

Univ.
Q
1
C27

care

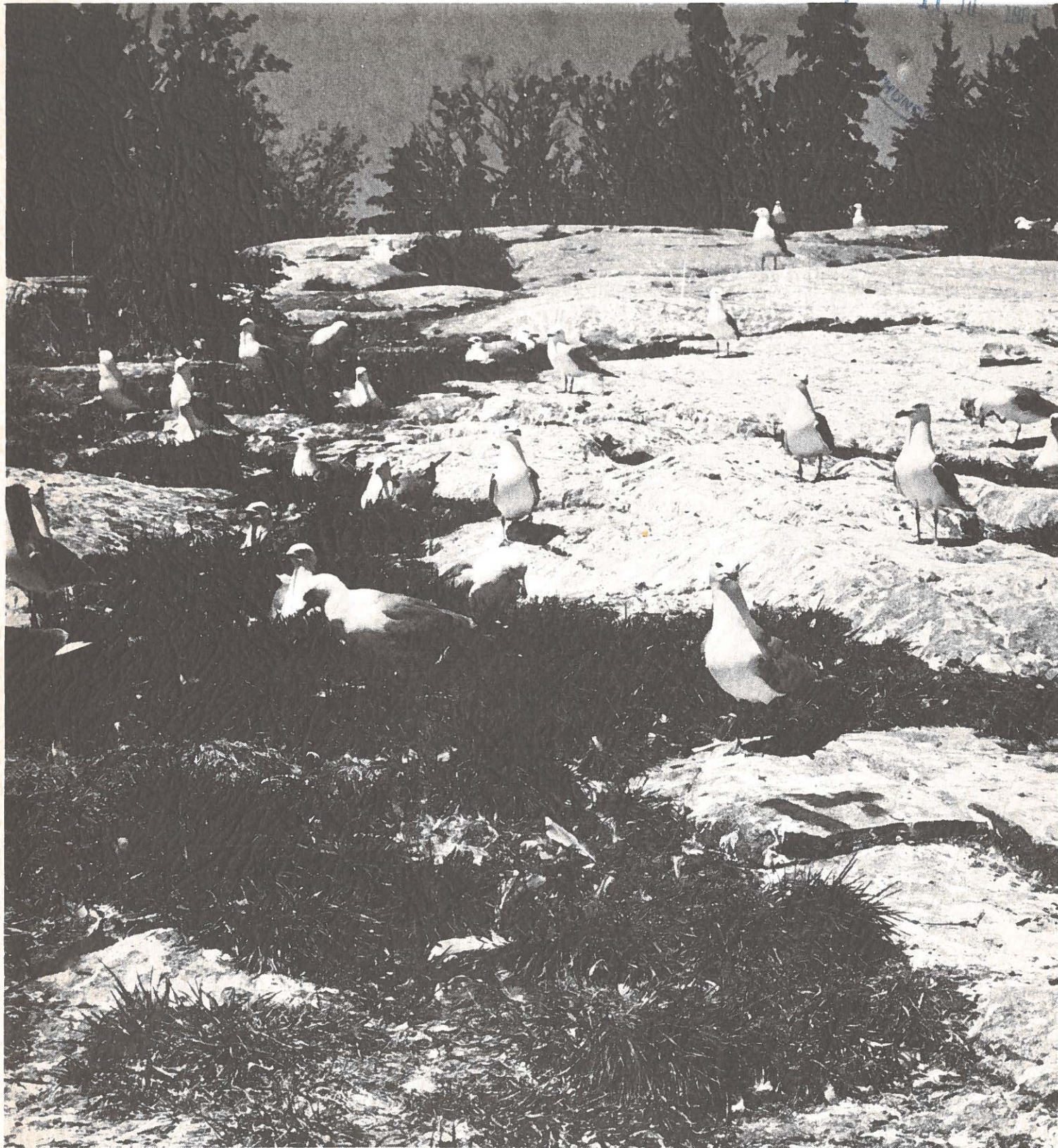
LAKEHEAD UNIVERSITY SCIENCE REVIEW

VOLUME 1 NUMBER 2

.50 cents



A PUBLICATION OF THE ONLY FACULTY OF SCIENCE THAT TRULY UNDERSTANDS NORTHWESTERN ONTARIO



OUR COVER

Dr. John Ryder, an ornithologist of international repute has been studying the habits of the graceful ring-billed gull which frequents Thunder Bay and occasionally makes excursions onto the University campus. Two articles in this issue describe the observation post. In the cover photograph, gulls are to be seen incubating their eggs in the grassy areas while the guards on the rocky areas stay alert to the danger from predators and interference from "foreigners".



Minister of State

Ministre d'État

Science and
Technology

Sciences et
Technologie

January 18, 1973.

Dr. John Hart,
Department of Physics,
Lakehead University,
Postal Station "P",
Thunder Bay, Ontario.

Dear Dr. Hart:

You have asked me to furnish you with a letter which will indicate the importance of science and technology to young people.

I do not know that there are aspects of science and technology which have relevance only to the young. It seems to me that science and technology vitally affect the well-being of all Canadians and the future of Canadian society as a whole.

Perhaps it is because of its effect on the Canadian society of the future that you have directed attention particularly to young people. They unquestionably will inherit the benefits of our stewardship of science and technology. They also will bear the burden of the negative aspects of that stewardship.

More and more we are realizing that science and technology are, after all, two-edged swords. Every day the message becomes clearer that we must orient our scientific and technological efforts towards pre-determined goals. It is, of course, impossible to predict all the effects of a given innovation before it is invented. Yet we must hope that by directing our energies to the solution of present and foreseeable problems of importance to our society as a whole, we can help build a better Canada and avoid the unfortunate side-effects that certain inventions may bring.

.../2

- 2 -

Dr. John Hart,
Lakehead University.

January 18, 1973.

At this stage the problem becomes one of choosing the most desirable directions. These choices will inevitably be dictated by the system of values of the society and of the individuals that make up the society.

This is the most important point for the young to remember, namely, that the mere existence of scientific and technological knowledge places an obligation on them to learn, question and evaluate both that very knowledge and the value structures of past and present societies. Since no single person can have all the answers, everyone must contribute, or our society will surely fail in its fundamental obligation to provide a life worth living for its members and their descendants.

I hope that this will meet at least part of what you had in mind.

Yours sincerely,

A handwritten signature in dark ink, appearing to read 'Jeanne Sauvé'. The script is cursive and fluid, with a large initial 'J'.

(Mme) Jeanne Sauvé

Table of Contents

1	<i>Editorial</i>	
2	<i>Letters to the Editor</i>	
5	DO SCIENTIFIC EXPLANATIONS EXPLAIN?	J. Douglas Rabb
10	THE PLACE OF SCIENCE IN EVERYDAY THOUGHT	E.S. Bodzin
12	SCIENCE AND APPLE PIE	Jim Wheeler
15	BASIC AIR NAVIGATION — A LOST ART?	Air Vice Marshal D.A.R. Bradshaw
19	THE CONSTRUCTION OF AN OBSERVATION TOWER	John R. Butler
22	THE USE OF AN OBSERVATION TOWER	John Ryder
23	BIOLOGY FROM THE STUDENTS' EYE VIEW	Jean Pekkala and Frank Cartwright
24	THE RESPONSIBILITIES OF BIOLOGISTS	C. A. Elsey
28	THE CATALYTIC REMOVAL OF AIR POLLUTANTS — QUO VADIS?	Robert A. Ross
31	DETERGENTS AND OUR WATER	Gordon Francis
33	THE CTS PROJECT AND SOME EDUCATIONAL IMPLICATIONS	T. R. Ide
36	PRESENT AWARENESS	A Liberal Science Student
38	HARWELL ATOMIC ENERGY RESEARCH ESTABLISHMENT	Huw Dorkins
41	THE EFFECTIVE SHAPE OF A MOLECULE	E. Tyrrell
42	PHYSICS AND BIOLOGY — ARE THEY SEPARABLE?	Margaret Hawton
43	FUTURE CAREERS	Moe Kytör
46	HIGH SCHOOL "DROP OUTS"!	Maurice G. Black
48	SO YOU WANT TO BE A NURSE?	Madeline Hookings
50	A BRICK PROBLEM	J. H. M. Whitfield
51	INTERVIEW WITH LAKEHEAD UNIVERSITY CHEMISTRY STOREKEEPER: Bert Harding	
55	THIN SECTIONS	R. L. Bennett
58	HOW MAY TEACHERS KEEP IN TOUCH WITH EXPANSION OF THEIR SUBJECT?	J. S. Griffith
59	ARE TEACHERS BORN OR MADE?	Casey A. Gehrels

continued

60	THE ADVENTURES OF MATHMAN	L.U. Math Club
61	LAKEHEAD BECOMES CANADIAN OPEN UNIVERSITY	Edward Mercy
62	TRANSLATION ON A COMPUTER	K. H. V. Booth
64	BLACK AND WHITE HOLES	J. S. Griffith
67	A PACKING PROBLEM	J. H. M. Whitfield
69	THE SCIENTIFIC APPROACH TO THE GAME OF BRIDGE	Larry Hansen
73	CROSSWORDS	
75	QUICK CROSSWORD	

Caret

A LAKEHEAD UNIVERSITY SCIENCE REVIEW incorporating LAKEHEAD UNIVERSITY MATHEMATICS GAZETTE

CARET (*kar'at*) *n.* A sign ($\wedge$ or λ) placed below a line to indicate where something should be inserted.

Our **CARET** symbolizes the disastrous communications gap between High Schools and Universities: the bridge across it is missing and we will hope to span the void if only with a gossamer thread.

Let us know what kind of articles you would like to see. *Write an article yourself and send it in.* Push your science teachers into sending us stories about their scientific and personal interests, or write about them yourselves (what an opportunity!) Above all, *don't think that what you have to say will not be of any interest to us: let us be the judge of that.* And, please don't assume that university scientists are somehow not quite human; we experience the same emotions of fear and hope, love and hate as the majority of human kind.

*The views expressed in **CARET** do not necessarily reflect the opinions of the Editor, the Faculty or the University.*

CARET is published by the Faculty of Science of Lakehead University, Thunder Bay, Ontario, Canada. P7B 5E1

Our Competition

The four volume Encyclopaedia goes to

Nancy Hathaway,
18—32 Arden Avenue,
Winnipeg, Manitoba. R2M 2J9

She proposed the title SCIENTIFIC CHANNEL, which she says "incorporates the ideas of a bridge between high schools and science, and of tuning in to science".

*It's a good title, Nancy; but the competition board have decided to stick to the old title after all, so **CARET** is still **CARET**.*

To everybody who returned the forms, a big THANK YOU. We hope you will write to us again, and keep us informed. Communication has to be two-way, so LET US HEAR FROM YOU!

Editorial

The production of the first number of a magazine is an adventure: the initial impetus is bound to be strong and the problems of production are seen as a challenge. The real test of success is the *second* number which is produced on the basis of experience. Modifications in technique are introduced, and the Editor has a somewhat more perceptive view of his constituency. Many an editor has quailed before the task of producing a second edition, and national libraries are graveyards of one-issue journals.

CARET has made it! We have learned some lessons, and have modified our ambitions in terms of the paper and print, but *not* our demand for good authorship. We are gratified that we have articles in cold storage far in excess of the quantity we can publish and we shall continue to approach likely authors for subjects of special interest. It is very rare for us to receive a refusal as this number amply demonstrates: in these pages are as wide a range of topics as one would meet anywhere, with authorships from laboratory technicians up to the Minister herself.

In some ways, we seem to be too successful. Science teachers seem

to have developed the habit of taking CARET home for their families to read and 'forgetting' to bring it back. Shame on you! We have visited schools throughout Northwestern Ontario, and it is a rare occurrence to find students who are even aware of its existence. At fifty cents, CARET is a bargain, and surely deserves the widest circulation?

collections for the best essay discussing the reasons why our complicated life-style prevents us from being rational.

Yours etc.

Edward Mercy, Chairman,
The Geology Department,
Lakehead University.

LETTERS TO THE EDITOR

DEPARTMENT OF GEOLOGY OFFERS VALUABLE PRIZE — CHAIRMAN TAKES AIM AT THE AUTOMOBILE

Sir:

The U.S. Government has introduced legislation aimed at reducing pollution of the atmosphere by auto exhausts. The major manufacturers of autos have responded by fixing control systems to engines which meet the stringent requirements laid down by law - but increase the consumption of gasoline by as much as thirty per cent. What a waste of a resource, the availability of which is becoming less and less.

Following a recent editorial in 'Science', I bring to your attention a solution to the pollution problem. Since most autos in North America weigh about two tons and have 300 cubic inch engines, let the Government pass legislation to restrict the weight of autos to a maximum of one ton and the size of engines to 150 cubic inches. At once, pollution is halved and so is the need for gasoline.

Since this simple solution is not possible, given our present economic and social system, I offer a handsome mineral specimen from the Departmental

Sir:

I have read your first edition (January 1973) and must say that I enjoyed it very much. In your opening remarks you asked for suggestions for a title and suggestions of what kind of articles should be included in this magazine. Below are some suggestions, which I hope will be of interest to you.

First of all, I think "Science Summation" or "Science $\sum_{1973}^{1974}$ " would be a good title for your magazine, since it would seem to me that one of your chief aims is to give the scope of scientific learning and information. Also, because there are these inter-related yet distinctive areas of scientific study, it would seem feasible to have sections in the publication set aside for each of these areas - somewhat like you did for the Math section in your January edition but perhaps not as long.

Another aim of your magazine would seem to be an interchange of scientific happenings in Northwestern Ontario as well as Lakehead University, thus why not contact difference science chairmen and/or teachers* (who in turn could contact students) in the High Schools of Northwestern Ontario and have them submit articles which could be published in a Northwestern Ontario section. This section should include short reports from each of the communities in Northwestern Ontario. They should be encouraged

to send in several reports and the best ones be printed. Also any reports that are too long for this section could then be placed in one of the specific subject areas (i.e. Math, Physics, Biology, etc.) or could be placed in the miscellaneous section, which would follow "Letters to the Editor as it does in your January edition. More reports on the different courses and comments such as "Liberal Science" articles would be appreciated.

It might seem as if I'm suggesting that you publish a choppy magazine, but what I'm really trying to say is that Mathematicians would automatically turn to the Math section first and then read the other articles; Physicists would turn to Physics; Northwestern Ontario readers would turn to Northwestern Ontario and compare notes and programmes and get ideas, and in each case the rest of the magazine, especially if they found their section interesting and informative.

This leads me to my last suggestion that the first page should not only include letters to the editor but also a list of contents and a statement as to whether this is a monthly, bi-monthly, etc. magazine so that subscribers would know when to get their reports in and readers would know when to watch for the next edition of the magazine.

I do hope I have not wasted your time with these few scribblings and if I can be of any assistance in any way feel free to contact me.

Yours etc.

Sheila Flesher,
333 Ogden Street,
Thunder Bay F, Ontario.

*We did! - Ed.

Sir:

On page 22 of the last issue there appears the statement that "LS104 -

The Physical Nature of the Earth - is merely Geology 1a6 which is the first-year course for specialist students who wish to continue in the field of geology". May I correct this statement?

Geology 1a6, and therefore LS104, is one of the few science courses which is open to any student who has the pre-requisite, "A grade 13 Science Subject". In this year's class, there are students from each of the five science majors, from both the Liberal Science and General Science programmes, as well as students from the Departments of Geography, Economics, Psychology and Sociology. It is not a course for the specialist student and certainly is not a course 'geared' towards the Liberal Science student. If it is 'geared' to anyone it is to the intelligent student.

Yours etc.

Edward Mercy, Chairman,
The Geology Department,
Lakehead University.

Sir:

Congratulations on an excellent Volume 1! Our students, teachers and myself found the articles most interesting.

Find enclosed a recent experiment that my Environmental Chemistry class conducted this past two weeks. The students enjoyed the experiment, and are presently inviting other students in the school to bring their own detergents from home for analysis. Gordon Francis wrote up a small report for our school newspaper, which is a bi-monthly, maybe you can use it.

Looking forward to your next edition.

Yours etc.

Bob Aitken,
Lakewood Secondary School,
Kenora, Ontario.

Sir:

I have just read a copy of your first issue of **CARET**. You have developed a very worthwhile publication which I suspect will go a long way toward bridging the university - high school gap that seems to exist everywhere. This will be specially true if you can encourage high school teachers to contribute. Would you please be so kind as to place me on your mailing list.

I am taking the liberty of sending you a copy of our publication, *Physics Teaching Today*, which is making some progress in increasing communication between the university and the high schools.

Yours etc.

Dr. Richard Reis,
Assistant Professor,
Department of Curriculum and
Instruction,
Memorial University of New-
foundland - St. John's.

Thank you, Dr. Reis. *Physics Teaching Today* is a lively publication - where did you get that centrefold Playmate?
- Ed.

PROFESSOR PSYMPATHI ADVISES

Dear Professor:

My teacher says science is all facts, but I try to argue with him that it's no good learning them because they're all crap and will be changed by the time I get out of school, and then he gets mad, and throws me out of the class. Why should I learn all this stuff?

- G.K.

Dear G.K.

Some parts of science are so well established that they can rightly be called "facts". These "facts" are

often difficult to learn and even more difficult to apply to problem solving. It is true that in university, you will discover that some of the things you were taught at lower levels were crap! That's all part of the excitement of science.

Dear Professor:

I'm very keen on chemistry, and get good marks. Sometimes I do things in the laboratory which I'm not supposed to do, and make an awful stink. I think I'm being original, but my teacher is threatening to ban me from the lab. Why can't I be left alone? - W.J.

Dear W.J.

Burning flesh smells terrible.

Write to:

PROFESSOR PSYMPATHI,
c/o THE DEAN OF SCIENCE,
LAKEHEAD UNIVERSITY,
THUNDER BAY, ONTARIO.
P7B 5E1

■ Say first, of God above, or man below,
What can we reason, but from what we know,
Of man, what see we but his station here,
From which to reason, or to which refer,
Through worlds unnumbered though God be known,
'Tis ours to trace him only in our own.
He, who through vast immensity can pierce,
See worlds on worlds compose one universe,
Observe how system into system runs,
What other planets circle other suns,
What varied being peoples every star,
May tell why Heaven has made us as we are.
— pope

DO SCIENTIFIC EXPLANATIONS EXPLAIN?

By J. Douglas Rabb

THE SCIENTIST IS NOT A PASSIVE OBSERVER

Do scientific explanations explain? I have suggested to the author of this paper, whom I know quite well - he being myself, that this question is a rather silly one. Surely it is obvious that scientific explanations explain. Indeed that is why we call them 'explanations'. The author, whose opinion I greatly respect, has replied that in asking this question he was, in fact, wondering whether scientific explanations actually increase our knowledge and understanding of the world. But surely this too is a rather silly question. Has not the advance of scientific knowledge over the past few decades been one of the most dramatic accomplishments of mankind? Is not the purpose of scientific inquiry to unravel the mysteries of the universe? This certainly seems to be the most common belief concerning what science is up to. But if one is bold enough to ask whether or not this prevailing opinion is correct, and the author of this paper assures me that he is, then it seems that we are back to the question with which we began - i.e., Do scientific explanations explain? But how does one go about answering this sort of question, as opposed to telling other people not to ask it? First, it will be necessary to establish what exactly a scientific explanation is - what sort of thing we are doing when we are offering this kind of explanation. Only after this is accomplished can we even begin to ask whether or not scientific explanations increase our understanding of the world.

It should be noted that I am primarily concerned with what may be called the empirical sciences - that

is, those sciences such as physics, chemistry, geology and biology, in which observation plays an important role.¹ Although we all know, in some sense, what observation is, it is important to realize that there are some striking differences between scientific observation and our ordinary sightings and noticings.

Scientific observation is, generally speaking, undertaken in order to put some tentative hypothesis to the test. The scientist is, then, not merely a passive observer; rather he sets out deliberately to make certain observations for a particular purpose. As Charles Darwin once put it "*All observation must be for or against some view if it is to be of any service.*"² One of the most important aspects of scientific observation is the demand for public verifiability or objectivity. That is, any particular scientific observation must be capable of repetition by any qualified observer. As the contemporary philosopher of science, Max Black puts it:

*".... the report of the individual scientist gets no more credit than it can win through the critical repetition of the observations by other scientists ... The requirement for public verification ... is the best instrument we have against personal bias and prejudice."*³

However, this demand for public verifiability has exerted a most interesting influence on the sort of observations scientists are willing to admit. Since the observations must be repeatable they are limited to those about which no dispute could, in practice, arise. Since sight is the most accurate of our senses, the observations are usually limited to visual ones. And as Max Black correct-

ly points out in a most illuminating passage:

*"What needs to be seen tends to be increasingly narrowed down to the position of a pointer on a numbered scale The situation to be observed is defined in the light of increasingly more complex theory, and what is recorded becomes increasingly something selected, abstracted, or calculated from the direct observation. The "felt warmth" of an object is replaced in turn by the readings of a mercury thermometer, a "calculated value" that is "corrected for errors" ... It is for this reason that reports of scientific investigation become increasingly hard for the layman to follow. It is not merely that the scientist has come gradually to discover unusual and hidden phenomena; the cause of the obscurity is still more to be found in the transformations imposed on common-sense concepts by the criterion of public verifiability."*⁴

What Black is here drawing our attention to is the increasing mathematization of the observation statements used by scientists. In fact, it is partially for this reason that mathematics is popularly regarded as the tool of the sciences. I will, however, argue shortly that mathematics has a much more fundamental role to play in the empirical sciences.

THE ACID TEST

Thus far I have been discussing only scientific observation. Scientific explanation, however, involves much more than mere observation statements. In fact what is observed is often 'explained' in terms of what is, in principle, unobservable. A scientific theory may, for example, make reference to such unobservables as electrons, genes, the

unconscious — in general, theoretical constructs. Theories of this type can only be confirmed indirectly, since we cannot observe the entities or properties to which they refer. By indirect confirmation, I mean the following: we can deduce that if the theory were correct then a certain set of observation statements would then be true. If the observation statements turn out to be true then the theory is confirmed, or at least on the way to being confirmed. But if some or all of the observation statements which would be true if the theory were correct, in fact, turn out to be false then the theory is incorrect and must be discarded or at least amended.

In order to facilitate discussion of this argument it is helpful to state it in rather more formal terms. If we let the statements expressing the theory or explanation be represented by the statement-variable 'p' and the observation statements by 'q' then the important part of the above argument can be stated very simply as follows: if p then q, but q is false, therefore p is false. It has been argued by some that this deceptively simple argument form which logicians honour with the Latin name *modus tollens*⁵ is, in fact, at the very basis of the validity of the empirical sciences.⁶ If this view is correct, and I am inclined to believe that some such view must be correct, then two important consequences follow. The first is that the scientist is constantly searching for ways of falsifying currently held theories. Rom Harré, a philosopher of science at Oxford, summarizes this kind of account of scientific investigation as follows:

"... we begin with certain vaguely formulated ideas about the way things are and how the world works, giving us a certain horizon of expectations about what will happen in given

circumstances. This we make more precise by constant refinement as we find reasons for rejecting those parts of our vague view of the world which do not fit in with our further experience ... laws of nature are always provisional, their temporary acceptance meaning that they have not yet provided any grounds for their own rejection."⁷

The second consequence of this view of scientific explanation is that the validity of the empirical sciences is ultimately dependent upon pure mathematics. The mathematician and philosopher, Bertrand Russell, in his famous essay on 'Mathematics and the Meta-physicians' offers the following definition of pure mathematics:

*"Pure mathematics consists entirely of assertions to the effect that, if such and such a proposition is true of anything, then such and such another proposition is true of that thing. It is essential not to discuss whether the first proposition is really true, and not to mention what the anything is, of which it is supposed to be true. Both these points would belong to applied mathematics. We start, in pure mathematics, from certain rules of inference, by which we can infer that if one proposition is true, then so is some other proposition ... Thus mathematics may be defined as the subject in which we never know what we are talking about, nor whether what we are saying is true."*⁸

Since I am suggesting that the validity of scientific explanation depends upon the kind of logico-mathematical arguments Russell is discussing here, it follows that mathematics is not merely the tool of the empirical sciences, but is rather at the very basis of their reliability.

NECESSITY FOR COMPETING HYPOTHESES

But is my suggestion correct? Is scientific explanation based on the *modus tollens* argument mentioned above? Is science the constant search for observations which will falsify its hypotheses and theories? Of course, the position as I have stated it is grossly oversimplified. The scientist, quite rightly, would not allow one observation, or set of observations, to falsify a given theory. He must first have a competing hypothesis from which the observation made can be deduced (explained?). Further in referring to the statement-form 'if p then q' I have been talking as if 'q' stands for observation statements and premiss-set 'p' stands only for statements making up scientific theories. However, something must also be said about law-like statements and statements describing the antecedent conditions of the phenomena described by 'q'. The account of scientific explanation that I am suggesting would not be complete and could not be defended unless something was said about all the above. But this, the reader will be relieved to see, is completely beyond the scope of this short paper. As the French philosopher, Voltaire, said somewhere *"The surest way to be a bore is to leave nothing unsaid."* Actually what Voltaire said was *"Le secret d'être ennuyeux c'est de tout dire"* but I prefer the rather liberal English translation.

As I said above I cannot offer conclusive proof that my description of the logic of scientific explanation is correct. I will, however, offer some evidence to show that I am, at least, on the right track. I will not appeal, as I might, to the actual practices of the older established sciences such as physics and chemistry. It will, I think, be more revealing to

look at what an exponent of a relatively young science has to say about what he is up to. This will be revealing because a person in this position is still, in effect, trying to win acceptance of his discipline as a genuine field of scientific inquiry.

The science of Theoretical Linguistics, compared to say Physics, is still in its infancy — if indeed it has passed the fetal stage. One of its best known practitioners, Noam Chomsky, is most concerned that his linguistic theories be accepted as *bona fide* scientific theories. In order to gain this acceptance, Chomsky argues, rather convincingly, that his principle of universal grammar, his deep structure of *all* languages, is in fact "... an empirical hypothesis, falsifiable by factual evidence".⁹

THE LIMITATIONS OF SCIENTIFIC EXPLANATION

I have presented a brief sketch of what I think a scientific explanation is and I have offered some support for this position. I now wish to draw attention to what I regard as two important shortcomings of scientific explanation. The first is, in fact, a problem with the nature of scientific observation. As I have noted, the scientist must be objective — his observations must be limited to those which can be repeated by any trained observer. I suggest, however, that when the scientist turns to the study of himself, or of man *per se*, as opposed to some aspect of man such as his body, this demand for objectivity hinders rather than aids the investigation. For when the investigator or the observer becomes the investigated or the observed, he tends to lose his essential characteristic — his subjectivity, the fact that he is, or can be, an observer. The result of this sort of exercise is usually some kind of behaviouristic psychology where the subject becomes a mere object. In fact what usually results is the odd sort of schizophrenia illustrated by the opening passages of this paper, in which I did not go so far as to treat myself as an

object but merely as another subject. In consulting the author of this paper I find that he agrees with me, at least on this point. Would it be logically possible for him to disagree with me on any point?¹⁰

My second worry about scientific explanation is a rather more general one. We normally think of explanation as the reduction of the unfamiliar to the familiar. That is, the explanation offered has to be more familiar than that which we set out to explain. But scientific explanation seems to do the very opposite. It takes some quite ordinary familiar event and 'explains' it in terms of unobservable theoretical constructs. Perhaps what my worry comes to is simply a request that the explanation offered, itself be explained. However, I think that most practicing scientists would give a rather pragmatic answer to this request saying, in effect, that if we require that everything be explained, we will, in fact, explain nothing. Nevertheless, I for one cannot seem to shake the belief that no explanation can be ultimately satisfactory if it leaves something unexplained.

In conclusion, then, I am suggesting that scientific explanation does not represent the condition of optimum development or final goal of our understanding and knowledge of the physical universe. However, let us not forget, it does represent the beginning.

FOOTNOTES

¹I will, however, also say something in passing, however misleading, about the formal sciences, such as mathematics and logic.

²As quoted in Max Black, *Critical*

Thinking, (New York, 1955), p. 357.

³*Ibid.*, p. 360.

⁴*Ibid.*, p. 361.

⁵Since the point of the argument is to deny the truth of 'p' it is called *modus tollens* from the Latin '*tollere*' meaning to deny. For a discussion, see I.M. Copi, *Introduction to Logic*, (New York, 1972), pp. 234 f.

⁶See, for example, Karl R. Popper, *The Logic of Scientific Discovery*, (London, 1968); and *Conjectures and Refutations; The Growth of Scientific Knowledge*, (London, 1963).

⁷R. Harré, *An Introduction to the Logic of the Sciences*, (London, 1965), p. 133.

⁸Bertrand Russell, *Mysticism and Logic*, (London, 1963), p. 59.

⁹Noam Chomsky, *Problems of Knowledge and Freedom*, (New York, 1971), p. 23.

¹⁰For an account of some other paradoxes that can result from applying scientific explanation to human behaviour see: C.S. Ripley, "Why Determinism Cannot Be True", *Dialogue*, Vol. XI, March, 1972, pp. 59-68.

Dr. Rabb is an assistant professor of Philosophy here at Lakehead University. Born in Kenora, he studied philosophy at Carleton University (Ottawa), Queen's University (Kingston) and the University of Edinburgh. He has published articles and reviews on a wide variety of philosophical concepts and topics including imagination, memory, belief, the self, materialist theories of mind, our knowledge of material objects and nineteenth century German Idealism. He is a member of the Canadian Philosophical Association, the Mind Association and the Aristotelian Society. He is admired and liked by his colleagues in the University who appreciate his even-tempered disposition. He has a profound knowledge of philosophy and is always ready to speak on the subject with great fluency.

FACT AND HYPOTHESIS

— Irving Marmer Copi

The job of science, we all know, is to discover facts; but a haphazard collection of facts cannot be said to constitute a science. To be sure, some parts of science may focus on this or that particular fact. A geographer, for example, may be interested in describing the exact configuration of a particular coastline, or a geologist in the precise nature of rock strata in a particular locality. But in the more advanced sciences, bare descriptive knowledge of this or that particular fact is of little importance. The scientist is eager to search out more general truths, of which particular facts are instances and for which they constitute evidence. Isolated particular facts may be known — in a sense — by direct observation. That a particular released object falls, that this ball moves more slowly down an inclined plane than it did when dropped directly downwards, that the tides ebb and flow, all these are matters of fact open to direct inspection. But the scientist seeks more than a mere record of such phenomena; he strives to *understand* them. To this end he seeks to formulate general laws which state the patterns of all such occurrences and the systematic relationships between them. The scientist is engaged in a search for the natural laws according to which all particular events occur and the fundamental principles which underlie them.

Irving Marmer Copi [1917 —]

was educated at the University of Michigan where he took his doctorate in 1948. Taught for one year at Illinois; returned to Michigan. Has written on logic, scientific method and the philosophy of language.

THE PLACE OF SCIENCE IN EVERYDAY THOUGHT

By E. S. Bodzin

CURIOSITY AND CRITICISM

Despite the ever-widening gulf between scientists and non-scientists, it is still true, as William James once observed, that the only important intellectual difference between the habitual drunk and the compulsive scholar is the point at which they stop asking questions. The curiosity of the child can become more intense with time, or it can be channeled into resignation and passive acceptance. When the young child defiantly asks why he should not climb onto the back of a chair, he may painfully learn something about centers of gravity or he may meet with an equally painful lesson about authority; and while either of these lessons might discourage him or whet his curiosity all the more, he has at least posed a question that had to be asked.

As we grow, thousands of similar questions beg for answers, even if we do not devote much time to formal study. Our reluctance to continue to ask certain kinds of questions — the kinds that specialists alone can cope with — should surely not deter us from asking questions altogether. And if we cannot all be professional scientists, so long as we learn about life generally we can confront its lessons with the same critical attitude that the scientist brings to bear upon his.

A number of striking parallels can be drawn between the critical method of the scholar and that of any thinking person. For example, the child mentioned above, whose chair has tipped over, will learn no more initially than to avoid climbing on *that* chair in *that* way. His experience at first will tell him nothing about sofas or about counterbalances. Since his knowledge is of limited scope, it is of limited usefulness as well. Eventually, he will be able to do far more with the knowledge that he can climb anywhere on any chair if a heavy enough weight

holds the seat down. This information can be tested and confirmed in a variety of situations.

GENERAL ASSUMPTIONS MAY BE INVALID

If we each had to go through this kind of process for all our conclusions, we would know far less than we do. Luckily, we come to depend on the experience of our predecessors and to accept their findings as our own. In other words, the individual accommodates his own knowledge to a scientific tradition much larger than himself. He realizes that if humanity had never taken the liberty of assuming it was right until all risk of error was past, mankind would still be back in the stone age. As a group, men have always acted as if certain bits of knowledge were true, and some of them actually have been. So the individual for his part assumes that the general assumptions of the past are correct.

Of course, they are not. Much in the same way as an individual might reflect upon the lessons of his youth, each age perceives the formulations of the past to be at best a collection of over-simplifications, partial truths, and useful errors. Knowledge is always being refined and made more precise, even radically altered on occasion. Recently, for example, cultural historians have replaced the vague traditional term "romanticism" with "organicism", which describes a process and a method generally believed in and used during the early years of the nineteenth century. The new concept provides a more precise, orderly way of uniting such diverse figures as Herder, Keats, Rousseau and Emerson.

Understanding the implications of this paradox — that we must accept the past if we are to grow as indi-

viduals, but that we must constantly re-examine traditional conclusions or stagnate as *Homo sapiens* — is the underlying basis of a rational, critical view of life. As thinkers we walk a line; sometimes we fall over on the side of certitude, and sometimes on the side of skepticism. As we have seen, accepting too much of the past is just as likely to draw us into error as is rejecting too much. To develop a critical perspective is to realize this, and to avoid both errors.

CONSTANT RE-VERIFICATION IS NECESSARY

As the above example from cultural history suggests, the methods of social science can be as crucial to everyday thought as those of the exact sciences. We do well to learn from exact science not to accept one demonstration of a discovered hypothesis, but to constantly re-verify it in the light of subsequent discovery; similarly, once we interpret and evaluate our own experience, we should be willing, like social science, to modify that vision whenever necessary.

It is a truism of our time that this is a relatively open-minded age — we tolerate and do not dogmatize. But in developing habits of thought, especially in regard to interpretation and evaluation, most of us accept some unyielding attitudes. We do not tolerate intolerance, for example. Thus, even open-mindedness has its limits. Few of us will wish to define those limits because not everybody is James's compulsive scholar. But whatever the scope of our investigations, our questions arise because understanding some of our experience is important to us.

Science in its broadest sense — that is, all knowledge — has become a complex and highly demanding pursuit. Only a part of it is available to the layman who has not given over his life to study and discipline. We all stop asking questions at some point; but life is too important for us to stop too soon. It would be

irresponsible of us simply to admit life's complexity and to leave the examination of life to professional thinkers.

Dr. Bodzin has never believed in the traditional distinctions among academic disciplines, nor in the isolation of academic life from life as a whole. His career has seen him move from rabbinical training to physical education to philosophy, the field in which he ultimately received his undergraduate degree. As a graduate student in English, he wrote a doctoral dissertation treating an aspect of American cultural history, in which he came close to avoiding any mention of literature. Currently Assistant Professor of English at Lakehead University, he considers improved judgment and the development of critical method to be more worthwhile goals for his students than the acquisition of any particular subject matter. Students hold him in the highest esteem: he is demanding and critical. Anyone who has taken one of his courses knows that he gives superb academic value for money.

DEFINITION OF DEMONSTRATIVE EVIDENCE

— John Stuart Mill

It has . . . been held by some writers that all ratiocination rests in the last resort on a *reductio ad absurdum*, since the way to enforce assent to it, in case of obscurity, would be to show that if the conclusion be denied we must deny some one at least of the premises, which, as they are all supposed true, would be a contradiction. And, in accordance with this, many have thought that the peculiar nature of the evidence of ratiocination consisted in the impossibility of admitting the premises and rejecting the conclusion without a contradiction in terms.

SCIENCE and APPLE PIE

By Jim Wheeler

Of Science, Webster says:

"Science — a branch of knowledge especially one concerned with establishing and systematizing facts, principles and methods"

Sounds like a filing clerk working in the middle of the Sahara Desert It's like describing an egg as a spheroid — ridiculous — if you are hungry!

The best way by far to describe science, if you want any nourishment out of it, is from the inside out with words like *delicious, all-consuming, unexpected, innovative.*

What's delicious about science? It's the apple pie fresh out of the oven. Just by looking at it your mouth begins to water ... "just a small taste", you say ... but there is no such thing for us apple pie lovers.

"What piece to cut?" — "What shape?" — "What size?" These are questions that only the eater can answer. If you can't ask: "How does it taste?" and get a reasonable answer, then take a small slice to sample yourself — certainly don't leave it untouched, for you may find it indescribably delicious.

How do you sample the apple pie and give an honest opinion? Well, let's list some of the *do's* and *don't's*. Perhaps the most important one is: Do approach it with an open mind and the honest desire to render a just decision no matter what it is. Do savour the flavour of each mouthful accumulating your impressions until the plate is clean, then render your decision. Don't gulp it down too quickly. You may end up choking. Don't precede the taste by eating a strong onion ... the true flavour will never get through. Don't take such a small piece that the taste is too fleeting to decide.

Let's look at the reactions of the one person we all know — ME, for it's the ME's who graduate from high school year after year. It's the ME's who stand on the threshold of decision. Well, it sure smells good out there! There's the smell of freedom, new cars, a full time job, marriage, and maybe even University. What to do? What to do?

My own exit from high school I must admit came as a pleasant shock to me. My physics marks prompted the guidance department to suggest I should pursue a career in electronics, and so I did to everyone's satisfaction, including my own. I must say, however, I was guided to a decision with blinkers on: as for those who supplied the blinkers and did the guiding, I thank God you were right in my case, for there must be some who still wonder: "Why am I doing this? — How did I get *here*?" For the rest of this article, I'm going to give you the highlights of seventeen years as seen from the inside looking out. My taste of the pie.

My first job was with DeHavilland aircraft in a division manufacturing electrical power supplies. I counted meters and other electrical equipment and kept them ready for use (by someone else!). "Everyone starts at the bottom" I'd been told so many times that it came as no surprise, and I didn't resent any of my "bottom jobs" as I recall. Four years later I was pretty well dry behind the ears and had taken part in the flight test of DeHavilland's new aircraft, the Caribou. Its letters were CF-KTK-X — and I'll tell you the first day it flew I was the proudest employee they had. My contribution was only some minor instrumentation, but you would have thought I'd designed half the aircraft myself: I suppose every employee watching that first flight must have been just as proud. Looking back over those first few years, I must say I was very happy with Science, because I had been allowed to put the fundamentals I

had learned in school into practice to the profit of both my employer and self.

About this time you could say I'd eaten my first slice of pie and had savoured every mouthful.

There were outside influences by this time that prompted me to apply to United Aircraft in Montreal for the position of Instrumentation Designer. United Aircraft were developing a new turbine engine and were putting together an experimental engineering department. I should tell you how I almost missed this one completely. I had written to the company in Longueuil, just outside of Montreal, and by return mail was told an interviewer by the name of Thompson would be at the Royal York and would be expecting me at 2:00 p.m. Shining, clean and nervous, I appeared no Thompson, they never heard of him. Was I ever disappointed! I returned home, down in the dumps and finally decided to phone the company direct, and ask them why they were so insensitive that they could change their mind about the interview and not even tell me. Well - it appeared they sent a last minute replacement when Thompson caught the flu and the new interviewer couldn't get in touch with me. As a result I rushed back to the hotel and was interviewed as he packed, paid his bill, and caught a plane for Montreal I got the job and within two weeks was working near Montreal.

Every new employee likes to make a good impression on his boss during his first few weeks, and I was no exception. One day during the first week, a shiny new calibration furnace and control system was delivered and because I was experienced with this type of equipment I was asked to put it into operation and set up a series of procedures for its use by less technical personnel. All went well the first day, but the second day the

thing literally exploded (due to a faulty component we eventually found out), but for the next hour I'll bet there were some misgivings about having hired me. Every time something similar to that incident happens and, believe me, things *do* go wrong in laboratories from time to time, I'd have sold my slice of Science for a nickle and given change to boot. These incidents are, thank God, few and far between but they nevertheless occur, so for those people starting out thinking that Science is a hard factual life ... equipment is made and labs are staffed by people like you and I and that's what makes laboratory life sweet and sour, exciting and depressing. My stay at United was one of the most taxing and yet pleasurable periods in my work-career. Here I was, with not only my education to draw on, but also several years of related experience, and I was being asked to use every bit of it. I went from design job to design job usually suggesting or developing instruments that made the test engineer's job easier. The test engineers ran the jet engines in large test areas called "test cells" and it was their job to test a new seal, or a new fuel system or a new propeller or thousands of other things that go into a modern aircraft engine. It was my job to make sure the answers they got were correct.

Exciting, you had better believe it! Imagine yourself involved as I was with up to ten such tests all going on at the same time. By this stage we were using two aircraft as test vehicles, one a helicopter on "tie-down" tests at the plant and the other a Beech 18 aircraft flying out of an airport over 35 miles away. There were about eighteen of us by this time all doing the same general job but each specializing in one aspect or another. I must have made a favourable impression as things progressed because I became the supervisor of this group and as you can again guess even more involved in not only my own work, but that of everyone else.

I learned several very important truths about life in this job - one is *make sure there is always a clear line of communications between people* because isolated people do not pull their fair share of the load. The other one is when handing out work after you select the people you want to do the job *let them do it!* Hold regular meetings to discuss progress by all means but don't stop progress just because it doesn't follow your exact line of thought. This last one is the one most often forgotten.

Well, I could tell all sorts of stories about building new test facilities, hiring new personnel, forming the flight test group, and the two days of pre-flight medical tests everyone went through in Toronto - not forgetting the time the test engine exploded - this all served to flavour the work and mold the people into an exciting happy team and I was, I can tell you, a very proud member.

I'd eaten another large slice of the pie and was ready for more.

About this time I moved to Kingston, Ontario to take up a similar position with a small company developing a free piston engine. It was while we were in Kingston my family started school, we built our first house, and I sold the patent rights to an instrument I had designed. My stay in Kingston was less hectic than Montreal and while I stayed there almost five years my work took on a routine colour that I rather enjoyed. We spent weekends on picnics, planting lawns and gardens, swimming, fishing, tobogganing and skating. I started to have a new approach to work that allowed me more free time for other things. I could still dive in and get completely immersed but now I could also climb out and dry off pretty quickly.

In the late 1960's I moved once again, this time to the flight research section of the National Research Council in Ottawa, so I was once again back with airplanes. This time I worked as

one of a group of three on developing and flight testing C.P.I.'s "Crash Position Indicators". My job was still trying to measure things, and I spent almost as much time flying as I did on the ground. You think this sounds exciting, I'll bet - well, I get air sick - not sick sick, just woozy which is almost worse, and the hardest thing to do is finish the job when your stomach is bent on taking over your mind. There were exciting moments here and the team atmosphere was perhaps the strongest I had ever been in. I had by now eaten enough of the pie to be a connoisseur of sorts and while this pie was definitely right for me there were slices that I have a preference for.

After I had been with the Council only one and a half years, a friend with whom I had gone through high school came to Ottawa and offered me a job at Lakehead University and to add to the offer I would also be allowed to continue my education to any degree I wanted at no expense to myself. Well, needless to say, I came, perhaps more because it was "home" than anything else, but anyway I did come. Since then I have obtained my degree, and still, I hope performed in a worthwhile fashion for my employer.

Is this the end of my wandering? Maybe - but it is only another slice of my pie, and I'm still looking forward to my next bite!

Jim Wheeler is a Master in the Retraining and Technology Divisions of Confederation College. His career has led him through Canada's Missile and Aircraft Industries where his enthusiasm for Science has grown with each new assignment. His educational experience includes a diploma from Ryerson Polytechnical Institute as well as a BSc from Lakehead University. His non-paying hobbies include amateur radio (VE3EEG) and boating which he enjoys with his three daughters and three sons.

BASIC AIR NAVIGATION — A LOST ART ?

By Air Vice Marshal Bradshaw

PEOPLE GET LOST BECAUSE THEY WILL NOT NAVIGATE

Before the days of Marco Polo, caravans used to cross the deserts of Afghanistan and Mongolia, arriving at their camping sites and destination with remarkable accuracy. How? By using an amazing Chinese magic needle which was on a leaf floating in a bowl of water. It always pointed in one direction if the bowl was kept perfectly still. It was the earliest magnetic compass. The famous early navigators of Portugal who explored the African coast could find their latitude using a crude forerunner of a sextant called an Astrolabe invented originally by the Greeks.

The sense of the foregoing is that men, for centuries, travelled great distances over unexplored land and seas using the crudest of simple instruments and highly developed instincts for conditions of sea, wind and weather. What is most important is that they got to their destination and returned!!

Why then in this day of highly refined electronic and other navigating devices, which are so numerous that the buyer has to decide which combination he needs, do modern pilots get lost in rather large numbers? Because they get lost, air and ground searches for downed aircraft cost the taxpayer millions of dollars annually.

The reasons are numerous, such as flying in an area with few or no electronic aids to navigation, on-board navigating equipment not working properly, flying in weather too severe for the pilot's capability — to list but a very few. Nevertheless I contend that most pilots flying over unpopulated areas, such as our northern bush country, get lost because of failure to use good basic air navigation methods.

NAVIGATIONAL AIDS

The basic equipment (which must be kept in serviceable condition) is:

- a) Up-to-date maps of the area of flight
- b) Compass: properly swung
- c) Altimeter
- d) Air Speed Indicator
- e) Turn and Bank Indicator
- f) Ruler, Protractor and Dividers
- g) Several Pencils
- h) Accurate Watch or Clock.

Common additional "luxury" items:

- a) Calculator
- b) Directional Gyro
- c) Artificial Horizon
- d) Sextant and Appropriate Star Tables
- e) Two-Way Radio.

With the above, many of the early pilots have circumnavigated the earth blazing trails which are now established airline routes.

HOW DISASTERS OCCUR

Not too long ago I was in a small plane taking off from one northern point for another several hundred miles away. After a while, the pilot turned to me and said, *"What time did we leave?"* This startled me and I asked him for the map. There was some scrambling around and after several minutes he handed me a map of the area — which was blank — that is, there was no flight line or other information pertaining to our flight on it! We didn't get lost, but that is precisely how these disasters commence. Lack of knowledge of the art of basic air navigation, lack of proper pre-flight preparation, lack of proper in-flight navigation, poor airmanship and laziness are the root causes of lost aircraft. Familiarity breeds contempt and pilots who fly to and fro, back and forth over the same route tend to relax their vigilance until one day they get trapped by weather — out of sight of the ground; unknown winds push them off course. Eventually, they may see the ground again, it is unfamiliar to them, they

are lost, fuel runs out!

HOW NOT TO GET LOST

What should a pilot, particularly one flying small aircraft over "bush" type country or over new routes, do to minimize his chances of getting lost and maximize his chances of arriving safely and on time at his destination after an enjoyable flight? The following is an effective pattern of procedure which may be considered basic. It will take longer to write it out than to do it.

Pre-Flight:

- (1) Using up-to-date aeronautical maps, draw a line (called the track) from the point of departure to destination or first stopping point or to each turning point.
- (2) From departure point, draw straight lines at 5° and 10° angles each side of your track. Extend these lines for at least 50 miles. Draw them on the destination side of your departure point.
- (3) At destination, repeat procedure with 5° and 10° lines drawn on the departure side of destination point.
- (4) Using dividers, mark track in 10 or 20 nautical mile intervals.
- (5) Measure distance to be flown in nautical miles.
- (6) Study route and 20 miles either side of track for prominent features, such as lakes, high hills, prominent river courses, etc., etc., and circle or indicate on map those features you plan to look for or will recognize at a glance.
- (7) If available, obtain latest weather forecast for your route area, destination and alternate. If available, obtain forecast winds for route at the altitudes you plan to fly plus winds from surface to at least 5000 feet above your planned flight altitude.
- (8) Using above data, carefully calculate your compass headings for

each leg of your flight, flying time for each leg in hours and minutes, fuel consumption for each leg of flight, including leg to alternate destination, and record this data on a suitable card for in-flight reference. If winds are not available, then the procedure to be used will be referred to later; see In-Flight, item (8).

(9) Calculate fuel required for flight to destination, plus fuel to alternate, plus fuel for holding pattern at destination as laid down in Air Regulations. (It is different for piston and jet aircraft.)

(10) File flight information as soon as possible with nearest aviation authority, plus time of departure.

(11) Ensure compass is serviceable and properly swung.

(12) Set clock or watch accurately.

(13) Check availability of maps (in proper sequence), calculator, ruler, protractor and pencils.

(14) Check functioning of radio and note frequencies to be used enroute.

In-Flight:

(1) After take-off, circle and set course over airport or from predetermined start point.

(2) Set clock or note time over airport or start point.

(3) Hold predetermined compass headings and read map carefully. After 5 or 10 minutes, mark exact position on map. This will indicate drift off course. Take clock reading.

(4) Refer to your 5° and 10° lines and you can estimate quite accurately the number of degrees you are off course.

(5) Alter heading towards your track the same number of degrees and you will make good a line parallel to your track.

(6) If you alter course towards your track, double the number of degrees and for the same amount of time taken to your first map check you will arrive back on your track.

(7) Now alter course back towards your original heading by the same number of degrees you were off course at first map

check point. You will now hold very close to your track.

(8) After regaining your track, take time between marked intervals. (Read the map continuously.) Using your calculator, find the ground speed of aircraft. Continuing to use calculator or just plain pencil, paper and simple arithmetic, recalculate estimated time of arrival at destination or turning points.

[With practice, this can all be done in your head and very quickly, too. Using calculator and this data, new wind direction and wind speed can be determined to recalculate new headings, if you wish to be more professional.]

(9) Continue to repeat sequences (4) to (8), inclusive, for the rest of the flight as flight situation warrants. (10) If weather drops toward the minimum for your licensed capability or type of aircraft, either return to departure point or look for nearest suitable landing area.

REMEMBER. *"There are old pilots and there are bold pilots, but there are no old bold pilots."* Just sit and have a cup of coffee until conditions improve.

Many experienced pilots and navigators will spot deficiencies in the above. Many will have all kinds of additional "tricks of the trade". Agreed — but the basis of this dissertation is to demonstrate that with minimal equipment, common sense, *self-discipline* and reasonable application of basic air navigation, the chances of getting lost can be made negligibly small.

If I were asked in what area an amateur pilot or bush pilot (or any other kind of pilot) should become as proficient as possible, I would have to say *meteorology*, with particular emphasis on weather phenomena during all seasons pertaining to his part of the country. After that, if he uses his head he will enjoy more *"Following Winds and Happy Landings"*.

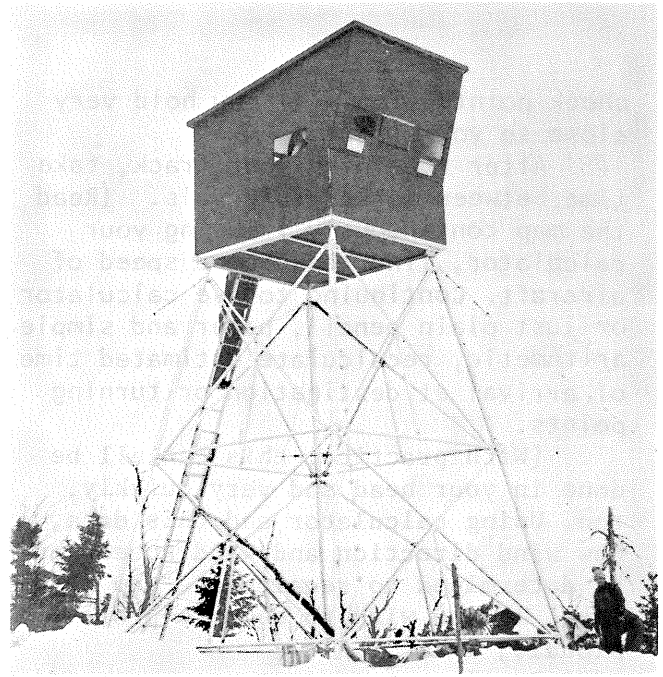
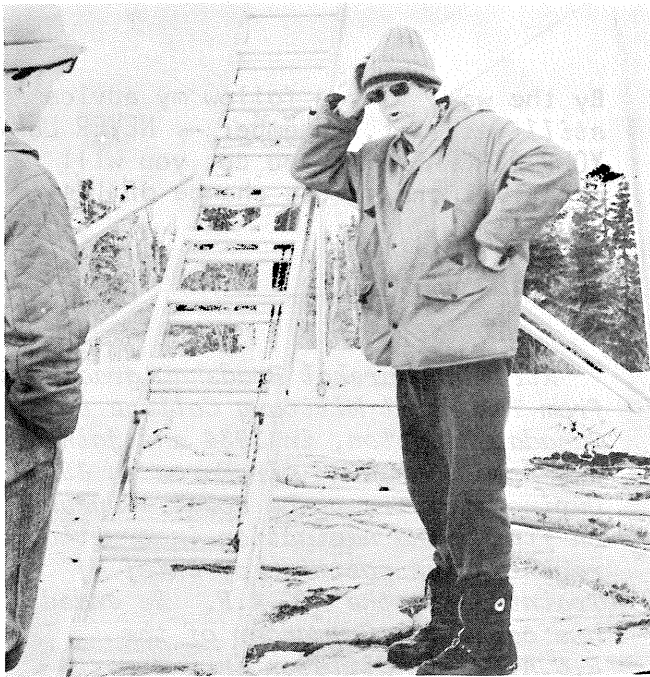
By the way, if you follow my advice and *still* get lost, remember — **NEVER LEAVE YOUR AIRCRAFT**. If you do, you will greatly increase the chance of losing your life.

Air Vice Marshal Bradshaw graduated from The Royal Military College of Canada, Kingston, in 1934 and joined the Royal Canadian Air Force in 1935. During his career, he spent 19 years in flying and navigation instruction, reaching the position of Chief of Training for the R.C.A.F. He ended his career as Commander of the R.C.A.F. Air Division in Europe which was equipped with supersonic 104 aircraft in the nuclear role. Air Vice Marshal Bradshaw has been President of The Confederation College of Applied Arts and Technology since 1967.

TRANSPORT MINISTER MARCHAND RELEASES REPORT ON FATAL ST. JAMES AIR CRASH:

OTTAWA — The crash of a Beechcraft 18 aircraft at St. James, Manitoba, with the death of the pilot and his passengers, eight school children, last June 24, was caused by loss of engine power and the pilot's failure to respond effectively to the situation. The report of the Transport Ministry listed the following conclusions:

- The aircraft's left engine lost power after take-off from Winnipeg International Airport.
 - The pilot did not follow prescribed emergency procedures after the initial power loss.
 - The right engine lost power because the pilot turned the right fuel selector valve to the "off" position.
 - The pilot had not been adequately trained in emergency procedures.
-

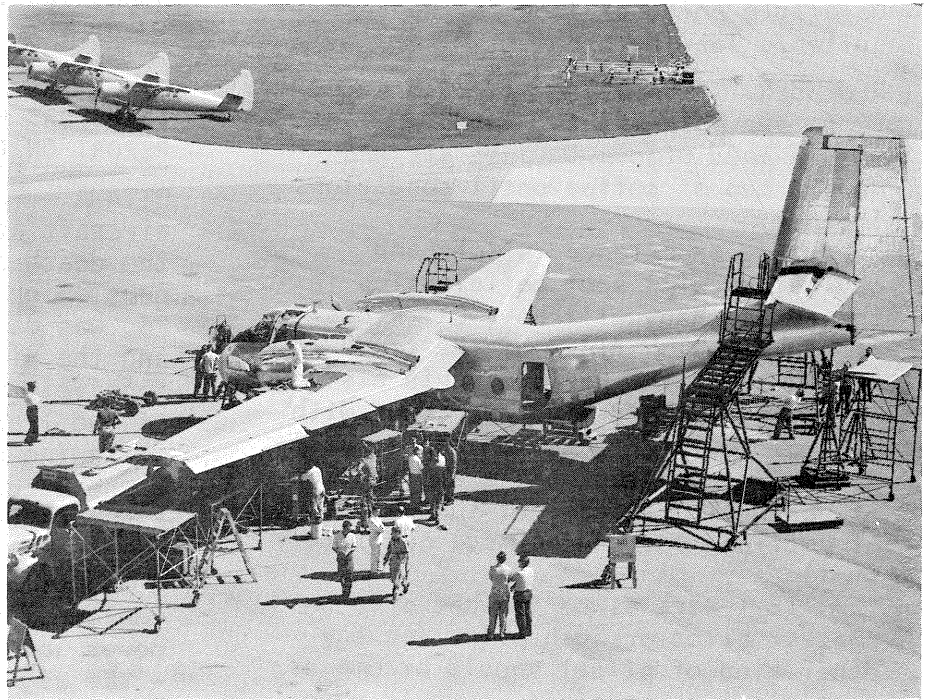


"Wolf" Ozburn (see Caret I) and John Butler (right)
... assemble ... The Tower.

"Some difficulty was experienced The completed tower looks most impressive"



Air Vice Marshal Bradshaw
*"There are old pilots
and bold pilots but"*



CF - KTK - X was one of Jim Wheeler's assignments.
"... I was the proudest employee they had"

THE CONSTRUCTION OF AN OBSERVATION TOWER

By John R. Butler

"At 0010 hrs, the party headed out into the teeth of a 30 m.p.h. wind. The temperature was 5°F, and this coupled with the wind, produced a chill factor of -55°F — the snow felt like hot needles on the face."

The above sounds more like an excerpt from Scott's diary than a description of the conditions encountered by a work party from the Science Faculty adventuring out to erect a bird observation tower on a remote island in Black Bay.

The project started when Dr. J. P. Ryder of the Biology Department asked if my department could construct an observation tower in connection with his study of gulls on Granite Island, six miles offshore in Black Bay, on Lake Superior. Apparently, the gulls are very nervous and conventional blinds are ineffective — the slightest noise will disturb the birds during the nesting period. It was hoped that a solid, insulated cabin on top of a tower would enable the colony to carry on with the minimum of upset (and give a modicum of comfort to the observers!).

The tower was completed about the middle of February, 1972. Its completion finally brought to a head the nagging problem — how to get it to Granite Island? Several ideas were proposed, most of them impractical. The Canadian Armed Forces, when asked for help, did not flatly reject the request, but the tower had to be assembled before the birds returned to the island to nest and the Services were not prepared to indicate when they could help.

The fact that we had a 3,000 pound load to move and the knowledge that the snow conditions generally start to deteriorate rapidly in March suggested that

we get cracking.

A J5 tracked-vehicle was rented with a truck large enough to carry the structure along with ropes, ladders and a rock drill.

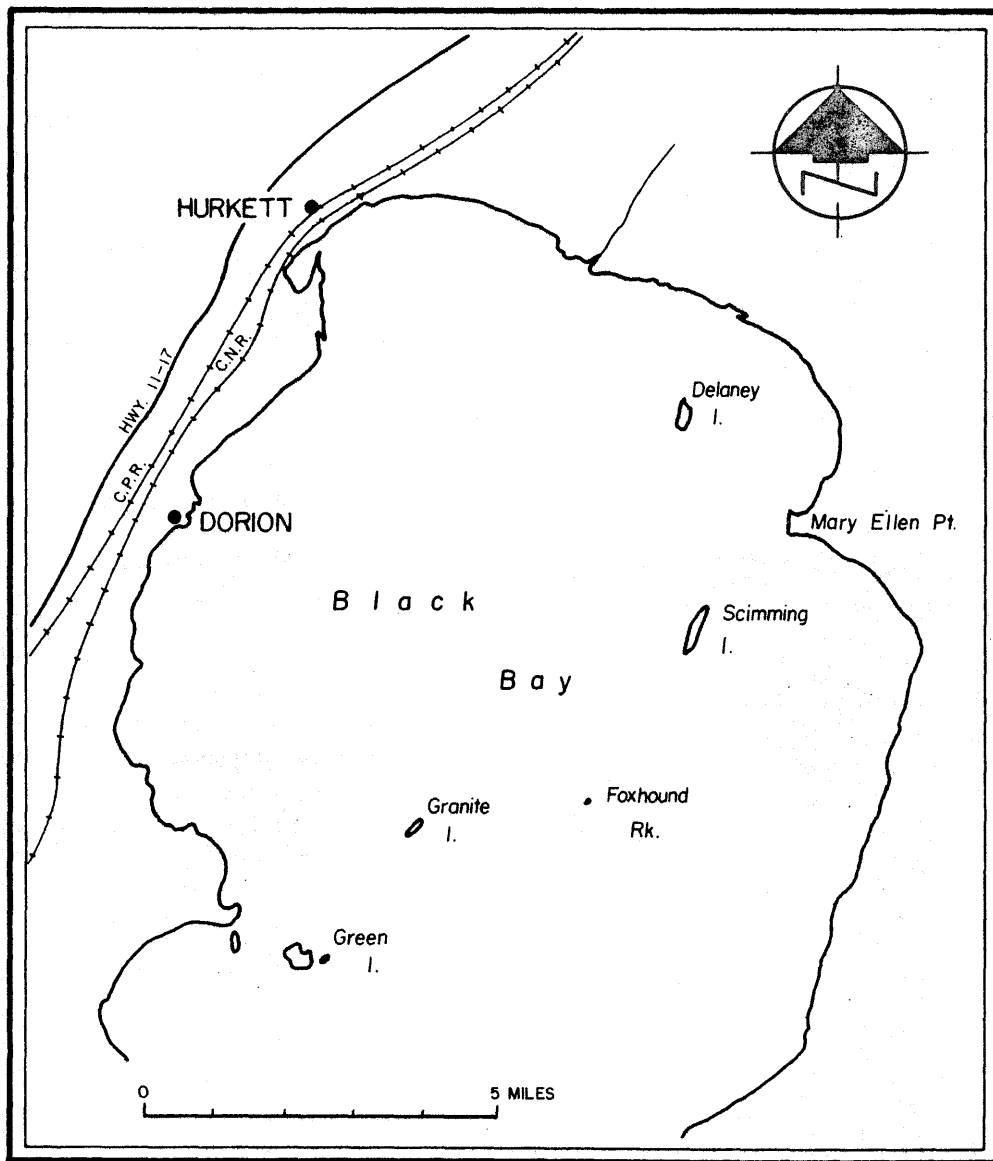
We managed to squeeze the tower into the truck (disassembled, of course) and the party then proceeded to Ray Trowbridge's cabin which lies at the foot of Black Bay. This was to be our headquarters. The assembly party varied in number from time to time, but fortunately, there were never less than eight members comprised of faculty, students and staff.

On the morning of the great day, a party of five (three on snow machines, two on the J5) started on an exploratory trip to the island to check the snow and ice conditions. Visibility was down to about a hundred yards, and the crews on the small machines were to run ahead of the J5 to check ice thickness and the depth of slush under the snow.

Unfortunately, we had no prior knowledge of the performance of the J5 and we rapidly discovered two problems. The top speed was 2 m.p.h. and it was difficult to steer in a straight line. As a result, our course was like the trajectory of a curve ball!

The island loomed out of the driving snow to an impressive height as we finally approached it. We found it impossible to climb to the top with the machines, as the lower rocks were glazed with ice from the early winter storms, and so we inspected the tower site on snowshoes. As everything seemed to be in order, we returned to base to prepare for the big haul the next day. The round trip time for this journey was seven hours in the most miserable of conditions.

Next morning, the party assembled early in clear and sunny weather.



(This often occurs in Northwestern Ontario the day following a storm.) We quickly loaded the tower and cabin components on a massive sleigh which was borrowed for the occasion from a local farmer. Almost before sunup, the party now numbering ten distributed on four snow machines and the J5 with sleigh behind ran down the bank onto the lake.

The lake surface was very irregular as the wind tends to form the snow into a series of waves — very much like sand in the desert. The trip out to the island was fairly uneventful. The major problem was the lack of steering response from the J5. When a course correction was needed, the sleigh had to be disconnected, while the machine was maneuvered into position! Also there was some concern that the old sleigh would collapse, as it was sinking very deeply into the snow and the towing machine had difficulty at times to keep moving.

The party arrived at the island about noon, and after a snack, started unloading and transporting the materials up the side of the island where a cache was made just below the summit. Not enough time was left that day to start erecting the tower, and so the party returned to camp and set about reloading the truck with the equipment that would not be required for assembly. Some difficulty was experienced in coaxing the J5 back onto the truck, since the snowbanks were either not high enough or too soft to maneuver the machine over the tailgate. A number of the party finally drove the truck and the J5 to the Dorion Hotel where a loading ramp was available. The J5 had no lights, and so it was fortunate that the O.P.P. were not encountered on this occasion!

The next two trips to the island were conducted in fine, almost warm weather. On the following weekend,

the party successfully erected the tower components, after the site was cleared of snow and all parts had been carried to the top of the hill. We had taken the precaution of including a gasoline-powered rock drill in our equipment, and our intrepid J5 driver, Bud Russell, turned out to be an efficient hole puncher.

On the final trip, a week later, a little more energy had to be expended as some of the cabin components were quite heavy and these had to be manually lifted twenty feet up the tower for assembly on the cabin floor. Luckily there was no wind blowing that day.

The completed tower looks most impressive. It is very sound and is now weathering its second winter. Dr. Ryder is so pleased with it that we have been commissioned to make another smaller installation for the McKenzie Delta.

The whole operation was really quite enjoyable and illustrates the wide scope of the work undertaken by the University's technical staff.

Mr. Butler is in charge of the Science Workshop of Lakehead University. He is responsible for the manufacture of a wide range of equipment which is used by undergraduates and research workers. One day, he is to be seen making a tiny, tiny instrument no larger than a lady's wrist watch and the next day, he is working on a major building project like the one described in his article. People like Mr. Butler are vital to the functioning of a good Faculty of Science and it is rare that they are able to describe their work to the public, not because they are inarticulate — it's just that nobody gives them the chance!

THE USE OF AN OBSERVATION TOWER

By John Ryder

THE TOWER IS ESSENTIAL TO RESEARCH

The observation tower that Mr. Butler built is used in a project dealing with the "sociobiology" of Ring-billed Gulls. These birds are colonial, nesting in large numbers close together on a small island near Thunder Bay. There are about 1200 gull nests on the island so it is easy to rapidly obtain information we are looking for.

Ring-billed Gulls are timid birds. If a person walks on the nesting area the birds take to the air and chaos prevails until the person leaves. Under these conditions, collecting biological data, especially about their behaviour, is impossible. This is where the overwhelming importance of the observation tower is realized.

The observation tower is an extremely important tool of behavioural research conducted under natural, uncontrolled field conditions. It allows the investigator to observe animals behave normally and respond to the many environmental stimuli the same as they would with no person present. Individual items of information collected from watching undisturbed animals are valuable to the scientist when he pieces them together to determine how the organism he is studying has adapted to the environment in which it lives.

Tower operation is fairly precise. The investigator enters the tower early in the morning. This initially disturbs the gulls so information cannot be collected for at least thirty minutes. During this time, the observer sits quietly in the tower so as not to re-disturb the birds as they settle down on their nests. When the birds have settled down, the observer can then start collecting data.

DATA ARE COLLECTED ON MANY CHARACTERISTICS

In our project we are marking birds with special tags so that we can recog-

nize individuals. It is important for us to know where individuals are nesting, how many eggs are in the nest, how many fights an individual has and with whom, how many fights each individual wins and loses and most importantly, what part does fighting play in the success of a pair in hatching their eggs. You would be surprised that fighting and aggressive displays are very important attributes which can determine the success of a nest. In addition, we want to find out if the same birds come back to the same nest site each year and if they nest near to the same birds year after year. We can only answer these and other questions by watching marked undisturbed birds in their natural environment.

The gulls get used to the tower. They actually sit on the roof during observation so that's pretty good proof that it works!

After two or three hours in the tower using a scope to check tag numbers, the observer leaves because his observation efficiency rapidly declines after that amount of time. Observations are continued, generally on a daily basis, in an effort, which may take years, to understand the workings of a complex animal society.

Dr. Ryder is Assistant Professor of Biology at Lakehead University where he teaches ornithology, boreal ecology and next year comparative vertebrate anatomy. His research interests involve the sociobiology of Ring-billed Gulls and parasites of gull nests. The results of Dr. Ryder's research have been published in a number of scholarly journals and natural history magazines.

BIOLOGY FROM THE STUDENTS' EYE VIEW

By Jean Pekkala and Frank Cartwright

PRO AND CON

As science students in the Biology Department we find the program open in that it allows the choice of a wide scope of topics, be they plant or animal in nature.

Once we had the essential introductory courses in first and second year Biology, we were then free in third and fourth year to choose our own courses in relation to our proposed post-graduate work.

Most third and fourth year courses are half-term in duration. They have their *pro* and *con* as viewed by the students. The *pro* is that you can get a wide survey of selected topics in your chosen field, and by Christmas your first term subjects are all over and done with; then with the start of the new year one embarks on a study of completely new topics. The *con* is that an excess of knowledge is crammed into a limited amount of time. If a student has problems and does not seek assistance, by the time he solves his problems, it may be too late to do well on his exams — which are finals! Some new core courses which run for the full year combat this problem.

Lakehead University is not a big university and the classes are relatively small. Thus biology students have a more intimate contact with the professors, who are easily available to the students during the day. The labs are not only open in the daytime, but in the evenings and weekends, as well.

EXTRA-CURRICULAR ACTIVITIES

For third and fourth year students, there is a wide range of opportunities made available for "demonstrating" the laboratory portion of most of the courses offered: this enables one to put his knowledge combined with his own personal skills into use and use his acquired knowledge to teach others. There are also opportunities open to

second, third and fourth year students for summer employment in the field of one's choice, working on research projects being carried out by the professors.

Besides the regular hours of class and studying, there are a great many activities one can participate in — school-related or otherwise. Students are given almost a free hand as to what they would like to do for themselves or for the benefit of their Department or both. They can carry out a great number of projects under departmental supervision and it is up to the students involved to see to it that these extra-curricular projects are consummated.

After classes, we now have the newly formed Biology Club, which is looking for help, suggestions and most of all support from the student body, which is the essential stuff of which clubs are formed. The Club is planning various activities such as guest speakers, field trips, movies and socials whereby the students can meet the faculty and actually participate in the activities be they academically centered or otherwise.

The total approach is not of overburdenment, for *once interest has been shown on the student's side, faculty will do everything possible to aid the student to achieve a chosen goal.* ■

THE STRESS WHEEL: The stress wheel is a planting design for test crops. It resembles the spokes of a huge wheel with the rim removed. Single rows, about thirty-five feet long, stretch out like the radii of a circle from a central point. The planted rows vary in width from narrow at the center to wider at the outside rim. Spacings are three feet at the end and narrow down to zero at the center of the wheel. During 1972 at Brandon, one wheel contained ninety-two rows or spokes. As you stand at the center, you can see at a glance how each variety in the test performs.

THE RESPONSIBILITIES OF BIOLOGISTS

By C. A. Elsey

THE IMPORTANCE OF OPTIMIZATION

The goal of the Ministry of Natural Resources is "to provide opportunities for outdoor recreation and resource development for the continuous social and economic benefit of the people of Ontario and to administer, protect and conserve public lands and waters".

Within the bounds of this statement lies the objective of the Outdoor Recreation Program "to provide from public lands and waters and to encourage on other lands and waters: a wide variety of outdoor recreational opportunities accessible to and for the continuous benefit of the people of Ontario; the identification and conservation of unique or representative physical, biological, cultural and historical features of the province; a continuous contribution to the economy of Ontario from tourism and its related industries". The objective of the Resource Products Program is "to provide an optimum continuous contribution to the economy of Ontario by stimulating and regulating the utilization of available supplies of fish, furbearers, minerals and trees by resource products industries".

To attain these objectives, the program of the biologist is correlated with the program of the foresters, land managers, geologists and other ministries of government.

The direct responsibility of biologists to the people of Ontario is to provide an optimum opportunity for recreation through fishing, hunting and viewing, and to contribute to the economy of Ontario through tourism, commercial fishing and trapping. It is important that full utilization be achieved with-

out adversely affecting the complex and frequently sensitive ecosystems. It is therefore the responsibility of biologists to determine optimum utilization or harvest limitations and thus manage the resources on a sustained yield basis to provide opportunities for continuing outdoor recreation and resource development.

ONE MOOSE PER SQUARE MILE

In this part of Ontario, we can consider that we are dealing with a sensitive environment. In most places, soils are very thin with bedrock not far below. The fertility of what soils we have is low. We live in an adverse climate — one that does not provide for optimum or maximum use of available fertility.

Moose populations can be expected in our area to have an average density of 0.8 to 1.0 moose per square mile. This means that we can expect to have something a little less than 20,000 moose in Thunder Bay district. Good management suggests that we can harvest about 25% or between four and five thousand per year. We are now harvesting slightly less than 2,000 per year. However, because of access problems, some areas are being lightly harvested and other areas heavily harvested. In the interests of good management, it would be desirable to redistribute the harvest. How is this done? Management is trying to find an answer and that answer must, by objective, consider the economic needs (tourist industry, jobs, etc.), as well as the recreational needs of the people of Ontario.

The fur business is an economic

need for many people. To some it is a hobby as well. The trap-line manager is faced with the responsibility of designing a management program that will meet the economic needs, as well as biological requirements. Recreation is not a primary consideration in this program.

FISHING IS IMPORTANT, TOO

Our lakes in this area suffer from low fertility levels and a very short growing season. Because the chemical and physical characteristics of lakes vary from lake to lake, the productivity of lakes will vary. On the average, we can expect lake trout lakes to yield about one-quarter of a pound to one-half pound per surface acre per year. Pickerel-pike lakes may yield about two to three pounds per acre per year. A sport fishery will contribute to both recreational and economic needs. A commercial fishery will contribute to the economic needs of a different group of people. If a fishery can withstand both angling and commercial fishing on a sustained yield basis, then it is obvious that both types of fishing should co-exist. Here again the biologist is looking for that thin-line position where he is working within biological limitations to meet both the economic and recreational needs of the people of Ontario. In the nature of resource management, it is inevitable that there should sometimes be conflict of interest between branches of the same ministry and between ministries. Such conflicts are ironed out by consultation.

Mr. Elsey graduated from the University of Saskatchewan in 1946 with an MSc degree in limnology. After graduating, he stayed on at the University of Saskatchewan for a year as an instructor. Since that time he has worked in Ontario (mainly in the north) as a biologist and fish and wildlife supervisor.

FUR PRICES INCREASE

Fur farmers are smiling on their way to the bank this year.

Prices have increased sharply and mink producers are optimistic that the market will remain firm.

The return of strong prices will enable mink ranchers to pay off debts which accumulated during recent years, when prices sometimes sank below the cost of production.

A clearer assessment of production, demand and longer-term price trends will be available early in the year, particularly for wild furs.

Fur prices normally fluctuate and, in the past, strong prices have often been followed by a sag as buyers fill their needs.

This year, however, overall demand is strong and there are indications that the fur industry may be on a general upswing which will shore up prices.

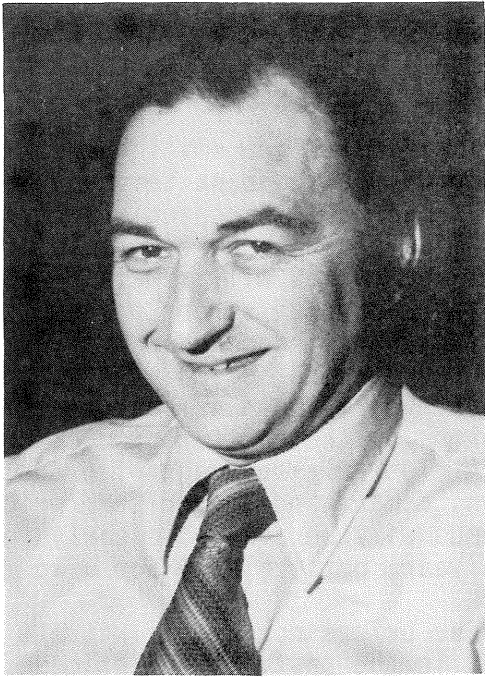
The reason for the increased demand is hard to pin-point, but there is speculation that incomes around the world are rising to the point where more consumers can afford the luxury of fur.

Prices for ranched mink in December were about twenty-five per cent higher than a year earlier.

The quantities of wild furs available are limited. All colors are in demand, but price increases are strongest for female pelts. These are smaller and lighter than the males, and thus are well suited for capes and jackets, currently popular retail items.

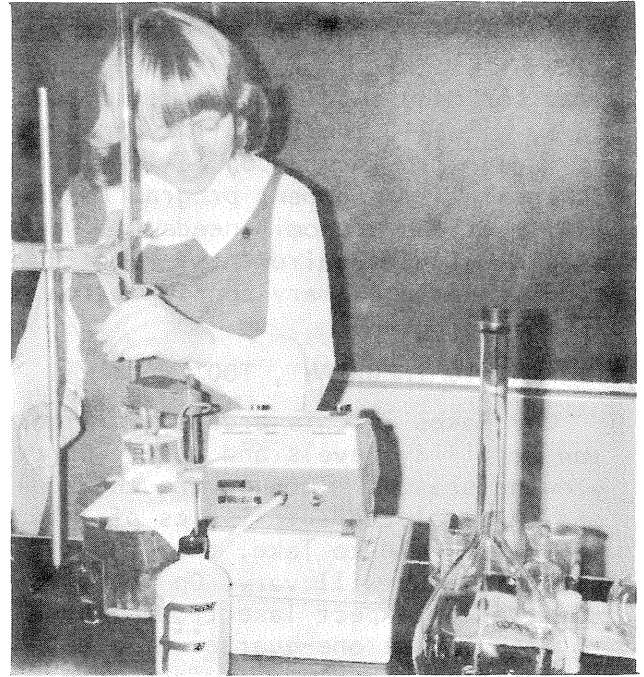
The demand is very strong for furs from Canada's north, and competition by buyers from many countries has pushed prices to the highest levels in many years.

Beaver pelts brought about thirty-five per cent more this year, red fox almost one-hundred per cent more; lynx pelts set record prices; and coyote and racoon prices advanced nearly one-hundred per cent.



Robert A. Ross

"Man's ingenuity knows no real bounds"

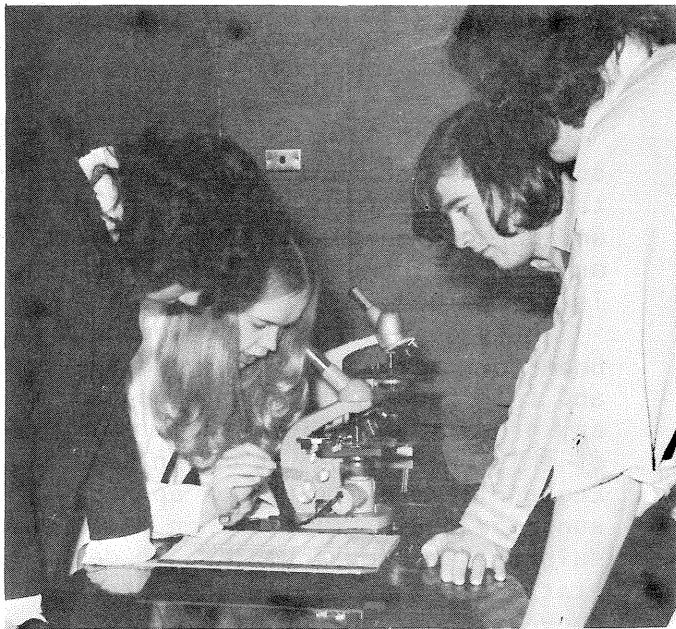


Leslie Woodrow

*"Every housewife washing clothes . . .
is hindering the survival of man himself!"*



"0.8 to 1.0 moose per square mile!"



Jean Pekkala and biologists
"There is a wide range of opportunities"



Ran Ide
*"The opening of culture can be achieved
 in education programs"*



Mr. Elsey (right) and friends
"The fur business is an economic need for many people"

(Courtesy, Chronicle Journal)

THE CATALYTIC REMOVAL OF AIR POLLUTANTS — QUO VADIS ?

By Robert A. Ross

HYGIENE: CAVEMAN TO ASTRONAUT

Contrary to popular belief, problems associated with the disposal of solid, liquid and gaseous waste products are not new but must have exercised the mind of Neanderthal man. The rudiments of elementary hygiene were not unknown, even then! The rapid growth of the materialistic needs and desires of our astronaut society in the past two decades has created waste and more waste and engendered an awareness of waste-disposal problems in the minds of both professional and amateur environmentalists. To most politicians, the pollution of the environment is almost a *cause célèbre*! On the other hand, many industries find the costs of installing existing remedial processes so prohibitively expensive that plant closures are often considered, and thus employment is jeopardized. Such is the dilemma and challenge posed to our society by this huge issue.

THE GUILTY SOURCES

The particular problem of the contamination of the atmosphere is created mainly by the exhaust gases from chemical and metallurgical process plants, oil refineries, power plants, domestic and industrial heating processes and internal combustion engines. These contaminants may be emitted as particulate matter -- dust, smoke, and smog -- or as 'trace' amounts of deleterious gases, often both types occur together. The gases may be poisonous, malodorous or even apparently innocuous. After exhaustion to the air, the contaminants usually do not fall within the immediate vicinity of the emitting source but are dispersed by the wind and are spread over an extensive fall-out area. The nature of the dispersion process depends on several factors including meteorological

conditions, the properties of the contaminant, the topography of the area, and the design and height of the stack or chimney through which the exhaust is discharged.

Many of the exhaust components undergo reactions in the atmosphere and fall back to the earth as secondary products. A significant example of this phenomenon occurs in London, England in the absence of appreciable sunshine during winter when smoke and sulphur dioxide accumulate in damp, static air masses with the consequent conversion of sulfur dioxide to sulfuric acid or sulfate compounds attached to smoke particles. Ultimately, with slow precipitation thousands of tons of sulfuric acid and filthy soot seep into the city with disturbing consequences on mortality rate, corrosion and erosion of buildings and botanical plant life-cycles. In the great London smog of 1952, four thousand deaths of people with respiratory diseases were attributed to this cause. Subsequent legislation compelling both the industrial and domestic use of smokeless solid fuels has eased, but not entirely eradicated the problem.

Since the concentrations of gaseous pollutants in air are considerably greater than those of particulate matter, most current research is devoted to the discovery and application of methods designed to minimize and possibly eliminate deleterious gases from industrial effluents. Disregarding carbon dioxide, the most abundant air pollutants are carbon monoxide, sulfur dioxide and oxides of nitrogen. The tolerance level for carbon monoxide is considered to be exceeded on exposure to 30 parts per hundred million, ppm, of the gas for more than eight hours. This level of exposure is not likely to occur in normal circumstances. Furthermore, carbon monoxide does not partake in

any significant reactions after its emission and hence its removal from exhaust gases has received much less attention than that accorded to sulfur and nitrogen dioxides. The magnitude of these removal tasks can be appreciated by noting that in the United States alone, nearly 29,000,000 tons of sulfur dioxide were emitted to the atmosphere in 1966 and for 1980, a potential figure of more than twice that amount can be estimated.

A POSSIBLE REMEDY

The choice of a method for partial or total removal of air contaminants depends on many factors including operation efficiency, feasibility and cost. Of the many techniques available for the reduction of pollution due to sulfur and nitrogen dioxides, the heterogeneous catalytic method presents a viable possibility. For example, sulfur dioxide may be converted to the trioxide in an oxidizing flue gas at high efficiencies when it is passed over a composite solid catalyst containing transition metal oxides supported on alkalized silica gel. Subsequent operations may be introduced to produce sulfuric acid from the trioxide in a controlled way. An alternative catalytic oxidation process which originated in Japan involves mixing ammonia with oxidized sulphur dioxide in the flue gas to form ammonium sulfate over a vanadium pentoxide catalyst.

Although the catalytic treatment of nitrogen oxides in the exhaust gases from internal combustion engines is complicated by the presence of hydrocarbons and lead compounds, the method is still attractive since the principal products of the decomposition of the oxides are nitrogen and oxygen which can be vented safely to the atmosphere. Substantial current research activities by automobile manufacturers on catalytic methods of exhaust emission control seem to be emphasizing the use of

costly platinum group catalysts which were first studied in the decomposition of nitric oxide nearly fifty years ago! Of course, giant corporations and interests are involved in these activities and the various implications are truly extensive.

THE NORTHWESTERN ONTARIO PROBLEM

In Northwestern Ontario, the significant sources of air contamination are the pulp and paper mills. The malodorous components of the effluent gases are mainly hydrogen sulfide, mercaptans and organic disulfides. Hydrogen sulfide is possibly the most common offender of such gases with an odour threshold reported to be as low as 0.7 ppm. The gas is also extremely toxic since a level of 400 to 700 ppm may be dangerous to life after an exposure time of 30 to 60 minutes. In spite of recent efforts to eliminate the hazard, the gas can still be detected in the effluent from some chemical recovery plant emission stacks.

A possible method for the removal of these sulfur gases is by catalytic oxidation, which can be followed by recovery of the sulfur dioxide formed. At Lakehead University an active research program, led by Dr. Walter Cook, has been initiated on this theme. A key feature of the study is the emphasis placed on the catalytic removal of the compounds to an effluent level below that of the odour threshold. The method would not be considered to be a success by the local population, at any rate, unless this were achieved!

Using a series of mixed oxide catalysts supported on alpha-alumina, Dr. Cook has shown that hydrogen sulfide at 600 ppm in nitrogen/air mixtures can be almost completely oxidized to sulfur dioxide when passed once in a flowing stream over these materials at 200 to 320°C. The most effective catalyst that he has discovered so far, contains molyb-

denum and cobalt oxides. One substantial bonus from this work has been the development of instrumental analytical methods for the detection of hydrogen sulfide in these low concentrations.

Further studies in cooperation with Dr. Michael Jeanes are presently concerned with an examination of the reactivity and efficiency of the catalysts in the oxidation of organic sulfides and thiols using more complex carrier gas mixtures which reflect more closely on the actual composition of Kraft mill stack gases.

This local example illustrates that environmental problems created by advanced technology can be solved by technology. Man's ingenuity knows no real bounds and undoubtedly there are better ways than that chosen. However, the question still remains-- HOW MUCH ARE WE PREPARED TO PAY?

Formerly an industrial researcher for Unilever Limited and Marconi's Wireless Telegraph Company, Dr. Ross came to Lakehead University from an academic post in Belfast, Northern Ireland in 1969, just when the current "troubles" in that province were starting. Now the Dean of Science at Lakehead University, he is the author of several papers on heterogeneous catalysis, technological and surface chemistry. He maintains that he is a hopeless golfer and a lazy gardener.

A Canada-wide inventory of five major air pollutant emissions has been completed by Environment Canada.

Announcing the findings of the study, Environment Minister Jack Davis noted that it was the first comprehensive nationwide inventory of its kind in Canada.

Pollutants covered in the inventory are: sulphur oxides, particu-

lates, carbon monoxide, nitrogen oxides and hydrocarbons. The information has been classified into five major categories of sources: industrial processes, fuel combustion in stationary sources, transportation sources, solid waste disposal and miscellaneous sources. The study is based on 1970 data and will be updated at regular intervals. This updating, combined with ongoing measurements of air pollution levels by surveillance networks throughout Canada, will give a clear indication of progress in the control of air pollution.

Commenting on significant findings, Mr. Davis noted that transportation accounted for 57% of total air pollution emissions of 31.2 million tons. The Federal Government is actively engaged in the control of motor vehicle emissions. "The inventory further confirms our concerns about air pollution from this source", Mr. Davis said.

The inventory also shows that one industrial sector -- primary copper and nickel -- accounted for 4.5 million tons, or 14% of total emissions in Canada. He noted that Environment Canada has been working closely with the Provinces in tackling this problem.

Copies of this inventory, in summary form, are available to the public on request. Write: *The Information Branch, Department of the Environment, Ottawa, K1A 0H3* or telephone (819) 997-2944.

TREATMENT OF METAL FINISHING EFFLUENT:

Pickle liquor or spent plating bath solutions can be treated to recover valuable metals (nickel, copper, zinc, silver, etc.) and to remove toxic compounds such as cyanides, chromates and phenols. Reverse osmosis, chemical precipitation and ion flotation techniques can be used to treat the effluent streams.

DETERGENTS AND OUR WATER

By Gordon Francis

Most people feel that large industries are the main polluters of the environment. This may be true, but many housewives do not realize that they are also contributing to the deterioration of our waters. Every housewife washing clothes with a detergent is hindering the survival of aquatic life and in the end, man himself!

When detergents are dumped into waterways, whether they are soft detergents (ones that break down into their elements easily) or hard detergents (ones that take a long time to break down), they lower the oxygen content and may kill aquatic life, such as fairy shrimp, mayfly larva and other minute organisms. This life near the bottom of the food chain causes predators that

feed on these organisms to die from starvation if they have not already died by suffocation.

The Chemistry 40 class did a series of phosphate and phosphorous tests to determine the levels in some of the leading brands of detergents. The results are shown below.

From our experiments we found that Sunlight contains the smallest amount of phosphorus and/or phosphate of all the detergents tested. We conclude that Sunlight would be the best detergent to use in the home if you want to do your part in trying to improve our water quality. This is consistent with the fact that Sunlight is a soap and does not contain the same nutrient phosphorus as detergents.

	DETERGENT	% PHOSPHORUS	% PHOSPHATE
GOOD ↓ BAD	SUNLIGHT	Less than 1%	Less than 1%
	ARCTIC POWER	9.9 %	30.50 %
	ALCONOX	10.0 %	30.6 %
	TIDE	11.75 %	36.20 %
	IVORY LIQUID	13.2 %	40.5 %
	ALL	13.98 %	39.49 %
	GALGONITE	21.50 %	62.52 %
	BOLD	24.8 %	76.6 %

THE EXPERIMENT

Purpose:

To determine the phosphates in detergents.

Method:

1. Place $1.00 \pm .01$ g of detergent into a crucible. Heat carefully over a low flame until most of the

volatile and combustible material has escaped and smoking subsides. Now heat vigorously for 5 minutes.

2. Allow to cool and transfer the contents to a 250 ml erlenmeyer flask, rinse the crucible with several 5 ml portions of concentrated hydrochloric acid, adding

rinsings to the flask.

3. Carefully heat the flask almost to dryness (use a retort stand and asbestos mat to avoid splashing).

4. Cool. Add 50 ml distilled water, 10 ml concentrated HCl, cover with a watch glass, and boil gently for about 10 minutes.

5. Allow to cool and filter, washing the filter paper with several 10 ml aliquots of distilled water to bring the total volume to 200 ml in a 400 ml beaker.

6. Set up pH meter, allow meter to warm up for 10 minutes before standardizing.

7. With electrodes partially immersed in solution, add 50% sodium hydroxide to convert H_3PO_4 to H_2PO_4 until pH of above 4 is reached. Now add dilute sodium hydroxide until pH is exactly 4.3.

8. Record the burette reading and continue to add dilute NaOH until the pH = 8.8.

Recheck your titration value by adding concentrated hydrochloric acid and bring pH back to 4.3 and repeating the titration.

Opencast Coal Mining

Opencast coal mining began in the United Kingdom in 1942 when as much coal as possible had to be produced. It still goes on because it is a flexible and economical method. Opencast sites can quickly meet demands for a coal of a particular quality when traditional deep mining methods cannot. It also frequently offers a unique opportunity for the clearance of dereliction in coal mining areas and British manufacturers are provided with a lively home market for earth moving and other equipment that they sell abroad, too.

In the South Wales Coalfield, the

Opencast Executive of the National Coal Board operates mainly along the northern outcrop from Kidwelly in the west to Blaenavon in the east and along the southern outcrop east of Port Talbot. Annual production is about two and a half million tons compared to a total of fourteen and a half million tons won by the National Coal Board's East and West Wales Areas by conventional deep mining methods.

The Opencast Executive has no compulsory powers to acquire land and it is required to operate subject to such conditions as are laid down by the planning authorities. These conditions invariably set out the type of restoration that is required after mining has finished and over a period of years the opencast coal industry has been at pains to show by the success of its restoration that it is not only economically right but can also contribute greatly to the improvement of the environment.

The techniques of opencasting involve stripping topsoil and subsoil which are stacked in separate dumps for eventual replacement. The ideal is to restore one foot thickness of topsoil and two feet of subsoil over the area stripped. Topsoil found on sites in South Wales is invariably very much less than one foot thick, and quite often the subsoil is clay of very small particle size which is virtually useless for agriculture. So the practice is to set aside not only the available topsoil and subsoil but as much soil-making material as is required for the proper restoration of the sites. This material usually consists of sandy clay contained in the glacial drift that can sustain good plant life when fertilized and cultivated.

The topsoil and subsoil are stripped off first and dumped to form sound baffles or screens near to houses. They are sown with grass and kept from weed growth so that they are not eyesores. ●

THE CTS PROJECT AND SOME EDUCATIONAL IMPLICATIONS

By T. R. Ide

COMMUNICATIONS TECHNOLOGY SATELLITE — A NEW VENTURE

In August 1975 the Canadian Department of Communications, in co-operation with the National Aeronautics and Space Administration (NASA), plans to launch a Communications Technology Satellite (CTS). The concept of this joint program was first put forward in 1969, and an agreement was subsequently reached in which Canada undertook to design and build the spacecraft, with NASA providing the launch vehicle and some of the advanced components, such as the 200 Watt Travelling Wave Tube transmitter.¹ This is the first such experimental project. Previous Canadian Satellites, Alouette and Anik, were operational rather than experimental, and reflected an interpretation of established technology, whereas CTS is a distinctly new venture and is so designed that, if successful, it will mean a major step forward towards the improvement of the means of communication.

The principal objective of the project is to demonstrate the viability of relatively low cost ground receiving and transmitting stations in the order of \$2,000 — \$15,000 compared with the present Anik's \$150,000 — \$200,000. To this end, the designers are utilizing frequencies in the 12 and 14 GHz² bands at power levels significantly greater than those provided by existing spacecraft. Prior to 1971, the only frequencies allocated for satellite communications were below 9 GHz which had to be shared with some fixed terrestrial services, and hence were subject both to frequency sharing constraints and power limitations by international agreement. In contrast, there is no power limit imposed on satellite transmissions on the new frequencies being used,

and it is this feature that permits the use of the smaller and less expensive ground receivers and transmitters.

Existing satellites, despite the relatively high cost of their receiving and transmitting stations, have proved valuable in linking points at great distances from each other. It is not practical or economic, however, to utilize them unless there are highly sophisticated secondary forms of communications systems such as broadcast networks already in existence. Such restraints will not apply to nearly the same degree to the CTS.

ORBIT IS SYNCHRONOUS

The Spacecraft, expected to have a life of two years, will be launched by NASA using a three stage vehicle (DELTA) and will be located in synchronous orbit at 114 degrees west longitude. A synchronous satellite rotates around the earth at the same speed as the earth and consequently appears to be in a stationary position over the earth. Once stationary with respect to the earth, the power will be derived from two batteries plus solar cells mounted both on the body of the satellite and on two extendable sails each 244 inches long and 51 inches wide. There are two antennas, each of which provides for the simultaneous transmission and reception of signals that may be aimed at any area in Canada or the United States (including Hawaii).

The size of the signal contours (foot-prints), of course, varies with latitude and longitude. However, in Canada, each foot-print is approximately 1000 miles long and 300 miles wide.

Despite the fact that the experimental time is limited, not only

by the life of the satellite and the fact that it will be shared by both countries, but also by the numerous technical systems and sub-systems to be tested, an unusual opportunity exists for organizations interested in the educational and sociological implications of satellite communications to devise and propose experimental projects which might utilize effectively the unique capacity of the satellite to span distant and diverse communities, to access isolated communities, and to utilize the feedback capabilities of the system. In Canada, the federal Department of Communications convened a meeting in Winnipeg on October 18, 1972, at which an invitation to submit proposals was given³ and some of the parameters to be considered were outlined.

The satellite itself will have the capability of transmitting from a main station simultaneously a combination of a colour TV signal, a sound broadcast signal, and up to ten channels of two-way voice to a variety of remote terminals. At the same time, it will be possible to transmit a colour TV signal from a remote transmission station to the main terminal. Ground terminals will consist of: (1) the existing 30 foot terminal at the Communications Research Centre in Ottawa — capable of transmitting all types of signals envisaged for the CTS satellite; (2) TV Remote Transportable Transmitters with ten-foot antennas and high power transmitters with a similar capacity as the Ottawa terminal; (3) medium-sized terminals with eight-foot antennas capable of receiving a TV signal with one audio channel and/or receiving and transmitting a telephone-quality voice channel and/or receiving sound broadcast signals, and (4) small-sized terminals with three-foot antennas capable of a two-way voice channel and sound broadcast receiver.

Up to the present no decision has been made by the federal authorities as to the final number of ground stations they intend to supply. It is presumed, however, that the number of such stations will be determined by the availability of funds and the quality of the proposals received.

EXCHANGES OF PROGRAMS ESSENTIAL

The Ontario Educational Communications Authority has been authorized by its Board to submit a communications experiment proposal to the Department of Communications. In essence, we see four possible configurations: (1) North to North; (2) North to South; (3) South to North, and (4) South to South. At the present time the proposal is in the draft stage, but it is hoped that Ontario might cooperate with other provincial jurisdictions, particularly in the north to north experiments, and with the United States in the south to south. It is the Authority's view that exchanges of programs between agencies with similar interests are essential if we are to devise techniques for surviving in a global village where electronic walls, even if desirable, are no longer possible.

The Authority has also volunteered to act as a clearing house for submissions from individual educational institutions. One such proposal has already been received from Lakehead University. It will be given every consideration by the OECA to see whether or not it might be an integral part of the general configurations described above, as well as being forwarded to the appropriate Department of Communications Project Officer.

THE SEARCH FOR IDENTITY

It is our belief that the experiments should utilize the unique characteristics of the CTS

systems. For this reason, we have emphasized communications with isolated areas. Some of the issues described in detail in the OECA'S proposal include: the search for identity and its association with the problems of isolation; health care; education - both culturally maintaining and expanding; and the need for opportunities to participate in the decision making process. Some of the purposes of the experiment which are central are assumed to be: development of communications skills in native peoples; formation of guidelines relating to the nature of future communications policies in the North; measurement of the impact of modern communications on the Northern peoples; determination of the viability of satellite communications systems in remote areas; diagnostic assistance and health education; and an exploration of the extent to which an effective balance between the maintenance of a culture and the opening of the culture can be achieved in education programs. While the major emphasis has been placed on experiments which relate to the needs of the peoples in the Northern regions, some suggestions have been included which will test the economic viability of using the CTS system in the South. These include: an exchange of audio-visual programs between provincial ministries of education; a co-operative project with the State of New York to investigate programs designed to assist in the rehabilitation of the physically disabled, and links between post-secondary institutions in Ontario and California of a teleconference nature.

In summary, the CTS satellite appears to offer educators and sociologists a unique opportunity to investigate the potential of a satellite communications system when the ground stations are of a moderate cost. In the past, it has seemed inevitable that the development of hardware always outstrips

that of software. Perhaps in this case the trend may be reversed.

FOOTNOTES

¹Unique aspects of the satellite, in addition to the frequency and power of the transmitter, include the ion engine which uses the thrust of ions emitted to help maintain a more exact stationary position in orbit, and liquid metal slip rings which are used to transmit electrical signals between rotating parts of the satellite.

²A gigahertz (GHz) is unit of frequency measurement corresponding to one billion cycles per second. Thus the frequency of CTS is 12,500,000,000 cycles per second. By comparison, VHF television operates in the range 54 to 216 megahertz (MHz) [54,000,000 to 216,000,000]*, and UHF television in the range 470 to 890 MHz [470,000,000 to 890,000,000]*. A megahertz corresponds to one million cycles per second.

³Proposals in writing should be submitted to:

Mr. J. Gilbert, Manager,
Socio-Economic Project Officer,
DEPARTMENT OF COMMUNICATIONS,
100 Metcalfe Street,
Ottawa, Ontario.
K1A 0C8.

**Editor's gloss.*

T. R. Ide is the Chairman of The Ontario Educational Communications Authority, a Crown Corporation of the Province of Ontario, responsible for the development of communications technology. Mr. Ide spent twenty years in Thunder Bay as a teacher, principal and superintendent with the Port Arthur Board of Education.

PRESENT AWARENESS

By a Liberal Science Student

This winter, the citizens of the United States have been experiencing gas cuts, failing oil deliveries and electrical "brown-outs": they have experienced the energy crisis at first hand. Canadians are only vaguely aware of the problem, which concerns us because in simple terms, *our neighbours want our fuel*. Some of the more perceptive Canadian politicians and their constituents are beginning to wake up to the fact that perhaps we should take stock before we agree to let them have it. In a nutshell: we should make sure that we have enough for our own needs before we sell any more.

SOURCES OF ENERGY

Our present sources of energy are oil, gas and coal. There is nuclear energy - but how soon will nuclear reactors take over the task of providing the electricity that is needed? There is much misunderstanding about reactors: they cannot take over from oil tomorrow, next year, or even next decade. Reactors take about ten years to design and build: they can take up only a fraction of total load, and development is retarded by environmentalists who are opposing them on the grounds of safety and thermal pollution. The new breeder reactors are more attractive than the present nuclear reactors but design problems are fierce, and they represent a greater potential hazard than the "conventional" CANDU type reactors designed and installed in Canada. In the United States many vociferous citizens' groups are vigorously opposing the proposed proliferation of breeder reactors. Yet the energy from them is urgently needed.

Scientists are seeking other ways of producing power. *Experiments* in fusion (the H bomb effect) *may* be successful by the end of the century and might eventually provide us with tremendous amounts of energy. *This is not by any means a sure thing*. Solar energy (harnessing the sunlight) is a long-term possibility, but trapping and storing energy would involve the use of vast expanses of territory and is not at present a feasible project. Efforts by scientists to improve our exploitation of the sun as a source of power have, in the past, been aimed at increasing the sunlight-conversion efficiency of solar cells. Such cells, in the form of large panels attached to satellites, might one day allow their collected energy to be beamed down to earth by microwaves.¹ But the developmental problems of all such innovative techniques are of such a scale as to be almost beyond our grasp.

CANADIAN RESEARCH

Another programme, instituted by Canadian scientists, would use the energy from vegetation waste. It is contended that if Canada would devote some of its research budget to promote "Bio mass research" the economic pay-off would be great. (A simple bio mass energy source has always been used for energy - wood chips and sawdust!)²

Many other types of research into energy production are being carried out. Wind power is unreliable but might be useful on a small scale in under-developed regions.

However the time it takes between the birth of each novel idea and the final implementation is long, much longer than people usually realize. The ten years lead time for a nuclear reactor is a flash compared with the lead time for a fusion reactor of a large-scale generating station. It is

going to take a century for some of today's ideas to bear fruit. The results of today's decisions on the selection of projects for scientific research may not show up till 2000 or later. The Canadian Government is right I think to insist that scientists should expend more energy on applied research than they have hitherto. If we let other countries continue to do the applied research, we shall never improve our economy.

CAN WE HELP?

Can we cut down on the amount of energy we shall need? We can take certain precautions. We can limit the size of our families; form car pools instead of traveling one person to a car; encourage the greater use of mass transportation; turn off unnecessary lights and go without air conditioning. But there is one form of energy without which we are lost. *In Canada we have to heat our homes in winter.*

Milton Rubin, an American scientist working on energy-utilization of efficiency, believes that "in considering the complete energy-use system, the trend should be toward the development and manufacture of more efficient (and probably more sophisticated and expensive) equipment". He gives the startling example that saving 200 kWh per year per refrigerator could be achieved by re-designing the domestic refrigerator. In the U.S.A. this simple exercise would eliminate the strip mining of four million tons of coal or the equivalent energy potential of many oil cargoes carried by supertankers. However, he does realize that there would not be a reduction in total energy consumption unless "the *manufacture* of this more efficient equipment is economical in the consumption of energy resources".³ Here is a task

for applied research, and no doubt the Americans are working on it already.

The Government of Canada is promoting us a policy on energy within the next few months. Its policy on scientific research is still in the forming stage.[†]

Citizens who are aware of the situation do have opportunities from time to time to make their voices heard. We, in our Liberal Science courses, are given at least a general background of knowledge on which to base our judgements. Scientists are beginning to realize that their work can only go forward if they have the backing of the government. We, as informed laymen, must realize that our duty is to encourage scientists and policy makers to make a greater effort to communicate with each other in the solution of real social problems. The energy situation will come to the top of the pile within our lifetimes. There's a better than even chance that our children will shiver as a result of our mistakes.

REFERENCES

- ¹"Physics in 1972", American Institute of Physics publication, p. 35.
- ²Drew McGarton, Winnipeg, speaking on C.B.C. radio broadcast, February 1, 1973.
- ³Milton D. Rubin, "Waste not, want not" in I.E.E.E. Spectrum, Vol. 10, No. 1, January, 1973, p. 70.

[†][Are you kidding? — ed.]

► Britain now has to deal with about 18 million tons of domestic refuse per year. It can be used as raw material for the process *pyrolysis* — in which the refuse is turned into fuel gas and light and heavy oils.

HARWELL ATOMIC ENERGY RESEARCH ESTABLISHMENT

A remarkable publication has come into our hands. It is entitled ENQUIRY 1972 - The Science Journal of Harrow County School for Boys. This magazine is fully professional - it contains a wide range of articles contributed by the students, and about an equal number written by experts.

We are delighted, with permission, to reproduce an article on Harwell written by a young man of fourteen. The original was illustrated with a photograph of the LIDO reactor, which for technical reasons we are unable to reproduce. The article is atypical, in the sense that it is basically an essay on a "school visit", whereas many of the other contributions are really miniature research papers, showing considerable flair.

What makes the enterprise so successful? We suspect that it was set up as a sound business organization, with a Business Manager (who is our contact), and a professionally orientated sales and advertising staff. Certainly, the workers have managed to corral some pretty impressive advertisers from areas of British business circles not particularly noted for their philanthropy.

We hope the students are making a profit. Whether or not they are doing so, they can be assured that they are gaining invaluable experience which they will find has a market value. Harrow County School for Boys must be an extraordinary institution indeed.

— Editor

By Huw Dorkins

The author is fourteen and very interested in science, being a founder member of the Junior Scientific Society. He was responsible for the initial organization of the visit to Harwell on which this article is based.

Harwell, near Didcot, is the site of the Atomic Energy Research Establishment (AERE), and recently a group of students from school was taken on a guided tour of this establishment. It is situated on a site of approximately two square miles next to the Science Research Council and the NIMROD accelerator. The site is divided into two sections. First, the main site which is a large area of laboratories, accelerators, administrative buildings and a housing estate for those working there. Second, a smaller area which contains the three more modern reactors and their associated buildings. It would have been impossible, due to the restricted time available, to show us the whole of the AERE so, since we were mainly interested in the reactor assemblies, it was these that we were shown. Before describing the particular reactors that we saw I should explain how reactors work.

REACTORS

All reactors depend on a process called FISSION; this is when an atomic particle, called a neutron, collides with an atom of a fissile material, usually an isotope of uranium. This atom becomes unstable, eventually splitting into two smaller atoms and emitting two or three new neutrons and a considerable amount of energy. Each of the two or three new neutrons may then collide with more atoms of fissile material, causing the entire process to be repeated two or three times over. If this continued unchecked, so much energy would be produced that an explosion would occur and indeed this is what happens in an atomic bomb. Therefore in reactors it is extremely

important to control the fission. This is done by using control rods made of a substance which will absorb excess neutrons. The fission will only take place if the speed of the neutron is within a certain range, when it is known as a thermal neutron. However, the neutrons emitted from a splitting atom are moving too fast and so they must be slowed down. This is done by using a moderator, in which the neutrons collide with the atoms of the moderator and are thereby slowed down. Last, but not least, a coolant is necessary to cool the reactor core and stop it from overheating and, in the case of power station reactors, to transfer heat for use in the production of electricity.

Normally the core of the reactor consists of a block of the moderator into which fuel rods containing the fissile material and control rods may be placed and through which the coolant may pass. It is necessary to protect the reactor operators from any harmful radiation from the core, so a large biological shield of concrete is needed to surround it.

Basically, there are two main types of reactor in use. First, the large scale type used for power production (such as Calder Hall) and second a smaller type for research. It is the research reactor that is to be found at Harwell. These reactors are used to develop new techniques for use at the former type of reactor, to make radioisotopes for medical and industrial use, and to carry out research work involving the use of high power radiation such as may be obtained from the reactor core.

The reactors at Harwell are LIDO, DIDO, GLEEP, BEPO (which is now shut down), PLUTO and DAPHNE and we were shown the first four of these and some of the techniques and instruments that have been developed there.

LIDO REACTOR

This was the first reactor we visited and is called LIDO because it is a mem-

ber of a class of reactors, known as swimming pool reactors, that have the core immersed in a large tank of water which acts as moderator and coolant. The whole reactor is enclosed in a concrete tank but because the reactor is under eight metres of demineralized water it is safe to have the top open. This is very interesting because one can see a powerful blue glow, known as "Cerenkov" radiation, in the water surrounding the reactor. The reactor has been in operation for sixteen years and its maximum power output is 100kW.

DIDO REACTOR

DIDO, so named because the moderator used is heavy water or D₂O, is much more powerful than LIDO. The reactor is of the conventional type, but all those who work on the reactor, and visitors, must put on special overshoes and pass through an air lock on entering the reactor. They are monitored by means of a large scale Geiger counter on leaving. As I have mentioned, DIDO is comparatively powerful and has a normal power output of about 15 MW. As well as being the moderator the heavy water acts as the coolant dissipating this power.

DIDO and its sister reactor, PLUTO, are both constructed in buildings where the pressure inside is lower than atmospheric. This is so that if a leak occurred, the movement of the air would be from the outside inwards and as a result no radioactive particles would be spread, thus avoiding external contamination. It is a member of the group known as "Materials testing reactors" and its purpose is to test various materials to study their structure and the effect of radiation on them. It also produces radioisotopes.

GLEEP REACTOR

GLEEP stands for "Graphite Low Energy Experimental Pile" and is located on the main site. It was commissioned by the Atomic Energy Authority in 1947 making it the oldest pile in Europe. It is used

for measuring a property known as the "Neutron cross-section" of various substances. Its maximum power level at present is 3 kW. GLEEP is an air-cooled reactor with its core in a block of the moderator, graphite which is inside a cube of concrete with sides of six and one half metres.

BEPO REACTOR

Although not as old as GLEEP, BEPO was shut down in 1968 when most of the work being done on it had been transferred to DIDO or PLUTO. As a result the fuel rods were removed and the channels for fuel and control rods and experimental rigs were filled with concrete. The reactor cannot be completely dismantled because of the radioactivity of its graphite core which still remains.

CONCLUSION

We all enjoyed ourselves greatly, and the visit proved to be very interesting and valuable, giving us an insight into the operation of the AERE and some of the problems that still remained to be solved in this field of research. I would like to thank all those at Harwell who contributed to the success of the visit and who helped me in writing this article.

Uranium Sale To Spain

OTTAWA:- Canada and Spain have signed a sales agreement for nearly \$60 million, involving some nine million pounds of Canadian uranium oxide, to be used by Spanish electric utility companies for the generation of electric power, the President of Uranium Canada Limited, Jack Austin, announced. Mr. Austin is also Deputy Minister of Energy, Mines and Resources, and he signed the agreement in Madrid on behalf of the Government of Canada.

The Hon. Donald S. Macdonald, Minister of Energy, Mines and Resources, pre-

dicted the possibility of this sale in a speech last February. Mr. Macdonald noted that although selling uranium at this time was a difficult assignment, Canada had succeeded in making a sales agreement with Spanish utility companies.

The sale to Spain comes at a time when world uranium supply exceeds market demand. The order will be filled from the joint Canada-Denison stockpile and the general government uranium stockpile. Deliveries will take place over the period 1974 to 1977.

The sale will provide a market for all of the uranium stockpiled under the Canada-Denison agreement of 1971. Under this agreement, the Government of Canada, through its crown corporation, Uranium Canada Limited (UCAN), agreed to acquire more than six million pounds of uranium oxide from Denison between 1971 and 1974 in order to stabilize employment and production at Denison's Elliot Lake mine in Northern Ontario until long-term contracts come into effect. The government's share of revenue from the sale to Spain will recover the \$29.5 million of public funds spent in accumulating the stockpile.

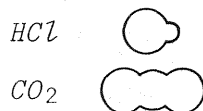
The stockpile is controlled jointly by Denison and UCAN, with Denison acting as sales agent. As only a portion of the general stockpile will be used to fill the order, UCAN will continue to oversee the disposition of this government-controlled stockpile.

In accordance with Canada's national policy on the sale of uranium, the uranium sold to Spain will be used for peaceful purposes only. This will be assured by the application of International Atomic Energy Agency safeguards.

THE EFFECTIVE SHAPE OF A MOLECULE

By E. Tyrrell

In the treatment of the Kinetic Theory of Gases, molecules are assumed to be spherical in shape. This assumption usually troubles students of chemistry more than it troubles students of physics because, in their studies, the former acquire a detailed knowledge of molecular structure and molecular shape. Thus, in the introductory course in chemistry, the student soon learns to write the structure of the hydrogen chloride molecule as $H-Cl$ and that of the carbon dioxide molecule as $O=C=O$. As he learns more of the electronic structure of molecules, it becomes clear that these molecules have the following approximate shapes:



Scale models of these molecules can, in fact, be made using, amongst others, the Fischer-Stuart Models. Neither of these molecules is, then, spherical. It should, however, be remembered that in addition to translational motion, there are two other types of motion open to a molecule: rotary motion and vibratory motion. Thus the molecule of hydrogen chloride can rotate about its centre of gravity and, in so doing, demarcate a spherical region in space. In other words, although the *actual* shape of a molecule may be non-spherical, its *effective* shape will, by virtue of its rotational motion, be spherical.

That this is so is confirmed in an interesting manner by studying the crystal structure of solid hydrogen chloride. However, before the results of this study can be properly appreciated, it is necessary to remember that, although the translational kinetic energy of a molecule can vary continuously,

this is not so in the case of either rotational energy or vibrational energy. Both these are quantised. We are only interested in rotational energy. Because rotational energy is quantised there is for each substance a temperature - characteristic of that substance - below which the rotational degrees of freedom will be frozen, i.e. below which the molecules will not rotate. This temperature lies below room temperature for all substances so that the molecules of all polyatomic gases rotate freely at room temperature. In the case of hydrogen chloride the temperature at which molecular rotation becomes important is well below room temperature - it is, in fact, below $100^\circ K$. Now in this temperature region crystalline hydrogen chloride undergoes a transition, the higher temperature form having a cubic close-packed structure. This transition (at $98^\circ K$) is believed to be due to the assumption, by the hydrogen chloride molecule, of an *effective* spherical shape consequent upon the onset of molecular rotation.

Thus, although the *actual* shapes of molecules vary, their *effective* shapes in the gas phase will be spherical provided that the temperature exceeds the characteristic temperature for molecular rotation.

Mr. Ernest Tyrrell is Head of the Chemistry Division, Northern Ireland Polytechnic. A graduate of the University of Manchester, he carried out research in thermodynamics of high polymer systems with the late M. G. Evans. Before moving to Northern Ireland, he was a research chemist with Imperial Chemical Industries, Ltd. He is a devoted swimmer and an established raconteur.

PHYSICS AND BIOLOGY – ARE THEY SEPARABLE?

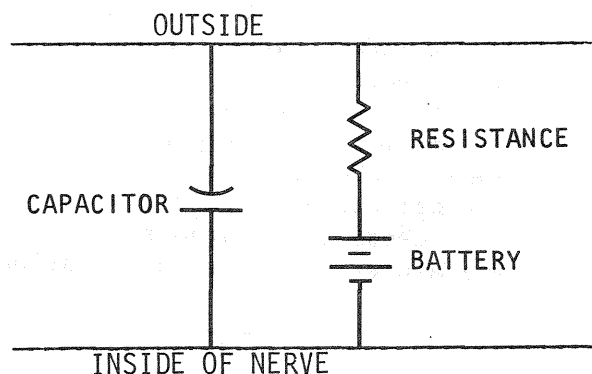
By Margaret Hawton

BIOLOGY BECOMES QUANTITATIVE

There is a growing trend today to making biology quantitative. This doesn't just mean weighing and counting things. Our basic understanding of biological processes depends on a knowledge of physical science. A few examples will illustrate the point.

The numbers of predators and their prey oscillate much like the position of a mass on a spring. Since the number of predators and their food supply (prey) are interrelated, the oscillations are "coupled". Thus the predator-prey relationship is similar to the coupled harmonic oscillator of classical mechanics. Much of the elegant theory that has been developed over the last few hundred years for oscillators can be carried over to their biological counterparts.

An electrical potential exists across the membrane of a cell. An analogy can be made between the membrane and the electric circuit shown below. If the cell can transmit an



impulse (e.g., a nerve cell), it is said to be "excitable". There are many theories of the nature of the excitation, but all involve physical principles. One recent suggestion is that the membrane contains two layers of dipoles (a dipole is a positive and negative charge of the same magnitude, separated by some distance) that flip over when the nerve is

excited. The transmission of the signal is much like the transmission of a signal in an electrical cable.

All means of locomotion (walking, running, skiing, flying) are examples of the laws of mechanics. The size limitations on animals with internal skeletons, the way the muscles work and the circulation of the blood are all just simple physical principles in action.

THE SCIENCES ARE INDIVISIBLE

If you think that you can understand biology (or even physical education) properly without first coming to grips with the laws of physics, you are mistaken. The sciences cannot be separated into neat little packages called biology, chemistry, geology and physics. They are all part of a whole, and the boundaries that separate them are becoming increasingly unclear!

Mrs. Hawton was born and educated in New Brunswick and has been teaching at Lakehead University since 1966. Last year she spent her sabbatical in the Biology Department at Carleton University, Ottawa.

MICROORGANISMS IN PULP MILL EFFLUENTS –

B.C. Research is completing the initial \$50,000 phase of a continuing contract for investigating the significance of microorganisms present in pulp and paper mill process streams and effluents. The Committee on Pollution Abatement Research of the Federal Government and the pulp and paper industry of Canada are financing this investigation.

The results indicate limited growth in waste streams, but significant growth associated with raw materials and the effluents resulting from their initial processing.

FUTURE CAREERS

By Moe Ktytor

"CAREERS" ARE OBSOLETE?

The idea of "career" may be obsolete. Dynamic changes in career patterns, the increasing rate at which vocational and professional skills become obsolete, new problems created by the accelerating process of urbanization and major shifts in social value suggest that more than a single career will soon be the order of the day for most workers. Already jobs are becoming obsolete at the rate of two and a half per cent per year. In twenty years, according to a Wheaton College sociologist, Zonda Linblade, sixty per cent of all jobs today will no longer exist.

The familiar question put forward by teachers and parents, "What are you going to be?", will have to be re-phrased: "What will be your first vocation?" No one can accurately predict which jobs will be part of the forty per cent still in existence twenty years from now, so flexibility seems a sensible attitude to develop. Ten years ago, an employer might have looked askance at a job application by someone who had occupied four different positions in ten years; nowadays, the same employer might *prefer* the application of such a person over another who had not moved at all, because the "mover" has proved that he is flexible and adaptable.

There is a crisis of confidence in social and educational institutions. We often hear that there are no jobs for university graduates, or that the number of jobs is decreasing. Let us look at it another way. What does the new university graduate have to offer? Furthermore, does the university exist to train people for jobs?

Students who are considering going to university should, but seldom do, ask themselves "Why am I going?" It is absolutely astounding to discover how many students reply by saying "I don't know". A student who makes this reply should perhaps delay attending university until he can identify a purpose. As in anything else, a lack of motive, understanding and enthusiasm can only result in a very poor job.

GRADUATES FLOUNDER ABOUT

What is even more astounding is that when many young men and women finally graduate from university they are still in a complete fog, and are very quick to criticize everyone and anyone about not being able to find a job. My question is — "What do you have to offer?" This is the most important question for all graduates.

A university gives every member the opportunity of becoming a "quality person". What I mean is that one is encouraged toward achieving a high standard of intellectual excellence, how to think and understand, how to express ideas with clarity, how to develop solutions to the increasingly complex problems which we all must cope with. Most importantly, a student should develop an *awareness* of reality of self and others.

As far as *specific* training for a job is concerned, it is unlikely that a university will offer much. However, there is the opportunity to develop a unique human skill that is imperative to be successful in *any* career; that is the ability to grasp quickly, understand and communicate. The

university, in a phrase, trains to get trained!

If one could achieve only part of the above out of a university education, and then ask oneself the question, "What do you have to offer?", there is little doubt that the answer would be considerably more positive than the usual "I don't know".

■ A new manpower training initiative specially designed to alleviate regional and national shortages of skilled workers and provide additional job opportunities for unemployed workers was announced by the Hon. Robert Andras, Minister of Manpower and Immigration.

As a continuing element of the federal Manpower Industrial Training Program, Training on the Job for Skill Shortages is now offered to employers to encourage the hiring and training of workers for hard-to-fill occupations.

As indicated by the Statistics Canada Job Vacancy Survey and by the number of unfilled job vacancies at Canada Manpower Centres across the country, employers are having difficulty finding fully qualified workers to fill available jobs.

"The new program will greatly improve Canada's effectiveness in matching labour demand and supply across Canada," Mr. Andras stated. He added that, "Many of our workers will now have the opportunity for training and employment in occupations for which they would not otherwise qualify and employers will not have to lose production and profits caused by skill bottlenecks."

In conjunction with the provinces, the Department of Manpower and Immigration will assist employers in developing training projects that will give new workers skills to perform jobs

for which a local, regional or national shortage exists and is expected to continue.

A special employer reimbursement formula is part of the new program whereby employers will receive, from the federal government, fifty per cent of the trainee's wages during the first half of the training period and twenty-five per cent during the second half.

All employers not financed primarily by tax revenues, including non-profit private agencies, are eligible for participation in the new program.

It is also open to public employers, either government owned or controlled, who are financed mainly by public fees or sales, i.e. public transportation companies, provincial hydro or telephone companies, and hospitals which are not wholly owned, staffed and funded by provincial governments.

The average amount of training time in which the federal government will participate financially with employers is expected to be about five months.

Maximum reimbursement will be \$118 per week per trainee.

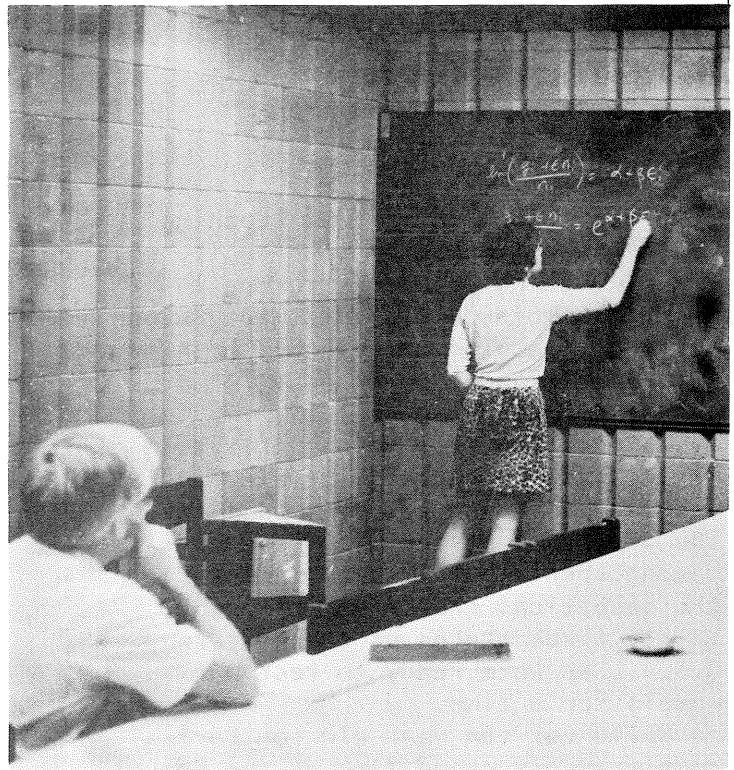
Training periods may range in duration from six to fifty-two weeks and will be carefully determined in relation to the complexity and number of skills to be taught, prior experience or training of the trainees, and expected productivity of trainees at various stages of training.

Trainees will be screened as to their suitability for training in a particular occupation by Canada Manpower Centre officers. They will be referred to the employer for final selection.

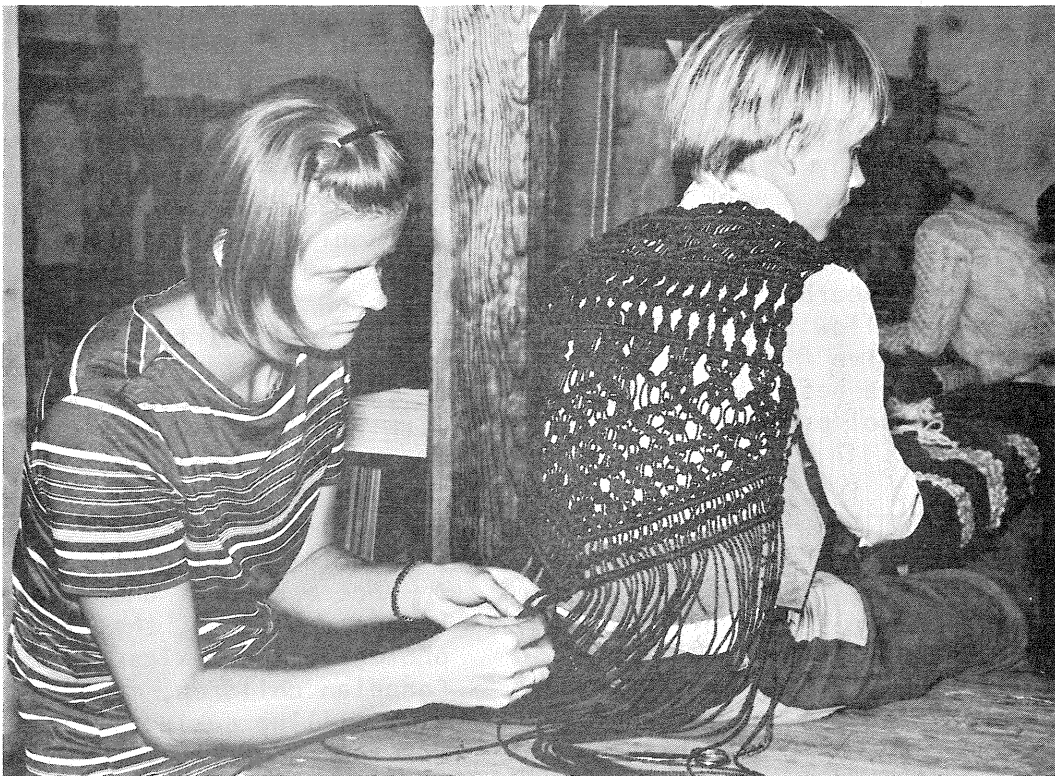
To qualify for training, trainees must be "adults", that is, one year beyond the school leaving age of the province where they reside. They must also have been unemployed or on layoff for one week.



Moe Ktytor
"flexibility seems a sensible attitude to develop"



Margaret Hawton
"The sciences cannot be separated into neat little packages"



Mrs Black and offspring in the Institute.
"Travel can be a broadening experience to be shared with students"

HIGH SCHOOL "DROP OUTS"!

By Maurice G. Black

A SABBATICAL IN MEXICO

A sabbatical leave from teaching for one year! What an opportunity to travel with no deadlines to meet! After a combined total of twenty nine years of teaching experience, both my wife Jackie and I were ready for a change of pace.

We ended up in a school of art in Mexico, taking courses for six days a week and pounding out my thesis for the degree of Master of Fine Arts. Having spent the first five months of the sabbatical trailering through thirty three states of the eastern U.S.A., we were ready to rest our wheels for a time.

While our ten year old son Earl completed his grade five at the Escuela Bilingue in San Miguel de Allende, Jackie and I enrolled in the Art school for two semesters. Institute Allende is an internationally known and recognized art school incorporated with the University of Guanajuato, Mexico. The colonial beauty of the town, the availability of intriguing subject matter and the ideal climate with perpetual sunshine provided a conducive atmosphere for a concentrated study of the arts.

Gallery openings once a week by artists of varying talent; excellent live entertainment at the local theatre; weekly swims at the nearby hot pools; daily visits with fellow trailerites; watching various native fiestas — we squeezed in all these besides keeping up our numerous school projects.

SEEING FOR OURSELVES

During the nine month period that we spent in Mexico, we drove more than eight thousand miles of highway and dirt roads. My family and I had spent months doing spare time research on Mexico and its people before we crossed its borders in early December. We had read and listened to many disturbing, but often conflicting reports from

guide books and travellers we met along the way. Exaggerated tales led us almost to believe that Mexico was a vast area of desert and mountains populated by thieves and beggars. The water was unfit to drink; the food was guaranteed to make you ill. During our eight month stay in Mexico we discovered how false and distorted these accounts were.

We found Mexico to be a land of surprises geographically, populated by people who were friendly and helpful. An abundance of fresh fruit, vegetables and meat enabled us often to eat better quality for much less money than we spend on food in Thunder Bay. We found on many occasions during our travels, that third-hand information is certainly no substitute for first hand experience.

TWO WAY COMMUNICATION

The three month crash course in Spanish that we pursued at the Institute in San Miguel, Mexico, helped us immensely to communicate with Mexican people we met on our travels. Mexican families pursuing various craft skills described their work in Spanish and were quite interested in finding out more about Canada — the 'land of ice and snow'! Everywhere we stopped to ask directions, to obtain supplies, to bargain for craft work or simply to talk to the people, we were treated with gracious courtesy. In every case the Mexican people were most willing to help us extend our limited Spanish vocabulary and to correct us in the pronunciation of difficult words.

Once a bond of understanding had been established, that I was a teacher photographing Mexican life to show Canadian children, most Mexicans became willing subjects for the camera. Written and oral accounts regarding the so-called dishonesty, filth and

laziness of the Mexican people *per se* readily arouse our indignation and desire to disprove such unwarranted prejudice.

HIGHLIGHTS

To select highlights from this nine month adventure is difficult. My son's choice was the expedition to the volcano of Paracutin which developed in a cornfield and erupted in 1943. After reaching the departure point, a rather remote village at the end of a rough dirt road, we hired a guide and horses for the ninety minute ride to the lava beds. Nature's phenomena were awesome, since molten lava had flowed through a village leaving portions of a church and remnants of homes standing but embedded.

My wife was enamoured with the sea coast of the Pacific. Life evolved in a leisurely fashion for the natives who spread large nets once every two days to obtain enough fish for their needs. Coffee beans, shrimp, and an abundance of vegetables and tropical fruit were available at low cost. Here was an ideal site in which to park our trailer where we could read, relax and think undisturbed, with miles of uninhabited sunny beaches on which to wander.

The costumed Indians frequenting the town of San Cristobal intrigued me. This mountain town located only sixty miles or so from the Guatemalan border is sufficiently remote to be yet unaffected by tourism. Our strange fashion of dress and white skin attracted considerable attention since these natives continue to wear tribal costumes that have not changed in design for many centuries. After first allowing some of the shy yet fascinated young men to view their friends through my camera view finder, I was permitted the opportunity of photographing them.

We explored the archeological ruins of Mitla and Monte Alban and toured the museums in Mexico City, Tuxtla Gutierrez and Oaxaca to learn more of this amazing Aztec civilization. The floating gardens of Xochimilco ... the Mexican Folklorico ballet ... the coppersmiths of Santa Maria del Cobre ... famous Oaxaca pottery ... historic Vera Cruz ... colourful fiestas ... bull-fights ... each one provided a unique and not-to-be-forgotten experience for us.

IT'S HARD TO RE-ADAPT

Since arriving home, we have been caught up in the bustling "rat race" which we left over one year ago. Oddly enough it is the cultural shock of a return to *civilization* to which we had difficulty adapting! Our future holiday plans include return trips to Mexico, especially the Yucatan peninsula which could not be included on our sabbatical itinerary.

We feel that travel can be a broadening experience to be shared with students and as such deserves valid consideration by those contemplating sabbatical leave. The opportunity to observe other educational systems in operation and to exchange views with teachers in areas removed from ours makes the granting of sabbatical leaves valuable in that it enriches those who have the opportunity to communicate their heightened experiences to the next generation. Finally, the sense of achievement gained through furthering one's education is in itself a most rewarding experience.

Maurice graduated from Lakehead University in 1965.

Jacqueline graduated from Lakehead University in 1969.

Ed. - People like the Blacks are Canada's most effective ambassadors.

SO YOU WANT TO BE A NURSE?

By Madeline Hookings

A KNOWLEDGE OF SCIENCE IS NECESSARY

Why, we might ask, is science necessary in learning to care for the sick? Because the central concern of nursing is to serve Man, then many of his attributes must be understood if this service is to be skillfully performed. To gain knowledge of this really unique being, a nurse will need to know about both his physical and emotional nature.

THE HUMAN PUMP

One of the most efficient and enduring pumps ever conceived is the heart. This pump beats approximately seventy times per minute as long as a person lives. Believe it or not, by eighty years of age, the heart will have contracted over a trillion times. It is very doubtful whether any man-made apparatus could possess such lasting properties.

The heart, besides its marvellous ability to function continuously, has a number of other interesting and unique qualities. Each time this pump works, it jettisons out into the blood vessels from each of its two chambers about seventy to one-hundred and forty milliliters of blood. In the athlete, this amount can rise as high as two-hundred milliliters from each chamber. This is a large output indeed, when one considers that the human heart is roughly the size of a man's fist.

THE RHYTHM OF LIFE

At about the tenth day of embryonic growth, a very minute package of bright red tissue begins to pulsate. This tissue represents what will in time become a four-chambered heart. How did this small bit of tissue begin to pulsate? Located in what will become the upper right cham-

ber of the heart, the atrium, is a small group of cells somewhat different from the other cells forming the heart tissues. This microscopic island of cells possesses an innate ability to send out electrical impulses that stimulate the heart muscle to contract. Although scientists are yet to unravel how this group of cells, called a node, actually accomplishes this unusual and interesting phenomenon, there is ample scientific data establishing that it is the "pace-setter" or "pace-maker" of cardiac rhythm. It sets the rate at which each individual's heart will beat throughout his entire life. When it ceases to emit these electrical charges, the life of the organism ends.

THE EFFECT OF THE EMOTIONS

As a censor of the individual's environment, the nervous system can alter the established rhythm of heart beat. This added control is a most salient factor in preparing the body for an emergency occurrence, such as some external danger or an illness. Also, the deepest emotions are voiced in the language of the heart, and while happiness is "heartfelt", sorrow is "heartbreak". With success, one is "heartened" and with disappointment, "heartsick". The heart is the tissue of life, governed by its own innate rhythm, nervous mechanisms and other physiological factors.

THE RED RIVER

Like any other pump, the heart must have fluid to perform normally. In the human body, a very remarkable fluid serves this purpose — The Red River — blood. Should this fluid volume be decreased by about two-thirds of its normal complement, the heart would no longer pump. This principle also holds when the fluid volume, over a period of time, exceeds

its normal amount.

Blood is a red, viscid, salty fluid that constantly bathes every cell of an organism. Should an artery become blocked, even for a few minutes, the cells supplied by this vessel would commence to degenerate or break down. For example, if the flow of this river to the brain were to be stopped for four minutes, many of these all important cells would die.

One unique quality of blood is its special ability to transport food and oxygen to all parts of the body; it is also the body's housekeeper. The body cells are extremely active miniature chemical factories, and where there are factories there is usually waste. In this case organic acids, carbon dioxide and heat are some of the waste products. The Blood is the River of Life. Death is only minutes away should it cease to flow.

STRESS — THE VILLIAN

Statistics reveal that about half the yearly deaths are attributable to heart disease. Medical literature lists many reasons for heart disease, but certainly an overall cause, in the opinion of the famous Montreal scientist, Hans Selye, is stress.

Temporarily, stress marshals the body to ward off impending danger. It prepares the body to fight, for it is a survival mechanism of life. However, this defense mechanism can harm the heart, blood vessels or other body organs. When an individual's body is continuously subjected — for long periods — to a stress state, irreversible harm results.

Nurses observe the results of stress every day, as they work with patients with stomach ulcers, high blood pressure, heart disease and other bodily ills.

ARE FATS CULPABLE?

On the North American continent

many of us indulge in food high in animal fats. Once an overabundance of these fats enters the circulatory system, they can, over a period of years, cause untold damage to arteries of the organism. Of special significance is the damage to the vital arteries that carry food and oxygen to the heart itself.

What are these changes that occur? Fats, in excessive amounts, invade the walls of arteries and this over a period of years leads to a narrowing of lumens (or tubes). This finally results in occlusion or blocking of the vessels, especially those that supply the heart muscle. With complete occlusion, the individual has what is commonly called "a heart attack".

IMPLICATIONS FOR NURSING

The foregoing discussion has indicated some of the scientific knowledge from which nursing concepts can be drawn. When a patient has an enlarged heart, the manner of positioning, to ensure the greatest expansion of the thorax, is accomplished through the application of the nurse's knowledge of science. When patients move in bed, they are inclined to hold their breath. In heart disease, this can be dangerous, even fatal. As an individual holds his breath, pressure builds up in the thorax inhibiting blood from flowing into the heart. When he breathes again, changing the pressure, a great rush of blood enters the heart, causing stretching that can, in turn, cause cardiac arrest. This is perhaps one reason why persons with heart disease can die suddenly. The nurse can, because of her acquired knowledge, assist patients to understand the danger of holding their breath when performing various activities.

As a nurse, one must look scientifically at all the components that represent Man, and gain a relatively comprehensive understanding of the river — our blood — its

sources, its channels and its actual composition. One must acquire a detailed knowledge of the engine that makes blood flow through these channels — the heart. One must know what the implications are when this pump breaks down or wears out, what parts can be replaced.

With this kind of scientific background the nurse then has the facts in her possession with which to truly serve that unique organism we call Man.

Ms. M. Hookings is presently on the faculty of the Lakehead University School of Nursing teaching Medical - Surgical Nursing. She hails from the Eastern Provinces where she received her basic education. Following her post-graduate work at McGill University in Montreal she has taught in various schools of nursing in and around the Toronto area. She brings to her present appointment a depth of experience and knowledge.

A BRICK PROBLEM

by

J. H. M. Whitfield

A contractor wishes to build a $4 \times 4 \times 4$ solid cubical pillar out of $2 \times 2 \times 1$ bricks. The faces of the bricks are parallel to the faces of the cube, but they need not all lie flat. Also he wishes to have a thin rod pass through the pillar without passing through any of the bricks. Can he do it? Sure!

Divide the cube into unit cubes. This gives a 4×4 grid on each face. If a rod passes through the cube in the manner described, it will intersect the face at a grid point. There are 9 lines perpendicular to each face, each intersecting it at a grid

point, or 27 distinct such lines passing through the cube.

Consider one of these lines. The two planes containing this line and perpendicular to the faces divide the cube into four quadrants. Choose one of these quadrants and call it A. Each $2 \times 2 \times 1$ brick that intersects A will intersect it in 1, 2, or 4 unit cubes. Those that meet A in 1 unit cube are precisely those bricks pierced by the line. Since A contains an even number of unit cubes, there must be an even number of bricks that meet A in 1 cube. Thus, there are an even number of blocks that are pierced by the line.

It requires then 54 bricks if each line is to pierce at least one (and hence 2) bricks. However, a $4 \times 4 \times 4$ cube contains only 16 bricks. Therefore, there is at least one (in fact 14) lines that don't pierce any of the bricks. The rod should be passed along one of these lines.

Consider an $n \times n \times n$ cube to be constructed as described above. Can you show, using an argument as above, that if $n^3/4 < 2.3(n-1)^2$, there is at least one way to pass a rod through the cube without piercing any bricks? What is the largest value of n for which the argument works?

PUZZLE ???

THERE ARE 3 CANNIBALS AND 3 MISSIONARIES. THEY HAVE TO GET ACROSS A RIVER INFESTED WITH CROCODILES. THE BOAT HOLDS ONLY TWO PEOPLE. IF AT ANY TIME THE MISSIONARIES ARE OUTNUMBERED, THEY WILL BE EATEN. GET EVERYONE ACROSS THE RIVER. (Swimming is out!)

-- John McLaren --

INTERVIEW WITH THE LAKEHEAD UNIVERSITY CHEMISTRY STOREKEEPER: Bert Harding

IS TECHNICAL KNOWLEDGE MORE IMPORTANT
THAN SYSTEM MANAGEMENT?

Us: Did you read the first Caret?

Bert: No, not all of it. I suppose I have read about half of the articles.

Us: Well, did you read the interview with Ken Sumpter? What we are trying to do is to produce in every issue an interview with somebody like yourself so that the students in high school who read it have some idea of what kind of jobs we do around the University. We also want to bring out the personalities and interests of the people who work in the Faculty of Science. I honestly don't know what your job is: I just see you there surrounded by glassware and chemicals. Can you tell our readers what your job really consists of?

Bert: Yes. Well, essentially, I am storekeeper for the Chemistry Department.

Us: How did you get into the job?

Bert: As well as passing my technician's diploma course, I also had some storekeeping experience; but I would say that on the whole my skills are in chemical technology rather than in business. I use my technical knowledge in what we might call stores systems - that is, understanding the specifications and properties of chemicals and equipment for the benefit of the other technicians and the professors. For example, they expect me to know whether a particular piece of equipment will do the job they want it to do.

Us: Well, I have learnt something already. I would have thought that you would have had to have all kinds of business courses such as accounting, systems

analysis and that kind of thing - but I must add that my own view of accounting at the Departmental level is that any intelligent person can do it.

Bert: Yes, as far as the Department is concerned, there is no need to get too deeply involved in the accounting procedures. In fact, you want it as simple as possible. What the Department needs to know is how much money we have, how much we have committed to date and roughly where it has gone.

Us: So you just keep a list of the running expenses?

Bert: Yes. I send in the records to the Chairman regularly, as a report, which tells him more or less where we stand.

Us: Do you find that more pressures come on you when the University is in a state of budgetary crisis? Who decides what is necessary spending and what is just frills and can perhaps be delayed for a while - do you?

Bert: I decide, or at least make recommendations, as to what we need and what I think our priorities are; the final decision is, of course, that of the Chairman, Dr. I. M. Hoodless.

Us: Yes, well he carries the final responsibility.

Bert: Other input also comes from the faculty members who are in charge of the various courses, and they are often faced with the problem of what is really necessary to run their own courses, and how they relate to all other courses.

Us: Where did you get your training?

Bert: The Western Ontario Institute of Technology in Windsor.

Us: I think we ought to get across to our readers the fact there were Institutes of Technology

other than Ryerson long before the present community colleges were formed.

Bert: Yes, there were four others including the Institute at Windsor which has always been one of the best Institutes in Canada. I was there for three years ...

Us: *Did you go there before it became a community college?*

Bert: Yes.

Us: *Most people think that Ryerson was the only Institute that predated the colleges.*

Bert: Ryerson is extremely well known, perhaps because of its size. But Windsor has always been competitive and graduates from Windsor always have the offer of several jobs each. Windsor produced its first graduating class in 1961, so it preceded the colleges by about five years, at least.

Us: *What are your main problems in storekeeping - apart from finding forty-five gallon drums for the Editor of Caret?*

Bert: I suppose the main problem, although I don't consider it a problem, more of a challenge ...

Us: *Alright, let's call it a situation ...*

Bert: ... is to obtain the maximum amount of equipment for the minimum amount of capital, sometimes in a very critical situation.

Us: *How do you do that? Do you talk to salesmen or do you go out on tender?*

Bert: I talk quite a lot with salesmen in person or on the telephone. Perhaps I interview *them* rather than the other way round! I get ideas of what I want and then discuss with various companies how their particular equipment operates to see if it comes up to my ideas of what it ought to do for the Department and whether the claims are exaggerated. When I know exactly what is available, we write specifications which are based on a compromise between what we would like and what is

available, then we send out tenders ...

Us: *Do you do that or ...?*

Bert: No, I do it most of the time. Occasionally, I will use the assistance of the Purchasing Department, which is excellent, but generally they are very busy.

Us: *This is no criticism of Purchasing, but do you find that you really know more about the technical specifications than they do and in fact it is more efficient ... quicker and more accurate for you to send out the tenders yourself? You save on one step in the chain.*

Bert: Right. They are very helpful. In fact, sometimes Purchasing will have a problem connected with another Department and they will phone me for information on a specification and how a company's product stands up to both its specification and to the wear and tear of use in the laboratory. Manufacturers' claims and performance do not always match! Some other departments are not so technically orientated as those in the Faculty of Science.

WASTE NOT, WANT NOT

Us: *When I was in school, more years ago than I care to remember, all I can remember about chemistry labs is that there was a great tendency to use too much. "Don't use a gram when a kilogram will do" seemed to be the motto. Do you have any problem in that way?*

Bert: Yes, especially at the first year level. When there are a hundred or two hundred students doing the same laboratory, the technicians have a terrible problem in guessing how much of the reagents they need to prepare. In some laboratories where the students are particularly sloppy, we may have to

prepare two or three times as much of a solution as is really necessary, and often they will run short in the middle of a lab period which causes a great panic — but the students have only themselves to blame. Unfortunately the innocent suffer with the guilty.

Us: Have you ever suggested to the professors that they fine the students if they use too much?

Bert: No, we have never taken that approach. By the second year, the students are more lab orientated and we have less trouble.

Us: Do you have to separate the requirements of teaching and research?

Bert: Yes, but much of the research equipment is ordered by individual professors out of their research grants.

Us: Do you have any problems keeping track of research equipment? Finding out who's got it ... whether undergraduate equipment has wandered into some professor's research lab, for instance?

Bert: There are some small problems, but the real problem seems to be more the mental attitude of the individual.

SCOUTING

Us: To complete the profile, what do you do in your spare time? I know what you do in your spare time ... could you tell the readers?

Bert: Well, I like to be busy, active all day. Perhaps I am more physically active in the evenings. As well as indulging my interest in radio and electronics, I spend a great deal of time with the Boy Scouts' Association.

Us: What's your position in the organization?

Bert: At the present time, I am on the Executive Committee of the District Council.

Us: How do you find enough time to do that?

Bert: The solution is reasonably simple. As a means of relaxation. When I leave the door of the University, I enter a different sphere, and relax from the problems that I may have encountered at work. Similarly when I come to the University to work, I leave my home and hobby problems behind! This system affords greater use of my mental capacities and replaces mental tension with pre-occupation.

Us: Do you go camping out in the bush at thirty below?

Bert: I've never been in camp at thirty below, but I have done a great deal of outdoors work including winter camping in Northwestern Ontario.

Us: What sort of ages are the boys?

Bert: Well, we run programmes here for boys from ages eight to twenty-three.

Us: Is the scout movement growing or decreasing?

Bert: At the present time, unfortunately, membership is decreasing.

Us: What is the problem?

Bert: There are a number of factors.

Us: Does the increase in social self-discipline play a part?

Bert: Yes, this is one of the bigger social problems.

Us: Is there any military content in scouting?

Bert: Very, very slight. We obviously have to have some degree of discipline, but we are far from being a military force or having a militaristic philosophy.

Us: Is there anything I have NOT asked you that you would like to tell our readers?

A SOURCE OF EQUIPMENT AND TECHNICAL HELP

Bert: Well ... getting back to the store, it might be interesting to note that my store on the second floor of the Science

Building has the largest stock of scientific materials and equipment in Northwestern Ontario. Not only do we lend equipment out to other Departments in the University, we also lend to various high schools and in particular to students at the high school level who are working on projects for the Science Fair. Such projects involve using apparatus and chemicals which are not available in the high schools. It gives me great pleasure, both personally and on behalf of the University, that we can provide this service to assist the students to develop their knowledge and skills.

Us: Too right. A lad came to me for some phosphor which he wanted to use for a Science Fair project. I was able to give him ten different ones, which was I think beyond his wildest expectations. But we have got to be careful that such requests don't become too great in volume for us to handle. They go back to school and show all their mates who then descend on us in droves! But I suppose that's a good thing for the University in the long run.

Bert: Yes, I like them to come to us looking for information and ideas.

Us: You know the National Science Fair is going to be here this summer?

Bert: Yes. I'm looking forward to it very much. I have been involved in the Science Fairs in small ways in the years past, and it will be interesting and exciting to see what the rest of the country has to offer.

Us: Thank you very much. ■

INFORMATION * CANADA

Skunk Hollow, Deadman's Ledge, Squirrel Jump Gulch, Horseback Ridge. Names out of the American West? No, they're all in

New Brunswick and so is Utopia, Sugarloaf Mountain, both Upper and Lower California and even Loch Lomond.

These are some of the fourteen-thousand names of populated areas and natural features listed in a new edition of the Gazetteer of Canada for New Brunswick, published for the Canadian Permanent Committee on Geographical Names by the Department of Energy, Mines and Resources. The last edition, issued in 1956, contained only seven-thousand names.

The bilingual gazetteer includes a glossary of terms, a map of New Brunswick showing counties and parishes, the exact geographical position of each place and a map with instructions on how to obtain maps of regions within the province on a scale of 1:50,000.

Other exotic place names found in the province are: Push and be Damned Rapids, Pull and Be Damned Island, Slingdung Brook, Spit Shoal, Skull Island, Hells Kitchen (a ravine), Left Hand Leg (a bay), and The Old Sow (whirlpools). New Brunswick has thirty-three Mud Lakes, four Devils Elbows (river bends), ten Dead Brooks, a Five Fathom Hole (a cove), the Kouchibouguac River and Scoodawabscook Bend. And there are some lyrical names as well: Diffin Heath, Frosty Hollow, Little Dipper Harbour, Raspberry Cove, Strawberry Marsh and Woodpecker Hall.

The Gazetteer is one of the most advanced in the world. Committee staff went into the field interviewing, checking spellings and verifying geographical features over a two-year period. Up to this point, names in gazetteers have usually been drawn from maps and records. It has been found, however, that field studies result in an increase of one-hundred percent in the stock of names. They also reveal an inaccuracy rate of twenty percent in documents and maps already printed. The Gazetteer of New Brunswick is available from Information Canada for \$4.00. ■

THIN SECTIONS

By R. L. Bennett

WHAT A THIN SECTION IS — AND WHY

One of the most striking natural substances seen through a polarizing microscope is a "thin section" of rock. A thin section is a sliver of rock .03 mm. thick on a glass slide with a protective glass cover slip.

The purpose of the thin section is to examine the crystalline structure of rock, to determine to which category it belongs - igneous, sedimentary or metamorphic. Its geological interest, as in stratigraphy, to help in the making of a geological map, or in the identification of a rock type for economic purposes, say as an aggregate for concrete, or to see whether the rock texture is suitable as a foundation for a dam or similar huge engineering project.

The name given to the general study is Petrology, which is derived from the greek *Petros*, rock and *ology* - the study of. The first person to think of a method of examining the internal structure of a rock was William Nicol, a Scottish Geologist:* he had a lapidary do the work for him, (this was in 1827). He discovered or invented the Nicol prism, a piece of Iceland spar ($CaCO_3$) cut in such a way as to give polarized light. All his work was done purely by hand.

The modern method of making a thin section is a comparatively simple mechanized technique, only the last operation being done by hand.

ALL THE DETAILS

Stages.

1. The first rough cut
2. Cutting to size for glass slide
3. Grinding to mount on the slide

*Mr. Bennett is himself an undoubted Scot! - Ed.

4. Mounting the slide
5. Cutting off the mounted slab
6. Thinning down to transparency
7. Hand finishing to petrological thickness
8. Mounting the cover slip

Stage One.

— The first rough cut:

This is done with a "cut-off machine" equipped with a diamond impregnated cutting blade, which is a round disc of metal of something over a foot diameter having a diamond-charged edge a little thicker than the blade itself. This is to prevent the blade from jamming in the cut, and also allows the coolant fluid to wash away the rock powder. The procedure is to have the rock firmly clamped and to have a smooth easy feed against the blade to ensure a smooth clean, cut surface. The rock slab should be about 1/8" x 1/4" the precise size depending on its texture.

Stage Two.

— Cutting to size for glass slide:

Having examined the cut surface and selected the area required for the thin section, the slab is marked with a pencil or ink marker, and is cut by a hand or a trim saw. The finished slab should fit on a slide, the edges not overlapping the slide as this would cause difficulties in later stages.

Stage Three.

— Grinding to mount on the slide:

The slab is now ground with 400 carborundum and water on a lapping machine until all the cut marks are out and the surface is flat with even texture, and then further ground on plate glass with 600 or

1,000 grit carborundum to ensure a smooth surface. This is a very important stage. If there are pits in the surface air bubbles will be trapped and that part of the section could be lost during the final stage of grinding.

Stage Four.

— Mounting on the slide:

The slab, having been washed clean, is placed fine ground surface upward on a hot plate at a temperature of about 150°C. This is not a critical temperature but a handy one to work on.

A glass slide is cleaned and laid on the hot plate. The adhesive material used is a Thermo plastic under the listing of Lakeside 70. It has very great adhesive powers and a refractive index of 1.52 which is very important in the determination of the Feldspar group of various igneous rocks.

The adherence of the slab to the slide is a matter of melting a small amount of the adhesive on the slide and the slab surface, putting the two surfaces together and pressing out the air bubbles, at the same time centering the rock slab on the slide.

A number or mark is scratched on the back of the slide for further identification, should it need to be catalogued for teaching purposes.

Stage Five.

— Cutting off the mounted slab:

The now mounted slab is reduced to its proper thickness. The first stage is to cut off the slab with a fine diamond impregnated blade, usually about 5" in diameter and about .012 thick with a speed of 2,000 r.p.m. The slide is held in place by a vacuum chuck, and the feed is advanced by hand at

a rate suitable for the texture of the rock. In an alternate technique, the slide is machined by means of a diamond impregnated buff which grinds the slabs down to a set thickness.

Stage Six.

— Thinning down to transparency:

The now transparent section of rock is removed from the cut off machine and fitted to a similar machine equipped with a diamond buff. The slide is held by a vacuum chuck on a hand operated arm. With the aid of a micro-threaded lathe slide, the rock is moved into the buff, and 2 to 4 thousands of an inch is removed at each forward movement. This continues until the slab is thin enough to examine through the microscope. It will be observed that under polarized light the colours given by the quartz, Feldspar crystals will be of a green blue red orange hue. The section should now be washed and hand finished on the glass plate, with 600 carborundum.

Stage Seven.

— Handing finishing to petrological thickness:

Finally, the last touch is added by hand — grinding. As the art of making a thin section of rock is to retain the outside of original slab so as it can be compared against the rock cut, it is advisable not to use a circular movement on the glass. This is apt to give rise to a rounded thin section. The grinding movement should be elongated, with not too firm pressure of the finger on the back of the slide. Depending on the texture which in turn governs the hardness, the final grinding should take a few minutes to produce the standard "first order" grey to the quartz and Feldspar.

Stage Eight.

— Mounting the cover slip:

The surface mounting medium is removed, by using a razor blade or similar instrument, the slide is cleaned off with acetone, chloroform or alcohol. A glass cover slip is cleaned and covered with Canada Balsam enough to cover the slip. This is placed on the hot plate and the balsam allowed to heat, driving off the solvents. It is not necessary to overheat the balsam, which is ready for use when all the air bubbles are out, at which time the rock slide is reversed onto the balsam, i.e. rock section downward. It is then lifted clear off the hot plate and pressed down to remove the air bubbles, making sure the cover slip is evenly down on the rock section and centred on the slide.

The surplus balsam is cleaned off by immersing the slide in acetone for a few minutes, and subsequently wiping with a tissue, the process is repeated in chloroform, the slide is wiped clean, washed in warm detergent water and dried.

Dear Reader, that is the basics of how a thin section of rock is made — believe me, I have made all sorts. There are many papers and chapters in geological books written on the subject, but, in my view, there is only one way to learn the technique — the more you make, the better the results!

Mr. R. L. Bennett came to Lakehead University in 1967 from Edinburgh University where he was the Chief Technician of the Department of Geology. He was the founder and first President of the Scottish Mineral and Lapidary Society, the first to be formed in Great Britain. He enjoys fly fishing and relaxing in his cottage on the Kam River, but regards hunting as a pastime he can do without.

□ "Hugh Miller, to his dying day, insisted that nothing *organic* lived in the north of Scotland previous to the deposition of the *Old Red conglomerate*. The Old Red conglomerate was to him the fossiliferous base in the north. He knew and acknowledged the Silurians of the south of Scotland; but he argued that Durness limestone was of Old Red age. Professor Nicol said it was of mountain limestone. Sir Roderick Murchison has classed it Silurian.

When Hugh Miller was in Orkney he saw the Old Red conglomerate at Stromness, and followed the fossiliferous rocks along the sea-shore *upwards*, until he found a fossil bone, which he termed the 'Nail', and he counted how many feet this 'nail' was above the Old Red conglomerate. He considered this 'nail' the oldest bone in Scotland. So he said. He knew of none older at that time. The Durness fossils being all shells and molluscan animal remains, Hugh probably thought that nothing of a bony nature existed in Scotland older than his Stromness 'nail'. And this bone was a fish remain, many hundred feet above the Old conglomerate.

But what would Hugh have thought of fish *underlying* Old Red conglomerate? Fish remains older than conglomerate? Alas, poor Hugh! such is actually the case. The other day I turned up and brought home with me to Thurso the remains of fish that had lain buried below the Old Red conglomerate! But Hugh had seen the 'Base' in many places and preferred retaining the old opinion.

I believe the opinion entertained by our highest geologists is that there is Old Red conglomerate of many ages; whereas Hugh Miller considered it as of one age — one great formation. He says that it extends from the Grampians to Orkney, and from Peterhead to the Western Isles; that it lies in a continuous stratum of variable thickness; and that no fish lived then in what is now Scotland. A great mistake! □

HOW MAY TEACHERS KEEP IN TOUCH WITH THE EXPANSION OF THEIR SUBJECT?

By J. S. Griffith

Both school and university teachers are faced with the knowledge explosion. Subjects at one time the preserve of university courses are moving into the school curriculum, graduate level subjects are moving into undergraduate level courses. New facts and methods of approach are available.

Here I will concentrate on one subject area, but many of the suggestions are applicable to other disciplines. The teacher should use the courses he teaches as an avenue to creative activity. Books, journals and articles should be scanned for lively examples and applications while dissatisfaction with a textbook may be turned into the writing of substitute units and their existence (and the dissatisfaction) brought to the attention of other teachers by publication in *Caret* or in the *Ontario Mathematics Gazette*.

Cooperation with other teachers in interdepartmental courses and projects, and advice of interested students in competitive opportunities like the Gelfand Club and the various Mathematics Contests will aid in stimulating thought and in keeping abreast of the tide.

Organization of a mathematics club with invited talks from visitors (any of us at Lakehead are willing to come), as well as by teachers and advanced students on their independent reading (for example historical development of a certain topic), problem sessions together with visits to the university's periodic seminars (ask to be put on our mailing list) will help, as will the reading of expository books and articles. Again there are two publications that are willing to publish book reviews and reports on articles you find valuable.

Attendance at (or organization of) development days or summer institutes

will aid you and your fellow teachers. If you think we can help, why not ask?

Contribution of articles to the *Ontario Mathematics Gazette* is another avenue to be explored. We want more articles from practising teachers, especially from those at the elementary level, and the editors are helpful and understanding!

All these suggestions require time, motivation and opportunity. I hope that *Caret* and the *Gazette* offer some stimulus. There are presumably boards, provincial and federal sources that support investigations into curriculum reform and innovation, staff training, and experimental courses. Why not tell others of the avenues you are aware of by using the embryo 'Letters' section of the *Gazette*?

The establishment of an individual program of study and exploration will help keep you active. Resolve to read through at least one journal or book a week. Each departmental head should encourage junior members to stay alive mathematically and, both in schools and universities, bears the responsibility of keeping teaching loads down so that free time for intellectual stimulation is not eliminated.

These ideas were stimulated by a paper by D. E. Christie and J. H. Wells in the *American Mathematical Monthly* (74, October 1967).

*Even as the finite encloses an
infinite series
And in the unlimited limits appear,
So the soul of immensity dwells in
minutia
And in narrowest limits no limits
inhere
What joy to discern the minute in
infinity!
The vast to perceive in the small,
what divinity!*

— Jacques Bernoulli / 1674-1705

ARE TEACHERS BORN OR MADE?

(OR HOW TO KEEP YOUR COOL AMIDST THE EDUCATIONAL JARGON)

By Casey A. Gehrels

Elementary and secondary education is becoming saturated with terminology that means little to anyone involved in the schools, least of all the people it is serving, the students and their parents.

The people involved in education will usually state that the basic function of the school is to produce good citizens and to provide the opportunity to students to develop to their fullest potential. It is difficult to find fault with statements such as these, but we as teachers run into trouble when we try to interpret what they mean in the classroom situation.

I should comment here on two points which I believe handicap a teacher in his responsibilities. You can also observe these points with post secondary teachers. First, it is difficult for a teacher to picture that learning takes place anywhere but in a classroom. If you were assigned and paid for performing in a single room in a school, which is true in most schools, you would experience the feeling that this room constitutes a completely separate and unique world for the teacher and the students. You can see a consequence of this situation in the intense difficulty students have in transferring any of their learning to situations outside their classroom. Second, teachers like to think that "teaching" and "learning" are the same thing. This is reasonable to expect because teaching gives an immediate sense of accomplishment, whereas learning can probably not be observed by another person. It is also easier to teach than to help people learn.

Let's look at some of the jargon in education. To start with, if you are a good teacher you should have "valid and viable aims, and objec-

tives". You could even state your objectives in "behaviour terms". This means that you should know why you are teaching things and that you could predict the results of teaching in terms of what students will act like when they come off the assembly line.

Courses that are up-to-date should be "multidisciplinary, interdisciplinary, transdisciplinary, non-disciplinary or integrated". This means that your courses must not be based on one of the disciplines, otherwise the student won't have a "felt need" for the material. Many teachers assume that their main function is to organize the subject material for their students. The way to do this in science is along "conceptual schemes". This means the teacher must weave spaghetti-like story lines through his subject matter, so students will learn important things. If you have taken grade 13 Physics lately you know that it takes a year of following a predetermined line of thought to learn something about the hydrogen atom.

If your courses are up-to-date they should be based on "process" not "content". This sort of means that students may end up learning whatever it is they learn; the important thing is what happens while they are learning.

As a student in a modern school your learning falls into three "domains: cognitive, affective and psychomotor". This means that your learning is organized into three areas; what you learn about knowing, feeling and doing.

Have you spent any time lately trying to explain to a seven year old what a garbage man is? It didn't help your cause much when you defined

him as a "sanitary engineer". You were talking Greek. When teachers get to talking with one another, the jungle of meaningless terms makes the legendary language confusion of Babylon look like a Grade 1 "Reader" (reading book).

Teaching boils down to being able to talk to and understand your students. Educational jargon stifles this communication. When we train or try to improve teachers, we offer them little but jargon. People do not learn to communicate by having other people talk at them in strange language.

Teachers are not made by other teachers or books.

But perhaps teachers are born in the classroom?

■ THE ADVENTURES OF MATHMAN ■
by
L.U. MATH CLUB

After finally reducing the 8th degree differential equation to a series of harmless 1st degree equations, MATHMAN was heading home to his Locally Compact Hausdorff Space on his trusty homomorphism, Hans. Hiding under an open cover, his Arch Enemy $\text{SIN}^{-1} \frac{1}{x}$ chose a lethal $\epsilon > 0$ from his arsenal of real numbers. Heedless of the Heine-Borel property, the villian projected his ϵ right through a finite subcover at our hero!!!! Having previously predicted that the probability of this event was negligible, MATHMAN was caught with his functions down. Frantically he grabbed his pocket APL terminal and by inspection sought a suitable $\delta > 0$ depending only on ϵ to make the sequence of destructive elements to converge in a harmlessly distant Hilbert Space!!

Will he find a suitable δ ?
Will the computer stay up?
Will $\text{SIN}^{-1} \frac{1}{x}$ ever converge?

Watch for the answers in the next MATHMAN adventure.

■ "The main function of a language, communication, has been analyzed by K. Bühler into three functions: (1) *the expressive function* - i.e. the communication serves to express the emotions or thoughts of the speaker; (2) *the signalling or stimulative or release function* - i.e. the communication serves to stimulate or to release certain reactions in the hearer (for example, linguistic responses); and (3) *the descriptive function* - i.e. the communication describes a certain state of affairs. These three functions are separable in so far as each is accompanied as a rule by its preceding one but need not be accompanied by its succeeding one. The first two apply also to animal languages, while the third appears to be characteristically human. It is possible (and I believe necessary) to add a fourth to these three functions of Bühler's, and one which is particularly important from our point of view, viz. (4) *the argumentative or explanatory function* - i.e. the presentation and comparison of arguments or explanations in connection with certain definite questions or problems. A certain language may possess the first three functions without the fourth (for example that of a child at the stage when it just 'names' things). Now, in so far as language *qua* institution has these functions, it may be ambivalent. For example, it may be used by the speaker to hide his emotions or thoughts as much as to express them, or to repress rather than to stimulate argument. And there are different traditions connected with each one of these functions. For example, the different traditions of Italy and of England (where we have the tradition of understatement) in connection with the expressive function of the respective languages are very striking..."

CONJECTURES AND REFUTATIONS: The Growth of Scientific Knowledge - KARL J. POPPER.
[Harper & Row, Inc. - 1968]. ■

LAKEHEAD BECOMES CANADIAN OPEN UNIVERSITY

New degrees give unique open access

By Edward Mercy

The Senate of Lakehead University has given approval to a new kind of degree structure to be known as the B.Sc. (or B.A.) General Programme. It is a particularly suitable study programme for the part-time adult student, although it is open to any student who has met the usual entrance requirements. Consideration of two factors led to the regulatory basis for the new degree.

Universities are urged to be relevant to the needs of present day society and to serve the region in which they operate. At a time of severe financial restraint, it is just not possible to develop new courses which meet these criteria. The General Programme overcomes this difficulty by making all existing courses available to the student, subject to certain conditions.

FREE CHOICE OF SUBJECTS

Most of the programmes of study at Lakehead University are arranged so that the student may meet the requirements of various professions. This means, in general, that choice of courses is severely limited and that specific requirements, especially in the major subject and to some extent in the minor subjects, have to be complied with. There are probably many people in the community who would like to study certain aspects of knowledge but have no desire or need to meet existing pre-requisites. The nature of the General Programme is such that students may make an entirely free choice of subjects to be studied.

REGULATIONS ARE MINIMAL

The regulations for the degree are these:

(1) A student must obtain fifteen credits in order to be granted the degree.

(2) The credits may be obtained by taking any available courses offered by the University without regard to published pre-requisites.

(3) The student is *advised* to discuss the importance of pre-requisites for a particular course with the Instructor of the course.

(4) Only seven first-year credits may be included.

(5) At least two third-year credits must be obtained.

(6) The remaining six courses may be taken at second, third or fourth year levels.

Thus, the degree programme really is as free as it possibly can be. The only important restriction is the one concerned with pre-requisites because, especially in the more professional courses, prior knowledge of the subject may be essential. But the University recognizes that such prior knowledge may already have been obtained elsewhere than at the University, for example by private study or practical experience.

Whether a B.Sc. (or a B.A.) is finally obtained is simply based on whether there is a majority of Science or Arts courses in the fifteen credits.

■ Lakehead University evolved from the Lakehead Technical Institute which was established on June 4, 1946. Classes commenced in January, 1948, in temporary rented quarters in downtown Port Arthur. In September of that year, first year university courses were added to the curriculum. The Lakehead College of Arts, Science and Technology was established by an Act of the Ontario Legislature assented to on March 28, 1956, and proclaimed on August 1, 1957. The present university site was occupied on October 2, 1957.

TRANSLATION ON A COMPUTER

By K. H. V. Booth

PROGRAMS PRODUCE ROUGH TRANSLATIONS

For many years work has been going on directed at producing translations from one language to another using a computing machine. Much attention has been paid to the problem involved in translation to and from English and Russian, but here in Canada work has concentrated on English to French translation for the reason that our bilingual laws necessitate a great deal of this.

So far the results of this work have been one or two programs which produce rough but fairly understandable translations of technical papers from Russian into English, and a program, developed at the University of Saskatchewan, which has processed about 10,000 words of translation from English into French. The output is far from perfect but can be understood and edited fairly easily by a French speaker.

To see why we are still far from producing perfect translation we must look in more detail at some of the processes which are entailed.

THE METHODOLOGY

Suppose that we wish to translate the sentence: *The man speaks.* into French.

The first step is to look up each word of the sentence in a dictionary, for unlike ourselves the computer cannot "recall" information instantaneously, but must consult the dictionary each time.

The French equivalent of *the* will be found to have four alternative forms, *le*, *la*, *l'* and *les*, depending on the gender and person of the following noun and the first task is to pick the correct form. The dictionary entry for *man* will contain the information that this is a masculine singular noun, normally requiring the translation *le*, but since the

French word *homme* begins with a mute *h* we actually choose the abbreviated version *l'*. Next we have to look up *speaks* and here the difficulty occurs that a normal English/French dictionary will have no entry for this form of the verb, but only for the infinitive *speak*. We could possibly program the computer to recognize that *speaks* consists of the root form *speak*, together with the ending *s*, but it turns out to be easier to store all possible forms of verbs (*speaks*, *speaking*, *spoken*, etc.) in our computer dictionary. Of course our program must also be able to recognize compound forms such as *will speak*, *has spoken*, etc. and choose the appropriate French equivalent. The latter process incidentally entails coping with the numerous irregular verbs of unhappy memory for anyone who has struggled to learn French!

Fortunately, however, all this is fairly easy to accomplish. Computers are very efficient at storing long lists of words and at referring to them. They can also be made to manipulate words, adding endings, etc. using the techniques of text processing.

Another problem which has to be faced is that word order is rarely the same in two languages. Suppose that we consider the sentence: *The blind man speaks.* In the French equivalent: *L'homme aveugle parle.* the adjective must be placed after the noun instead of before it as in English, and this is just one example of the differences between English and French in this respect.

Again, this is a task which can easily be programmed into the computer.

WORDS ARE TWO-FACED

So far, however, we have ignored one huge difficulty. When we look up

man in our dictionary, there will be three different translations depending on whether the word is used as a noun, adjective (man sized) or verb (to man the ship). Similarly *blind* might be either a noun, adjective or verb.

Faced with multi-purpose words such as these (and in a typical piece of prose about half will consist of them) how can the computer decide on the correct choice?

Several ways have been suggested. One of these is to make the computer "parse" the English sentence, using a set of construction rules which define the combinations of parts of speech which are permissible in a grammatical sentence. For example, the combination (Adjective Noun Verb) is possible, whereas the combination (Adjective Verb Noun) is not.

This method which has been evolved by a group at the University of Montreal is theoretically attractive since new rules can be added easily. In application to actual texts, however, it appears less so, since the multiplicity of possible parsings which have to be considered make it very slow, particularly for long sentences.

In the method developed at the University of Saskatchewan a completely different approach based on the statistical likelihood of the function of each word in a sentence is used.

Instead of defining rules for constructions, we use statistics accumulated from text of similar type to make decisions on the function of each word in a sentence. This method is very fast but has the disadvantage that, being statistical, mistakes are made sometimes and for this reason the translation must be checked by a post-editor who corrects such errors (they are usually obvious). The error rate is low enough, about 3.5%, to make this possible for the type of text which we have tested so far.

IDIOMS AND STYLE

Our difficulties are not at an end, however, even when the parsing problem is disposed of. Every language has an abundance of "idioms", i.e., phrases which do not literally mean what they say. As an example consider the English saying "like it or lump it" which nearly brought Prime Minister Trudeau to grief. Similarly French has many idiomatic phrases which cannot be rendered word for word into English, for example, "boîte de nuit", which is the French version of "night club" and which translates literally as "box of night".

This problem can be overcome by storing a dictionary of idioms and making the program locate any which may occur in a sentence before translating it. In the program developed at the University of Saskatchewan we have a very efficient routine for accomplishing this.

A final and still unsolved difficulty must be mentioned. In the sentence: *It is within the province of the province to deal with education.* *province* is used twice as a noun, but requires two different translations in French. This is a problem in semantics (i.e. meaning) and no one as yet has found a practical way of solving it. The solution adopted so far is to print both possible translations and leave it to the post-editor to decide.

Still more intractable are the problems of choosing the "best" French equivalent where more than one exist for a particular word in a particular sense. This involves considerations of "style" and as yet we have no idea how to make a computer make such choices. Indeed human translators will sometimes disagree on them so perhaps it is too much to expect a mere machine to succeed!

England and America are two countries separated by the same language.

— G.B.S.

BLACK AND WHITE HOLES

By J. S. Griffith

Now that black and white holes have become both respectable objects of scientific investigation, what are their accepted properties?

Black holes appear to be capable of having a wide variety of sizes ranging from one hundred thousandth of a gram (1) to solar sized objects and up to 10^{10} solar masses (in galactic nuclei) (2). They result from the complete gravitational collapse of objects. Space and time are so strongly curved that no radiation can escape from the object into our Universe, nothing material can escape, and any attempt to explore the black hole by the physical introduction of a space probe would result in the destruction of the probe. The only characteristics of the probe that would still exist are its mass, electric charge, and linear and angular momentum. These three quantities are the only characteristics of the hole that may be measured by their effect on the orbits of both charged and uncharged objects (from normal stars to space probes) which pass near the black hole or orbit around it.

The appearance of a black hole depends upon the location and motion of the observer. If a spaceship was fortunate (?) enough to be present during a collapse and the astronauts decided to follow the collapsing matter down into the black hole, they would find the matter being crushed to increasingly higher densities, and the ship (and the astronauts themselves) torn apart by increasing tidal forces. No form of engine, rocket or nuclear powered, would be sufficient to save them from their fate, once the ship had crossed a certain critical position (the 'horizon'). The ultimate collapse will occur a finite time after the passage of the surface, and is inescapable.

The interchangeability of space and time in the black hole leads to an inevitable passage to the centre of the hole as time increases. As time advances, all objects within the horizon move towards the centre.

Should the astronauts decide on a safer course of action and watch the collapse from a great distance, they will find all signals and information from the later phases of collapse denied to them. These signals are caught up in the collapse of space-time and can never escape into the surrounding universe.

However, during the formation of a black hole, pulses and trains of gravitational radiation will be given out. Matter falling into a black hole will be compressed and heated to about 10^{11} °K as it is funnelled into the hole, and X-ray and γ -ray radiation may be observed. Jets and similar activity produced in the ergosphere of rotating black holes may be observed.

The ergosphere. This is the region between the surface of infinite red-shift and the horizon.

If a spaceship ejects an escape capsule in this region, with the ship itself being caught up into the black hole, the capsule can escape (as it has more energy than the original spaceship) (4). There is no way for a spaceship to remain at rest in the ergosphere, however it fires its motors!

As the core of a late giant star collapses in volume by a factor of one million, the material of the core starts moving in slowly. The rate of collapse quickly increases, with the inner part of the core soon so contracted that it draws the core down much faster than the surrounding envelope. If the mass and the velocity of implosion are large enough, complete collapse ensues with the production of a black hole. However, in

other conditions the collapse is suddenly halted, releasing a great deal of kinetic energy of motion into heat energy - like thousands of nuclear explosions. The consequent high temperatures lead to high pressures and consequent reversal of the implosion, propelling the envelope into space with the emission of cosmic rays and an expanding cloud of ions. A star of the order of the solar mass was responsible for what we observe as the Crab Nebula.

If the star were rotating (as most stars are) and had a magnetic field, the winding up of magnetic lines of force (like cotton on a reel) leads to an elongation in the direction of the axis of rotation (3) and the emission of jets of matter from the poles. Added interest to the computation of such a situation arises when we have to take into account nuclear reactions - a problem that is, as yet, unsolved.

The collapse into a black hole is preceded by the star passing quickly through the neutron-star phase. Other names for black hole are 'continuing collapse' and 'frozen star'. Seen by the distant (wiser) spaceship crew, the collapse will never be complete (the radius diminishes exponentially with time). However, the probe moving with the matter (if it somehow can survive the process, which seems highly improbable) will see the dimensions become indefinitely small after a short period of time.

The system will have a completely black appearance to the external spaceship. No light escapes, and laser beams shot at it disappear as they fall in. An adventuresome crew member shot into the hole would disappear to his fellows. Manoeuvring close to the hole and inserting a long stick or probe would lead to fragmentation of the stick by tidal forces and the disappearance of the broken pieces.

Before the critical Schwarzschild radius is reached, light emitted

from a specific cone can escape. As the Schwarzschild radius is approached the core becomes smaller, with ultimately (once the critical radius is passed) the light being perpetually caught by the collapsing geometry of space-time around the material in the hole.

Should the external spaceship venture within the critical radius, it can never escape, and is forced towards the centre of the hole. No matter what sort of material takes part in the collapse, the characteristics of the black hole are the same, apart from the mass, charge and angular momentum. "A black hole has no hair." (2).

How can black holes be detected?
Their size is of the order of 15 kilometers, so direct visual observation is out of the question. A companion 'normal' star may be observed orbiting around a black hole. Material from the companion may be drawn into the hole and disappear. Black holes may exist within stars (and even in the Sun!) (1). A black hole moving through an interstellar cloud may be observed as it sucks up material.

The inflow of material will lead to emission in the X-ray region or in the γ -ray region (5). Orbiting telescopes may give observations of such events. Weber's observations of gravitational waves may indicate a stellar collapse rate in the nucleus of the Galaxy of over one a day (1). In this reference is discussed low mass objects that have gravitationally collapsed, which may account for the low value of the density of the Universe, and indeed they may already have been observed as unidentified tracks on bubble chamber photographs. If, as is suggested in Ref. (1), the Sun has a central hole of mass 10^{17} gm, radius 10^{-11} cm, then in 10,000,000 years the Sun will be totally absorbed, giving first pulsar-quake-like phenomena followed by rapid collapse with the emission possibly of gravitational waves. This

theory indicates that life on the Earth is limited, instead of having billions of years to go, we have only millions. Even then, if we take man to have been 'civilized' for ten thousand years, we are still in the first one thousandth part of our possible evolutionary development. We may compare our present state of development to a twenty day old baby, who can at least expect to survive to the age of fifty years. Certainly the human race has far to go, and much time for refinement of our present culture. Science fiction writers have a great range of time to deal with, and we can only hope that human nature will change, so that eventually we are much more civilized. Perhaps we have already been examined by galactic civilization, classified as in the pre-playpen stage, and left to our childish devices until we are worthy, in our adulthood of joining a galactic federation!

R.M. Hjellming (National Radio Astronomy Observatory, Green Bank, W. Va.) has propounded the theory that black holes must have their opposites — *white holes*.

Theories about pairs of complementary opposites are relatively common (matter and antimatter, electrons and positrons, etc.). Just as black holes take matter out of our universe (the ultimate in garbage disposal?), white holes are places where material enters our universe. Maybe all material that leaves by the black hole route returns by white holes, having been purified' by intense heat and pressure, or we may be exchanging material with one or more other universes, with each maintained in a steady state, losing just as much as one gains.

The white hole hypothesis is claimed to be an explanation for the energy source of quasars and galactic nuclei, for even thermonuclear reactions are insuffi-

cient to provide the power. If energy and matter are pouring in from another universe, then sufficient energy may be available.

The mathematical and physical details are not yet fully worked out, but there are tempting extrapolations and questions.

1) Can some way be found of passing information from one universe to another?

2) Does another, much more advanced, universe use ours as a 'garbage disposal unit' — is energy strictly conserved, so that they get back purified versions of what they disposed of?

3) Could one wage war, one universe against another, by putting more and more material into black holes, in the hope that the other universes are inflicted by a raise in radiation? (What time lag is there between disappearance in one black hole and appearance in a white hole?)

4) Is life in our universe bred from some incompletely processed garbage from another universe — a 'black hole' that somehow was not functioning correctly?

5) What relationship is there between the distribution of black holes in one universe and white holes in another?

6) Galactic nuclei appear to be long lived objects — is this consistent with a corresponding long lived black hole?

There is a great deal more work to be done before these objects are fully explained and the white hole / dual universe theory put on a firm foundation.

REFERENCES

- (1) Hawking, S., 'Gravitationally collapsed objects of very low mass', *Mon. Not. Roy. Ast. Soc.* 152, 75 (1971).
- (2) Ruffini, R. and Wheeler, J.A., 'Introducing the black hole', *Physics Today*, January 1971, p. 30.

- (3) Leblanc, J.M. and Wilson, J.R., Lawrence Radiation Laboratory publication UCRL - 71873 (1969).
 (4) Penrose, R., Rivista del Nuovo Cimento, numero speciale 252 (1969).
 (5) Zel'dovich, Ya. B. and Novitrov, I.D., Sov. Phys. - Dokl 9, 246 (1964).

A | P | A | C | K | I | N | G | P | R | O | B | L | E | M

by

J. H. M. Whitfield*

How should trees in an orchard be arranged, how should mills in an urban area be situated, boxes in a warehouse, tables in a night club, containerized cargo in the hold of a ship, etc.? These are all types of packing problems. In this note we briefly consider a particular problem: the packing of a number of equal nonoverlapping circles in a sphere.

The influence on the present note of the expository article (1) by H.S.M. Coxeter and the popular presentation (2) by Victor Klee is gratefully acknowledged.

ANGELS

One of the earliest known packing problems of the type we wish to consider is the medieval theological problem: "*How many angels can dance on the point of a needle?*"

To formulate the problem mathematically, we assume that the point is a hemisphere, the angels are all of the same size and they dance by spinning with their wings tightly folded. (A slightly weaker set of restrictions would allow the size of the angels to vary but restrict their dancing within a circle of fixed radius. At least this would allow the smaller angels more freedom in their dance!) We arrive at the mathematical problem "*What is the maximum number of points that can be placed on a hemisphere of radius r so that the distance be-*

tween any two of the points is greater than or equal to d ?"

The value of r depends on the size of the needle point and d depends on the prescribed size of the angels. When d is small relative to r the answer to the above question is approximately one-half the answer to the same question on a sphere, so, give or take half an angel, we will consider the question on a sphere.

POLLEN GRAINS

The Dutch botanist P.M.L. Tammes in 1930 (3) interpreted the placing of such points on a sphere as an arrangement of orifices on a pollen grain. He wanted to explain the distribution on spherical pollen grains of the orifices (hereafter called *exit places*) at which a pollen tube can emerge in the process of fertilization. He observed, for example, that there are frequently 3,4,6,8 or 12 exit places, while 7,9,10 are quite rare and 5 and 11 exit places almost never occur. Further, the same plant may produce pollen grains with different numbers of exit places. However, each pollen tube requires a certain amount of space, so there is a number d , which turns out to be genetically invariant, such that the distance between any two exit places is at least d .

Nature's packing problem is placing as many exit places as possible on a pollen grain, subject to the distance restriction, in order to maximize the chances of fertilization.

MISANTHROPES

For another view of the problem of the pollen grain or of the angels consider n misanthropic individuals. Each so hates his fellow misanthropes that he wants to get as far away from them as possible. The misanthropes want to maximize the minimum distance between any two of them, while it is important for the pollen grain to maximize the number of exit places for a given minimum distance. However, a complete

solution for one problem yields a complete solution to the other.

The solution for n misanthropes are reported by Coxeter for n between 2 and 13 and $n = 24$. Some of the solutions are easily seen. Two misanthropes should live at opposite poles and three at the vertices of an equilateral triangle inscribed in a great circle. Given four miserable persons, they should locate themselves at the vertices of a regular tetrahedron inscribed in the sphere.

Fig. 1 shows the best arrangement of 5 and 6 misanthropes. You will observe that the solution for 5 is not unique as the three on the equator can be rearranged as long as the distance between any two of them is at least $\frac{1}{4}$ of the circumference. Also, you will note that the minimum distance is the same for 5 and 6. This explains Tammes' observation that five exit places on a pollen grain almost never occur, for, if the grain is large enough to accommodate five, it can also accommodate six. Nature makes the best choice.

A similar situation obtains in the case of 11 and 12 misanthropes. For $n = 12$, they should dwell at the vertices of a regular icosahedron inscribed in the sphere and for 11, just remove one of the vertices. Hence Tammes' observation that 11 exit places on a pollen grain occur infrequently.

The other known solutions can be found in the indicated reference. The reader may wish to find the solution for 8 misanthropes, which is not difficult but mildly surprising.

We have here an easily stated and easily visualized geometric problem which, generally speaking, is unsolved! Where should sixteen or twenty miserable people live?

References

*This note is extracted from a talk entitled "Convexity: An Elementary

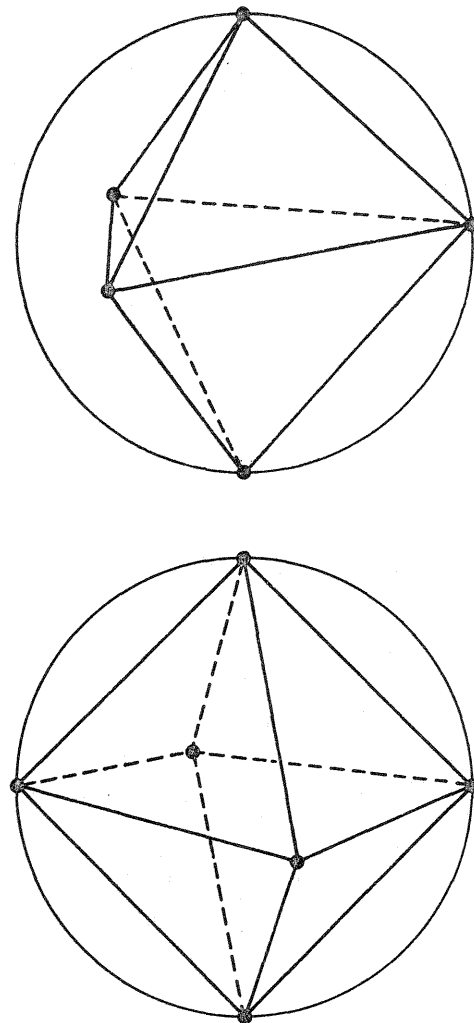


Figure 1.

Discussion of Shapes" presented to the High School Mathematics Teachers on their Professional Development Day, October 1972.

(1) Coxeter, H.S.M., "The problem of packing a number of equal nonoverlapping circles on a sphere", Trans. New York Acad. Sci. (2) 24 (1962), 320-31.

(2) Klee, Victor, "Shapes of the Future", Am. Scientist 59, 84-91 (1971).

(3) Tammes, P.M.L., "On the origin of the number and arrangement of the plates of exit on the surface of pollen grains", Rec. Trav. Bot. Neerl. 27, 1-84 (1930).

THE SCIENTIFIC APPROACH TO THE GAME OF BRIDGE

By Larry Hansen

The game of bridge has developed into a pastime enjoyed by a great many people around the world. People play the game for many reasons but in this article I would like to concentrate on the aspects of the game that appeal to people with scientific minds. For the sake of brevity, I will assume that the reader has at least a knowledge of the basic rules of bridge. However I will briefly describe the three phases of the game in order to bring out some important points that will have a bearing on the remainder of the article.

THE DEAL

The fifty-two cards are shuffled to produce a random order, then they are dealt face down to the four players so that each one sees only his thirteen cards. If we assume for a moment that each contestant could see all four hands then it would be possible to decide the maximum number of tricks that each partnership could take if we assume that the contestants are capable of perfect play and perfect defense. From this it is possible to deduce whether or not the pair that can take fewer tricks (or the same number of tricks but in a lower ranking contract) will lose more points by sacrificing or by letting the opponents play in their best contract. The least number of points that this pair can lose is called the *value of the hand* and the contract that can be played to arrive at this result is called the *par contract*. If we consider the game of bridge from a game theoretic standpoint we see that if we assign specific values for part scores and non-vulnerable games each deal produces a type of two person game with a unique value and at least one saddle point. (See Appendix).

THE BIDDING

This phase of the game gives each partnership the opportunity to attempt

to arrive at a contract better than the par contract. Since an above par contract for one side is a below par contract for the other side the conclusion is that the result of perfect bidding would be that every hand would be played at the par contract. However since it is illegal for a player to look at any cards except his own during the bidding and since there are not enough possible bidding sequences to describe the other three hands completely it is impossible for a player to always know what the par contract is on the various deals he encounters. In actual play it is very rare for a player to know what the par contract is before the play of the hand begins. Therefore, we can draw the conclusion that even if all four participants co-operated there is no perfect bidding system that will always result in the par contract being reached.

THE PLAY

After the cards have been dealt and the bidding is completed the defender on the declarer's left finds himself in the position of having to make the opening lead. The only information that this defender has at his disposal is a knowledge of his own thirteen cards and an inferential knowledge, gained by listening to the bidding, of the distribution of the remaining cards. We can see that the success or failure of many contracts rests upon the crucial decision of which card to select for the opening lead.

Once the opening lead has been made and the dummy is spread each player has a knowledge of the location of at least half of the cards in the deck. Declarer's responsibility is to take as many tricks as possible with his primary aim being to make the contract. On the other hand, the defenders try to take as many tricks as

possible in order to defeat the contract. The declarer formulates all the plans for his side, whereas successful defence requires that both defenders arrive at an accurate analysis of the situation, formulate a successful line of attack and co-ordinate their efforts to bring about the desired result. We see then that no matter how difficult it is to be a capable declarer it is even more difficult to be successful in defence. An application of the laws of probability indicates that approximately 25% of the time a bridge player is dummy, 25% of the time he is declarer and 50% of the time he is a defender. Consequently, a prerequisite for achieving success as a bridge partnership is the mastery of the art of defence.

BIDDING SYSTEMS

Since it is impossible for a partnership to legally gain the necessary knowledge about the placement of all fifty-two cards in order to bid with assurance to the par contract, bidding systems are constructed on the basis of the partnership holding of twenty-six cards. An experienced player by looking at his hand and his partner's can assess approximately how many tricks the two hands together will produce in play. This assessment is based on application of the laws of probability to the missing cards and an understanding of how combinations of cards can be treated to produce the maximum number of tricks. The main aim of any bidding system is to produce a sequence of bids that will give at least one of the partners a very clear picture of his partner's hand so that someone is in the position of being able to decide upon a sensible final contract. (One problem many players encounter is that of realizing when they have already bid up to six spades, for example, that the most they could possibly make is five spades).

The two basic approaches to bidding

that have evolved are the natural approach and the coded or artificial approach. With the natural approach when you bid spades you are suggesting a possible final contract in spades or at least you are showing high card values in spades. However, with the coded approach a spade bid might mean almost anything. To illustrate, an opening bid of two diamonds, depending on the system you are playing, might mean (i) a hand strong enough to make a game in diamonds, (ii) a hand containing eleven to fifteen high card points and a singleton or void in diamonds (iii) a hand of slam potential that is asking for aces (iv) a hand containing four spades and five hearts and eleven to sixteen high card points. In tournament bridge the rules make it mandatory to explain any special understandings that a partnership has about a particular bid. This ruling reduces some of the power of coded systems. Nuisance bids interjected by the opposition also have a tendency to weaken the power of artificial sequences. Natural systems on the other hand, do not have the required precision to explore accurately for slam contracts. The path that most experts seem to follow is to play a system that is basically natural with the addition of certain artificial bids and sequences.

DEFENCE

While the eventual declarer and his partner are bidding back and forth, exchanging information that will enable them to decide upon a final contract, the defenders are listening and thereby gaining the same information about their opponents' hands. This information is one of the defenders' most valuable tools in their attempt to make as many tricks as possible on a given hand. A second device used by all expert defenders is a signalling code in the play of equivalent cards. These signals tell each defender

whether or not his partner has an even or odd number of diamonds, whether he should play hearts if he gets on lead and so on. However, just as the rules of bridge make it mandatory to explain bidding understandings to your opponents, they also require that you inform declarer of the meaning of defensive card play signals. Consequently, everything the expert defender does to improve his lot in life makes it a little easier for the expert declarer to play his cards.

DECLARER PLAY

For several years I thought that it was only necessary to attain one goal in order to become an expert declarer. I believed that all one had to do was to look at the opening lead, the dummy and one's own hand and use the laws of probability to arrive at the most likely distribution of the missing cards in the opponents' hands and then, use one's knowledge of card combinations to arrive at a line of play that mathematically offered the best chance for success. Being expert in this aspect of the game will allow you to do reasonably well in most levels of bridge. However, to reach the pinnacle of expert play one has to be capable of inferential location of missing cards as opposed to probability location of missing cards. To locate cards inferentially one has to understand the opponents' system of bidding and defensive play exactly as well as they do. The next step is to climb into their minds and decide which distribution of the outstanding cards is the one that seems to mesh with the bids and plays that they did and didn't make. After this has been done it is a fairly simple matter to decide how to play the hand.

CONCLUSION

It can be seen that the game of bridge offers intellectual challenges in the creation and use of effective bidding systems in the development

and refinement of successful defensive play and in the honing of the skills required for expert declarer play. In fact, just as pursuit of knowledge in any of the sciences can become a life-long pastime and pleasure, the game of bridge can prove to be a scientific ego trip of virtually limitless horizons.

APPENDIX

The following table displays some of the possible contracts and the resulting scores for a typical hand of bridge. All scores are given relative to N-S. For example, -80 means that N-S lose 80 points irrespective of which column the -80 appears in. Successful part-score contracts receive a bonus of 50 points. On this particular hand N-S are vulnerable and E-W are not. The saddle point for this hand occurs when N-S bid and make 2S. If E-W bid more, they will get doubled and lose more than 110 points and if N-S bid less, then E-W can bid 2H and lose only 100 points if they are doubled.

	<u>N-S CONTRACT</u>		<u>E-W CONTRACT</u>	
	undoubled	doubled	undoubled	doubled
1C	70	140	50	100
1D	70	140	50	100
1H	-100	-200	-80	-160
1S	110	360	100	300
1NT	90	180	50	100
2C	-100	-200	100	300
2D	-100	-200	100	300
2H	-200	-500	50	100
2S	110	670	150	500
2NT	-100	-200	100	300
3C	-200	-500	150	500
3D	-200	-500	150	500
3H	-300	-800	100	300
3S	-100	-200	200	700

ACROSS

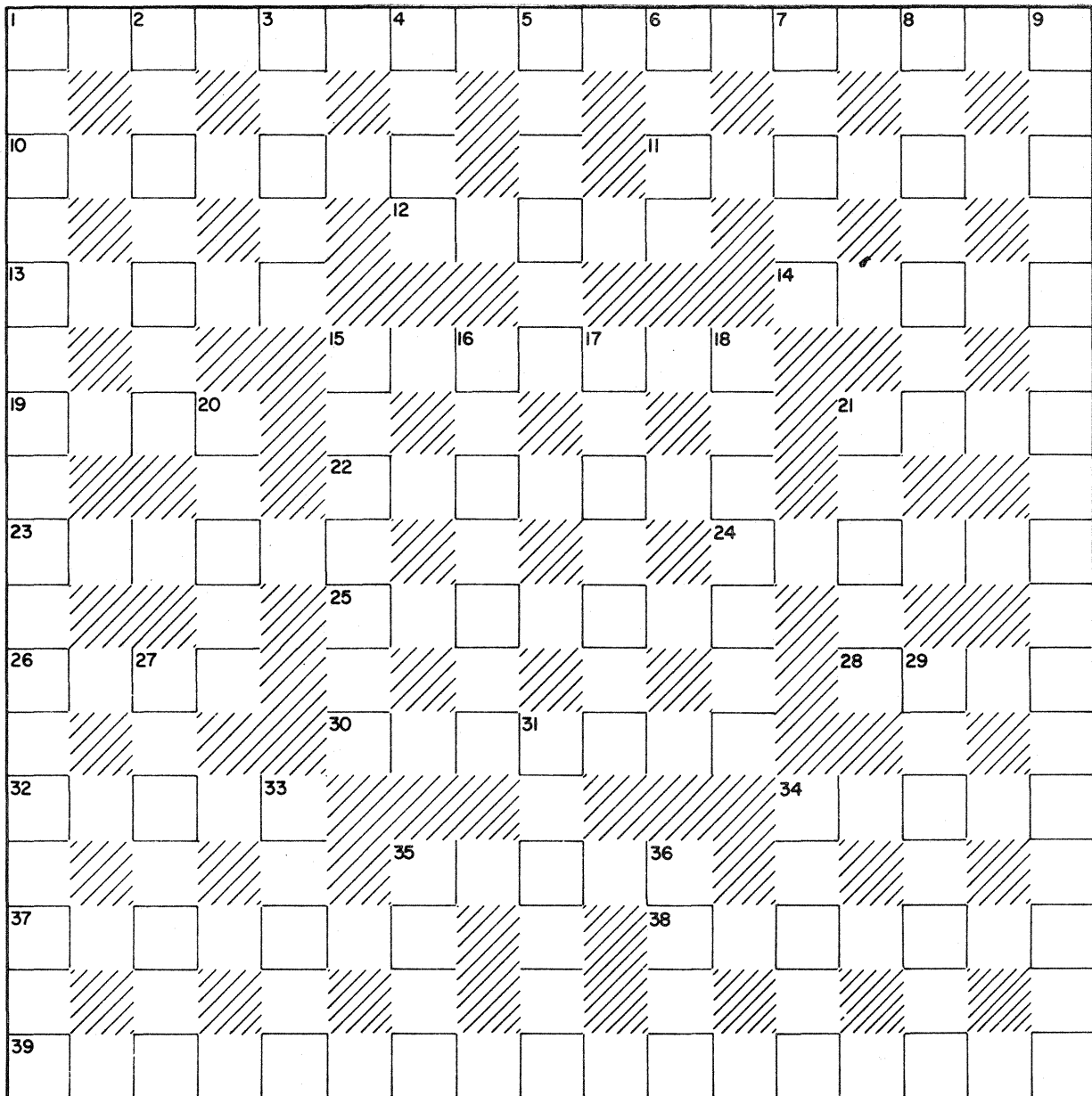
- 1[9,8] Cobras, kraits and rattlers
 10[7] Atoms in a crystal are arranged in a window
 11[7] Curricula
 12[5] Send a payment to reduce disease symptoms
 13[5] American vital power
 14[5] "Junior" is a detached piece of plant
 15[7] Scientists recognize this as a sound unit
 19[4] The most frequent state of a boy
 21[4] Hot and cold fits this clue
 22[7] Genus *Falco*
 23[6] Relating to either of the muscular flaps in front of the teeth
 24[6] To transfer a liquid, take an initial sip — then aspirate on
 25[7] Shorten a structure to cross a river
 26[4] The upper end of a mountain valley cherishes a desire for good
 28[4] One's cards
 30[7] Puts into symbols for economy
 32[5] A theatre for musical contests sounds like a bad state to be in
 34[5] A short physician
 35[5] '
 37[7] A change of momentum
 38[7] A dashing large wing covering
 39[9,8] The function of ductless glands

* clues *

DOWN

- 1[17] A rubbery plastic
 2[7] A whole number
 3[5] *Salix viminalis* makes baskets
 4[4] At an end
 5[6] Norway Lobsters
 6[4] Where dawn approximately is
 7[5] Boulder clays or shales found in stores
 8[7] Charging ready to fire
 9[7,3,7] The theme of Liberal Science courses
 15[7] Reduce in pressure
 16[7] Old heat
 17[7] Thought about with a frown on eggs
 18[7] Diminishes
 20[5] Watered mohair in an interference pattern
 21[5] A helium nucleus begins an alphabet
 27[7] A swimming leg
 29[7] Symbols of medicine
 31[6] A member of the *Icteridae* from Baltimore
 33[5] An acid from an unripe apple
 34[5] Strait across which Brunel built a tubular bridge
 35[4] A Persian fairy begins to surround
 36[4] A famous account of heroic proportions

CRYPTIC CROSSWORD

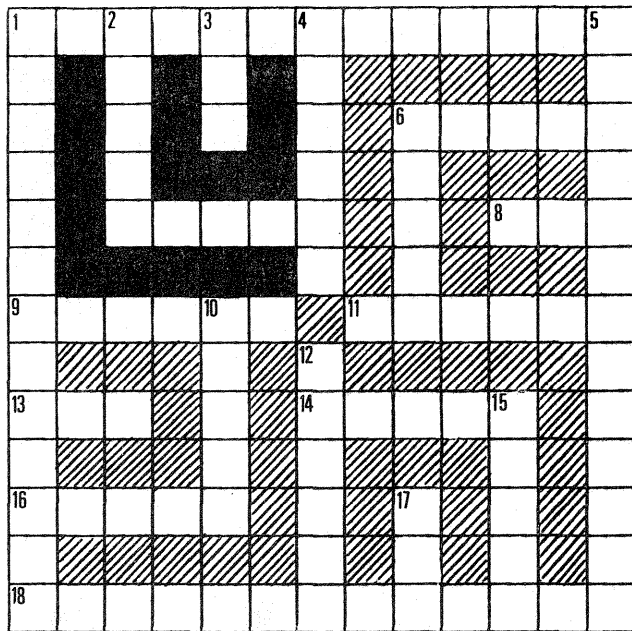


Solution in the next issue

or, in desperation, telephone: 807-345-2121

■ EXT. 529 ■

QUICK CROSSWORD

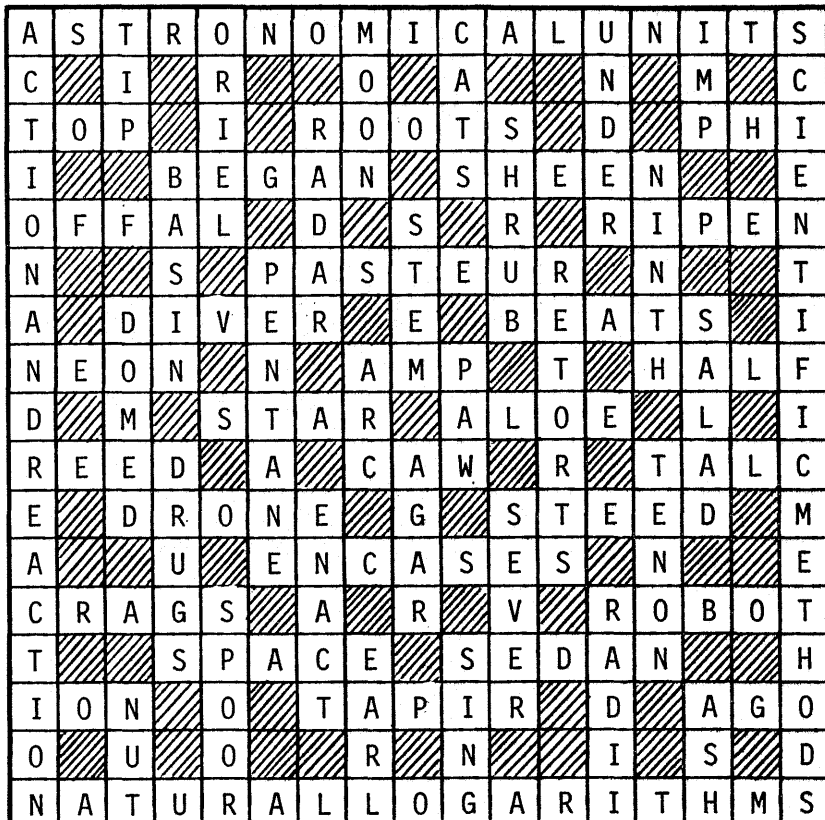


ACROSS

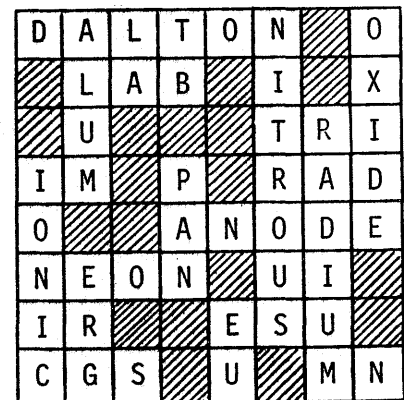
- 1[13] Change of structure
- 6[5] Wooly animals
- 7[5] Fossil resin
- 8[3] Pitch
- 9[6] Metal 27
- 11[6] Purple dye
- 13[3] Snakelike fish
- 14[5] Mexican aboriginal
- 16[5] Castrated bull
- 18[13] Flashes of light

DOWN

- 1[13] "Kissing disease"
- 2[5] Shinbone
- 3[3] One male human
- 4[6] Small explosion
- 5[13] One thing on top of another
- 6[5] Iberian country
- 10[5] Bile-secreting gland
- 12[6] From the centre
- 15[5] Latin early spring flowers
- 17[3] Deoxyribonucleic acid



★ SOLUTIONS ★



If you have enjoyed reading **Caret**, please write to us.

If you have **not** enjoyed reading **Caret**, please write to us.

If you would **like** to contribute an article, please write to us.

If you have any **suggestions** for improvements, please write to us.

"CARET"

Lakehead University
Thunder Bay, Ontario
P7B 5E1

PLEASE LEAVE ME
ABOUT FOR OTHER
STUDENTS TO READ