president of Proflex Ltd., Lure's parent company, said the development of a disposable camera became economically feasible only with the wide availability of 16-millimetre film. Before the acceptance of pocket-sized cameras, this film was not generally available. Before it was in use, Mr. Colborne said, any pocket camera design would have been too complicated to offer in a disposable form.

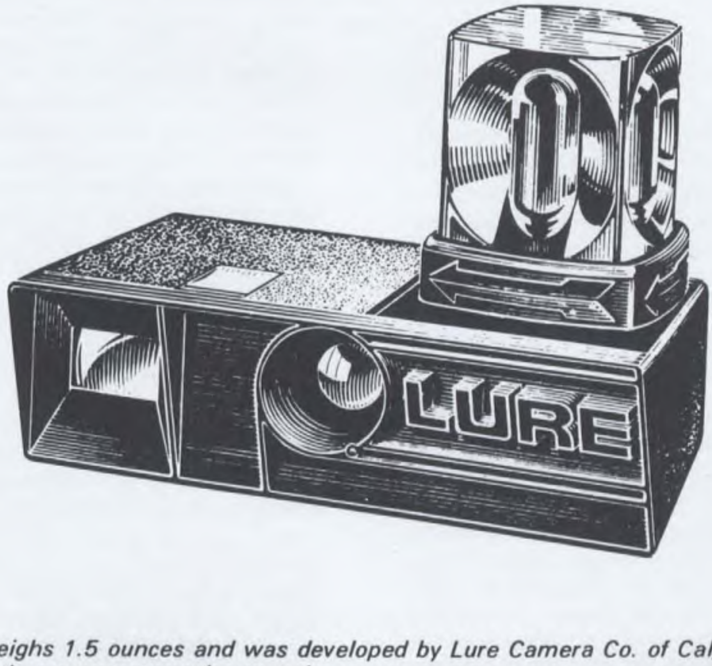
According to the company, the quality of the pictures was their main concern. The spokesman said the prints he had seen were excellent, even after the camera that took them had been tested for damage resistance.

Not all film processors would be able to develop the films from the Lure camera because some were not equipped to handle 16-millimetre film. Processors were selected in Canada and the United States primarily on the quality of their developing and printing.

The company expected its initial market to be businesses that offered premium items as sales incentives, but Lure anticipated a more sophisticated model of the camera would be offered for retail sale later.

Large volume sales of the camera were also expected at major sports events.

All initial production was to be for markets in the United States, but the camera would probably be available in Canada and Europe during 1973.



This camera weighs 1.5 ounces and was developed by Lure Camera Co. of Calgary. Once the film is exposed the camera cannot be reused.

Heart Surgery

MARLENE SIMMONS

The era of open heart surgery and cardiac pacemakers dawned in 1951 when a Toronto surgeon, Dr. Wilfred Bigelow, developed a refrigeration technique for safely "turning off" a patient's heart for up to 10 minutes during an operation.

The first successful open heart surgery was performed by Dr. Floyd Lewis of the University of Minnesota in 1951 using Dr. Bigelow's hypothermic technique. By 1972, between 200 and 500 open heart operations were performed annually in every major hospital throughout the world, and at least 75 to 80 per cent of these operations used a combination of hypothermia and the heart-lung machine.

Hypothermia, the lowering of the body temperature, has been used in many fields besides cardiac surgery. For example, it was used to diminish shock and the effects of oxygen deprivation in babies delivered after prolonged labor. It also helped babies born of Rh-negative mothers through the rigors of having their blood removed and replaced by transfusion.

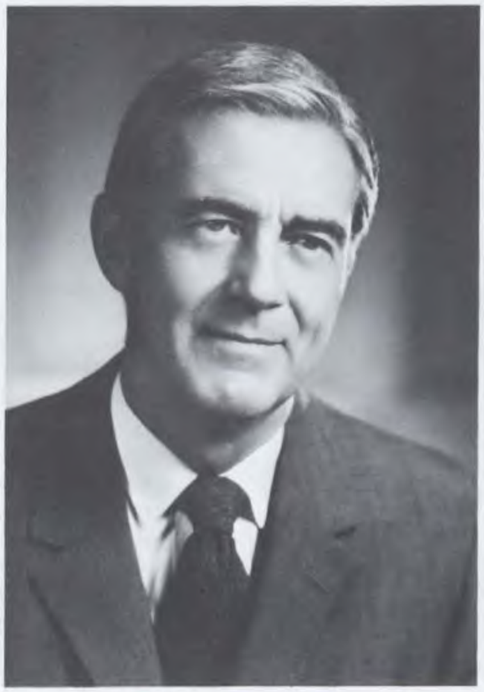
Hypothermia is usually induced by immersing the patient in a bath of ice water with a temperature between 35 and 40 degrees Fahrenheit, or by wrapping him in a rubber blanket through which a refrigerant is circulated. Shivering, which tends to maintain body heat, is prevented by muscle relaxants such as curare.

After two or three hours in the bath or the blanket, the patient has been cooled some 30 degrees below normal body temperature to approximately 70 degrees Fahrenheit. His metabolism — the chemical changes in the body which, among other things, produce body energy — then has slowed enough to permit the heart to be stopped for a few minutes.

Normal temperature is restored two or three hours after the operation by means of a warm bath or by circulating warm water through the rubber blanket.

The number of minutes made available to the surgeon by the shutdown of circulation is determined by the hazard to the brain rather than to the heart.

The brain is extremely vulnerable to oxygen deprivation and, at the normal rate of metabolism, it may suffer irreversible damage from an interruption of its blood supply for more than 5 or 6 minutes.



Dr. Wilfred G. Bigelow, developer of the hypothermic technique used today in open heart surgery.

Hypothermia, however, slows down the brain's metabolism and thus its need for oxygen just as it does that of other organs.

Dr. Bigelow, head of cardio-vascular surgery at Toronto General Hospital, said interest in hypothermia waned in the late 1950s and early 1960s because surgeons preferred using the heart-lung machine, which completely took over the function of the heart and lungs.

He said, however, that there had been an upsurge of interest in hypothermia since the mid-sixties, especially among the Japanese who were interested in its possible application to brain surgery.

It was early in the development of hypothermia that Dr. Bigelow's research led him into an avenue that resulted in the development of the cardiac pacemaker.

In his initial hypothermic experiments in 1949 at the Banting Institute in Toronto, Dr. Bigelow used groundhogs because they were hibernating animals, and it was possible to bring their body temperatures comparatively low.

However, many died as the result of an irreversible breakdown in the co-ordination of heart action, a condition known as ventricular fibrillation. At temperatures below 80 degrees Fahrenheit, heart beat becomes abnormal because the nerves that transmit heart contraction impulses are affected by the cold.

It was his efforts to resolve this problem that led Dr. Bigelow to the concept of the pacemaker in 1950.

Dr. John C. Callaghan, Research Fellow at the laboratories of the Banting Institute and now director of cardio-vascular surgery at University of Alberta Hospital in Edmonton, worked with Dr. Bigelow on the medical side of the problem. With the assistance of Jack A. Hopps, head of the radio and electrical engineering division of the National Research Council in Ottawa, who worked on the instrument itself, the

Canadian group built the first pacemaker in the world to be used clinically for humans.

"We used them to keep the groundhogs alive. By 1951 we had adapted them for use on people," Mr. Hopps said. "Because they were as large as mantle radios and the electrodes were placed directly on the nerve that stimulates the heart through the exposed chest, these pacemakers could only be used in hospitals."

Mr. Hopps said that during 1956 and 1957 American researchers improved the pacemaker by connecting it directly to the main heart muscle.

"This lowered the incidence of failure in pacemakers greatly," Mr. Hopps said. "Before this they often failed because of conduction blocks in the nerve that transmitted stimulation to the heart." The use of transistors in the electronic circuitry enabled more compact pacemakers to be built and in 1959 U.S. surgeons totally implanted one.

"At least 20,000 pacemakers a year are implanted in North America now, and probably another 20,000 in the rest of the world," Mr. Hopps estimated.

The modern circular pacemakers have a two-inch diameter and are made of a clear plastic. They run on tiny mercury batteries with enough power for up to 1 1/2 years. The pacemakers are implanted below the ribs and the electrodes are pushed through a vein into the heart.

In 1948, Dr. Bigelow also pioneered the study of microcirculation, that is, circulation through the smallest blood vessels in the human body. He had made photographs of "sludged blood" — blood in which cells, damaged as a result of shock or similar stresses, block or move slowly through the capillaries. This helped surgeons to understand better the effects of shock.

In explaining his work, Dr. Bigelow stressed that the experimentation and technological development involved in his discoveries were carried on by a varied group of specialists — doctors, biochemists, chemists, physiologists, experts in silicones, plastics and electronics.

"Each knew his own field thoroughly," he said, "and each had at least a good working acquaintance with the fields of all the others. In many cases I simply maintained the continuity of all the work."

Dr. Bigelow was instrumental in setting up the first training school in Canada for heart surgeons in 1958 with co-operation from the Sick Children's Hospital, Toronto Western Hospital, St. Michael's Hospital and the University of Toronto.

In recognition of his achievements, Dr. Bigelow was made an Honorary Fellow of the Royal College of Surgeons in England in 1968. Among other awards, he received the first medal given by the International Society of Surgery for his hypothermia research.

Reclaimed Oil

HEATHER BUCHAN

Each year hundreds of thousands of gallons of oil are drained from automobile and marine engines, diesel locomotives and bus and truck fleets.

It cannot be dumped for it would pollute every river and stream in the country. It cannot be burned without contaminating the air. These, however, have been the main disposal methods used since the invention of the internal combustion engine.

But at least one Canadian company has made a profitable venture of reclaiming the inky fluid, re-refining it and marketing it again as a quality lubricating oil.

In 1971 Turbo Resources Ltd., of Calgary produced 1.5 million gallons of lubricating oil, and half of it was recycled material. Their sales for this reclaimed oil totalled $ 1 million.

The company, which has been operating since 1965, collects approximately 80 per cent of the used lubricating oil available in Edmonton, where the refinery is located, 50 per cent in Saskatoon and 20 per cent in Calgary. They are presently investigating an agreement with the city of Winnipeg.

The recovery rate of the Turbo process is approximately 70 per cent. Ten per cent of the residue is also recovered in the form of gasoline and light oil. The rest of the residue is about half waste and miscellaneous byproducts, and half sulphuric acid sludge.

The sludge may be treated in a number of ways. It may be collected in ponds and burned off, not a desirable method in view of air pollution studies. It may be partially recoverable for use in the manufacture of detergents.

Turbo has developed a technique for turning this waste byproduct into asphalt and roofing material.

By neutralizing the acid and treating the sludge with emulsifiers and water, the company has developed a usable commodity. The process is presently in the pilot plant stage. Four patents have been filed in the United States.

So convinced is Turbo of the economic potential of the recycling industry that company president, Robert Brawn, has travelled to Kenya, Nigeria, Brazil, Mexico and the Ivory Coast to discuss establishing recycling plants with government and industry representatives.

He says the idea has been favourably received and he anticipates the company will conduct a feasibility study in Nigeria in the near future.

Why has recycling been so slow to catch on in this country?

Possibly the greatest deterrent is the cost of collection. Used oil must be available in sufficient quantity to offset the costs of collection and re-refining.

Re-refiners of the future will locate in densely-populated centres where there is the highest concentration of automobiles and industrial users. Collection in smaller centres by present methods is uneconomical, and thousands of gallons of used oil are wasted annually.

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