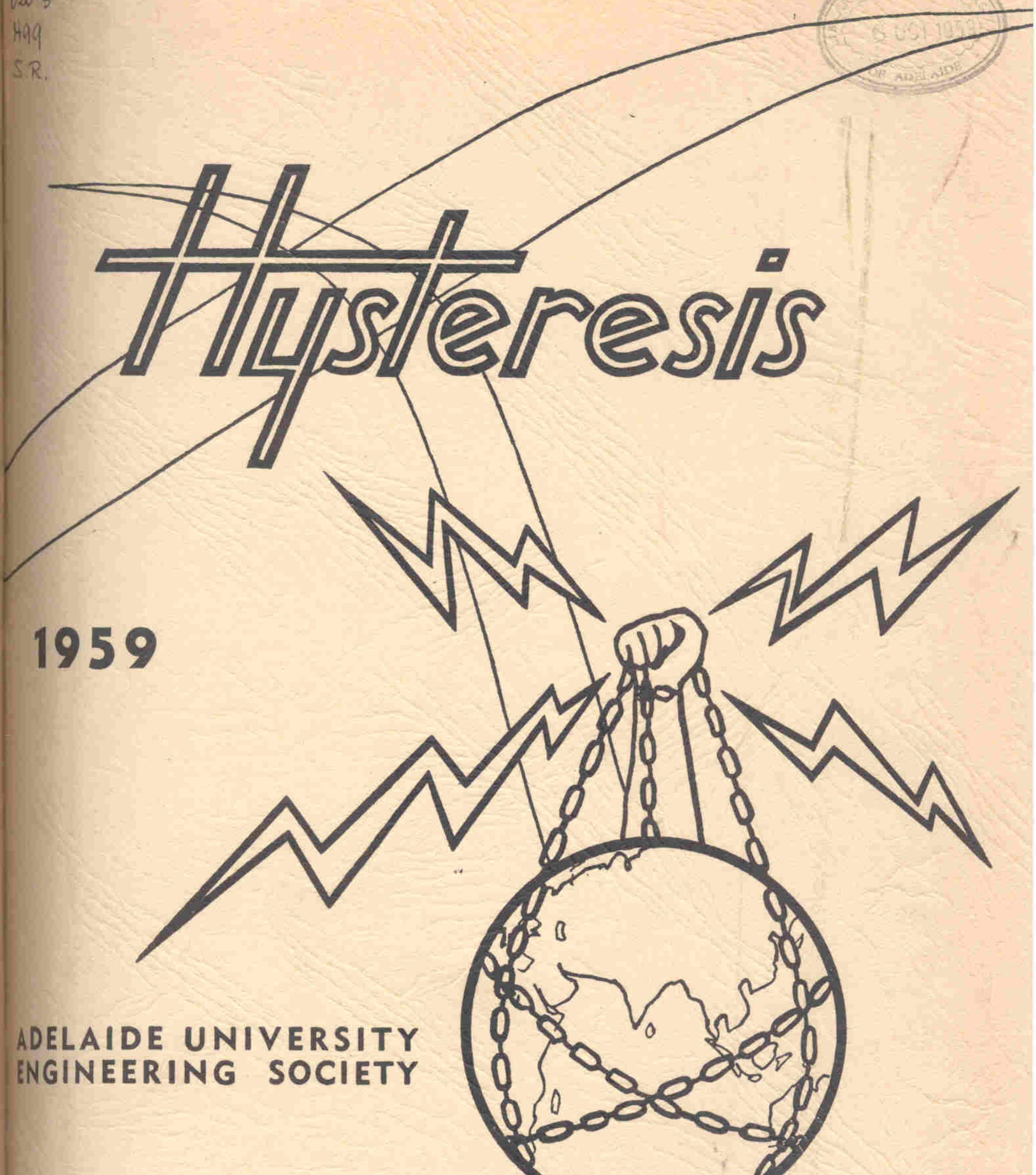
Hysteresis



1959

ADELAIDE UNIVERSITY
ENGINEERING SOCIETY

HYSTERESIS

1959

Official Journal of the Adelaide University Engineering Society.
University of Adelaide,
South Australia.

MAGAZINE COMMITTEE

Editor: Ian Flower. *Assistant Editor*: Peter Rogers.

Business Manager: Chong Chow Pang.

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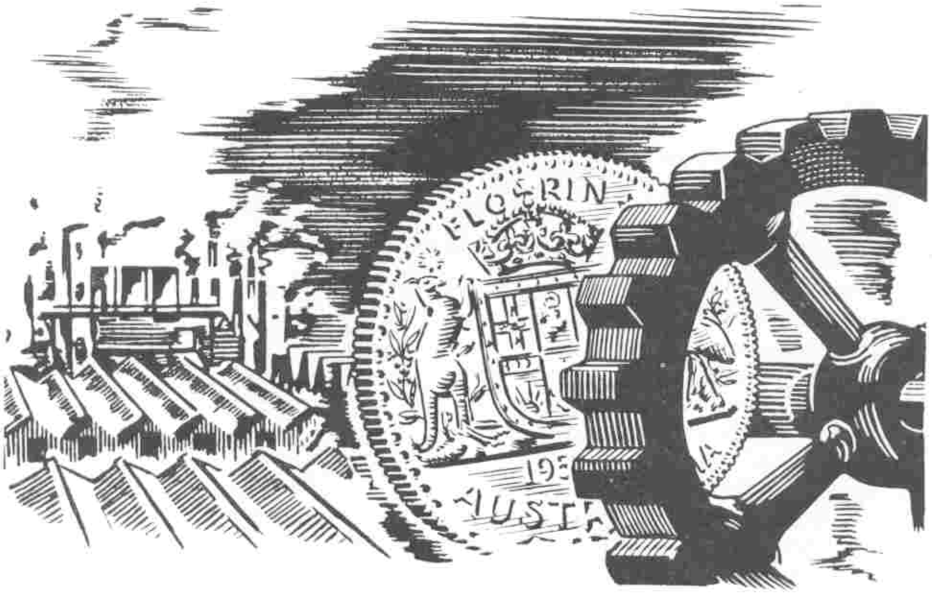
EDITORIAL . .

Ever since you reached these venerable halls of learning you have been liberally indoctrinated about the evils of not participating in extra-curricular activities. This advice is particularly applicable to engineering students, as the subject matter in the engineering course is not nearly broad enough to give them a professional **education,** as distinct from a professional **training.** This is reflected in the fact that not many engineers reach the top of the social scale, and become leaders in society. The men who achieve these positions are usually lawyers, doctors, and the like, who are in constant contact with all types of people, whereas the engineer is in contact with only a small group of workmen under him—divorced from the rest of the world. This deficiency is one which can, and must, be corrected in our student days. You can train a student to solve any engineering problem, but you cannot train him by a series of formulae to take his place in society. This is an attribute which comes from engaging as much as possible in stimulating social intercourse with his fellow students. It is up to us to choose whether we leave the University with merely a professional qualification, or whether we find material and inspiration that will help us to lead a full and satisfying professional life. As engineers, we must learn all we can about people—to understand them, and appreciate their viewpoints, so that we will be able to work with them. Broadening of your education, which is desirable for this, cannot be achieved by introducing arts subjects into the course, which is quite hard enough now; thus it must be provided by extra-curricular activities.

It was to fill this gap that the Engineering Society was first formed, but the full benefit of such a society cannot be reaped withour **your** active participation. Besides providing activities for engineering students, it is also their voice in University affairs, but at the moment, due to the apathy of students, its voice has dropped to an almost inaudible whisper. This lamentable state of affairs is reflected in the recent A.U.E.S. elections. Everyone nominated was elected unopposed, and in many cases there were no nominations for certain positions. If you have any good ideas, get yourself nominated for the A.U.E.S. committee next year. By serving on a committee you can obtain much experience of inestimable value in your future professional life. You learn how to conduct a meeting, the attribute of keeping your head, organisation, and many others. However, perhaps the most important thing you learn is the art of improvisation (especially as magazine editor). In life you never achieve ideal conditions, and you must improvise with what you have got, and there is no better way to learn than on a committee at the University.

In compiling this magazine, we again had to turn to graduates and lecturers for articles, and we are very grateful to them for rising to the occasion so nobly. However, this is essentially a students' magazine, and as such, should ideally be written by the students as a forum of their ideas.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DEAN'S PAGE . . .

Engineering Courses

Due to the modest degree of industrialisation in Australia until about twenty years ago, it was natural that the B.E. courses in Engineering should aim to be very broad in their training, to make the graduate capable of undertaking a very wide field of work.

In the past 20 years, mainly due to the Second World War, there has been an enormous growth in engineering knowledge and applied science generally, coupled consequently with a very rapid growth of industry.

The possibility of specialisation in Australia is an established fact, and the first move of this University to take account of the situation was the introduction of the B.Tech. courses for the engineering executive.

Recently the Faculty decided that the next step was the revision of the B.E. courses to make the syllabus better matched to the needs of engineering administrators and engineering scientists, and with this in mind, a committee was formed under the chairmanship of Mr. Sved to prepare revised syllabuses.

This Committee has submitted its report, and in the absence of Mr. Sved overseas, the work of organising this information in the light of Faculty discussions has largely fallen on the Assistant to the Dean, Mr. Tyler. As a result, I have asked him to prepare for your information the subsequent notes of the changes which are pending.

. . . .

The basis of reorganisation accepted by the Faculty is a Five-Year Course with exemption from the First Year for students who have passed the Leaving Honors examinations in Mathematics Parts I and II, Physics and Chemistry. Students who have not passed the Leaving Honors Examinations in these subjects will be required to pass in General Mathematics, General Physics, and Chemistry 1A before entering the Second Year.

A great deal of discussion has preceded the introduction of "service courses" in Civil, Mechanical, and Electrical Engineering, for students who are not taking these as major subjects. Thus a student who intends to study Electrical Engineering I, II, and III will take special one-year "service courses" in Mechanical and Civil Engineering. It is hoped that Civil, Mechanical, and Electrical Engineering (S), (as they will be known) will provide a general training in their respective fields, whilst better integrated and more highly specialised courses extending over two (or three) years will be provided in the major disciplines.

The Mathematics Department will provide revised courses in Mathematics I and II (Engineering) and Mechanics, to replace the present Pure Mathematics IIA, Applied Mathematics IIA, and Applied Mathematics I. Mathematics III (Engineering) will be an optional subject in the Third Year of the Civil, Mechanical, and Electrical Engineering courses. It is proposed that this subject should be given jointly by the Mathematics and Engineering Departments, with the object of developing the analogies and comparing the analytical and experimental solutions evolved in various fields.

Another important innovation is the introduction of Economics (Engineering) as an optional subject in the Third Year of the Civil, Mechanical, and Electrical Engineering courses. This course will be given by the Economics Department. The syllabus will cover such topics as the theory of allocation of economic resources, introduction to money and banking, and the economics of industrial relations.

An expanded course in Engineering Management will replace the present course in Industrial Engineering, with the object of providing a better background for those interested in administration.

It is probable that the new courses will be introduced in the following ways:

1 (Year 1960)—Introduction of new Second and Third Year Courses. Students who took the First Year of the Four-Year Course, or the Second Year of the Five-Year Courses, as published in the 1959 Calendar, will change to the new Third Year Course.

The following courses, as printed in the 1959 Calendar, will be continued in 1960:

- (a) Fourth and Fifth Years in Mining, Metallurgical and Chemical Engineering.
- (b) Third and Fourth Years of Four Year Courses in Civil, Mechanical, and Electrical Engineering.
- (c) Fourth and Fifth Years of Five-Year Courses in Civil, Mechanical, and Electrical Engineering.

2 (Year 1961)—Introduction of new Fourth Year Courses. Only the final years of courses as printed in the 1959 Calendar will be continued.

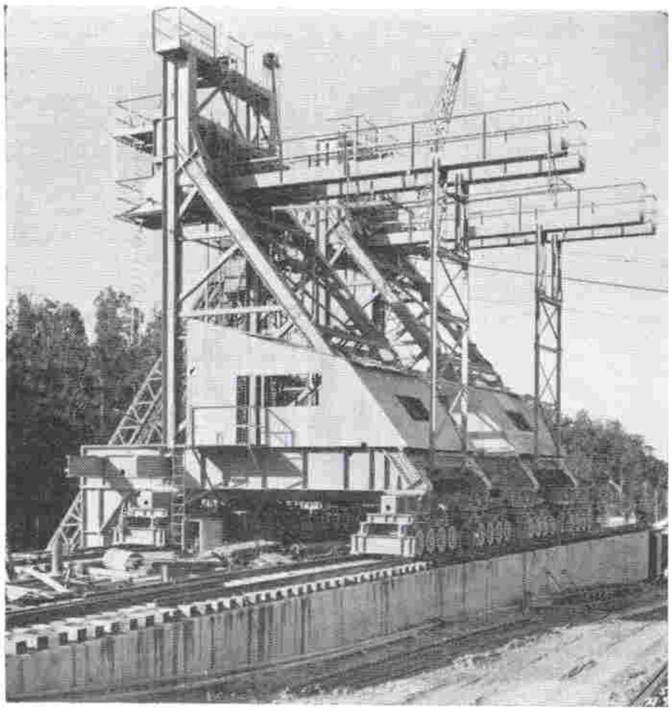
3 (Year 1962)—Introduction of new Fifth Year.

Suitable "equivalent" subjects will be nominated in the case of failure in a subject which is to be discontinued.

Extensive reorganisation of the time tables, schedules, details of courses, and syllabuses is involved, and it will therefore be imperative that all students should consult the most recent official publications of the University before presenting their proposed courses of study for 1960 to the Assistant to the Dean for approval.

These publications should be available from the University office early in January, 1960.

PROFESSOR E. O. WILLOUGHBY.



PRESIDENT'S REPORT

The Engineering Society has had another successful year, the pattern of events from the two years being followed and consolidated. Most encouraging has been the interest shown by students of the first and second years of the course. This indicates that the society will continue to operate on the same high plane in the following years.

The new committee took office in September, 1958, and consisted of seven executive officers, nine year representatives, and five S.R.C. members. The first year representatives were elected in April, 1959.

FRESHERS' WELCOME

This followed the same pattern of previous years. However, I believe that it was the first time that the Chapman Lecture Theatre was unable to seat the large numbers of staff and students present. After the staff had been introduced, the 1958 Mobilgas Trial film was shown. The supper which followed was soon consumed. Unfortunately, however, freshers seemed reluctant to stay and "chat" with the staff, preferring to adjourn to the dance in the Refectory.

BALL AND COCKTAIL PARTY

This was a very successful social event, some 520 guests attending. Unfortunately, the cocktail party was not up to the usual standard, since the caterers employed (as recommended by the University Union) were not as good as in previous years. The decorations and floor show at the ball were acclaimed by all present. We are indebted to Lightburn Industries Ltd. for donating the many wonderful prizes given out during the evening. I wish to thank all members who so ably helped in organising the ball, and especially those who helped clean up the following morning.

ENGINEERING FACULTY BUREAU

This organisation was set up to foster interstate co-operation between Engineering students. The E.F.B. Symposium was held in Melbourne this year, and was attended by about ten Adelaide students. The title was "Transport—Linking the Horizons," which provided a wide field of discussion. The next Symposium is to be held in Brisbane, so start saving.

The first edition of "Torque," the Bureau newsletter, was published by the Brisbane students, and arrived in Adelaide in April. A further edition is expected soon.

The Indian Student Exchange Scheme, conducted by the Bureau, arranged for three students from Madras to come here. However, due to transport difficulties, only one student was able to make the trip. He was employed in Adelaide for some two months, and while here, was entertained by members of the Colombo Plan Students' Association, United Nations' Youth Association, as well as the A.U.E.S. The idea behind this Exchange Scheme is very commendable, but it suffers from a lack of co-ordination between the E.F.B., Engineering Societies, and India itself.

Indian Student Arriving in Adelaide

MAGAZINE COMMITTEE

This unit has again produced another volume of the best magazine in the University. The work of the editor and business manager cannot be spoken too highly of.

TALKS AND FILMS

In Room 110 of the Mechanical Engineering Building, films have been shown every Tuesday, and a talk given by a prominent member of society on Fridays. Both these functions have been well attended throughout the year. The

success of these meetings is mainly due to the timeless work of the talks, films, and publicity officers.

INTER-FACULTY SPORT

The annual tug-of-war was not held until the middle of June this year. The Engineers were unlucky in that they had to pull twice on the unfavorable southern bank, but they put up a very fine show, and almost managed to pull the Meds. in on the third and final pull. When the Med. supporters saw that the Engineers were likely to emerge as the victors, they resorted to the very underhand expedient of distracting our team by hurling flour bombs at them. Watch out, Meds.; it cannot happen twice in a row!


Heave! Heave! — and in they went!

Unfortunately, other forms of inter-faculty sport have been absent, which is not a good thing, and perhaps future committees may be able to rectify this position.

PUBLICITY

The publicity for the various functions held by the Society is a very important phase of the activities. The good attendances at the lunch-hour meetings and the ball are a result of the excellent efforts of our publicity officers. The Society must not be afraid to spend money on publicity—it is a good investment.

FACULTY OF TECHNOLOGY

It is pleasing to see that students from this Faculty are joining in the Society's activities. The representatives on the committee have been most helpful, and we look forward to continuing co-operation.

DINNER

This was held on July 31, at the Hotel Adelaide, some 75 students and 10 staff members attending. Mr. A. G. Gibbs, the personnel manager at General Motors–Holden Ltd., Woodville, gave an excellent address, the text of which appears elsewhere in the magazine. Judging from the comments of those who attended, this was probably the most enjoyable dinner for several years.

FUTURE

The activities of the Society have been much the same as in the past two years. With the increasing number of students, perhaps some new activities, such as car trials, smoke socials, and inter-faculty dances, could be held. The Society should also devote some thought to obtaining a student common room within the Engineering Buildings.

The only way in which the Society can advance is by looking to the younger members of the committee, as the future is in their hands.

DAVID FISHER.

BOUQUETS

We would like to thank everyone whose help and co-operation have made this magazine possible.

In particular we would like to thank all contributors, the photographers, cartoonists, typist (Miss Joan Anderson), and members of the A.U.E.S. committee.

Thanks also to the advertisers, without whose generosity this magazine would certainly not be possible.

We would also like to thank the staff and management of E. J. McAlister & Co. for the friendly way in which they have handled all our problems.

Finally, we would like to wish the next Magazine Committee all the best in their at first awe-inspiring but later enjoyable task.

Applications are invited for the positions of Editor and Business Manager of "Hysteresis," 1959-60. If you are interested in taking on either of these jobs, see a member of the A.U.E.S. committee. More information can be obtained from the present editor.

PRINCETON '54

By DAVID ELLIOTT

After the last war a plan, due to Senator Fullbright, came into being which enabled a much freer interchange of students between the U.S.A. and other countries. For an Englishman wanting to go to the States a travel grant was available, enabling him to travel from his home in England to any University in the U.S.A. and back, at no cost to himself. This was a great help to anyone wanting to go to an American University, and so, when I graduated from London University in 1951, I was able to consider seriously a trip to the States. A trip abroad had the additional advantages of postponing (and, with luck, avoiding) National Service, which at that time involved two years with the Regular Army—so I thought, and so did about one hundred thousand other students.

The Americans are an efficient race, and their first step was to weed out those who were only half-hearted in their wish to travel. This was done quite simply by requiring every form to be filled in at least in triplicate. I left the London offices of the English Speaking Union weighed down by a couple of pounds of forms. This daunted many, who deposited the pile in the nearest garbage tin. But I persevered, and a month later was able to send them all off to their respective destinations.

At that time I knew very little of American Universities, or even what I wanted to study. It had been suggested that Aero-Engineering might be a good field of study for an Applied Mathematician with interests in hydrodynamics and elasticity. To my great surprise, the Aero-Engineering Department at Princeton University offered to take me as a Graduate Student, and what was more important, to pay me a few dollars for the privilege of employing me for 20 hours a week. I accepted the offer without hesitation; but bureaucracy had not finished with me yet.

In order to enter the U.S.A., all aliens must possess a visa. As students, we only required a visitor's visa, but even this involved filling in another stack of forms, having one's fingerprints taken, and finally, an interview with the Consul. This was a most serious business, where we had to swear that we had never been a Communist or Fascist, and would never attempt to overthrow the Government by force. Having assured this gentleman that no such unpleasant thoughts had ever crossed our minds, and swearing on the Bible to be good citizens, we were in. I have heard in later years of a friend who, in addition, had to swear that he had never been a prostitute! After assuring them of his virtue he, too, was granted permission to enter "God's Own Country."

The trans-Atlantic crossing was uneventful. On arriving at New York, we students were issued with a stack of literature before passing through the Immigration Authorities, which said, among other things, that if we found ourselves on Ellis Island (a prison island in the Hudson River, where all people attempting to enter the U.S.A. illegally were held before being deported), then it was no disgrace, but we must contact our Universities as soon as possible, and they would put things right. Cheered by these comforting remarks, we faced the Immigration officials. But all was well, and, to my knowledge, no student failed to get past these gentlemen. It is easier for a camel . . .

Princeton is not far from New York, and a more pleasant town one could not wish to find. It is essentially a University town, and everything rotates around the University. I soon discovered that the University was considered to be one of the finest and richest in the U.S.A. No expense had been spared on the buildings. The Graduate College (or Goon Castle, as it was known to the Undergrads) was situated off the main campus, and built in the style of the Oxford and Cambridge Colleges, but in the best 1920 Gothic. Here were combined the beautiful lines of traditional Gothic with the comforts of modern civilisation. Beneath the delicately carved stonework were pipes for central heating, and hot and cold running water in all bathrooms. Some purists, I am sure, would wince at the thought of such a combination, but I am not a purist, and enjoy all modern comforts. The G.C. accommodated about 200 students of all nationalities, and included about 20 Englishmen.

Having arrived and settled down, I then set about discovering why an Engineering school wanted a Mathematician. I had refused to be worried by such a problem before getting there, but now I began to have some doubts. I had no idea as to how to use a slide rule (and still refuse to have any dealings with such a crude analogue machine), I knew nothing about drawing or Whitworth threads, lathes or steam engines. I then discovered that engineers like to have a few "tame" mathematicians around the place. These are looked upon as queer birds by the Engineering fraternity, but occasionally most useful. Actually, the Princeton Aero-Engineering School was interested, among other things, in the phenomena of flight at hypersonic velocities, where viscous effects are of great importance. There was an experimental group which had just finished building a hypersonic wind tunnel, using helium as the working gas, and capable of achieving speeds up to Mach number of 14. They worked

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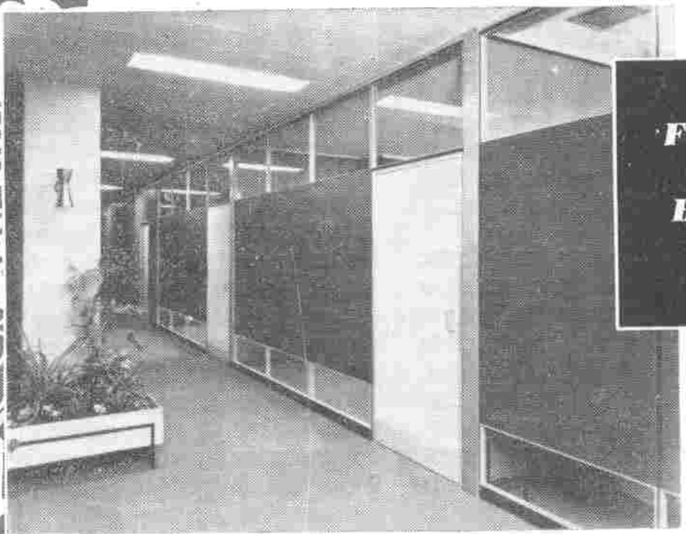

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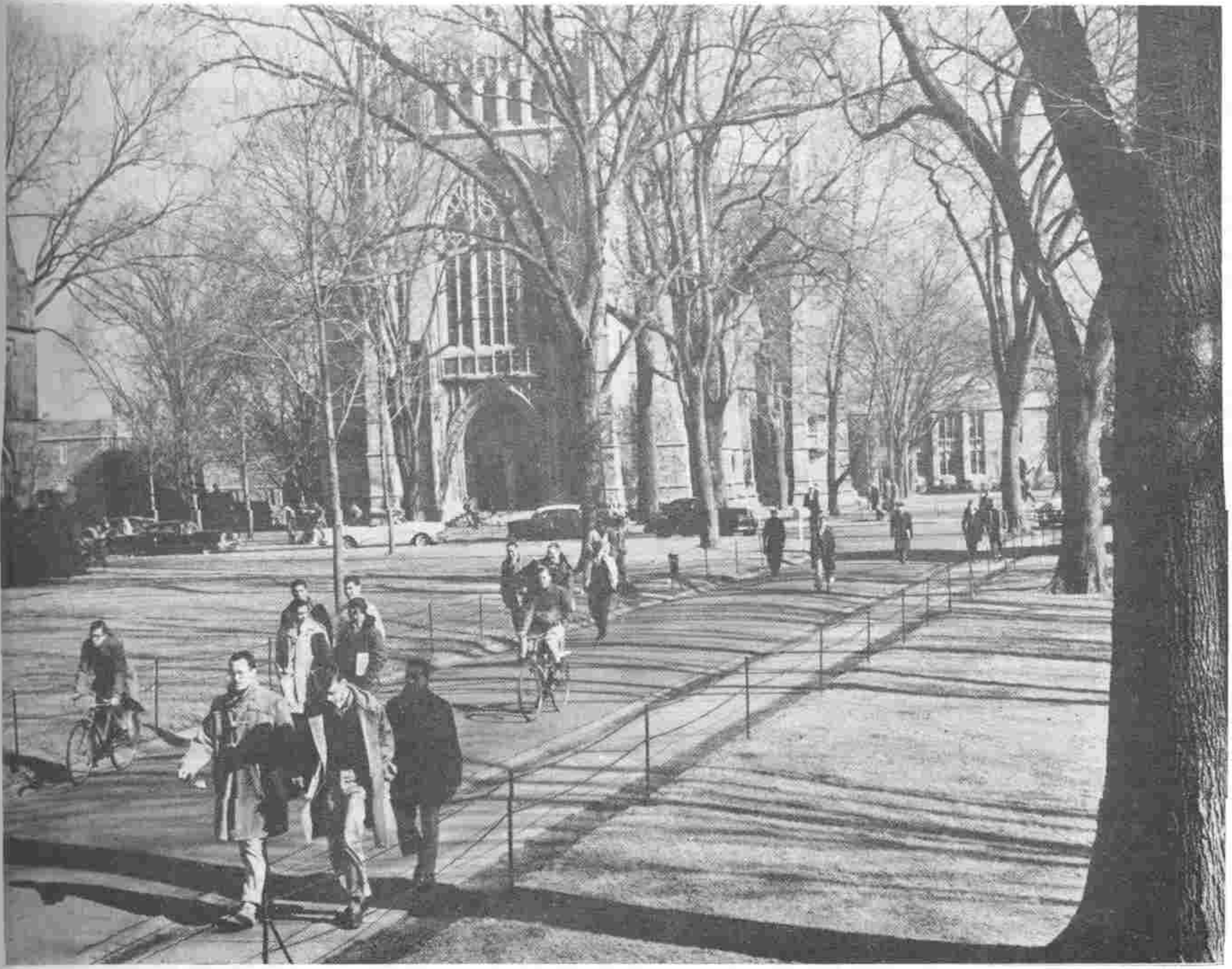


View of Chapel, Princeton

closely with a theoretical group who were working on a mathematical analysis of the problem. The American University system in those days did not produce Applied Mathematicians as such. Most American Mathematicians were Pure Mathematicians, who had long ago forgotten how to differentiate x with respect to itself. To find persons to work in theoretical fluid mechanics, they had either to teach a lot of Mathematics to Engineers (and that is hard!), or to interest Physicists in the subject. Someone then had the bright idea of getting English Applied Mathematics Graduates, and it happened that I was privileged to be the first of many.

Having put our living and working arrangements into some sort of order, we then began to wonder how our leisure time could be spent. We had heard of pyjama parties, sorority houses, and drive-ins, and were keen to sample such features of American life. We made an appalling discovery. Princeton had the distinction of being the only all-male University, at both Graduate and Undergraduate level, remaining in the U.S.A. It took a while to recover from this shock, but we survived . . .

To our surprise, the American graduate has a most serious approach to his work. He knows that he could be earning big money outside the University, and his main aim is to get his Doctorate or Master's degree as quickly as possible. He will work 14 hours or more a day, will be proud of the fact, and let everyone know. The English attitude is quite the reverse, and most people will keep their number of working hours a secret, and prefer to discuss any topic under the sun but work.

Being left more or less to our own resources, we formed a cricket club to occupy our time in the summer months. The sight of 22 flannelled fools was an uncommon one on the American scene, but we were able to find quite a few teams to play. Cricket had, apparently, been most popular before World War I. In fact, the "Gentlemen of Philadelphia" toured England many times at the start of this century, and played the first-class Counties. The war brought this to an end, and in the 1920's baseball began to make great strides as the national summer game, to the exclusion of cricket. In the 1950's only one American University played cricket at the Undergrad. level—Haverford College, in Philadelphia. We were fortunate to arrange a game with them, and found their cricket ground to be delightful. They even had a pavilion, with framed photos of cricket heroes. The photos of Bradman, Hammond, Larwood were not to be seen. Instead, there were faded photos of a bewhiskered Yorkshire team of 1880. The individuals picked out for display were Grace, Spofforth, and the like. However, the present Haverford team did not follow the styles of the last century. They were clean-shaven, used straight bats, and had three stumps for each wicket.

I could write at great length on life in the States, but doubtless the reader is anxious to look at something else (if he has not done so already). In all, I spent three years at Princeton. It was a terrific experience, and if any of you get the chance to go to the States, fill in all those confounded forms, and go! It is a fascinating country, and I only hope that one day I shall again find myself agreeing to let the American Government to do its job in peace, unimpeded by any threat from me.

After obtaining an M.Sc. from the University College, London, in 1952, Mr. Elliott went to Princeton University, where he spent a year as a research assistant in the Gas Dynamics Laboratory, gaining an M.S.E. in 1954. Also, during his comparatively short but quite illustrious career, Mr. Elliott spent two years in the Mathematics division of the National Physics Laboratory in England, and held the post of Lecturer-in-Charge of UTECOM Programming at the University of N.S.W. His present position is that of Senior Lecturer in Mathematics at Adelaide University.

The people people work with best
  Are sometimes very queer;
The people people own by birth
  Quite shock your first idea.
The people people have for friends
  Your common sense appal,
But the people people marry
  Are the queerest folk of all.
    "Queer People," Charlotte Gilman.

FROM A LECTURER'S DIARY

By QUELQU'UN

March 15th, 1958:

Jop came to see me this morning. He's going to sit in, once again, on Applied Maths. lectures. This will be the fifth occasion that this class has been so favored—not because Jop fails each time. Oh, no. He doesn't fail, because he doesn't sit for the exams.; he just doesn't see the distance. A man of the world is Jop, well dressed, well groomed, with an easy and plausible manner, and a personality that has not visibly faltered through comparing what he has attempted with what he has achieved. This morning he suggested that full-time attendance at lectures was perhaps—in his case, in view of his previous experience—not really necessary. Perhaps if he came occasionally, just to keep in touch . . . ? This followed his usual scheme of study, and apparently he was loth to change a routine which gave consistent results.

I rather like Jop, in spite of his lack of self-discipline in matters of study; his regular presence in the class lends some measure of permanence to it. I feel I have one old friend to whom I can unconsciously address myself during lectures, in spite of the certainty that the seeds of learning are unlikely to germinate in that particular spot. Jop reminds me of another similar student, Jed, who attempted eight times to pass first year Maths. He had none of Jop's polish—in fact, Jed's irregular attendances at lectures frequently found him distinguished by his casual dress and untidy appearance. This was sometimes due to his late return from fishing—a pastime in which he indulged with no mean success, and which always meant a gift of fish, wrapped somewhat carelessly in newspaper, placed on my table before lecture. Some of the other students even suggested that Jed was trying to buy his pass in Mathematics. How foolish students must consider lecturers to be, and how lacking in the knowledge of the ways of man outside the cloisters! Fancy passing Jed to another class, and so cutting off a supply of fresh, free fish!

Actually, Jed ceased his student activities of his own volition; he had reached his fortieth year, and felt that life was just beginning. He had considerable means of his own, and I rather fancy that the continued clash of lecture times and favorable tides brought matters to a head.

Unfortunately, Jop had no such extra-curricular activities which endear the repetitive student to his lecturer. His main recommendation was his submission of a weekly homework paper (later becoming monthly, before ceasing altogether), which was a delight to mark. He attempted but the easiest one or two of the questions set (his decision on whether to attempt a second question seemed to depend as much on what remained on one side of a single foolscap sheet as on how difficult the question was). His solutions were without explanation, and although it would be more true to character if I could write that they were invariably wrong, I cannot do so, because many of his answers were correct. This I at first attributed to the co-operation of other students, but this was, in fact, not true; strangely enough, it was other students who, at times, sought Jop's advice (which no doubt he gave with such an air of assurance as to make the new students wonder what misfortune caused the omission of his name from the pass list). I eventually realised that Jop excelled only on those problems which had been repeated from previous years. Such opportunism does show his ability to learn from past experience.

May 1st, 1958:

Collected the weekly papers this morning; Jop's was missing. This was expected, but not as late as May; his defaults usually begin during mid-April.

June 19th, 1958:

Haven't seen Jop at lectures for some time now.

July 28th, 1958:

Jop rang. What with stock-taking at work (he is a part-time student), the end of the financial year, the imminence of the birth of his second child (he married in his second year of attendance at Applied Maths. lectures), and his pressing duties as secretary of a football club (which, he feels, can enter the finals if some good players he has been chasing decide to play), he has been unable to attend lectures for the last few weeks. He hopes he can resume his accustomed place in class soon, the more so because this year he really wants to concentrate on Applied Maths. (I had long been aware that his concentration, for several years previously, had been directed elsewhere.) He was full of apologies, and resented the intrusion on his time of any other activities which prejudiced his success as a student. I think he believed every word he said.

March 19th, 1959:

Jop came to see me today. He's going to sit in on Applied lectures . . .

SKINDIVING AND SPEARFISHING

By CHRIS VON DER BORCH

Most people, at some stage in their lives, have had a desire to be able to fly.

Flying is merely unrestricted movement in three dimensions, and the simplest (and, in my opinion, the most enjoyable) manner in which to do this is to become a "skindiving addict." In the medium of cool, clear water one is free to move like a bird, the speed being limited by the fact that water is approximately 85 times denser than air. If a person is properly equipped, and his natural positive buoyancy neutralised, then virtually no effort is required to move horizontally or vertically. To become slightly romantic, time is meaningless in the ocean depths, and all human movements become slow and graceful, in harmony with the gently waving fronds of the kelp. Necessarily so, too, because a diver must conserve his air to enable him to remain longer in his new element, the better to appreciate the beauties that surround him.

I think, perhaps, that I had better begin with a few words about equipment. The essentials, in my opinion, are mask, flippers, and bathing trunks, in order of preference. The mask is to enable the human eye to overcome the difficulties of undersea vision. The lens of our eye is adapted to seeing in air, and as water is an optically denser medium, the naked eye cannot focus an image on the retina under the sea. The mask simply places an air space between the eye and the water, and results in the underwater scene being revealed in all its startling clarity. The only unexpected effect is the magnification of all objects by a third, resulting in some quite remarkable "fish stories."

In addition to the three items mentioned above, we have the snorkel. This simply enables a diver to swim along the surface and breathe comfortably with his eyes beneath the water. Of course, when he dives he holds his breath, and most snorkels have a valve to exclude water.

Aqualungs I classify as a luxury, certainly not essential, but nevertheless desirable. These turn a human into a fish, and he can dive safely to depths of up to two hundred feet, and remain under the sea for several hours at a stretch, provided certain precautions are taken. This equipment is only for experienced divers, and a full description would include a long discussion on the pressure effects on the human body. However, I will only touch on these briefly.

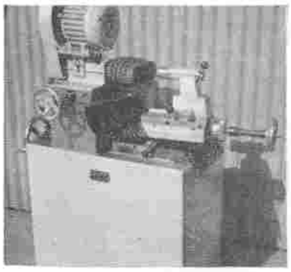
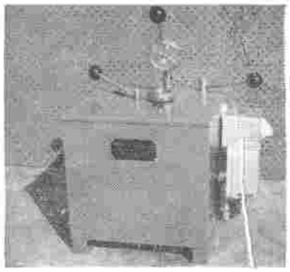
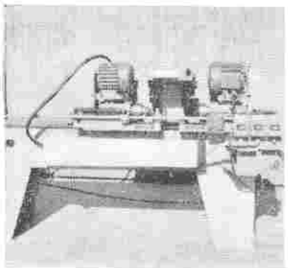
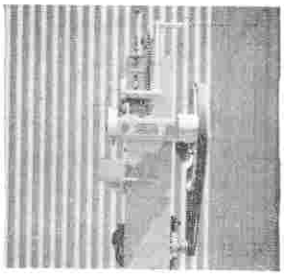
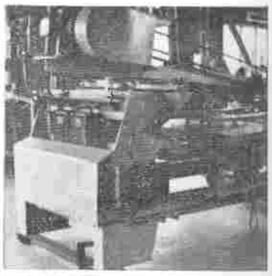
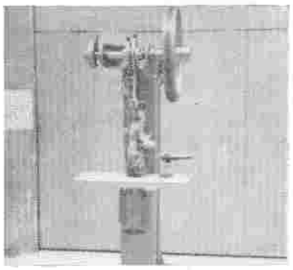
Essentially, the aqualung consists of one or more cylinders strapped to the diver's back. These contain compressed air (not oxygen), at a pressure of about 1800 pounds per square inch, and this pressure is broken down by two reduction valves to a value equal to the external water pressure at the particular depth of the diver. The second reduction valve is a demand valve, with a diaphragm in contact with the water, and a simple system of levers provides air only when one breathes in. On exhaling, air is expelled through a valve into the water, and bubbles to the surface. In this manner breathing is effortless and normal, and one really becomes a part of the undersea world.

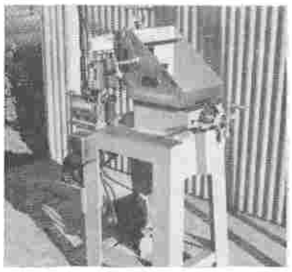
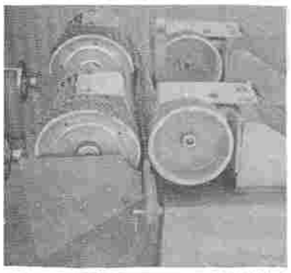
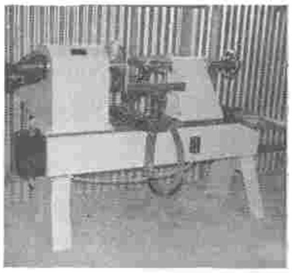
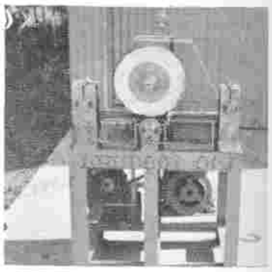
Unfortunately, as a diver descends the pressure on his body increases by one atmosphere for every thirty-three feet of depth. Thus, for the first thirty-three feet the pressure is doubled, and the volume of air in his lungs (assuming it is not replenished) is halved. As he descends deeper the volume change becomes progressively less, so if his respiratory system and ears stand up to the first thirty-three feet, he finds it relatively easy to go deeper. If his ears begin to hurt and he cannot clear them, it is not advisable to carry on. The pain is caused by an unbalanced pressure about the eardrums, causing the latter to be forced inwards, and this can usually be relieved by wearing a nose-clip under the mask, and blowing forward. This actually forces air through the eustachian tubes of the inner side of the eardrum, thus equalising the pressure and relieving the pain.

More serious effects of depth are due to the fact that gases tend to be absorbed by body tissues, and this phenomenon increases with depth. Nitrogen is the worst offender, and if a diver remains at depths greater than fifty feet for long periods (the time depends on depth), the "bubbling-out" of nitrogen from the tissues causes "the bends," a disease that is often fatal. At a great depth (exceeding 200 feet), nitrogen also affects the nervous system in a manner not yet fully understood, causing symptoms of drunkenness. This is usually fatal, as a diver may offer a passing fish his aqualung mouthpiece or mask, with obvious consequences.

I hope the above brief and insufficient account of the physical dangers of self-contained diving apparatus has not turned the intending diver against the sport. All effects are negligible for well-instructed people, and skindiving is as safe as any other outdoor occupation.

The latest innovation is the "Underwater Sledge." This is an apparatus somewhat resembling a sawn-off aeroplane, that is towed behind a boat at speeds of up to four knots.



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Corrugated Fastener machines (for joining wooden box ends).

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Diamond edging machines, for lenses, etc.

Toric Generators (for grinding toroidal surfaces on lenses with diamond wheels).

Lens blocking machines.

Lens Polishing machines (for spheres and Toric cylinders).

Special purpose presses with roll feeds and tooling for them.

Jigs, Fixtures, Dies and tools.

Centreless polishing machines (one to six head machines) for polishing tubing prior to chrome plating (with automatic unloading devices).

Pneumatic tube benders in various sizes (high speed).

Tube cutting machines (cuts tube in a fraction of a second).

Tube deburring machines.

Automatic machines for forming and threading wire parts (at over 4,000 per hour).

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Special purpose surface grinders for large surfaces.

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Pegboard making machines (these punch over half a million holes per hour).

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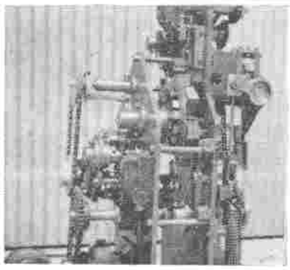
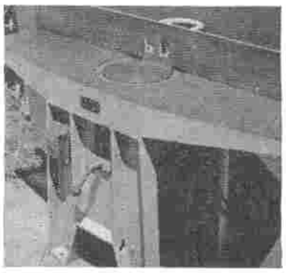
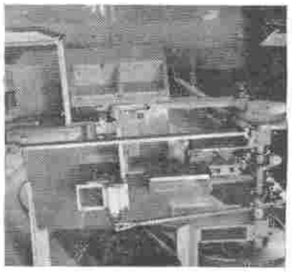
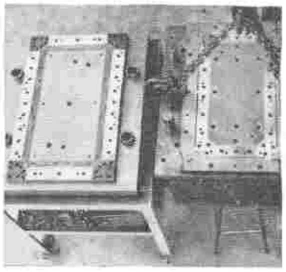
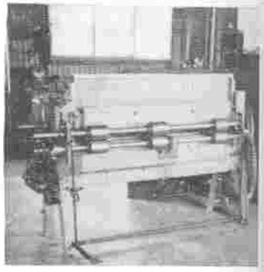






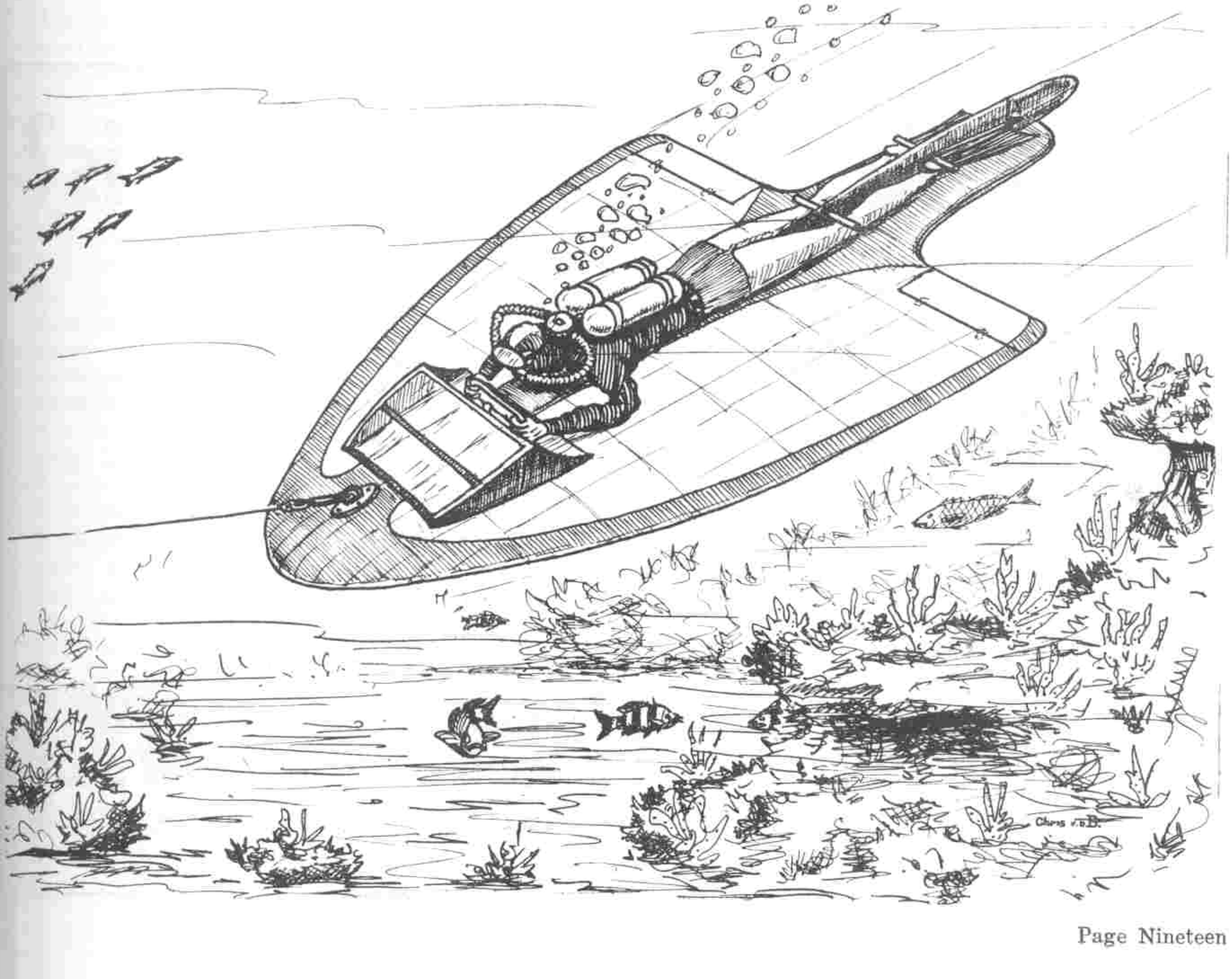
The aqualung diver lies along the sledge with his hands on a joy stick. This operates horizontal fins, and enables the sledge to "fly" like a glider, banking, diving, and even barrel-rolling under the sea at depths of up to a hundred feet. As you can guess, this is real sport, and useful, also. Large areas of the sea floor can be combed in a short while, searching for wrecks or lost objects.

Perhaps the best manner in which to illustrate the thrills of spearfishing is to present a true description of one of our recent trips to Streaky Bay on the Great Australian Bight, the Mecca of underwater big game hunting.

We left Adelaide a few days after Christmas, the utility loaded with an assortment of guns, gear, and enthusiastic hunters. After fourteen hours of bumping about, we arrived at the beautiful rugged coastline south of "Streaky" in time to pitch camp for the night.

Next morning dawned hot and clear, with the ocean an oily calm. Lack of wind seemed to encourage the great swell, but as our quarry (groper, weighing up to 100 pounds) thrived in exposed water, we were not daunted. My first job before breakfast was to hike to our chosen bay, climb down the cliffs, and spear a quantity of yellow crabs that abound in rock pools. These I crushed and placed in a sugar-bag for "burley," throwing it into the clear deep water off the rocks at the headland. I then returned to breakfast, after which four excited campers prepared their gear, oiled their spears, and checked their traces of steel cable and three hundred pound breaking strain nylon. We shouldered our packs and set out in eager anticipation. As we approached the cliffs overlooking the chosen bay, a large blue fish was seen drifting in the swell not far from the burley, and our pace quickened. In silent and unadmitted competition we hurriedly donned flippers, mask, snorkels, and knife belt. Carbon dioxide capsules (our ammunition) were screwed into our powerful guns, and we entered the water carefully between surges.

The clarity of the water was startling, as was the sudden silence as our ears were submerged. The thundering surf on the headland, in fact all land associations, were part of another world, and we all glided to the bottom on our first breath. We broke up into pairs for company and safety, and swam silently around the point to the deep water and the crab-bait, our blood tingling with the excitement of the hunt. Suddenly I thrilled as an almost unbelievably large blue fish glided towards us in curiosity. My companion was nearest, and I saw him inhale and sink quietly to the sea floor twenty-five feet below. His breath



was good, and he remained poised with his gun at the ready beside a limestone ledge. Slowly the great fish approached him, while I held my breath in sympathy and tension. The peace was shattered by the explosion of the gun. When the large bubble of carbon dioxide had disappeared to the surface, I saw that the spear had hit the groper just above the backbone, and that he still had plenty of fight left. My friend had surfaced, snatched a breath, and was then pulled under by the powerful fish, which disappeared into a limestone cave. The gun was allowed to float, and the diver swam down along the line, and disappeared, all but his flippers, into the cave. After a struggle, he managed to grab the spear, which protruded on either side of the fish, and literally "steered" it to the surface. The water was lashed to foam, but the victim was slowly worked towards the rocks. Using his judgment, my companion landed the fish neatly just after a rather strong swell had abated.

We all congregated to examine the prize, which tipped the scales at fifty pounds. Then, greatly inspired, we hurried back to try our own luck. At the end of the day we had each landed a fish, and all were over forty-five pounds, the largest weighing fifty-eight pounds. We had also seen a graceful shark, and had gambolled with an apparently tame and curious seal. We gave the fish to a local fisherman for crayfish bait, thus earning a lifelong friend, and returned to our camp for a well-earned meal.

Well, the above, as I stated previously, is a true account of one of many days of happy hunting. The "Bight" is a long way from Adelaide, but untold pleasure is to be had exploring the coastline nearer to Adelaide, diving down to explore old wrecks, and taking undersea color photographs and movies. Therefore I hope that this brief account of the healthiest of sports will fire the enthusiasm of anyone who reads this article, so that you, too, may enjoy the wonders of a new world.

STOP PRESS

The executive of the A.U.E.S. for 1959-60 consists of:

President: K. O. Lightburn.
Vice-Presidents: P. Ingleton, R. A. Duncan.
Secretary: G. Meija.
Assistant Secretary: G. Evans.
Treasurer: I. C. Flower.

Among the acres of electronic brains that are the centre of activity at the U.S. rocket launching centre at Cape Canaveral, Florida, is an ancient Chinese Abacus, encased in a glass cabinet. On the cabinet is the legend: "Break Glass in Case of Emergency."

AFTER GRADUATION

By J. F. B. BLACK

After graduation the student's thoughts will necessarily turn to selecting a job—in these days selection is possible, rather than hunting for a job—a thankless task, which has not been the problem of graduates for many years.

I have suggested that job-finding is a post-graduation task. I believe it is, yet at the same time I think that some definite ideas on employment should be held long before the final examinations appear on the horizon. The percentage of students who have mapped out the future in detail is probably rather small. However, the vacation employment in industry has two objectives—the student should experience and observe—both form part of his curriculum, which is, after all, only a preparation of himself for a particular position.

The general experiences of vacational employment are insufficient to guide a man to his final task. After ten weeks' work it is doubtful if one has learnt much more than the names of the nearest twenty people in the office, the name of the blonde secretary on the next floor, and the exact time at which the paymaster arrives at his desk on Thursday mornings.

Having graduated as a Civil Engineer, employment is usually found in one of the Governmental or semi-Governmental Departments. The majority of graduates from Adelaide take these positions, although there is now a tendency for more to join private industries or consultant or architectural groups.

I believe there is also a tendency now for the Civil Service Departments to employ consultants, with a consequent reduction in their own design staffs.

No matter where a graduate first works he is likely to change jobs after a period of one to three years. In only a few cases is it a matter of dissatisfaction. It is fairly normal for the man to want to move round gaining experience while he makes up his mind as to what particular niche he desires to make his for the next fifteen or twenty years.

Of those who move, perhaps half go interstate to some project such as the Snowy Mountains Scheme, and the others go overseas.

For those who go overseas three choices are available—Great Britain, Canada, and the United States, the former being a natural choice owing to the association of our countries, and the latter two due to the wider fields and far greater salaries.

Personally, I selected Canada, and entered as an immigrant. The company which I joined was a large one, having sixteen plants and offices, and which employs one person for each two thousand Canadians.

Their products varied from normal structural steelwork to ships, cranes, mechanical handling equipment, and pressure vessels of all kinds.

Their policy was to have all graduates pass through their own private draughting school, and then to spend an indefinite period as detail draughtsmen. In my particular case, I was loaned after five months to the Plant Engineer, to act as designer and detailer under the supervision of an architectural draughtsman for a large plant extension. I was then transferred to the Civil Design Department.

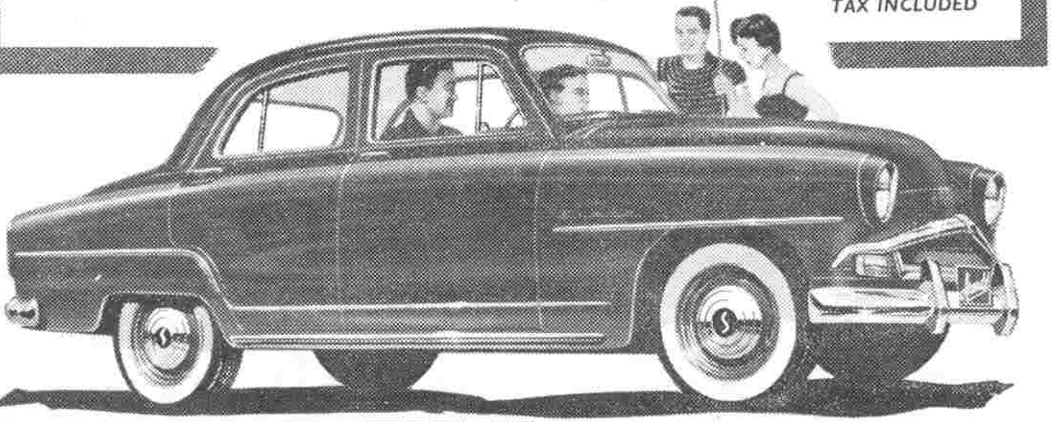
The set-up of the head office was as follows: Firstly, there was the Company, Office, and Plant Administration; Employment; Accounting and Sales Departments, and the Engineering Section. The Engineering Section was broken down into various sections or squads—Civil, Mechanical, and Plate and Boiler Design Departments, Plant Engineering and Erection Departments. Behind these came three structural detail squads, two bridge detail squads, and two for mechanical and one for plate and boiler. The complete picture included a Steel Stock Department, Estimating, Pricing and Shipping Departments. A total office staff of some three hundred and fifty was employed.

Owing to the climate, a number of new and different conditions were met in design.

The Quebec Bridge, whose basic layout is similar to two-thirds of the Firth of Forth Bridge, collapsed when it was being erected in 1912. Later, after a new design was made, the suspended span dropped when a casting broke—a fated bridge. When I arrived in Canada it was found that the expansion joints, which have to allow for a total movement of 15 in., were locking up with an ice concrete made of snow, road dust, and gravel.

When the bridge contracted further, all the connections between a floor beam and a series of roadway stringers failed, and a section of the road very nearly dropped into the St. Lawrence River beneath. It was necessary, therefore, to provide an increased clearance between the fingers of the joint, and to protect these fingers with a cover-plate, which was maintained in a mean position to exclude snow and gravel from the joint until the temperature was below 10° F. This was not a design problem really, but a type of minor, though important, detail which had to be considered in Canada, but not in Australia.

Of greater importance is the problem of null ductility, a condition that develops causing steel to become brittle, and shatter if shocked in the vicinity of a stress raiser. This problem is probably encountered in outdoor steel structures in Australia's snow areas, but not elsewhere.



This condition of brittleness at sub-freezing temperature is aggravated if the steel's composition tends to the borderline of the specification controlling the percentages of sulphur, phosphorus, and several other impurites, and is considerably affected by welding. In one instance a seven-span continuous girder bridge collapsed during a snap freeze when loaded by no more than four or five tons of passenger automobiles.

During 1957-58 there were three bridge failures in Canada.

The first was a 280 ft. simple truss, which carried a 30 in. water main. The cross section of this bridge was triangular, with the top chord made of two 15 in. channels, whose major axes were at approximately 30° to each other. The design details showed plate diaphragms which maintained this angle between the channels, but did not show any diaphragms to maintain the longitudinal position of one channel relative to the other. Consequently, when the bridge suffered a transverse load, the top chord buckled into an S shape—this occurred just as the pipe had been filled with water.

The second collapse concerned the ill-fated Tacoma Narrows Bridge. The towers and cables of this bridge were re-used to bridge the Peace River on the Alaskan Highway. Some time after the bridge was commissioned one of the towers tilted slightly—some 11 in. at the top—and then some cable ducts near one side of the anchor blocks were found to be broken. Investigation showed that the anchor block had moved, and before anything could be done it slipped forward, and the approach span collapsed. Apparently seepage had produced a slimy clay layer beneath the block, which then skated forward.

The third disaster occurred in Vancouver, when the Second Narrows Bridge failed during erection. This failure has been attributed to the failure of piling beneath a false bent, over which the 460 ft. span was being cantilever erected. There has not been a full report released about this accident yet, although some responsibility has been laid, most unfairly, at the feet of a field engineer who was amongst the twenty who lost their lives.

Of course, it should not be imagined that every engineering enterprise in Canada is bugged by failure and disaster. On the contrary, vast projects such as the St. Lawrence Seaway, recently opened by Her Majesty Queen Elizabeth II, have gone forward with virtually no unforeseen difficulties. In fact, in a country where sub-zero conditions and several feet of snow make outdoor activities most difficult for three or four months of the year, it is only the natural wealth of the country, and the powerful progressive people, that has made such undertakings possible.

Some of the most interesting work in Canada has been carried out by utilising aluminium. One such project was in the Rockies, where transmission line towers of aluminium were erected with the aid of helicopters in lieu of other transpost.

Another advertisement for aluminium was a two-pin arch bridge at Arvida, near a major site of the Aluminium Company of Canada.

An interesting problem recently solved in Montreal by a young engineer was the introduction of pre-stressed wind bracing in the four inch curtain walls of a multi-storied hotel. Since only 4 in. was available, bars had to be used, and hence no compression was permissible. The final bracing was also used as temporary bracing, and thus the pretension had to take into consideration the ultimate load above the panel considered causing an axial shortening of columns, and consequent loss of pre-stress. The effective solution of this problem earned the engineer an award from the Canadian Institute of Engineers.

Eventually my return trip to Australia was converted into a premature long service leave holiday through twelve European countries.

As the Greeks and Romans left their mark on architecture, so the modern States will leave their marks to posterity. Personally, I felt that autobahnen and express-ways typified the people who built them. Americans join "A" to "B" by a profit-making ribbon of concrete, which is basically flat and straight. Valleys are filled, hills are lopped; the countryside becomes a blur of huge advertisements. The British and Belgians produce a functionally attractive expressway which avoids the towns and leaves the country untouched. The Germans build fast roads which run up and down hills that get in the way, and connect together the large industrial cities. All roads lead to Rome, but not so the autostradas. These are practically freeways, though very narrow and dangerous except for their limited access. The driver has to concentrate on the hot-blooded Italian driving towards him at high speed—probably on the wrong side of the road.

If roadways will in the future exhibit our national character, then Australia must hope that the future is yet some years away.

ENGINEERING DEFINITIONS

Hysteresis: A hilarious Elec. lecture.
Universal Vice: A bad habit that everyone has.
Spirit Level: Amount of spirit consumed.
Slipping Clutch: Must you go so soon?
Moment of Inertia: Who said I was going?
Reluctance: That's all right; I don't want to go, either.
Impedance: Uh-huh, here come Mum and Dad.

If men knew how women pass the time when they are alone, they'd never marry.—"Memoirs of a Yellow Dog," O. Henry.

Kelvinator

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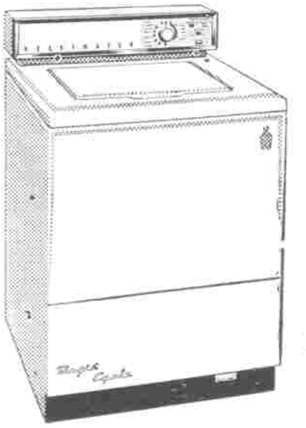
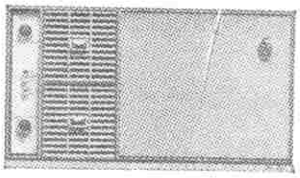
WASHING MACHINES



Dial and Disappear! Here is the new concept in automatic washing now introduced into Australia by Kelvinator. Just set the dial, and while you're away your Kelvinator washes, rinses and damp dries all your clothes — automatically. Added features include the exclusive Filter Fountain, three-way washing action, five-way rinsing action, "Magic Cycle" three-way pump, variable washing time, variable washing and rinsing temperatures, plus glamour styling to bring beauty to the laundry.

ROOM AIR CONDITIONERS



The Kelvinator Room Air Conditioner introduces "Magic Cycle" heating and cooling! You simply press a button once — after that the "Magic Cycle" Heat Pump with Thermostatic Control automatically 'senses' the ideal temperature — for Winter or Summer.

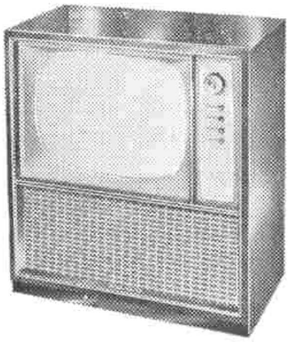
The exclusive "Magic Cycle" Heat Pump is the Kelvinator secret of automatic, perfect all-year-round air conditioning.

This completely different method, the newest feature in the U.S.A. eliminates costly, old-fashioned elements.

In hot weather the Unit removes 8,250 B.T.U.'s of heat per hour from your room, and in the cold weather this amazing Unit delivers up to 10,880 B.T.U.'s of heat per hour into your room (more than any other unit), yet operates at half the cost of elements for the equivalent heat produced.

REMOTE CONTROLLED

TELEVISION



Only Kelvinator offers you remote control on all the Television sets in their range at no extra charge. With remote control, you operate your set easily from your chair anywhere in your room.

The full range of Kelvinator Television Receivers covers every requirement from table model to full Console.

The Kelvinator Aluminised Picture Tube almost doubles picture intensity. The circuit has been designed with maximum excess capacity so that it is never working at full load — lengthening the life of each component.

You must see Kelvinator Television Receivers.

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The full range of Kelvinator Radios, Radiograms and Record Players includes the magnificent 7 valve Stereophonic Radiogram with three dimensional reproduction, the Hi-Fi Automatic Radiogram-vivid Hi-Fi at its best, the mighty Transistor Portable Radio, and the Transistor Record Player. Whatever your choice in Radio, Radiograms or Record Players there is a Kelvinator Model that will suit your needs.

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THE UNIVERSITY AND THE ENGINEERING PROFESSION

By PHILIP FARGHER

There has been a great cry for technologists. In answer, the Universities have been making provision for training more students in technology. Yet, although many graduates in Engineering and other technical fields find satisfactory employment in their profession, there are some, and those by no means only poor graduates, who find difficulty in establishing themselves in positions suitable to them as graduates. There are those, also, who, having graduated, waste their talents by not using their University training at all.

Despite the loud cry for more training and more technologists, it seems that no real study has been made of what happens to graduates after they have left the University. Therefore no adequate information is available to show whether or not the University is serving its purpose in training technologists, or whether it is falling short of the desired standard. Truly, many employers of engineers, men of some standing, sit on the committees and councils of our Universities and, to an extent, influence the training. But that influence must be small compared with the influence of the academic staff. The Murray Commission Report no doubt covers the effectuality of training, but the time available for the Commission to study this particular problem has been too short for it to markedly affect the basic concept of technical training.

In the last hundred years, the function of the University has changed greatly. Hitherto it had been an organisation established as a haven for scholarship and the education of gentlemen's sons in the more classically based professions. The industrial world did not employ people of University education as a rule until the beginning of this century. Now "industry" in all its forms employs a large percentage of the gradautes trained in financial, technical, and administrative matters. Thus the demand.

But the truth remains that few graduates really make proper use of their training in technology, or of their broader University "background," if they have acquired this latter asset. My opinion of Engineering graduates in general is low, because I feel they have failed to see, let alone grasp, what the requirements of our community are. The wiser sometimes express a regret that they had not studied some subjects outside Engineering (even at the expense of some of their technical subjects), in order to be able to analyse the non-technical problems with less narrow vision. Employers of highly specialised technologists, on the other hand, are apt to complain that University graduates are not sufficiently trained in technical skills, and advocate a more intensive and specialised training. Often such people are dubious about employing University graduates, and do not properly understand just how the University graduate can be employed.

This presents two conflicting views—one of the highly trained graduate wanting an even broader training, and the other of the specialist employer, expecting a far more specialised training from the University than the University can be expected to give.

One questions the efficacy of the University Engineering school here. Are students being adequately trained? Furthermore, what is the purpose of University training?

Fundamentally, the University's purpose is to educate people of high intelligence both in a specific profession and, more broadly, to provide facilities for students to learn by curricular and extra-curricular means what causes society to move, and how men think in as many of the branches of thinking as the student can poke his nose into.

It seems an innate characteristic of our Universities in Australia that they fall short in this latter business of providing facilities for students to learn about other people's ways of thinking. The reasons are obviously manifold.

First, the isolation of Universities in Australia, both from one another and from overseas Universities, inhibits a free exchange of ideas, especially between students of different Universities. Second, the Universities here have a majority of students living at home, thus inhibiting a natural exchange of ideas between fellow students. Of these, more anon.

There is a great desire in this country to give everyone the opportunity to attend a University. It seems overlooked that a relatively high percentage of graduates will do work that is not suitable to them, much of which could be done by people of technical school training.

In the cry for technologists, I think the biggest answer to the call should come from technical schools, which can train students more rapidly, but to a sufficient standard to meet the demand of industry. Having rid University technical courses of the high percentage of non-sufficiently capable students (of whom I would probably have been one), the more able would have better room to expand their ideas. But even then, I think, not enough would have been done. Raising the matriculation standard is one thing, making the Engineering courses more valuable is another. The theory that a full time-table keeps the students hard at work all the time and thus produces better engineers, is probably fallacious. Many of us have complained for years that the Engineering course is too crowded, and too loaded with set studying hours.

The set 30 hours per week of classes that occurred in the year of Civil I, Mech. I, and so forth, proved prohibitive, and by the end I really doubt whether the average students (or even the above average) had learnt a great deal. There was a fearful stuffing for exams. of matter that was neither liked nor understood.

University years are to an extent unnatural. At this particular stage of existence human beings normally start work, marry, become independent, and generally change from school children into responsible adults. The student of a University has to keep himself in a stringent harness for a further three to six years, being held both, as it were, as a schoolboy and a super-intelligent adult. A training of 30 hours per week (not counting outside classes) prohibits the natural desire of the student to discover the other fields of thought that lie at his doorstep.

In European Universities nowadays, I am told, the actual class hours are less, thus giving students some more free time to arrange their own affairs.

University "Types"

In Germany, for instance, the students have as much work to do, but much more is left to themselves. Designs are given to be done privately, as are seminar projects and the like. To nominate hours within which these things should be done would, to such a student, seem ludicrous.

My experience in Europe and England indicated that the Australian University system lacked maturity. The above observations may confirm that, but the main reason for this lack of maturity not only depends on the internal organisation of the University, it has to do also with the ways the students live. In Australia most students are forced to live at home while studying at the University. In England and Europe they are generally forced to live away from home. The home influence on students is rarely a good one, since family demands make it difficult for students to study properly, and little, if any, encouragement is given to them while they are studying. Also, this fact of living at home tends to inhibit the natural exchange of ideas which comes from having students living and mixing together freely, both in and out of the University.

I advocate that students should live in self-contained lodgings, halls of residence, or individually chosen forms of residence, rather than in colleges, where too much social organisation can tend to overcome the value of living away from home.

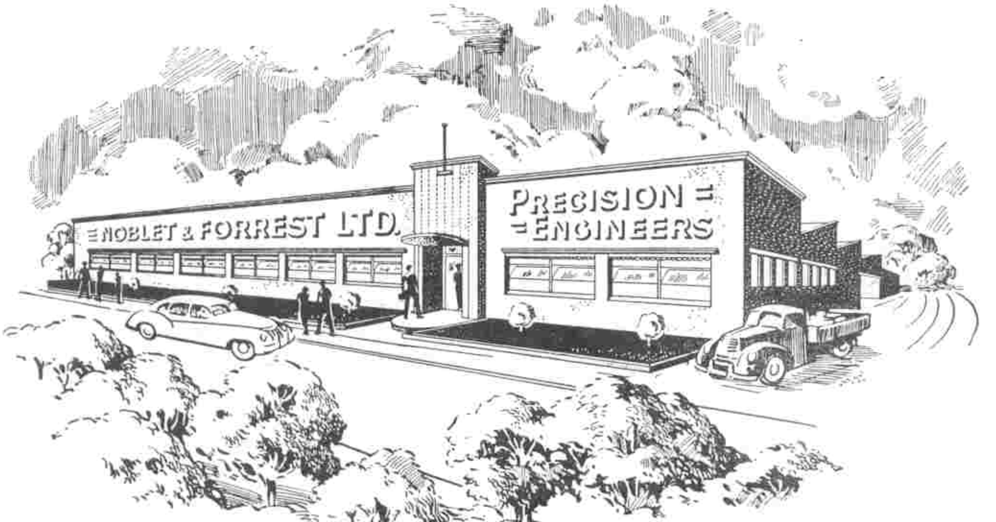
The prospect of removing Universities from the main centres of population, or encouraging students to travel interstate for University training, to ensure that most students live away from home, may not seem either wise or economic at the moment, but it appears as a good solution to one of the University's worst problems.

Finally, I think a great deal of responsibility lies with the employer to provide specific training where it is required, rather than to rely solely on the training given in the University (such a scheme as the Graduate training of A.E.I.—Metropolitan Vickers is a good example). More especially in this country, where industries are small and the real use for graduates is often limited, I think employers should be sure that the graduates they are employing are used properly, and not in some place where a foreman welder or a good draughtsman would suffice.

Arts Student: One who speaks twice before he thinks.

Engineer: One who has a good reason for guessing wrong.

Rules are the only means of a girl's assessing which man she likes well enough to break them for.



ENGINEERS' MARRIAGE MANUAL

I may explain that the author of this document is a young chartered civil engineer, occupied chiefly with the preparation of specifications, estimates, and the like, and that his absorption in professional work has lately become so exaggerated as to influence his whole manner of thought, speech, and general conduct. For this reason I had deemed it well to suggest discreetly the advisability of taking a wife as an antidote. Rather to my surprise, he expressed definite disapproval of my idea, provided the change would not interfere with his sole relaxations of swimming and occasional walking tours—the latter mere excuses, I believe, for indulging his passion to tabulate and analyse times, distances, and the readings of what I understood him to refer to as his pocket adenoid.

Reassuring him on this point, I told him to let me know something of his tastes, so that I might arrange one of the several suitable introductions I had in mind, and the following is the result:

SPECIFICATION FOR THE SUPPLY OF ONE WIFE

Method of Tendering:

Tenders shall be accompanied by a full description giving the principal dimensions and other particulars, as mentioned below, together with photographic and/or other views showing the outside front and side elevations and plan (but sectional views are not required in the first instance); also certified records of performance under the conditions prescribed. These papers shall be submitted to the undersigned in a sealed envelope bearing the words "TENDER—WIFE" in the upper left-hand corner, on or before the last day of the current month. The undersigned does not bind himself to accept the lowest or any tender.

Dimensions:

The overall length, unshod, shall be between the limits of 5 ft. 4 in. and 5 ft. 11 ½in., a tolerance of ¼ in. above or below the length given in the drawings being permitted. The extreme girth on the largest horizontal section shall not exceed 3 ft. The net weight shall be between 100 and 120 lbs.

Locomotion:

The specimen shall be capable of travelling under its own power on the level at a speed of 3.8 m.p.h. unloaded, or at 3.1 m.p.h. bearing a load of 10 lb. for one hour continuously; also of withstanding an overload of 50 per cent. for a short period without over-heating or showing signs of baulking. The motion shall be smooth, graceful, and uniform, the spring adequate, and the carriage erect (but a reasonable forward tilt will be permitted in ascending a gradient). The ankles shall be of ample size to withstand the repeated impacts caused by travelling over rough ground at speed.

Flotation:

The specimen shall be capable of floating in fresh or salt water with at least four inches of freeboard, and unaided propulsion therein. The skin and other parts shall not be subject to deterioration through aqueous immersion.

Constructional Details:

The hair (which may be of any approved color, and fitted in accordance with any recognised modern practice) shall be of the non-detachable type, of uniform quality, and each strand having a tension breaking load of not less than 5 lb., with corresponding anchorage. The teeth shall be in good repair, true to shape and size, and free from all looseness and unsoundness. The nose shall be of such design and capacity that the intake of air is effected without emitting the noise technically known as "snoring."

Automatic Action:

Besides being capable of travelling from point to point without intermediate guidance or adjustment, the specimen shall be able to satisfactorily perform a great variety of operations, such as sewing, preparing the ingredients of foodstuffs, etc., without attention beyond the supply of raw materials. A high degree of excellency will be required in these adaptations.

Appearance and Finish:

The outline and contours of the face shall be such as to present a pleasing and well-proportioned aesthetic effect, conforming generally to the best Australian models, and shall be free from all surface cracks, blisters, or other obvious defects. The coloring shall be such as to form an harmonious and pleasing whole, and shall be secured without the addition of pigment or extraneous treatment of any kind, the natural surface being left clear and unmarked after removing any scale, grease, or dirt, and washing down with soap and water.

Coverings and Accessories:

A complete set of usual textile or other covering shall be supplied, together with an outfit of small tools and spare parts for effecting ordinary running repairs to the same.

Delivery:

Delivery shall be completed within six months of the acceptance of the tender.

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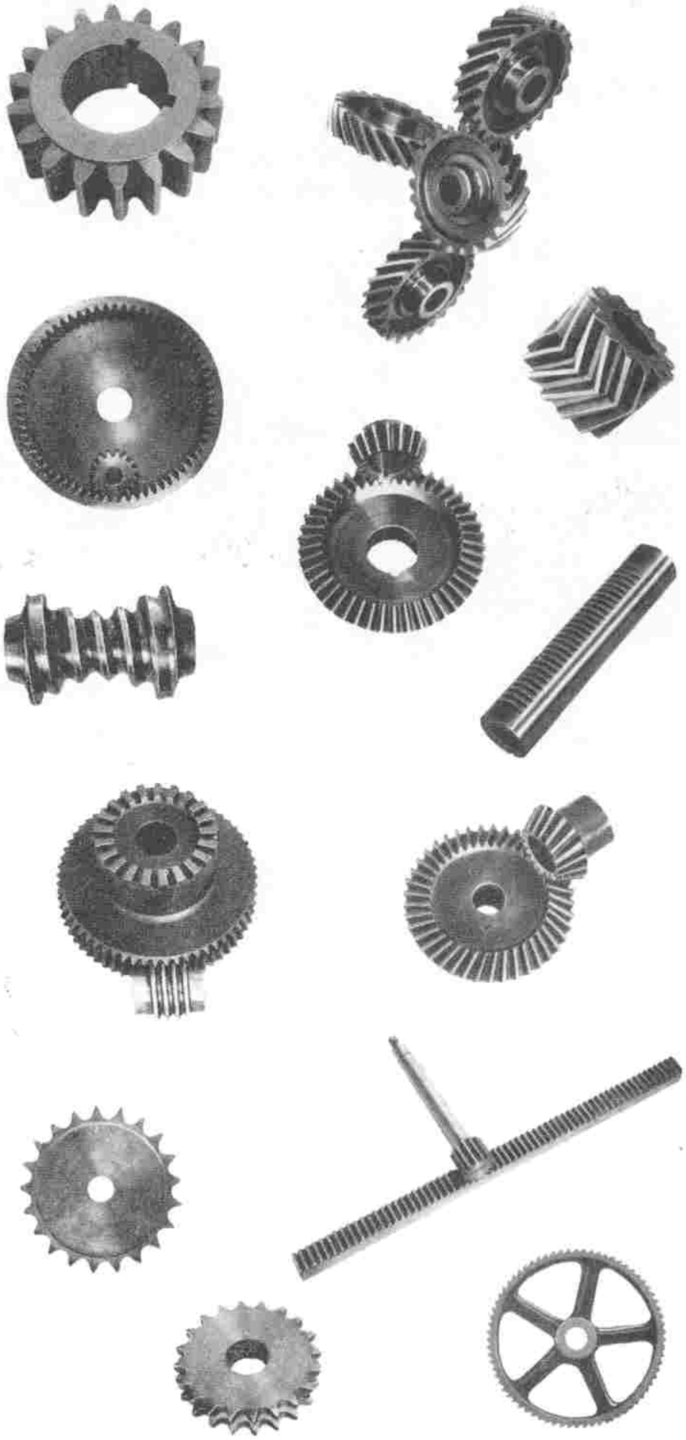

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ADELAIDE UNIVERSITY ENGINEERING SOCIETY

GENERAL ACCOUNT

DEBIT	£	s.	d.	CREDIT	£	s.	d.
Cost of Badges	50	0	0	Bank Balance	170	4	4
Cost of Ball	94	6	7	Petty Cash	2	12	10
Cost of Dinner	110	8	2	Subscriptions	67	19	0
Grant, Magazine	70	0	0	Badge Sales	37	2	6
Grant, Symposium	30	0	0	Badges on Hand	14	12	6
Loan, Magazine	90	0	0	Repayment of Magazine Loan	90	0	0
Freshers' Welcome	5	5	0	S.R.C. Grant	90	0	0
Petty Cash	10	3	8	Ball Receipts	233	6	6
Miscellaneous	32	5	6	Dinner Receipts	68	8	0
Transfer to Function Account	60	0	0	Refunds for Symposium Account	13	11	10
Stationery	9	8	6	Bank Interest	3	4	0
Badges on Hand	14	12	6				
Petty Cash, 1/9/58	2	9	2				
Bank Balance, 1/9/58	212	2	5				
	£791	1	6		£791	1	6

FUNCTIONS ACCOUNT

DEBIT	£	s.	d.	CREDIT	£	s.	d.
Cost of Pre-Ball Cocktail Party	65	5	8	Balance in Bank	6	8	4
Balance at Bank	9	12	5	From General Account	60	0	0
				Refunds of Deposits, etc.	8	5	0
				Interest	0	4	9
	£74	18	1		£74	18	1

September 12, 1958. Audited and certified correct. (Signed) JAMES H. FOWLER.

FOUNDATIONS AND THE ENGINEERING SCHOOL

By "TAFFY"

> **"This man began to build, and was not able to finish."**
> **". . . he looked for a city which hath foundations . . ."**

In 1922 the entire Engineering School of the University was housed in one room and a cellar in the front building, and three rooms in the northern section of the Prince of Wales Building, together with the present Health Centre area as a testing laboratory. But it overflowed into the crook of the staircase at the southern end of the ground floor of the Prince of Wales portion, where stood a contraption of flooring boards and timber frame. It was here that Mr. A. R. Shepley (now Chief Civil Engineer of the State Electricity Commission of Victoria) and the author could have been seen in the early spring sweating as they lifted heavy buckets of Findon sand to fill a bin behind a timber retaining wall. It was a project set by "Chappie" (the late Sir Robert Chapman, the "father" of the Engineering School), and watched over by the late Sir Claude Gibb, who was then demonstrator. Dial micrometer gauges were unknown, so an electrical contact was rigged to give the signal when first "give" of the wall occurred as sand was run from a bucket hanging from the rope holding the wall in place. Three separate hinge positions were used in the attempt to determine the forces acting on the wall, by the earth, and their position. The terms "Soil Mechanics" and "Soil Engineering," not to mention "Geotechniques," had not been coined, but the urge to understand the behaviour of soils was there, and the name mattered little. In the field, drays provided cartage, and bullock teams provided compaction. The motor car and the aeroplane were just beginning to demand earthworks on a large scale. From Sweden came news of Petterson's work on disastrous earthslides in railway cuttings, and of his analysis of them; Terzaglii was beginning his outstanding work at Robert College, Constantinople; in Germany and Holland investigations and research were proceeding; the United States provided data on stresses in culvert pipes, railroad track, and under-loaded plates. The principles of soil compaction were being developed by Proctor in America, and simultaneously by Kelso, in Victoria. Soil Mechanics as a separate subject was being born.

When, in 1939, the author was appointed as a lecturer in the Engineering Department, one of his tasks was to establish lectures and practical work in this new discipline. It is believed it was the first school in Australia to do so. World War II and the financial situation of the University prevented the full provision of equipment. But the war provided an opportunity for the school to make a direct contribution to the general course by seconding the author's services for about eight months to the Allied Works Council. There his task was to keep liaison (blessed word) on all cement stabilisation work on soil, to select six air strips for experimental construction, and to write the specification for that construction. All this was because of the danger of "dusting" of our aeroplanes in 1942, when there was a grave threat to our supplies of bitumen. Fortunately, the Battles of the Coral Sea and of Midway relieved the position, and in the event only two strips were so constructed, one of them at Gawler, the other in Tasmania. Except for some small home-made equipment and a gradual consolidation of lecturing, little further development occurred until the present building was occupied in 1947. It was realised that in the near future active investigation of South Para Dam would be required, so as an opportunity came to have a triaxial testing machine made in Melbourne, it was grasped. This machine now occupies the south-eastern corner of the Soils Laboratory, where it was first installed, and is surrounded by a four-champer preconsolidation apparatus and some percolation cells, much of which was installed, and all of which was extensively used, by the Engineering and Water Supply Department, free of charge.

Most of these machines are not suitable for undergraduate work, though the triaxial machine has been used by Honours students (in 1956). So student work in soils was confined to other equipment, such as the study of contact pressures beneath footings pressed on to sand in a tub in the old 100-ton "baling press," and of soil compaction.

Since 1954 development has been rapid. The three lines along which this has occurred have been, first, the gradual extension of equipment suitable for student use, and also for commercial testing, then the increased desire on the part of industry to have advice on foundation problems, and finally, the advent of Honours students into the Soil Mechanics field. Some excellent work has been done on a restricted scale by ordinary degree students, but time is against them, because specimen control, preparation and testing, are time-consuming operations. Soil must be tested when IT is ready, not only when the operator is disposed.

Today, in addition to the apparatus already mentioned, the main equipment in the laboratory includes six consolidation machines, two direct shear machines with three shear boxes, two triaxial machines, with four pots for 1½ in. diameter specimens, and one for 4 in. diameter specimens, six each of compaction and California Bearing Ratio sets, together with ample auxiliary equipment, such as balances. On order are volume charge and bore pressure measuring equipment. Besides all this standard equipment, special apparatus has been made for research purposes. These comprise a special triaxial pot for measuring the shear strength of soil by collapsing a thick cylinder, equipment for the two dimensional study of the action of earth pressures on retaining walls, bulkheads, and cofferdams (thereby eliminating side friction), and apparatus for studying the failure of soil under the action of tensile or low compression stresses.

Consulting work has been accepted on a considerable scale for two main reasons. The first is that, until recently at least, there was a lack of such service on modern lines. The second is because of the choice which presented itself to gather information on the engineering characteristics of the soils of South Australia, which would not otherwise occur. Today, with large and heavy construction programmes imminent, with novel forms of building developing rapidly, and with greater specialisation being generally prevalent, more problems are being posed. To solve some of these is surely the object of a live soil mechanics school, and one appreciated the opportunity to tackle some of them. What have been the results so far? A few examples will be offered to give an insight.

It was proposed to build a large installation of wheat silos on an old slag dump about 16 feet deep, composed of lumps of slag up to 18 inches in size. Beneath was a little slag, then granite. The main problem posed was what would the settlement be? Normally, for a reasonably fine-grained soil, either loading tests or laboratory tests or undisturbed samples would have been made to make an estimate. Clearly (at least to some of us), neither method was applicable here, though it is remarkable that an experienced contractor elected to conduct a bearing test, against our advice. The result was a complete failure. Instead, a new approach was adopted, wherein samples of the slag were placed in a 30 inch length of 30 inch diameter pipe, packed in various ways, and subjected to pressures comparable to those to be imposed.

The result showed the likelihood of settlements within a reasonably narrow range, which could have been used then for design. Notice also that variations in the packing of slag are covered in such test procedures. Unfortunately, a change of site prevented the check of field measurements.

Not so successful were the first attempts at forecasting settlements of such structures on mottled clays. Results obtained seemed extraordinarily high, so that some considerable attention has been paid to this aspect since. It is believed that today methods of test and interpretation (probably the more important aspect) will give results much nearer reality. When opportunity permits, it is hoped to go back and re-assess the earlier forecasts, and to correlate them with actual measured settlements.

One of the objections to adequate site investigation in Adelaide seems to be that of cost. Therefore, whenever the department undertakes to make such an investigation, it stipulates that some of the work done will be essentially of a research nature. The most promising speeds and economics seem to lie along the lines of vane testing on the site. However, such tests are normally confined to soft clays, having little or no internal friction, and many of our foundation soils have considerable internal friction, according to test. Interpretation must therefore be modified to suit. It is hoped that a recent job will afford material for a paper on this subject to be written shortly.

Other examples come to mind, but this article is long enough. Without workers, the large amount of experimental work required for research cannot be performed. It is here that higher degree students can give creative effort to the school. In 1956 two Honours students conducted a reconnaissance survey of soils around town. Their findings have been used several times by outside consulting engineers. Last year four others helped the work along on two other fronts, one of which has already borne fruit in design by an interstate authority. It is hoped that enough students will want to major along such lines of research to enable progress to continue.

The application discipline lacks the precision of electrical engineering, or even that (??) of the design of a superstructure or machine. It calls for a wide background knowledge of geology, pedology, hydraulics, structural action, elasticity, and plasticity and then much common sense. In essence it is similar to the approach of a medico, where numerous symptoms must be correlated for a proper diagnosis, and then scientific knowledge used (with an adequate bedside manner) to effect a cure (pardon, I mean a suitable preventive treatment).

Probably the major advances will be made by adequate correlation of laboratory testing with field observation, and the would-be soils engineer must be prepared to "dig a 'ole" for himself. At present such an approach is well beyond the resources of the school, so co-operation will be extended to the Soil Mechanics Section of C.S.I.R.O., which might undertake it. It may be of interest to note that the head of that section and a recent appointee to the staff are each graduates of our Engineering School.

ENERGY AND SOCIETY

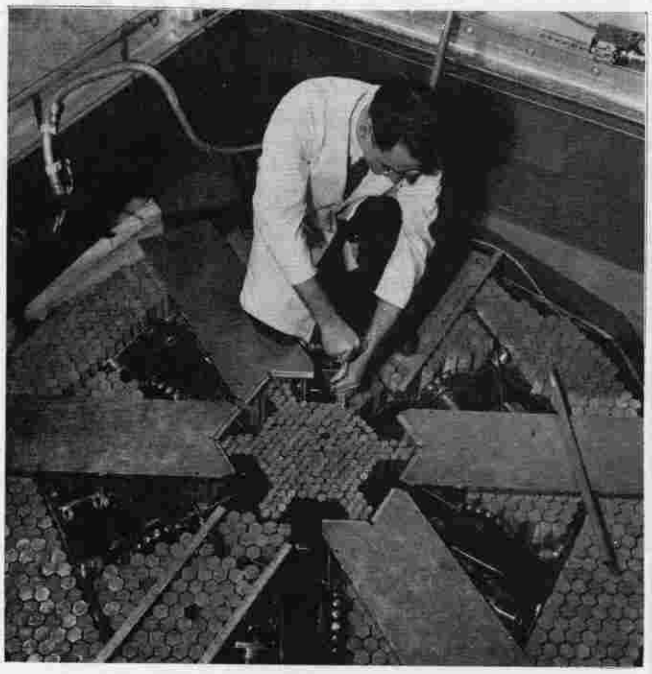
By DR. R. G. BARDEN

Any study of the resources of the earth to support life must of necessity include the availability of energy. The ever-increasing tempo of our modern way of life, with the rising world population, presents an immense challenge to man. To foretell and prepare for the requirements of future generations is one of the urgent tasks which confront responsible men. To assign at birth to each new member of the world a "quota" equivalent to the standard of living enjoyed by the more advanced societies presents a formidable problem, and one which may have no easy solution. The way of development in advanced societies has been such that the need for energy in increasing amounts is continuous, and, in fact, such development is possible only by virtue of readily available energy at all times. The Engineer and Scientist have so far met this demand with reasonable success.

To predict accurately the demand for energy in the future is impossible, and is best limited to a time period similar to man's own life span. The basis of prediction must still be in keeping with progress as is known in society today. The alternative is for a new form of society to emerge and develop along a path foreign to us. With the existing foundations of our society so firmly embedded, such a likelihood seems very remote and the world must accept that the demand for energy in the future will be great. Influenced by the many expanding economies of the world, the overall energy requirement is increasing at a rate of some 2 to 3 per cent. per annum. By 2025 A.D. the demand will be four to eight times that of today. Such figures arise not only from the increase in population of about 6 per cent. per decade, but also from a higher average demand per capita.

In passing, it is of interest to hear views expressed some generations ago. In 1895 Arthur James Balfour, in "The Foundations of Belief," had the following to say:

"The energies of our system will decay, the glory of the sun will be dimmed, and the earth, tideless and inert, will no longer tolerate the race which has for a moment disturbed its solitude. Man will go down into the pit, and all his thoughts will perish."



Technician Removing Fuel Element from Core of Zeus Reactor

Our patron, the sun, has served us well, and in the past has provided all sources of stored energy available to man today. Its current energy also continues to play a most important part in the supply of food and warmth. Its glory still remains, and it demonstrates in no uncertain manner the "golden plum" of future energy supply —nuclear fusion. It turns to energy four million tons of mass per second, and even at this rate should last for ten million million years. It seems, therefore, that Balfour's vision was projected many millenia hence. But "the stored energies of our EARTHLY system will decay," unless man is prepared to accept the challenge of today. Man's own life span is certainly a moment compared with the age of the earth of at least 3,000 million years. But in such life spans, and through successive generations, the problems are presented which demand human analysis and creative response at the highest scientific and technical levels, in order to ensure survival and adequate material standards of living.

The supply of energy, as far as primitive man was concerned, was met largely by the working of the human machine, and by the available domesticated animals of that time. Fuel resources of the combustible type were used only as a means for cooking and for providing warmth. Wood was the staple fuel supply, although supplies of oil and coal were evident. In 1100 B.C. the Chinese were mining coal and drilling wells to produce natural gas. They were perhaps the first to use coal in this fossil-fuel age. Asphalt was promi-

nent as a commercial material in the Middle East about 6000 B.C., and was used as a fuel and in other ways as a waterproofing agent.

The technological advancement in those far-off days amounted to the acquiring of skill and the adaptation of ores from the earth for the production of various metallic articles. The working of many of the metals depended on the heating of the materials by a hot fire. The calcining of limestone to make lime dates back to at least 3000 B.C., and this was possible only by the heating from fuels. It appears that, although certain societies were beginning to develop a high rate of technological progress, a period followed which was to stifle further progress. Such was the stagnation that the events necessary for the birth of our own modern civilisation did not occur until relatively recently. Following the conditions which set going the industrial revolution in the 18th century, power derived from the combustion of conventional fuels sustained the ensuing industrial activity. The technical developments leading to the extraction of iron with coal were of primary importance. The age of mechanisation had commenced, and seeds were sown for the science and technology of our present age.

Little thought was given at that time to the possible extinction of the energy-giving supplies, these often being assumed indefinite. Recently a saner attitude has arisen, emphasising at least a closer scrutiny of the world's fuel resources. Detailed investigations have been undertaken by various bodies to assess their availability. All conclude that a stage has been reached for additional energy sources to be developed to meet the needs of future generations. Already energy from nuclear fission is being made available in limited amounts at an almost competitive cost, and this should be more than competitive with coal and oil within a decade in appropriate situations. For the world as a whole the position is not yet critical. It is, however, our responsibility to see that steps are taken to ensure an abundant supply of energy for the generations to come. Thought must be concentrated and effort diverted to achieve this. Nuclear energy is under intense study, and provides the greatest promise of "energy unlimited."

The development of other "new" resources at the present time is in its infancy, and includes sources of "photo" origin. These latter processes include photo-electric and photo-chemical methods of energy production.

It is perhaps fitting to conclude by recalling the following words from an Editorial of the "Advertiser" concerning the uses and abuses of energy:

"If the gains of science are pooled for the common good, future generations will arise to call us blessed. If they are prostituted to purposes of death and destruction, we cannot be sure that there will be any future generations at all."

A.U.E.S. TALKS AND FILMS

TALKS

April 3—Dr. Derek Van Abbe (German Department): "Why Be An Engineer?"

April 10—Mr. R. E. Jennings (Shell Chemical): "Plastics in Engineering."

April 17—Prof. E. C. R. Spooner (Met. and Chem. Engineering): "Speaking and Writing."

April 24—Mr. E. W. Hughes (School of Mines): "A Visit to the Oldest Mine in the World."

May 1—Mr. W. D. Doble (Mechanical Engineering): "The Beginnings of Flight."

June 19—Prof. F. B. Bull (Civil Engineering): "Channel Tunnel."

June 26—Mr. H. W. Baddams (Shell): "Combustion Engineering."

July 3—Mr. J. E. Schofield (Department of Civil Aviation): "Air Accidents — Prevention and Analysis."

July 10—Mr. J. R. Dridan (Engineering and Water Supply): "The Importance of the River Murray to South Australia."

July 17—Mr. K. D. Coutts (Shell): "Quality Control."

July 24—Mr. D. A. Dunstan (Hon. M.P. for Norwood): "The Politics of Town Planning."

July 31—Dr. R. G. Barden (Mechanical Engineering): "Engine Research."

Richard Duncan and Mr. Don Dunstan, M.P., following his talk to A.U.E.S.

FILMS

The object of these weekly film sessions is to present some of the aspects of Engineering not in the curriculum, and also subjects of general educational value.

This year's topics have included Aircraft Research, Television, Metal Joining, Antarctic Exploration, Motor Racing, and Aboriginal Customs. Attendance has been very pleasing, an average of 80 students being present at each session.

In future it is hoped to present more films of a general nature, dealing with Medicine, Science, and Economics—subjects important to an Engineer, which cannot be covered in lectures.

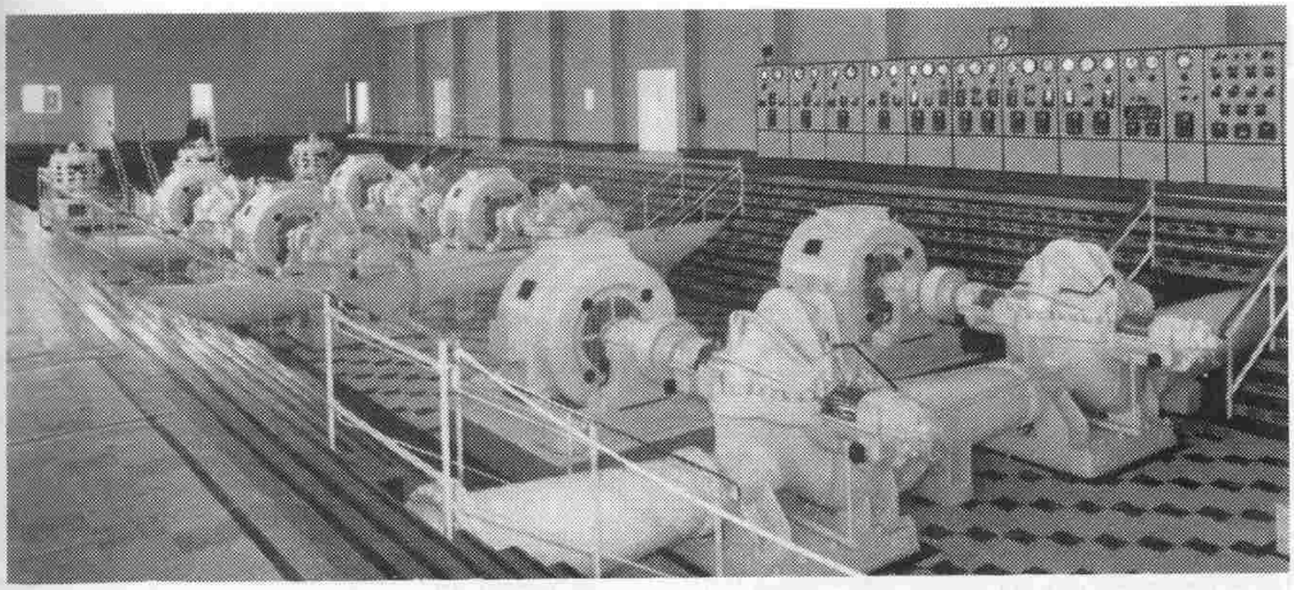
A.U.E.S. Films are Popular!

The A.U.E.S. would like to express its appreciation to the Shell Co. of Australia Ltd., B.P. Australia Ltd., the Vacuum Oil Co., the Department of Civil Aviation, Philips Electrical Industries Pty. Ltd., Dunlop Rubber Co., and the S.A. Government Tourist Bureau, without whose assistance these film sessions would not have been possible.

FILMS SHOWN DURING 1959:

Powered Flight. Warragamba Story. First Grip. Kwinana Oil Refinery. Route de Cimes. Ditch and Live. Address Antarctica. Giving Orders (Industrial Training Film). Reprimanding (Industrial Training Film). The Moving Spirit. Nurburgring. Building for the Nations. Formula I, 1956. Steel—Man's Servant. Endurance—Le Mans Trial.

SECOND TERM: History of the Helicopter. Night Hop. Magic Window—Television. Birth of the Gramophone Record. Test Flight 263. Metal Joining. The Conquered Planet (Cartoon). The Cornish Beam Pumping Engine. Grand Prix, Nurburgring, 1953. Week-end at Le Mans. Flinders Ranges. Tjrunga — Aboriginal Customs. Foothold on Antarctica. Speed Tests, Coonabarabran. Mille Miglia, 1953.



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SOME RECENT ADVANCES IN ASTRONOMY

By A. G. THOMPSON

Although not until recent years considered by the man in the street to be of use as a practical science, astronomy has always ranked high in the interests of youth, and is an absorbing study to the many thousands of amateurs and professionals throughout the world. Now that we suddenly find ourselves in an era where rockets, satellites, and man-made planetoids have become familiar items in the news, the man in the street is realising that astronomy will be for man's exploration of space what geography was for the exploration of the earth. This is a welcome development. Schools in every part of the country have become space-conscious, and the activities of amateur astronomical societies have received a vigorous boost from new membership.

So far, the Universities do not appear to have been greatly affected by the sudden demand for courses in astronomy as such. However, in view of the increased general interest in the subject, it may be opportune to describe some of the recent advances which have resulted from the development of the new technology in instrumentation and controls.

JUPITER

Unsuccessful attempts have been made to correlate Jovian radio noise with individual markings on the planet, visible through telescopes. Since the solid surface of Jupiter is invisible beneath a thick cloud layer, optical astronomers can measure only the rotation of cloud features, and these have different periods. By analysing data obtained over a period from 1951 to 1958, radio astronomers at the University of Florida have found that the periods of maximum and minimum activity appear to rotate, with a constant period of 9 hours 55 minutes 28.8 seconds. The constancy of the period from 1951 to 1958 seems to indicate that the radio source is anchored to the surface of Jupiter, and does not drift about in its atmosphere. If this finding is definitely established, further radio records may give a very precise determination of the true rotation of the planet's solid surface. Further observations of Jupiter's sporadic radio emission have shown the emission to be elliptically polarised, indicating that the planet has both an ionosphere and a magnetic field.

RADAR ECHOES FROM VENUS

Since 1946, the reception of radio signals reflected from the moon has become a familiar experiment, which has been performed by ten different scientists in six countries.

Successful radar contact with Venus on February 10 and 12, 1958, has been recently announced by the Lincoln Laboratories of the M.I.T. The planet was about 28 million miles from the earth at the time. For both transmitting and receiving, the antenna used was an 84 foot radio telescope at Millstone Hill, Massachusetts. In each experiment a five-minute sequence of pulses was transmitted, with a peak power of 265 kilowatts. Of this power, about half a watt was intercepted by the tiny apparent disc of Venus, and only 10^{-21} watt was returned to the antenna. As the travel time for the two-way journey of the pulses was also about five minutes, the transmission ceased just before the echoes began to be picked up.

Most of the technical difficulties arise from the weakness of the returning signals. Success was possible only through the use of a solid state maser to amplify them, without adding appreciable noise. The maser is a recently developed piece of equipment which amplifies and re-emits micro-waves, and it is interesting to note that the operating temperature of the device is –456°F, obtained by immersion in liquid helium.

The extremely weak signals from Venus were nearly drowned in noise originating in the antenna and other components, as well as from cosmic sources. Because separate returned pulses could not be recognised, it was necessary to compare the tape recording with a recording of the transmitted signals, in effect, trying various superpositions until the best fit was found. This matching process (known mathematically as cross-correlation analysis) required very extensive calculation on a high speed IBM digital computer. Once the most satisfactory fit was found, it gave proof that the echoes had actually been observed and indicated the travel time.

For radio waves to travel from Millstone Hill to Venus and back took 295.5065 seconds on February 10, 1958, at 19:21:05 Universal Time, and 302.9842 seconds on February 12, at 17:00:55. The uncertainty in each case was about ± 0.0005 seconds, and the seven-second increase is fully accounted for by the change in the distance of Venus from the earth during the two-day interval. With this accuracy, the uncertainty in the distance of Venus can be reduced from more than 5,000 miles to only a few hundred miles, and sets a new scale for the relative distances of the planets.

THE MOON

The 70 miles wide lunar depression known as the crater Alphonsus was the scene, on November 3, 1958, of the first lunar eruption to be observed with certainty.

Astronomers, used to regarding the moon as a completely dead world, at first received the news with incredulity, but no doubt remains now that the Russian astronomer, Dr. N. A. Kozyrev, did see what he claimed to have observed.

The eruption was not at all like those which occur in volcanoes on the earth. It consisted only of a faint seepage of gas from the interior, accompanied by a slight veiling of the surface of the crater by a reddish haze.

At the time, Dr. Kozyrev was photographing the spectrum of the sun's light reflected from the crater Alphonsus. To do this he had to keep his eye to the guiding telescope. While the exposure continued he noticed the lunar details became washed out in appearance, and assume an unusual reddish hue. After an interval, he began a second exposure, and soon noticed that the central mountain peak had become unusually brilliant. When it faded again he stopped the exposure.

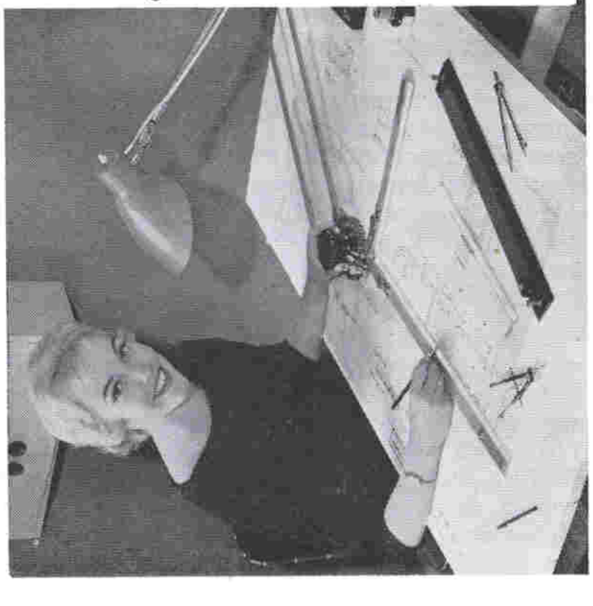
At the time he thought the changes were due to fluctuations in our atmosphere, but when the spectrograms were developed the second plate showed an undoubted emission of gas containing carbon. The emission lasted for less than 2½ hours.

It is interesting to note that previous objective evidence has been obtained in the past for such appearances of haze which have temporarily veiled details of several lunar craters, including Alphonsus. However, it is possible that the observations just described will be unique for some time to come. The coincidence of the central peak can hardly have been accidental, and may indicate that the basic relief of the moon originated from within rather than from the impact of giant meteorites.

BALLOON ASTRONOMY

On a quiet September morning in 1957 a huge transparent balloon, brilliantly lighted by the sun, floated across the sky 16 miles high above the fields of Minnesota, carrying a 12 inch telescope and a 35 mm. motion picture camera. Following its course in automobiles on the ground was a group of anxious astronomers. Like all astronomers, they were used to the fact that the objects they were studying were hopelessly out of reach, but to have their viewing equipment also inaccessible was a new experience. Fortunately, their fears were not necessary, as the instruments did quite nicely on their own, obtaining pictures of the sun's surface sharper than any made previously.

While the balloon hovered at a predetermined height of 82,500 feet, the telescopic camera, kept on its target by a photo-electric guiding device, took about 8,000 photographs of the sun. Then the telescope, with its film, was automatically separated from the balloon, and parachuted back to earth, its fall eased by a styrofoam crash pad four feet thick at the base.



The aerial telescope was almost 10 feet long, and weighed 300 pounds. The 12 inch paraboloidal quartz mirror had an enlarging lens which doubled its effective focal length. The walls of the telescope tube were made of perforated steel, to minimise its expansion and contraction under the full strength of the sun's rays.

The position of the focal point at which the photographs would be taken would vary as the tube lengthened in the heat. As no way was known of predicting these changes, the design included an arrangement for continually varying the focus of the photographic image. Under this system it was realised that a large proportion of the exposures would be blurred and out of focus, but the method had the advantage of making sure that at least some of the pictures secured would be exactly right.

Because the secondary mirror, where most of the sun's heat would be concentrated by the large mirror, would be subject to large distortions, arrangements were made so that it was turned away from the sun except at the moment of exposure.

To find the sun, and to remain pointed at it, the telescope had to be free to turn both horizontally and vertically. It was mounted in a steel frame in which it could swing, and a pair of motors guided by light-sensitive semiconductor "eyes" were arranged so as to drive the apparatus in the two directions. During exposures, it was essential that the rate of motion should not exceed one rotation of the telescope per hour. The system did its work very well, as was confirmed by ground tests.

The "Skyhook" balloon on which the equipment was carried aloft was of polyethylene film 2/1000 in. thick, reinforced with fibreglass, and would be 130 ft. diameter when fully inflated. In operation, the balloon reached altitude in two hours, and operated for about four hours longer before the equipment parachuted back to earth. In the first flight, and a second flight a short time later, about 1,000 feet of exposures were obtained, from which a number of pictures of very good definition were secured, showing more minute detail than had ever been obtained either visually or photographically.

Now that it is under way, high-altitude astronomy will develop rapidly. It is expected that in future ventures attempts will be made to point and focus the instrument by remote control. With such an instrument it would be possible to study a number of problems not capable of solution at the bottom of the atmosphere. Among these would be photographs of the surfaces of the planets, and the study of fine details in the structure of galaxies and the nearby systems of stars.

ROCKET OBSERVATIONS

In addition to bad seeing caused by atmospheric turbulence, the atmosphere handicaps astronomers in another way: it absorbs all the ultraviolet and much of the infrared radiation of the sun and stars. Although many of the astronomical problems affected by bad seeing can possibly be overcome by the use of stratospheric balloons, for investigations in the ultraviolet the much higher altitudes of rockets and satellites are needed.

A fairly detailed mapping of the sky in fair ultraviolet light of 1225 to 1350 A.U. wave length has been obtained from the flight of an Aerobee-Hi rocket on the night of March 28, 1957, at White Sands Proving Ground. The findings from this ascent to 90 miles were reported in the Astrophysical Journal (November, 1958).

Four calcium fluoride photon counters in the side of the rocket received sky radiation through bundles of tiny hollow nickel tubes .0315 inches inside diameter and 0.600 inches long. This limited the field of view of each counter to a circle 3 degrees in diameter. The fields of view of the four detectors were centred at 75°, 82.5°, 90°, and 105° respectively from the spin axis of the rocket. Thus, as the rocket rotated, the photon counters scanned in a fan 30° wide about the rocket equator. The precessional motion of the rocket allowed a large area of the sky to be observed in this fashion. The information obtained by the detectors was telemetered to the ground, and received by oscillograph.

In order to identify signals recorded on the telemeter records, an accurate knowledge of the trajectory, the spin rate, and the rocket orientation as a function of time is required. This problem is simplified by the fact that as soon as the rocket leaves the region of significant air drag, at about 100 K.M., its motion is completely described by the equations for a body freely rotating in space, and falling in a uniform gravitational field. The trajectory is computed from data obtained by radar and tracking cameras. The spin rate is determined by means of a photomultiplier photometer mounted in the rocket. It receives strong signals from the airglow layer each time it scans through the horizon. The intervals between these horizontal signals give the spin rate directly.

The rocket orientation problem may be solved in two steps. If the visible light photometer is not mounted perpendicular to the spin axis, it will scan a small circle on the celestial sphere. The horizon signals can then be used to measure the fraction of this small circle that is below the horizon; this in turn determines the zenith angle of the spin axis. Zenith angles computed in this way are only approximations, since the motion of the rocket throughout the spin period is neglected, and the height of the airglow layer is not sufficiently well known. However, starting with this preliminary determination of rocket zenith angle as a function of time, stellar signals from the visible light photometer can be identified with bright stars by trial and error, to obtain a consistent description of the whole flight. For this purpose twelve visible light photometers were used each with a 5° field of view. The requirement that the rocket precession conform to the equation of motion for a freely rotating body enabled the aspect to be determined to within 1°, which would therefore be the positional accuracy of the observations described.

The peak altitude attained on the flight was 146 km, and the useful observing time (limited to altitudes above 95 km at these wave-lengths) was 200 seconds. The spin period was 15.8 seconds, and the radius of the precession circle was 73° 55′, centred at an azimuth of 280° 22′, and a zenith distance of 70° 51′. Thus the spin axis of the rocket, starting near the zenith, slowly tipped over, crossed the northern horizon, and pointed down toward the earth at the end of the flight, allowing the detectors mounted in the rocket body to scan almost the entire sky.

Although the reduction and interpretation of data are rather complex, it was found possible to determine the orientation of the rocket for each moment, and the scans could be pieced together to form a map of the ultraviolet sky. Most of the ultraviolet radiation was found to come from extended nebulosities. In a previous flight in 1955, for which the counters' field of view was 20 degrees, several sources had tentatively been identified as the hot stars Regulus, Zeta Puppis, and Gamma Velorum. The improved resolving power of the 1957 experiment, however, shows that these sources are actually emission nebulae surrounding the stars, the latter being scarcely detectable.

ELECTRONIC LIGHT AMPLIFYING

Essentially a closed circuit television system, an electronic light amplifying system being developed by RCA and the Westinghouse Electric Corporation is able to detect very small differences of light intensity not apparent by conventional photography because of its ability to increase contrast electronically. Combining the light amplifier with a conventional telescope, it has been found possible to make exposures of remarkably short duration, even in daytime. Photographs of the planets have been obtained in daylight with exposures of only 1/25 second. The short exposures with this system may furnish a way of reducing the blurring effects of poor seeing in the atmosphere. The high contrast which can be obtained with this device also offers promise of observing structure on the moon not easily detected by visual means. Applied to the 200 inch Hale reflector at Mt. Palomer, the limits of range of the telescope could conceivably be increased from magnitude 24 with a 30 minute exposure to photographic magnitude 26.5 with only 100 seconds exposure.

[Acknowledgement is made to "Sky and Telescope" for the foregoing information and details.]

ON THE TRAIN TO MANDALAY

By JACK McLEAN

A Delegate from the Australian Student Christian Movement to the Asian Conference of the World's Student Christian Federation, Rangoon, January, 1959

"An' the sunshine an' the palm trees an' the
tinkly temple bells,
On the road to Mandalay."

—Kipling.

The torrent of Burmese words stopped abruptly as the woman read the name on the compartment reservation tag.

"I am very sorry, sir. This is not my compartment," said the finely dressed woman of Burma as she stepped down from the doorway which she had been defending only moments before. Her daughter followed her down—a girl with beautiful white feet, that surely had never been required to walk far through the dust of Burma clad only in the ubiquitous leather thong sandals.

I lifted my suitcase into the compartment and bounded up after it, only to slide right across to the far wall on the greasy floor. The smell told me at once that this was one of the peculiar services of the Burma Railways—disinfectant on the floor to keep the insects under the floor for at least a few hours. It also meant that passengers had to keep their luggage off the floor.

People were still coming to the station to see the Night Mail, called the "Shweman Lwin," depart for Mandalay, as the service has been running for less than a week. It was a pleasant, if more expensive, change from the regular train, which travelled in the heat of the day. We moved out from Rangood station on schedule at 3 p.m.

The sun glinted on the gilded spire of the great Shwedagon Pagoda as we looked back at the city slowly disappearing in the distance. We explored our compartment, the bunks, the overhead shower, which was one of the legacies of the British administration, and then settled back on the foam rubber upholstery.

"Good afternoon, Sirs! Are you well? We are on schedule."

The guard of the train had found that we were the only Europeans aboard, and was alongside our window almost before the train had stopped moving. This was our first stop since leaving Rangoon, but the conversation, or, rather, monologue, was to be repeated at almost every subsequent station.

"At 0630 hours, 1830 perhaps, we will stop for breakfast!"

"Do you mean dinner?" we queried.

"Yes. Breakfast. Tiffin. Lunch. Dinner!" the guard replied enthusiastically, delighted that here were two people who could talk English with him. Dinner at six-thirty was carried past in baskets, but I suspect that it could have walked by itself. We fasted.

At seven o'clock we pulled into Nyaunglebin Junction. At eight o'clock we were still there. For the first fifteen minutes we made faces back at the swarm of noses pressed against our window. Then we drew the blind. There were many small Burmese, but only two of us to play that game.

Hunger led me out on to the platform in search of food at eight o'clock. I had not eaten since early morning. The guard was drinking coffee, and called to me to join him. I longed for even the fragrance of refectory coffee. I was disappointed.

Scene at Thazi Station, Burma

"What time do we move on?" I asked.

"Don't really know, Sir," he beamed.

"Then do you know what is the cause of this delay?"

"No, Sir."

"No idea?"

"Well, let me see. Oh, yes! A goods train derailed, perhaps—something like that, perhaps."

I bought two large buns and returned to our compartment. At 3 a.m. the train moved off.

The breakfast stop finally arrived, after a long, cold night. The bun I had left over from the night before was almost sliding around on the shelf as hundreds of ants attacked it. They had come on board while the train was stationary. Leaving the bun to the ants, I went across to the restaurant and saw, to my delight, that a serve of fried chicken cost only eight shillings. Later I saw many under-nourished chickens, but at the time I could not understand how any bird could have so many bones and so little meat.

We travelled on up the Sittang River Valley, crossing the many bridges over the tributaries to the river, which runs through arid semi-desert, with distant blue hills barely visible through the heat haze. At each station fully equipped combat troops mingled with the crowds. Onlookers squatted on the seats, drawing on their cheroots, or spitting out the red juice of the betel nut. Their dress was often an odd mixture of felt hat, sports coat and longyi, or sarong. Everyone but the troops wore leather thong sandals.

The train often stopped before moving slowly across the bridges. Workmen were occasionally busy with welding torches, but always there was a man standing outside a small hut near the approach to the bridge. These men all held a red flag in one hand, and waved a green flag with the other. We began to look out for these flag-wavers, and saw one on every large bridge, and there are over four hundred bridges on this line. We wondered why they were there.

Occasionally we passed complete trains that had been blown up—freight vans distorted into a spherical shape, locomotives at the bottom of embankments. The war damage had been worse than we thought.

George Suriva was as cheerful and as courteous as ever when he greeted us at Mandalay, even though he had waited eight hours for the train, which should have arrived at eight in the morning.

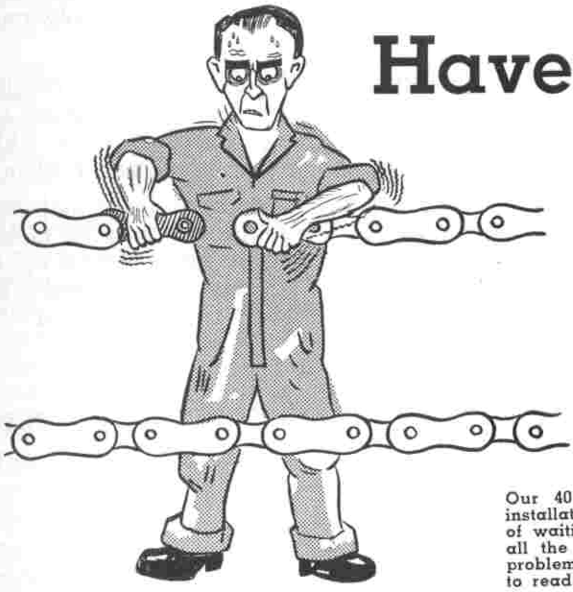
"Another bridge," he said, when we asked if he knew what the trouble had been.

"Yes, you had to wait while they repaired it after the insurgents had blown it up. They blow up at least one bridge a week."

Then we knew why the man had a green flag and a red flag . . . !

Two days later we were picked up at Rangoon station by Dr. George Daniel, the Chief Medical Officer of the Burma Railways, and brother of the General Secretary of the Indian S.C.M.

"I'm glad you're back," he said. "Three weeks ago they blew up a passenger train forty miles north of Mandalay, killing twenty-three people. But they are much more careful when they know that Europeans are on a train. There's such a fuss when one of them is killed."



DEPARTMENT OF METALLURGICAL AND CHEMICAL ENGINEERING

During 1958-59 our work has continued along the lines first laid down in 1955-56.

R. Staker has completed his work on heat transfer in the falling-film evaporator, and has fully confirmed the results tentatively reached in 1957-58. He has been able to show that the heat transfer coefficient in a falling-film evaporator cannot be described by one equation. This is due to the fact that this coefficient is dependent on the liquid flow rate, the vapor flow rate, and the temperature difference. At low temperature differences the effect of feed rate on the result is significant, but this is not so at high temperature differences. Again, at low feed rates an increase in the feed rate causes a decrease in the rate of heat transfer, whereas at high feed rates the reverse is true. Furthermore, vapor velocity has been found to have an appreciable influence on the results. Since the vapor flow rate increased gradually from one end of the apparatus to the other, the difficulty of finding a true mean heat transfer is manifest.

MINING ENGINEERING SUB-DEPARTMENT

During 1958-59 the Honors Degree investigational activity in this small sub-department was linked with one of Australia's major mining companies, namely, Mount Isa Mines Ltd.

In the field of mine ventilation, G. G. Northcote investigated the application of a National Coal Board type of network analyser to a multilevel mine situated in tropical Northern Australia. It must be remembered that in North Queensland the rainfall occurs during summer, and that winter, comparatively speaking, is the dry season. Therefore, in summer, hot, moist air, frequently near saturation point, is drawn into the mine. In this study, data was obtained on the number of thunderstorms which occur in the area during the year. The frequency of thunderstorms is as high as 40 per year, the majority of which occur during the summer season.

Adequate ventilation is important in any mining operation. This mining company already has a large air-conditioning plant to cool the air entering the mine.

Another research activity which has been pursued by this department in various parts of Australia since 1953 is that of investigating hoisting system characteristics.

In this investigation a study is made of the dynamic shocks which occur in hoisting systems. By analysis of the shocks and conditions, methods have been evolved by which the shocks can be reduced or eliminated.

In this work accelerometers are used, and also an instrument invented in this Department, namely the "Cage Roll Recorder," which can indicate bad shaft guide joints which might generate transverse dynamic shocks during high-speed hoisting. Results have pointed the way for the elimination of transverse shocks of as high as $3\frac{1}{2}$G in mine shafts.

The elimination of dynamic shocks of this type increases the life of the mine hoisting ropes, and also increases the safety of the hoisting system.

Mine sampling has been investigated since 1945 in many countries. In South Africa, Bias Errors were first investigated by the Transvaal Chamber of Mines. Shortly after the statistical theorem of Maximum Likelihood was applied to mine sampling problems on the Rand. This was followed by an author in the Orange Free State who, for the first time, investigated the application of Confidence Limits to the processing of mine sample data. In 1953 studies were undertaken in this department of the Adelaide University, with the object of applying statistical Decision Functions to the problem of mine sampling.

All the above investigations have one aim, and that is to reduce the "band of no decision" which exists between what is obviously a payable mining proposition, and one which is just as obviously unpayable.

The investigations in Adelaide have resulted in the derivation of an elementary decision and acceptance technique, based on probability, which can be applied to the mine sampling problem.

The work here and elsewhere leads naturally to the application of computers, since in mining engineering it is easy to accumulate several million items for processing. Interest in this work has been shown by Australian, Canadian, and U.S. authorities.

SOUTH AUSTRALIAN SCHOOL OF MINES AND INDUSTRIES

In the field of reaction kinetics, lead sinter is being reduced with hydrogen in a vertical tubular reactor. In this reactor the finely divided sinter is fed into the bottom of the tube, and reduced to lead while being carried up to the top in a stream of hydrogen. At the present time the effects of varying particle size and gas velocity on the efficiency of the process are being investigated. Studies of a more fundamental nature are in progress at the Bonython Laboratories, where the oxidation of single crystals of galena is being examined in order to assess the experimental conditions under which the highest rates of oxidation may be obtained. Later it is hoped to pursue these studies on a pilot plant scale.

Gas permeability and absorption studies are being carried out on charcoals and reactor graphites of varying porosity. In the case of the latter the results obtained should be of considerable practical importance, since the permeability of graphite to gases such as CO_2 may prove a limiting factor in the design of gas-cooled atomic reactors. The present permeability apparatus is designed to operate at room temperature, and to cover the pressure range 0–600 p.s.i., but a new apparatus is being constructed which will enable measurements to be made at temperatures up to 600°C.

DIGITAL COMPUTER STUDIES

By G. A. ROSE

During the last decade, advances in computing aids to scientific and engineering problems have been revolutionary.

Recently, the inclusion of transistors has resulted in very reliable digital computers of small physical size and power consumption.

The foundation machines of ten years ago used many thousands of valves (E.N.I.A.C., 18,000; E.D.S.A.C., 3,000), and consumed considerable power (e.g., 20 K.watts). Storage or "Memory" capacity was typically 20,000 binary digits (bits), or approximately 7,000 decimal digits, and the operating time of the order of 1,000/usec. per logical operation.

True, the early machines were inefficient, and tended to be unreliable, but their impact was terrific, and the challenge to design faster machines of great reliability and storage capacity was established.

At present this challenge has resulted in machines operating as fast as 10/usec. per logical operation, and random access storage of the order of a million bits is practicable. The cost of these machines is necessarily high, and a large staff of machine operators (programmers) is required to satisfy the computing appetite of such computers.

This year the Electrical Engineering Department have begun the task of designing a Digital Computer, using transistor techniques, with the object of producing a machine of moderately high speed and compatible storage. The machine "order code" or language will have sufficient features and flexibility to satisfy the normal requirements of scientific computation, student and post-graduate training, and control applications.

The conflicting requirements of cost and speed have been compromised in a serial-parallel organisation where words of 32 bits are handled in four serial blocks, each of eight parallel bits. A ferrite core storage (random access) of approximately 100,000 bits, and an operating speed of approximately 80/usec. per logical operation are proposed.

Economy in functional units results from an integrated logical design in which the various units perform different operations during progressive phases of the machine cycle.

The order-code of a digital computer requires very careful planning, for it is used by many people, and forms the translation phase between operator and the machine. The code must be comprehensive, but easy to memorise and use.

In this case the order code is expressed as a 32 bit sequence, and specifies operand address, accumulator address (up to 32 registers), address-modifier address, the word length to be used (double length working enables calculations of 64 binary digit precision to be performed), and the type of operation to be performed (64 in all, classified as 8 functions, each with 8 variants).

A separate order enables the flow of instructions to jump from one sequence to another, so that many programmes may be shared by the computer. This technique fully utilises the logical circuitry, and provides a means of doing many jobs at the same time. Complex plant processes, requiring frequent computations, may be handled in this way by a central computer.

Assessment of priorities for shared problem working can be carried out currently by the machine, thereby ensuring optimum machine usage and safe control of difficult processes. Normal business data, such as pay roll calculations, proceed as one of the parallel programmes.

Punched paper tape (seven holes per character) will be used for coded symbols and data handling.

It is believed that, by designing and building a machine of this complexity, speed, and storage, interest in the computing field will be fostered in Adelaide, and provide an invaluable teaching aid for engineering students.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THE DESIGNING WOMAN

By ONE WHO WOULD LIKE TO BE

If a girl is going to talk about engineering, she may be challenged as to what she understands by the term "engineer."

"This term is hard to define," says E. Hitchcock in Canterbury University College Engineering Society Proceedings, Vol. 19, "as the engineering profession, like any other, is not fixed; it is changing."

All right, then! Why can't it change sufficiently to welcome women to its ranks?

It is most unfortunate that the noble profession of engineering has come to be regarded, particularly in Australia, as the almost exclusive milieu of the mere male. Just what IS it that seems to deter our "jeunes femmes savantes" from subjecting themselves to five fascinating years under the influence of hydraulics, soil mechanics, drawing, R.S.J.s, eccentric loading, and statically indeterminate beams? Perhaps there is something rather pathetic and distressing about the engineer of the imagination; the unkempt youth who staggers from one laboratory to another in a fearful fury because a stubborn bar of steel has failed to fail . . .

> " Soot, oil, and verdigris are on his hands;
> Large spots of grease defile his dirty clothes;
> The while his conversation drips with oaths."

It may be true that few of us aspiring B.E.s (fem.) see ourselves to advantage in such a setting, but in our gradual enlightenment we are realising that such a sordid existence isn't absolutely necessary for success in this self-contained little world, and there certainly aren't any weighty reasons why the engineering profession should not include many more women that it does at present. In Australia, anyway, there are perhaps three women engineers, and although the English Universities apparently turn out several every year, no one quite seems to know what happens to them.

Success as a qualified engineer does not necessarily call for an expert capacity for handling nuts and bolts. Actual construction is only a single aspect, despite its importance, and like some of the tougher medical jobs, for instance, need not be work for women. Actually, one need not even come within sight of a spanner. Electronic work, for example, with its intensely mathematical thinking-on-paper, is the job of the trained professional man, who usually hands over the business of assembly to technicians. All the same, a bit of assembling has never hurt an engineer (male), so why should it hurt an engineer (female)? After all, who concocted your television set out of a bewildering array of "things"? A girl, probably.

Why SHOULD engineering present a difficult aspect to a mathematically-minded, public-spirited, stress-crazy young woman? It's not as strenuous as being a nurse, or a school teacher, or a waitress, or a policewoman; super-human strength is not a pre-requisite, and if one has a natural ahorrence of soiling one's pale, tapered fingers, there is a single answer, a simple reply . . . Three cheers, they cry, hurrah for the Decline and Fall of Workshop Practice!

Disadvantages may, of course, present themselves. Living conditions may not always be outstanding. . . . I shudder to think of myself crouching in the doorway of a small flapping tent on a bleak peak in the Snowy area, clutching a map in one tiny frozen hand, and a survey peg in the other. I must confess that I lack the stamina of our noble Russian sisters, who are, it would seem, of stronger stuff. Then, again, think of Survey camps . . . THINK of them . . . how chaotic . . . how nerve-wracking . . . how marvellous! Another objection comes from within the select world of engineers themselves. One learned and irreverent gentleman, although he PROFESSES to approve of women in the faculty, said, on being questioned closely, that this would bring a possibility, though only a possibility, mind, of an odd and disconcertingly feminine tendency to unnecessary and perhaps startling experiment. A reproachful stare from his interrogator was enough, however, to produce a quick: "ONLY a possibility, of course"!

It is obvious that to entice more girls into the Engineering Building—er—Faculty, the distinction must be made clear between the operator of a machine and the thinking, creative artist who is an engineer (sigh!). What is needed is inspiration, a clear head, originality, courage . . . in short, a woman. (Think of Letitia Chitty, chaps!)

And there's another reason, if necessary. In support of the enthusiastic sophomore who studied engineering because, she said: "It's the only place in the University where there would be six hundred men, and me," I quote from "Advice to Future Engineers" (Hysteresis, 1958):

"The qualities which you will have to bring into play are not quite the same as those which take you to the top of the school; the art of handling men, for instance . . ."

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THE DAYS WE SHOULD CELEBRATE

Address given by MR. A. G. GIBBS, Personnel Manager of G.M.-H., Woodville, at the recent Engineering Society dinner.

In looking around for a suitable subject for an occasion such as this, I found it impossible to come up with a highly technical paper, which I know you all wanted. It did appear to me, however, that the most important aspect of tonight's dinner was the opportunity it provided for staff and students to meet together and join in drinking various toasts. This gave me the idea that perhaps if there were a lot more toasts to be drunk to honor certain events (and the liquor supply held out), then the success of the evening might be in direct proportion to this. There is no doubt a simple hydraulics formula to cover such a condition in which N (the noise level in decibels) is a function of T (the number of toasts), of G (size of glass in ozs.), of C (alcoholic content of liquor), and varies inversely as A (the capacity of the experimenter). By increasing T, then G and C could become variables, related to the year of the course of the drinker, with a feed back correction factor for his age. I have decided, as a consequence of this, that a dissertation on how to increase the factor T might be a suitable theme for my address.

I have therefore selected as my subject for tonight "The Days We Should Celebrate," with the object of making some suggestions as regards additional toasts that could be considered for future dinners.

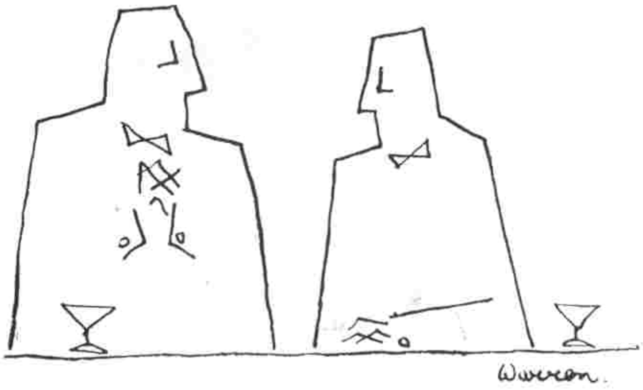
I would first like to mention how the Corps of Royal Engineers has a very old custom (which the Australian Corps has joined them in maintaining), namely, that of having a dinner every year to celebrate the Battle of Waterloo, which was fought on 18th June, 1815. (As a matter of interest, the Army Engineers in this State held their celebration last month with the G.O.C. Central Command, who was a former Engineer-in-Chief, as their principal guest.) The Waterloo Day dinner is an occasion when there are many speeches and toasts related to "The Day We Celebrate," but the interesting point about carrying on these celebrations is that it is well known and accepted that there were no Corps of Engineer Officers or Sappers at the Battle of Waterloo!

Of course, the matter of historical accuracy is a mere detail to Engineers when it comes to finding a reason for celebrating!

I am now going to suggest that this might be an example for your Engineering Society to follow—namely, of celebrating at your Annual Dinner some events in which your Society did not participate, and this would become the basis for a programme of toasts relating to "The Days We Celebrate."

Your committee will naturally want some help in looking around for suitable events to commemorate, so I am going to make a few suggestions.

I automatically excluded anything which was of a non-engineering nature, in case there were some University Council rules on the subject, or in case the particular events were already earmarked for future University Processions. On the other hand, your committee may disagree with this approach, and it is possible that they may come up with far brighter suggestions, such as the day that Sabrina gave her vital statistics to the world, but I am afraid I am too old to appreciate such events. However, I will try and suggest a "Wine, Women, and Song" theme for the toasts.



I have to keep to respectable items, and therefore, in making a survey of events that might get past the University staff, I have selected the following:

1.—The Day the Engineers Became Respectable. I am going to deal with the occasion when the early Bishops became Engineers (or the early Engineers became Bishops—I don't know which.)

My purpose in selecting this subject was to give your Society such an air of respectability that no one (including the Hotel Proprietor and the Warden) could ever complain about the way your dinner was run, after knowing the purity of your predecessors.

We all know that purple is the color traditionally associated with Bishops and Engineers—we see it in the Army color patches, the Navy's insignias of rank, and University hoods. (I know the Professors and staff present here tonight would be happier if I enlightened the students

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that a hood is a vestment, worn over a gown (or surplice), indicating the degree that has been conferred by the authorities of a University on a matriculated student, who has complied with certain and duly specified attendance regulations, and has passed the necessary examinations.)

Reverting to the color of purple, it has generally been the color of dignity and high office. In ancient symbolism it stood for purity, fidelity, and constancy. What an appropriate color for your menu card next year!

Now to provide the link between the Church and the Engineers.

In the early history of Rome there was a Corporation of Bridge-makers—called "Pontifices"—of whom the head (who was called the "High Bridge Maker," and would be something like the rigger today on top of a suspension bridge) was the most sacred of all Romans—because in those days his life and the lives of all his companions was deemed necessary to the safety of the town, as the defence of the town was determined by the bridges over the Tiber. This title later became shortened to "Pontiff," which, as we know, is another name for a Bishop. (For those of the students who are in the final year, and thus far removed from secondary school education, I would explain that "Pontiff" is derived from "pons," a bridge, and "facere," to make. A Pontiff, therefore, was literally a bridge builder.) It was not uncommon, years ago, to find that military and episcopal duties were combined, as they were by the famous Bishop Gundulph, who built the Norman Keep adjoining Rochester Cathedral, and the Bishop who built the White Tower of the Tower of London.

The Pontiff and the Engineer came together in 300 B.C., and formed the Brethren of the Bridge (the event we are going to celebrate), which was an association of Bishops, Engineers, and other cultured, superior, pure, honest, and sober-minded people in the community—(includes electronic people, I think).

Now, without spending all night going into a long explanation of how this was arranged without union demarcation disputes, I believe it best that the Roman historian Livy tell you in his own simple words the story of this memorable event, which I think will absolutely convince you of the need to include this as one of the principal toasts that you will want to honor as part of "The Days We Should Celebrate":

> "Itaque postquam est oves traditus thesauro
> Obliti sunt romai loquier latina lingua
> Ne epistula quidem ulla sit in ardibus
> Ut ego illic oculis exoram lampadibus ardentibus,"

and so on.

2.—The Celebration of Building the First Dyke (or the Introduction of the Specialist)

Having lifted the whole tone of the gathering by the Latin touch and the ecclesiastical link, I now seek for the second toast some occasion which will give an air of dignity and majesty to your Society's dinner, and at the same time remind us of some of the early structures that were made famous by the pioneers. Some may have been a little primitive by to-day's standards, but have stood up to considerable wind pressure.

We are naturally interested in the work of the early military engineer, and the story of building the first dyke by a company of pioneers provides an example of the use of a specialist for the first time in history. We owe a lot today to the role of the specialist in engineering, and therefore this event should not be overlooked.

The man who built the first dyke was Offa, and it was made possible by a decision of the Privy Council of that time. Offa's dyke, stretching from Chester to Chepstow, provides the evidence today of early Saxon military engineering. The dyke was constructed in 751 A.D., and was designed to keep the marauding Welsh within their own back yards, and give the Saxons some privacy. It has the characteristics of all dykes—usually deep-seated, and often well exposed.

History records how the completion of this dyke by the soldiers of the day was the occasion of much celebration, which was described as follows:

"About seven o'clock the Company assembled, and sat down to a sumptuous dinner. Plates were laid for 900 men, with each of which there was a quart pewter tankard for the convenience of drinking wine, and to every six men a firkin pot. At convenient intervals were stationed 24 kilderkins of porter. (I might explain that a kilderkin is 18 gallons.) The troops applied themselves to the duties before them with great glee, while the managers of the dinner set before each man a pint bottle of excellent port wine. They separated in the greatest good humor, and it is a proud tribute to their character as citizens to declare that although the greater part of them were sufficiently elevated by these festivities, not a single quarrel or the slightest disposition to tumult clouded the pleasures of the day."

(I might add that there were no University students recorded as being present.)

This quotation tells you how a dinner should be run, and apart from suggesting a toast to the first specialist, it also provides an item of great historic interest. It was the first occasion recorded when 18-gallon kegs (or kilderkins) were used—an event well worth celebrating, and might even be worth a third toast on its own.

3.—The Day the Engineers First Used Women.

A toast to women hardly needs any justification—at least to the students. Women's role in the world of today is a source of constant dispute, but I think most of you will want to know what history has to say, and what were their major relations with engineers. The authority I am quoting tonight is one T. W. J. Connolly, who published a "History of the Royal Sappers and Miners" in two volumes many years ago.

In the section dealing with the troops employed in the construction of field works and fortifications in the Netherlands in 1815 he wrote:

"Not less than 20,000 civil laborers, with strong military parties, were employed on the line of works extending from Ostend to Mons.

"Sergeant John Purcell, a sapper, had from 300 to 400 women working under him at Ypres; and from some winning peculiarity in his mode of command, obtained from their willing obedience and energies an amount of labor that was astonishing."

Now, I know it has always been the aim of most engineering schools to pursue a broader education for students (but opposing any substantial addition to the syllabus), and perhaps this early account of the use of women in the field may lead to further study, and be a fitting subject for some research by Honours students. (They are the only ones we can trust!)

4.—A Toast to "The Society."

This is my last toast, which is to honor the Engineering Student, his knowledge, his accomplishments, his purity, and many other things. The toast is to be coupled with a song which describes all these virtues.

You all know of the work of W. S. Gilbert, particularly in association with Sir Arthur Sullivan. The song about the modern major-general in "The Pirates of Penzance" is as well known as any of their songs, but whereas Gilbert wrote of the major-general in a mock serious manner, he was much more honest when he wrote of the Engineering Student.

Well, I will read it to you, and apologise for not being able to sing it:

I am the very model of a modern Engineer;
To avoid misunderstanding, let me make my meaning clear,
You cannot puzzle me with odontoidal interference,
I know the snags relating to compressors and their clearance,
I'm a most accomplished draughtsman, having failed E.D. & D.
I can still project truncated cones upon the plane V.P.
The adjustments of a transit I consider very easy.
I'm familiar with the formulae of Bazin and De Chezy,
I understand the theory of the throttling calorimeter,
There's nothing I don't know about the slide rule or planimeter,
I'm considered an authority on flux and hysteresis,
On rotary converters I have just completed a thesis,
Although I've no affection for equations differential,
I have many other attributes which might be called essential,
I can swear for 30 seconds without pause or repetition
(With a very special phrase consigning professors to perdition),
And, to crown the whole caboozle, I've acquired a taste for beer,
So I am the very model of a modern engineer.

BANDUNG INSTITUTE OF TECHNOLOGY

By HUGH REEVES

In August, 1956, I left Australia to spend two years working in Indonesia. I went under the Volunteer Graduate Scheme, which meant that I was able to mix with Indonesians on much more equal terms than most Europeans there. I knew that there was a great shortage of trained people of every description, but I had wondered if there would be much demand in an under-developed country for a physicist, so before I left I wrote to the Professor of Physics at the University of Indonesia, and he replied that I would be welcome there. Three days after my arrival in Djakarta I found myself sitting behind a desk in Bandung, already hard at work, and wondering just what was all around me.

Before the war there were in Indonesia three University faculties — Law and Medicine in Djakarta, and Engineering in Bandung. After the war the three were very much expanded, and joined to form the University of Indonesia. A Faculty of Science was added in Bandung, and then last year those two faculties separated from the University to form an Institute of Technology, or, as we would say, a University of Technology. There are now many other Universities in Indonesia, but it is probably true that Bandung has the best Engineering faculty, as it did not have to be built entirely from nothing. Nevertheless, the growth has been enormous; the number of students has increased at least twenty times, and new buildings are going up all the time, although they cannot possibly keep pace with the overcrowding.

Although the Physics Department was a department of the science faculty, in fact, most of our first and second year students were engineers. The science faculty had about 1,000 students, most of whom did only one year of Physics, while the Engineering faculty had nearly 3,000 students, nearly all of whom did two years Physics. Engineering students started specialising after six months, but for the first two years those from different departments had some of their more basic subjects in common. The relatively large number of engineers is natural in a country which is struggling to develop itself, and which must largely leave basic research to other countries. Few of the University departments could afford to do any research, because their staffs were too small to spare anyone from lecturing. Every University lecturer was one person less to do some vital job in the field.

Although the number of students is now very large, the number of graduates is regrettably small. This is partly because, even four years ago, there were many fewer students, but partly it is due to a high failure rate. In colonial times the authorities were very anxious that standards should not suffer in comparison with Dutch Universities, so, in fact, they were higher. These ideas have been slow to change, and a few years ago a failure rate of 75 per cent. was considered normal in some subjects. A large influx of American lecturers and the obvious needs of the country means that this would now be considered a sign of poor teaching, and the number of graduates is starting to increase sharply.

Bandung Institute of Technology

The Engineering Faculty has all the departments one would find here, and perhaps a few more. There is much more specialisation, however, with a common feeling that the training is very theoretical by comparison with Anglo-Saxon countries. I was less sure of this, but certainly the opportunities for practical work in laboratories are less. The need for lecture rooms is equally great, and they are cheaper to build. The course used to be five years, but in 1957 it was reduced to four, although most departments seem to expect an extra six months of work on a project of some kind.

The school-leaving standard would certainly be lower than in Australia; students may have a wider knowledge of facts, but they are often disconnected and useless facts, and the student is less able to make use of his knowledge to work out a problem. However, it was my opinion that by the time four years had been spent at Univer-

sity, most of the difference had been made up, and the degree from Bandung was almost equal to an Australian degree.

The Indonesian student is familiar with all the same problems as the Australian student, and a few more besides. He may be able to get a Government scholarship, but it will only be adequate if he lives as cheaply as possible. Or he may rely on his family; but usually there will be half a dozen brothers all wanting an education, and nowadays several sisters, too. Many students must work part time, generally as teachers in the high schools. To be sure of a part-time job, some students will even spend a year getting some sort of teacher training before starting on their University course. Accommodation is always a problem, because Bandung, like all other cities in Indonesia, is desperately over-crowded. Many students live in a hostel, although that means sharing a room with three or four others, and perhaps sharing a desk also. Perhaps the biggest problem is the lecturers; so many of them are foreign. By now very few students speak Dutch, and although there are a few Dutch lecturers, Dutch is not allowed in the University. On the other hand, very few foreign lecturers speak Indonesian, so the only alternative is English. Most students have done six years of English at school, but often the teaching methods were old-fashioned and the teacher not very competent, so when they arrive at University they may be able to read a little, but they certainly cannot understand spoken English. As far as possible, all the first year lectures are in Indonesian, but by the second year many are in English, and that means English with an Australian, an American, a German, a Danish, or perhaps even an English accent. Actually, the lecturers whose native language is English are more difficult to understand than those like the Germans and Austrians, who tend to speak more slowly and less colloquially. I tried to learn a little Indonesian as quickly as possible, and use it, but then the problem was that I was so much less efficient as a teacher. Textbooks are a similar problem, as so far very few have been translated or written; but it is easier to read English than to speak it. However, books are difficult to get, and expensive, even though the Government will usually pay half the cost.

Despite all their problems, most students manage to enjoy themselves, and the atmosphere in the cafe was much the same as the atmosphere in the refectory here. Some students would live in one of the hostels near the University, some would live with relatives, and probably the majority would share two or three rooms in a house somewhere. Lectures begin at seven o'clock, which means that a cold shower before breakfast is quite an ordeal, because Bandung, at an altitude of 2,000 feet, gets cool at night. Nearly every student owns a bicycle or an autocycle, and most can reach the University in ten or fifteen minutes. Most lectures are over by one o'clock, except on Friday, when they stop two hours early to give students time to get to the mosque by 11.30. However, the number of practising Moslems is very small amongst students, so it was usually possible to fit in an extra lecture or tutorial on Friday. Most lecture theatres were too small, so there was always a scramble to secure a good seat. The late-comers had to sit at the side on the floor, and use their knees as a desk.

The overall impression in the University was one of rapid changes. Building was always in progress, professors and lecturers came and went, and what was more important, the system of teaching and examining, and the contents of the courses, were always being revised. Students found this very confusing, and it undoubtedly meant wasted time for many of them, but it seemed to be necessary. The new needs and ideals of Indonesia required enormous changes in the University, and what is to be the pattern for the future could only be decided by experiment. Already Bandung has one of the outstanding Universities of South-East Asia, and in a few decades it may be an example which we shall be studying with interest.

FABLE OF THE INSPECTOR AND THE BOLTS

There dwelt in the City of Manch an inspector of a Turbine Factory. And his chief spoke unto him, saying:

"Lo, there is in the wilderness of Traff a maker of bolts, and he hath made two score and five special bolts. These by Super-Dooper bolts, and great is the tensile strength thereof, that they may fix the top of a cylinder casing even unto the bottom. Get thee hence and inspect them. And take micrometers and things, that thou shalt gauge them unto within the wideness of a certain part of a gnat. For I say unto thee, if thou shalt release them and they be found wanting, then I will tear a strip off thee. Yea, if the bolts be not properly inspected, then will I cause a great misfortune to fall upon thee."

And the inspector, who was a sound bloke, spake thus:

"O.K., O Chief. That which is asked for by Drawing and Specification shall be done."

And then he departed, and journeyed unto the maker of the bolts, who spake unto him, saying:

"Here they are, Charlie. Want a sixinshrool?"

But the Inspector chided him, saying:

"Before I measure them, command your servants and your hand maidens that they may deliver unto me all the paper works thereunto."

Then there were carried unto him one hundred and fifty-nine scrolls, which were the Release Notes and the Test Certificates for the raw materials, and the M.S.L. Certificates of the fiery furnace in which they did heat the bolts, and the Calibration Charts for the hardness machine, in which they did test the bolts, and a host of Certificates of Accuracy for the tensile and Izod machines in which they did stretch and smite the test pieces. And there was also brought unto him a dog licence, a copy of the Factories Act, and a Pools coupon, which were included amongst the papers in error. And they delivered unto him also many M.S.L. Certificates relating unto the Wickham Gauges used upon the Bolts. There were also Records and many other reports of strange and wonderful things of which none knew the meaning. And they brought a copy of the order, and a set of drawings, and a Pyrometer Record Chart which was fifty cubits in length, and a multitude of other things too numerous to recount.

For twelve days the inspector looked upon these things, and on the twelfth day he said they were good. Then he did measure the bolts, and all the dimensions thereof were according to Hoyle. And he put them in strange potions and tested them upon a machine of Magnaflux. And he performed Rockwells upon them all, and some he rubbed with a precious jewel. Then he cast his eye upon them through a microscope, a horoscope, a telescope, a periscope, a stroboscope, and other strange devices. And he did project the threads upon a screen, and gazed upon their form, and it was fair. And he gauged the threads by the Law of Go and Nogo, and by the Law of Best Cylinders. And from one bolt which seemed doubtful he did cause a test piece to be made, and great was the tensile strength thereof, and the Izod and the Elongation were fair to behold. Then he caused X-rays to shine upon them lest there be concealed weevils inside them. These things, and many others which are in the Sacred Book, did he perform with great cunning.

And when all these things had come to pass it was the evening of the nineteenth day, and he made out a release note, and inscribed therein all the necessary details. And he signed it, and put his stamp upon it, and upon the bolts also. Then he spake unto the Bolt Maker, saying:

"I do declare this batch of bolts to be pretty ruddy good. Despatch them unto the Turbine Factory. And if they bounce, then I shall eat them without salt."

But lo, it came to pass that they were rejected. They had been fashioned to an obsolete issue of the drawing. And the grief of the Inspector was terrible to behold.

S.C.I.I.A.E.S: PURITY PAGE

In the past year, "anno domini" 1958-1959, in the City of Adelaide, there lived men who were not only wise, but also pure in heart, who, on perceiving the lack of moral purity in their fellow men, did not despair or run away as had done pure men before, but increased their labors to save those who had wandered from the straight and narrow path of the lily.

Firstly, their early efforts were crowned with success when a well known, highly respected citizen, scholar, lecturer, engineer, and gentleman was embraced into the ranks of the honorary members of the S.C.I.I.A.E.S. on the noteworthy occasion of his engagement to Lilly. Great were the rejoicings of the purists at the "Head" and at the "Richmond"! Further, after a short period of revolutionary upheaval, during which the past patron of the society, Elvis Presley, was denounced and removed from his office and honor, and the right pure Miss Diana Dors substituted in his place, there was conferred upon the following members of the S.C.I.I.A.E.S., on the merits of their work for the cause of purity, the degree (honoris causa) of Doctor of Social-superpropitiousness. The small ceremony took place in the Refectory during the visit of the right pure Miss D. Dors to that establishment. The right moral Doctors are Messrs. J. Bateup, F. Symons, R. W. Hercus, D. Rudd, A. Read, A. J. McLean, M. J. Blaskett.

Since then the struggles have increased in intensity. Before the opening ceremony of the 1959 Architectural Exhibition, foul rumors, fabricated by various elements of the left wing, immoral group of faschistic, demoralising exploitists, intended to harm the brotherhood of purists, were spread among the lecturing masses at this University. Open and camouflaged threats were made, with the result that the purists made their protest against such tactics known by their massed absence from the opening ceremony.

Then there was nearly a moment of great triumph, when twenty-four purists seated themselves comfortably inside a telephone booth, and another ten were getting ready to enter the establishment in order to proclaim a new world record. These noble efforts, however, were frustrated by the local constabulary, who, attracted by the hysterical screams of a number of immoral women, misunderstood the situation completely.

Besides all these activities so much in the public eye, the S.C.I.I.A.E.S. has been busily working towards other goals. For the furthering of better social relations between the Engineers and the Physios, an informal dance was organised in the Lady Symon Hall. This turned out to be a huge success, and the studying public has lodged many requests for a repeat performance. At the same time, the S.C.I.I.A.E.S. had launched a publicity campaign, which had its climax in the exhibition of historical material in the form of a purity corner at the annual Engineering Ball.

All these healthy activities point to the general revival of the purist movement, and it is hoped that the S.C.I.I.A.E.S. doctrine will proceed to spread still further under the able guidance of the new president and committee.

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Ejectors for Steam, air and water.
Injectors for boiler feed water—stationary and locomotive.

Greenwood & Batley Ltd.

Leeds, England

Mining Locomotives, battery and Diesel-electric-operated.
Electric platform trucks and fork lifts.
Also:—Hot and Cold Forging Machines—Turbo Alternators.
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Upsetting Machines. Thread Rolling Machines.
Screw Presses—Oil Expelling Machinery—Special Electric Motors, etc.

Hilger & Watts Limited

London, England

Optical Projectors for Shop, Toolroom and Laboratory installations in floor and bench types.
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Surface Grinders, capacity 18" x 6" to 24" x 12".
Plain Cylindrical Grinders 8" x 18" to 14" x 40".
Cylindrical and Universal capacity 2⅞" x 5¼" to 14" x 40".
Universal Grinders incorporating a raise and fall wheel-head capacity 8" x 18" to 14" x 40".
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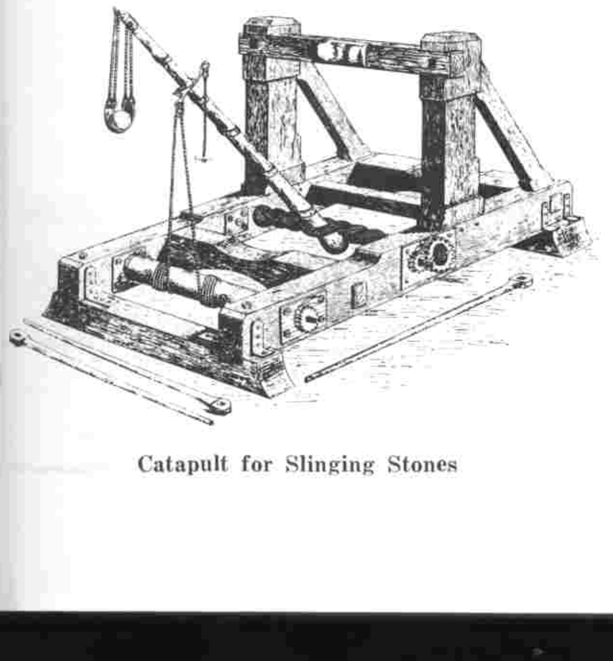
EARLY BALLISTIC MISSILE LAUNCHERS

By A. J. DAWSON

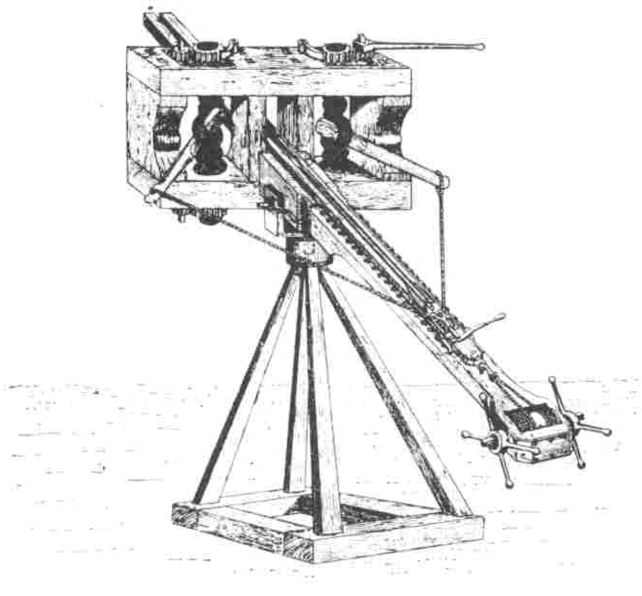
Of the vast collection of instruments that man has designed for doing away with his neighbors, none were so impressive as the projected throwing engines built by the military engineers of old, the artillery of their times. War engines appear to have come into use about 800 B.C., for we can read of King Uziah, who ruled about that time: "And he made in Jerusalem engines, invented by cunning men, to be on the towers and upon the battlements, to shoot arrows and great stones withal." Earlier references, while giving details of attacks, never mention war engines. They continued in use in Europe well after the invention of cannon in about the fourteenth century. We find that Leonardo da Vinci was interested in both.

The chief types of ancient war engines were the catapult and the ballista, whilst the commonest mediaeval engine was the trebuchet. The catapult was the most effective ancient engine. This weapon was powered by a huge twisted skein of rope, made from hair or animal sinew, which held a long vertical arm. The projectile was placed in a cup at the end of the arm, which was pulled back by a windlass, and triggered when secured. Evidently making the arm light enough, while still retaining adequate strength, was a major problem. Composite arms of wood and animal sinew were often used. One solution was to use a shorter arm and to equip it with a sling about one-third the length of the arm, greatly increasing the departure velocity. Eventually slings became very fashionable.

Considering the limited theoretical knowledge of the ancients, the power of their catapults is astonishing. One of the most reliable accounts of their capabilities is given by Josephus, a senior Jewish commander during the last revolt of the Jews against Titus. Writing of the Roman catapults, he says: "Now the stones that were cast were of the weight of a talent (57 lbs.), and were carried two or more stades (400 to 450 yards)." This range sounds difficult to believe until we realise that the catapults would have to be out of bow shot from the walls, for it appears that the operators did not rely on shields for protection. It seems possible that lighter missiles could have been thrown to 800 yards, for Sir Ralph Fayne, Gallway Bt., from whose book these illustrations have been taken, constructed a half-size catapult that could thrown an 8 lb. stone to over 450 yards.



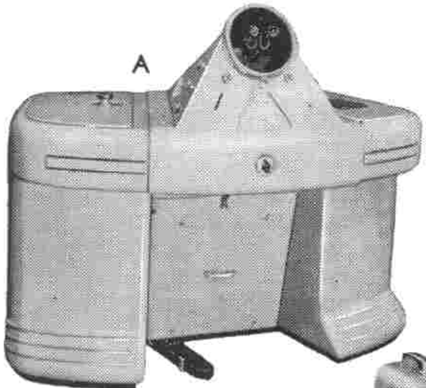
Catapult for Slinging Stones



Balista for Discharging Heavy Arrows or Javelins

The ballista was a smaller weapon than the catapult, but was powered by the same principle, having two vertical skeins, with short transverse arms. The larger ones had skeins of about 8 inches in diameter, and could fire a javelin or stone weighing about 6 pounds up to 500 yards.

The ballista and catapults were perfected by the Greeks, and later adopted by the Romans, to whom they were introduced by Archimedes at the siege of Syracuse in 214-212 B.C. Archimedes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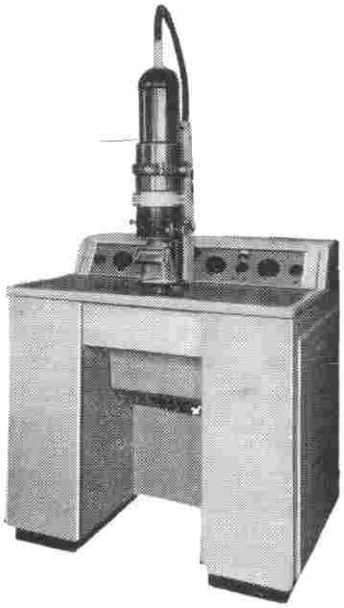
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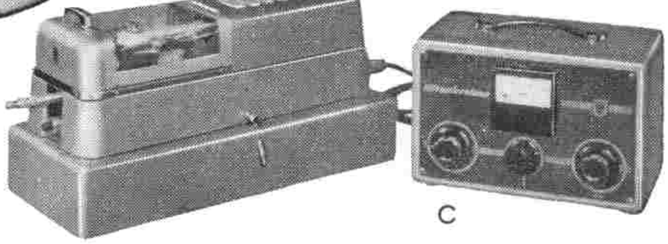
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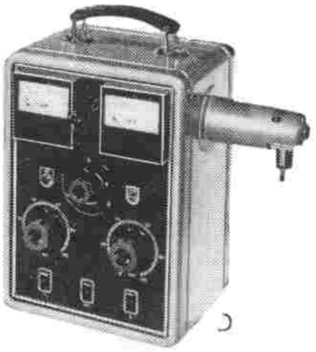
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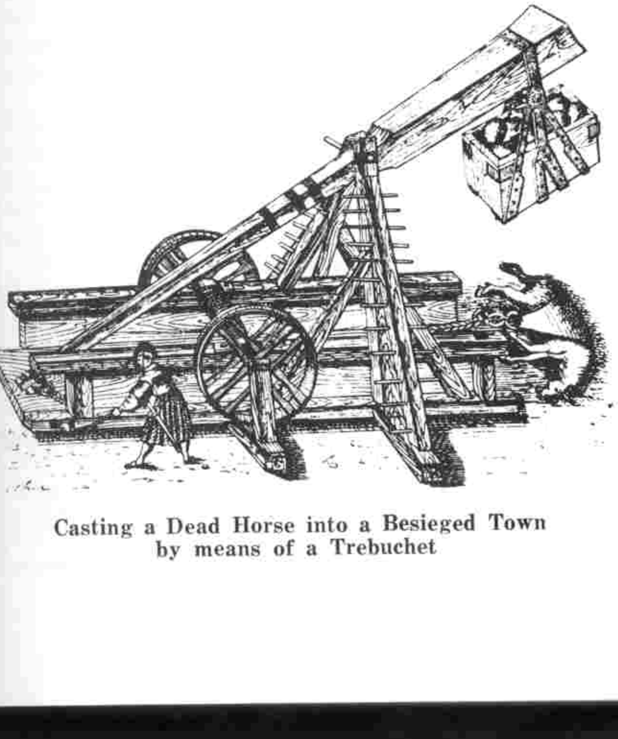
defended the town entirely by way of engines, to the distress of the Romans, who were completely demoralised by them. Being used to fighting in a decent and orderly manner, they withdrew in disgust, and were held at bay for some time, but later took the town by a surprise attack. To the regret of the Roman general, Archimedes was killed in the final assault. He left no record of details of his engines, considering them far inferior to his geometrical problems—a poor engineering outlook.

In later years the Romans had ballistas on wheels, drawn by mules. At one time every cohort was equipped with a catapult, and every century with a carro-ballista, as they were called. These were fired over the heads of the mules, constituting the Roman field artillery. It must have been very demoralising when a ballista dart, fired into the packed ranks of those days, skewered two or three of one's neighbors! Procopius states that he once saw a Gothic chieftain in armour hanging from a tree to which he had been nailed by a ballista dart.

The art of making the ballista and the catapult gradually declined, and in mediaeval days the catapult was superseded by the trebuchet. This clumsy weapon had none of the finesse of a good catapult, consisting of a heavy weight that swung a very long arm carrying a projectile in a sling. The arm of the trebuchet was of the order of 50 feet in length. One historian describes a trebuchet having for a weight a bag of sand 12 feet by 12 feet by 8 feet, which would weigh about 50 tons. The trebuchet had a comparatively low departure velocity, which limited its range to about 300 yards. Nevertheless, if its weight was big enough it could throw tremendous loads. It was not uncommon for beseigers to throw dead horses into a town in order to spread disease. Even this dirty habit was exceeded when, "at his ineffectual siege of Carolstein in 1422, Boributcaused the bodies of his soldiers whom the beseiged had killed, to be thrown into the town, in addition to 2,000 cartloads of manure."



Casting a Dead Horse into a Besieged Town by means of a Trebuchet

The trebuchet enabled communications with the enemy to be speeded up. The historian Fraissart tells us that at the seige of Auberoche an emissary was sent out to entreat for terms. Apparently these were unacceptable, for "to make it more serious, they took the varlet and hung his letters about his neck, and instantly placed him in the sling of an engine, and then shot him back into Auberoche. The varlet arrived dead before the knights who were there, and who were much astonished and discomfited when they saw him arrive."

Another historian explains that to shoot a man from an engine successfully, he should first be tied up to form a compact bundle, like a sack of grain.

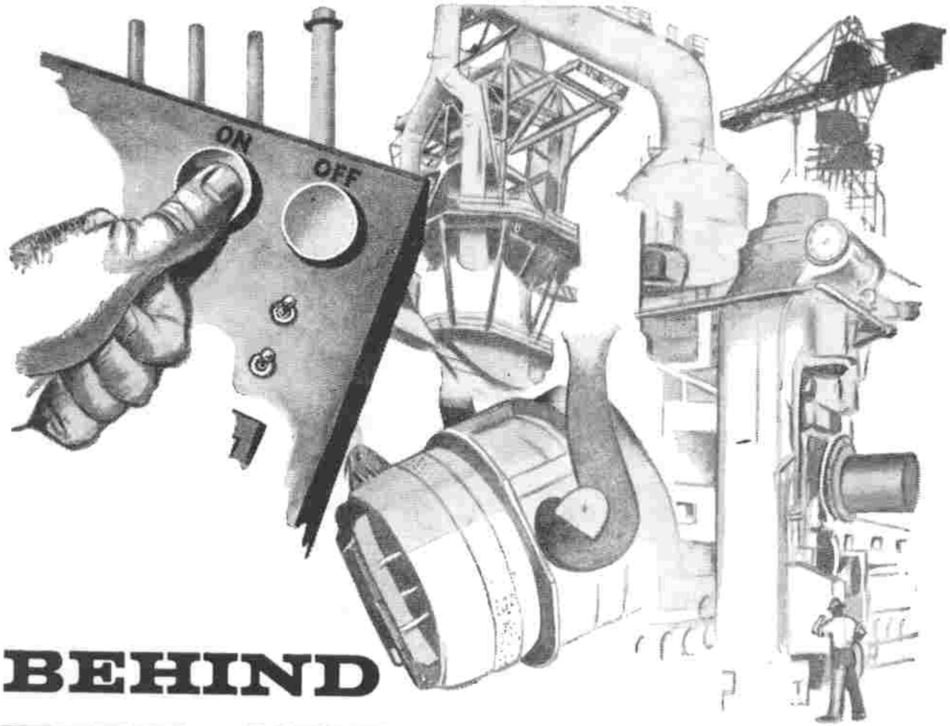
Leonardo de Vinci rated his engineering accomplishments, including the design of war engines, before his talent as an artist! His war engine designs include a huge bow 80 feet long and 3 feet thick at the centre, and a "machinecatapult." This consisted of a battery of several levers of about 8 feet in length, having a fulcrum about 18 inches from one end. A stone was placed in a cup at the end furthest from the fulcrum, and a man with a sledge hammer struck the short end. When half a dozen were mounted in a battery on the ramparts, a rapid rate of fire could be achieved. A shower of stones that had the energy of a sledge hammer behind each one would have a discouraging effect on the attackers!

Apparently the design and the construction of war engines was a full-time occupation for the engineering profession. It was when engineers began to busy themselves with less destructive pursuits, turning to works of public utility, that the term "civil engineers" arose, to distinguish them from the military engineers, the forefathers of our profession, who put horses into orbit long before the Kremlin and the Pentagon were dreamed of.

As If An Excuse Was Needed!

If all be true that I do think,
There are five reasons we should drink
Good wine—a friend, or being dry—
Or lest we should be by and by,
Or any other reason why.
"Reasons for Drinking"—Henry Aldrich.

To define it rudely, but not inaptly, engineering is the art of doing that well with one dollar which any bungler can do with two after a fashion.


ON
OFF

GUIDE TO HI-FI REPRODUCTION

By R. L. BAMFORD

Does High Fidelity Sound Reproduction appeal to you? Perhaps you like to relax to some quiet Chamber Music, hear Benny Goodman or Louis Armstrong make their respective instruments "talk" to you, the Berlin Philharmonic making a fearful avalanche of sound, initiated by Wagner, or the Philadelphia Orchestra take a piece composed for violin and piano, play it faster than intended, and make it seem not only easy, but fun to the players themselves.

Perhaps, in a demoniac frame of mind, you would like to turn 20 watts of 15,000 cycles/sec. on the dog next door which barks at you every morning, or drive your family and neighbors crazy by playing Bruckner's Symphony No. 9 at full volume. This article may help you to get set up.

To decide what is needed we must appreciate what has gone before in the recording studio and factory. A microphone, piezo-electric, condenser, or magnetic, picks up the sound, which is amplified and stored on magnetic tape. This is edited, various effects are added (echo chamber, background noises, etc.), and the result cut on a master disc. The records you buy are direct copies of this original.

The finished record has several strange features. The record company tries to reproduce the sound as if you were sitting in the "best" seat of the opera house, i.e., the same balance of sound, to reproduce the high frequency sounds which are so easily lost in certain concert halls, to take a calculated guess at the acoustic properties of the average living room, and to compensate for the fact that a record is a mechanical device, and therefore suffers mechanical limitations of groove amplitude, the geometry of grooves, differences in peripheral speeds at inner and outer edges of the record, and noise from the record surface.

The last mentioned factors most affect reproduction. Consider an average L.P. disc. There are approximately 225 tracks/inch, the spacing being varied slightly according to the general sound level. Centre line spacing is therefore .004 in. By drawing two tracks to take a stylus of .001 in. radius, it can be appreciated that the miximum **amplitude** is about .001 in. (to exclude cross-talk between tracks). Consider two sounds, one at 1,000 c/s, the other at 10,000 c/s. If the amplitude of the first is .0005 in. at full vol., then for the same power the amplitude of the second will be .00005 in. When 20dB below full volume, the amplitude of the second sound is 5×10^{-6} in., which is obviously of dimension comparable to the particle size of the record. In the same way the amplitude of low notes would be such that much record space would be wasted. Frequency compensation is obviously necessary, and is limited at both ends of the frequency spectrum for the following reasons:

(1) The reproducing turntable, pickup, and leads give rise to motor rumble and magnetic pickup. If the stimulus at low frequencies is too low, it must be excessively amplified to produce balanced sound, and, of course, the above sources of distortion will also be highly amplified.

(2) If we consider a sine wave, the maximum velocity of any point tracing the locus is proportional to (dy/dt), maximum when $y = 0$ (i.e., $v \propto$ [slope]). Increasing amplitude increases v. If the amplitude of high frequency sounds is increased excessively, the peak stylus velocity will be so high that it will be impossible for the stylus to track the record faithfully.

Present L.P. records have a constant amplitude compensation, and follow what is called the R.I.A.A. Recording Curve.

Before going any further, let us consider the cart we want to drive before the horse, i.e., the human ear. The limits of hearing are usually quoted to be 16–18,000 cycles, at a loudness level of 75dB (or higher) above the threshold of hearing (0dB), but in adults it is usually restricted to 25–15,000 cycles. To appreciate fully the effect of this non-linear device we must look at the Fletcher-Munson Loudness Curves, to be found in most engineering reference books. It is seen that hearing is most acute in the range 3,000–4,000 cycles/sec, and least at very low frequencies. If the threshold of hearing is taken as 0dB at 1,000 cycles/sec, power must be increased by 60dB to be audible at 32 cycles/sec.

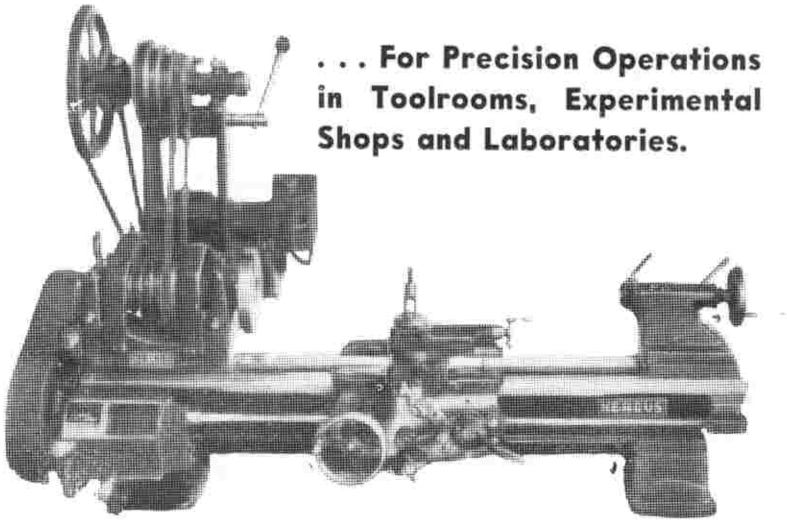
$$\text{Note dB} = 10 \times \log_{10} \frac{P_2}{P_1}$$

$$P = \text{power}$$

The power output of the small commercial playergrams is of the order of 60dB above reference, and thus it can be seen that fidelity is impossible, if only because of the variation of acuity of hearing with frequency. An average Hi-Fi amplifier will produce 80dB power, at which level the contour of equal loudness is approximating as near as possible to linearity, as at any power level.

In order to improve fidelity and retain as much of the elusive higher frequencies as possible, recording companies usually place at least one microphone near instruments such as piccolo, flute,

"HERCUS" *9 in. Swing x 40 in. VEE BED LATHE*



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A and B are based on C.

The Model "A" is the standard Machine, but in addition is fitted with quick change gearbox and with automatic feeds by friction clutch to both longitudinal and cross motions.

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clarinet, and violin. The sound intensity in the region of the microphone is frequently 90dB and above, which, if faithfully reproduced in your lounge room, would shatter mirrors and quickly reduce the house to much dust. Thus the usual Hi-Fi system supplies about the bare minimum for faithful reproduction, and at lower and more usual power levels (equivalent to twenty rows back from the orchestra) bass and treble correction must be provided. To this end there are available devices called "loudness controls," which vary not only the power level, as in a volume control, but also provide some bass and treble boost at low output. They are approximate only, and not usually used on Hi-Fi equipment.

While the ear is fairly insensitive to low frequencies, any distortion at high frequencies, about 5,000 cycles/sec, is particularly objectionable. Thus on full range equipment, 0.5–1.0 per cent. distortion is noticeable, on radiograms of limited range (100–5,000 cycles) 3–5 per cent. is usually acceptable, while, depending on the instruments, 7–8 per cent. can pass unnoticed. Distortion is of five basic types:

Harmonic,
Inter-modulation,
Transient,
Phase distortion,
Random noise.

The system required must therefore have an output of 5–10 watts continuous, be able to handle peaks above 10 watts, have a flat response 30–15,000 cycles, and less than 0.5 per cent. total distortion.

The achievement of the above requirement is now a function of how much you can raise on the family heirlooms. Thus, if you are satisfied with two extremes of 100 c/sec and 5,000 c/sec, with a fairly lumpy response in between, you race into the local, slap your money on the counter, and leave a few minutes later, a glassy stare in your eyes, clutching a machine costing £30–50. You may, however, demand more than this—an automatic changer and plenty of "bass"(?). The changer, of course, ruins any good records; the "bass" is obtained from the natural speaker resonance and the resonance of walnut-veneered, three-ply panels, response 50–6,000 c/p, cost £50 (+), the more expensive masquerading under the title of high fidelity. The upper frequency limit is deliberately reduced, since for a given percentage of distortion the equipment with the smaller frequency range is less objectionable.

With a little care and home construction, quite a good system can be assembled, which will have a better frequency response than the above, more and cleaner power, and less hum and background noise. The performance of any sound system is, of course, limited by the weakest link, which in terms of cost is usually the pickup. Your ready cash will therefore force you to seek a compromise of some sort. Using frequency response as a basis, a good rule is that the product of the two extreme usable frequencies should equal 400,000. Thus, in the above cases cited:

30 x 15,000 = 450,000
100 x 5,000 = 500,000
50 x 6,000 = 300,000 or
40 x 10,000 = 400,000

Most engineering students either know or can find out enough to make a very creditable amplifier, and it is only on this part that any saving can be made.

TURNTABLE

A plain turntable, NOT a changer, will cost about £10–15. It will have a pressed steel turntable, unshielded motor, and will radiate hum. There will be slight rumble, even when new, and slight "wow" or "flutter" (the terms are self-explanatory, I hope). There is one other main group of turntables—the out-and-out transcription units, at £30–40, with a few better class first group tables at intermediate prices. The second group tables have virtually no "flutter" or wow, cast aluminium table weighing 5–7 lb. wt., a well shielded motor and precision bearings. These are a "must" with any magnetic P.U., which are very efficient at picking up stray hum from any steel objects.

PICK-UP

The stylus must faithfully track the record grooves over a frequency range of nine octaves. A mechanical device to achieve this at the low power of the record must indeed be a precision instrument. As a general rule, all parts of the sound chain should be under-stressed. Thus, if 40 and 10 kc/s are the limit frequencies, the pickup should be rated 30–15 kc/s, to give a margin of safety.

For a pickup in particular the best test is listening. Watch for the various forms of distortion and non-linear frequency response. There are two types of cartridge—crystal and magnetic. The cheaper crystals are terrible, have big peaks at either ends of their frequency spectrum, and a fairly rough response in between. There are one or two exceptions, the Ronette TX88 being outstanding value at £3. Better crystals cost £10–15, and even these are susceptible to a lesser degree to the peaks inherent in crystals. In general, a magnetic pickup means better, smoother response, with less distortion; cost, £15–25, with arm. They usually have a much higher value of stylus compliance, measured in cm./dyne. This aids in easier tracking, and reduces record wear. With these better cartridges, only the listening test will decide which one is the best, although the published response and distortion figures are a guide. A point to watch is the cost of stylus replacement. Some cost £7 for a diamond point, but the cost may be as high as £15, and also it may be recommended that the work be done by a specific company, appointed by the pickup agent, usually interstate.

Damping material is used in most expensive cartridges, some better than others. It must be of a permanent nature if used, since the performance can fall off considerably without suitable damping.

PRE-AMPLIFIER AND AMPLIFIER

(1) When the record was cut the highs were accentuated, the lows reduced in volume. The pre-amplifier has a feedback circuit which causes its output to revert to the original balance of sound amplitude. Compensation is also provided for the pickup characteristic itself. Most crystal types, being amplitude sensitive devices, can be made to give a flat output with a very simple input circuit, crystals having a natural rise in the bass response, which can be made to follow the R.I.A.A. equalisation curve very closely. Magnetic types are velocity sensitive, and since they reproduce a constant amplitude record, need suitable compensation. Tone controls are provided to permit slight variations with individual discs, and to provide a measure of compensation for the unknown factor of room acoustics. The pre-amplifier must therefore provide three main functions:

(a) Record equalisation.
(b) Pick-up compensation network.
(c) Tone controls.

(2) The amplifier consists of voltage amplifier(s), phase splitter (and driver), and push-pull output stage, the valves being so biased that they work as near as possible on the linear parts of the characteristic curves, particularly in the voltage amplifying stages. Phase distortion is reduced by large cathode by-pass condensers, large interstage condensers. Other features are low noise, non-microphonic valves, well filtered power supply, a grain oriented core output transformer, and about 20 dB feedback. To be convinced about the C-cores, as they are known, one has only to compare their magnetic characteristics, losses, etc., with any of the usual transformer steels. As an example of the effect of feedback, my own amplifier without feedback was $\frac{(+0)}{(-1\text{dB})}$, 70 c/s – 30 Kc/s, and with 24 dB of feedback was $\frac{(+1)}{(-1\text{dB})}$, 10 c/s – 150 Kc/s. This is an example in improvement in frequency distortion and phase distortion, which are related in the following way. At both low and high frequencies the signal current and voltage differ in phase. Thus the voltage component in phase with the output current is reduced, and the power decreases, i.e., the output falls off at the two ends of the frequency range.

Custom built amplifiers cost £50–100, but the home constructor, by following either of the above designs, can for £25–30 produce an amplifier guaranteed to perform as well, if not better, than those available commercially.

SPEAKERS

A speaker in the open air is a most inefficient radiator of acoustic energy. The sound waves from the front and the back of the cone tend to cancel each other out at low frequencies and it is necessary to at least mount the speaker on a Flat Baffle, this being an approximately square board with a hole cut to take the speaker. When the length of the path from the front to the back of the core is $\frac{(\lambda)}{(4)}$, cancellation occurs, an acoustic short circuit.

e.g., for a 300 c/s note, $\frac{\lambda}{4} = 8$ ft.
$\therefore$ dist. from speaker centre to edge of board = 4 ft.
$\therefore$ size of board = 8 ft. square.

It would be rather difficult to obtain or to house a board as large as this.

The Reflex enclosure or Infinite Baffle provides the answer to the above difficulties. Both are variations on the theme of an Helmholtz resonator, the Reflex enclosure being easier to construct and adjust. Construction details are available for Wharfedale and Goodman's speakers, and recently for Rola speakers. There are two excellent books by Mr. G. A. Briggs, of the Wharfedale Wireless Works, on the subject. With this design, two peaks appear in the low frequency response instead of the one speaker resonance. In general, they can be reduced in power by increasing the enclosure volume, and adjusted in relative size by varying the cross-sectional area and the length of the reflex port. For 8 in. speakers, 2 cu. ft. volume is a minimum, 3–4 cu. ft. recommended; for 12 in. speakers, 5 cu. ft. is a minimum, 10 (+) cu. ft. recommended for best bass response.

One speaker cannot adequately handle power over nine octaves without some intermodulation distortion. This is greatly reduced by arranging through a cross-over network for one speaker to handle all the high frequency sounds (tweeter), and another to handle the lower sounds (woofer).

A good guide to the quality of the speaker, and thus its output, is the total flux, being a function of flux density, pole diameter, and flux length, the last being most important in the "woofers." Any speaker costing £10 or over (to £50) will give good results, but the L.F. speaker should have a total flux in excess of 50,000 lines to ensure linearity at large cone amplitudes.

MOUNTING

The speaker box should be mounted so that the speaker is 3 ft. above the floor, and pointing slightly upwards, to ensure that the H.F. sounds are not lost in heavily padded settees. Standing wave formation can be reduced by placing the box in one corner of the room, and facing diagonally towards an opposite wall.

The turntable and amplifier should be mounted in an adjacent room, but separated acoustically to minimise any possible feedback.

LISTENING TESTS

Having ascertained the frequency response of the part being tested on sine waves alone, it is necessary to test for distortion. As mentioned previously, this is of several basic types, harmonic, intermodulation, transient, phase distortion, and noise. It is known that when a sine wave is fed into an amplifier, the output contains overtones besides the fundamental frequency. Depending on the frequency, the overtones may be hard or easy to detect, but all the additions have frequencies a finite number of times the fundamental. This is harmonic distortion.

If two sine waves of dissimilar frequencies are fed into a non-linear device (e.g., a valve), besides the effect described above, the two frequencies interact to provide addition and subtraction frequencies. Consider 700 and 400 c/s waves. These will give small output at 100, 300, 1,100 c/s, etc.

The above forms of distortion are found to some extent in all parts of the system. Thus output from a crystal pickup with "peaky" frequency response will be colored by what you recognised as intermodulation distortion, since the output obtained will be the sound you expect to hear, plus additional frequencies not on the record. It must be remembered that in the same way, intermodulation occurs in the live performance, but we have grown accustomed to it, and accept it as a matter of course. It is these other additional frequencies which we do not expect, and which result from the sound passing through the reproducing system, which are termed intermodulation distortion. Select pieces of music which will accentuate each. Both piano and violin are rich in harmonics which may make the note being played appear an octave higher in the event of harmonic distortion, or make a piano sound like a vibraphone or marimba. Intermodulation is best heard with an organ playing very high and very low notes, the high notes appearing to rise and fall in intensity at the same frequency as the low notes. A piccolo will not only test the H.F. response, but also the harmonic and intermodulation distortion of every part of the sound system. Transient distortion is particularly noticeable with percussive sounds—strong drum beats, piano played loudly. Full frequency noise, like handclapping, wooden clappers, cymbals, are all a good test of the equipment.

From the above it can be seen that a sound system to give good results will cost a minimum of £55, and may be as expensive as £350. Comments regarding magnetic tapes and stereo reproduction of either tape or disc have not been considered in this article because of their additional complexity, and the fact that stereo for the home enthusiast is still in stages of development.

ENGINEER IN TROUBLE *(women)*

By G. MEIJA

"Oh! Hallo there, Sebby!" beamed Mrs. Jones-Smith as she opened the front door. "Do come in, dear boy! You'll have to make yourself comfortable; Cynthia, I'm afraid, is not ready yet. How are your studies? Cynthia has been doing a lot of housework for me, poor dear. She is quite brilliant at home, you know; she'll make some lucky man a good wife. . . ."

With a knowing wink and an additional few hundred words, she disappeared.

Roger Sebastian Springbottom sat down at the piano and let his fingers find their way among the keys. How his relation with Cynthia had changed! Yes, it had been an ideal relationship, with Mrs. Jones-Smith chirping away when he came for Cynthia, praising the girl's popularity, telling him how Cynthia was always dining and dancing. Well, that had suited him perfectly, since usually she was not going dining and dancing when he asked her out, and such an easy-going relationship with a good-looking girl like Cynthia was good for his ego, and, of course, for general relaxation, too. . . .

But then he had committed a fantastic blunder. In a moment of weakness, when suffering from the negative effects of brandy-lime and soda, and from the lack of air due to Cynthia's clinch, he had blurted out the fatal words: "I love you."

This had changed things immediately. Cynthia's love-making lost its fervour; he had even caught her once looking through a French fashion magazine for "The Young Bride" behind his back, whilst engaged in a soul-searching kiss.

She developed a taste for the "Home, Sweet Home" magazines, and left them in strategic places. The display windows of furniture shops attracted her, and they spent hours looking at double beds. Innocent babes, wherever she could get hold of them legally, were robbed of their well-earned peaceful slumber, cuddled, and bundled, and paraded in front of him, until he imagined that the world was chockerblock full of screaming infants.

There were frequent trips to her married sister's matrimonial nest in the country, where he was treated as a backward member of the family in need of a little bit of coaching. Even his friends no longer saw him as a happy bachelor, but as a man who has finally settled down!

In between their well organised appearances together in the social world, at her friends' engagement parties, wedding ceremonies (everybody seemed to be throwing themselves into the open arms of matrimony), he had tried to tell her that it was all a mistake, that he was not ready yet, that he was unworthy of her—but that produced only an uncontrollable stream of tears, confronted by which he was rendered completely helpless and domestically docile. However, now he felt that he had to do something very drastic—and soon.

"Sorry I am late, darling." Cynthia touched his cheek lightly. "Stop playing that silly piano and let's go."

In her father's Studebaker they drove to the reception. Cynthia was again that radiant social beauty, beaming on everyone, talking about everyone not present there, displaying her beautiful teeth and her latest acquisition, our handsome but rather miserable friend, Sebby. She watched over him with the devotion of a guardian angel. After the second glass of brandy-lime and soda she gently but firmly poured lemonade into his glass. Later he was treated with a punishing glance because he had followed with his eyes the movements of a rather ravishing blonde.

Still later that night, back at Cynthia's, they sat in front of the fire.

"Do you know, Cynthia, what I am studying?" he asked casually.

"Of course, dear. Engineering. If you asked me, I don't understand a thing about it . . ."

"That's just it," he interrupted her. "I'm training to be an engineer. Now, let's see what that means. An engineer must possess mathematical and scientific ability, must be of inflexible integrity, truthful, accurate, resolute, discreet, of cool and sound judgment, must be courageous, must believe in his own ability, must be fair and impartial as a judge, must have experience in his work, know all the scientific facts related to his work, must have experience in dealing with men, must have a knowledge of business habits, and of accounts . . ."

"Yes, dear, but . . ." Cynthia was getting nervous.

"Do not interrupt, Cynthia, please. Thus, as I was saying, a successful engineer is essentially an economist who has been entrusted with the world's resources — water, coal, mineral, manpower, liquid fuel, etc. These are his responsibility. He must see that they are used to add most efficiently to the comfort of our civilisation. This cannot be accomplished in the set hours between eight and five; his mind works constantly . . ."

"Yes, but what about doctors?"

"They, however, are one of the best paid professions, whilst we engineers are the most underpaid profession. But that is not the point. Have you ever looked in the dictionary under 'engine'?"

'No," she said angrily.

"Well," he continued, smiling broadly, "in Latin 'ingenium' means a genius, and also 'ingeniosus' means naturally clever, talented, acute, able, ingenious. Thus, in the English we get 'engineer,' meaning a person of genius and ingenuity. So, you see," he concluded simply. "I am going to be a genius."

"Roger Sebastian Springbottom, are you suggesting that I am not sufficiently clever for you?"

"You are clever, all right, but . . ."

"Get out! I never want to see you again! Never! Never! Do you hear?"

Outside he performed a few crazy leaps—he was free again! Free! !

"Ye gods, that was a close shave," he mumbled to himself.

THE FLYING SAUCER FIASCO

By MEL DUNN

Recently one of the biggest controversies in modern times was initiated when reports from all over the world began appearing concerning strange sky objects. Immediately some people postulated space ships as the cause, while others were prepared to accept the fact that all these sightings were due to natural phenomena. Many hundreds of observations have since been recorded, and many books written, but still the controversy rages. What are they?

The only really exhaustive investigation to be undertaken has been by the U.S.A.F., which between 1947 and 1953 concluded that 27 per cent. of the reports received by them were "unknowns." This means they were either some unidentified flying object, such as a space ship, or some unknown natural phenomena. Apart from this, they were non-committal; and this appears to be the ostrich-like attitude of every military power throughout the world. Why? Surely they do not believe in flying saucers?

Admittedly, some reports have the smell of authenticity about them. Also, thousands have seen these objects, radar has locked on to them, photographs have been taken of them, and pilots have been supposedly killed by them, whatever they are.

I do not doubt that something peculiar, and at present unknown, has been seen in the skies, but I do not believe that they are inter-planetary space ships. This, of course, does not mean that there is no such thing as an inter-planetary space ship. Surely it would be the height of absurdity to assume that, out of the billions of existing planets in the universe, this earth is the only inhabited one. Our scientists expect space travel for us within fifty years. It must be possible that some other planet exists, inhabited by intelligent beings, which is scientifically at least fifty years ahead of us, if not many more. Also, need such a planet have developed along the same lines scientifically? They might have discovered some form of propulsion, for example, entirely unthought of by us.

In addition, I believe that if ever some planet decides to send a delegation to earth, they will come for one of two reasons—peace or war. Either

(Continued on page 80)

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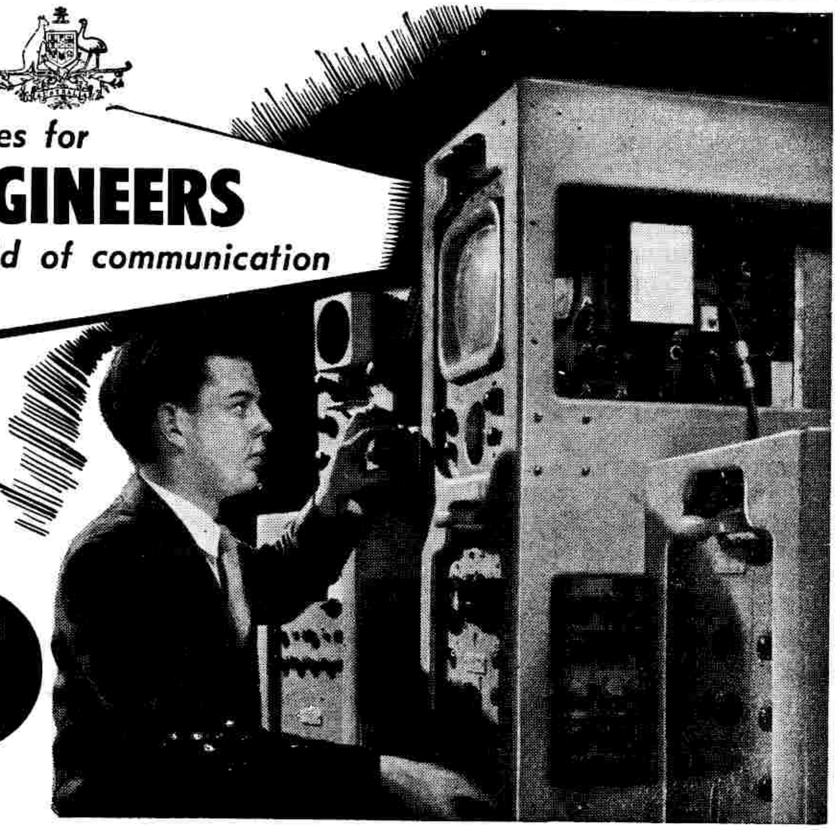

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FEEDBACK CONTROL SYSTEMS

By KHOR TEIK HEAN

The accelerated advances in Technology and Science during and after the Second World War now makes it most difficult for scientists and engineers to keep abreast of changes even in their own fields, let alone in related fields. One of the fields where recent changes have been most noticeable, and, in fact, explosive, has been Feedback Control Systems, or Automatic Control. That this is not an exaggerated statement is supported by the fact that one of the earliest instances of organised academic instruction in the field was at the M.I.T. (in the Electrical Department) in September, 1939, as a course entitled "Theory and Application of Servomechanism," while today the theory of Feedback Control is exploited not only in most fields of engineering, but also in fields like sociology, military armament, and government. Amongst the pressures for this explosive growth has been the growing complexity and speed in industrial and technological operations. But Automatic Control in turn gives quantum jumps to whatever it touches, and finds application wherever there is need for reflexive control.

The basic control problem can always be reduced to the following: Given a command (which is generally a function of time), control some physical quantity so that it closely agrees with the value of the command. The controlled physical quantity may be a position, speed, or acceleration in a mechanical system, in others it may be a temperature, voltage, pressure, neutron flux, etc.

The simplest type of control is the open-loop control. For example, we can imagine a room to be warmed by some heater, and that the heater is set by a dial marked for various temperatures. When the dial was set to a certain position, the room temperature would normally reach a desired (normally comfortable, but not necessarily so!) temperature. Even if there were no draught, and the walls were good insulators, this would not be a satisfactory method of control if the room is to be warmed quickly.

If one were in the room, however, one would set the dial to the maximum, and when the room temperature has reached the desired temperature (by reading a thermometer, say), one would adjust the dial to keep that desired temperature. This is the simplest type of feedback control, with the human being forming the feedback loop. We can, of course, arrange to have a thermostat to measure the room temperature, and have a device to obtain the error between the actual and the desired temperature. The error then influences the heater so that the room temperature is changed in such a way as to reduce the error.

A feedback control system, therefore, is one in *which the action of an output or controlled variable is measured.* This measured value is compared with the command or desired value, and the error influences the forces tending to change the output or controlled variable, so that the error is zero (or greatly reduced). This is illustrated in Fig. 1, which is the essence of feedback control systems.

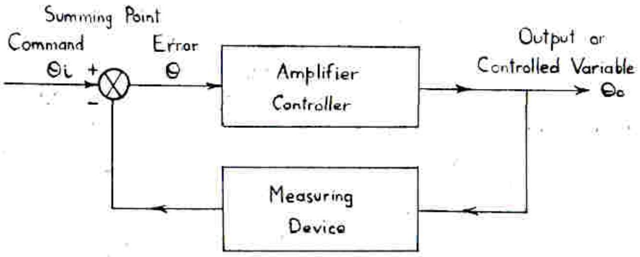

Fig. 1: Basic Feedback Control System.

Thus every feedback control system is characterised by having (1) an input command or reference, (2) a device to measure the controlled variable, (3) a comparing device (summing point), (4) a unilateral element or amplifier, and (5) a reversible power controller, which exerts force on the controlled variable. The unilateral element or amplifier distinguishes the system from a network. In this unilateral element, power, information, or a quantity, can flow only in one direction. Examples are the heat flow (from the heater to air in our example), hydraulic, valve, electrical or pneumatic amplifier, the fractionation of petroleum, or in manufacturing. The advantages over an open loop control are that the error between the controlled quantity and the desired one is greatly reduced, while the time in doing so is faster. Further, variations in load (such as some draught when someone enters the room, in our example), and in the components (amplifier controllers), have little effect upon system accuracy. It will be obvious, however, that the performance cannot be better than the input command or reference. (For example, if you want to make the guest leave early, the desired temperature is far from comfortable!)

Although feedback control systems offer many advantages over open-loop controllers, one difficulty may arise—instability. Suppose in our example there is some change in load. Even if the thermostat reacted immediately, there will be a time delay before the heater can be brought to a higher temperature to counteract the change. There will be a further delay for the air to be warmed. When the air is finally warmed to the desired temperature, the heater would take some time to come back to the lower temperature, due to thermal inertia. There is thus the tendency for the controlled air temperature to oscillate about the desired temperature. For a well designed system this oscillation must be zero, or so small that the function to be performed is satisfied.

Thus the study of feedback control systems embraces the knowledge of all the components in the control system, be it electrical, mechanical thermal, or others, reducing them to unified mathematics, and the effects of combining the various elements to perform a job. The control engineer must be able to synthesise various components into a system, be able to analyse the performance of proposed or existing systems, and be able to meet the specifications of the job, which can be very stringent (such as missile guidance control, or reactor control). Further, in actual problems things are not so simple as in our example. There may be more than one factor affecting the controlled quantity, there may be more than one summing point, and there may be more than one feedback path.

Fig. 2 shows the block diagram and the direction of "arrows" in a temperature control for a radiantly heated dwelling.

Around the simple diagram (Fig. 1), consisting of a block embellished with a summing point and the direction arrows, hundreds of papers have been written to explain the mysteries of stability and performance that pertain to this simple loop when actual physical equipment is substituted for the symbols representing it. Tools and techniques in the various compartments of studies, engineering science, and mathematics, were exploited. Extra loops have been added to the diagram, various switching modes (or modes of control) have been investigated, and many graphical, mathematical, or electronic techniques for solving the resulting mathematical equations for the various blocks and feedback loops have been developed.

As to the role, the present and future status of Automatic Control, it is best to quote Prof. G. Brown, of M.I.T.: "Philosophically minded technologists see it as a manifestation of one of the greatest intellectual revolutions in thinking that has occurred for a long time. They see in it the natural consequence of man's urge to exploit modern science on a WIDE FRONT to perform useful tasks in, for example, manufacturing, transportation, business, physical science, social science, the military and government. They see that it has brought great changes to our conventional way of thinking about the human use of human beings, and, in turn, about how our engineers will be trained to solve tomorrow's engineering problems."

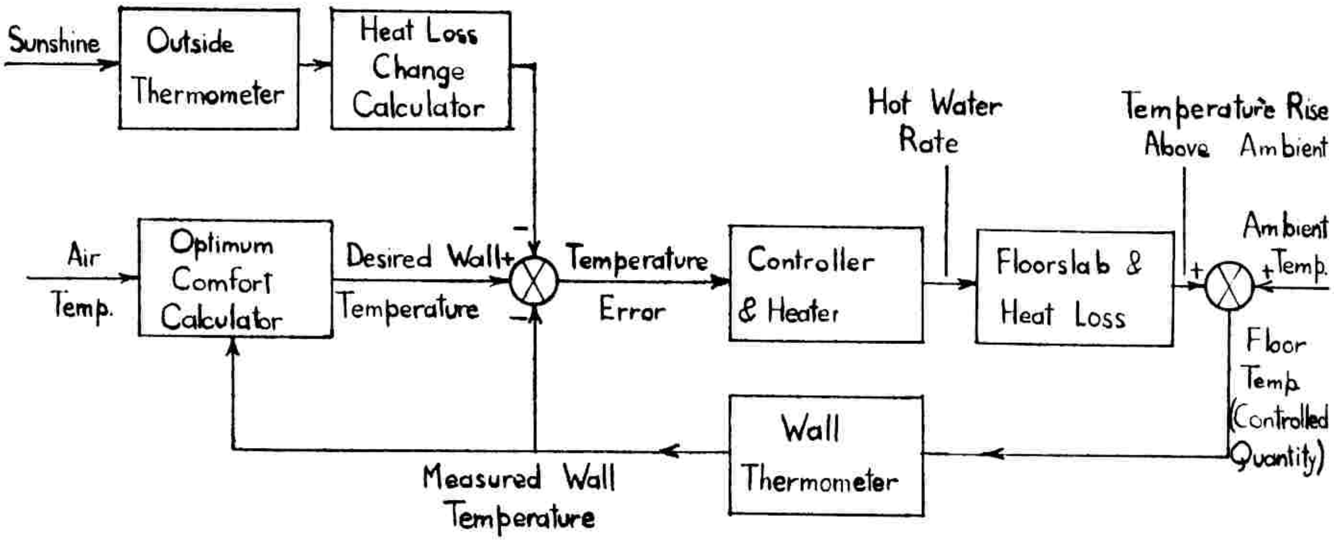

Fig. 2

ESCAPE AND LIVE—OR DIE?

By MEL DUNN

A short discussion on some of the problems associated with emergency escape from high-speed aircraft

In the early days of flying, when speeds were low, it was a relatively easy matter to "bail out" from an aircraft in trouble. However, with the advent of the jet towards the end of World War II, escape by means of a parachute was more a matter of good fortune than good management.

THE TREND IN ESCAPE

When human flight was in its infancy an emergency condition usually resulted in a crash landing, and any landing which you could walk away from was considered a good landing. With low stalling speeds and gross weights, such landings were considered a feasible solution to a difficult situation, and even today forced landings have been universally accepted as the major safety precaution in most aero clubs.

The concept of the parachute was promoted initially to allow a balloonist to escape from his runaway or burning balloon, and was eventually applied to aircraft. This "bail out" procedure was the only form of emergency escape between 1913 and 1944, and was used with relatively little change in technique or equipment during that period. From 1913 to 1940, 88 per cent. of these escapes were successful; but from 1940 to 1955 this figure decreased to less than 40 per cent. One of the major factors was the pilot striking parts of the aircraft during the escape sequence. Hence some form of assistance was needed to help save the pilots, and the idea of the ejection seat was first utilised by the German Air Force during World War II. They reported sixty successful combat ejections with their device.

Today, aircraft design has far outstripped escape system design, and a pilot has less than a one in two chance of escaping successfully, via the ejector seat, in an emergency.

THE PROBLEMS

There is no real problem in designing a suitable ejector seat to shoot an inanimate object anywhere, but once a human being is brought into consideration, many difficulties arise, a few of which are mentioned below:

The pilot must be able to:

1.—Activate the escape mechanism easily, regardless of the motion of the aircraft.

2.—Withstand the explosive decompression, particularly at height.

3.—Survive the ejection acceleration.

4.—Clear the aircraft structure.

5.—Survive the wind blast, deceleration, and possible violent tumbling.

6.—Retain consciousness.

7.—Avoid frostbite, which is possible above 35,000 feet.

8.—Survive the 'chute opening jolt.

9.—Survive the landing shock.

10.—Survive the elements where he has landed until he is rescued.

It is clear that a successful escape does not depend wholly on the ejection seat alone. Points 1 to 5 are closely connected with the escape system design itself, while points 6 to 10 are more concerned with the pilot's personal flight equipment.

Individual problems, of course, become more critical under certain conditions. Low-level ejection, for example, demands a high trajectory, an early 'chute opening, and also a single control to release the hood and fire the seat simultaneously. All these are necessities, particularly in an emergency landing on an aircraft carrier. However, an early 'chute opening at high speeds would possibly damage the 'chute, and injure the pilot. Also, at high altitudes, an early 'chute opening would abandon the pilot in a rarefied and freezing atmosphere, with possible loss of consciousness and frostbite resulting. Here we have conflicting requirements. The first problem is overcome by a device which automatically selects the time required for safe deployment of the parachute to meet the conditions of speed prevailing at the time of ejection. A barometric pressure release over-rides this at high altitudes, allowing the pilot to fall to a warmer and denser atmosphere before the 'chute is deployed. This overcomes the second difficulty.

CONCLUSIONS

It is quite obvious that all these troubles are inter-connected, and each escape system must provide a solution for each one. For this reason downward ejection seats and capsule or pod escape systems are condemned for operational aircraft, since they are useless at low level, and therefore defeat their purpose. Furthermore, it is clear that not enough emphasis has been placed on the importance of a successful escape system. Some fifteen years have elapsed since the ejection seats were first introduced, and although the problems are numerous, they were all known at the beginning, and, I am sure, would have been successfully overcome if a concentrated effort had been made.

An escape system which saves the pilot every time still has to be designed, and it is up to an engineer to do it. Pilots' lives may be in your hands.

RADIO CLUB

The Radio Club was originated as a club for radio "hams" within the University. Because of the specialised nature of amateur radio, they were a little publicised, select group; most students would have little idea of (and probably little desire to know) the nature and activities of the Radio Club. If, by some accident, an ill-fated student happened to climb the many flights of stairs, and finally reach the "shack" while a "contact" was in progress, there would come to his ears such things as "VK5UA right back—roger, ole man; bit of QSB that time, but all O.K. Well, thanks for the QSO—I'll send you a QSL; 73^s, 88^s to the girl friend; we'll see you on the breeze again."

Well . . . .!!? I guess you would get back down those stairs a lot faster than you came up, and let the "ole man" rave into his microphone all by himself.

Ham radio began in the days when radio and electronics were in their infancy. The ham developed many of the techniques of modern communication, and, in fact, he is a communication engineer in his own right. And with the development of new methods and ideas came the peculiar technical jargon that only hams understand.

But a club with its roots in this old and quite unique hobby obviously does not readily fit in with the University setting. Accordingly, the committee decided that it was time for a reorganisation—a shift of emphasis. Would it not be better to encourage students to participate in practical electronics, and help bring to maturity the desire for original thought and experiment? The University, to function as an instrument for passing on knowledge, must have organised lectures and exams—conformity; nevertheless, we feel that there is still room for experiment, not only at final year and post-graduate levels, but all the way along.

At the preliminary discussion a project committee was formed, consisting of Lance Horvath (committee representative), Bob Roper, Malcolm Haskard, Frank Choate, Brian Sorell (first year member), and Professor Willoughby (technical adviser). The purpose of the project committee is to collect ideas for projects, mould them (if need be) into a form of most benefit to all members, ensuring that the financial aspect is covered, and finally, to authorise their carrying out. When needed, the committee also lends a hand with project organising.

Before the project committee had been long in office, plans were drawn up, and construction of a new transmitter was under way within a couple of weeks. This will supersede the old one and allow operation on two extra bands, reducing netting time from 15 secs. to 2 secs., and band charging time from 5 mins. to 10 secs. All materials have now been obtained, and the chassis for the transmitter and modulator have been completed. The transmitter will be housed in a 5 ft. 6 in. rack, and all the front panels will be hammertoned.

Frank Choate (our worthy V.P.—not to be confused with V.I.P.) is rebuilding the 288 m/c rig, and is altering the receiver converter stage to a crystal mixer. He is finishing the front panel in glossy white, with red markings to "show us what good equipment really looks like."

The Radio Club on the Air

The following projects for the future have been suggested: (1) T.V. experiments, both transmitting and receiving. (2) Crystal controlled gear on 288 m/c, to be used to scatter propagation, and T.V. experiments. (3) Setting up the Admiralty receiver for direction finding. (4) Remote controlled receiver to overcome the shocking interference at the University. (5) Study of chassis currents (as aid to the less "bugs" and better layout design in new equipment). (6) Transistorised remote modulator (to allow anyone operating the station to move freely without trailing mike leads). (7) Electronic device for mass-producing silver-plated pennies (the committee WILL insist on economics being taken into account when planning projects).

This list is purely tentative, and any further suggestions would be greatly appreciated by the project committee. Up till now most of the interest has centred around radio; any ideas dealing with audio, pulse, flip-flop circuitry, and the like would be welcomed, to broaden the field of interest.

Activity covers a fairly wide field of interest—design, practical construction, experiment, and

(Continued on page 80)

"on the air" operating. There is great fun and recreation to be gained in designing and building equipment; at the same time, one becomes familiar with modern techniques and equipment of all kinds. For the more socially-minded students there is the opportunity to get to know people not only all over Australia, but in most countries of the world. Many interesting discussions and friendships have been made across distances annihilated by ham radio stations throughout the world.

Students interested in joining the club should contact any member of the committee. We are now holding monthly meetings, on the fourth Monday in the month, at 7.45 p.m., in the Chapman Lecture Theatre. The club is open to all faculties, and although we have not taken the S.C.I.I.A.E.S. entirely into our confidence, we even have members from the MED. fraternity.

QSB—Variation of signal strength.

QSO—"Contact."

73^{s}—All the best.

88^{s}—Love and kisses.

THE FLYING SAUCER FIASCO (Continued from page 73)

way, they would not be stupid enough to wander all over the countryside in odd shapes and sizes, for no apparent reason other than to scare one or two people out of their wits, or to give others a short sight-seeing tour in their latest flying saucer, as some "reports" have pointed out.

Therefore I conclude that all the supposedly proved "unknowns" can be explained away by some unsuspected or undiscovered natural phenomena, and that when space ships from another world do visit earth, if they ever do, something more tangible than queer lights in the sky will inform us of the fact.

Further information can be gained from the following publications:

Aimé Michel: "The Truth About Flying Saucers."

Edward J. Ruppelt: "Report on Unidentified Flying Objects."

Donald E. Kehoe: "Flying Saucers are Real."

Donald E. Kehoe: "Flying Saucers from Outer Space."

Donald E. Kehoe: "The Flying Saucer Conspiracy."

And others.

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