

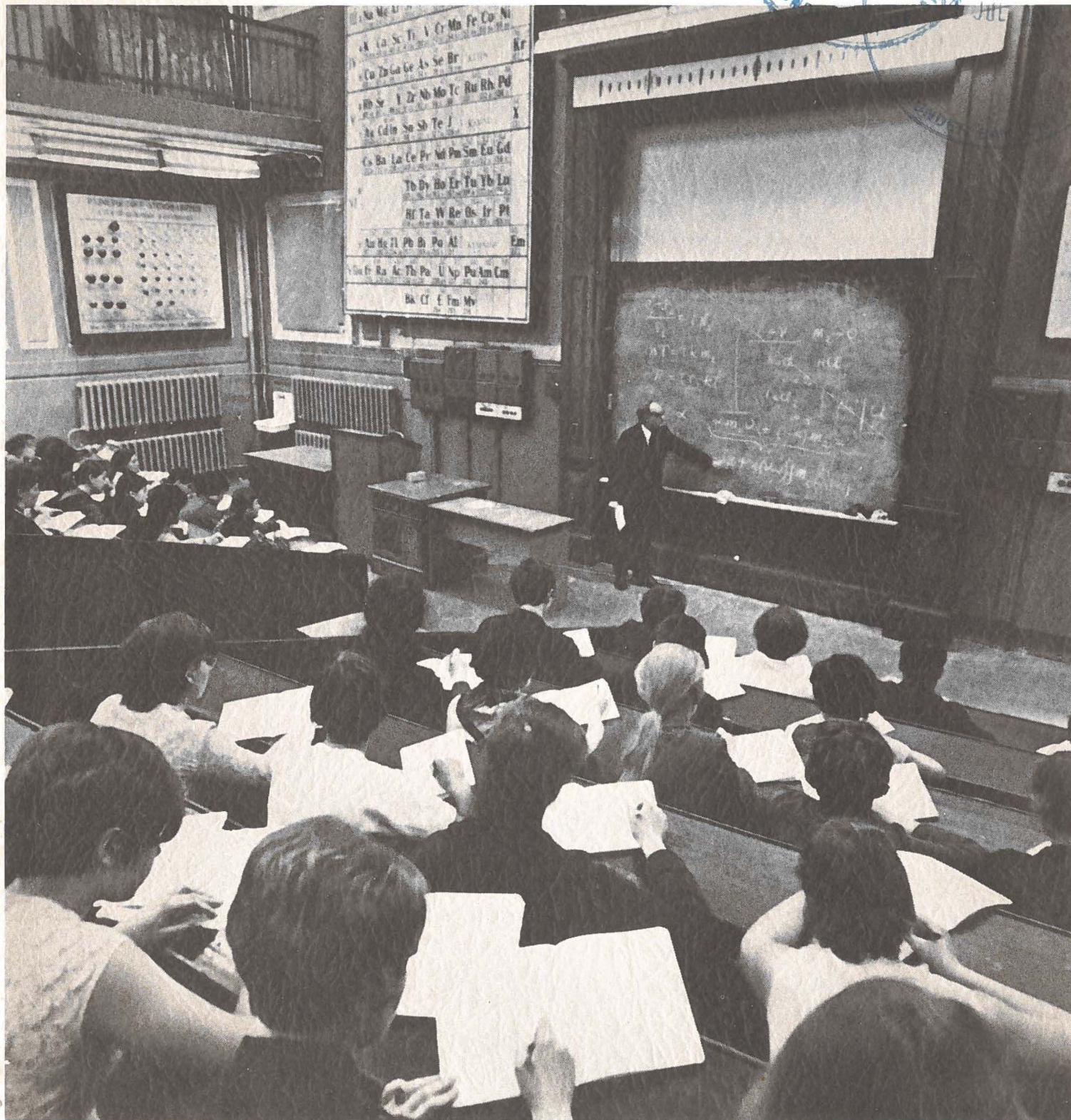
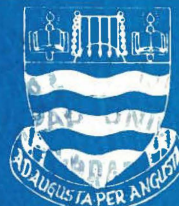
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LAKEHEAD UNIVERSITY SCIENCE REVIEW

VOLUME 1 NUMBER 3

50 cents



INTERNATIONAL

NUMBER

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.

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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.

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EDITORIAL

By Martin Steward

At a time when, to the general public, a period of really dramatic technological advance appears to be coming to an end, it is perhaps unfashionable to try to anticipate the state of our society, say a hundred years from now. This, however, must have been a question in the mind of every scientist during the last year, as the government's views on the sponsorship of scientific research have gradually crystallised through the Rothschild Report and the White Paper, "A Framework for Government Research and Development".

As most scientists are only too uncomfortably aware, there is one major problem inherent in the present system. As far as the government is concerned, scientists involved in pure research are being paid largely to satisfy their own appetites for knowledge of the universe. Apart from unfortunately negligible intellectual value to the public (negligible because of extreme specialisation in many topics, and poor communication between scientists and public), the only real value of such research to the country is the occasional technological innovation which results. As inflation and other short-term problems gradually reduce the available funds, it is only natural for the government to re-examine the system and attempt to improve the efficiency in terms of technological yield. As a result, though, government support for pure research, i.e. that which does not have any technological goal in mind, will have to be severely restricted. This is a logical necessity — however uncomfortable for the pure research scientist. Equally logical is the request that scientists take an active interest in DES* policy, but, if present indications are a reliable guide, such a change of approach will get off to a shaky start amongst our more conservative scientific institutions.

Though a logical necessity, such a system is likely to play havoc with advance in pure Science. A swing away from the idea of technology as a by-product of pure research, towards fundamental advance as a by-product of "R & D" is almost inevitable. Indeed, it is impossible to see the country's scientists satisfied with such a system.

Would it not be more realistic for the government to continue to sponsor research in such fundamental subjects in the universities as part of general educational policy, and encourage the more "useful" fields to follow the example of the Pasteur Institute in Paris, and take immediate advantage of their practical applications? At the beginning of this year, the Pasteur, France's outstanding institute for fundamental biological and medical research, founded its own wholly-owned limited pharmaceutical company, whose total profits will pass directly to pure research. As this example demonstrates, it requires the initiative of scientists alone to spark off such a venture, and clearly it is *their* responsibility to attempt this and, in doing so, help the country to maintain work in the less technologically useful fundamental sciences that are really the vital inspiration behind all scientific research and for which we have such a high reputation.

*Department of Education and Science.

This article first appeared in ENQUIRY 1973, the Science Journal of the Harrow County School for Boys. Martin Steward won an Open Scholarship to read Natural Sciences at Christ's College, Cambridge and is now studying there.

It has been slightly abridged.

LETTERS TO THE EDITOR

I thoroughly enjoyed the magazine and think it would be very useful in the library.

Please let me know the cost of a yearly subscription.

P. Backer, Librarian
Hanmer Secondary School
Hanmer, Ontario ■

The publication of CARET (Vol. 1, No. 2) should delight our students and teachers.

We appreciate the complimentary copy mailed to Campanile Library and feel we have something really worthwhile to call to the attention of the science teachers.

(Sister) Evelyn Beerepoot
Librarian
Campanile - Notre Dame
Ottawa, Ontario ■

We, the staff and students of the Sheridan Technical School appreciated receiving your complimentary copy of CARET. It is a welcome addition to our library.

Thank you.

V. McDougall
Teacher-Librarian
Sudbury High School
Sudbury, Ontario ■

Thank you very much for the two copies of CARET.

To enable as many students as possible to have access to these science reviews, we have put cards and pockets in them, and let them out on an overnight basis.

These publications are indeed a welcome addition to our library.

Vera M. M. Watt, Librarian
West Ferris Secondary School
North Bay, Ontario ■

Thank you very much for the complimentary copy of the Lakehead publication CARET. As suggested, we will see that it is left about for others to read. Future copies will also be appreciated.

John Cozzi, Librarian
Midland Avenue Collegiate
Institute
Scarborough, Ontario ■

I have just returned home and have had an opportunity to look at the new publication CARET. I found it very interesting reading and, while there was a good deal of it I did not understand particularly because I am not able to live up to Jim Widdop's calculations, I did enjoy the whole thing.

I think you are to be congratulated.

With kindest personal regards, I am,

R. J. Flatt
Thunder Bay, Ontario ■

Thanks very kindly for sending me a copy of CARET, the Lakehead University Science Review.

Although not a scientist myself, I gave the magazine a careful look and found several of its articles most interesting. I am particularly delighted that you are printing articles not only from within the University itself, but also from people outside the University. I think this is a very valuable contribution to the development of ideas in Northwestern Ontario.

James F. Foulds
MPP for Port Arthur
New Democratic Party ■

The information on the colourful "Outer Space" insert in the second issue of CARET needs amendment and correction:

[1] Mercury's "rotation" should read

59 days (1965).

[2] Venus rotation 243 days retrograde (1961).

[3] "Space ship time schedule". The times are based on a speed of 25,000 m.p.h. without considering the time taken to accelerate to that speed or the time to deaccelerate and match velocities with that particular planet. Trajectories in the solar system are approximately sections of elliptical orbits and not straight lines. For minimum energy requirements, we have:

LEAVING EARTH FOR	TIME IN YEARS	VELOCITY REQUIRED MPH
Venus	2.08	5,000
Mars	2.66	6,000
Mercury	0.76	15,000
Jupiter	6.05	18,000
Saturn	13.03	20,000
Uranus	33.01	22,000
Neptune	62.01	23,000
Pluto	91.00	24,000

J. S. Griffith
Mathematical-Sciences Department
Lakehead University ■

Thank you for sending two copies of CARET, Vol. 1, No. 2, for use in our school library.

The articles will be especially valuable to the teachers and to the Grade XIII students who are interested in careers at this stage of their education.

Thanking you again and wishing you success in this worthwhile undertaking, I am,

A 1969 Lakehead University
Graduate,

Sister M. Andrea
St. Joseph's College
North Bay, Ontario ■

WE ARE ALWAYS GLAD TO HEAR
FROM OUR READERS!

- Editor

FIBRE - THE NEGLECTED FACTOR IN FOOD

AMONG ALL THE RESEARCH THAT HAS BEEN DONE ON FOOD IN ATTEMPTS TO DISCOVER AN ADEQUATE DIET, ONE ELEMENT HAS BEEN, UNTIL RECENTLY, COMPLETELY IGNORED: FIBRE. THIS HAS BEEN REGARDED AS A CONTAMINANT, TO BE REMOVED WHEREVER POSSIBLE. NOW, IT IS REALIZED THAT A NUMBER OF DISEASES SUFFERED BY LARGE NUMBERS OF PEOPLE IN THE "WESTERN CIVILIZED" PARTS OF THE WORLD ARE DUE TO THE REMOVAL OF THE HUSKS OF FOOD, PARTICULARLY WHEAT.

Endless studies have been under taken to determine the amounts of different food constituents required for the maintenance of health. From time to time, hitherto unrecognized requirements have come to light, adding to the list of substances considered necessary for normal body metabolism. But in spite of this search for a totally adequate diet, one of the major elements of all plant foods, consumed in large quantities by nearly all human races and by all but solely carnivorous animals, has been almost totally neglected: the fibre, regarded virtually as a dietary contaminant and consequently removed and discarded.

Because it is largely unabsorbed from the intestine and so contributes little to nutrition, the fibre has been considered dispensable and has barely, if at all, been alluded to in standard text books on nutrition. Stockbreeders have appreciated its contribution to animal health, whereas physicians and nutritionists have almost totally discounted any role it may play in the human context.

Now, we are gradually realizing that this 'Cinderella' of dietics deserves promotion to the prominent role for which it was destined, as in the case of the fairytale princess.

- Denis P. Burkitt, MD, Dsc (hons),
FRCS, FRS,
Medical Research Council, London.

THE UNIVERSITY SCIENCE SQUAD

By A. W. Kruijschoop

INTERACTION BETWEEN HIGH SCHOOL AND UNIVERSITY STUDENTS

The University of Papua and New Guinea, established in Port Moresby in 1966, now has 1500 students from all over the South Pacific studying the normal range of subjects in all Faculties in a modern, well-equipped and adequately staffed institution.

Secondary education in this country is quite a different chapter. The High School system is expanding rapidly and experiences growth pains, despite good efforts by the Government and Church Missions. The High School teacher may find himself presented with large classes, a lack of suitable textbooks, domestic and administrative duties, his own duplicating jobs and often incomplete laboratory equipment.

The basic High School takes four years, but a number of schools are now being converted into Senior High Schools with a six-year programme. Biology, chemistry, geology and physics are taught as parts of an integrated science course, developed in Papua New Guinea in 1970-71. This course is based on experiments done by students in small groups followed by classroom discussion with the more difficult or dangerous experiments done as demonstrations by the teacher. In more advanced courses much material will have to be presented on the blackboard or straight from books because equipment is not available or because the teacher simply cannot afford to spend days of his time preparing a few specialized lessons.

We in the University felt that by using our expertise and equipment it should be possible to give more High School students an opportunity to observe new and interesting phenomena and to actually perform certain crucial

experiments. With sufficient student support (100% voluntary, no credits or exemptions) we could try to bring a few 'morale boosting working sessions' to schools with road access to Port Moresby.

THE UNIVERSITY SCIENCE SQUAD

In August, 1972 the University Science Squad was formed with 25 students and 3 staff members from the Science Faculty. With each new semester there are a few changes in the participating student groups. We set out to prepare a range of two hour experimental programmes suitable for Form III and IV High School students.

The student members organized themselves into working groups: Microbiology, Electricity and Chemistry of the Elements (groups on Mechanics and Geology are projected). Within each group, long discussions took place to draft demonstration outlines and to work out the technical details. Most work was done during weekends and the mid-semester study breaks. Two experienced High School teachers, one from a Government school and one from a Catholic Mission School, took an active interest in the development of the Science Squad. They attended meetings at the University, described their own curriculum and the difficulties they experienced. It was recognized that the demonstrations would be most meaningful if they were related to the school's current science programme and if the level of complexity was the same or only slightly higher than that of normal teaching.

Over the past year three Science Squads have now made visits to High Schools in the Port Moresby area. In each case, six to eight University students set up experiments in one or two High School classrooms.

The teacher divided his class into groups of four to seven students and these small groups then circulated. Each University student acted as a specialized "guidance officer" for one or more experiments but the High School students were encouraged to do all assembling, manipulation, instrument reading, microscope work and calculations.

It was important that students were left to work out the experiments at their own pace without interference or even observation by teachers. They developed interest and initiative and during all visits continued working in a playful but concentrated atmosphere for at least an hour longer than was planned, i.e. outside the normal school hours. Another feature was the degree of participation and small group leadership of the girl students at some of the schools visited.

BRIDGING THE GAP

The advantages of University students and High School students getting together to do and talk about Science are clear. The University students renew links with the schools, gain experience in an informal teaching situation and confidence in their scientific understanding. The High School students see students a few years older than themselves involved with and enjoying Science.

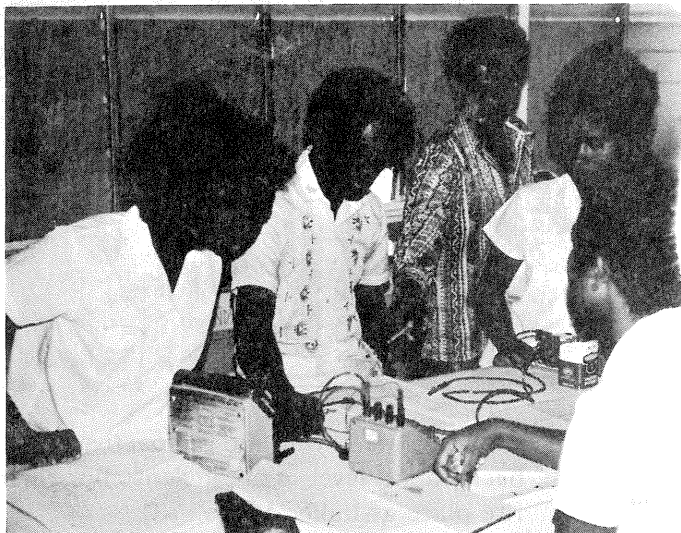
Maybe this idea of (privileged!) University students giving fresh inspiration and assistance to schools on a voluntary basis is worth serious consideration "back home" in (over-) developed countries as well?

The University of Papua and New Guinea in Port Moresby is an extraordinary undertaking, sponsored by the Government of

Australia. In some ways, the situation is not unlike that of Lakehead University. The Port Moresby University serves a large area of inhospitable terrain, populated by people with a wide diversity of ethnic and cultural characteristics. The University is relatively new, and is still searching out ways of serving its community.

Dr. Kruijshoop has been associated with innovative ideas from the outset, including some ambitious programmes to educate the native peoples with "crash" techniques. The University is a going cultural concern: with the coming of independence, it will be a very influential force in shaping the future of this colourful Nation. □

A QUIET PROPULSION UNIT - THE OTTAWA JOURNAL OF JANUARY 12, 1974 REPORTED THAT HPL ENGINEERING OF OTTAWA WILL TEST THE MARKET IN OTTAWA AND THE SURROUNDING AREA THIS SPRING WITH A NEW AIR DRIVE UNIT FOR BOATS, SNOW PLANES AND LIGHT HOVERCRAFT THAT IT HAS DEVELOPED. RESEARCH ENGINEER T. APPARAO SAYS THAT THE QT-30 AIR DRIVE IS THE RESULT OF YEARS OF RESEARCH AND DEVELOPMENT AT HPL WHICH WAS BACKED BY THE NATIONAL RESEARCH COUNCIL AND MHV INDUSTRIES. HE DESCRIBED THE QT-30 AS A "COMPACT, SIMPLE OUTBOARD PROPULSION UNIT THAT ALLOWS BOATS TO BE OPERATED IN INCHES OF WATER!" IT USES AN AIR DRIVE OR "OUTBOARD MOTOR WITH AN AIR PROPELLOR AND LIGHT-WEIGHT TWO CYLINDER AIR COOLED ENGINE" THE "QUIET THRUST PACKAGE" CAN BE USED SINGLY OR IN PAIRS; IT IS BOLTED ONTO A PLATFORM OR FRAME ON THE CRAFT. THE QT-30 WAS ORIGINALLY DEVELOPED FOR THE SPECTRA II HOVERCRAFT OF MHV INDUSTRIES. □

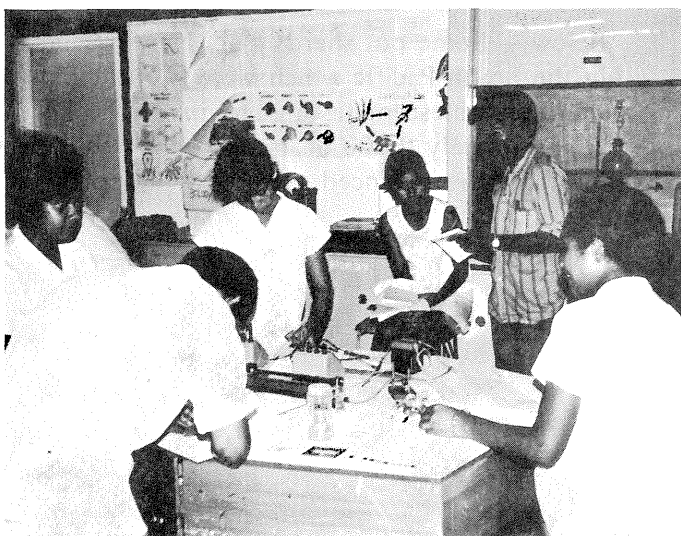


*"instrument reading, microscope work
and calculations."*

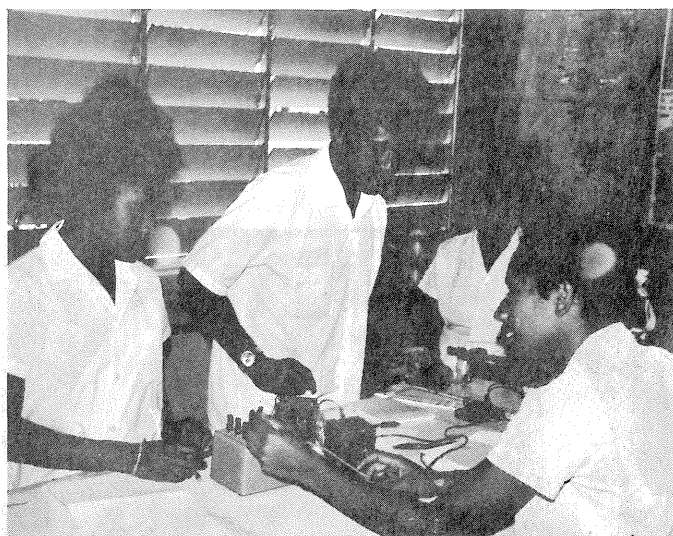


*"getting together to do and talk
about science . . . "*

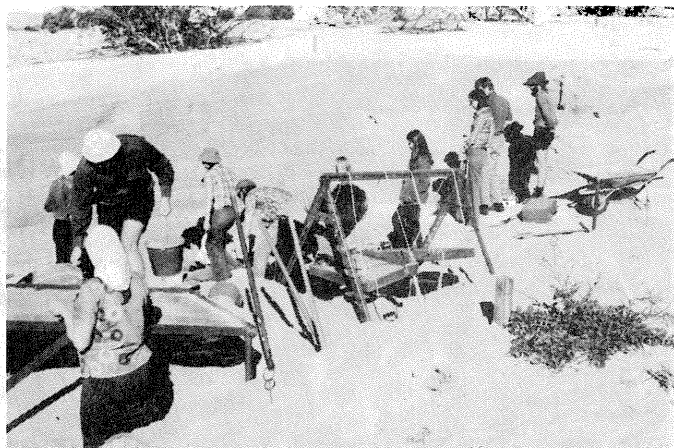
THE UNIVERSITY SCIENCE SQUAD IN DIVERS ACTIVITIES



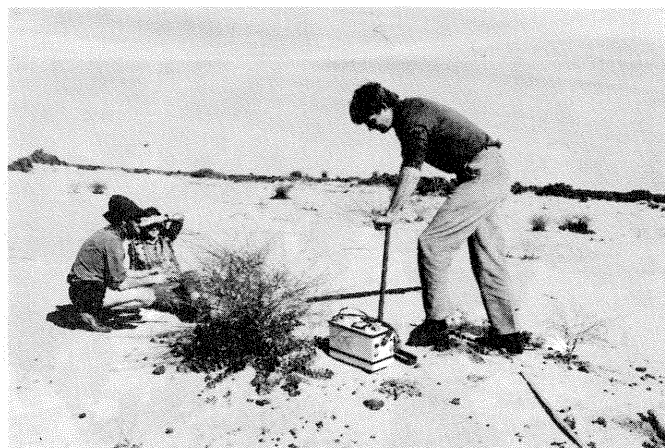
*"experiments done by students in
small groups . . . "*



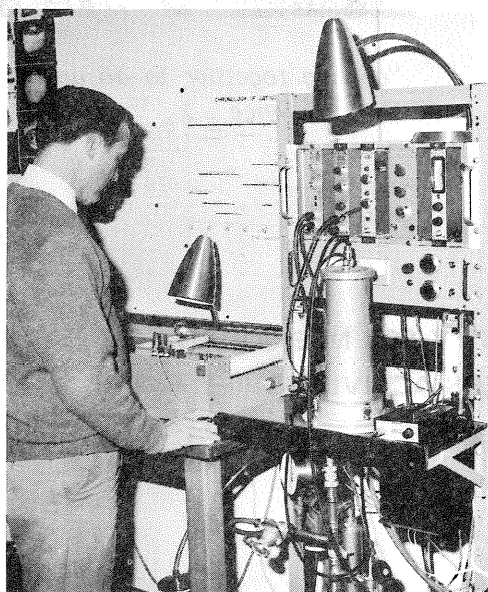
"participation of the girl students . . . "



Above — Archaeological dig in progress at Lake Mungo, New South Wales.

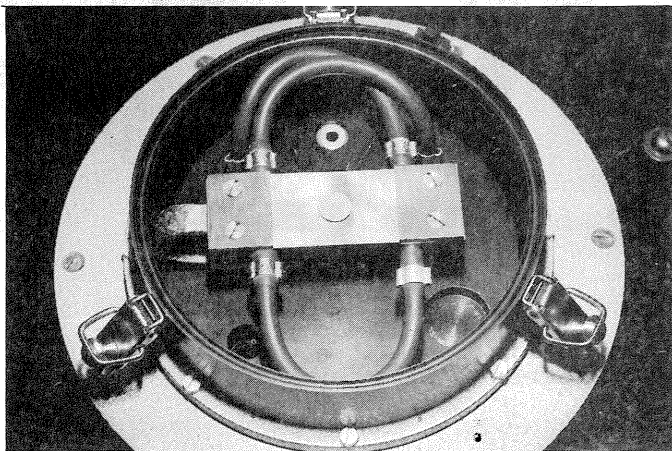


Above — Measuring the radioactive background level in an ancient aboriginal fire place at Lake Mungo.

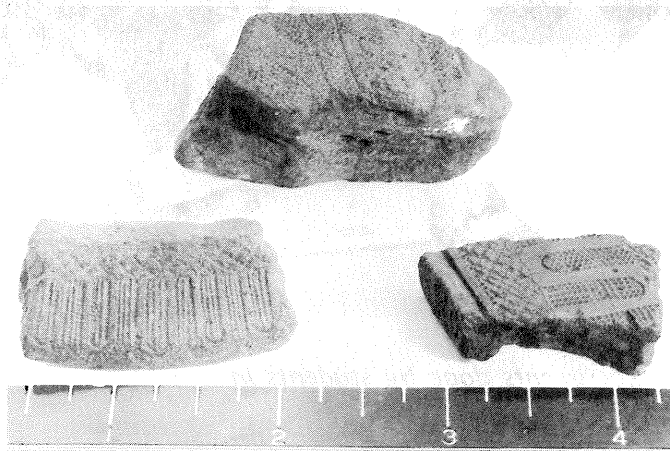


Dr. Mortlock with one of the sets of thermoluminescent dating apparatus in the Physics Department at the Australian National University in Canberra. The cylindrical glow oven is in the centre and the XY recorder on the bench at the left.

Below — A disc covered with fine quartz grains from the object under test positioned on the heating strip inside the glow oven.



Below — Some pot sherds from New Ireland in the South Pacific which were subject to thermoluminescent testing and proved to be approximately 2,000 years old. The decoration indicates the advanced culture of the potters.



ARCHAEOLOGICAL DATING IN AUSTRALIA

By A. J. Mortlock

SETTING THE SCENE

Lake Mungo is an ancient dried up lake located in New South Wales about 70 miles from Mildura and 80 miles from Balranald. It is reachable from either one of these centres by car although the red sand country roads involved would be difficult after heavy rain. As the Lake is part of private land holdings, permission to visit needs to be sought from the graziers of either nearby Joulini or Mungo Stations.

Lake Mungo is roughly five miles in diameter with a long sand dune thirty or more feet high running around about half of its circumference on its eastern side. This dune, called the Walls of China, was perhaps fifteen feet higher in ancient times and was used by the aborigines as a place to live when the Lake was full. Erosion of this dune by wind and rain has exposed a remarkable density of aboriginal artefacts in the form of fire places, a cremation site, hand tools, etc. Studies of these artefacts have indicated that the aborigines were in the area as long ago as 30,000 years B.C. and probably longer. Archaeologically, therefore, this site is of great importance because it represents the earliest proven presence of man in Australia.

Our visit was made in a small party complete with two excited school children to coincide with a large scale excavation investigation of the dune by Professor J. Mulvaney. After a long high-speed drive across the Hay Plain we arrived at Mildura which we planned to use as a centre. The next day we set out for Lake Mungo and, after some back tracking near the end of our journey, located the main party at the southern end of the Walls of China.

What a fascinating sight it was! The near-white sand of the dune stretched around and into the far distance encircling the vast utterly

flat green floor of the Lake. Dotted along the dune were small areas of uneroded soil standing proud of the surface by a few feet, rather like a toy version of the rock pinnacles of Monument Valley in Arizona. Here and there were the remains of ancient fire places in the form of localised collections of blackened residues. These also could be raised up relative to the surrounding sand due probably to the hardening action of the original heating. Underfoot were the shaped stone tools and shell fish used and eaten by the original residents.

THERMOLUMINESCENT DATING

We unloaded our car and joined Professor Mulvaney's group to view the way modern archaeological excavation proceeds. A mechanical shovel had produced a wide trench across the dune by removing some five feet or so of over-burden and hand work with brushes and small shovels had taken the excavation down to lower levels and thereby to earlier times: the search was on for Mungo Man. We, ourselves, got out our radioactivity measuring equipment to test background levels in the ancient fire places. These determinations are part of our thermoluminescent dating studies in this area. The technique is new, absolute, and particularly applicable to fired ceramics or baked mud from old fire places. In this way, we busied ourselves during our stay, talking with the archaeologists about the new dating technique. Although scientists themselves, they seemed fascinated by the ticking of the register on the portable monitor.

The continuing feeling one has while one is there, however, is the eerie connection the place has with the undisturbed and distant past. This feeling is added to by the vastness of the scene, the quietness, and the apparent lack of human habitation. One thinks of those long

ago black fellows sitting by the edge of this large isolated lake and wonders what thoughts they had about the sun and the night sky above. A dream time to be sure in a place of dreams.

ARCHAEOLOGICAL DATING USING THERMOLUMINESCENCE

The application of the phenomenon of thermoluminescence to the dating of ceramic objects is a relatively new technique which is gaining in popularity because of its absolute nature and the apparent ease with which results can be obtained. In actual fact it is not nearly so easy as it first appears, and great care has to be exercised to avoid misinterpreting the data and producing wrong answers.

Thermoluminescence or TL is the light given off when a body is heated due to the dissipation of stored internal energy. Black-body radiation accompanies this TL radiation but is distinct from it: black-body radiation is always present, but the TL radiation may be "glowed out" during the first heating.

The energy storage process which is of interest to us here is due to the presence of small amounts of radioactive impurities in the fabric of the ceramic object. The particular isotopes involved are U-238, Th-232 and K-40. Because the half-lives are long ($\sim 10^9$ years) the fabric of the material receives a constant dose rate due to their presence. This radiation ionizes the constituent mineral atoms. The resulting electrons can become trapped at other defect centres. Some of these are deep enough for there to be negligible leakage from them over archaeological times. However, on heating, these traps are emptied and TL radiation produced. The wavelength of this for quartz is $\sim 4,200 \text{ \AA}$.

When the ceramic object is first fired during manufacture, the traps are emptied. Over archaeological

times they slowly fill until a second (laboratory) firing empties them again. The strength of the associated TL signal is proportional to the rate at which the electrons are emptied out of the traps. By keeping the laboratory heating rate fixed, intercomparison of TL signals can be made.

STANDARDIZATION BY ARTIFICIAL IRRADIATION

The propensity of various materials for the production of TL varies. For this reason, samples have to be irradiated with artificial isotopes to measure this propensity. We then have a simple equation based on proportions leading us to the age of the object:

$$\frac{\text{NATURAL TL}}{\text{NATURAL DOSE}} = \frac{\text{ARTIFICIAL TL}}{\text{ARTIFICIAL DOSE}}$$

but

$$\text{NATURAL DOSE} = \text{AGE} \times (\text{ANNUAL DOSE RATE})$$

thus

$$\text{AGE} = \frac{\text{ARTIFICIAL DOSE}}{\text{ARTIFICIAL TL}} \cdot \frac{\text{NATURAL TL}}{\text{ANNUAL DOSE RATE}}$$

The annual dose rate, which should be measured for each object, includes contributions from not only the object itself but from the surrounding soil (if it has been buried) and cosmic rays. It is roughly 0.5 rads/yr . Determination of this rate is perhaps the most time consuming part of the dating procedure.

THE DETAILS

The details of the application of the technique are worthwhile describing. In the case of the dating of an art object such as a small figure, samples suitable for testing are obtained by drilling two small holes in an inconspicuous part of the object, for example, the base. The drilling operation

provides a powder which contains small quartz crystals in which most of the TL energy is stored. In what is known as the fine grain technique, crystals in the size range 1 to 8 μm are selected by an in-liquid settling procedure and deposited on small aluminum discs. These discs are then placed in turn on a heating strip in what is known as a glow oven. Each disc is then heated in a highly pure nitrogen gas atmosphere and the light given off picked up by a very sensitive phototube. The output from this is fed to the Y-axis of an XY recorder, the X-axis being fed with the temperature data as it rises at the rate of 20°C per second to about 500°C.

APPLICATIONS

One of the simplest applications of the technique is to the authenticity testing of ceramic art objects. As all that is generally required is to tell whether the object is young or old, it is usually not necessary to measure the radioactive impurity content: this can be safely assumed. Fakes can be easily detected in this way and it is becoming increasingly common for dealers in expensive art ware of this type to state that a particular object which is for sale has been authenticated by the technique. There are an amazing number of fakes about, as approximately 50% of the suspect objects submitted for test turn out to be young.

Other applications relate to archaeology and, in the case of the Canberra Unit, to the testing of artefacts from around the Pacific Basin and Southeast Asia where the written history is virtually absent.

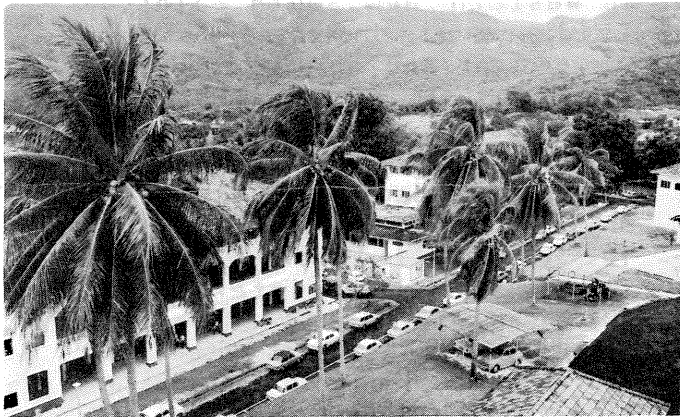
The archaeology of Australia is beginning to benefit from the technique as it is applicable to the baked hearth mud from aboriginal fire places. The earliest signs of man in Australia are at Lake Mungo

in Western New South Wales. Evidence here indicates that he was present and able to make and use hand tools more than 32,000 years ago.

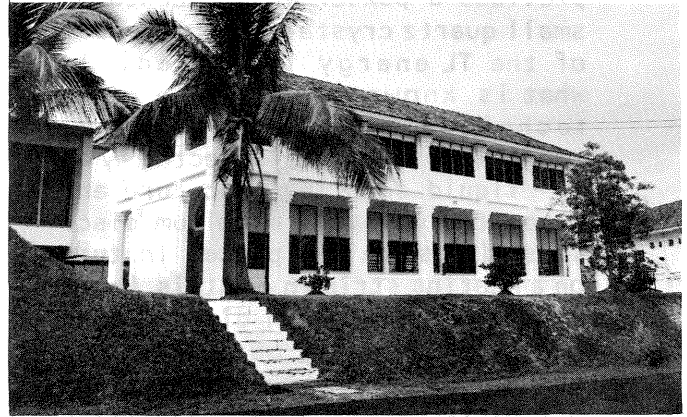
Generally speaking, TL-testing has been applied with success to objects ranging in age from 20 to 10^5 – 10^6 years. It is being extended to new materials of interest to the earth scientists as well as to old bones! These new materials represent challenges in the separation of wanted from spurious TL signals and also in specimen preparation.

■ *Dr. Mortlock is a member of the Department of Physics of the Australian National University at Canberra. He has had a life-time of experience in the measurement of low levels of radiation activity; and his recent excursion into the dating of ceramics will, as his article implies, have profound effects on the Australian archaeological scene.* ■

FOSSIL FISH FOUND BY OIL RIG: A 60 million year old fossil, 3 inches (8 cm) long is a species of smelt thought to be new to scientists. It was recently located in a Tertiary formation 2135 m below the seabed of the North Sea during exploratory drilling in the famous Forties oil-field. Geologists working for British Petroleum recovered the fossil smelt from a core sample made from the *Sea Quest* drilling platform which stands well out in deep water. The smelt probably choked to death swallowing head-first an eel-like fish. The fossil has been sent to the Natural History Museum in London which possesses one of the finest fossil collections in the world, and which has not so far found the primordial smelt's parallel. Its bone structure is being given special study. ●



A general view

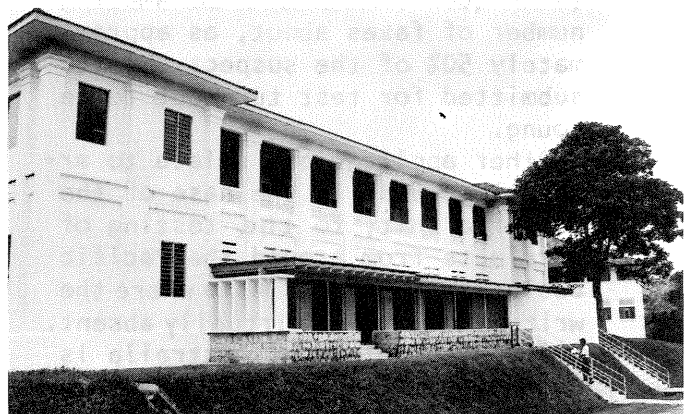


The Bursary

**THE UNIVERSITY
OF
SCIENCE OF MALAYSIA
IN PENANG**



The Chancellory



The Registry

SCIENCE WITHOUT ELECTIVES

By R. J. Julian

CAN THE QUESTION BE ANSWERED?

I have made the title of this paper a question. If I had written the title out, it would have been too long. It should read like this: *Should Science Majors only take courses in their field or should they take courses outside their field to become 'well rounded' students?*

There probably is no answer to this question, but we can look at some of the arguments and some of the advantages of the two different schools of thought. We can first consider that "streaming" the students provides them with more time to work on their major field. (In this paper we will not consider the question as to how much material an undergraduate should cover in his quest for a degree.) The argument is that a student can be more broadly educated in his major field. This means a student not only gets what is considered a "basic programme", but he reaches further into his field and becomes more useful.

The second argument is that a student can achieve his goal in a shorter period of time. He does not have to "waste time" on subjects that are not related to his programme.

EDUCATION AFTER THE DEGREE

The arguments above are very true but we can counter them with some very good arguments. Let us ask the question, "How much of a degree programme is actually used by a graduate?" Most industrialists feel that in receiving a degree, a student has proven that he can be educated. Industry then provides the training ground for him to become educated. If we were to

educate a student to fit into all situations after graduation, it would take many, many years. This is not a student who will be productive; just one to fit into a situation. To make a person productive, an industry plans on a six month to two year training period. In this time, he is not being utilized on only one concept. He is usually sent from section to section to become familiar with the entire system.

We can go one step further and consider a move to another industry that is related. The systems may be the same but the processes will surely be different. Again, there is a training period involved to make the new employee fit into the new system. If related industries feel the need for specialized training, how can a university produce the broad training needed to fill all the needs of a graduate?

If we accept this argument, then the university education should consist of a "basic programme" that lays the ground work for further education. We can argue that this is a foundation on which all other knowledge is an extension. The basic programme is still undefined, but let us say that the solution of one problem usually leads to the solution of another more complicated problem. I am not advocating a university that does problem-solving. It is the technique in solving a problem that is important. A student must be schooled in how to find this technique and then how to apply it to various problems. When he has mastered this art, he will be considered capable of being trainable in many areas of his field.

THE EXPANDING MIND

Now let us consider the "wasted

time" on unwanted subjects. A person must have contact with the outside world. He cannot close himself in a shell made up of his major field. Basically, he must meet and communicate with other people. The world is becoming smaller and a person no longer lives in his own little community without outside contact.

If you have never been exposed to the world at large, you cannot communicate with others. Educational material outside a student's field of study will prepare him to be able to communicate. Again, if we accept this argument, we cannot say that it is "wasted time" to take courses outside a major field.

In conclusion, both sides of the story have a good case. It probably depends on one's background as to which one will accept as the best solution. Maybe a middle-of-the-road solution would benefit the students the most. After all, this is what education is all about.

Dr. R. J. Julian is a graduate of the Arizona State University, where he was awarded a Doctorate for his work on shock waves. He has worked on several NASA projects, including digital command systems. He has been a Senior Lecturer at the University of Science, Malaysia since 1971, and has been responsible for many innovations in that relatively new university. □

■ MANAGING NOISE POLLUTION ■

BY ANGELA CROOME

The international value of noise research under Dr. D.W. Robinson, at the National Physical Laboratory near London Airport, has come into particular prominence lately. The endeavours to achieve an acceptable noise level for cars and lorries and to introduce standards for busy

airports is being tackled on a world-wide basis.

One branch of the NPL noise research relates to the measurement of airport noise so that meaningful standards may be produced for the allowable in that aircraft engines may make on take-off and landing. This is when they cause the maximum disturbance to the community. Whether it is a fine or a wet day makes more difference to the propagation of noise and, therefore, to people's perception than a few decibels more or less in the absolute noise level of a jet engine. The same sort of factors apply to the propagation of motorway noise to nearby houses. Distance away and noise level are not of governing importance; a cornfield in front of the house (which tends to break up and absorb the frequencies), and garages in the gaps between houses (which reflect the sound back), have a decisive influence. Reliable prediction of what the noise burden on people will be is the overriding requirement.

NPL work has now produced a Noise Pollution Level Index (the initials quaintly come out NPL!) which relates the physical description of different noise environments to the subjective reaction of people. It makes possible the prediction of noise nuisance and the reaction to it without, for instance, having to build an airport handling a jumbo jet a minute to find out what the neighbours will think.

▷ Noise pollution had low priority at the UN Environment Conference at Stockholm. In world terms, there were more urgent considerations to be tackled by the international delegates. Nonetheless noise nuisance is an increasing problem with a number of international aspects. Work on the complex character of noise is continuing. ◁

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BIOMECHANICS – YOGAMECHANICS

By B. R. Seth

Rapid advances in cybernetics, information theory and servomechanism are now making it possible to study the most perfect machine in the world, called the human body. The problem is to be tackled by rheologists, physicists, psychologists, anthropologists, etc. It is, therefore, high time that at conferences of scientists we pay some attention to Yoga Mechanics whose fragrance seems to have spread all over the world. This will involve both the macro and micro fields and their interactions. The impact of strong impulses on the senses and the reaction of the brain centres can form the subject matter of many good Ph.D. theses.

Yoga talk has become a fashion all over the world. Its physical and mental benefits are being advertised and presented in a mystic atmosphere. To become scientific and available to all, it should be developed as a controlled discipline. Its study is to be objective and experiments are to be conducted on the body itself. All modern electronic techniques will be necessary. The corrosive effect of anger and passion impulses, the retardation due to frustration forces, the exhilaration resulting from success and appreciation, all need quantitative measurement. A number of cycles with definite centres exist in the body. Their study involves problems of system dynamics and can bring about appreciable harmony and synthesis in human relationships. Man is being pounded with all types of forces incessantly, resulting in internal conflict, which only a scientific study can resolve. The human body is to become a more important laboratory than Skylab and the thought-waves investigated can have a velocity greater than that of light. Is it not very exciting to know that the Conscious Energy in the body is out to control the Universe?

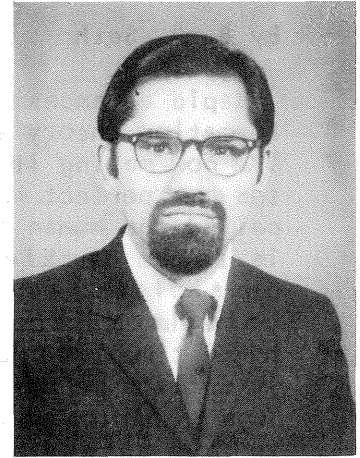
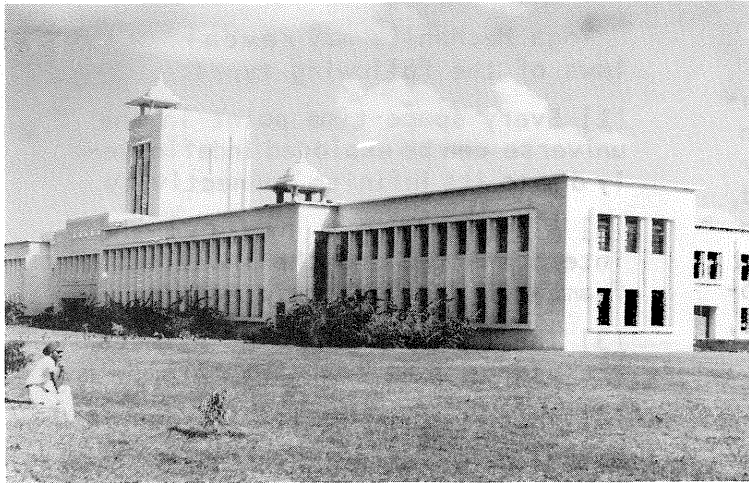
Yoga Mechanics may reveal new laws of the following types:

- [1] Every space-time point in the universe can be explored indefinitely due to its infinite connectivity.
- [2] All events are neutral and interconnected and the individual framework decides their nature.
- [3] The force of hatred affects the source more than its target.
- [4] Each event is the result of global optimization by Nature.

■ *The Editor met Dr. Seth on an Air India Viscount en route from Calcutta to Dibrugarh, a university town at the eastern extremity of the beautiful tea-growing Province of Assam. It was not until we were nearly at the gates of the University that Dr. Seth let drop the fact that he was indeed the Vice-Chancellor. He has since left to take on the Directorship of The Birla Institute where he is responsible for charting the course of research in applied science which is so necessary for the development of India. Dr. Seth is a charming gentleman, a highly respected mathematician, and a skilled administrator. As his article demonstrates, he is greatly concerned with the relationship between Eastern and Western philosophies: we should listen carefully to what he has to say, for he has much to teach us.* ■

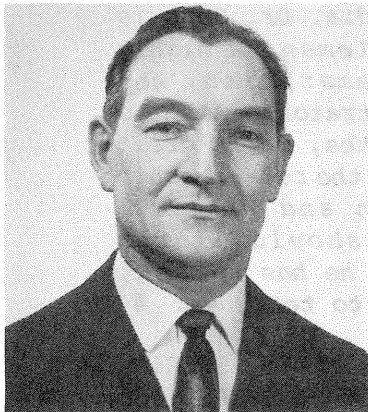
"GOVERNMENT DEPARTMENTS, SPECIAL ADMINISTRATIVE AREAS, UNIVERSITIES, GROUPS OF UNIVERSITIES AND INDUSTRIAL CORPORATIONS ALL CONSTITUTE ORGANIZATIONAL COLLECTIVITIES WHICH MUST BEGIN TO COMMUNICATE ABOUT MATTERS OF SCIENCE AND SECTORAL PARTICIPATION. IT WILL INVARIABLY BE A PROCESS BASED ON PERSUASION, NEGOTIATION AND TIME-CONSUMING FRUSTRATIONS."

— G. Bruce Doern.



The Birla Institute of Technology.
*"Yoga talk has become a fashion
 all over the world . . ."*

Dr. Khanna
*"increasing lawlessness and disorder
 in the universe."*



Mr. Bobrov
*"the planning of the national economic
 development should proceed from the
 outline of future scientific and tech-
 nological progress."*



Graham Chandler
"my actual job is a mixture of things . . ."

THE ENERGY DILEMMA

By G-A. Grin

ELECTRICITY AND WELL-BEING

It becomes more and more apparent that providing Switzerland with sufficient electric energy could prove to be one of the serious problems of the next decade. The importance of an adequate energy supply can certainly not be minimized when, in large part, the socio-economic well-being of the country is at stake.

SWISS REALISTS VERSUS IDEALISTS

As elsewhere, the question has degenerated into a confrontation between, schematically speaking, two categories of human beings: on the one hand, the "realists" — or those whose foremost concern is with the near future; on the other, the "idealists" — or those thinking in terms of generations. Too often, unfortunately, the debate — if one can speak of a debate — has been marred by subjectiveness and emotionalism, if not a lack of honesty or simply incompetence.

There is another peculiar aspect to this matter. Although electricity covers only 15% of Switzerland's overall energy requirements, the controversy centers primarily on its future, and not on the situation as a whole, characterized by a heavy reliance on oil, all of it imported. To compound the problem, this same portion of Switzerland's energy supply, always regarded as secure and entirely indigenous, by virtue of the famous mountain dams, must now depend both on the acceptance by the population and on foreign supplies for the essential part of the equipment, as well as the fuel. We are talking, of course, about nuclear-fission power plants which have been chosen as the only acceptable alternative at present to cover the ever increasing demand anticipated for electricity.

THE BASIC FACTS

At this point, it might be useful to refer to some basic facts concerning production and consumption of electricity in Switzerland. What comes out clearly is that if the beginning of construction of a second group of nuclear power stations is further delayed, Switzerland will face the prospect of electricity shortages, starting in 1975-76. In this connection, it may be encouraging to report that some serious thinking is now devoted to the formulation of a national energy policy, which would comprise, especially for electricity, generation, distribution, and in some way, consumption. Under consideration, together with the siting problem of future power plants, is the possibility of coupling the nuclear production of electricity with remote central heating of apartments and offices, as well as industrial use of thermal energy.

As is well known, similar problems, though in different connotations, are bound to affect most industrial nations, including the United States. What is striking also, is the rapidly increasing international interdependency with its manifold political implications, created by the overall growing demand for energy.

A good case can certainly be made for trying to curb the excessive demands for energy, especially as far as losses and wastes are concerned. However, it is probably not realistic, at least not at this stage, to call for a halt to any further increase, particularly as regards electricity which, by most accounts, will see its relative role strengthened by, among other reasons, the necessity to better protect the environment, an undertaking which is said to require more energy, mainly in a "clean" form.

OPPOSITION TO NUCLEAR TECHNOLOGY

Conversely, it should be admitted by the all-out proponents of nuclear energy that not all of their opponents' apprehensions are irrational or ill-founded. Indeed, more should be learned and probably disseminated on safety problems connected with the operation of ever larger nuclear power plants (for example, the emergency core cooling system). Even if an accident, of one kind or another, appears highly unlikely, it is advisable, especially among professionals and men of reason, to foresee possible consequences and take preventive measures which could include doing more research on the safety aspects. Among the future headaches of the nuclear industry are the treatment and storage of a growing amount of highly radioactive byproducts generated by nuclear reactors, including the extremely toxic and long-lived plutonium, the prime fuel of the future breeders.

Clearly, the problem of site selection in Switzerland has been further complicated by the obligation to resort, henceforth — along the Aar and the Rhine — to huge and inaesthetic cooling towers. Only the future will tell if the government decision in the matter was unduly conservative.

Since the time is not yet ripe for the fast breeder reactors (either sodium or gas-cooled) to take over from the present ones (mostly light water), the high temperature gas-cooled concept could well play a significant role in the meantime; it is especially attractive for Swiss industry, due to its anticipated use in association with gas turbines. Furthermore, now that the Canadian heavy water type is regaining some momentum, one might doubly regret that the Swiss reactor venture (Lucens) did not fare too well.

This line would have provided a valuable interim alternative, at least with respect to the crucial fuel supply problem (natural versus enriched uranium).

ARE NEW TECHNOLOGIES THE ANSWER?

New, yet-to-be-developed technologies might help solve the latent energy crisis. We are alluding here not only to controlled thermonuclear fusion or to magnetohydrodynamics, about which a reasonable level of research efforts ought to be maintained also in Switzerland (in cooperation with other countries), but likewise to refined classical processes and less explored methods.

At any rate, the problem is there and the nuclear controversy goes on. Among the latest news on the subject can be mentioned that the Federal Office of Energy in Switzerland — following in the footsteps of the U.S. Atomic Energy Commission — has decided on a more restrained role than before, leaving the utilities in the forefront of the contention.

The double role of promoting nuclear power generation and regulating it has led to some difficult, nearly schizophrenic, situations.

The functioning of society — its institutions in particular — is increasingly put under severe test by such problems. The difficulties probably lie there as much as in technology, if not more so. It is undeniable that a commitment to nuclear energy, as necessary as it may be, is an act of faith in the wisdom of man.

■ *Dr. Grin is Scientific Counselor to the Embassy of Switzerland in Washington.* ■

HEAT, ENTROPY and LAWLESSNESS

By K. M. Khanna

MEASURING "DISTURBANCE" IS DIFFICULT

In the early days of science, it was assumed that temperature is a measure of *disturbance* of a system and that the temperature must rise when a certain amount of heat is given to the system. But the processes of boiling and melting at constant temperatures established the fact that in some processes heat may be added to the system, but the temperature may not rise. The amount of heat given to the system at the melting or boiling point was given the name latent (hidden) heat. But this nomenclature and concept did not solve the problem of the *measure* of disturbance which the adding of heat brings about in the system. Certainly when a solid melts into a liquid or a liquid evaporates into a gas, its heat content increases (it is a more loosely bound system or its constituents have larger amplitudes of vibration) and the disturbance in the system is large. The question arose "If heat is not the measure of disturbance, then what measures the disturbance or disorder that comes about due to the addition of heat to a system?" In fact, whether heat is added at constant temperature or the temperature changes, the disorder of the system definitely increases. The quantity that is a measure of the disorder in the system is called entropy (s). If dQ is the amount of heat added to the system at constant temperature, T , then the change in entropy of the system $ds = dQ/T$. If no change in temperature takes place, dQ is simply the latent heat. If the temperature changes, a more general equation for the variation of entropy is obtained by the integration of

the equation above

$$\int_1^2 ds = s_2 - s_1 = \int_1^2 \frac{dQ}{T} \quad (1)$$

Most of the processes in the universe are irreversible, barring a few of them like melting and evaporation which are reversible. In an irreversible process, we do not get back to precisely the starting point, if we reverse the course of events - for example, running a refrigerator as a heat pump. Whereas for a reversible process, we do get back to the starting point if we wait long enough. The parameters in deciding whether a process is reversible are pressure, temperature, heat flow and so on.

SOME LAWS ARE NECESSARY

Now to describe the thermal behavior of a physical system, we need some laws and they are called the laws of thermodynamics. A large number of thermal concepts are integrated into simple looking equations. To understand the laws of thermodynamics, it is necessary to have a clear perspective of the thermal variables involved. The equations connecting the various thermal variables lead to the different laws of thermodynamics.

THE LAWS OF THERMODYNAMICS

(i) ZERO LAW OF THERMODYNAMICS

It states that if any two bodies are separately in thermodynamic equilibrium with a third body, these two bodies are in thermodynamic equilibrium with each other also. It means that when two bodies are in thermodynamic equilibrium, the thermodynamic variables which describe the behaviour of the body are the same for the two bodies

concerned. Of the large number of thermodynamic variables, we have to choose a few which could give a reasonable equation that could be called a law of thermodynamics. The thermodynamic variables could be the internal energy U , the pressure p , the volume V , the temperature T , the entropy s and so on. If we look at the equation of state of an ideal gas, $pV = RT$, we find that the state of the gas could be known if we know any two of the three thermodynamic variables involved. In the same manner given a thermodynamic equation one can find out the independent thermodynamic variables required to determine the state of a thermodynamic system. Each thermodynamic equation representing a law of thermodynamics will indicate the nature of thermodynamic variables required to represent the state of a thermodynamic system. After having said so much about the thermodynamic state, it could be said that the 'zero law of thermodynamics' is a self-evident fact.

(ii) FIRST LAW OF THERMODYNAMICS

The first law of thermodynamics is just a restatement of the law of conservation of energy plus the additional information that heat is a form of energy. Newton's laws imply that all energy is mechanical and that this energy is conserved. But soon situations arose where mechanical energy was not conserved and it was partly converted into other forms of energy, like electromagnetic energy, heat energy, etc. and thus various forms of energy came to be known, and the law of conservation of energy was restated by saying that the sum total of all forms of energy is a constant.

If an amount of heat energy dQ is given to a system such that its

internal energy is increased by dU and an external work dW is done, then

$$dQ = dU + dW \quad (2)$$

This equation is known as the First Law of Thermodynamics. The changes in the internal energy of the system are governed by some perfect laws which determine the internal dynamics of the system. Thus dU does not depend upon the path of change. For instance, if U is a function of any two thermodynamic variables x and y , then whether x changes first or y changes first, keeping the other variable constant, the value of dU is the same. Expressed analytically

$$\frac{\partial^2 U}{\partial x \partial y} = \frac{\partial^2 U}{\partial y \partial x} \quad (3)$$

When the above equation is valid, dU is said to be a perfect differential. But dQ depends upon the mode of absorption of heat, i.e. whether heat is absorbed, for instance, at constant volume or at constant pressure. Hence, the value of dQ depends upon the path of change or dQ is not a perfect differential.

Eqn. (2) can be restated in another way also. The system can be assumed to possess just one pool of energy, and that is the internal energy U . Contribution to U comes from the input of both mechanical energy and heat energy. During any quasi-static process, any change in U , i.e. dU , is predetermined and it is equal to the difference between dQ and dW . Thus both dQ and dW are imperfect differentials.

(iii) SECOND LAW OF THERMODYNAMICS

Eqn. (1) is said to be the analytical form of the second law of thermodynamics which states

that heat cannot of itself flow from bodies at lower temperatures to bodies at higher temperatures. Since bodies at higher temperatures will have more heat content and, therefore, more entropy, they will be more disorderly. The second law of thermodynamics could thus be restated in the following way: only a more disorderly system can spare heat which can easily flow to a less disorderly system and the reverse is not possible.

ENTROPY AND THE SECOND LAW

We now conclude our article by correlating the concept of entropy and the Second Law of Thermodynamics with the increasing lawlessness and disorder in the universe.

The concept of entropy and the Second Law of Thermodynamics assert that it is difficult to convert an orderly system into a more orderly system by drawing heat or entropy out of it, but it is easy to convert it into a disorderly system by pumping heat or entropy into it. Since most of the processes that are taking place in the universe are irreversible, and entropy increases in an irreversible process, the disorder or lawlessness in the universe is increasing. It would appear that the increasing disorder or lawlessness in the universe is a consequence of the laws of thermodynamics and is thus a natural process.

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Dr. K. M. Khanna is Professor of Applied Physics at the Birla Institute of Technology, Ranchi, India. His fields of research are Theoretical Nuclear Physics, Statistical Mechanics, Low Temperature Physics and Space Sciences. ■

MARINE AND FRESH WATER ECOLOGY

MONITORING PROGRAMS - In general, the discharge of pollutants into lakes, rivers, estuaries and oceans will reduce the diversity of animal and plant species, causing certain species to dominate others in the competition for food and habitat. By regular quantitative examination of the animals and plants in areas receiving pollutants, the effects on the biotic community can be determined. Sessile (attached) animals and plants are particularly useful organisms for monitoring pollution. They are unable to avoid pollutants, thus changes in their community structure may be related to particular pollutants if other controlling and limiting environmental factors are known.

RECENT COASTAL MARINE AND ESTUARINE STUDIES - B.C. Research biologists with experience in intertidal and subtidal benthic ecology have carried out ecological programs along the Pacific coast. In one study, an assessment was made of the effects of the sewage effluent from the Vancouver Sewerage and Drainage District's outfall at Iona Island. Animal and plant communities were monitored in relation to the outfall; sediment chemistry (organic matter, nutrients and metals) and particle size were related to faunal distribution while wind data, together with the result of drogue studies, was used to determine the effluent dispersion. An intertidal baseline study was carried out in 1973, on an area located west of Vancouver for which recreational development was being planned. The results of the study were used to predict the probable consequences of the development. A study being undertaken at the present time includes an assessment of the effects of oil refinery effluent on marine intertidal and subtidal biotic communities. ■

AN INTERVIEW WITH GRAHAM CHANDLER,

DEPUTY REGISTRAR OF THE UNIVERSITY OF SALFORD, ENGLAND

Us: How long have you been in Canada at the moment?

C: Six weeks.

Us: What is the purpose of your visit?

C: I am here because I have a Commonwealth Fellowship from the Association of Commonwealth Universities which is part of a scheme that they run to encourage administrators in the Commonwealth to visit one another's countries to find out something about various administrative arrangements and problems. I am here in Canada because it has been a country that has always interested me, in that I had already read something about experiments, innovations and changes in the Canadian higher educational system. I was interested in, for example, the University of Toronto's unicameral system of government and the reports of the Ontario Commission on Post Secondary Education. There are many areas I wanted to find out about.

Us: I wonder if you could just repeat what you said about your early days at Aberystwyth, and then we will take it from there.

C: Yes. Well the work was concerned with the admission of students, primarily; prior to the formation of the central council.

Us: Is that a central council for admissions in Wales only?

C: No, it is for the whole United Kingdom: it serves all universities and all subject areas within universities.

Us: I see — well, how do the universities divvy up the students, how do they decide who goes where?

C: They have the total responsibility for decision in that all the Centre does is to ensure that only one application form is

filled in by the student. On it, he is allowed to name five universities, in order of priority: or perhaps the first one or two he would most like to go to, and the other three he is about equally expectant about, and there are various permutations that can be indicated on the form. In no sense does the Centre control his choice.

Us: Now I got a bit ahead of you. Is in fact the system changing now?

C: It is not changing. What I was referring to was the fact that I had experience in admissions work before there was any central system at all, when all universities were in a free-for-all situation, and each university had its own application form. Students at the high school level would apply to as many as ten or perhaps a dozen universities, and no one university would know which students were in fact coming.

Us: Can I ask whether in your opinion it is better to have a free-for-all system or a central system? Or perhaps there is some even better system that should be adopted?

C: I have no doubt about it; it is much better to have a central system. It is easier for the student, it saves him time and effort (and a certain amount of money); it is simple and it is infinitely better for the universities because there is a very good information system associated with the Centre, so they know at any one time what is the position with regard to any one student who has applied. They know if another university on his list has made him an offer, they know what his reply was to that offer, and they are

kept up to date at fortnightly intervals with regard to all the students who have applied to them — so they are in a much better information position. The Centre also produces something called a clearing system which applies toward the end of the application cycle, and which assists those students who have not found a place: this helps the universities to soak up vacant places.

Us: Have you become familiar with the Ontario high school system?

C: Only at second hand.

Us: Have you got any impressions from university admissions officers and faculty members about problems in Ontario high schools? Don't answer this if you don't want to!

C: I have. What I have been told from time to time is that things are more difficult for your universities than for ours. There have been great changes in the high schools, including a departure from an examination which involves external assessment. There has been a move toward more local assessment, in other words, marking by the teachers in their own schools. This does seem to cause problems that we do not have to deal with.

Us: You are a university officer of great experience. If you, in Great Britain, were to face the problem of assessing marks obtained from a school in a small village in the wilds of Wales and another school nominally at the same level in Cardiff, how happy would you feel?

C: I would not feel happy at all. I think what might happen would be the reintroduction of the university-conducted entrance examination. It did exist at one time, but most universities dropped it some time ago. If the standards of grading in the schools were to become variable, the universities would reluctantly be forced

into the position of running entrance exams. But remember, we are still talking about an elite system—very much so—in simple statistical terms, a very small proportion of the university age group reaches university in the United Kingdom.

Us: Yes. I think that is true. Expatriates like me tend to equate the Canadian and U.K. systems forgetting that the constituency here is much wider. Going on from this, we are introducing options lower and lower in the system: in other words, students are allowed to select their subjects at a much earlier age, even now they are already selecting subjects at the Grade 11 level, which means that they may be coming into university with great gaps in their education from our point of view. Now at the university level, there is a very wide range of options in what we call major fields. Is there a trend towards options in the United Kingdom?

C: Yes, there is a trend towards options, a trend towards the introduction of more interdisciplinary courses which in turn will introduce a great degree of choice. But I would not like to say that it has gone a very long way yet. The backbone of the university system is still the standard three-year honours degree. Experimentation with other arrangements is still on a moderate scale.

Us: Do you have a two-year general degree?

C: No. That, to my knowledge, does not exist. We have ordinary degrees and general degrees, the latter with not many students in them, usually designed as a safety net to catch students who are not making the grade.

Us: Is there anything in particular that you would like to comment on, on the general tone.... you can see what I am trying to get

for the high school students. Is there anything you think should be said that would be useful to them?

C: Well I was quite interested in the Ontario Applications Centre at Guelph.

Us: *We, at Lakehead, hate it!*

C: What interested me about it was that obviously in its origins it was based on a model very close to the U.K. system

Us: *That's right.*

C: but had responded since to local situations, which has changed its function remarkably. The original intention was to have a clearing system but this was not desirable, and now there is a "drop and add" system which goes along a student can at any time tell the Centre which university he is dropping, and which he is adding on. On the whole, it reflects a situation where there are more places than students that is not to say that we do not have this; we do in some areas, but they are in selected areas. They tend to be in areas like physics and engineering where it is difficult to fill places.

Us: *Our engineering situation is quite different from yours, because you have two channels by which people can get into engineering: one through the certificate system and the other the degree system. I had hoped that when the community colleges were started here we should produce something equivalent to the Higher National Certificate in engineering, but that has not in fact happened, and the tendency is for people who would get HNC in the U.K. to get a degree here.*

C: In contrast to these difficulties, we have very large numbers of candidates wanting to get into the arts faculties, social sciences, and into biological

science; and of course into the professional subjects like law, medicine and dentistry. For example, at my last university, Nottingham, where I was very closely associated with admissions work, the department of law admitted fifty people out of two thousand applications. It is still a very selective system. There is one interesting contrast. We have not developed the high school liaison system; we do not send representatives out to individual high schools on a formal regulated basis. What takes place is that most of the schools have something which they call a Careers Convention, and they will invite representatives of employers of all kinds — local government, civil service and various industrial companies — to send representatives to talk about the jobs they have for school leavers in their organizations. Now, at the same time, they also invite a neighbouring university to send someone to talk about universities, admissions criteria and so on. One man will go by himself to that school to take part in a wide careers convention on behalf of all universities, and he will be discouraged from talking about a particular university — including his own! In no sense do we have these mass invasions of the high schools, where representatives of all universities make their pitch.

Us: *That is a very interesting distinction. Now, could you tell me something about your job?*

C: My present job is one in which I look after a section of the administration of the University of Salford, which is called the Academic Division. It broadly covers all academic administration; that is to say the admission of students, their records and examinations, and it also provides

the committee secretariat for the Senate and its subcommittees. There is another division which looks after the Council Secretariat, equivalent to the Board of Governors and is also concerned with central services like telephones and mail systems as well as doing all the personnel work. There is a further Finance Division, which deals with payroll and similar items. The difference between our system and yours is that there is rather more of the tradition of the professional civil service in the universities; the Vice Chancellor is the equivalent to your President, he is the senior administrator. He is almost always a man of some academic distinction. Below him are the administrative staff. The usual situation is that the officers are professional administrators and not academics. The Registrar at my institution is the single senior officer below the Vice Chancellor in the administrative structure and he in turn has a number of deputies who look after those areas that I have described. Very briefly, my job is a mixture of things that I do in my capacity of Secretary of Senate (I prepare the Agenda and expedite the business of Senate) and I also have a supervisory role in that I have nine graduate assistants who divide the work among themselves. They bring me their problems from time to time!

Us: In a large university here, that would be equivalent to a Vice President, that is what it would amount to — you do not have to comment!

C: I agree.

Us: Could we come back to the transition from high school to university for a moment? We have the concept of schooling in Great Britain; that students are very much "streamed" and

that when a student comes to the end of high school, he knows exactly what stream he wants to enter in the university, and what degree he can look forward to, how long he has to take and what job he wants after he finishes. Is this true, or is it a false impression?

C: It is something of an exaggeration. There is no doubt however that he is streamed into rather broad streams; that is to say, that by the time the student gets to what would be the equivalent of your Grade 13, our sixth form, he has made certain final choices about subjects of study, and broadly speaking, it is still true that he will be, for example, very much on the science side, and will typically be reading

Us: what do you mean by "reading"?

C: "studying"! "taking"! ... three main school subjects, in which he will be examined by an external examiner. If he is on the science side, he will probably be taking something like chemistry, physics and mathematics, or chemistry, physics and biology. A student on the arts side will be taking three arts subjects, for example, English, history and perhaps geography. These are national exams which qualify for a general certificate of Education.

Us: I see that we have run out of time: there will be a lot of questions stirring in the minds of our readers, and I hope they will write in about them. Happy Landings! □

"... I THOUGHT THAT THE SCIENCES CONTAINED IN BOOKS ... COMPOSED AS THEY ARE ... ARE FURTHER REMOVED FROM TRUTH THAN THE SIMPLE INFERENCES WHICH A MAN OF GOOD SENSE ... DRAWS RESPECTING THE MATTERS OF HIS EXPERIENCE ..."

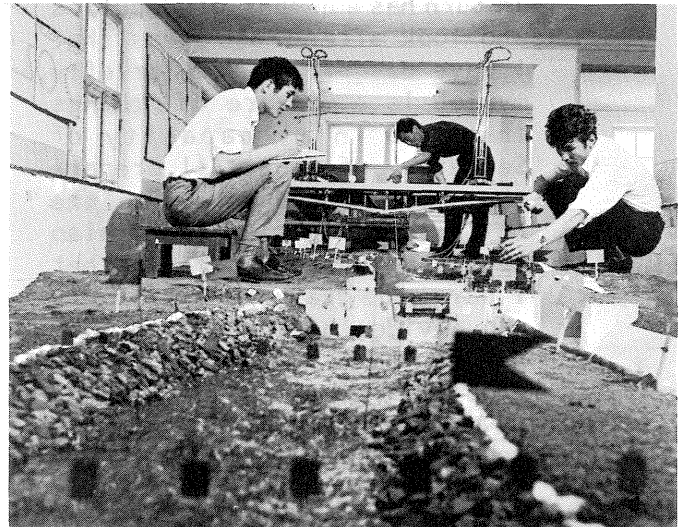
— Descartes.



In the U.S.S.R. research work is becoming a necessary element of college curricula from the first year of study. There are now over 200 students' design groups which are fulfilling the orders of different mills and factories.



A university and dozens of colleges and vocational schools graduating students in over 150 fields have been opened in Kirgizia (Kirgiz S.S.R.) where people did not have their written language before the revolution.



A practical lesson in the water problems laboratory of Frunze Polytechnical College. (Kazakh S.S.R.)

THE ORGANIZATION AND MANAGEMENT OF SCIENCE IN THE U.S.S.R.

By E.S. Bobrov

SPEED UP OF SCIENTIFIC PROGRESS IS SOUGHT

In describing the current system of the organization and management of Soviet Science, let us start from the administrative agencies.

In the USSR Supreme Soviet — the highest organ of legislative power — the functions of deputies' control over the elaboration and implementation of scientific policy are discharged by the Standing Commission of the Soviet of the Union and Soviet of the Nationalities for public education, science and culture. At their separate and joint sessions, the commissions of both chambers hear reports by the chiefs of ministries and departments on their activities in managing scientific and technological progress.

The main functions in the field of managing the development of science and technology are discharged by the USSR Council of Ministers, the highest organ of executive power. Today there is hardly a section of the Council of Ministers' activities unrelated, directly or indirectly, to the problems of science and technology.

According to the Directives of the 24th CPSU Congress, the chief goal of the 9th Five-Year Plan (1971-1975) is to ensure a substantial growth of the people's living and cultural standards on the basis of the high rate of development of socialist production, its growing efficiency, scientific and technological progress, and the accelerated growth of labour productivity. Proceeding from this, the Directives provide for speeding up the rates of scientific and technological progress, ensuring the implementation of a single

technical policy, developing fundamental and applied research in every way and introducing their results into the national economy more promptly.

These tasks have been set, on the whole, to three state organs — the State Committee of the USSR Council of Ministers for Science and Technology (GKNT), the State Planning Committee of the USSR Council of Ministers (GOSPLAN of the USSR) and the USSR Academy of Sciences (AN of the USSR). While the USSR Academy of Sciences, the country's top scientific institution, coordinates fundamental research; the USSR State Planning Committee plans the use of the achievements of science and technology and carries on a single state scientific and technical policy.

PLANNING DEVELOPMENT

The State Committee of the USSR Council of Ministers for Science and Technology determines the main trends of the development of science and technology in the country, organizes research into inter-branch scientific and technical problems, ensures the growing effectiveness of research and a prompt use of the achievements of science and technology in the national economy, organizes scientific and technical information and carries out international scientific and technical cooperation. The State Committee for Science and Technology gives technical and economic appraisal to the level of development of science and technology in individual branches and takes measures for speeding up scientific and technological progress and for development of the scientific organization of labour in the country. In pursuance of these aims, it selects,

jointly with the USSR Academy of Sciences, Ministries and Departments, the most promising results of fundamental research, organizes their realization by the branch research institutes and the designing bureaus, maps out the fields of application and the methods of introducing research findings into production. The State Committee for Science and Technology pays special attention to control the timely introduction of the achievements of science and technology which are of the greatest importance.

The role played by the State Committee for Science and Technology as the leading organ of state policy is confirmed by the fact its Chairman is Vice-Chairman of the USSR Council of Ministers, a member of the Central Committee of the CPSU (CC-CPSU), a member of the USSR Academy of Sciences. However, the entire work of the State Committee is collective. The resolutions of the State Committee are adopted by its board which, besides the high-ranking officials of the Committee itself, includes authoritative representatives of the USSR Academy of Sciences, Ministries and Departments. In his work, the Chairman of the State Committee for Science and Technology has the assistance of his deputies on various problems; in turn, the deputies are in charge of departments and functional boards and also the composite departments of the scientific and technical plan.

HOLDING THE REINS ON RESEARCH

Learned councils, dealing with key complex and inter-branch problems, play an important role in the work of the State Committee of the USSR Council of Ministers for Science and Technology. Working in these research and consultative organs on public lines are more

than 5500 members of councils and their sections, of whom 160 are academicians and corresponding members of the USSR Academy of Sciences, more than 1000 doctors and 1600 candidates of sciences. The learned councils hear and discuss reports by chiefs of technical boards of ministries and departments, directors of institutes and individual scientists on the state of research into various problems in the USSR and abroad. They map out the basic research trends in the interests of the earlier solution of the problem, work out recommendations on the ways of the practical use of the results obtained and of the latest scientific and technical achievements, adopt decisions on stopping the research jobs which have no prospect of success. It is obvious that such problems cannot be solved on a merely administrative basis, and the councils play an especially great role here as the organ of scientific examination.

In their activities, the learned councils of the State Committee for Science and Technology are connected with the learned councils of the USSR Academy of Sciences (many leading scientists are members of both councils), with the scientific and technical councils of Ministries and the appropriate branch boards and departments.

DISSEMINATION OF THE RESULTS OF EXPERIENCE

Ranking very prominently in the work of the State Committee for Science and Technology, under the USSR Council of Ministers, is the dissemination of advanced scientific and technical experience, the organization of an effective system of scientific and technical information. Under present conditions, such a transfer of "know how" on a

"horizontal" plane is no less, if no more, important than that on a vertical plane, from the birth of a new idea to its realization. The reduction of the "science-production" culture will be of little use if the latest achievements of science and technology remain in the possession of one industry or of one enterprise. The Committee for Science and Technology is supported in this sense by the USSR Exhibition of National Economic Achievements, the All-Union Scientific and Technical Information Centre, the All-Union Institute of Scientific and Technical Information (VINITI), the State Public Scientific and Technical Library.

The Chief Committee of the USSR Exhibition of National Economic Achievements, jointly with the State Committee for Science and Technology, systematically conducts contests for the best solution of major scientific and technical problems, and awards the winners with medals, diplomas and prizes. The Exhibition, situated in one of Moscow's most picturesque parks, propagandizes advanced experience and new developments in the field of science, technology and production among representatives of all the republics and territories of the country visiting it. The pavilions of the Exhibition are specialized in the branches of the national economy, science and technology. Lectures, seminars, and film shows are arranged for the visitors.

The State Public Scientific and Technical Library is the main scientific and technical library of the USSR. It offers its subscribers the leading periodical and non-periodical publications in all the spheres of knowledge published in the USSR and abroad. The Library carries on extensive methods and bibliographical work. Besides, it fulfills orders for the making of microfilms and various copies from the materials in its repositories.

The All-Union Scientific and Technical Information Centre plays the main role in the organization of specialized information in the field of science and technology, which includes the information of a branch and departmental character. Stored in the Centre are candidates' and doctors' theses in the field of science and technology, reports on the completed research jobs or those still in progress.

The All-Union Institute of Scientific and Technical Information complements the activities of the Centre. It collects and gives primary analysis not only to special, but also general information in the field of science, technology and economics. The VINITI is in a double subordination to the State Committee of Science and Technology and to the Academy of Sciences and meets the needs for information for fundamental and applied science and production alike. The institute publishes journals of abstracts on various fields of knowledge and on industrial economics, including the organization and financing of research projects, as well as express information and other materials, including the "Scientific and Technical Information" monthly.

INFORMATION NECESSARY FOR PLANNING

The Directives for the 9th Five-Year Plan of the USSR's economic development provide for setting up in the country a single state system of scientific and technical information. In their reports at the 24th CPSU Congress, L.I. Brezhnev, General Secretary of the CC CPSU, and A. N. Kosygin, Chairman of the Council of Ministers of the USSR, stress a close interconnection between the improvement of the system of scientific and technical

information and the improvement of the planning and economic management standards in the present-day conditions. "Our planned economy", A.N. Kosygin stressed in his report, "makes it possible to create a nationwide automated system of information collection and processing for the planning and management of the national economy on the basis of the state system of computing centres and a single automatic system of communications in the country". The Directives provide for the improvement of scientific and technical information and for the systematic transfer of data on the scientific and technical achievements and advanced experience in the field of technology, production processes, the organization of production and management to the branches and enterprises concerned. It is necessary to develop and introduce automatic systems of the planning and management of branches, territorial organizations, associations, enterprises; and to ensure, from the very beginning, the organizational, methodological and technical unity of the nationwide automated information system.

Automatic process control systems are to be introduced in industrial enterprises. In the course of 1971 to 1975, we shall introduce no less than 1700 such systems in industry, agriculture, post offices, in the trading network and on transport.

The State Committee for Science and Technology and the Scientific Information Centres subordinated to it play the leading role in the development and realization of the single system of scientific and technical information. The introduction of this system will make it possible to make a much fuller use of electronic computers and of the work of the ever growing number of people employed in the sphere of information supply to science, technology and production.

The single system will cater not only to the local and regional computing and information centres, but also to the automatic control systems (ACS). In the final analysis, this system is to become the basis of the scientific management of the national economy and of the very scientific and technological progress by ensuring the fastest and fullest possible translation of the last word of fundamental science into the language of practice.

The state system of scientific and technical information set up in the USSR comprises 10 All-Union, more than 180 branch republican and territorial institutes or centres and about 9000 departments or bureaus of scientific and technical information at industrial enterprises and in organizations. They have accumulated more than one billion units of reference and information materials reflecting the achievements of science, technology and advanced experience. Electronic computers, equipment for making microfilms, electrographic and other kinds of copies are used in the search for, collection, storing processing and transfer of information.

The task now is to keep enhancing the purposefulness of information, to differentiate its spread, depending on the requirements of the given research institution or industrial enterprise. The USSR Council of Ministers has made it binding on all the information services of the country to submit to the planning organs, ministries, departments and enterprise managers, every year, materials on the major Soviet and foreign achievements in the field of science and technology. This

information is taken into account in working out and considering the plans of national economic development.

REGISTRATION OF EXPERIMENTS

Obligatory state registration is being introduced not only of completed experimental and designing jobs, but also of those in progress and even those that have just been started. Ministries and departments, the USSR Academy of Sciences and the Councils of Ministers of Union Republics have been instructed to exercise control over the continuous and uninterrupted influx of this information. The automatic subsystems of the collection, processing, storage and transfer of scientific and technical information are coupled with the automated systems of production management. Such a combined system is already functioning in the instrument-making industry, for instance.

The USSR State Planning Committee (GOSPLAN of the USSR) plays the leading role in the system of national economic management. Its main job is to work out plans ensuring the proportional development of the Soviet national economy, the continuous growth and increasing efficiency of public production. The USSR State Planning Committee is paying an ever closer attention to the planning of the use in the national economy of the achievements of science and technology, to the output of technically perfect machinery, to the mastering of modern production processes, comprehensive mechanization and automation of production, to the use of economic and mathematical methods, computers and automatic planning systems, as well as the systems of automatic management and information processing. The USSR State Planning Committee exercises control over the fulfillment of

these plans and organizes, jointly with the USSR Academy of Sciences, economic research in respective fields.

The USSR Academy of Sciences is the main organ for the management of fundamental research in the sphere of natural and social sciences in the first place. It determines the basic research trends and coordinates the efforts exerted in this sphere by its institutes (the Institutes of the Academies of Sciences of the Union Republics and branch academies, the Academy of Medical Sciences, the Academy of Pedagogical Sciences, the Academy of Construction and Architecture, the All-Union V. I. Lenin Agricultural Academy) and also by higher educational establishments and the biggest research institutes of various departments. The chief tasks of the USSR Academy of Sciences are as follows: to develop research along the main trends of natural and social sciences, to carry out research work in the interest of scientific and technological progress in the field of electrification, comprehensive mechanization and automation of production, the use of new power sources and new methods of energy conversion; the bringing out of the entirely new possibilities of technological progress, the drawing up of recommendations for their use in the national economy; the study and generalization of the achievements of world science and the promotion of their fullest possible use in practice.

DEMOCRATIC PRINCIPLES

The activities of the USSR Academy of Sciences are based on democratic principles. Its highest organ is the general meeting of the Academy, convened at least once a year, with the full members,

honorary members and corresponding members of the Academy of Sciences taking part. The Presidium is engaged in organizational work and the day-to-day management of the Academy's subdivisions. The Presidium is comprised of the President, Vice-President, the Chief Learned Secretary of the Presidium, academicians-secretaries of the divisions and other members; the number of which is set by the General Meeting of the Academy. The Presidium convenes General Meetings, endorses the plans of work in the field of national and social sciences, jointly with the State Committee for Science and Technology and the USSR State Planning Committee, sets up learned councils for dealing with the key complex problems, sets the research trends and specializations of institutes, takes measures for ensuring the use of research findings in the national economy. The President of the USSR Academy of Sciences supervises the activities of the Union Republics through its Coordination Council.

THE ACADEMY

The USSR Academy of Sciences has 16 departments united into 4 sections (3 natural science sections and 1 social science section). Each department of the Academy is the scientific and organizing centre of one or several sciences and carries out scientific guidance of the institutes of the respective specialization. The highest organ of the department is its general meeting. The department bureau is headed by an academician-secretary.

The branches of the USSR Academy of Sciences and research centres in Autonomous Republics, Territories and Regions have the administrative organs of their own (Presidiums) and are coordi-

nated by the Presidium of the USSR Academy of Sciences. The Siberian branch of the Academy of Sciences is subordinated not only to the Presidium of the Academy, but also to the Council of Ministers of the Russian Federation and shares the scientific guidance of its institutes with the respective departments of the USSR Academy of Sciences.

Besides the national level, we can also speak of the *branch level* of science management - *the level of ministries and departments*. At this level, the requisite rates of industrial development and labour productivity growth are ensured, a single technical policy is carried on, the latest advances of science, technology and advanced experience are introduced, the technical and economic performance of production is enhanced and a scientific organization of labour, production and management, ensuring the maximum use of the knowledge and experience of the employed is introduced.

The ministries and departments appraise the technical and economic level of production achieved, map out ways of the most effective use of the achievements of science and technology, exercise control over the work of research and designing organizations for their branch. In most cases, these organizations are subordinated to branch central boards, except the organizations dealing with the problems confronting the whole Ministry; such organizations are subordinated to technical boards. In the Ministry of the Gas Industry of the USSR, for instance, the technical board manages all the research and designing organizations of the branch.

In its work of guiding the research and development work, the administration of ministries and departments has the coopera-

tion of technical councils which employ the most prominent specialists in the given sphere as experts.

The ministries and departments organise, in close contact with the State Committee of the USSR Council of Ministers for Science and Technology, the scientific and technical propaganda and information service, which is usually combined with the service of technical and economic analysis and the patent and licence service, and maintain contacts with foreign countries.

The Soviet science management system contributed to the rational arrangement of the network of research institutions and centres in the country, to the organization of fundamental and applied research and development work. A controlled system of research activities — the so-called model of development, unparalleled in the developed capitalist countries — was set up in the country. The system is of great interest to the developing nations.

As distinct from the majority of Western countries, fundamental research in the Soviet Union is concentrated mainly in the institutes of the USSR Academy of Sciences, the Academies of Sciences of the Union Republics and of the branch academies; higher educational establishments play a more modest role than in the USA, Western Europe, Canada or Japan. The Soviet Union is by right called abroad a country with the "academic system" of research organization. This is directly connected with the role played by the Academy of Sciences of the USSR, in the first place, in the guidance of research.

The total number of research establishments in the USSR grew from 2359 in 1940 to 4985 in 1970, that is, more than doubled in the past 30 years. An especially striking numerical growth was registered by research institutes, their branches and divisions — a

form of research organization which Russia's advanced scientists had urged way back before the October Revolution. As of late 1970, the USSR Academy of Sciences had 234 research institutions which employed 35.1 thousand researchers, including 693 academicians, full members and corresponding members. Altogether, the system of the USSR Academy of Sciences, the Academies of Sciences of Union Republics and branch academies comprises 862 research establishments, employing 85.9 thousand research associates.

HIGHER EDUCATION

Higher educational establishments — universities in the first place — are closely connected with the system of academic research institutions. It is noteworthy, that in the USSR, as distinct, for instance, from the USA, institutions of higher learning offer four to six-year courses of training to graduates of ten-grade secondary schools. The total number of higher educational establishments in the country was 811 in the 1971/72 academic year. The emphasis was laid on the deliberate regulation of the number of higher educational establishments while raising their quality standards through the modernization of study programmes, improving the qualifications of professors and instructors, the provision of more experimental and training facilities to the higher school, the drawing of even more instructors, post graduates and students into research work. At present, about one-third of all Soviet research workers are concentrated in the higher school.

In a number of leading higher educational establishments, junior students are drawn into an active participation in research

and designing work. Rich experience has been accumulated in this field by the Novosibirsk State University, the Moscow Physical-Technical Institute, Moscow's Bauman Higher Technical School, and the Moscow and Leningrad Universities.

The activities of students' scientific societies have gained in scope; their membership at the leading higher educational establishments accounts for about a third of the total student body. The growing standards of these societies' work can be judged at least by the fact that more student papers (especially those by senior students) are of considerable scientific and practical importance.

FUTURE SCIENTISTS AND ENGINEERS

The future gifted scientists and engineers show their abilities while still at school. It is only natural that serious attention is paid to the timely revelation and cultivation of these abilities. Various faculties of Moscow's Lomonosov University arrange yearly contests in which senior school pupils take part. Pupils are invited to the University's scientific circles, the members of which are given priority in enrollment. The circle set up by the Faculty of Mechanics and Mathematics of the Moscow University, for instance, has been functioning successfully for many years now. Prominent scientists, academicians, corresponding members of the USSR Academy of Sciences and professors devote much of their time and energy to the training of gifted young people. Many leading scientists of the Siberian branch of the USSR Academy of Sciences take an active part in conducting the so-called summer schools in the Academic Town every year, to which the winners of scientific contests by correspondence are invited. The most gifted of them are accepted by the boarding school of the Novosibirsk State University.

Together with higher educational establishments, academic research institutions make up less than one-third of the total number of the country's research bodies, but it is they that create the "scientific backlog" which ensures the development of science, technology and production. New ideas are made a reality by a vast network of branch and other applied research institutes and designing bureaus, plant laboratories and scientific-industrial associations.

The 24th CPSU Congress paid most serious attention to the problem of speeding up the introduction of the latest achievements of science and technology into production.

A programme of economic, legal and organizational measures for the solution of this problem was worked out. The basic organizational form, making it possible to carry out the whole complex of the measures planned is the science-industrial association headed by the director of a research institute. It is precisely the institute, and not the plant, that plays the decisive role in determining the technical policy and strategy of the science-industrial association.

ADVANTAGES OF SCIENCE - INDUSTRIAL AND PRODUCTION ASSOCIATIONS

The associations showed their advantages in the early years of their existence. In the science-industrial associations of Leningrad, for instance, the duration of the "science production" cycle was reduced to one-third or even to one-fourth as compared with the enterprises which have not joined the associations. Labour productivity grew remarkably and personnel fluctuation was reduced. Science-industrial and production associations have a great future ahead of them in the epoch of modern scientific and technical revolution. The most important thing is that these associations open up

broad prospects of the effective use of modern automatic control systems.

The experience of Soviet science-industrial and production associations confirms that such systems produce good results given a sufficiently efficient and substantiated organizational structure, well-adjusted communication channels and an unhindered influx of information.

SUMMARY

The system of organs of the state management of science in the USSR has worked out and implemented, with the support of the broad scientific and technical public and all the working people, a smoothly operating system of the organization and management of research work in the country. This system is an organic part of a broader system of national economic planning and constitutes its ever more important element.

Following the principle accepted in the USSR, the planning of the national economic development should proceed from the outline of future scientific and technological progress. Therefore, branch and comprehensive forecasts of scientific and technological progress and long-range plans based on them are drawn up. These plans serve as a foundation of the State Five-Year Plan of research and of the utilization of technical and scientific achievements in the national economy and also of coordination plans for solving basic scientific and technological problems which are presented in more detail in the appropriate branches and organizations. These plans, in turn, serve as a basis for the yearly planning of scientific and technological progress all along the line - from the country as a whole down to an individual research institute, a designing bureau or an industrial enterprise. ■

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EDUCATION IN THE THIRD WORLD - THE PEARSON COLLEGE OF THE PACIFIC IS THE THIRD IN A NETWORK OF UNITED WORLD COLLEGES CREATED TO PROMOTE INTERNATIONAL UNDERSTANDING THROUGH EDUCATION AND TO PROVIDE A PATTERN OF EDUCATION TAILORED TO THE NEEDS OF THE TIMES. THE PIONEERING UNITED WORLD COLLEGE OF THE ATLANTIC WAS ESTABLISHED IN WALES IN 1962. A SECOND COLLEGE, THE UWC OF SOUTH-EAST ASIA, OPENED IN SINGAPORE LAST YEAR. THE ULTIMATE PLAN IS TO HAVE SIMILAR COLLEGES IN EVERY MAJOR REGION OF THE WORLD. THE GRADUATES ATTAIN AN INTERNATIONAL BACCALAUREATE, RECOGNIZED BY ALL CANADIAN UNIVERSITIES.

Mr. Bobrov was born in 1925 near

A GEOLOGIC TRAVERSE ACROSS AFRICA

By John S. Mothersill

THE LIMNOLOGY OF LAKE SUPERIOR

Lakehead University is in the fortunate position of being on the doorstep of one of the largest natural labs in the world — Lake Superior. The opportunities for scientific research on Lake Superior are limitless and since becoming a faculty member of the Geology Department at Lakehead University in 1966 I have carried out limnological studies of Lake Superior in conjunction with the Canada Centre for Inland Waters. These studies included physical and geochemical research of the lake bottom sediments, interaction processes of the sediment-water interface and the chemistry of the lake waters.

The decision to spend my sabbatical leave in Africa was not difficult to arrive at, for a number of reasons, not the least of them being the opportunity to do comparative research on Lakes Victoria and Chad.

Most of the time, from graduating from Queen's University to taking up a position on the faculty of Lakehead University, I had spent with an international oil company carrying out oil exploration in the Middle East, Africa, South Africa and Europe. Having lived in West Africa for several years I was aware of the extreme housing shortage in most of the African countries. As I was being accompanied by my family, this presented a problem to which, fortunately there was a solution. As most universities in Africa provide housing for their faculty and senior staff, I wrote to Makerere University, Uganda, and the University of Nigeria, Nigeria indicating my interest in carrying out limnological studies on Lakes Victoria and Chad, respectively. The Vice-Chancellors of both universities replied that they would be pleased to accept my proposal and designated me as

a Visiting Reader (equivalent to an Associate Professor in Canada) which resolved the housing problem and also expedited the process of obtaining our visas. In most independent African countries, an ordinary visitor's visa allows the holder to remain in the country for a limited period of time only, usually six weeks or less, which was of little use to me. To obtain an ordinary visa can take many months while an extended visitor's visa and work permit presents much greater problems. Fortunately, with the help of the universities in both countries, this red-tape was made much easier to copewith and after receiving our visas we left Canada for Uganda in June 1972.

RESEARCH AND PRESIDENT AMIN

The problems encountered in carrying out independent research in any underdeveloped country are quite staggering, just a few will be mentioned in this paper. The lack of trained manpower was the first problem encountered as, being in short supply, all of the trained men available are fully employed. This matter was not eased at all by the expulsion from Uganda, by President Amin of all Asians, of whom most of the skilled trades were composed. All eight launches of the Department of Fisheries and the only research vessel of the East African Fresh Water Fisheries Research Organization were under repair. Of course the mechanics of both organizations were Asian and they had been ordered to leave the country so why should they work? Eventually a launch was provided by the Ministry of Works and by early September, after one complete engine change in the launch (the details of which will not be entered into here) a limnological survey was carried out on the northwestern area of Lake Victoria. The survey was terminated

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Mr. Bobrov was born in 1925 near

when ten armed soldiers took over the launch on behalf of President Amin who wanted to go fishing! We discovered later that the authorities suspected that the vessel might be used to transport Asians to and from Uganda and Kenya, and was not to leave the dock at Jinja. We left for Nigeria in mid-September five days before an attempted coup took place and things became rather unpleasant for expatriates living in Uganda.

Apart from the limnological studies, our stay in East Africa was most interesting from a general geological point of view. We took every advantage of our stay to visit some of the places which to us were almost legendary. In particular, I examined parts of the unique East African Rift system which consists of a series of down-dropped blocks (grabens) and uplifted blocks (horsts) of the earth's crust extending from Tanzania to Turkey. In addition, a visit to Olduvai Gorge where Professor Leaky discovered the bones of *Zinganthropus* and *Homo erectus* leakeyi which many scientists believe to be direct ancestors of man proved to be most interesting. Work was still being carried out at 'the dig' under the direction of Professor Leaky's widow. On the way to Olduvai we visited Ngorongoro crater, advertised, and possibly correctly so, as the largest known crater of an extinct volcano.

THE SOURCE OF THE NILE

One of the great geographic challenges of the last century was to discover the source of the Nile. Eventually the riddle was solved by Speke who in 1858 postulated correctly that Lake Victoria was the source. We followed the Victoria Nile from the source, Lake Victoria at Jinja, to Lake Kyoga and along the Albert Nile to Lake Albert and its link-up with the White-Nile,

visiting on our journey Murchison Falls and its game park. The time passed so quickly that, when our time came in September to leave for Nigeria, there was so much we wished still to do!

In Nigeria, the Federal Fisheries Department provided us with a bungalow at their research station at Malumfatori on the shores of Lake Chad, 175 miles into the Southern Sahara! The transportation of 1,000 pounds of equipment from the University at Nsukka in the East Central State over 850 miles of very inferior roads (175 miles of which were across a trackless scrub desert) proved to be somewhat of an obstacle. Three different Land Rovers were required to complete the journey. The first, a brand new 1972 vehicle belonging to the university, came to an untimely end at Jos, after completing approximately 350 gruelling miles, with a broken axle. Replacement parts not being available we were lucky to obtain the use of a Land Rover from the Ministry of Natural Resources, which could take us only as far as Maiduguri, 175 miles from our destination. We were met at Maiduguri by personnel from the research station who transferred our equipment, yet again, to the final vehicle which conveyed us across the desert to Malumfatori.

SEVERE DROUGHT THREATENS

A survey of the open water area of Lake Chad was carried out from the research vessel, *El Kanemi*, during January and February. The studies of the lake, which has a maximum depth of merely 14 feet although it covers an area of 5,000 square miles, has uncovered some interesting data at a time when severe drought threatens the very existence of thousands of people in Central Africa. The fluvial input to the lake is mainly from the Chari River which flows into the Southern Basin. There is no outlet from the lake, and the

fluvial addition is kept in rough balance by the high rate of evaporation in the northern basin which fringes the Sahara. The combination of fresh water influx in the south and evaporation in the north has resulted in a salinity gradient towards the north. Situated as it is in a depression a substantial increase in rainfall could increase the volume of water in the lake, but unless this happens in the next few years, the fish population will be badly depleted in an area already faced with the threat of wholesale starvation.

BEFORE YOU GO TO AFRICA

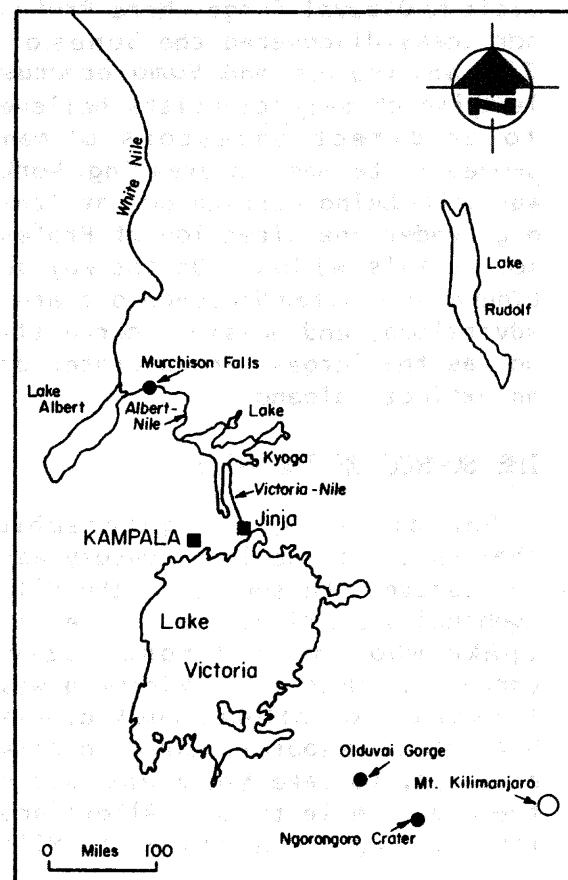
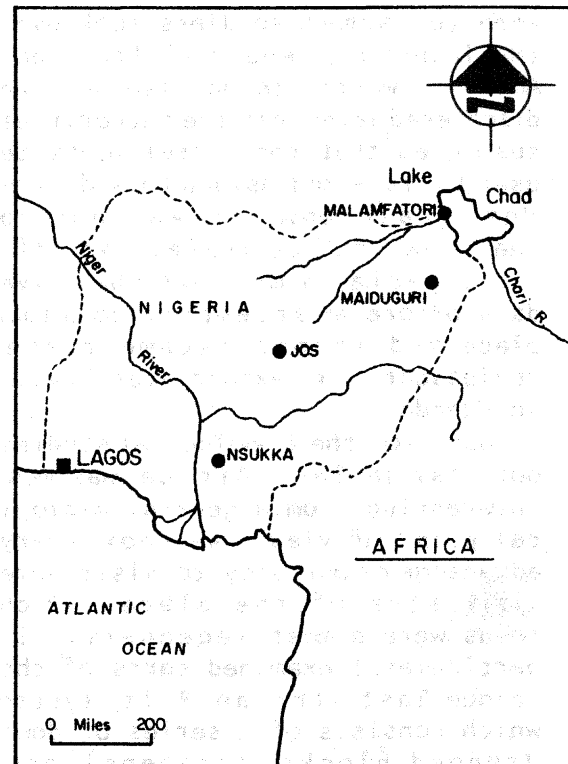
If you are planning a trip to Africa in the near future you would do well to heed the following advice:-

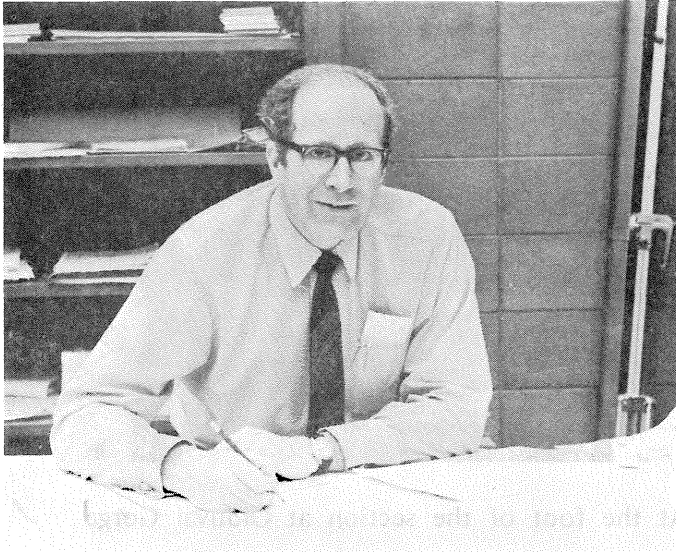
[1] Check thoroughly and well ahead of time on visa and vaccination requirements. Most African countries have Embassies or High Commissions in Ottawa and this information can be easily obtained.

[2] Dress conservatively as Africans in most Independent African countries tend to be conservative about dress. For example, the wearing of shorts or miniskirts by girls in African countries could result in a fine or imprisonment.

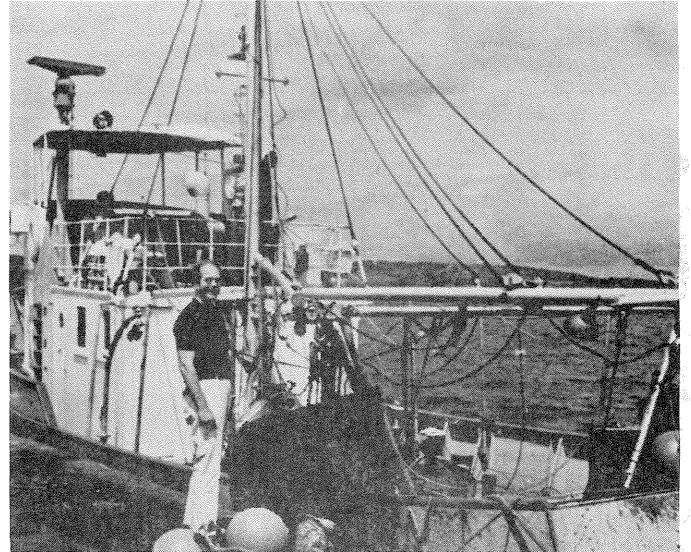
[3] Don't try smuggling as you could end up in an African jail which is a part of the African scene you would probably wish to avoid visiting.

■ *Dr. Mothersill has been a faculty member at Lakehead University since 1966. Born in Ottawa, his work has taken him to Turkey, Nigeria and Columbia amongst other places. As well as analyzing the results of his studies of Lake Superior and lakes in Africa, he is currently Supervisor of the Federal Government Seismic Station at Lakehead University.* ■





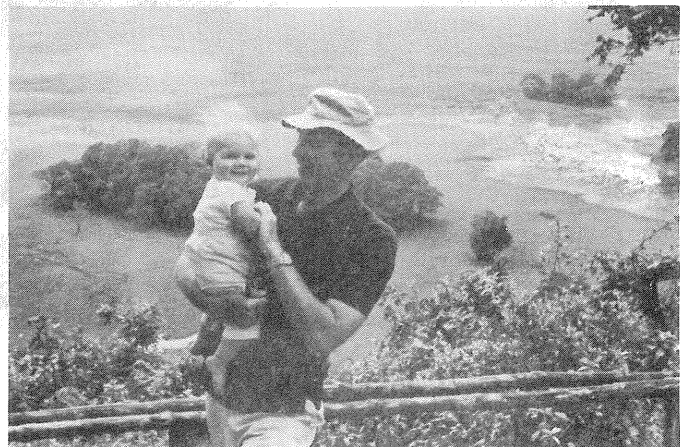
Dr. Mothersill at home



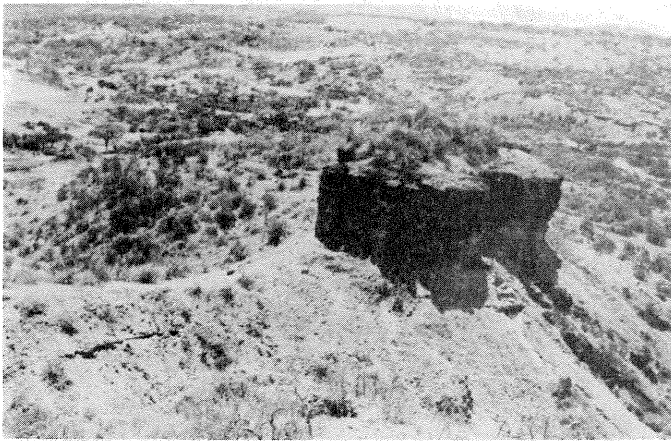
and away



Mrs. Mothersill and infant at
Mount Elgin on the border of
Uganda and Kenya.
*"in the best of spirits and
well fed . . ."*



Overlooking the Victoria Nile.
*"a child . . . whose father has
more than a passing interest
in geology . . ."*



Olduvai Gorge
where Professor Leaky made his discovery.



At the foot of the section at Olduvai Gorge



Above — Murchison Falls
*"Our first encounter with the spectacle
of the African panorama . . ."*



A Kanuri family at the communal water tap
near Lake Chad
*"the people [were] very hospitable and
extremely friendly . . ."*

TRAVELS WITH MY SON

By Valerie Mothersill

When my husband informed me that he had been granted a sabbatical leave and that we were to spend that precious year in Africa, carrying out research studies on Lakes Victoria and Chad, the thought of any difficulties being encountered in taking our son, then aged eight months, on an extensive tour of East and West Africa did not occur to me; after all, we had taken him to Toronto when he was merely three months old!

We left Canada in June, 1972 and after a brief stopover in England arrived in Uganda twelve days later. Living as we were in the fairly sophisticated capital of Kampala, the routine of daily life was not so very different from that encountered in Thunder Bay. It was our expeditions beyond the urban areas which put to the test our ability to adapt and improvise. For example, can you imagine travelling many miles in Canada without encountering a road-side snack bar urging you to "EAT", let alone an A&W? First lesson - never contemplate even the shortest car trip without taking along a couple of thermos flasks of boiled water, a packet of dried milk, half-a-dozen jars of baby food and, if you are lucky enough to have any room left, some sustenance for Mum and Dad. The second lesson, that of the necessity of having an inexhaustible supply of disposable diapers, was of little use to us as this commodity is not regarded as an absolute necessity of life by the Ugandan people and hence is unavailable. Dirty cloth diapers, combined with lack of water do test one's ingenuity.

VENTURING INTO THE COUNTRYSIDE

Our first encounter with the spectacle of the African panorama

was on a visit to Murchison Falls National Park where crocodiles in the Nile are as common as lamprey in Superior: elephant, giraffe, water buffalo, kob¹ and many other animals roam freely, unhampered by man's urge to kill.

The political situation being as it was, my husband's work on Lake Victoria was delayed, giving us a few days to fly to Kenya to do the safari thing. After an exceptionally sumptuous over-night stay in the New Stanley Hotel in Nairobi, we felt well fortified for our drive to Tanzania and the wonders of Kilimanjaro Serengeti and Olduvai Gorge. Lesson number three - if possible always take along a baby when going on safari. At border crossings what is in effect a mere formality of stamping a passport often can be turned into a marathon wait for the 'right man' to come to perform the ritual. An accompanying child acquires the uncanny ability to cut red tape as if he transformed to a pair of enchanted scissors, his presence has the effect of making an insignificant border guard into a great stamp-wielding man (perhaps because of those dirty diapers in the car?).

The equal measure of pleasure and curiosity with which a child treats all new experiences is either an object lesson in how to find joy, excitement or merely a stimulus for one's curiosity in all things, be they ugly or beautiful, mundane or ethereal, precious or inexpensive. The beautiful Masai people clothed in bright flowing robes and adorned so elegantly with handmade, beaded jewellery, earrings which stretch their ear lobes out of all proportion, aroused great interest (but then so does Mum in a shocking pink housedress and ceramic medallion). To an adult the vision of Kilimanjaro, surrounded as it is by the mystique of Hemingway,

is awe-inspiring, but to a nine months old boy who has already seen Mount McKay,² what else is there? Serengeti, with its thousands of square miles of arid savanna land and great herds of zebra and ostrich, proved to be of not much more competition to the teddy bear than were the elephants of Murchison. Even being the largest extinct volcanic crater in the world did not save Ngorogoro from being relegated to the position of "just another pretty valley with nice animals — but no teddy bears!"³

But the genetic heritage of a child (whose Mother is not averse to joining in an archaeological dig and whose Father has more than a passing interest in geology) cannot fail to make that child appreciate Olduvai Gorge, the home of Australopithecus and the Mecca of all who are concerned with pre-history. Where else can one be photographed with the femur of an elephant circa one million years old, in its natural habitat?

A LONG AND DIFFICULT JOURNEY

To detail the eighteen hour drive from Arusha, Tanzania to Thika, Kenya would require an article in itself, but the value of adhering to rule one was made abundantly clear to us during that time. Careful planning ensured our arrival in Thika in time for supper, contingent on our leaving Arusha by 8 a.m. which we did. However, our careful planning, although it did take into account visiting Ngorogoro Crater and Olduvai Gorge and allowed for a reasonably leisurely drive through Serengeti National Park, did not allow for the deplorable driving conditions in a constant fog of swirling dust and roads which would make a tank driver shudder in horror: a 'flat' dealt us a final blow on re-entering Kenya. Our pioneering spirit was further severely tested by the lack of food! In the original, carefully made itinerary, arrival at safari lodges coincided

with meal times: the actual time of arrival in Kenya coincided with the area of no-man's land between meals. Witness the wisdom of rule number one — whilst the two adults of our little party were without sustenance, save a packet of cookies and two melted chocolate bars, for eighteen hours, the youngest member thrived on milk, puréed spinach, minced chicken and the inevitable apricot pudding. He arrived in Thika at 2 a.m. in the best of spirits and well-fed, the envy of his Mum and Dad.

THE CHILD AS DIPLOMAT

The ensuing months saw us in Nigeria, Liberia and on the borders of Niger, Nigeria and Chad at Lake Chad. It was at Chad that rule three again exhibited its worth. Situated as we were, at a scientific research station 140 miles into the Southern Sahara, accessible only by four-wheel drive vehicles and camel, the social life, although enviably peaceful, at times did become rather wanting in stimulation and here the child as diplomat came into his own. The people from the neighbouring Kanuri village, although very hospitable and extremely friendly, were rather shy of strangers, especially a white, female stranger who wore trousers! But a child, like a dog, has the uncanny ability of breaking down all barriers, even that of uncommon language, to make communication not only enjoyable but uncomplicated. By this time he had learned to walk and could be seen toddling over to the communal water tap for his daily ration of ground nuts from the women of the village.

As I am writing this, my mind is flooded with incidents, most of them enjoyable to recall, which we experienced with the 'little man' as we began calling him and all of them reinforce my conviction that where-

ever two adults go together, a child can go and probably suffer a lot less from the accompanying problems of adjustment; in fact, if you don't have one yourself, borrow one for journeys in foreign lands, they are invaluable.

- ¹ A Kob is a member of the antelope family.
- ² A local wen of which Thunder Bay is inordinately proud.
- ³ The Mothersills should go to Queensland on their next Sabbatical - there are teddy bears (Koalas) all over the place. □

OPEN LINE UNIVERSITY

A university with an 800 mile campus? The educational needs of Quebec make it necessary, and communications technology makes it practical.

Scarcely five years ago, the University of Quebec did not exist. In the short period since, however, it has become one of the pioneers in the concept of multi-campus universities, and has broken new ground in applying state-of-the-art technology to the problems of providing effective communications.

To maintain a constant link among its seven campuses, stretching across an 800 mile territory in Quebec, the university has used engineering and ingenuity to develop a unique communications system, not only to provide more effective administration, but for teaching and research as well.

The University of Quebec, founded in 1968 by an act of the National Assembly, is the province's seventh institute of higher learning, its fourth French language university and the first to go public. Its creation was the culmination of a ten year reform of Quebec's educational system which had already

taken root in the reorganization of the elementary and secondary schools and community colleges.

As well as the headquarters at Quebec City, the University of Quebec has campuses located at Chicoutimi, Montreal, Rimouski and Trois-Rivières and smaller study centres at Rouyn and Hull. In addition, L'École nationale d'administration publique, l'Institut national de la recherche scientifique and l'Institut de microbiologie et d'hygiène are administratively a part of the university. Total enrolment in 1973-74 is 30,000 students.

The networks

From the outset, it was seen that such a wide dispersion of facilities would present administrative difficulties. More serious, if less tangible, problems of providing for a free flow of ideas and information among students and professors - the kinds of exchange so vital to the educational process - are also more acute when significant distances separate the physical elements of a university.

One of the first projects in providing effective communications throughout the university was to launch a data communications network to aid in teaching, research and management. The system, based on a Control Data CYBER-73 computer, at Quebec, provides both batch and real-time processing facilities. Each campus has access to it according to its demands. The central computer serves all of the other university elements, including the smaller study centres. Because computing demands are higher at three locations the central computing facility has been beefed up by separate computers installed at the Montreal, Trois-Rivières and Chicoutimi campuses.

- Louis Brunel, Vice-President,
Communications, University of
Quebec. □

AU SEUIL D'UNE NOUVELLE TECHNOLOGIE: LA SUPRACONDUCTIVITE

Par Gaston Fischer

L'attribution du prix Nobel de physique pour 1972 est remarquable à deux titres. Tout d'abord, ce prix récompense non pas une invention, mais la découverte de l'origine d'un phénomène observé depuis longtemps, mais dont on ignorait jusqu'alors entièrement la cause. Ensuite - fait sans précédent - il s'agit de l'attribution d'un deuxième prix Nobel à une même personne, pour des travaux dans un même domaine. En effet, l'un des trois lauréats américains,* John Bardeen, avait déjà reçu le prix Nobel en compagnie de William Shockley et W.H. Brattain, pour avoir inventé le transistor.

Mais alors que le prix Nobel de 1956 récompensait une invention en physique des semiconducteurs, celui de 1972 a été attribué pour l'élaboration d'une théorie microscopique de la supraconductivité. L'adjectif "microscopique" signifie qu'il s'agit d'une théorie expliquant l'origine du phénomène de la supraconductivité en termes de processus à l'échelle atomique, par opposition à une théorie qui ne ferait que décrire le phénomène tel qu'on l'observe à l'échelle humaine ou "macroscopique". La nouvelle théorie de la supraconductivité est désignée par les initiales BCS, de ses trois auteurs; elle a été complétée quelques mois seulement après que Bardeen eut reçu son premier prix Nobel. A cette époque, Bardeen avait 48 ans et - de par son activité de professeur - dirigeait les travaux d'un groupe de jeunes chercheurs, parmi lesquels Cooper, qui était au bénéfice d'une bourse de perfectionnement postdoctorale, et Schrieffer, un étudiant préparant sa thèse de doctorat.

Le phénomène de la supraconductivité est si spectaculaire, et il est appelé à jouer un rôle tellement important dans les technologies de

demain, que nous allons essayer d'en présenter les traits principaux.

LORSQUE LA RÉSISTANCE ÉLECTRIQUE DISPARAIT

La supraconductivité est la propriété qu'ont certains métaux, à des températures voisines du zéro absolu, de présenter une conductivité électrique infiniment élevée (ou une résistivité nulle). La loi d'Ohm $I = U/R$, où I = courant et U = tension, nous montre qu'un courant I non nul peut parcourir un supraconducteur, bien que la tension U soit zéro (mathématiquement: $I = 0/0 \neq 0$). Ainsi, un anneau supraconducteur (p.ex. un anneau de plomb à une température de 4°K, c'est-à-dire 4 degrés centigrades au-dessus du zéro absolu qui est à -273,16°C) pourra être parcouru par un courant I véritablement permanent. Ce courant permanent est un courant d'électrons, tout comme le sont les courants électriques dans les conducteurs traditionnels. Puisque nous savons que les électrons sont des particules atomiques bien réelles qui ont une masse m (donc une inertie) et une charge, e , ce courant I dans l'anneau représente une sorte de mouvement perpétuel, au même titre que la ronde incessante des électrons autour du noyau d'un atome.

La résistance électrique des métaux provient des forces de freinage auxquelles sont soumis les électrons de conduction lorsqu'ils entrent en collision, soit avec les atomes ou ions du réseau cristallin, soit avec des imperfections de ce réseau, tels que les atomes d'impuretés ou des défauts cristallins. Un réseau sans imperfections freine les électrons par son agitation thermique. Au zéro absolu, un réseau cristallin parfait opposerait une résistance nulle au courant électrique. Mais on sait que le zéro absolu ne peut être atteint.

Revenons à la supraconductivité. Comment comprendre que pour des métaux qui ne sont ni parfaits, ni au zéro absolu, les forces de freinage semblent disparaître lorsque la température descend au-dessous de T_c ? Il se trouve que dans les supraconducteurs un phénomène tout nouveau apparaît. Les électrons responsables de la conduction électrique, qui dans un métal à la température ambiante se comportent comme des particules essentiellement indépendantes, s'associent soudain en paires dont les deux partenaires tournent l'un autour de l'autre. Ces paires, dites paires de Cooper - puisque c'est lui qui les a découvertes - forment une nouvelle particule de très grandes dimensions. Les deux électrons de chacune de ces paires restent constamment à plusieurs dizaines ou centaines de distances interatomiques l'un de l'autre. Pour ces nouvelles particules, les collisions avec le réseau deviennent sans effet; lorsqu'un des électrons subit une collision, son partenaire absorbe le recul du réseau, de sorte que la paire n'a pas perdu d'impulsion (ou quantité de mouvement) dans cette collision. Les deux électrons de la paire changent simultanément d'orbites cristalline par un processus qui ne fait ni gagner ni perdre d'énergie à la paire. En d'autres termes, cette paire ne subit pas une force équivalente de freinage, ce qui revient à dire que la résistance électrique a disparu dans le supraconducteur.

DES MATÉRIAUX NOUVEAUX

Dès qu'il eut découvert, en 1911, le phénomène de la supraconductivité, le physicien hollandais Kamerlingh Onnes a tout de suite pensé à la construction d'électro-aimants qui ne consommeraient pas d'énergie. Il dut cependant vite se rendre compte que cela n'était pas si facile; la supraconductivité disparaissait

rapidement dans un champ magnétique de quelque intensité. Il importait peu que ce champ soit d'origine externe - par exemple produit par un aimant permanent - ou d'origine interne, c'est-à-dire produit par le courant circulant dans le supraconducteur lui-même. Aujourd'hui, heureusement, on comprend bien mieux le phénomène de la supraconductivité, surtout en raison de la théorie BCS. On sait que les fils supraconducteurs de matériaux comportant une très grande densité d'imperfections cristallines sont extrêmement insensibles à l'influence des champs magnétiques. On fabrique ainsi déjà des électro-aimants extrêmement puissants, qui ne consomment pas d'énergie électrique (hormis celle nécessaire à la réfrigération), dont les dimensions sont très réduites comparées à celles des électro-aimants classiques et qu'on peut faire fonctionner comme des aimants permanents en reliant les bornes d'alimentation par un fil supraconducteur une fois que le courant a été établi.

VASTES PERSPECTIVES D'AVENIR

Ces nouveaux matériaux supraconducteurs ouvrent des perspectives toutes nouvelles pour les futures technologies de production d'énergie, telles la fusion thermonucléaire et la génération d'électricité par la méthode magnétohydro-dynamique (MHD), ou l'on aura besoin de champs magnétiques très puissants sur de très grands volumes. On envisage aussi - et un gros effort de recherche y est engagé - la construction de câbles électriques supraconducteurs, beaucoup plus économiques que les lignes à haute tension d'aujourd'hui. Ces nouveaux câbles supraconducteurs seront en forme de tuyaux, à l'intérieur desquels circule l'hélium liquide réfrigérant. Cette méthode a d'ailleurs révolutionné toute récemment la technologie des aimants supraconducteurs elle-même déjà révolutionnaire par rapport aux électro-aimants

classiques. On vient en effet de construire au CERN, à Genève, des aimants de chambres à bulles, parmi les aimants les plus gros qui soient, avec circulation forcée d'hélium liquide sous pression. Ce procédé s'est révélé incomparablement plus économique que de plonger l'aimant entier dans une grosse cuve pleine de réfrigérant, qu'il faut continuellement maintenir pleine et qui nécessite un énorme volume d'hélium, gaz rare qui reste encore cher.

La possibilité de produire des champs magnétiques intenses à peu de frais permet d'ailleurs d'envisager des progrès rapides dans bien des domaines, par exemple en médecine, où l'on pourra déplacer des objets pourvus d'un petit aimant à l'intérieur du corps, en particulier du cerveau ou le long de vaisseaux sanguins (navigation intravasculaire). Par cette méthode on a réussi tout récemment aux USA à colmater quatre ruptures d'anéurismes (ruptures de vaisseaux sanguins). En exploitation minière, on étudie la séparation de minerais dont les propriétés magnétiques sont très légèrement différentes. Pour effectuer la séparation, il suffit de réduire le minerai en poudres suffisamment fines pour que chaque grain de la poudre ne contienne plus en général qu'un seul composé; un champ intense sépare ensuite les différentes sortes de grains. Un gros effort de recherche se produit aussi dans le domaine des transports publics, où l'on essaye d'employer des champs magnétiques autant pour accélérer que pour supporter un train (lévitation). Dans un tel train, les roues décollent du rail dès qu'une certaine vitesse (environ 70 km/h) est atteinte; le train "flotte" ensuite au-dessus d'une piste d'aluminium, repoussé par des forces d'induction magnétiques. On espère atteindre ainsi des vitesses de 500 km/h.

Il semble donc que l'on soit à la veille de voir la supraconductivité prendre une place de choix dans

notre vie technologique. Cette entrée a tardé, d'abord parce que les techniques cryogéniques sont restées longtemps confinées aux laboratoires de recherche pure; ensuite parce que l'on pensait que la supraconductivité ne pouvait pas avoir d'intérêt pratique à moins de pouvoir trouver des supraconducteurs dont la température critique dépasse 30 ou 40° K. On a dû finalement se rendre à l'évidence qu'il y a une sorte de barrière naturelle autour de 20° K. Mais, l'avènement d'alliages fabriqués en laboratoire, qui restent supraconducteurs dans des champs magnétiques très intenses et qui peuvent par conséquent transporter des courants 2000 à 3000 fois plus forts que le cuivre, promet des perspectives tellement révolutionnaires et économiquement attractives, qu'il a valu la peine de développer la cryogénie pour accéder facilement aux températures où ces fabuleuses propriétés deviennent réalité. Un peu de retenue est de rigueur, cependant, car les obstacles techniques restent importants et des déboires sont encore à prévoir, tels ceux qu'on a eu dans le domaine des ordinateurs. Ainsi, plusieurs laboratoires américains ont investi des millions pour le développement de mémoires supraconductrices de très haute densité, mais ont finalement renoncé devant certains obstacles encore infranchissables aujourd'hui. Il n'en reste pas moins que la supraconductivité est une science à suivre pour tous ceux qui s'intéressent aux technologies d'avenir.

■ *John Bardeen de l'Université de l'Illinois, Leon N. Cooper de l'Université Brown et John Robert Schrieffer de l'Université de Pennsylvanie. ■

Cet article a paru d'abord dans la *Revue Polytechnique* (Genève, juin 1973).

WELCOME TO MY SCHOOL

By Ernie Dojack

LIVING AND LEARNING

I'm not sure I like what I see in our high schools. Ontario has been on the credit system for a few years now. We've all been "living and learning". But the Hall-Dennis report has been gathering dust on my principal's shelf for a long time. Guidance counsellors are still trying to fit student wishes into personal timetables. "There's so much choice." "I don't know what to take." "I hate History and Math!"

Why, I remember when you had to take French and English to get into University (and then, if you were like me, the first chance you got, you dropped those subjects faster than a hot ring clamp).

At last, I made it!! Into the confines of Chemistry and Physics. No more languages or history. No more iambic pentameter or 'King Lear'. I'm safe. Finally, I'm feeling comfortable ... very, very, comfortable.

A LETTER FROM LAHR

I decided to write this letter even though we haven't been communicating very well.

I'm living in a small apartment located in the heart of the Rhine Valley - and somehow I don't feel as comfortable as I did before. Felix Wankel was born and raised in the little town where I live. Remember him? He's the fellow making all the money with his rotary engine. Have you ever driven an Audi? Kurt Mauer lives in my town, too. He's my landlord. But he only speaks German, so we don't talk much.

Brigitta is Kurt's daughter. She is only in Grade 5. I will

never forget her first words to me. "Hi! How are you?" Brigitta and I talk a lot. In fact, she's my interpreter. I even had to get her to ask Kurt to turn on the heat the other day. Felt a little silly. I just don't feel that comfortable any more.

I returned from a tremendous holiday the other day. Cyprus, Greece, Yugoslavia, Austria, Italy and France. Not bad, eh! I must have twenty shots of the Acropolis. Never was able to figure out what it was doing up on that hill.

Here's a picture of me in Nicoseia, talking over a moussaka with a Turkish Cypriot guard - the one standing with the automatic rifle on his shoulder. He told me to say "Hi" to his daughter in Toronto. He was a real nice guy. He was never able to tell me why the Turks and Greeks are always fighting. Didn't feel very comfortable there, either.

Tell June that I finally saw the Mona Lisa. It looks just like a Safeway reprint - small too. I don't understand what all the fuss is about.

I even went to hear the Berlin Symphony the other night. Blew the budget - \$15 a ticket. It was OK, I guess - if you like that kind of music. Everyone seemed to worship the conductor; he got a bigger ovation than when the "Rolling Stones" came to town. Honestly!

Our Director of Education tells us to use Europe as our classroom, but it's not that easy. I feel a little uncomfortable at times because I know so little about it.

In the last issue of CARET, Jeanne Sauve said that "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".

It felt good to get back to school today. The old Chem. lab

up on the third floor never looked better. "Define physical and chemical change, and give two examples of each." It sure felt good talking about the subject I know. I finally feel comfortable again!

Good luck this year.

Ernie

P.S. Write soon.

■ Mr. Dojack came from Winnipeg to Port Arthur in 1966. He began his teaching career in Lakeview High School that year. In the Summer of 1972, he moved to Lahr, West Germany, to begin teaching at one of the Department of National Defence Schools Overseas. He is presently Head of the Science Department at Lahr, the Senior School. After the termination of his "Loan of Service" agreement, he will be returning to Thunder Bay. ■

OIL SUBSTITUTES?

The MONTREAL GAZETTE reported on January 5, 1974 a discovery by an inventor called John F. Hughes. Mr. Hughes, who was born in Wales, is a chemist who has found a way of making resins for plastics and coatings from a key carbohydrate, instead of from petroleum derivatives. This of course has great potential in view of the energy crisis, for it means that his strike could eventually provide a substitute for a multitude of products which now rely on oil.

What is his solution? It is a substance that is cheap and plentiful — starch. While the easiest source of starch is corn, it can be extracted from potatoes or tapioca. More than 60% of easily processable starch can be obtained from a dried ear of corn. There are an enormous

number of advantages and repercussions that could be derived from the scientist's find. Starch is, of course, a renewable commodity; oil is irreplaceable. As well as helping to solve problems of non-renewable energy resources, aid to ecology is also possible, for unlike regular commercial paint, paint made from starch resin disintegrates once it is buried. It would cost much less to make the paint. The raw materials used are cheaper; those used in latex paint, for example, cost \$2.50 a gallon, while those in Hughes' mixture would cost \$1.56 a gallon. This would be of advantage in holding down inflation.

Two years ago, Hughes got a small team together and incorporated Plastistarch in order to continue research and development. Paint makers and other major companies are finally evaluating his resin-based coatings and they are negotiating to license the process. Japan Maize Products of Tokyo is showing the most interest, but several major U.S. starch and oil companies and a couple of European petrochemical companies are interested as well.

CANADIAN SUPPORT IS LAGGING

The inventor already has one United States patent and around the world several others are pending. However, his lawyer stated that "we get zero support from Canada". He, Digby Clarke, financially supports the enterprise. He added that neither the National Research Council nor the Federal or Provincial Government could be convinced to support Plastistarch, nor could any major company. Clarke blames Canada's "cold shoulder" on the fact that many others have tried to do what Hughes has done, but failed. He is, in fact, turning back the clock thirty years or more when natural products were used to make natural synthetics, and when plastics were little used.

ARISTOTLE'S IDEAS ON MOTION

By D. G. Hughes

WHAT ARISTOTLE SAID

It is likely that you, the reader of this article, if you have been exposed to the study of mechanics, think that Galileo and Newton were the first to say anything useful or sensible about it. It is even possible you believe that because Aristotle lived and died in the 4th century B.C. his ideas on physics can only be laughable. It is certain that if you believe this, you are wrong.

Aristotle's ideas on motion are largely contained in two of his books, "On the Heavens" and "Physics". These books are probably versions of his lecture notes edited by his followers; they are easy to read and understand, whereas books about Aristotle tend to be neither. He begins, in "On the Heavens", by drawing a fundamental distinction between *natural* and *unnatural* motion, the former being that which bodies have of their own nature, the latter requiring some external agent to act on the body. Natural motions are further subdivided into *upwards* (i.e. away from the centre of the earth), *downwards* (i.e. towards the centre) and *circular*. Classification of this sort is typical of a scientific approach to any problem, but in choosing three subdivisions, Aristotle seems to be governed by reasons which appear alien to us: he points out that three is the lowest number of objects of which we use the word "all" ("both" being used of two objects) and therefore this number has a quality of completeness lacking in "one" or "two".

EARTHLY AND HEAVENLY MOTIONS

These ideas are then applied to account for the motions actually

observed around us, but in doing so Aristotle is careful to distinguish the behaviour of objects near the earth from that of objects in the remoter regions of the sky. For him the moon's orbit round the earth divided the universe into two, the terrestrial or sublunary region and the heavenly region. In the sublunary part of the universe, all material objects were compounded of the four basic elements: earth, water, air and fire, these being idealized essences of the common substances with those names. This idea did not originate with Aristotle but was handed on to him by his predecessors.

Aristotle, however, introduced the further notion that these elements each had their proper place in the universe; earth, for example, belonged properly to the centre of the universe (which was, for Aristotle, at the centre of the terrestrial globe) while fire belonged to the heavens. Objects made of these elements will, if free to do so, move with a natural motion in such a way as to find their proper place; earth will move naturally towards the centre in a straight line and is classified as absolutely heavy; fire moves naturally upwards and is absolutely light; water and air are only relatively heavy or light and their natural motions, still linear, will be towards or away from the centre according to the medium which surrounds them. Opposed to these linear natural motions of the sublunary elements is circular motion which is a natural motion only in the heavens, being an unnatural or forced motion in the earthly region: circular motion is natural to the fifth element, introduced by Aristotle, the aether, which exists, incorruptible, without beginning or end, only in the heavens. (This incidentally, leaves little room for

the Biblical account of the creation of the universe and was one of the reasons behind the attempts made in Paris in the thirteenth century to prohibit the public teaching of Aristotle's work.)

AGREEMENT IS QUALITATIVE, NOT QUANTITATIVE

These basic ideas take us a surprisingly long way in explaining (whatever that word may mean) the everyday observation of objects moving without constraint. Earthly objects, such as rocks, do fall, and in a straight line towards the centre of the earth; fiery objects, such as flames and smoke, do rise upwards; water surrounded by earth rises in mountain springs, but falls as rain when surrounded by air; the stars in the heavens do appear to move in circles. But the agreement with observation is qualitative only (and not even that when we consider forced motions), so that when Aristotle, in showing that it is impossible for a vacuum to exist, assumes that the time taken for an object to fall a certain distance is inversely proportional to its weight, he is assuming a quantitative relationship which is simply wrong. Heavy objects do, of course, fall faster than light ones of the same size in a resisting medium, though not to the extent Aristotle thought, and the resistance of the surrounding medium does affect the velocity of the fall, though again not in the way Aristotle thought. So his argument — when resistance is reduced to zero by allowing the object to fall in a vacuum the velocity of fall will be infinitely large, which is impossible, so a vacuum cannot exist — though logically faultless gives a wrong answer because it is based on wrong assumptions.

NATURAL AND UNNATURAL MOTION

Aristotle was well aware that falling objects moved faster the further they fell and had a perfectly good explanation, namely, that for objects moving in accordance with their nature towards their proper place, the climax of the motion would occur at the goal towards which they were striving; for unnatural motions, the contrary was true, and this was borne out for Aristotle by the observation that a stone thrown vertically upwards will slow down as it rises further from its proper place.

In discussing natural motion, then, Aristotle's ideas seem not unreasonable, at least qualitatively. In treating forced motion, he was less successful and it was not long before his ideas on the motion of a projectile were disputed. You may think it easy to show that the path of an arrow or a thrown ball is, at least roughly, a parabola and so, in an age when multiple-exposure photographs are commonplace, it is. But when the ballistics experts in the sixteenth century knew that a cannonball rose along a sloping straight line to the highest point of its trajectory, they knew it because the gunners told them so. If you think this is stupidity, try asking a Grade 9 student what happens to the speed of an arrow after it has left the bow (for that matter, try asking yourself, or a third-year university student).

THERE WAS A SHORTAGE OF EQUIPMENT!

Everyday experience plus high intelligence are not always enough to solve even the simplest problems in physics; that is why we are driven to use special laboratories and complicated equipment. But Aristotle was not foolish because he lacked these facilities and you would be foolish to think him so. □

KENORA ENVIRONMENTAL SURVEY

Lakewood's environmental chemistry students have received the results of a survey conducted in December and January on 355 Kenora residents. The ten questions all relate to environmental issues. The question responses were cross-tabulated according to sex, age and income groups. The survey results were key-punched and tabulated by the Computer Centre at Lakehead University.

SURVEY RESULTS

AGE GROUPS

■ BELOW 18	-----	21%
■ 18 TO 25	-----	20%
■ 25 TO 45	-----	34%
■ OVER 45	-----	24%

INCOME GROUPS

■ LOW	-----	11%
■ AVERAGE	-----	49%
■ HIGH	-----	41%

SEX

■ MALE	-----	48%
■ FEMALE	-----	53%

[All results are correct to only two significant figures, consequently totals may vary from 100%.]

SURVEY QUESTIONS

1. DO YOU FEEL GOVERNMENT IS CONTROLLING INDUSTRIAL POLLUTION ADEQUATELY?

YES: 20%
NO: 80%

2. DO YOU FEEL ENVIRONMENTAL PROTECTION SHOULD BE A POLITICAL ISSUE?

YES: 71%
NO: 29%

3. DO YOU FEEL THE NEWS MEDIA CONVEY OUR POLLUTION PROBLEM EFFICIENTLY?

YES: 47%
NO: 53%

4. DO YOU FEEL OUR TOWN HAS SUFFICIENT LITTER RECEPTACLES?

YES: 32%
NO: 68%

5. WOULD YOU CONSIDER SEPARATING CLEAN PAPER FOR RECYCLING, FROM YOUR TRASH?

YES: 69%
NO: 31%

6. ARE YOU REDUCING FUEL CONSUMPTION IN YOUR HOME AND AUTOMOBILE TO MEET THE ENERGY CRISIS?

YES: 45%
NO: 55%

7. WOULD YOU UTILIZE A PUBLIC TRANSPORT SYSTEM IF SERVICE WERE INCREASED?

YES: 60%
NO: 40%

8. WOULD YOU REPAIR YOUR AUTOMOBILE TO MEET EMISSION CONTROL STANDARDS?

YES: 64%
NO: 36%

9. WOULD YOU CONSIDER PAYING AN ADDITIONAL \$2.70/YEAR FOR IMPROVED SEWAGE TREATMENT; I.E. TERTIARY TREATMENT?

YES: 77%
NO: 23%

10. WOULD YOU SWITCH TO A LOW-PHOSPHATE DETERGENT IF YOUR PRESENT DETERGENT CONTAINED EXCESSIVE PHOSPHATE?

YES: 89%
NO: 11%

The computer print-out was analyzed by the environmental chemistry students in groups with the following results:

QUESTION 1 ANALYSIS

Young people, in particular, were concerned over the government's ineffectiveness at curbing industrial pollution.

QUESTION 2 ANALYSIS

The 71% consensus indicates that

our political leaders had best generate and make known sound platforms with respect to environmental protection issues.

QUESTION 3 ANALYSIS

Very reassuring to know that news media are conveying pollution problems adequately.

QUESTION 4 ANALYSIS

Middle age males in particular were concerned over the lack of litter receptacles throughout the town.

QUESTION 5 ANALYSIS

We were very elated to find such positive responses to the recycling question. Consequently, a feasibility study is expected to take place in the very near future to discuss the recycling concept. It is interesting to note that approximately 59% of our municipal trash consists of recycleable paper which could be sold to the paper industry for \$15-\$60 per ton, if processing facilities were available.

QUESTION 6 ANALYSIS

Middle age males of average and high incomes are not too interested in voluntary reduction of fuel consumption.

QUESTION 7 ANALYSIS

A 60% "YES" to taking a bus is a particularly favourable response. This indicates a truly sincere desire to reduce both air pollution as well as the petrol shortage. Young and middle age males were the least responsive to this question.

QUESTION 8 ANALYSIS

The favourable response was particularly evident for above income young males. The flaw in this question stems from the fact that not all people surveyed are in possession of a vehicle.

QUESTION 9 ANALYSIS

Kenora boasts a modern secondary treatment plant that is 90% effective at removing wastes from domestic sewage (unless it rains). Further improvement of existing facilities would cost the Kenora taxpayer \$2.70 per person per year (*Environment Science & Technology*, November 1973). It is interesting to note that the people most willing to pay were the younger people who generally are not involved in tax-paying.

QUESTION 10 ANALYSIS

As a result of the studies conducted at the Fisheries Research Station southeast of Kenora, under the able leadership of Dr. D. Schindler [1970], it has been conclusively proven that phosphates (present in most detergents) are the cause of the over-enrichment (eutrofication) of our Northwestern Ontario waters. 89% of all people surveyed are willing to substitute for their present detergent an effective low-phosphate detergent or soap. Analyses of phosphate in detergents collected in the survey are presently underway by the environmental chemistry students.

■ The details of this survey were sent to us by Mr. Robert Aitken who teaches at Lakewood Secondary School in Kenora. ■

AIRCRAFT 'CONTROL COLUMN' END IN SIGHT? Since the early days of flying, the main method of controlling flight movements has been by operating the control column or 'joystick'. The Royal Aircraft Establishment in Farnborough, England has devised an electronic system which does the work more effectively and more quickly.

LE CHAMP MAGNETIQUE TERRESTRE

Par Gaston Fischer

Nous nous proposons de parler d'un champ magnétique beaucoup plus faible, celui de la Terre. Chacun connaît l'existence de ce champ qui aligne l'aiguille des boussoles et permet au voyageur de s'orienter. Ce que le profane sait moins souvent, c'est que ce champ varie d'un endroit à l'autre de la Terre, qu'il varie dans le temps et qu'à tous les âges il a été intimement lié à l'histoire de notre planète. Nous allons, dans le présent article, essayer de présenter ces divers aspects du champ magnétique terrestre (CMT) et, autant que possible, essayer de les comprendre.

DEUX POLES NORD

Les usagers de la boussole, en particulier les navigateurs, se sont assez tôt rendus compte que la boussole ne pointait pas, en général, exactement vers le nord géographique, c'est-à-dire vers le pôle de rotation de la Terre. On a ainsi été conduit à établir des cartes qui donnent pour chaque endroit du globe la déviation angulaire, ou *déclinaison**, du nord magnétique par rapport au nord géographique.

Le CMT est une grandeur dirigée, donc un *vecteur*, caractérisée non seulement par son *amplitude* ou grandeur, mais aussi par sa *direction* dans l'espace. C'est pourquoi l'on représente souvent un champ magnétique à l'aide du concept des lignes de force. On conçoit donc bien qu'à la surface de la Terre le vecteur magnétique n'est pas représenté uniquement par la déclinaison et l'amplitude que nous venons de définir, mais qu'il faut aussi donner son *inclinaison* par rapport à l'horizontale. La représentation mathématique de CMT permet de faire la distinction entre une partie régulière (*champ dipolaire*) et des *anomalies* du CMT. Les pôles

magnétiques ne coïncident pas avec les pôles géographiques, cause principale des fortes déclinaisons qu'on observe lorsqu'on s'approche des pôles magnétiques, et d'autre part, on note que les deux pôles magnétiques ne sont pas dans des positions symétriques par rapport au centre de la Terre. Finalement, la déclinaison, et par suite aussi les autres paramètres du CMT, ne sont pas immuables. En fait, s'il est vrai que la déclinaison varie peu d'une année à l'autre, les instruments précis et sensibles dont on dispose aujourd'hui démontrent sans ambiguïté que tous les paramètres du CMT changent continuellement en un endroit donné. On a observé que ces changements semblent découler presque entièrement d'une lente mais irrégulière rotation d'est en ouest des anomalies du CMT. On estime qu'un tour complet de ce mouvement requiert de 2 à 5 mille ans. En Suisse, la déclinaison diminue maintenant d'un dixième de degré par an et l'inclinaison est pratiquement stationnaire.

Les propriétés du CMT que nous venons de présenter peuvent toutes être vérifiées à l'aide de la boussole classique bien connue. Si l'on ne disposait pas d'instruments plus précis et surtout plus sensibles, on pourrait croire que le CMT est de nature très quète, soumis seulement à ces lentes *variations séculaires* que nous avons décrites plus haut. On en concluerait aussi qu'il est d'origine entièrement interne à la Terre, résultant de quelque boucle de courant près du centre de notre planète. Comme nous allons le voir, il n'en est pas du tout ainsi.

UNE ACTIVITE FEBRILE

Les magnétomètres modernes ont révélé que le CMT était continuellement le siège de variations rapides autour de cette valeur moyenne

qu'indique la boussole. Si la boussole ne permet pas, en général, de les déceler, c'est que l'amplitude de ces variations n'est que de l'ordre du millièème de l'amplitude de ce champ moyen ou *champ principal* que mesure la boussole. Si l'on accepte que la majeure partie du CMT provient de courants électriques à plusieurs milliers de kilomètres sous la surface de la Terre, alors les lois de l'électrodynamique nous disent que ces variations rapides ne peuvent en aucun cas venir de l'intérieur de la Terre (*effet "skin" ou de peau*), et viennent par conséquent de l'espace. Il y a donc deux sources distinctes au CMT, l'une interne et l'autre externe à la planète, mais nous verrons aussi que ces deux sources ne sont pas sans interactions aux conséquences importantes.

LE CHAMP INTERNE

La sismologie, ou étude des tremblements de terre, a révélé que l'intérieur de notre planète n'était solide que jusqu'à une profondeur d'environ 2900 km. Cette partie est appelée *manteau de la Terre*. Au-dessous, en raison des températures élevées qui règnent à ces profondeurs, la Terre a un *noyau liquide*, formé essentiellement de fer fondu. Tout au centre de la Terre, on a finalement un coeur de fer solide, d'un rayon d'environ 1300 km. Cette solidification est le résultat des pressions énormes, de plusieurs millions d'atmosphères, qui règnent au centre du globe. A l'interface, entre manteau et noyau, la conductivité électrique change brusquement, le noyau liquide étant environ 1000 fois plus conducteur que le manteau solide. A cause de sa rotation avec la planète, cette masse hautement conductrice est le siège de phénomènes d'induction électromagnétiques et semble fonctionner comme une dynamo unipolaire. Le caractère encore quelque peu conditionnel de

cette affirmation est dû au fait que la répartition exacte des lignes de courant de la vraie dynamo terrestre n'a pas encore été élucidée.

Il nous reste à comprendre pourquoi la partie principale du CMT est si irrégulière à la surface de la Terre. Revenons à l'interface entre manteau solide et noyau liquide. On doit admettre que cette surface n'est ni bien franche, ni parfaitement sphérique. Il y a une zone de transition qui est le siège de forces de frottement. La rotation du solide entraîne bien le liquide, mais par suite de causes qui ne sont pas encore bien connues, il y a par moments des différences de vitesse de rotation entre liquide et solide. A cause de ces différences de vitesse et des irrégularités de l'interface, le liquide s'écoule de façon turbulente au voisinage de l'interface. Mais puisque c'est dans cette région que circulent les plus forts courants de la dynamo terrestre, ces courants sont déviés par la turbulence de la matière liquide et sont à leur tour de nature turbulente. Le champ magnétique produit par ces courants irréguliers est lui aussi irrégulier. Vu la grandeur de l'échelle sur laquelle se produisent ces phénomènes, la durée des irrégularités du courant et du champ est très grande et de toute manière, à cause de l'effet de peau cité plus haut, seules les fluctuations très lentes du champ peuvent être perçues à la surface de la Terre; la durée des fluctuations les plus rapides est de l'ordre de 10 à 100 ans. Une partie des irrégularités du champ principal provient donc de la turbulence des courants du noyau. Une deuxième partie provient des inhomogénéités du manteau solide. La distribution de ces inhomogénéités est elle-même sujette à une lente évolution; en effet, malgré le qualificatif de "solide", le manteau est en mouvement à des vitesses de l'ordre de 1 à 10 cm/an par écoulement plastique d'un ensemble de cellules de matière.

Quant à la dérive d'est en ouest des anomalies du CMT, on ne sait pas, pour l'instant, s'il s'agit d'un phénomène passager ou permanent. Ce sont les relevés récents, de quelques centaines d'années au plus, qui la relèvent, mais on n'a pas encore pu en confirmer l'existence dans un passé plus lointain. Aucune explication théorique de son existence ne s'est d'ailleurs imposée.

LE CHAMP EXTERNE

Comme nous le disions plus haut, la seconde contribution au CMT est d'origine externe et comprend en particulier toutes les variations rapides de ce champ. L'environnement de la Terre se révèle, à mesure qu'on le connaît mieux, plus complexe qu'on ne le pensait d'abord. Au-dessus de l'atmosphère terrestre, dans les couches inférieures de laquelle nous vivons, on trouve des régions très diversifiées de par le nombre et le type de particules qu'elles contiennent. Certaines de ces régions ne renferment guère que des particules chargées, électrons et protons, liées à la Terre précisément par son champ magnétique qui force ces particules sur des orbites assez bien définies. A ces mouvements de particules chargées sont associés des courants en haute altitude et par suite des champs magnétiques. D'autres particules chargées sont envoyées vers la Terre par le soleil, en même temps que la lumière, bien qu'à des vitesses 100 ou 1000 fois moins grandes que la vitesse de la lumière. Ce vent solaire interagit violemment avec le CMT. Dans les régions éloignées de la Terre le vent solaire domine complètement la scène établissant son propre champ magnétique. Entre la surface de choc et la magnétopause se trouve la zone où les particules chargées du vent solaire sont déviées de leur trajectoire rectiligne par le

CMT; c'est la région où vent solaire et CMT interagissent violemment. A l'intérieur de la magnétopause, la Terre réussit à établir les lignes de force de son champ, c'est la *magnétosphère*, mais la magnétosphère se trouve comprimée par le vent solaire, tandis que de l'autre côté le vent solaire semble entraîner au loin les lignes de force du CMT. La compression du CMT par le vent solaire produit à la surface de la Terre des *variations diurnes* ou journalières caractéristiques, différentes d'endroit en endroit, et dépendantes avant tout de la latitude.

Mais le vent solaire n'est pas un vent régulier; en réalité il est connu pour ses sautes d'humeur, en général imprévisibles, reflets de ce que l'on appelle l'*activité solaire*. Le nombre et la grandeur des taches solaires sont un indice de cette activité. Plus il y a de taches, plus la surface du soleil est en activité et plus le vent solaire souffle en rafales turbulentes qui se traduisent, à la surface de la Terre, par d'importantes et rapides variations des paramètres du CMT. On parle à cet égard d'*activité géomagnétique* ou, selon les cas, d'*orages magnétiques*. Comme l'activité solaire est soumise à un cycle de 11 ans, avec des années calmes et des années de grande activité, il en va de même de l'activité géomagnétique. Il y a encore d'autres périodicités, soit liées au système Soleil-Terre donnant lieu en particulier aux variations diurnes et à des variations annuelles, soit au Soleil seul qui semble être sujet à certaines variations périodiques très lentes, dont une de 60 ans, une autre d'environ 78 ans, et probablement d'autres aux périodes encore beaucoup plus longues. On voit ainsi que le champ externe produit à la surface de la Terre des fluctuations couvrant un spectre quasi continu, depuis les

périodes les plus courtes (moins d'une seconde) aux périodes les plus longues. Le champ d'origine interne, par contre, ne peut contribuer qu'aux variations lentes, commençant par les variations séculaires; mais nous verrons maintenant comment, dans le domaine des variations lentes, des interactions entre les deux sources de champ se produisent.

Des instabilités de la dynamo terrestre ou des renversements des pôles magnétiques.

Nous avons vu plus haut que la dynamo unipolaire n'est qu'un modèle extrêmement schématique de la dynamo terrestre, dynamo dont on ne connaît pas, en réalité, le fonctionnement exact, et surtout pas la distribution des courants. Néanmoins on peut tout de même, tirer des conclusions générales valables pour toutes les dynamos unipolaires, en particulier celle de la Terre.

En circulant dans le disque et le fil de la dynamo, le courant transforme de l'énergie en chaleur qui se perd, par exemple par rayonnement, vers l'environnement. La source de cette énergie est mécanique: en l'absence d'un moteur entraînant l'arbre de la dynamo, celle-ci se ralentit et finit par s'arrêter. Il en va de même de la dynamo terrestre; bien que ce soit par le biais de mécanismes mal connus, l'énergie que dissipent les courants de la dynamo provient en dernier ressort du mouvement de rotation de la Terre. Notons en passant que ce réservoir d'énergie est très grand; le ralentissement de la rotation terrestre se traduit par une augmentation annuelle de la longueur du jour de 20 millièmes de seconde environ, ce qu'on peut aussi exprimer en disant que la longueur du jour, il y a 600 millions d'années, ne valait que 21 de nos heures. Une partie du ralentissement vient d'ailleurs d'autres causes, telles les marées et leur dissipation d'énergie par frottement.

Une autre propriété de la dynamo unipolaire est celle de fonctionner indifféremment avec un champ magnétique orienté parallèlement ou antiparallèlement à l'axe de rotation. Pour voir cela supposons la machine en rotation, mais en l'absence de champ magnétique; il n'y aura donc pas non plus de courant induit. Supposons maintenant qu'une perturbation passagère produise un champ magnétique parallèle à l'axe. Si la machine satisfait certains critères de construction, cette perturbation induit des courants qui renforcent le champ perturbateur, ou pour le moins la composante selon l'axe de la dynamo. Après disparition de la perturbation il reste donc un champ dirigé dans l'axe de la dynamo. Selon la direction de la perturbation on aura un champ dirigé dans un sens ou dans l'autre de l'axe, et surtout on voit que la situation où le champ est nul est instable vis-à-vis de la plus petite perturbation. Mais la conclusion principale à tirer de cette propriété de la dynamo unipolaire, est que le CMT n'est pas un vestige du passé qui va diminuant, mais est continuellement entretenu par la rotation de la Terre. La dynamo terrestre est donc une dynamo self-excitée. D'autre part si le modèle simplifié de dynamo est sensible aux perturbations externes, la dynamo terrestre avec sa distribution de courants très complexe et surtout non localisés par des fils comme le modèle, y est encore beaucoup plus sensible. C'est là que se trouve le mécanisme d'interaction entre les champs de source externe et interne. La dynamo terrestre est instable vis-à-vis de certaines perturbations d'origine externe qui peuvent aller jusqu'à renverser la polarité de la dynamo terrestre. En fait, on admet que la dynamo terrestre est instable même en l'absence de perturbations externes et l'on a réussi

à créer, en laboratoire, des dynamos self-excitées d'un type naturellement plus complexe, qui changent de polarité de façon tout à fait aléatoire. Les études paléomagnétiques, c'est-à-dire l'étude du magnétisme rémanent des laves et des roches sédimentaires qui se sont formées à des âges différents, révèlent l'histoire du CMT et fournissent une preuve indéniable des renversements fréquents de la polarité du CMT. Elles ont aussi montré qu'il y a eu, dans le passé, autant de périodes avec la polarité que nous avons aujourd'hui que de périodes à polarité inversée.

PALEOMAGNETISME ET DERIVE DES CONTINENTS

Le paléomagnétisme n'a pas permis seulement de confirmer les inversions de polarité du CMT et de reconstituer toute l'histoire de ses variations séculaires en intensité et direction, mais il est en train de fournir une information précise et détaillée du mécanisme des inversions. Il faut de 3 à 20 mille ans pour compléter une inversion qui se manifeste par des signes précurseurs tels qu'un affaiblissement de l'amplitude du CMT à la surface de la Terre et des oscillations plus rapides et plus grandes de sa direction autour des pôles géographiques. Un comportement semblable précède le rétablissement d'un régime plus stable en position inversée. Ces études, il est certain, permettront une compréhension meilleure de la dynamo terrestre.

Le paléomagnétisme est en voie de fournir encore bien d'autres clefs vers la connaissance du passé de notre planète. Faute de place, nous ne pouvons en signaler que la plus révolutionnaire. Le magnétisme rémanent des roches d'une certaine région conduit en général à des résultats parfaitement concordants quant à l'histoire du CMT. Ces régions sont souvent de la grandeur d'un continent entier et il est alors intéressant de constater que les

directions de la magnétisation rémanente d'une époque bien définie convergent toutes vers un pôle qui se trouve ainsi être bien localisé. Si l'on passe à un autre continent, ou quelquefois à une autre partie d'un continent, on constate à nouveau une concordance parfaite de toutes les données de cette nouvelle région, mais un désaccord total avec celles déduites des échantillons du premier continent. Une étude approfondie de ces désaccords a démontré de façon éclatante qu'ils provenaient tout simplement de la *dérive des continents*, à la surface de la Terre. On a même pu reconstruire l'histoire de la dérive des divers continents, ou sous-continent, l'un par rapport à l'autre durant les 600 millions d'années qui nous précèdent. L'hypothèse formulée il y a 60 ans par Wegener se trouve non seulement confirmée, mais on commence même à comprendre aujourd'hui les mécanismes par lesquels ces dérives se sont produites. Les données recueillies jusqu'à ce jour suggèrent qu'il y a quelques centaines de millions d'années encore, toutes les terres émergées ne formaient qu'un seul continent. Le morcellement qui a suivi s'est fait en plusieurs étapes. Par exemple, l'Asie d'aujourd'hui comprend un sous-continent, l'Inde, qui a vogué seul à une certaine époque, après s'être détaché d'une plaque qui contenait l'Afrique et l'Antarctique il y a probablement moins de 100 millions d'années, pour heurter la masse continentale de l'*Eurasie* (nom donné au block Europe-Asie) voici 30 à 40 millions d'années seulement. Les plissements et soulèvements qui ont formé la chaîne des montagnes de l'Himalaya en sont la conséquence et l'on a de fortes raisons de penser que la poussée du sous-continent indien sur l'Eurasie n'a pas encore cessé.

Nous avons pu nous convaincre que la science du géomagnétisme a pro-

gressé bien au-delà de l'art de la boussole et qu'elle fournit aujourd'hui un des moyens d'étude les plus puissants des phénomènes géophysiques, c'est-à-dire des phénomènes qui se passent et se sont passés autour et à l'intérieur de notre planète. La connaissance de ce passé et des mécanismes actifs présentement nous conduira peut-être à modifier notre comportement et influencera la prise de certaines décisions, là où les activités humaines sont en interaction avec les processus naturels.

■ *Nous écrivons en italique les termes du jargon scientifique à leur première apparition. Ces termes ont en général une signification scientifique bien précise dans le langage du chercheur spécialisé.■

Après avoir obtenu un diplôme de physicien de l'Ecole Polytechnique Fédérale de Zürich en 1953, Gaston Fischer s'engagea dans une carrière en physique des corps solides. Il s'est intéressé tour à tour aux diélectriques, aux semiconducteurs et aux métaux. Un travail sur les propriétés semiconductrices de InSb qu'il fit au Canada lui permit d'obtenir son doctorat de l'Université de Neuchâtel en 1959. C'est en étudiant le comportement de métaux aux fréquences micro-ondes qu'il s'intéressa au phénomène de la supraconductivité. Depuis environ deux ans M. Fischer est codirecteur de l'Observatoire Cantonal de Neuchâtel et son activité s'est déplacée vers les sciences de la Terre, en particulier le géomagnétisme.

Cet article a paru d'abord dans la Revue Polytechnique (Gèneve, juin 1973).

■ COMPUTERS HELP AMPUTEES ■

AN ITEM IN THE MONTREAL GAZETTE OF NOVEMBER 27, 1973 REPORTED THAT PERFECT LIMB REPLACEMENTS FOR AMPUTEES ARE BEING DEVELOPED WITH THE HELP OF COMPUTERS. THE UNIVERSITY OF BRITISH COLUMBIA, IT SAID, IS PUTTING THE FINISHING TOUCHES TO RESEARCH, WHICH HAS AS ITS OBJECT THE PROVISION FOR AMPUTEES OF LIMBS WITH PROPORTIONS IDENTICAL TO THOSE OF THE LOST ONE.

IT WAS REPORTED THAT JAMES DUNCAN, WHO HAS ASSISTED IN THE DEVELOPMENT OF THE ARTIFICIAL LIMB APPARATUS, SAID THAT EACH YEAR MORE THAN 20,000 ARTIFICIAL LIMBS ARE NEEDED IN NORTH AMERICA. UNTIL NOW IT HAS BEEN NECESSARY FOR DOCTORS AND MECHANICS TO MEASURE THE LIMB PHYSICALLY, MANIPULATE THE ALREADY TRAUMATIZED PATIENT AND MAKE SEVERAL FITTINGS. THIS IS NATURALLY PSYCHOLOGICALLY DISTURBING AND DISTRESSING.

THE NATIONAL AND MEDICAL RESEARCH COUNCILS IN OTTAWA HAVE BOTH BEEN SUPPORTING THE UNDERTAKING FINANCIALLY SO THAT DUNCAN AND A SKILLED TEAM OF PROFESSIONALS IN MEDICINE, MATHEMATICS AND PHOTODYNAMICS HAVE BEEN ABLE TO DEVISE A METHOD OF PHOTOGRAPHING, OR RECORDING ON TELEVISION, THE DIMENSIONS AND DETAILS OF THE LIMB.

THE COMPUTER IS INFORMED OF THESE MEASUREMENTS, BY TELEPHONE IN SOME CASES. THEN THIS INFORMATION IS REASSEMBLED AND FED INTO A MACHINE WHICH ACTUALLY MAKES THE FINAL CAST. THE PICTURE IS COMPLETED, DUNCAN SAID, BY "LIMB COSMETICS", WHICH GIVE THE LEG OR ARM ITS SMOOTH, FLESHY APPEARANCE AND HIDE THE MECHANICAL DETAILS.

IT CAN TAKE LESS THAN 24 HOURS TO COMPLETE THE PRODUCTION OF A LIMB AT A COST OF LESS THAN \$100, EXCLUSIVE OF MECHANICAL JOINTS. THE PROJECT HAS TAKEN FOUR YEARS.

THEIR NEXT PROJECT IS TO LAUNCH INTO "THE CLINICAL STAGE OF TRIALS WITH PATIENTS IN VANCOUVER AND OTHER COMMUNITIES". □

THE CONTINUING ADVENTURES OF MATHMAN

By The Lakehead University Math Club

SUMMARY OF PREVIOUS ACTION

After finally reducing the 8th degree differential equation to a series of harmless 1st degree differential equations, MATHMAN was heading home to his Locally Compact Hausdorff Space on his trusty homomorphism, HANS. Hiding under an open cover, his Arch Enemy $\sin^{-1} \frac{1}{x}$ chose a lethal $\epsilon > 0$ from his arsenal of real numbers. Heedless of the Heine-Borel property, the villain projected his ϵ right through a finite subcover at our hero!

Having previously predicted 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 $\sin^{-1} \frac{1}{x}$ ever converge?*

NOW READ ON

Having polished his Riemann Surface to such a degree that he

slipped, MATHMAN fell headfirst into the backward Kolmogorov Equation where the one-step transition probability matrix instantaneously bound our hero in Markov Chains! This sent chills up and down his triangular spline. But MATHMAN was not thwarted!

" $\sin^{-1} \frac{1}{x}$ put you up to this!" accused MATHMAN.

From his utility belt, MATHMAN pulled out his Ax-*iom* of choice and chopped his bounds into independent random variables. Using reverse Polish notation MATHMAN escaped back to his Riemann Surface!

Will MATHMAN slip again or will MATHMAN's trusty homomorphism, HANS, rescue our hero from the Slippery Surface?

After having iterated his way out of the Black Hole of Runge-Kutta, MATHMAN was imagining the complex numbers when he found the nasty e^{it} and his alter-egos $\cos t$ and $i \sin t$ oscillating around him.

" $\sin^{-1} \frac{1}{x}$ put you up to this!" accused MATHMAN.

Just then his trusty homomorphism, HANS, arrived with MATHMAN's girlfriend LN who turned the tables (six place) on e^{it} and got it. While LN threatened it with | DESTRUCTION |, MATHMAN attacked $\cos t$ with his arc cos tables!

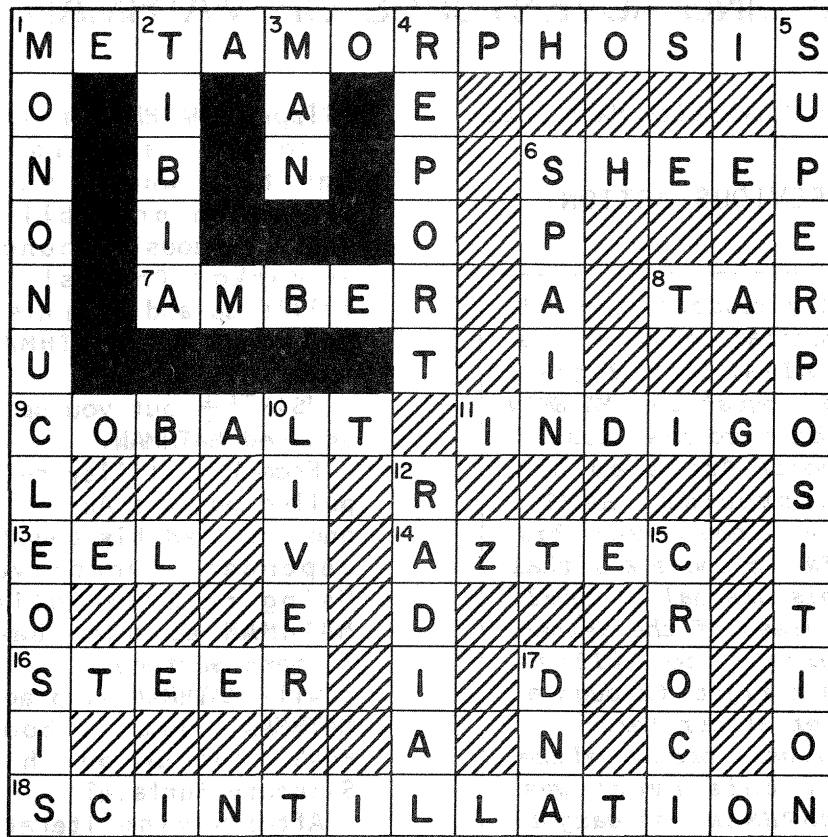
Will $i \sin t$ escape?

Will LN realize it?

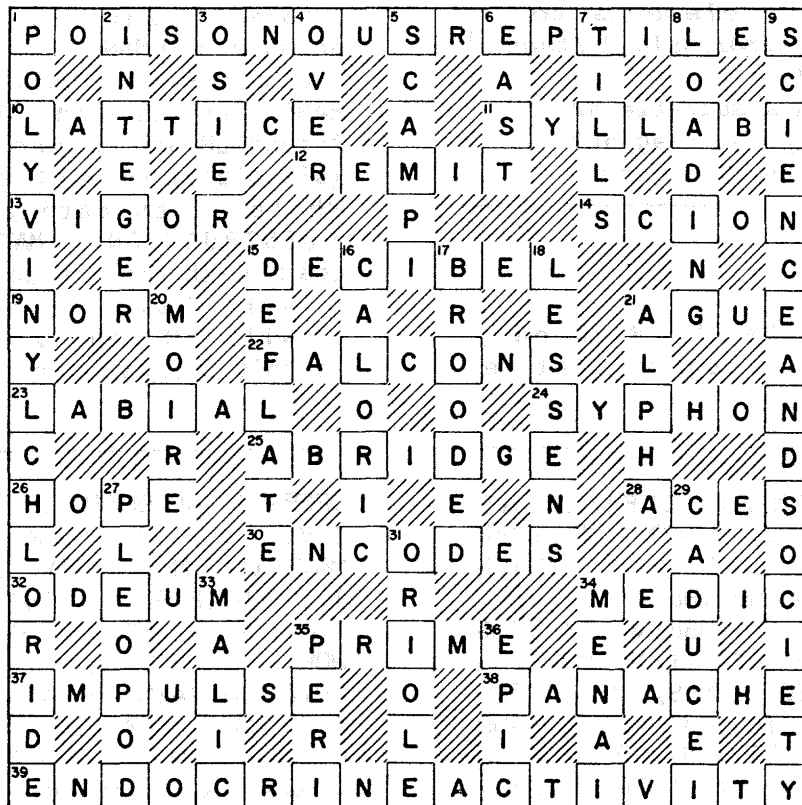
Is this story imaginary or real?

TRIBOLOGY: TRIBOLOGY, DEFINED AS 'THE SCIENCE AND TECHNOLOGY OF INTER-ACTING SURFACES IN RELATIVE MOTION AND PRACTICES RELATED THERETO', DEALS WITH ALL ASPECTS OF RUBBING, SLIDING AND ROLLING SURFACES. IT IS BASED ON A NUMBER OF DISCIPLINES, INCLUDING ENGINEERING, PHYSICS, METALLURGY AND CHEMISTRY. APPLICATION OF ITS PRINCIPLES LEADS NOT ONLY TO GREATER

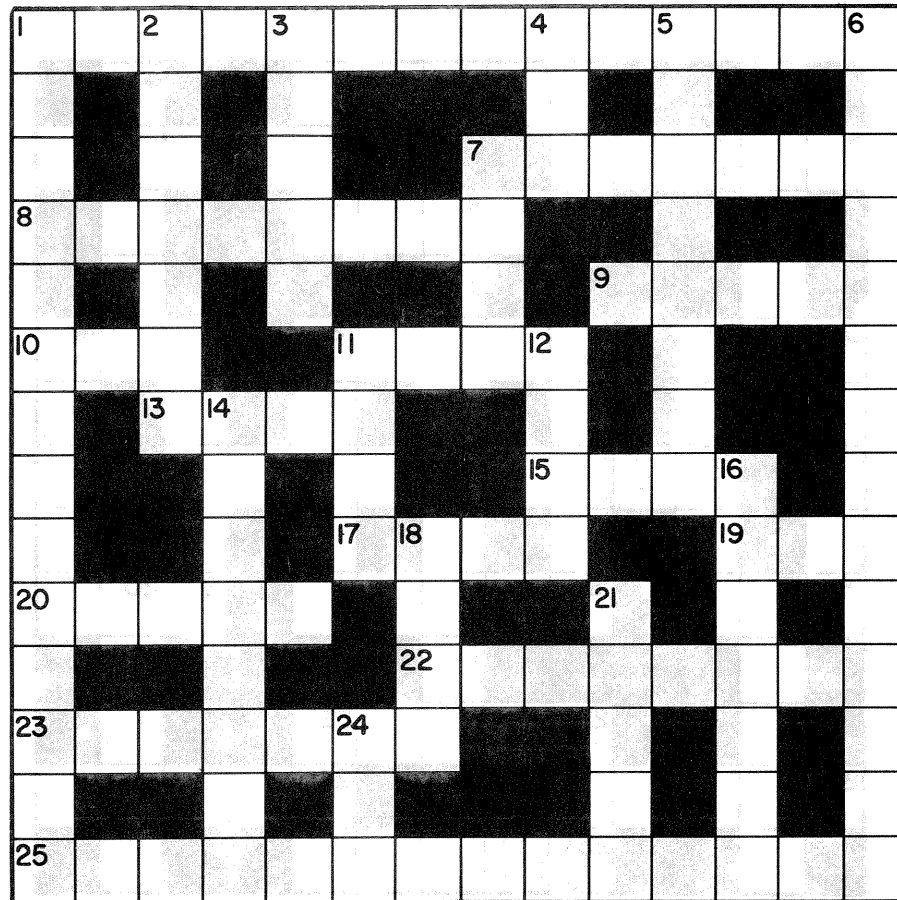
OPERATIONAL EFFICIENCY AND PRODUCTIVITY BUT TO CONSERVATION OF THE MATERIALS AND ENERGY. CONCERNED AS IT IS WITH SUCH PHENOMENA AS FRICTION, WEAR AND LUBRICATION, IT IS NOW A SUBJECT IN ITS OWN RIGHT IN WHICH BRITAIN IS ACKNOWLEDGED AS A WORLD LEADER. THE FIRST EUROPEAN CONGRESS ON TRIBOLOGY WAS HELD IN LONDON IN SEPTEMBER, 1973. □



SOLUTIONS



DIFFICULT CROSSWORD WITH INTERNATIONAL CONNOTATIONS



ACROSS

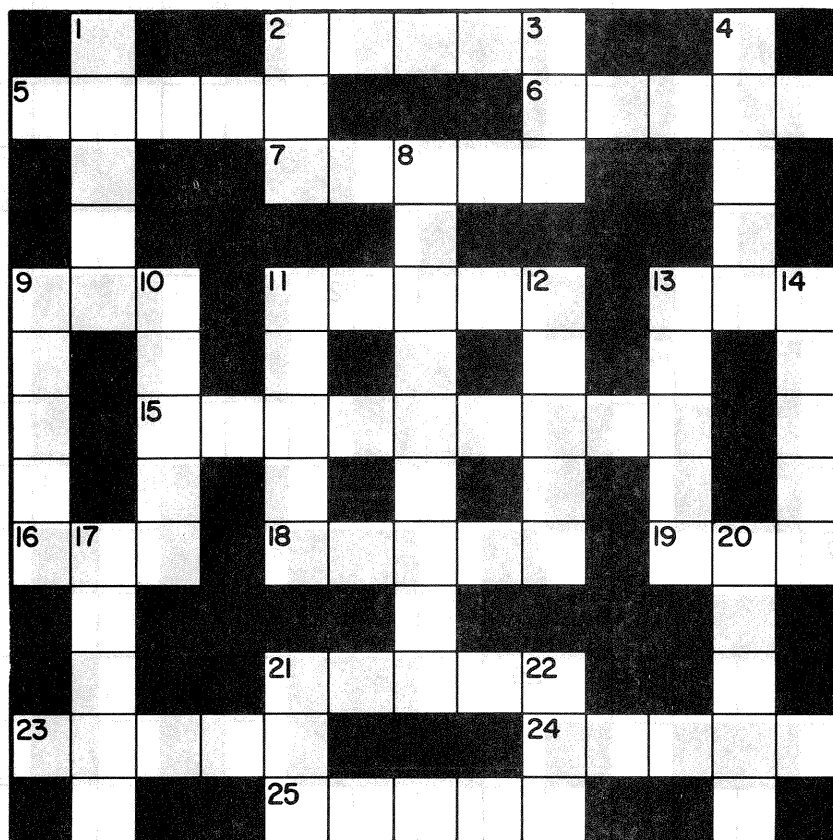
- 1[8,6] The deep Pacific, near the Phillipines
- 7 [7] Blood poisoning
- 8 [8] The highest large lake
- 9 [5] High U.N. officer (retired)
- 10 [3] Ancient Roman ballot box
- 11 [4] A sea in the U.S.S.R.
- 13 [4] A precious product of Lead (U.S.A.)
- 15 [4] Facts and figures
- 17 [4] 8 across is hardly a this this
- 19 [3] A reciprocating English river
- 20 [5] To seize without right
- 22 [8] The beard of Napoleon III conforms to English weights and measures
- 23 [7] A desert train
- 25[8,6] A Russian island with a Portsmouth connection

DOWN

- 1[4,3,7] A Drakensberg peak
- 2 [7] Entangling
- 3 [5] A banana, not far from 1 across
- 4 [3] This bit is small-time
- 5 [8] A Thai tractor
- 6[5,9] A cardiac patient may need this
- 7 [4] The source of the Blue Nile
- 11 [4] His apple is caused by the male thyroid cartilage
- 12 [4] 13 across is found here
- 14 [7] A characteristic of scientific activity
- 16 [7] A radiant inhabitant of the ocean
- 18 [4] The emerald isle
- 21 [5] A desert, scene of hostilities
- 24 [3] A bore

* FUNK & WAGNALL'S STANDARD DICTIONARY IS A USEFUL REFERENCE.

QUICK CROSSWORD



ACROSS

- 2[5] The beginning
- 5[5] An arm joint
- 6[5] A Mediterranean country
- 7[5] A citrus fruit
- 9[3] An Antipodean bird
- 11[5] A city in 5 across
- 13[3] Regulation
- 15[9] Cessation
- 16[3] Bitumen
- 18[5] Mobile male seed
- 19[3] Long-wave light
- 21[5] The microwave equivalent of
13 down (the initial initial
is changed)
- 23[5] A leg bone
- 24[5] A borer
- 25[5] A negative credit

DOWN

- 1[5] A collection book
- 2[3] A nocturnal predator
- 3[3] A can metal
- 4[5] Botanical growths
- 8[9] Scientists and hobbyists
- 9[5] Precise and accurate
- 10[5] The higher state
- 11[5] A city is a judge of
beauty
- 12[5] A teagrowing province
- 13[5] A source of coherent
light
- 14[5] The whole bit
- 17[5] A rose pest has his pa
- 20[5] A downy water fowl
- 21[3] Demented
- 22[3] A rodent

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

"CARET"

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PLEASE LEAVE ME
ABOUT FOR OTHER
STUDENTS TO READ

OUR COVER

A science lecture theatre in a Russian university, almost indistinguishable from one in an older Canadian university.