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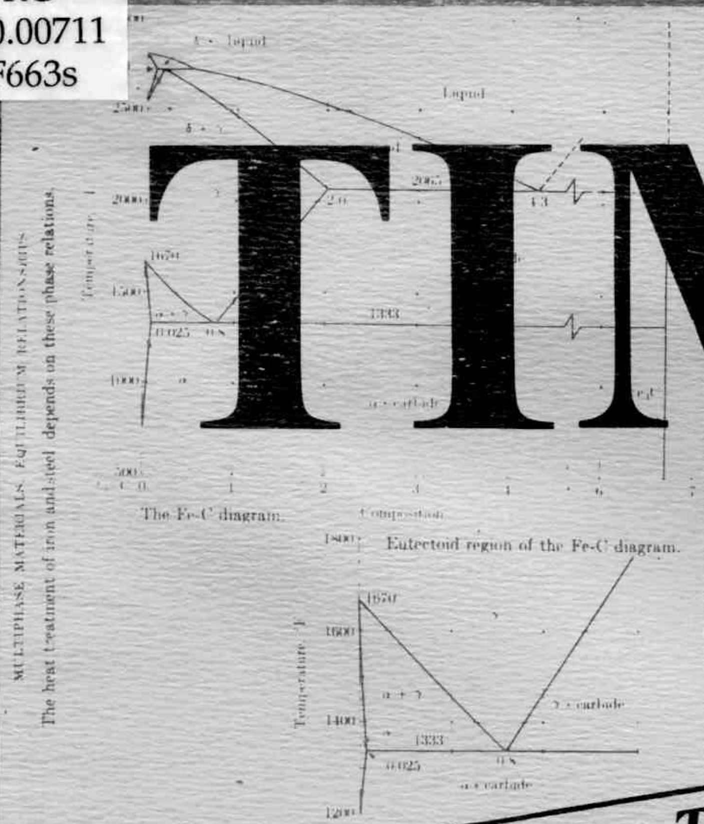
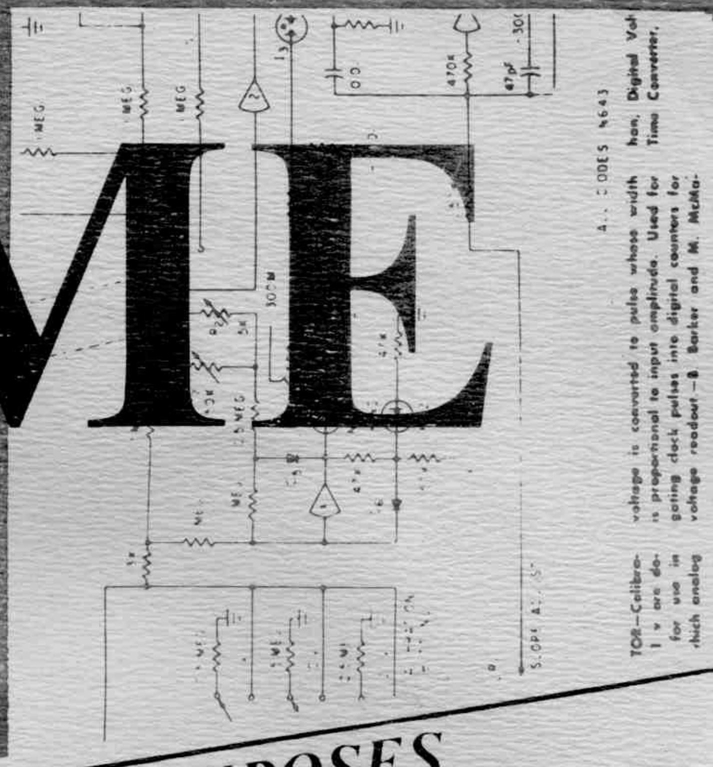
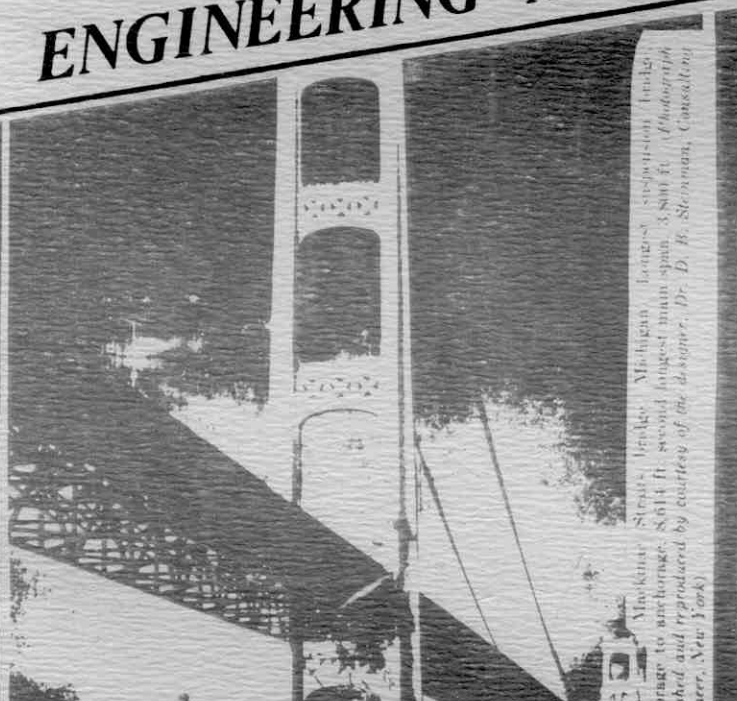
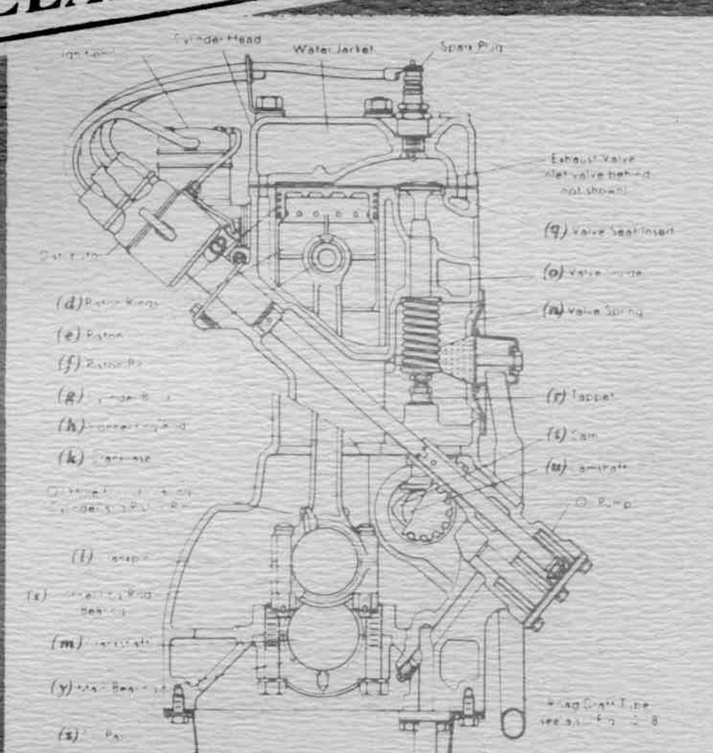




SPECIAL REPORT : TIME EXPOSES ENGINEERING AT ADELAIDE UNIVERSITY





THE ENGINEERING PROFESSION : Where is it going?

(B) AUSTRALIA

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STUDENT HANDBOOK ON ENGINEERING

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STUDENT HANDBOOK ON ENGINEERING

Produced by the Education Group (Associated with the Students Association at Adelaide University)

Edited by: Julian Foley, Student, Dept. of Mech. Eng. and Peter Jarrad, Postgraduate, Dept. of Mech. Eng.

With assistance from: Michael Norton, Mrs. Osman and Peter Love.

Thanks are due to those who have provided contributions: The Professors of Departments, lecturers, postgrads and, in particular, the seventy students who completed and returned questionnaires.

Graphics (the best) taken from: R. Cobb, Education News Service, Alternate News Service, On Dit, Orientation Handbooks, A Guide to Tertiary Education, Peter Love's collection and from many others.

Layout by: Peter Dillon, Lindsay Webb, Suzanne Jarrad, Michael Norton and Peter Jarrad.

Typed by: Mrs. Stevenson, Student Activities Office.

Printed by: Sarah and Frank in the Students' Association.

INTRODUCTION

This handbook on Engineering was produced for Engineering students .

There were many purposes behind producing the handbook:

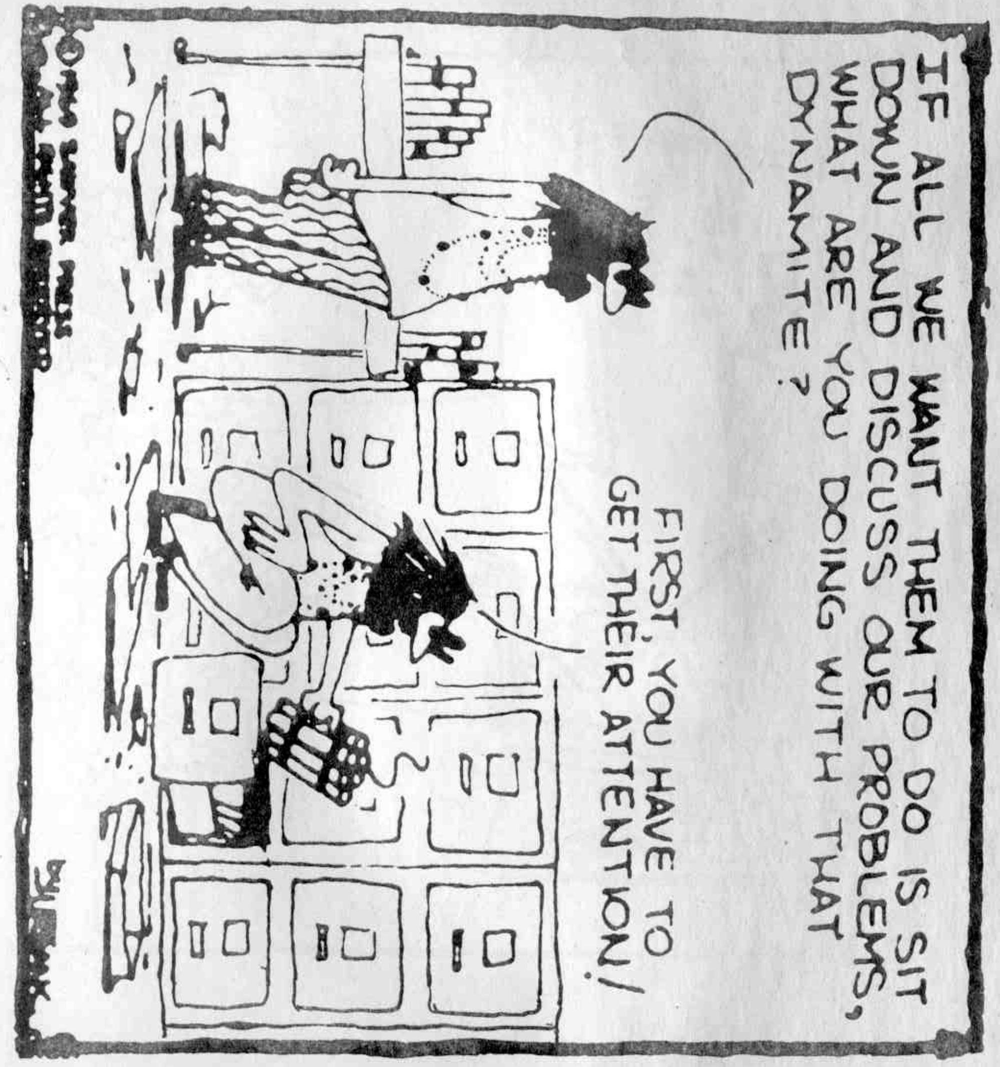
* to help first year engineering students orient themselves for study at University
* to provide information on the Engineering Profession and what engineers do, and to show how that fits into the educational scene
* to help make study easier by providing information on courses and hints from previous year's students
* to provide some perspectives on Engineering and Technology
* to provide students with constructive suggestions as to ways of improving different courses
* to promote greater openness and understanding between students and staff.

The handbook hopes to cater for all points of view and for this reason it may appear to be a little schizoid. You will almost certainly find there are parts with which you disagree, but that is to be expected with every publication. Above all, the handbook seeks to promote thought and discussion and most certainly not a passive acceptance of any of what is written.

In producing this handbook, information was sought from undergraduate students, post-graduate students and staff members. It is perhaps unfortunate that early publicity appeared under the name Counter Faculty Handbook and then Counter Course Handbook. It seems that many staff interpreted the counter as anti, and consequently withdrew their support. While counter can mean anti or against, it can also mean alternative or substitute and it is in this sense that the handbook has been produced. It just goes to show how easy it is for unnecessary barriers to occur.

While some fair criticisms directed against the handbook have been accepted, a case can be made for students to use a handbook just to voice criticism. When a patient visits a doctor, he may say, 'I feel good here, here and here but right here I feel real bad.' He does not say, 'I think I have such and such a complaint and I think I should have such and such a medication.'
If the doctor does not or can not help him, he eventually goes to someone else.
Only if staff permit students to take as much responsibility as they wish, can they expect them to be completely constructive, offering suggestions rather than just saying something is wrong.

P. J. J.F.



Section I FOR FIRST YEARS

A. PREREQUISITES FOR SUCCESS

1. A preparedness for at least 4 years of hard work

It is a fact that the pass rate of engineering courses is generally lower than that for other courses in this university. There may be many reasons for this; it may not be the fault of any one in particular, BUT, it is a fact. You'll find, too, the workload is heavy, over 25 contact hours before you begin your personal program of study and revision. There is nothing to suggest that this will be any different in 1976. There is nothing to suggest that this will be any different for the next X years!

Learning is painful; to become a skilled professional in any field is difficult, be it academic, sporting, political or whatever, and to become a real, professional engineer is neither trivial nor easy.

This problem of learning is accentuated by some lecturers who do very little, if anything, to facilitate the learning process. This may be partly due to factors about which little can be done, e.g. deep-rooted traditions about the mode of teaching, additional demands on lecturers time by the university or departments, lack of secretarial assistance, and in many cases the unresponsive nature of many students. It is also true, though, that some lecturers simply do not avail themselves of the knowledge, guidance and help (including teaching aids) that have been made available by recent research into learning and education.

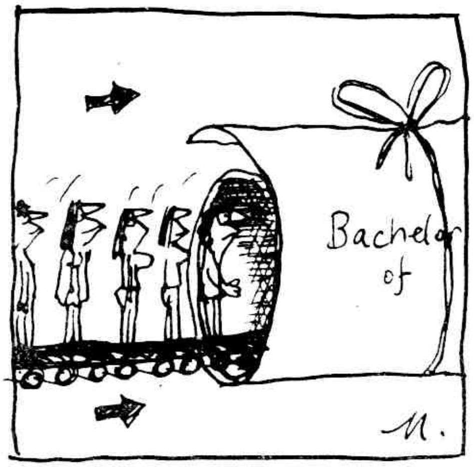
It is a disheartening fact that in most subjects there is only little scope for personal growth in even the smallest way. With heavy workloads and fairly rigid assessment schemes, it is very difficult to find the time to explore and develop personal interests outside the set curriculum. It can be done, but largely at the expense of other work and results. Some students would criticize the course as far too general, it being very difficult to get a good understanding in any area before passing on to the next. It is unfortunate that so few subjects use the core and option approach which, while covering most areas adequately, also permits some in-depth study on the options of most interest.

No matter how intelligent you are, no matter where your interests lie, there will be many times when you will find subjects difficult to understand, boring, apparently irrelevant to your own aspirations and ambitions, poorly taught, etc. and only self-discipline and hard work will get you through.

So, if you are not prepared for this,
EITHER DO NOT DO ENGINEERING
OR EXPECT TO BECOME A BYE-PRODUCT OF THE SYSTEM.

2. Intellectual Ability

The engineering courses at Adelaide Uni. must, among other things, cater for students of considerable ability, and those who wish to undertake postgraduate study and research. Courses tend to have a theoretical rather than a practical orientation. They tend to concentrate on understanding and the analysis and synthesis of different systems, rather than on the practical details involved in making a real system work.



Engineering courses at the Institute of Technology would tend to have the reverse approach - thus ALL STUDENTS ARE ADVISED TO CONSIDER THE COURSES AT BOTH INSTITUTIONS PRIOR TO ENROLMENT.

Some students just do not have the intellectual ability to cope with the work at the university. They are aiming too high and sad to say, will not succeed. Other students will be on the borderline; they will find it A CONSTANT GRIND, ALL THE WAY.

Many students would remark that it is not so much that the work is hard to understand, rather there is so much of it. Some just don't have the ability to cope with it.

Your academic background is important. You may have come from schools where teaching has been competent, or you may have come from schools where teaching has been poor. Some students have a good background in work related to subjects studied at Uni., while to others much of the work is unfamiliar.

There is a real physical limit to the amount of work that anyone can do during the course of a year. Many students, who DO have the ability to succeed (especially those on the borderline) will find that their background will catch up, and it will be necessary to repeat a year in one or more subjects. Often this will be enough and the student will pass well through the remaining years.

The first year at university should be (but often isn't) the time when a student works out if he has the ability to succeed. Often, poor results at first year level (or just satisfactory marks at matric.), should make a student question whether he should continue study.

3. Interest in Engineering and other allied areas

The interests and attitudes held by a student will have a significant effect in determining whether or not that student will succeed.

Many, if not most students have poorly conceived ideas about engineering, about the different disciplines within Engineering, and about the sort of tasks that engineers actually undertake in practice. They then face a barrage of subjects which seem only remotely linked with real engineering. When this is accompanied by poor lecturing, many students find themselves extremely frustrated, dismissing much of the work as irrelevant, meaningless, etc. They become disenchanted with the course, find the work unrewarding, and study becomes very difficult.

At best, the purpose of the engineering courses is to prepare the student, so that after 2-3 years of work or further training after graduation, the student might be validly called an engineer. The notion that one is gradually becoming an engineer as the years of study are completed is quite false.

Many lecturers consider it up to the student to determine interests and to find the motivation to learn; some seem unaware of the ways in which they actually discourage learning, and the motivation to work. Section VI includes an article on motivation, which may be useful in helping both learner and teacher promote the desire to learn.

One of the most important attributes of a competent engineer is to have a working knowledge in many fields, some of which are covered by other disciplines. The engineering courses are constructed in this way, and all students are required to study areas which appear to be essential only to other engineering disciplines. IT IS VERY IMPORTANT, THEREFORE, TO DEVELOP INTERESTS AND PROFICIENCY IN AREAS OUTSIDE YOUR FAVOURED DISCIPLINE.

It is the hope of this handbook to provide information on engineering, and the courses, to help you decide where your interests lie, and to help foster these. STUDENTS WHO ARE UNSURE OF THEIR INTERESTS ARE ADVISED TO CONSIDER DEFERMENT FOR A YEAR. Similarly, if you feel you lack the maturity to commence a university course, or feel reluctant to embark upon a further year of intensive study after matriculation, think about taking a year off. You will not be disadvantaged; your greater maturity and motivation will be assets when you return to study.

4. Support from others

All students will, to some extent or another, depend on others while they study. It is valuable to foster such support, for it may well be the deciding factor in your success, and we outline some ways of doing this below. The crucial point here is to establish good personal relationships with others, be they family, friends, lecturers, tutors or whoever. The key to good relationships is, of course, concern for others.

Most students will complete their study while living at home. Time spent in developing good relationships with parents (despite the many differences of opinion that will occur - most that can be played down) will often reap unexpected dividends, e.g. good study conditions, special consideration at exam time, help in providing aids like books, calculator, etc.

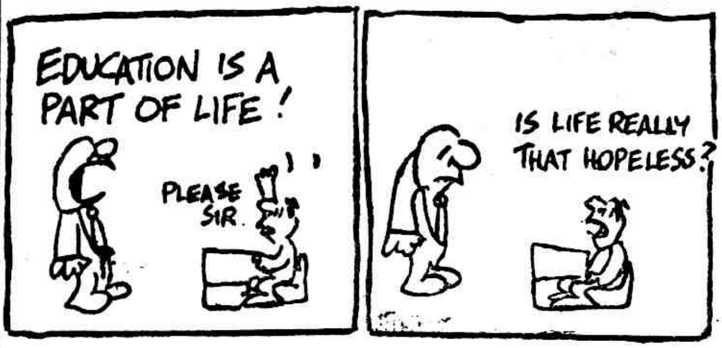
This does not always apply - in some cases parents may not give any help at all, possibly because of a background where further study is considered unnecessary or unimportant. Other parents may do just the opposite; trying to force study when interests and ability militate against it. In such cases help from friends can be very valuable, or assistance is available from the Student Councillor.

cont.

The cultivation of friendships is also important for both social and study reasons. Many students find it helpful to study together, so that it is easy to compare solutions to problems, discuss difficult topics etc. Here a willingness to help is usually reciprocated so that all concerned benefit. This is one way to overcome any shortcomings in the tutorial system. One caution is mentioned. Different students have different study habits and it is possible to form an association with friends where this is the significant difference. This can result in difficulties, for example, some may miss out or waste time in tutorials or free periods for they study better at other times and in other places. You may need to work hard during that time for that is when you can put in your best effort. Clearly such an association can be destructive and needs to be guarded against.

Perhaps the most influential relationships, and often the most neglected are those with lecturers and tutors. Lecturers have the responsibility to teach a course, set the standards and the power to arbitrate such responsibility. Tutors, to a much lesser extent, help the lecturers to carry out certain tasks associated with such responsibility.

Most staff have a reasonable open-door policy and many would welcome feedback about courses they are teaching. So, if you are having problems with particular topics do not hesitate to see the lecturer concerned. Do not hesitate to ask why a particular topic is taught, why it is relevant and why it is useful. Also do not hesitate to make suggestions about topics you would like to see taught and so on.



For some senior members of staff it may be necessary to make an appointment. It is best to try and do this at the end of a lecture or if the lecturer is not in his room, see the departmental secretary who can help you pass on a message.

It seems that many Australian students (as distinct from Asian students) are afraid or very reticent about approaching staff members for assistance. In most cases there are no real grounds for such fears or reticence. It may be that this is why the performance of many students is below that expected. It seems that many staff and students within the Engineering Faculty are shy, retiring or possibly even introverted. It is important not to let this prevent you from getting the very most from your time at University.

If you have difficulty, don't stew over it for weeks, see someone about it. Avoid the temptation to waste hours trying to sort it out yourself when a lecturer or tutor could help you in a few minutes. DON'T SAVE UP ALL YOUR PROBLEMS UNTIL THE END OF TERM - BY THEN IT MAY WELL BE TOO LATE.

With most problems it will be best to try to see the lecturer concerned. However, as some lecturers are busy or hard to catch, it may be more appropriate to see if a tutor or postgrad can help. Some postgrads have intimated that they are willing to help students (for nix) outside of other responsibilities, i.e. research, tutoring, demonstrating, correcting etc. Information about this may be found in section III. While tutors/postgrads may not be as skilled, or know as much as the lecturer about a course, they may be easier to approach and have greater time available.

B. ARE YOU CUT OUT FOR ENGINEERING?

(with the permission of Professor Tait)

Qualities for success in engineering

What type of young man is likely to find satisfaction and win success in the Engineering profession? Let the young aspirant answer the following questions "Yes" or "No":-

1. Have you a hobby for which you can claim a good working knowledge of the salient facts, the technique or the history?
2. Do you enjoy taking part in competitive outdoor games?
3. Do you enjoy quiz programmes or similar mental recreations?
4. Do you take any pleasure in mathematical problems?
5. When answering examination questions in mathematics or science, are you inclined to reason from principles as opposed to working mainly from memorised formulae or rules?
6. Do you obtain a genuine satisfaction in carrying out a scientific experiment or in the construction of a mechanical or electrical toy or working model?
7. Are you observant?
8. Do you record with logic and precision the details of the observations made during a scientific experiment, or can you afterwards record with logic and precision the significant details of a function or event at which you have been present?
9. Have you any interest in accuracy, e.g. if your watch does not keep good time, do you take trouble to correct the fault, or do statements which you know to be not strictly correct irritate you?
10. If the results of any experiment are not in keeping with the principles which you have been taught, or if a toy or model which you have built does not give the performance claimed for it, do you persist until all reasonable doubt of your own inefficiency may be dismissed?
11. Have you successfully concentrated on and achieved a degree of proficiency in any subject which you do not like?

C. WHAT DO YOU HOPE TO ACHIEVE ? . . .

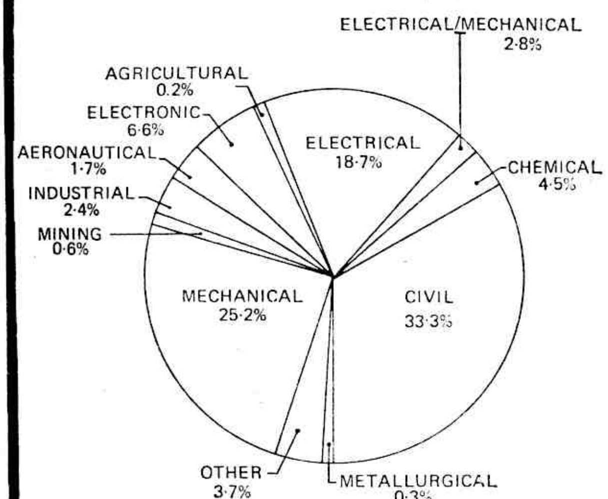
The purpose of this section is to relate engineering with the education you will re-receive during your years of study. Of necessity, this section is very broadly based, with little detail.

see also next page

THE PROFESSIONAL ENGINEER

A professional engineer is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the analysis and solution of engineering problems. He is able to assume personal responsibility for the development and application of engineering science and knowledge, notably in research, design, construction, manufacture, superintending and management and in the education of the engineer. His work is predominantly intellectual and varied, and not of a routine mental or physical character. It requires the exercise of original thought and judgement and the ability to supervise the technical and administrative work of others.

THE BRANCHES OF ENGINEERING



For the pie diagram above, specialization was defined as "that branch of engineering practice in which the respondent gained his or her highest academic qualification."

One-third of the engineers (33.3%) are recorded as having achieved their highest academic qualification in civil engineering. Civil engineers, plus mechanical (25.2%), electrical (18.7%) and electrical/ mechanical (2.8%) make up 80.0% of the engineering population.

Ref:

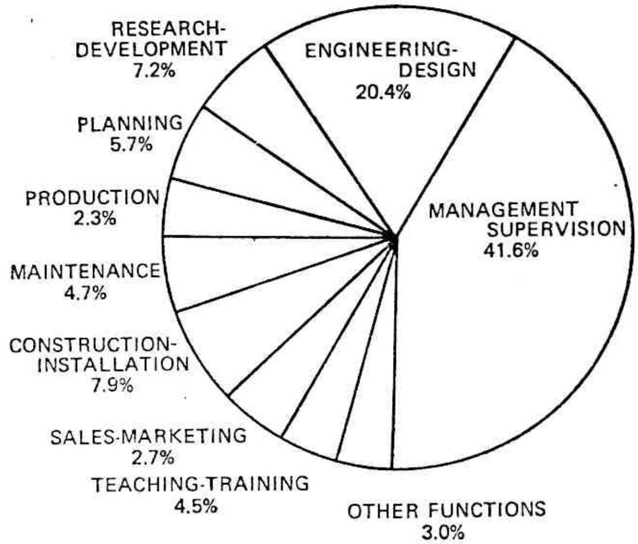
Professional Engineer : June 1974, pp8-10.

THE ENGINEERING PROFESSION

Engineering is the profession in which a knowledge of mathematical and natural sciences gained by study, experience, and practise is applied with judgement to develop ways to utilise, economically, the materials and forces of nature for the benefit of mankind.

- Definition adopted by the Engineers Council for Professional Development, U.S.A.

AREAS OF WORK



LEVELS OF RESPONSIBILITY.

Inspection of the pie diagram on areas of work will show that a significant proportion of engineers consider their major area of work as that of management.

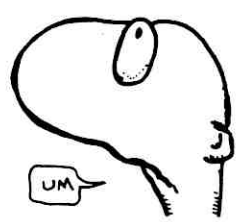
Most professional engineers can expect to have a component of management responsibility in their work. They may find themselves responsible for the supervision and direction of personnel whether this be from a large construction force down to a technician or draughtsman. They may find themselves responsible for the deployment of materials, plant and finance and the programming and organisation of work.

In order to manage properly, the professional engineer will need to develop the facility of logical thinking and acquire knowledge of the characteristics and capabilities of the men, machines and materials under his control.

The level of responsibility required of an engineer will depend on both ability and experience.

The pie diagram above indicates what different engineers considered to be their main area of work.

Although most engineers indicated that their time was spent on a number of tasks, the majority reported management (41.6%) as their main activity. The next largest groups of activities were design (20.4%), construction (7.9%) and research (7.2%).



WHAT CAN YOU HOPE TO ACHIEVE ?

ENGINEERING EDUCATION

Engineering education should encourage students to strive for the mastery of fundamentals, the discovery of the relatedness of things, and the cultivation of excellence. But all the while is should also be a creative experience, stimulating the imagination of students and helping them to prepare themselves for the unresolved contests and the new challenges of an imperfect world. It should encourage them to believe they can do the impossible from time to time, even if it means doing violence to precedent. It should ensure, through them, the continued advance and renewal of our society without sacrificing human values.

- Daniel V. DeSimone (1966)

OBJECTIVES OF THE PROFESSIONAL ENGINEERING EDUCATION

(a) **Integration of a broad background of basic** and engineering sciences into a meaningful **educational experience to develop the ability** to apply knowledge pertinent to a sub**stantial engineering discipline to the identification** and solution of practical eng**ineering problems within a branch of** engineering.

(b) **Development of a professional attitude** and an appreciation of the role of the engin**eering profession in society.**

(c) **The award of a qualification recognised** by the profession as fulfilling the academic **requirements of professional** practise.

GENERAL FEATURES OF ENGINEERING COURSES

BASIC SCIENCES. Fundamental and cumulative, with the objective of establishing an extens**ive knowledge of** natural phenomena including quantitative expression through analytical **mathematics.**

ENGINEERING SCIENCES. Built upon basic sciences, but carry knowledge further towards **applicability. Form** bridge between basic science and engineering situations from view**point of fundamental laws** and general principles of basic sciences, lead to statements and **methods of solution** for use in engineering analysis, synthesis and design.

MAJOR DISCIPLINE

Advanced Engineering. A group of subjects utilising the knowledge gained from the study of Basic and Engineering Sciences which, together, constitute a sequential and cumulative study of a substantial engineering discipline, embracing scientific and mathematical laws of the phenomena involved, advanced study of related materials and mechanisms, and their application, through the development of creative ability and synthetic approach to design, engineering construction, development manufacture and research.

Practice of Engineering. Includes laboratory and field work, workshop practice, drawing, design and research projects and work for external employers.

GENERAL STUDIES. Include material of a diverse nature, but it is unusual to find a wide coverage of such material in any one course. Topics cover some of the following: English expression, report writing, history, literature, arts, economics, government, sociology, psychology, industrial administration and management, finance, principles of accounting etc., ethics of the profession, social responsibility etc.

DEPTH. The advanced engineering subjects should reach such a level in one engineering discipline that the qualified engineer is able to read critically the literature on recent advances in the profession.

BREADTH. In basic and engineering sciences, subjects should not be limited to those having apparent specific relevance to the major discipline of the course but should include the basic principles of civil, mechanical and electrical engineering.

The major discipline should be supported by appropriate complimentary subjects, to form a coherent and substantial educational experience.

FURTHER INFORMATION ON THESE ASPECTS CAN BE FOUND IN SECTIONS II AND III OF THE HANDBOOK.

D. HOW TO STUDY FOR FIRST YEAR SUBJECTS

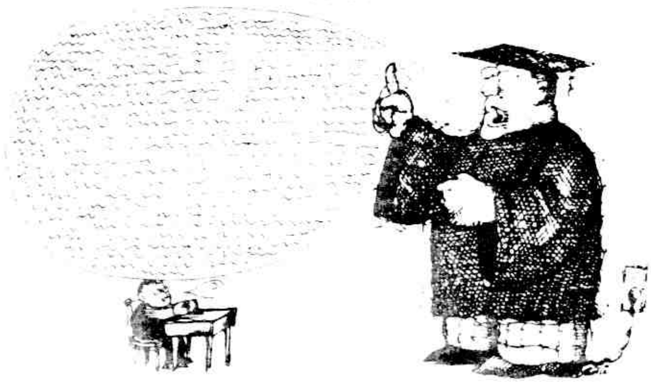
INTRODUCTION

There are many aspects of university life you will soon become involved in, and in most you'll find your own level pretty quickly. As engineering students, though, you'll soon be faced with the fact that the academic side of this course looms large on your happy horizons.

On the theory that you're going to appreciate any help you can get to handle this, we offer the following suggestions:

Most sad, but wise later year students have learned that the only way to attack this course successfully is by consistent effort. Don't let work get ahead of you. Start reviewing your work and notes almost immediately. The work mounts up quickly.

Practice on as many problems as you can as the work proceeds. This needn't take hours; as long as you can see what formulae etc. are involved, you've a good grasp of the work. Review your lecture notes while they're still fresh in your mind. If you can't pick up any good notes from your lecturer, at least note down headings of the topics he's covering. This will help when you've got to find notes from reference books.



It's bad practice to think that problems will sort themselves out as time passes....they generally don't. Front up to tutors with your problems, no matter how trivial they seem. You will usually get a helpful reception. If tutors aren't available, or you're having major difficulties with the course, the lecturers will always be prepared to help (you should realise, though, that most have a busy timetable - you may in some cases need to make an appointment).

Generally, first year engineering is a bit of a shock; a very crowded timetable with a lot of exercises, preparation etc. to be done outside of this. If you can work to a plan, that's worthwhile, otherwise make sure that you keep your work in proportion. Don't neglect one subject in favour of another because it soon mounts up... DISASTROUSLY.

If you know what's coming up, you can plan your work better, and maybe make a few short cuts - the following run-down may help.

STATICS: A good subject to take notes for; well organized and well-flowing. It's useful to read the relevant sections in the text (Beer & Johnston is probably the best). You will need to practice on a few sample problems, but once you grasp the basics you'll be able to answer most questions asked.

DYNAMICS: The basic material is simple, you've probably already done much of it in matric, and you'll do still more in the Mechanics section of the Physics course. However, it's easy to get confused by the type of problems which may be set.

ELECTRODYNAMICS: If you do Physics, this is largely a revision (from a slightly different angle), of the electricity and magnetism section. Save yourself time by getting a good grasp of the work when it comes up in Physics (if you do this, you'll also find electrodynamics more interesting).

Text books and references are almost impossible to relate to the course, so you'll need to try to pick up a good set of lecture notes. Again, go back to the Physics notes/text.

Attempt all problems set - they're largely the same as will come up in the exams. You'll need to know all the relevant formulae, and if you're not familiar with the concepts involved, you're not going to be able to work them out in that three hours in November.

DRAWING: If you're good at it, you'll like it, and breeze through. If you've no taste for it it will seem the most useless and confusing subject imaginable. Keep up with the exercises (you'll pick up a few marks you may need at the end of the year) and don't take shortcuts by following other students suggestions unless you really understand them; you'll just have to revise it all again, in a mad rush, at the end of year.

PHYSICS: If you like Physics, you'll love this course. It's packed with it! Most lecturers give good notes, which are most important for revision in this subject, as Resnick (text book) sometimes leaves out a few important bits. If you don't like the lecturer you're assigned to, shop around a bit until you find one who suits.

First term's work, on quantum theory, is repeated to some extent in third term. Get a good idea of what it's about, and a readable set of notes, and you'll be ahead in 3rd term, which you'll find a pretty hectic time.

Physics is a well organised course, and you can take advantage of this by organising yourself to take notes from the references as you go along. Thus you can make most use of the tutorials by asking about difficult points soon after they're covered in lectures (and you don't feel a fool when you can't answer tutors' questions on the previous week's work).

You need to be careful how you spend your time on practicals. It's worthwhile picking up as many marks as possible here, and even if the work you're doing isn't being immediately covered by the lectures, it will make them easier to follow later if you understand the principles in practice. There's a danger, however, of spending too much time in preparing for the pracs., at the expense of work or revision in other subjects. Keep it in proportion.

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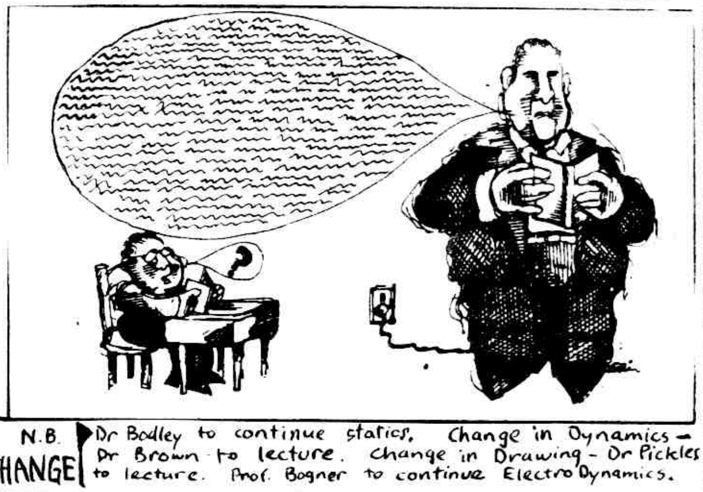
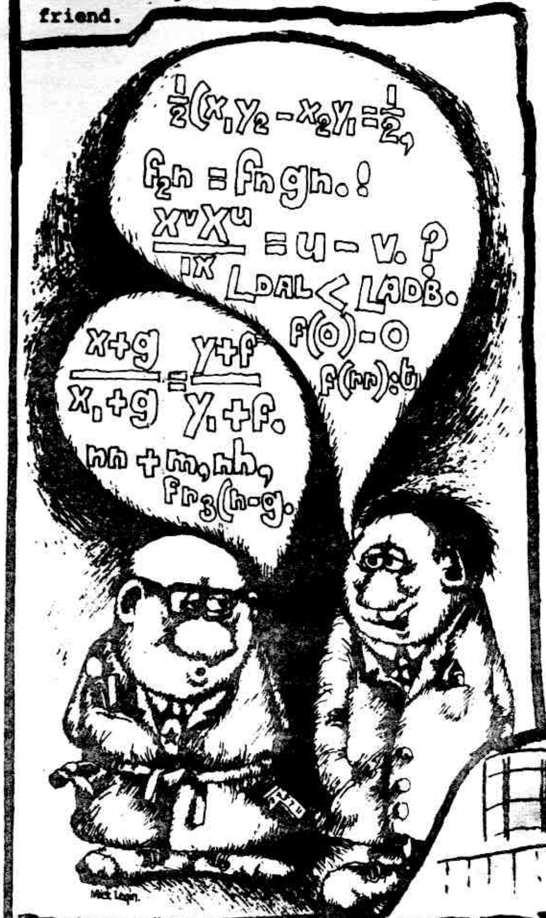


N.B. CHANGE Dr Bodley to continue statics. Change in Dynamics - Dr Brown to lecture. Change in Drawing - Dr Pickles to lecture. Prof. Bogner to continue Electro Dynamics.

MATHS: An awful lot of time is spent on theorems, proofs and highly theoretical work. A very Pure Maths approach.

Here you must really work consistently throughout the year. Much of the first term's work, especially in Algebra, involves concepts that come up throughout the year. You will save a lot if you become familiar with them as quickly and as well as possible. Some of these concepts are pretty obscure, but pester your tutors both during and outside of tutes until you know exactly what's intended.

It's tempting to gloss over some work, trusting you'll do well enough in other sections to see you through. This may work, but generally you are going to need every mark you can get, so don't overdo this. You'll need to attend the lectures. The textbooks don't treat the material in the same way, and the lecturers can often put across insights that won't come up in the notes of a friend.



If you've the time, check through the tute problems before the tutes and keep asking questions on troubling material, no matter how despairingly the tutors look at you.

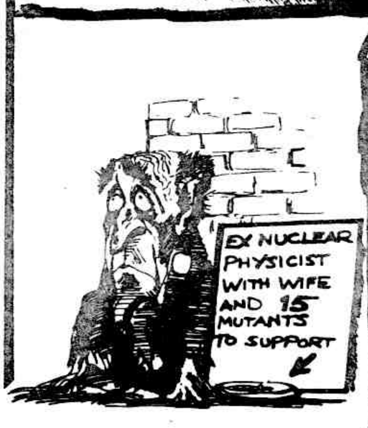
Again, shop around for good lecturers. It's not always wise to go with the crowd, however, the most popular lectures are also the noisiest.

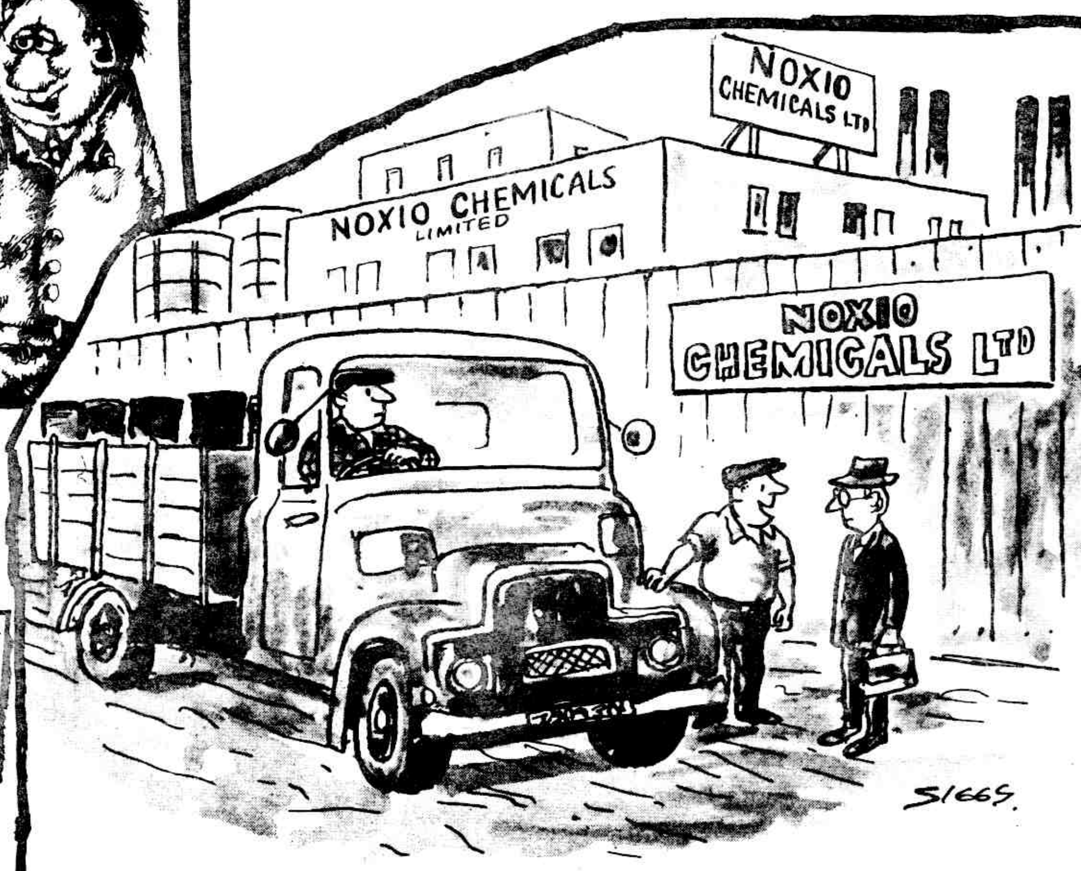
CHEMISTRY: If you choose this option, make sure you have a good feeling towards the subject. There's a lot of work covered in lectures and pracs. so you'll have to keep up your enthusiasm.

The prac. work can be awfully frustrating but rewarding when things do turn out right. The lectures are based on a series of booklets of written notes which are given throughout the year. Some lecturers follow them to the letter, others diverge widely from them. It's not enough just to rely on these notes to get you through, unless you do a lot of work in the library as well. You best need to attend all the lectures to find out what work is emphasized, what work may not be fully treated in the printed notes, and what can be omitted altogether. You may choose to take your own notes as well, although most lecturers don't lecture with that in mind, and you'll be rushing to keep up.

If time permits, preview the material before the lectures; at least make sure you're up-to-date by the time of your tutorial. This can be extremely valuable if you can use them properly.

First and second term can be passed by steady work, a lot of memory involved. Second term is usually found to be more difficult than first, a lot of calculations are involved, so the tutes are really valuable here. Third term, you really need an UNDERSTANDING of the work presented (and a memory for earlier work, as well). You will be rushed, so set down to it early.





"Go along with Charlie and show him which parts of the landscape they don't want polluted."

E. SUGGESTIONS ON THE FIRST YEAR COURSE

A copy of the following suggestions was sent to all staff teaching Engineering I in 1975 and 1976.

We emphasise that these suggestions relate to Engineering I as taught in 1975 and the lecturers for 1976 (there have been several changes) might well handle the subject differently.

Different members of staff have already been receptive to the suggestions and are eager to consider these in their efforts to provide what they believe students need. A meeting is planned (for February) to consider in detail the suggestions and there is every hope of a favourable response. (Of course teaching, like study, is a learning process.)

This should be born in mind when preparing for the year.

The editors.

SUGGESTIONS ON THE FIRST YEAR ENGINEERING COURSE.

Introduction

The following comments are our own opinions. We have based them on our own knowledge and experience of Engineering and on the results obtained from a questionnaire to 1975 first year students.

Julian Foley
Peter Jarrad

Dynamics

As the subject was taught in 1975, it was quite removed from the first-years' conception of what an Engineering subject should be like. In fact, the subjects Physics I and Mathematics I already cover much the same material.

We consider it appropriate for the topics to be covered in an engineering context and note that the subject as given in 1975 did go well beyond the mechanics section in Physics I.

To highlight the relevance of dynamics to all branches of Engineering, to maintain greater interest in dynamics as a subject and in Engineering as a course we make the following suggestions.

1. An introductory section, say 3-5 lectures, could give detailed descriptions of some real situations where dynamics is of paramount importance. For example, a description of the I. C. engine could be broadened into a study of the motor car. Such discussion need not confine itself merely to dynamics of the problem but should touch on those aspects which will help give a true perspective of the problem. All branches of engineering should be included if possible, with stress placed upon their inter-relationship. Descriptions could be given in such a way that later theory could be referred back.

2. We are of the opinion that the typical dynamics (mechanical) problems set for assessment purposes do not facilitate the understanding of dynamics, but with appropriate modification could be improved significantly.

The present method consists of numerical type problems and for final assessment, under examination conditions. There are a number of disadvantages arising from using only this type of method.
(a) The method requires a student to understand the concepts involved in order to formulate the questions in mathematical terms. If the student does not clearly understand the concepts, a number of things can happen.
(i) The student mixes up concepts and writes rubbish.
(ii) The student uses the wrong approach to solve a a particular problem. The problem may not be amenable to solution by that method, e.g. work-energy methods vs impulse-momentum methods. Under examination conditions, a student may realise this, only to find the time allotted to that question nearly gone. If he is an unusual student he'll calmly forget about it and try the next problem. If not, may become more than a little flustered which may substantially affect his thinking and effort on other problems.
(iii) The student may consistently but incorrectly apply principles in solving a problem. His answer may be 'reasonable' but incorrect.
(b) The problems tend to be of the hit or miss type. Many students will tend to get a problem either nearly all right or nearly all wrong. If the student is familiar with the problem he is likely to get it nearly all correct and in a short time. If not, it is possible for him to get most of it wrong and much time will be wasted in the process. The problems may fail to discriminate between students at the top. If a problem is set so that most students can answer it, there are likely to be a proportion of students getting it completely correct and discrimination is possible only by having a sufficiently large number of problems.
(c) Most problems involve many concepts e.g. gravity, friction, action of a spring etc. Under examination conditions with limited time, it is likely to be difficult to test all of the concepts taught in the most desirable way and this may result in low content validity and low reliability.
(d) Another difficulty that students face is the lack of experimental knowledge about the situations the problems relate to. Often problems involve several different concepts, one of which has a significant effect on the dynamics of the problem. Many, if not most students do not appreciate the effect that the dominant factor has on the dynamics, purely through lack of experience.
(e) The method does not facilitate the understanding of different concepts. The emphasis is on getting the problem out. The method will tend to find out what type of problem a student can or can not do and it may be difficult to infer exactly how much a student understands about particular principles.

cont.

There are a number of changes which might be made to improve the method and overcome some of the problems.

(a) Early problems in the course could require only a descriptive answer. Students could be given a particular situation and asked to describe or explain what happens, i.e. explain the effect of rotation, impact, friction, gravity etc. This would give a student practise in thinking and describing clearly exactly what happens before trying to write the mathematics.

(b) The question could then require the student to formulate forces or derive an equation etc. It might be suggested which method is most appropriate to solving the problem (and why).

(c) The problem could then require the evaluation of particular quantities etc. This part of the problem might have several parts of increasing difficulty.

(d) Finally the problem could require the student to comment on particular quantities etc.

Well designed problems would help reinforce familarity with lecture content rather than test memory of the content; would encourage more fruitful exchange at tutorials; and would indirectly act to effectively decrease the student's workload, by acting as a study guide.

3. Each alternate set of problems, say every second week, could be assessed with marks counting towards say, 10% of the total assessment. These problems could be relevant to current lecture material and solution sheets could be handed out at the appropriate time (as presently practised in the Statics section). To complement this, terminal examinations could be introduced. A significant percentage of first year respondants to the recent questionaire saw terminal examinations as most desirable.

4. Re-orientation of the time-table so that the Dynamics course can be taught for either half a year (2 lectures/week) or for two terms (1 lecture in 2nd term and 2 lectures in 3rd term/week). This would help eliminate confusion, reduce the term work-load and consequently enhance student appreciation of the subject.

Statics

We re-iterate the suggestions on the design of problems made in the dynamics section, but note that in certain sections of the course this may be inappropriate e.g. skill in truss analysis comes largely from practise via repetition of similar problems.

The current system of continuously set exercises is good, but these should form part of the actual assessment scheme, say 10%. Terminal examinations are even more applicable to this course which demands a degree of memory work with many topics covered.

The statics course could also be taught for half a year or two terms. This follows from the suggestion to teach Dynamics for half the year.

Drawing

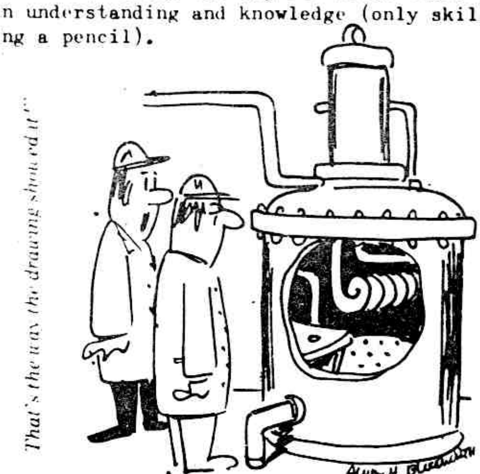
In general, the drawing exercises set seemed to be of inconsistent difficulty (with regard to length of time required). Some took only an hour, others took some students well over three (sometimes up to six) to complete satisfactorily. This is most frustrating and gives students a confusing idea of their abilities.

Arguably, the aim of the drawing in the 1st. year course is to help students aquire some skill at the manual art of drawing and sketching. Even more important is the development of the ability to visualize a final product and put it down on paper, read and interpret drawings and to recognise impossibilities and impracticalities in proposed designs. We consider that it is not necessary for engineering students to develop the proficiency and speed of professional draftsmen.

We consider it unwarrented to devote approximately 4 hours/week to drawing when barely 3 hours/week is given over to both statics and dynamics combined, which we understand all carry the same importance.

We make the following suggestions in relation to the Drawing section of Engineering I.

1. Drawings could be set which have been checked to take no more than 2 hours/week. Changes could also be introduced into the sort of tasks required of the student in order to further reduce needless, repetitive drawing. We do not wish to imply that drawing should be reduced to the extent that students develop little skill in the manual aspects of the subject. Students could be given a copy of incorrect drawings and asked to identify errors, explain why they are errors, correct them etc. They could be given drawings and asked to fill in tolerances, dimensions etc. These sheets could then be handed up for correcting etc. This could be a part of the total task set and could help test important sections of the course while eliminating some of the laborious drawing for which there is little gain in understanding and knowledge (only skill at wielding a pencil).



2. The number of drawings that are assessed could be reduced. A number of ways can be suggested. Students could be required to complete ever exercise but are given the assurance that the best, say 75% of the exercises will be counted towards the final assessment. Alternately, students could be given weekly exercises to complete but only 2 out of 3 or 1 out of 2 would be required for assessment purposes. These could then be assessed more carefully than at present. This would be similar to the practise in other subjects. It is likely of course that most students would not complete non-compulsory drawing exercises, but that indicates to us that students are allocating time to drawing that would be more profitably spent on other work. In both cases, it would be helpful if solution sheets were given out for all exercises so that students can check there own solutions. We think they should be encouraged to do this.

3. The weighting given to drawings completed through the year should be greater. We understand that last year only ~5 students did worse in the examination than in the class exercises. The given reason was that some students spent far too much time on the weekly exercises and had not developed the speed required for the exam. In as much as students are not required to become A1 draftsmen, we think that this is ample evidence for the reliability of the assessment of the weekly exercises and that it is possible to cater to student wishes. This was to substantially increase the weighting given to the weekly exercises. We suggest two possibilities; both which could be available. In one case, say 75% could be given to weekly exercises with 25% on the final exam and in the other case, 25% could be given to weekly exercises with 75% on the final exam. The weighting given to terminal work could be given greater preference towards the end of the year, e.g. 1st term - 15%. 2nd term - 25% and 3rd term - 35%.

4. If time spent on drawing exercises could be reduced to 2 hours, then the remaining time could be set aside so that students could ask the tutors present questions on statics/dynamics. We consider the idea of Mr Doble's of allocating a particular tutor to a group of students in the drawing office sessions to be of particular merit. We think this would help students take advantage of the extra time made available to ask questions on other subjects.

Tutorials

We understand and consider it unfortunate that tutorial assistance cannot be extended this year, as there was a strong response in favour of them. It is essential then, that tutorial time and assistance be made most effective and to this end we make the following suggestions.

1. Design of problems for tutorials could at best encourage investigation and discussion. Until now, tutorial time has largely been taken up with the mere writing of the mathematics of the solution on the blackboard. Here the major interaction can only be when a student has difficulty in following the mathematical steps. Tutorials of this form are made redundant when students can pick up solutions without attending (this is still very desirable). Perhaps tutors could be encouraged to discuss the major principles of several problems, rather than the mathematics of one or two. This might lead to a freer discussion of work covered in lectures, students' misunderstandings, and other problems with the work.

2. It seems pointless to make the tutorial system a further burden on an already over-loaded course. Judging by the decline in attendence over the last term, this is how it is being regarded. Only by ensuring their validity as a study-aid can they become valued by the students.

3. The system of General Engineering tutorials and lectures is excellent; well structured and encourages familarity among the group. One small point; the selection procedures for tutorials, practicals etc. seem to work only on an alphabetical basis, with the result that a student spends nearly all tutes and pracs with largely the same group (whose names all begin with the same letter). The Engineering Faculty might well encourage a broader circle of aquaintances by revising this system.

Workload

The course has a heavy workload, greater than other first year subjects, and contact time can hardly be reduced without loss of course content. It is vital then, to ensure that contact time is used efficiently and suggestions in previous sections are to this end.

Many students learn better outside of lectures and others find that other demands are made upon them to cut lectures, e.g. a practical report to be written up etc, and of course sickness etc. causes further absence from lectures. It is therefore vital that succint but comprehensive course outlines, supported by useful references be given out at the beginning of each lecture course.

Many students had particular difficulties with regard to text books and references. Many students found that they were not able to readily purchase copies of Beer and Johnston from the A.U. Book Shop and many recieved their text books only towards the end of the year. To make matters even more difficult, there were very few copies of either Meriam or Beer and Johnston in the Barr Smith Library and these were on 2 week loans. Consequently, there was a significant number of students without adequate reference. To help over come this problem perhaps special efforts could be made to get sufficient copies of these books on Reserve as well as Multiple-copy, in preference to on ordinary Undergraduate Loans.

The lecture is a convenient time to hand out further sheets of notes, problems etc., but it should be made clear to students that these can be collected freely (preferably from one designated spot) outside of lecture time. Problems for assessment should not rely on attendance at particular lectures for special hints to their solution. This also applies to hints for examinations too.

Conversely, there is a case for making tutorials compulsory. The General Engineering tutorials depend on particular students giving papers each week and require a good attendance for fruitful discussion. If properly organised (not as now, like a mini-lecture), the problem-solving tutorials too, could depend on the sharing of ideas among a large group.

The Introduction of New Students into the Faculty.

We would like to make one more suggestion to help orient new students into the Faculty.

In as much as some of the most interesting work done by departments is by research, we think it would be helpful if students could be shown over the laboratories, workshops etc. as soon as possible in the year, rather than later in the year. Perhaps an afternoon in orientation week (2-4p.m.) could be set aside for this.

Some discussion with post-grads. seems to indicate that most would be prepared to be available to explain to students what they are researching and possibly give a demonstration. Perhaps staff members (as many as can be available) could show a small group of students around the facilities, leaving most of the explanations up to the post-grads doing the research. ■

F. WOMEN IN ENGINEERING

The following is a copy of an article on the problems women face in studying architecture, printed in Architectural Design, Vol. XLV, 8/1975. There are a few women studying Engineering at Adelaide but we were unable to get anything of a more relevant nature. We think it is fairly applicable. (We are not really qualified to judge. - Eds.)

Discussing the problems faced by women architectural students, STEPHANIE WUENSCHE maintains that the question is how to inject more 'feminine' qualities into the profession and its educational system — such qualities being a preference for cooperation rather than hierarchy, discussion rather than argument; social awareness rather than aloofness.

The way in which women students view the situation of women in architecture is influenced by their experience of architectural education, how they as women are treated in colleges dominated in numbers by men. So women in architecture has two dimensions from the student viewpoint: present experience within the existing education system, and expectations of what future employment would or should involve. The first point to be made is that women find themselves to be a very small minority in architectural schools. In Britain, women are about 10% of the student total. In America, the figure is even lower. Female tutors are a similar small percentage of the total staff.

This reflects upon the gender role stereotyping present in secondary education: girls are often discouraged from studying subjects required to gain admission to an architectural college. Art and science frequently cannot be studied together because timetables conflict, and counselling services represent architecture as a male profession in which only exceptional women can succeed. One student remembers being shown a film by her counselling service meant to show children which professions were appropriate for which sex. Architecture was of course for boys.

The gender consciousness of counselling services is only one aspect of the role stereotyping of the sexes fundamental to our culture and economy. Our most basic institution and economic unit is the nuclear family in which the woman stays at home and does not work (housework is not considered work), and the man is employed outside the home. Man, as the source of income, is also the centre of family authority and chief decision-maker. This patriarchal structure underpins ever-widening spheres of decision-making from the corporation to the state. It would be surprising therefore if architectural education did not reflect the prevailing gender belief system. The fact that women are such a small minority in architectural schools makes them particularly vulnerable in this respect, more so than at universities with a near equal number of men and women.

Women students of architecture find that they are training in a system which expects traits typically considered male – competitiveness, keenness in problem solving, etc. and yet shows discomfiture if women participate on these terms. There is subtle pressure upon the woman student to remain feminine which means that, given the masculine rules of the game, she is forever learning in a different way. The sugar-coated pill is the temptation to cajole and charm one's way through school. Juries are the most obvious case in point. The 'dressing up for juries' syndrome is a well-known tactic. Combined with the 'poor little me' approach aimed at stirring protective male feelings it is supposedly an infallible way to survive any jury. Yet the results are self-defeating people think you can't take the criticism where you would actually benefit by it. The articulate and self-assertive woman, on the other hand, often finds her work over-criticised with no counterbalancing appreciation.

For many women the situation is one of 'knowing that one is female and can use it, and yet knowing enough to know that one shouldn't use it'. However, it is hard to escape the feminine role expected. Women who venture into the masculine sacred ground of a workshop are likely to find that tools are taken out of their hands and given back to them with a smile – after the task at hand has been completed by a competent male. Helpfulness is nice, but assistance in learning how to help oneself in carpentry and metal-work is nicer yet. Unfortunately, women are not taken seriously in workshops, nor in other matters predominantly technical. The experience of asking technical questions to a tutor who insists on answering, not to you, but to your male partner, is not an uncommon source of frustration.

Beyond the issue of whether women students manage or wish to assume the masculine role architectural education require, is the deeper issue of values underlying the educational system. Perhaps competitiveness is a waste of valuable creative energy. Perhaps the aggressive quality which juries teach of being able to persuade the client to accept what is best for him, as well as the patriarchal image of the omnipotent, impartial designer – perhaps these are all qualities unsuitable in socially responsive architecture. The question then is not how to make women students more masculine but rather how to inject more feminine qualities into the profession and its educational system: feminine qualities being a preference for cooperation rather than hierarchy, discussion rather than argument, and social awareness rather than aloofness.

Many women students express concern about their prospects in competing for employment and feel that being a woman will be a handicap. As one woman student put it, 'my greatest fear is that my ideas will be dismissed as 'a woman's viewpoint'. A growing number of women do not want to be professional if that means climbing the salary ladder in an hierarchal office.

The built environment is a positive reinforcement of sexual role stereotyping. If women architects were to deliberately design for a non-sexist environment, in the spatial arrangements of the home, the school, the office, then, in the future women in architecture and other professions would no longer be in a minority. Design policy is a positive contribution towards changing social policy. Traditionally feminism and professionalism have been diametrically opposed, based on the false philosophy of professional impartiality. But if design means involvement, then women cannot avoid the design implications of the issue which they know most intimately, the status of women in our society. Women students are beginning to draw connections between feminist theory and design practice, and in this way women in architecture will become a term no longer used to denote a curious minority but rather to describe a strong movement in design.

Section II LATER YEAR SUBJECTS

- The purpose of this section is to provide useful information on all later year subjects and to help make study easier by providing hints on the best way to cope with possible difficulties that might arise.
- This section is based on the response to questionnaires sent to both staff and students. In both cases the response was limited. Staff responses have been printed in full. The questions they answered have not been included as their comments are meaningful in themselves (and we didn't have room anyway). Student comments have been summarized.
- Because of staff movements it is possible for the student comments to be inapplicable; although where lecturers are known to have changed, comment on the relevant subjects has not been included. In all cases, the information will be most meaningful if considered along with all other information available on the particular subjects.

A. CHEMICAL ENGINEERING

SECOND YEAR

(Enjoyable year overall)

Student Comments

S CO2. Physical and Inorganic Chemistry II.

Suggestions: Some derivations of equations could be dropped. Some parts are irrelevant for Chemical Engineers.

Dr. Martin (Thermodynamics unit)
Very good lecturer.
Tutes are good, are part of assessment.
Continuous assessment very good.

NH12 Chemical Engineering II

Students are expected to understand how to use what is taught. Makes the course rewarding.

- Lecturing good.

Suggestions for change:
Notes would be more helpful if given out earlier.

Tips to students: (all subjects)
- Talk freely to lecturers,
- ask questions at lectures.
(the casual attitude in the department is good).

Professor R.W.F. Tait — Response to Staff Questionnaire

1 Chemical Engineering II (b)

Chemical Engineering Principles, Parts 2 and 3.

2. Equilibrium Stage Operations. A vital step in many chemical processes is the separation of components by transfer between two phases, e.g. the production of petrol from crude oil by separation of the more volatile from the less volatile components in a "fractionating" column. The intention of this part of the course is to give students an understanding of the basic principles of such separation operations by studying the simplest cases involving only two or three components and one or two degrees of freedom. Having achieved this understanding, the student may then proceed to more complex problems involving multi-component systems.

3. Introduction to Fuels and Energy. Western society cannot function without plentiful supplies of energy. It is the aim of this very brief course to introduce students to the problems involved in recovery and utilisation of fossil fuels. In the time available (9 lectures), no quantitative work can be undertaken. However, by the end of the course, the student should be able to see how other parts of the Chemical Engineering course (e.g. Chemical Engineering calculations, fluid mechanics, heat transfer, thermodynamics and kinetics) can be applied to help solve problems in fuel recovery and utilisation. He should also have some knowledge of the literature available on the subject.

2. In all the subjects which I teach, I emphasise the importance of a sound grasp of basic principles. This is the major contribution I hope to make to the education of engineers.

Laboratory work and tutorial problems are designed to make it clear that solution to a problem is not simply a matter of selecting the proper formula.

3. Assessment

Subject. Chemical Engineering II, part (b) Sections 2 and 3. The total weight of these sections is 20% of Chemical Engineering II. The weighting given in column 3 (below) is a percentage of this 20%.

Conditions	Nature of Method	Weighting	Skills, etc. taught
Part 2.			
Four or five times per term	Numerical problems (20-30 minutes each) done in class.	0 to 25%[1]	Understanding of basic principles of work just taught.
Written examination at end of term.	(a) Closed book (3/4 hour)	25%	Recall of salient facts; understanding of application of given facts.
	(b) Open book (1-1/2 hours)	25% to 50%	Understanding of basic principles.
Part 3.			
Written examination	Closed book (3/4 hour)	25%	Mainly recall of facts. One "essay" type question or about 20 short questions.

NOTE 1: If the student's mark in the class problems be better than his mark in examination problems, the former counts for 50% of his total problem mark. If it be worse, it is not counted, e.g. tutorial problem mark 18/25, exam mark 32/50 - total mark (18 + 32(2)/50 = 34/50, but tutorial mark 14/25, exam 32/50 - total = 32/50.

cont p. 16

CARL P. JEFFRESON - RESPONSE TO STAFF QUESTIONNAIRE

The following is in answer to your questions concerning the subjects listed below - Chem. Eng. I (Instrumentation), Chem. Eng. IIB (Elements of Process Control) and Chem. Eng. IIIB (Process Dynamics and Control).

1. **Objectives.**

An understanding of the principles of automatic process control which penetrates the mathematical manipulation level of appreciation and reaches an intuitive level so that the candidate may apply his knowledge to the control of operating plant with confidence. The subject is a technical one, taken in three stages: 2nd, 3rd and 4th year, the object being to develop a clear understanding by repeating some of the subject matter, each time at a more advanced level. Unlike courses at other institutions, a limited range of techniques are taught so that time is not spent on merely learning a multiplicity of algebraic manipulative skills.

2. Contribution.

Self confidence in applying apparently abstract concepts to the real world. An understanding of the subject which ensures that the knowledge will be used - not simply put aside.

3. Subjects: As above.

Conditions	Nature of Method	Weighting	Aims
Weekly tutorial - start in class, finish at home, hand back before next tutorial.	Numerical problem testing, understanding of lectures during same week.	About 6%	Reinforce lecture material and apply theory.
Laboratory work, 3 hr. session about every 2nd week with intervening time for writing of report when possible.	Full report with occasional "tutorial" (fill in spaces) type lab. report when experiment is ahead of lecture material	About 10%	Develop a "hands on" feel for the actual physical meaning of abstract concepts in lectures.
1st Terminal Exam and 2nd Terminal Exam.	Problem/Theory questions are "mixed up". Choice.	About 74%	Consolidate understanding prior to moving on to next stage. Feedback weaknesses.

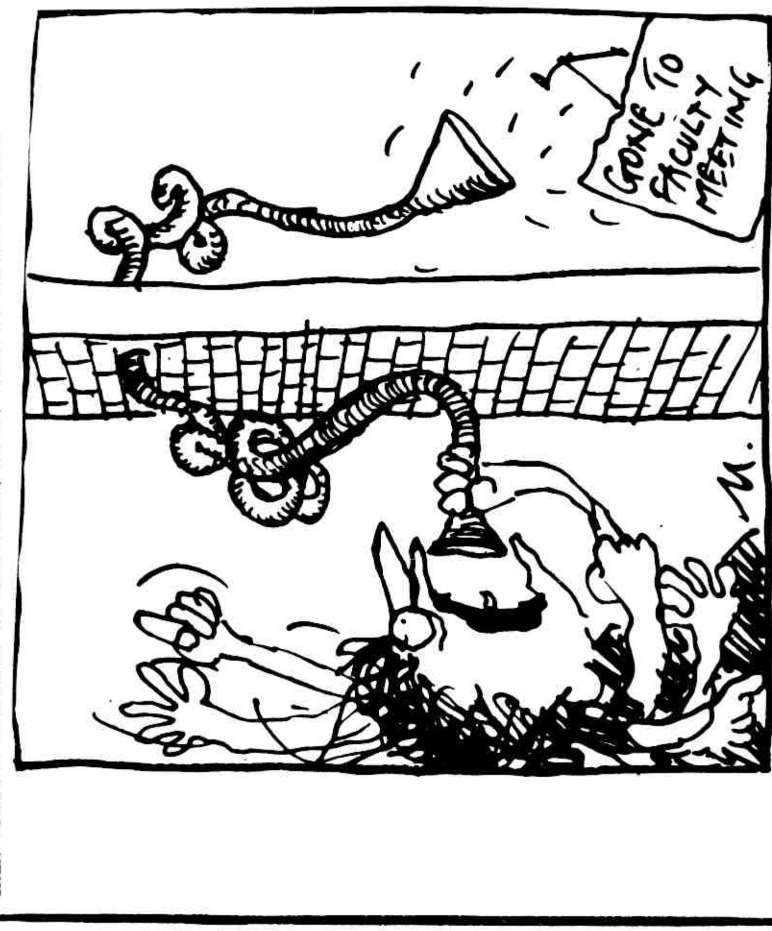
continued top p17

Prof Tait (from p 15)

(4) Redeemability.

Clearly there must be situations where a student has valid medical or compassionate reasons for failure to complete work before a set date. The right to redeemability in such cases is beyond question and I would be prepared to set an examination for such students at whatever time suited them, rather than at the "normal" time for supplementaries. However, where failure is due to laziness or lack of the academic ability needed to cope with the work of the course, I believe that the present Engineering Faculty rules are sufficiently generous - except with regard to 1st year students. In the case of 1st year students I would allow automatic "supplementaries" in all subjects provided it was clear that a student who failed to reach the required standard by the end of the supplementaries be "retired" from the course for at least one year.

(5) Most Australian (as distinct from Asian) students appear reluctant to ask for help even where they are clearly in difficulties. Probably I am also at fault for not pressing advice on a student where he does not seek it. My policy has always been to be as available as I possibly can for consultation about a student's work, although of recent years the pressure of Committee work has reduced my availability markedly. On the other hand, I seldom offer advice, other than written comments on lab. work, etc., when it is not sought.



I use problem classes and annual examinations as a method of assessing the effectiveness of my teaching, but this is of only secondary value to individual students. I would certainly welcome more interaction with students, but for naturally introverted members of staff, of whom there are many in the Engineering Faculty, it is just as difficult to approach students as it is for the latter to approach staff members. I am unable to suggest any ways of encourag-

(cont p 17)

Carl Jeffreson continued from p16

4. Opposed to unlimited redeemability especially when work is staged properly and assessed regularly during the year. In favour of more "redeemability" for those subjects (unlike present one) where all **assessment** is left until the end of the year.

5. Have always encouraged discussion of academic and other problems and have made use of suggestions to improve course, where possible.

THIRD YEAR

Student Comments

Course is rewarding. Some parts seem hard to begin with, but after reasoning and thinking become understandable so giving one a sense of achievement.

Tips to students:
- You'll have no trouble so long as you're prepared to work 40 hrs/week.
- If one has something to hand-in in a week's time, but it can be done in one night, do it on the first night, rather than the last.

Prof. Tait continued, from p16

ing staff-student interaction other than those I already use, viz. telling students in early lectures that I am willing to discuss any problems; always listening and helping as much as possible when approached; and taking part in social functions organised by student societies. Once again, because of the growth of "democracy" in the University the demands on senior staff members have become so great that they are unable to give the time they would like to what I, at any rate regard as our most important function - the teaching of undergraduates.

FOURTH YEAR

Prof Tait

Subject. **Chemical Engineering Seminar** (Part of IIIB and IVB).

This is not "taught" in the general sense. As part of the above subjects, each student during orientation week is given a topic on which he is to write an essay of about 4,000 - 5,000 words. 27 hours of "time-table" time are set aside for this purpose. The essays are of a non-technical or semi-technical (Scientific American) type. Quite frequently they are on matters of general interest at the moment (e.g. "Should students worry about assessment?"), or historical, philosophical, etc. The student is expected to write or type his essay on Fordigraph master sheets and a sufficient number of copies is made for all members of the two classes and staff. Each essay is read by several members of staff.

In second term, the essays are presented by their authors at seminars lasting about 45 minutes for each paper, of which about 20 minutes is presentation time and 25 minutes discussion. All staff who are not engaged on other University duties attend the seminars and students are assessed on presentation and the skill with which they answer questions.

This part of the course is a change from the purely Engineering and Science type subjects taught in the rest of the course. Most graduates comment on it favourably.

Assessment is on the basis of two-thirds for the essay and one-third for the seminar, and the essay plus seminar counts as 12% of the marks for IIIB or IVB.

Chemical Engineering IV A.

Part (a). Heat transfer, mass transfer, and simultaneous heat and mass transfer.

This part of the course builds on fundamentals established in Chemical Engineering II and III. The student is shown how to apply basic principles taught in those courses to the design of equipment for such operations as condensing and boiling; evaporation; gas absorption; humidification and de-humidification of gases; and the drying of solids. The lecture work is supported by problem solving classes and laboratory projects, as a result of which the student should be able to appreciate the problems involved in applying results from the literature to the design and operation of full scale equipment.

Subject. Chemical Engineering IVA, Part (a). (Total weight 50% or Chemical Engineering IV.)

Conditions.	Nature of Method	Weighting	Skills, etc. tested
Four or five times per term	Numerical problems (20 to 60 minutes each) done in class.	0 to 17%[1]	Understanding of basic principles of work just taught.
Written examination at end of 2nd term.	(a) Closed book (3 hours)	33%[2]	Mainly recall of facts and ability to derive fundamental formulae.
	(b) Open book (4 hours)	17% to 34%	Understanding of basic principles, including those taught in earlier parts of the course.
Throughout 1st and 2nd term	Laboratory work and reports thereon	33%	Ability to carry out standard experiments and to modify them to meet new problems. Considerable emphasis is placed on report writing and error analysis.

NOTE 1, See Note 1 to Chemical Engineering II. The time of 4 hours allowed is intended to reduce pressure as the problems set are identical in scope and content to those formerly set for a three hour examination.

NOTE 2. 8% of the mark in this subject is for a question on "Combustion" related to a course of 9 lectures given in the Mechanical Engineering Dept.

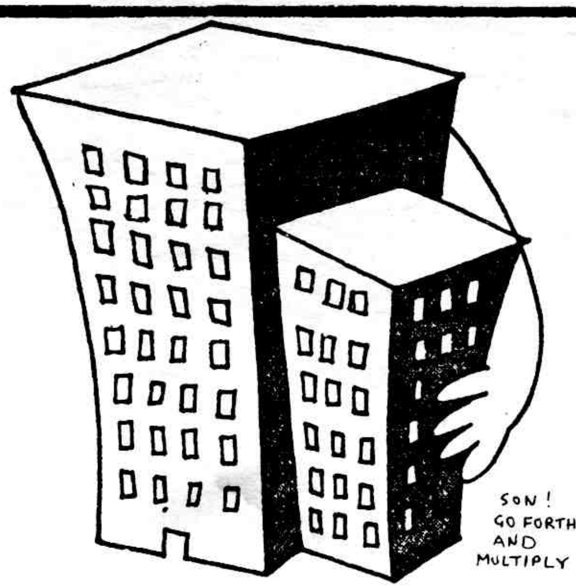
B. CIVIL ENGINEERING

Student Comments

SECOND YEAR

Tips to students:
- Keep up with the work. If you let it slip a bit, it will be hard to catch up.
- Just slog all year. You cannot revise in 3rd term only because there is just not enough time. STROP OR FAIL MISERABLY.

Suggestions for change:
- Introduction of terminal or mid-year exams would be helpful.
- Departments could help students try and find vacation employment.
- E.C. & M. and Electronics could be given a greater Civil Engineering emphasis.
- Could be greater emphasis on social aspects within the course.
- Introduce a General Engineering course, optional, possibly dealing with the development of engineering and covering different case studies with their peculiarities.
- Try and find texts using S.I. units.
- Reduce the work load.
- Practicals should be preceded by lectures on the relevant topic.
- Tutorials could be introduced into E.C. & M. and Electronics. (Perhaps every 4th or 5th lecture could be replaced by a tutorial).
- Some Stress Analysis Tutorials could be used for other subjects, e.g. Structural Analysis and Design.
- Some subjects with difficult graphics involved in the explanations might be improved by the use of good slides on an overhead projector.



NC02. Civil Engineering II (Second Year)

SURVEYING (Part of subject) D.A. Cummings.

Aims of the course are:

1. To develop an ability to think and design in three dimensions.
2. To illustrate methods of dimensioning and locating engineering structures.
3. To develop ability to do engineering calculations including methods of presentation and checking.
4. To emphasize the possibilities and difficulties of large scale accurate measurements.
5. To give some experience in engineering operations.

Time required:

Lecture, 1 hour/week for two terms.
Practical work in the field, 9 periods of 3 hours.
Computing, 8 periods of three hours.

(Information supplied seems to indicate the amount of work required for surveying has been reduced by about one-third. Detailed information on specifics will probably be supplied at the orientation lecture. - Ed.)

THIRD YEAR

Civil Engineering IIIB D.A. Cummings.

Soil Mechanics (part of subject)

Topics to be covered by lectures:

Origin of soils.
Textural classifications - laboratory tests.
Permeability - 1 dimensional water flows.
Unsaturated soils - measurement of suction.
Shear Tests - Direct and triaxial
  Active and passive wedge - Coulomb.
  Active and passive stress fields - Rankine.
  Passive wedge by friction circle.
Sheet piles - cantilever - Tied (Free earth support)
Consolidation.
Analysis of experimental results.
Finite difference calculations in 1-D.

Text and Reference Books:

Smith, G.N., Elements of Soil Mechanics.
Capper & Cassic, Mechanics of Engineering Soils.
Rosenack, S., Soil Mechanics.
Wu, T.H., Soil Mechanics.
Lambe & Whitman, Soil Mechanics.

Calender workload:

Lectures: 1 per/week for two terms
Practicals: 3 hrs/week for one term.

(Students are advised not to buy a text until after the course begins, i.e. orientation lecture: - Ed.)

Student Comments:

- Hydraulics very interesting.
- Interesting subjects depend on individual.
- Instrumentation; good course, good lecturing.

Tips to students:
- Start work on the first day and go through each day's lectures that night.
- Write up practicals and hand up as soon as possible after completion.
- Go and talk to and get to know the final years.

Suggestions for change:
- Could introduce terminal exams. Exam workload much too hard at the end of the year.
- Reduce workload.
- More tutorials in Theory of Machines could help.
- Some tutorials in 'Concrete' could be helpful to go through examples related to the lecture material).

- Worth wading through the first three years to experience final year.
- Interesting subject.
- Lighter lecture load.
- Individually encouraged.
- Vastly improved contact with lecturers.

FOURTH YEAR

Student Comments

NC14. Civil Engineering IVA - variety in material.

(a) Hydraulics: interesting approach.
(b) Soils mechanics: stimulating but very long. (Wonder what they are up to? - Ed)
(c) Surveying (1 term) and transport (2 terms); 1st term seems irrelevant. Transport is very good.

NC44. Civil Engineering IVB - the structures game.

(a) Plates, Shells and Columns: interesting; will help if you invent and solve some sample problems during the year.
(b) Finite elements, dynamic response of structures: very interesting.
(c) Moment distribution, sidesway, torsion: interesting, to follow the lectures better, re-read your notes prior to lecture.

NC34. Civil Engineering IVC

(a) Project: a valuable educational experience. Start reading up and doing lab. preparation where relevant, early in first term. Essential to have your report submitted before swot-vac. or else exam results could suffer.

(b) Seminar: (to learn how to appear confident when your knees shake). A very useful experience. The short talks are most helpful. (Helps empathise with nervous staff members - Ed.)

(c) Design: A novel and innovative approach is used. The group is given a design task and then splits into small groups, each of which is responsible for a specific area of design. This demands development of communication and technical skills as well as teamwork.

Suggestions for change:
- One tutorial per subject per term would be helpful or more exercises given out to cover the lecture courses. (Prof. Cheung's exercises are very helpful.)

C. ELECTRICAL ENGINEERING

Student Comments

SECOND YEAR

QN12. Applied Mathematics IIB. (See sub-section (E), Common Subjects).

SP02. Physics II.

Comments:
- Unless you really like physics, parts of the subject will be considered irrelevant, especially topics like quantum mechanics, thermodynamics.
- Assessment OK.
- Difficult to obtain a good understanding of tute questions, particularly at the start. Tutes are still useful.
- Of main interest is the practical use of methods from Maths course.

Hints for students:

- specified texts only fair. Better books around but these are not readily available. May help to hunt around for one that suits.
- Noting of lectures needs to be done carefully. May be best to take careful note of the headings and then look for good references to find supporting notes.

Suggestions for change:

- Answers to tutorials could be more detailed; sometimes difficult to follow.
- Parts of Physics II could be made optional for engineering students and replaced by an Electrical Engineering unit.
- Smaller tutorials would be helpful.

NE03. Electrical Engineering II. (This subject is the heaviest of the three)

Comments:
- Assessment was generally considered to be OK; some would have preferred terminal exams and prac. work to carry more weight.

(a) Networks. (Dr. Evans).

Tips to Students:

- Notes on blackboard sometimes difficult to follow. Be careful to note headings. It may help to seek further coverage from text-books.

(b) Electronics (Dr. B. Davis)

Comments:

- Very good course, good lecturing, a useful subject.
- Notes provided are good, no texts are really needed.

Suggestions for change:

- Problems to tutes could be given out prior to the tute being held; to give an opportunity to try problems and thus ask intelligent questions during tute.
- More problems related to the actual lecture material and also exam-type questions.
- solutions could be given out at the end of the tutes.

Electrical Engineering II - Networks Lectures *from Dr. C.R. Evans*

(1) The specific aims of the Networks lectures are

(a) to understand the methods of analysis of linear electrical networks
(b) to develop the ability to analyse the response of any linear network to any (except some aperiodic) source time dependence.

(2) Network analysis is a fundamental skill required for later subjects in the course and is often useful in professional practice.

(3) Assessment - Method not determined as at 3.1.76.

(4) The topic must be mastered before proceeding, thus poor performance must be redeemed (by repeating the course if need be).

(5) The failure rate in this subject is about 40%, which I attribute partly to students failure to seek help in the first term.

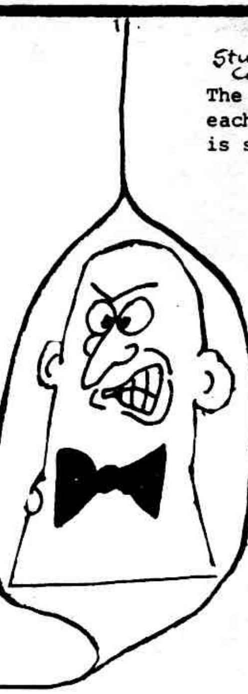
THIRD YEAR

Student Comments

NE13. Electrical Engineering III.

Comments:
- Most interesting and practical.
- Good lecturing.

Suggestions for change: (all the course).
- Any improvement whereby writing up of practicals can be done more during the practical than afterwards.
- Engineering IIE (Machine Design and Stress Analysis) could be geared more towards the students in the course.
- Could be more alternatives to either Pure Maths II or Statistics II.
- Students could be made more conscious of social implications during the course - perhaps optional visiting practising engineers occasionally.



FOURTH YEAR

Student Comments

The course is broken up into about 12 units which each have 1 or 2 lectures per week for 1 term. This is satisfactory.

Comments:
- Assessment of lecturers is irrelevant. Their purpose is to present certain material not TEACH it. The student must use his own mental facilities and research ingenuity to discover knowledge.

  In big wide world he/she can research and analyse a problem without having to be spoon fed or have someone change her/his nappy. If you can't pass B.E.(Elec) as it stands, you're not good enough to be an Engineer. (Just to show we're not biased - Ed.)
- Very interesting, bearable, dull, overpowering. All can be used to describe course at some stage or other. The first two describe most of the course.

Hints to students:
- Start 1st term project as soon as possible as the project report must be handed in before 1st term exams.

Dr. C.R. Evans

Response to Staff Questionnaire

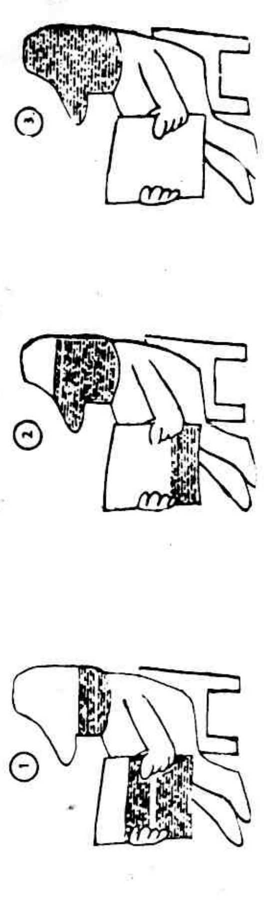
Electrical Engineering IVA - Antennas and Propagation Lectures

(1) The specific aims of the Antennas and Propagation lectures are

(a) to understand antenna parameters and their influence on a communication system
(b) to understand the influence of antenna geometry on antenna parameters for simple antennas
(c) to understand the principles of electromagnetic wave propagation in simple inhomogeneous media.

(2) The subject serves as an introduction to certain specialised electrical engineering devices.

(3) The subject is assessed by one or two of two questions at an annual exam. The questions are descriptive and/or numerical.



• Electrical Engineering IVC - Special Group Projects

Note: These "alternative" laboratory projects are available to self chosen groups by special arrangement in advance of the start of the term. (See Dr. Evans)

(1) The aim of the group project is to apply electrical engineering methods in order to design and develop to commercial standards a prototype of some desirable and saleable electrical product.

(2) The group project intends to simulate within the University the environment encountered in the design and development department of a business. It contributes to overall education by converting academic skills into commercially useful skills.

(3) Assessment: As for other IVC projects, except that care is taken to determine the individual contribution of each member of the group.

Electrical Engineering IVC - Lectures in the Commercial Aspects of Electronics

(1) The aims of lectures in the commercial aspects of electronics are

(a) to understand some fundamental concepts of commerce
(b) to appreciate that in an industry the engineer must contribute in some real way to the value added by the firm to its products.

(2) This should contribute to overall education by beginning to prepare the students to participate in a competitive commercial process which is just starting and which will result in the transfer of the electronics industry from its current foreign control to local ownership and control.

(3) Assessment: by one or two of two questions at an annual exam. The short answer questions examine understanding of concepts and of current events. ⌘

D. MECHANICAL ENGINEERING

<u>Professor R.E. Luxton</u> (Sam) <u>Response to Staff Questionnaire</u>

I will try to answer your questions one by one, but cannot guarantee that the answers will be exactly in the form that you request.

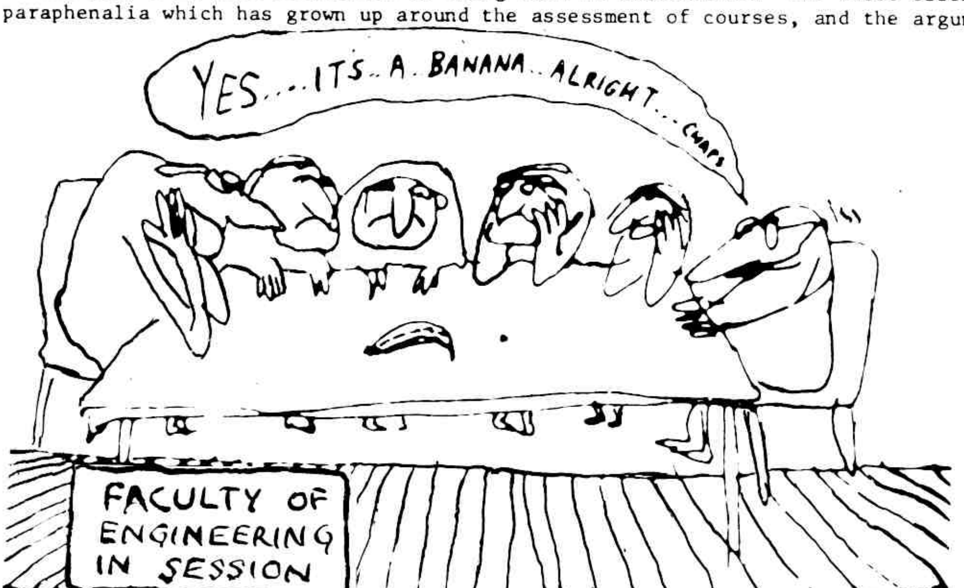
1. Your first question is what I hope the students will achieve as a result of taking the subject or part subject taught by me. Essentially the answer to this question is an understanding and appreciation (I use appreciation in its fullest sense) of the course. This means that I would hope that they would have gone beyond the minimum requirement to pass the examination. I say this in the realisation that the forgetting curve is just as important as the learning curve in the educational process. Forgetting curve depends not only on knowledge but also on understanding.

2. The second question relates to what I hope my specific subject means in relation to the overall education. I regard engineering as a way of thinking and not as a subject. Provided a student understands how to think in a logical and coherent fashion and to use the information available in forming conclusions to ill-defined problems, I would regard him as having reached a status which would allow him to be called an engineer. My own special subjects tend to be rather better specified than many other subjects in the engineering curriculum. Accordingly I tend to require students to read around the edges which are rather furrier than the strict discipline of fluid mechanics. Indeed if I may say in parenthesis that the reason why I regard turbulence as such a very good research medium, for the training of postgraduate students, is that turbulence is very furry around the edges, yet requires the rigid application of well-defined disciplines.

3. The third question relates to my method of assessing students. I have no intention of fitting into your over-rigid pattern. I regard the essential feature of any assessment procedure as assessment of a <u>student</u>, and not assessment of any piece of paper that student happens to submit. Indeed the pieces of paper submitted by a student are merely an indication of where the student requires remedial treatment. If a student can respond to such remedial treatment then I am prepared to say that he has satisfied the requirements of my course. Where he is unable to respond to this remedial treatment my reaction is to say that he has to mature for an extra year before attempting the course again. He has to solve tutorial problems set during the course to expose areas of weakness, and to encourage students to expose these areas for themselves. Terminal examinations are more related to the student's need to assess his standing in the subject on a more absolute plane than that provided by the weekly tutorial sheet. The end of year examination should be nothing more than a dotting of i's and crossing of t's and a stimulus to the student to look at the whole course as an entity rather than as a jumble of specific bits.

4. The fourth question relates to redemption. Redemption has an ecclesiastical ring about it and, whilst the universities originated in an ecclesiastical environment, I do not think that it is appropriate in this present age. If a student cannot satisfy me that he has understood a course on the way through the course and at the final examination, then I am prepared to say that he should repeat that course the following year, and that there should be absolutely no supplementary examinations other than those made necessary through medical or other unforeseen causes. (I might say at this stage that I regard the whole concept of supplementary examinations as an admission of defeat by the academic community in the assessment of students on the way through the course).

Students are inhibited in most respects from seeking help from anyone. The most common approach from students seems to be one given by an innate defence mechanism. They complain that their girl-friend has tossed them, that their mother asked them to sweep the path rather than do their assignment, that they went out to a party, that they cannot work in front of the television, that......rather than going to the real crux of the matter and saying "I want to learn!" You ask specifically whether I am prepared to encourage an interaction with students and whether I can suggest ways to promote such interaction. Yes, I can suggest many ways to promote such an interaction and yes, I am most interested in using such an interaction. The first essential is to remove most of the paraphenalia which has grown up around the assessment of courses, and the arguments on committees



about trivia, which occupies a far too high percentage of time in the academic community in the University of Adelaide. If only there was a situation where students and academics could trust other academics to get on with the job, we would be able to spend much more time in our real function of interacting with students and teaching. Perhaps I am being rather outspoken on this issue but I feel it is crucial to pursue further development along the above lines in the University of Adelaide. ♊

Dr. Gary Brown

Gary was interviewed for the handbook.

He admitted that he was kept very busy teaching both undergraduate and graduate courses and also personally supervising post graduate students (about 5-6). This was in addition to other departmental responsibilities and some consulting work.

He considered he was responsible to teach what he considered to be useful, and in that respect was interested in student discussion on the relevance of the material taught. Believes in student opinion (i.e. they are the buyers).

Considered that students should be directed to additional texts and references and believes that there is merit in setting class exercises every week and having them corrected.

Also believes there should be good laboratory work in conjunction with course work.

Is open to students who are having trouble with regard to particular problems (and in this respect it would be easiest to catch him at the end of a lecture). ⌑

SECOND YEAR

Interesting. Fairly heavy work load overall, especially maths subject.

Suggestions for change: (all the course)
- Terminal examinations would help relieve the workload at the end of the year.

QN12. Applied Mathematics IIB. (See sub-section (E) - Common Subjects).

NM02. Mechanical Engineering II.

(1) Theory of Machines

Tips to Students:
- Best approach is to note headings, taking down just the major points and following lecture, read relevant sections in text.
- See lecturer if any problems arise, don't leave them to build up.

Suggestions for change:
- More worked examples of problems on printed sheet could be helpful.

(2) Production Technology
- Gives a good picture of subject and is quite practical.
- Prac. sessions are good.

NX42. Engineering IIM. (See sub-section (E), Common Subjects).

THIRD YEAR

student Comments

- Need to read around the subjects. Different approach to second year.
- The course is very much what the individual makes it.

Suggestions for change:
- Students usually have developed special interests. These could be catered for by some options in the subject.

NM03. Mechanical Engineering IIIA.

(a) Thermodynamics

Comments:
- Can be an interesting and useful subject, depends on individual.

Tips for students:
- Rogers and Mayhew is invaluable.
- Wallace and Linning easy to read.
- Making friends with lecturers and p/g's helps a lot.

Suggestions for change:
- Amount of assessment OK, possibly weekly exercises could carry more weight.
- Blackboard sometimes difficult to read (press harder with chalk).

cont....

- Would help if some diagrams and explanations were given of real machines to help aid physical understanding.

(b) Fluid Mechanics

Comments:
- Well presented, well illustrated with practical problems, examples.
- Interesting.

Tips for students:
- Important to try the problems set.
- Concentrate on understanding the work and the problems.

Mechanical Engineering IIIB - Part 2. *J. H. Fowler*

Mechanical Systems Design.

1. This subject must be taught with two objectives:

   (a) To advance the students' knowledge of the characteristics of individual components found in machinery, and
   (b) To develop the students' ability to solve the problems associated with the design of machine assemblies.

The first objective is mainly met in lecture course work and to some extent within the drawing office tutorial sessions.

cont.... p23

J.H. Fowler cont. from p.22

The second objective can only be achieved within the structure of the drawing office tutorial sessions.

2. This subject interfaces with a previous and a following course and should contribute a stage of development for the mechanical engineering student. It should help to develop design ability without stifling individual creativity.

3. Assessment

Design tutorial exercises (Terms I and II)

About 14 - 3 hour sessions marked out of 10 marks. The worst 6 sessions performances are deleted.
Total Marks 80.

Final term design project (Term III)

This project occupies the final term and the student must present calculations and some drawings.
Total Marks 80.

Final Examination

The final examination tests the students' knowledge of the design and machine elements, i.e. is mainly concerned with the first objective.
Total Marks 100.

The marks are combined with a weighting indicated by the following formula.

The tutorial mark is reduced to a percentage and averaged with the examination percentage with weightings of one and two respectively.

cont...

4. I accept redeemability within the time scope of two consecutive years' work. I believe that there should be a reasonable time limit.

5. Some students seem to welcome the opportunity to discuss problems with the staff, others remain completely indifferent to any offers of staff assistance. So far as possible I have always adopted a reasonable "open-door" policy and beyond informing the students of this fact I feel that there is very little to be done. Perhaps if student leaders encouraged students to avail themselves of every opportunity for staff contact this problem might be resolved. ⌘

J.H. Fowler.

NM13. Mechanical Engineering IIIB

Mechanical System Design

Student Comments

Tips for students:
- Need to read around the subject.
- Note the heading etc. and important points in lecture and then do extra reading.

Faires is OK, gives a good coverage of most aspects. Solve problems by using the book rather than lecture notes. Helps to read through material prior to lecture.

Suggestions for change:
- Might help if synopses of course were given out early. Help student do preliminary reading prior to lecture.

NX-- Engineering IIIM. (See sub-section (E), Common Subjects)

FOURTH YEAR

Student Comments.
- Individual interests important.
- Parts of course are an extension of 3rd year.
- Have a good holiday at the end of 1st term and after the 2nd term exams. Work hard during the terms.

NM44. Mechanical Engineering IIIC.

Comments:
- Best subject in final year.
- Some choice is available to cater for interests.
- Most of the work is done in third term after the final exams (held during the second vacation).

Tips to students: (Design Project)
- Important to decide early on design project and work steadily, especially in third term. (Begin work as soon as possible after coming back from the 2nd term vacation).
- Choose an interesting project, helps when it comes to do all the work.
- See lecturer if there are any problems.

Tips to students: (Research Project)
- Begin laboratory work as soon as possible.
- Avoid procrastinating.
- Once started, the work doesn't seem so awesome.
- Talk to the post-grads, particularly those who are working in similar areas. Are very approachable and can give advice and help on how to go about things.
- Expect lots of things to crop up and hinder the work. That is normal. Pays to work around such problems.

Tips to students: (Seminars)
- Make sure that you research your topic well or choose one that you are very familiar with.
- Try and make it interesting for the people who are to hear it. It helps if the audience wants to hear what you have to say.
- If you feel nervous; that is to be expected. Good preparation is the best way to overcome this. (Then no reason to be nervous.)

NM85. Engineering Management

(a) Industrial Organisation and Management

Tips to students:
- Extra reading is required on top of the lectures. This helps understand the material.
- Helps to work steadily and not leave everything till the end of year.
- Helps to note the headings and important points in the lecture and use these as a guide to further reading.
- Printed material is often given out and this helps to supplement the lecture noted.

(b) Essentials of Accounting

Tips to students:
- Different approach. Need to learn how to note. Take down the topics covered and the important points made and use these as a guide to further reading.
- Some of the material given just "fills" in the background.
- Concentrate on understanding the tutorial problems given.
- Helps to work steadily and at least attempt the tutorial problems.
- Helps to go to most tutorials prepared. (Easier than trying to read it up in a book) ⌘

C. COMMON SUBJECTS

SECOND YEAR

Student Comments

QN12. Applied Mathematics IIB

Comments:

- Interest depends on mathematic inclination. Would help if there were more real engineering problems.
- Assessment is good.
- Text book approach is usually followed - makes everything fairly straightforward. Bookshop may be slow in getting the books in time.
- Tutorials good, fairly helpful. Good ratio of tutors to students.

Tips to students:

- Where lecturers provide good notes use these as a basis for study.
- Where notes are infrequent, jot down headings and the major points. Use these as a guide to what is required. Consult other text books. Don't buy texts without carefully considering how good they are. See the lecturers about which text books best cover different parts of the course.
- Concentrate on solving and understanding problems rather than building up a really good set of notes. If it is possible, it may help to adopt the 'engineers approach' of taking a classic text and trying to solve the problem from the book rather than from notes.

SECOND AND THIRD YEAR

ENGINEERING II and III.

- Comments varied considerably. Depends on personal interest.
- Some lectures provided good notes, others not.
- Most considered the courses could be geared more towards the students participating in the course.
- Tutorials would be helpful in most of the subjects.
- Terminal or mid-year assessment is to be preferred by some.

Section III POSTGRADUATE RESEARCH

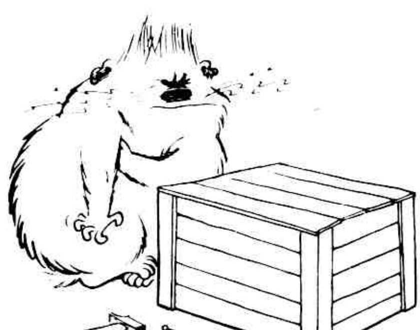
A. INTRODUCTION TO POSTGRADUATE STUDY

The purpose of this section is to

* provide undergraduates with information on the research that departments are doing and on the post-graduates undertaking the research.
* To provide information on post-graduate course work.
* To provide some comments which might be useful in helping ~~first~~ the-year students determine whether or not they would like to undertake post-graduate study.

In the different articles on their research, post-grads have commented on the different aspects of undertaking research. Students contemplating research should see the departmental Chairman and also some of the post-grads in that department.

In a nutshell, post-graduate study can be rewarding, enjoyable, frustrating, disappointing. It depends very much on the individual and the work undertaken. It depends on the nature of the project and the facilities required. It depends on which and how much course work is undertaken.



AND COURSE WORK

MASTER OF ENGINEERING SCIENCE COURSES in the FACULTY OF ENGINEERING, UNIVERSITY OF ADELAIDE, 1976.

The following courses which are being offered by the Faculty of Engineering for the Master of Engineering Science programme are also available for audit by members of the Institution and others. Individual course units may be attended, but will not be subsequently credited towards the Masters degree (intending students for the Masters must enrol as part time postgraduate students). Since these courses are at postgraduate level, it is advisable that students should have background to about graduate level in the topic or others related to it.

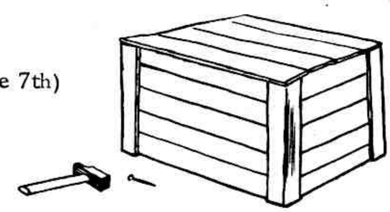
To obtain detailed information about the course offered, including dates and times when the lectures will be given, and course fees, please write or phone either the Departmental Secretary or the graduate course adviser of the appropriate department.

CIVIL ENGINEERING DEPARTMENT - (Graduate course adviser Mr. D.B. Crawley)

Courses offering:
(All 27 hours)

1st Term (begins week March 8th)

1. Geotechnical Engineering: (Dr. M. Arnold, Mr. D.A. Cumming).
2. Computer Analysis of Structures: (Dr. M.F. Yeo).
3. Prestressed Concrete Design: (Mr. D.B. Crawley, Dr. D.S. Brooks).
4. Coastal Zone Dynamics: (Mr. R. Culver, Mr. J.R. Ewers + others).

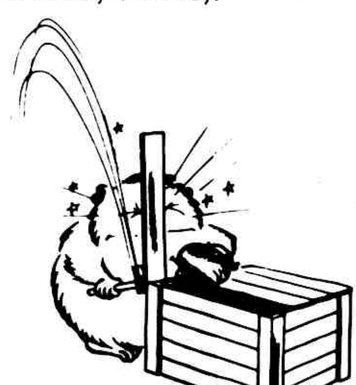


2nd Term (begins week June 7th)

1. Dynamics of Structures: (Dr. N.J. Gardner).
2. Finite Element Methods:- (elementary course) (Prof. Y.K. Cheung).
3. Water Resource Systems Pt. 1: (Mr. R. Culver, Mr. J.R. Ewers, Dr. W.E. Bodley + others).
4. Analysis of Transient Hydraulic Systems Pt. 1: (Mr. R. Culver, Mr. J.R. Ewers, Dr. W.E. Bodley + others).

3rd Term (begins week 30th August)

1. Theory of Plates and Shells: (Dr. S.G. Hutton).
2. Finite Element Method of Analysis - advanced (assumes basic knowledge of the method): (Prof. Y.K. Cheung).
3. Water Resource Systems Pt. 2: (Mr. R. Culver, Mr. J.R. Ewers, Dr. W.E. Bodley + others).
4. Analysis of Transient Hydraulic Systems Pt. 2: (Mr. R. Culver, Mr. J.R. Ewers, Dr.W.E. Bodley + others).



ELECTRICAL ENGINEERING DEPARTMENT - (Graduate course adviser Dr. B.R. Davis)

Courses offering:

1st Term (begins week March 8th)

1.	Computer Aided Circuit Design: (Dr. P.H. Cole)	(18 hours)
2.	Digital Systems (preliminary) (Dr. D.A. Pucknell)	(9 hours)
3.	Power System Dynamics (Part 1): (Dr. M.J. Gibbard, Dr. A.M. Parker).	(18 hours)
4.	Stochastic Processes in Communication Systems: (Dr. B.R. Davis)	(18 hours)

F. RESEARCH . . . AS I SEE IT by H L Horning

Research has for its object merely to glean that essential element in any situation which will be useful to the attainment of any given purpose. Research is largely a process of turning things upside down and sideways, looking at them on the inside and in the most unaccustomed ways.

RESEARCH DEFINED

I must accentuate how infinitesimal our knowledge is on any subject, how useless most knowledge is most of the time and how useful it sometimes may be. Research has for its object, not to corral all knowledge, but merely to glean that essential element in any situation which will be useful to the attainment of a given purpose.

Research is a system of reviewing all the facts on a subject for the purpose of separating the essential from the non-essential. It is the quest of the pertinent.

Psychologists tell us that the growth of thought has four steps:

(1) Gathering the facts
(2) Arranging them in some systematic order
(3) Analyzing the system of facts
(4) Applying the conclusions

If we are looking for an analytical definition of research, we need to go no further. Research is just straight, systematic thinking. We may clarify by saying that research is just common sense gone "high-brow".

While the four steps in the growth of a thought constitute the natural divisions in research, they also may conveniently be described as the four stumbling-blocks of research. By far the greatest amount of research is lost because too much is taken for granted in starting to gather the facts. Most men go about research ill prepared, which means that they do not use common sense. Thinking is the rarest and most difficult act of the human mind. When most men have a constructive thought, their faces light up and they become so excited and exhausted that they are unfit for thought for another year or so.
Habit usually makes a man approach a subject from the same old viewpoint and he thus loses perspective. The kind of facts needed, their careful selection and the range of facts to be considered require the finest intuition and intelligence. Often so little is known that every method must be tried. This is the Edison way and may be the only approach left. Try everything, observe results, then follow the clues.

Research is largely a process of turning things upside down and sideways, looking at them on the inside and in the most unaccustomed ways. The man who said that life is one grand illusion probably made plain the main reason why we need research at all. Research is not a system of study peculiar to engineering or science, but applies to the most common pursuits of life. In business it consists in taking an inventory every year to see what one has (that's getting the facts), what can be done with some articles (that's arranging the facts), what is worth keeping and what can be junked (that's analysis), and, then, when we act, we have completed the cycle; all the four steps have been observed. This is research in its commonest form.

VALUE OF INDIRECT RESULTS OF RESEARCH

In starting a research, certain ends always are in view. The direct results are the primary consideration, and that which justifies the appropriations of time and expenditure is the value of these. The most important factors, however, to which your attention is called are the indirect results, the collateral discoveries, influences or by-products. In a majority of cases they are of equal importance to, and in many cases of greater importance than, the primary objectives.

IMPEDIMENTS TO RESEARCH

Experience has taught that several peculiar things happen during every research project, and one will be sure to run into them. They are

(1) A general hesitation in getting under way. This is the period of gathering facts and corresponds to the homing pigeon's circular flights of orientation.

(2) The tendency to go off on a tangent or become interested in a by-product of the research. To keep the research train on the track is always difficult.

(3) The tendency to delay the finish. Bringing a research problem to a conclusion seems to be the most difficult part of the task, and the greatest value of research is lost at this time.

(4) The psychological collapse when the thing is done. Everyone loses interest in it and a great delay occurs in following through to the application of an idea.

(5) The skepticism of the practical man toward the results of a research.

(6) The usual difficulty in getting the market and the world in general to adopt the results of research.

All of these are mental-inertia phenomena of psychology.

SOME DISTINCTIONS AND TECHNIQUE

Some common misunderstanding exists as to what research is; for most research, as discussed in our magazines and trade papers - in fact, that which is proclaimed in the louder voices - is really industrial development. I like to make the distinction as follows:

(1) Pure research is the effort to ascertain facts regarding any subject, with no specific application in view and for the sake of the knowledge itself.

(2) Applied research is the effort to find the best way of meeting specific problems.

(3) Industrial development is an effort to apply the results of pure and applied research to a specific problem for useful gain.

While all research is interesting, such research as is now being carried on to learn why fish go in schools, the causes of their migrations and the influence of sun radiations on the fish food is, to my mind, the best example of pure research. Ascertaining how to take advantage of the results of the research for the purpose of making fishing safer in all weather is applied research. And learning how to keep the fish supply available for a greater number of months and utilizing supplies of less known fish to maintain the continuous supply is industrial development.

* Precis of a paper published in S.A.E. Journal, Vol. 32, 1933.

Competition drives most industries to try to understand their individual problems, and it has been found that companies which carry on research have great stability. Just to have a research department does not mean that a company will be stable, for this depends upon the quality of research, the guidance and the question whether the market will like the product.

Not many years ago a company in the automotive industry came to a dead center. The president became aware that something called "research" was sadly missing, and that was why competitive units in the industry were prospering. He ordered a proving ground and a laboratory. When plans for the laboratory equipment were presented to him for approval, he glanced at the amount of the appropriation, swept it aside with a grand gesture, and said, "Double it." His idea that doubling the laboratory equipment would double the value of the laboratory product is really one of the great misconceptions. I believe, after trying both ways, with little and with much equipment, that the value of the work done varies inversely with the value of the equipment. This should not be so, but it accentuates the fact that the mind is the thing and the apparatus just an accessory. American laboratories are overgrown. We Americans seem to lose sight of the problem in the maze of our equipment. It is a great delight to see many foreign laboratories and to observe the results they get from their meager apparatus. Results depend more upon mental equipment than they do on physical apparatus. Nothing is so rare as a man with a research mind.

BRAINS, THE FIRST ESSENTIAL

I cannot pass without emphasizing this characteristic called brains. Once we were helping a licensee to develop a lighting plant. The gasoline was contained in the base of the engine. When the tank was full, the engine worked well, because the lift was slight. When the tank was empty, the mixture was lean and the engine worked badly, or sometimes not at all. One of our engineers considered the problem. His mind went back to his days at the Massachusetts Institute of Technology and he wrote down a formula, studied it and said, "All you need is a tube 1¼ in. long, which you attach here and there, then the engine will never know whether the tank is full or empty." We tried it, and it worked. When we tried to patent the idea, we found that some of the best minds in the Society had missed the solution by two holes. As quickly as this all happened, it still was research, for that engineer went through the same processes of mind as if a year of research had been spent on it.

RESEARCH PROBLEMS CAN BE DIVIDED

Someone has said that you can't hurry a research any more than you can hatch the eggs ahead of time by using two hens. There is plenty of truth in that, but, if the problem is big enough, it seemingly can be split into units of conquest and each unit farmed out to one man, with management helping them all toward an end. You will find a lot of difference between men. Some seem just as intelligent to talk with as others, but, when you get them down to brass tacks in a research problem, you will find that one gets ten times as far in a given time as the rest. In the matter of intelligence you must rate them exponentially. One man may have a value of 10, another may seem 3 times as bright but really is 1000 times as bright; it's 10^3 for him.

During the World War we had trouble with the main bearings in the Liberty truck engine. Some German was throwing lead into the babbitt, and the bearings had bubbles. We could not determine this by inspection; bubbles showed up after the test was completed. Bearings had to be thrown away and others put in, which was a great loss. I put a man to work. He made a specific-gravity scale and, after testing about 100 bearings, we found that we had two piles. The sound ones in one pile were easy to distinguish after we had brought a great many together. Likewise, the bearings that had blow-holes could easily be distinguished after we had a great number to look at. After weighing the first 100, a tedius operation, we did not have to weigh any more. Our inspector won a hat and coat and a pair of shoes from the manufacturer, because he he picked 10 bearings out of 100 and every one showed up bad. I would point out that, in research, it is important to work your picture so that you have every factor brought to one point, for then you can distinguish the vital differences. That is the secret of all art.

Research, in its essence, is hunting. The first research man was a hunter who, instead of being discouraged because he found no game the first or the 20th time in going through a wood, stalked through in another way. A well-known rule in hunting is:

Do not look too intently for the object of the hunt. Let the eyes be at ease and rove carelessly and slowly and not too sharply over the woods. Thus you are much more likely to cover the ground more thoroughly and see your hiding game than by giving the attention to one object. Don't stare-browse!

This applies to the initial stage of research when facts are being gathered. The time to stare is when you have the facts.

In research a lot of time is lost by not anticipating requirements for equipment and not planning ahead and keeping equipment coming before the research worker needs it. Research can be scheduled; perhaps not as manufacturing is scheduled, but it may save just as much time. Research drags and drags because it is not planned. Some persons wonder how we get things done so quickly in our research laboratory. It is by planning ahead; by organization; by cooperation and foresight. Someone has brains. Someone has eyes. Others have ears. Others have the sense of touch and smell and together they get along rather fast.

I find that lack of faith in a certain piece of research slows it up more than anything else, except lack of planning.

COOPERATIVE RESEARCH IS PROFITABLE

Most research involves a narrow interest and the problem of only one individual. Some larger problems concern a company and others can be solved for an entire industry only by common research. Because the entire industry has a community of interest in the subject, it would be of little value if one company could solve the problem, and, even so, the combined brains and resources in ideas usually are required to solve some problems. Here it pays to get together; and, finally, for the benefit of all, it may be profitable for two or more industries or institutions to pool their resources for the solution of some very general and fundamental problem.

Many notable achievements have been accomplished in the last few years by the cooperation of entire industries on research problems of wide interest. Such mutual problems of the automotive and the petroleum industries, the solution of which would otherwise have been delayed for years, have been solved by consent and cooperation.

Finally, the more I learn about evolution, biology, psychology, business, industry and human affairs, the greater is my conviction that research is our most effective tool for refining the truth out of the chaos of ignorance, and therefore it should make life easier and happier. It is a creative process. Happiness is the reaction to a creative process in which we reproduce ourselves with variations in body or in some material or spiritual form.

Section IV

THE ENGINEERING DISCIPLINES

A. CHEMICAL ENGINEERING

What Chemical Engineering is:

A Chemical Engineer is defined as a professional man experienced in the design, construction and operation of works in which matter undergoes a change of state and composition.

He is then concerned with the reaction of chemicals, the control of the reaction, the addition or removal of energy and the subsequent separation of the mixture of chemicals which results. This is, of course, done by the laboratory chemist who, for example, distils a liquid from a mixture in a glass flask. The flask is filled from a glass beaker or glass measuring cylinder and is heated by a bunsen burner.

One of the major differences between a laboratory chemist and a Chemical Engineer is the emphasis that the Chemical Engineer must place on costs, the bases of which are studied in the subject "Industrial Economics". In the laboratory the chemist can use unlimited heat from a bunsen burner. In the plant, steam or other heating media must be effectively and economically employed. The Chemical Engineer learns about this and many other aspects of heat in the part of the course known as "Heat Transfer".

Distillation, as usually carried out in the laboratory, is a most inefficient and wasteful method, but the chemist is not really concerned with the way he distils, only the material he obtains. The Chemical Engineer must be concerned with all aspects of the cost of any chemicals he produces and must therefore separate them as cheaply as he can. The study of distillation, gas absorption and other operations enables him to design efficient plants to handle chemicals under all conditions. This study is known as "Mass Transfer".

"I'm glad you won't be needing the kiss of life!"

The way in which materials are handled on the plant must be considered. This is seldom of any real importance to the scientist but the Chemical Engineer must be well versed in all the various aspects of the handling of liquids, gases and solids.

The study of Heat Transfer, Mass Transfer and Materials Handling is the essence of Chemical Engineering. In addition to these, the Chemical Engineer must study, in "Reaction Kinetics", the problems associated with carrying out chemical reactions on a large scale. The behavior of large volumes of chemicals is not necessarily the same as the behaviour of small, laboratory scale quantities and this change of scale is more likely to lead to trouble than almost any other change of condition.

The rate at which the heat is applied in the distillation process, or the rate or quantity of liquid which is added to a vessel are controlled, on the plant, by instruments. The Chemical Engineer learns the way in which systems behave under control, and designs the instrumentation. He must decide whether the plant needs only a few instruments or should be fully automated. This is studied in "Automatic Process Control".

In the plant the Chemical Engineer rarely uses glass equipment. It is safer and cheaper to use a metal, but the right metal must be used if corrosion problems are to be avoided. The study of "Materials Science", which is an important part of the course, enables the Chemical Engineer to choose the right material for the job.

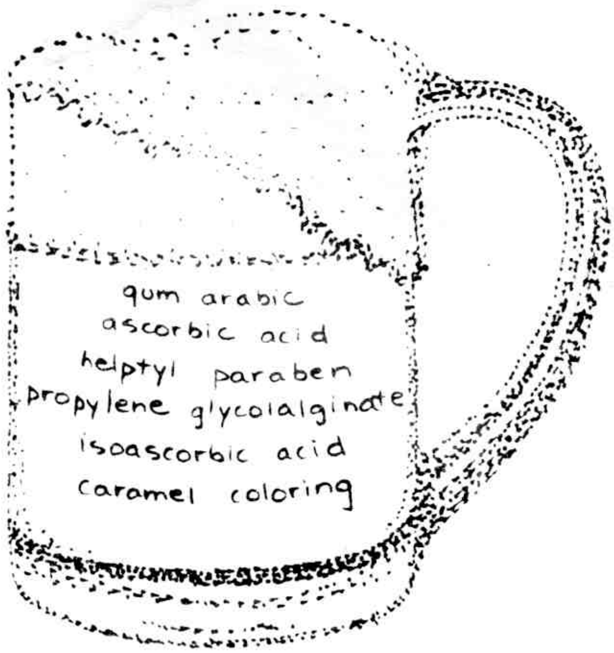
All these, which are studied in the later years of the course, must be based on the physics, mathematics, chemistry, and engineering subjects which are studied in the earlier years of the course.

The range of interests of the Chemical Engineer are as much physical as chemical. It is clear that Chemical Engineering is much more than just Chemistry and Mechanical Engineering mixed together, although the Chemical Engineer must know some Chemistry and some Engineering.

Where the Chemical Engineer works:

The Chemical Engineer has a bewilderingly large choice of industries which he may enter, and he is the key technical man in all of these:

Heavy Chemicals (e.g. Sulphuric Acid, Caustic Soda, Soda Ash).
Oil Refining, Petrochemicals and Town's Gas.
Plastics, Rubber, and Artificial Fibres.
Fertilizers, Insecticides and Pesticides.
Pharmaceuticals and Bio-chemicals.
Minerals Processing, Smelting and Metal Refining.
Glass and Paper.
Explosives.
Cement.
Soap and Detergents.
Beer and Foodstuffs, and many others besides.



In addition to the industries where chemicals are made, he may also go into industries which make plant and equipment for the chemical manufacturers. He may enter a firm which designs whole plants, or a firm which specializes in a few lines such as centrifuging, air conditioning, filtration and so on.

What the Chemical Engineer does:

A Chemical Engineer may be employed in three main ways:

Design Management Research.

but the border between these divisions is not rigid and the improvement of a working process may be tackled by a Chemical Engineer from any of the three. In other words the Chemical Engineer is versatile.

The task of the Chemical Engineer as a designer has been outlined above. He has to take the laboratory process which has been worked out for grams and must produce an economical, safe, easy-to-maintain and easy-to-maintain and easy-to-operate plant to produce tonnes of material at the right specification.

The task of the Chemical Engineer in management is to keep the finished plant running. He deals with all the problems that arise concerning not only the plant, but the men and the materials.

The task of the Chemical Engineer in research can generally be regarded as of two types. The first is in industry when he may be the man between the laboratory chemist and the designer.

IT'S PERFECT, REALLY. IT KILLS EVERY LIVING THING WITHIN 200 MILES WITHOUT OTHERWISE ALTERING THE ECOLOGICAL BALANCE.

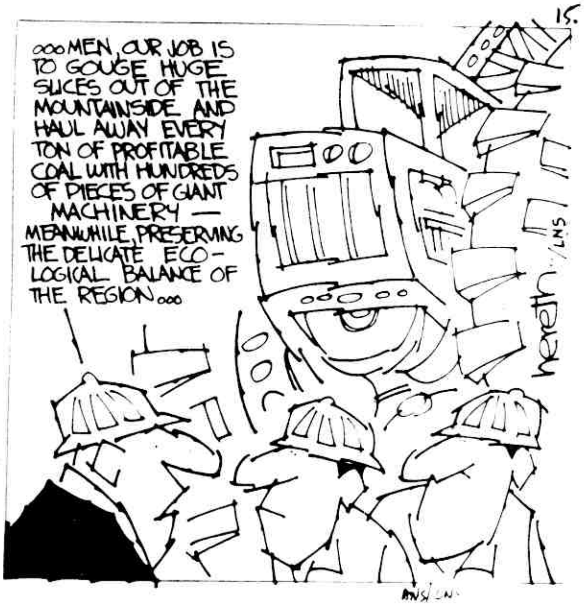
He is responsible for making sure that a process is possible and may be responsible for the design of an intermediate scale plant - the pilot plant. The second is more usually found in the Universities and in institutions such as C.S.I.R.O., A.M.D.L., and the Atomic Energy Research Establishment. It is aimed at improving the understanding of the principles used by Chemical Engineers so that better processes and better plants may be designed.

But whatever industry the Chemical Engineer enters, and whatever job he does in that industry, he will have a job which will never be repetitive, which will always be challenging and interesting, and which will be intellectually and financially rewarding.

Professor R.W.F. Tait.

B. CIVIL ENGINEERING

Civil Engineering is the name that was used for centuries to describe all peaceful activities of engineers, to distinguish them from Military Engineers. However, with the increasing specialisation in the last hundred years or so the name has acquired a more restricted meaning and the curriculum tends to be associated primarily with stress analysis, structural analysis and design, building and construction, hydraulics, soil mechanics and surveying. Fairly recently, with the rapid advancement of technology, courses such as transportation engineering, planning and management, environmental engineering, etc. has also been introduced.



Civil Engineers are now involved in the design and construction of buildings, waterworks, roads and bridges, dams and tunnels, pipelines, off-shore structures, etc. They are also involved in problems of water supply, sewerage and waste disposal, traffic studies. Because of their training in structural analysis and computer methods, many civil engineers are employed as stress analysts for aircraft and to a lesser degree ship structures, or as systems engineers in computer-aid-design activities. A number of more senior civil engineers will become managers of departments or firms.

The present teaching activities of the Civil Engineering Department of the University of Adelaide can be described under the following broad headings:

Solid Mechanics is concerned with the behaviour of solid bodies under the action of external and internal forces, the strength of solid bodies and their deformation. It provides a mathematical formulation of the laws that form the basis of all design work and supplies experimental methods to verify the correctness of the designed machines and structures.

Fluid Mechanics deals with the behaviour of fluids - gases and liquids. The Civil Engineer's interest in this discipline covers a very wide range from the behaviour of jets of water to coastal engineering, from the determination of the wind loading on buildings to the flow of water in channels, to mention a few of the topics.

Soil Mechanics investigates the properties of soils and other granular materials, the effect of water in the pores of soils, the design of foundations, and other similar problems. It also deals with such important problems as stability of slopes, earth and rock-filled dams, tunnels, etc. It is often called Geotechnical Engineering to include rock mechanics and earthmoving activities.

Structures encompass such widely divergent forms as multi-storey buildings, bridges and dams, such different materials as concrete, timber and steel. The theory of structures covers the design aspects, the dimensioning to ensure adequate safety under all static and dynamic loads. Economic construction of the structures designed demands that the Civil Engineer should be familiar with modern planning and scheduling methods and production techniques.

A special section of the structures course will deal with up-to-date computer methods such as matrix methods and finite element methods.

Surveying provides the basis of measurements and the accurate setting out of structures. It provides the necessary theory; it familiarizes the students with modern measuring instruments and it gives field experience in applying the theory and using the surveying instruments on practical problems.

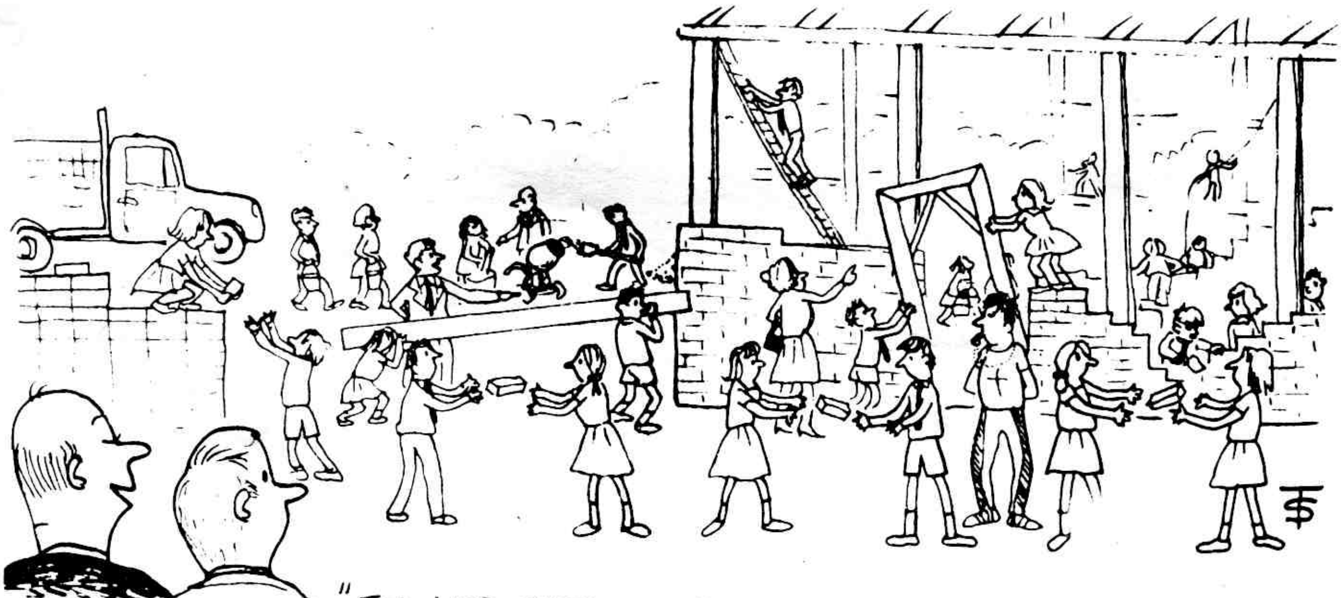
A course in Instrumentation is provided to explain the general principles and application of modern electronic instruments to Civil Engineering problems.

Transportation is primarily concerned with the movement of goods and people and all aspects of road, rail, air, water and pipeline transport. It encompasses the planning and design of port and airport facilities and the routing of railways. It deals with such problems as noise and vibration due to traffic, accident rates and safety measures.

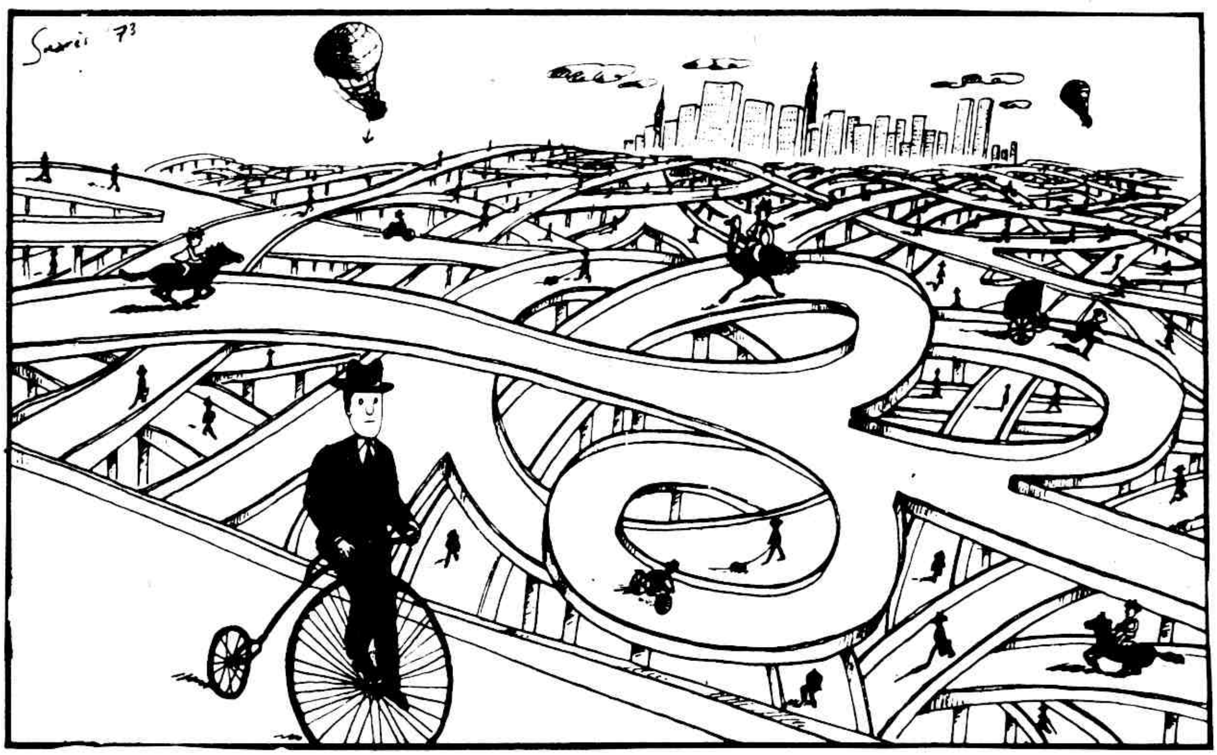
Thorough grounding in Mathematics and Physics is a prerequisite to the proper understanding of the theories expounded in connection with all the headings listed above. Courses provided by the other Engineering Departments on the properties of materials, introduction to Mechanical and Electrical Engineering ensure a correct appreciation of other disciplines that affect the work of the Civil Engineer.

Apart from teaching duties, members of the Department are acting as consultants and are carrying out fundamental research or investigations for Government Departments and for Industry.

Prof. Y. K. Cheung,
Civil Engineering,
University of Adelaide.



"IT *WAS* RATHER A BLOW TO FIND THE SCHOOL WASN'T READY, BUT NOW OUR 'GROUP WORK' AND 'COMMUNITY INVOLVEMENT' PROGRAMMES LOOK *MOST* IMPRESSIVE."

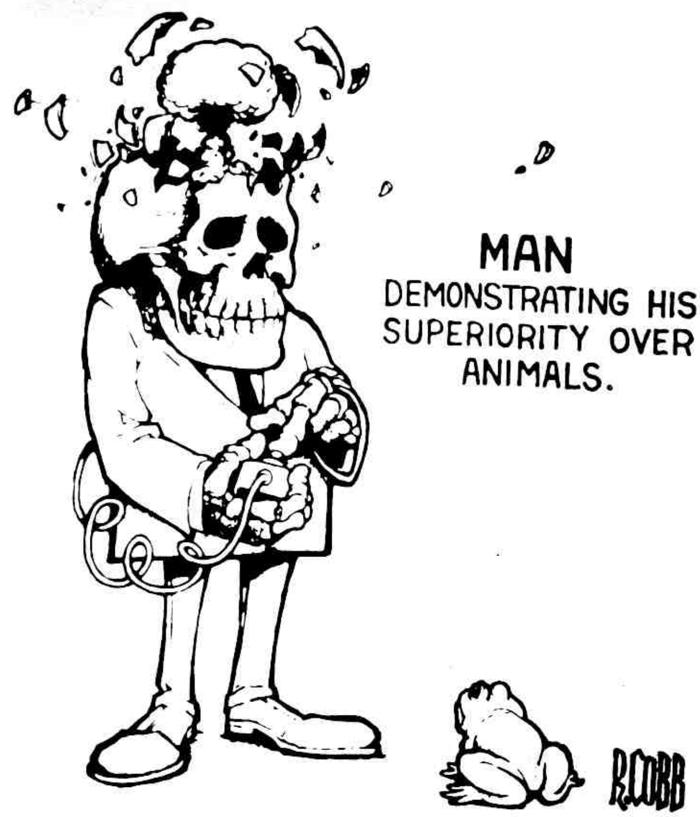


C. ELECTRICAL ENGINEERING

Electrical Engineering is characterised by the exploitation of the electrical properties of matter and space in order to satisfy society's needs for controllable energy sources, the production of goods and services, and rapid reliable communications. As the capabilities of electrical equipment and services increase, it is becoming more and more important to have a sound understanding of the criteria for determining what is required by society, and implications of technical decisions which can influence future development.

Historical development of electrical engineering from early last century led to subdivisions described as "power" (dealing with machines and electricity supply) and "light current" (dealing with telecommunication and measurement). Modern developments such as control, power electronics, and computers as system components have emphasized the common fundamentals of electrical engineering, and the modern graduate needs a sound understanding of many aspects.

Courses within the Department can be broadly described as follows:-



Electromagnetics: At other than the atomic level, most electrical phenomena can be satisfactorily explained by the classic equations postulated by Clerk Maxwell over one hundred years ago. Over long distances and at high frequancies, the transmission of electrical energy can only be satisfactorily explained by the exact solution of Maxwell's equations. Thus there is a common theoretical basis for the analysis and design of long-distance power transmission lines, hollow metal guides for microwave frequencies, optical transmission through air and through optical fibres, and radio antennas.

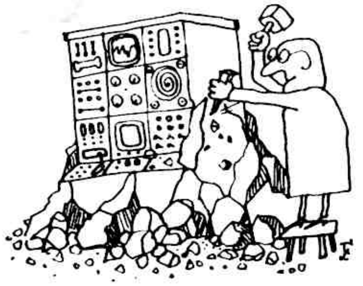
Electrical machines such as motors and generators also depend on the same fundamental principles, although the emphasis is usually different. For example, in such machines the time delays due to the finite velocity of propagation of electromagnetic phenomena may usually be ignored.

Electrical Machines and Energy Conversion: Energy is converted into electrical form for convenient transmission from the point of generation. Full advantage may then be taken of the flexibility of electrical devices at the point of utilisation. General methods of analysis have been developed for electromechanical energy converters, whether they be conventional motors and generators, or transducers such as the loudspeaker of an audio system.
The applications of high powered electronic devices and computers are making considerable improvements in the control, convenience and performance of electrical machines.

The advent of new materials and techniques is focussing attention on more direct energy-conversion processes and devices such as the fuel cell, magnetohydrodynamics, and the thermoelectric generator.

Network Analysis and Design: Where electric current is constrained to flow along well-defined paths whose dimensions are small by comparison with the wavelength of the electrical signal, simplified forms of Maxwell's equations lead to powerful general methods of analysis. These methods are used e.g. in the design of power distribution networks, frequency-selective filters for communication systems, wave-shaping circuits in radar, and tone controls and equalizers in audio equipment.

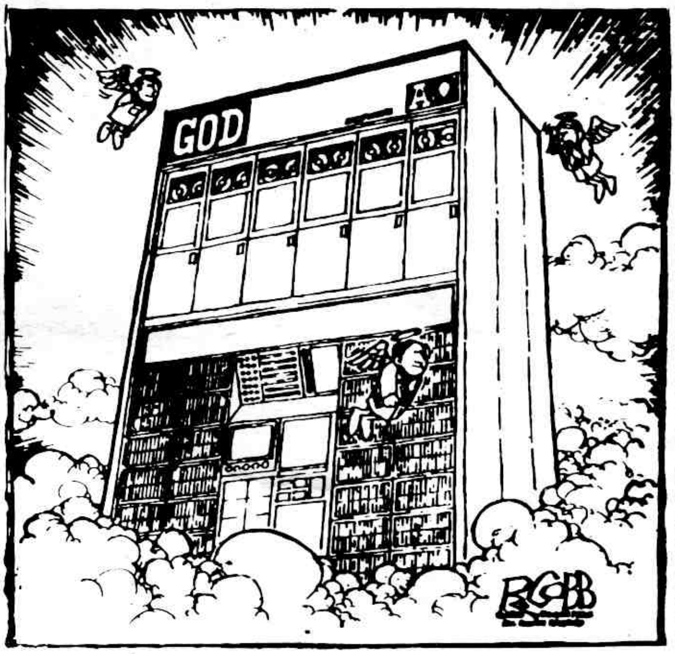
Computer methods have led to the use of extensive mathmatical developments for automated and computer aided circuit design.



Electronics: This is the field which deals with the applic- of physical principles to the control of the flow of electrons in devices. Examples are in cathode ray tubes, vacuum tubes, transistors, and integrated ciruits. Applications of such devices are found in almost every communication, data processing, control, transport, medical and entertainment situation.

Modern physics, electrical network theory, cultivated intuition and computer aided design are the major contributors to electronics. Electron devices handle signals with powers from 10^{-16} watts or less to millions of watts at speeds ranging from zero to beyond 10^{14} Hertz (in optical devices). Some devices individually occupy of the order of 10^{-15} m^3, and molecular electronics is now considered a possibility.

Control and Systems Engineering: Virtually any task that can be specified can be carried out by electronic systems. Computers have a major role, and are new considered as system components. A major concept in automatic control is that of feedback, in which a comparison is made automatically between a desired condition and the actual condition, the discrepancy being used to cause an improvement. Most feedback control systems incorporate electronic components and require electrical engineers for their design. Large systems, such as the telephone network, and electric power systems depend on electronic control via computers. Communication between men and machines comes within the area of systems engineering, and the interfaces frequently depend on electronic visual interaction.



Digital Circuits and Systems: T[illegible]eral-purpose digital computer is the most important pr[illegible] of electronic digital technology, but digital techniques [illegible]g applied increasingly wherever signals are to [illegible]processed. It is possible for example that in the future telep[illegible] voice signals will be converted to digital form for econom[illegible] error-free transmission.

Signal Processing, Communication T[illegible]ory and Information Theory: Telecommunication, includi[illegible] telephony, television, data transmission, telemetry, radar and sonar, involves processing of the signals before transmission, and after reception to ensure the required degree of freedom from interference and protection from errors. Information theory deals with fundamental limits to performance in such communication and gives valuable insights to a designer, and has led to understanding how to make use of the properties of the signals and needs of the recipients (e.g. characteristics of human vision) for efficient communication.

Other aspects of signal processing deal with analysis of signals such as speech, seismic vibrations, music, engine noises, and heartbeats to facilitate diagnosis and extraction of desired features from noise.

Electrical Properties of Materials: Modern solid-state physics has led to the development of new semi-conducting, magnetic, and dielectric materials which are responsible for many of the recent advances in electrical engineering. To apply these materials and devices based upon them most effectively, an appreciation of the underlying physics is essential.

Professor R.E. Bogner.

January, 1976.

D. MECHANICAL ENGINEERING

"Engineering is the professional art of applying science to the optimum conversion of the resources of nature to the benefit of man" (Encyclopaedia Britannica)

To this definition of engineering one must add a definition of the term *"professional"*. To use the words of a leading Adelaide based Mechanical Engineer, the adjective *"professional"* means *the timely exercise of a skilled conscience.*

The word *conscience* implies an involvement which is not only technical but also social. It is all very well to have a conscience about problems in society - for example, pollution - and to talk about these problems. But *engineering is more than talk!* The engineer must develop the skills, must develop a *skilled conscience*, to enable him to do something about the problems. And he must do that something at the right time. Thus, he must be able and ready to exercise his skilled conscience in a timely manner and at short notice if necessary.

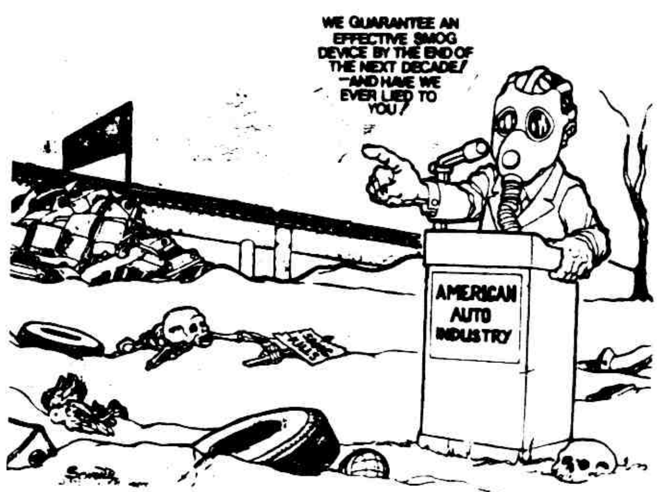
It is a rare problem indeed for which there is a complete understanding of the basic science. Thus the engineer must develop the art of breaking problems down into parts, the art of *approximating* those parts so that he can obtain *guidance* from known theory, the art of relating this theoretical guidance back to the real problem so that a solution can be *designed, implemented, tested* and *recorded.*

It will be apparent that I view engineering as a *method.* It is not simply technology. The *engineering method* can be applied to any problem, be it politics, religion or technology, in the same way as can the *scientific method.* Indeed it is a socially conscious extension of the scientific method.

I have said nothing so far about Mechanical Engineering specifically. Indeed there is little need to say anything other than that the aim of the Mechanical Engineering course is to develop in students an intuitive understanding of the engineering method. A graduate with such an understanding (and there is a vast gulf between knowledge and understanding) is not constrained to being "a contriver and maker of engines" (Oxford English Dictionary). He (or she, and there have been quite a large number of women graduates in Mechanical Engineering from Australian Universities) can turn his hand to any problem within the range of disciplines covered by an Engineering Faculty.

He can be an effective planner, or manager, or even politician. (Perhaps our country would break its tradition of limiting its vision to the next ballot box if we had more engineers in government). But to be specific about Mechanical Engineering, as the majority of the community demands such specificity, the professional Mechanical Engineer deals with the conversion of energy or motion from one form to another, the optimisation of such conversions, the minimisation of socially and economically undesirable consequences of such conversions. He is concerned with the behaviour of materials both solid and fluid, with manufacturing processes, with waste products from these processes, with noise, with people, with their needs and concerns. He must be a jack of all trades and have the ability and application to become a master in each and every one of them as the occasion arises. His education never ends. At the University it is just beginning and throughout his life he must continue to develop *"the professional art of applying science to the optimum conversion of the resources of nature to the benefit of man".*

Prof. R.E. Luxton



Section V PERSPECTIVES ON ENGINEERING AND TECHNOLOGY

A. DISCIPLESHIP : AN ALTERNATIVE WAY OF LIVING

DISCIPLESHIP TODAY

The following article is the first of a series of four talks by Dr. Athol Gill, Dean of Whitley College, broadcast on the A.B.C. (second and third networks) on the 21st, 22nd, 24th and 25th July, 1975.

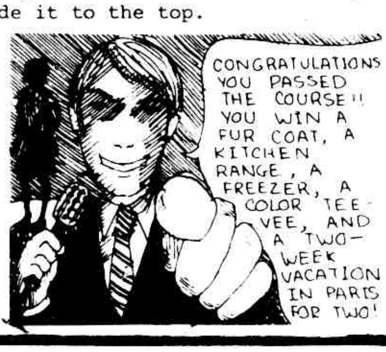
1. Discipleship: An Alternative Way of Living

The political intrigue, the dirt in high places, which has characterized the western political scene over the last decades has served to convince many people that realistic development through the normal channels of democratic machinery is an impossibility, that the old liberal notion of peaceful and progressive change based on the continuing reform of the existing social structures is a myth, totally divorced from the realities of the present world situation.

During the late 1960s many western students set out to achieve their goals of establishing a new world order by operating outside the mainstream of society, by developing an "alternative way of living" which would stand in opposition to the basic tenets of the modern technocracy.

They rightly saw that modern technocratic society rests upon three basic pillars: (1) the vital needs of man are purely technical in character. (If a problem does not admit of a technical solution it is not a real problem at all, it is only a figment of the imagination.) (2) The prerequisites of human fulfilment have been all but satisfied. (If there is social friction it is only due to a breakdown in communication. All we need to do is sit down and reason together and all will be well.) (3) The experts who have fathomed our heart's desires and who alone can continue providing for our needs, the experts who really know what they are talking about are all on the payroll of the state or large corporation. (Theodore Roszak)

They saw that life in the technocratic society is essentially a mad quest for material possessions. Children go to school and study for long hours in a competitive school system in order to gain entrance to University. After three or four years of seemingly meaningless grind they are ready to be released on the outside world and to continue the ambitious climb up the ladder of success where the consumer society has convinced everyone that the marks of status are large houses, expensive cars and beautiful women which, according to the Playboy view of sex, are always available for the suave young executive who have made it to the top.



The students of the sixties were protesting against "the plastic society". They were opposing the disintegration of the social fabric by corruption, hypocrisy and war. They were raising their voices against hard-core povert and distorted priorities, against uncontrolled technology and the destruction of the environment, against the decline of democracy and personal liberty, against the artificiality of work and culture, against the absence of community and the loss of selfhood which is so characteristic of modern society.

They wanted to develop a new society in which personal values would be exalted above all other things, where the emphasis would be on persons rather than on things. A society in which there would be a greater reliance on feeling, emotion and imagination than on the arid intellectualism of dehumanized materialism. A new society in which there would be true community, true relationships, true openness and honesty. A society in which there would be co-operation rather than competition.

In their enthusiasm they set out to develop new communities which would live in harmony with one another and the environment, communities which would reject the exploitation of men and resources, an exploitation which they believed to be characteristic of the modern technological system.

Unfortunately, the counter culture movement has failed. There are still some who are attempting to live an "alternative life", but the movement itself has come to an end. The university campuses of the world are quiet again. Not able to beat the system, the majority of university students have decided to join it and to reap whatever transitory benefits it might offer.

One of the positive side effects of the counter culture movement is to be seen in the fact that it prompted many younger Christians in Australia to ask whether it might not really be the case that in the life and teaching of Jesus there is a real basis for an alternative way of life, that despite all of its contemporary ecclesiastical trimmings Christianity was intended as an alternative way of living.

This new quest for a radical discipleship, as it has been called, is not just a pale reflection of a secular movement that has long since disappeared. It is not just a revival of old-style religion in a new dress. It is not just a resurgence of the left wing attack on the establishment. Rather, it represents a significant coming together of a number of contemporary theological trends and offers a new way through the polarizations that have characterized Australian Christianity over the last decades.

Radical discipleship is a serious attempt to come to grips with the realities of the present world situation and with the teaching of the Bible. It is of the opinion that the Bible, correctly interpreted, has many significant things to say in the contemporary situation. It incorporates the most recent results of Gospel study from the established theological schools of Europe alongside the exciting insights of the emerging Third World theologians, adapting both to the Australian situation. It embraces the evangelistic zeal of conservative churchmen alongside the social and political concern of their radical brethren, but above all else it is seeking to develop meaning patterns of discipleship for twentieth century Christians.

The starting point for radical discipleship is Jesus of Nazareth, the life and death of the man for others. The central feature of his teaching was that in his words and works the kingly reign of God had begun to break into human history.

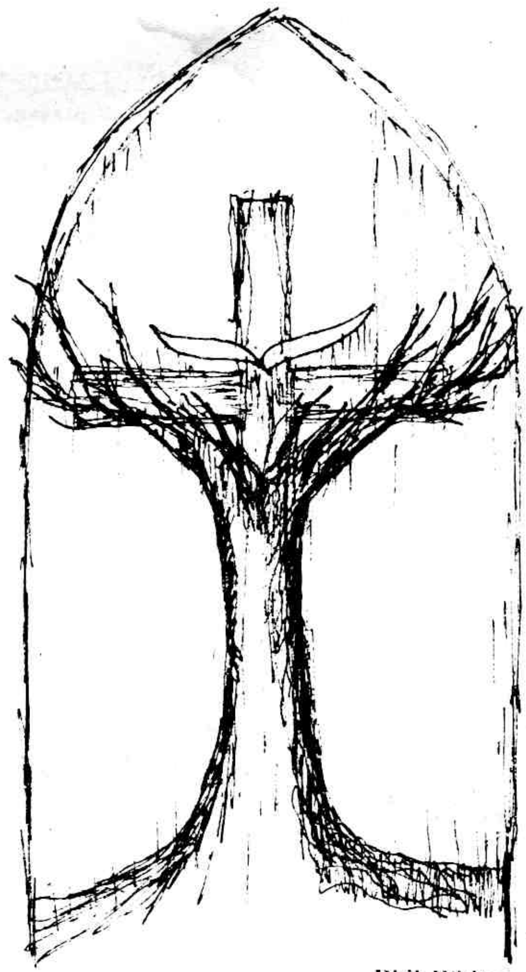
The kingdom of God, which for the Old Testament was but a vision of the future, the reign of grace, the time of joy for the down-trodden, the sinners and the outcasts, the era of the good news for the poor, the time of table-fellowship for the little people of society, had begun to dawn in the life and teaching, the parables and miracles, the death and resurrection of Jesus of Nazareth.

On the basis of what he believed to be the decisive and definitive intervention of God in human history, Jesus called for a radical reorientation of life. According to his preaching, nothing less than "repentance and faith" would suffice.

"Repentance", in the preaching of Jesus, is not just a "change of mind", it is not just "feeling sorry for your sin", it is "changing your way of living". "God's definitive revelation demands final and unconditional decision on man's part. It demands a radical conversion, a transformation of nature, a definite turning from evil, a resolute turning to God in total obedience. ...It affects the whole man, first and basically the centre of personal life, then logically his conduct at all times and in all situations; his thoughts, words and acts." (Behm)

"Faith", in Biblical terms, is not to be confused with "mental assent to a doctrine or creed" or with "faithfulness to a dying cause" or with "irrational credulity" It is the life of "believing obedience", the surrender of man's whole personality to God. It is the life lived as a result of the radical reorientation of life to God; it is the attitude of genuine obedience made possible by God's gracious action in Christ and so stands in marked contrast to those who think that they are masters of their own affairs.

The life of repentance and continuing faith is set forth in the gospels as the life of discipleship. The unconditional response to the unconditional demand "Follow me!" both made possible by the supreme act of "costly grace" (Bonhoeffer). This new relationship to God in Jesus must find concrete expression in new re-



Phil White

lationships with other people and in a new relationship with the earth.

The daily living out of the life of discipleship is the basis for a dynamic new life-style, a life-style which stands in stark contrast to the materialism and depersonalization of the present world order.

B. DEVELOPMENT: PEOPLE-BUILDING vs NATION-BUILDING*

WHEN FARLIE WINSON came across the border in the north of Niger in 1973, he and his family were traveling on a forged passport. He was a man with a record on three continents and the West African country was just about the end of the line for Farlie, his wife Enid, and their three small children.

Today he is a citizen of the country, carries a real passport issued by the government of Niger, and is considered by leaders of that country as an ambassador-at-large.

What made the dramatic difference? Two things. First, out on the desert one night Winson had an encounter with Jesus Christ which radically changed his life. He became a new person. In the words of St. Paul, "Old things passed away; all things became new."

Second, his agricultural background helped him see food-producing possibilities in the famine-stricken country that could conceivably make it self-sufficient in food. For a country which is considered an international basket case by the United Nations, that would be some achievement!

It all started simply enough. Winson was introduced by World Vision staffer Bernard Barron to Oumarou Youssoufou, a young Nigerian leader and advisor to the president. Youssoufou, educated in a mission school, was a "brother." He helped the new believer find a job as supervisor of a peanut-seed producing program. A fertile valley near the Niger River had been chosen for the project, and European engineers had designed an irrigation plan to pump water over a range of hills to the location. It would be expensive, but worth it for the export potential of the peanuts.

Winson spent two weeks going over the area carefully on foot and by Land Rover. He discovered that the lay of the land along the river was such that, by digging a canal eighteen miles long, he could irrigate tens of thousands of acres by gravity flow—not only for peanut production, but also for precious grain of which the drought-prone country never had enough.

Niger embraces about 490,000 square miles of West African desert and scrub land. Two-thirds of the area is pure Sahara sand; the other third is largely Sahel. Just over four million people try to scratch out what even in the best of times could be called only a bare existence.

Rainfall in normal years will total from four to twenty inches. The summer heat goes to 120 degrees for months on end. It is ironic that one of the best rivers in Africa, the Niger, flows through the country for some 500 miles, yet is little used. After the rains come, the volume of the flowing Niger River can be compared to its sister, the Nile, but there is no way to conserve it as it rushes to the sea.

Winson's proposal to Youssoufou was delightfully simple. Why not use the abundant Niger River flatlands, enriched with centuries of alluvial soil, to grow food for the rest of the country? His survey had already proven the feasibility of inexpensive gravity-flow irrigation. Between Niamey, the capital, and Gaya, near the southern border, there are over sixty thousand acres of treeless land awaiting cultivation.

Providentially, in the country at that time was Charles Williams, vice president of Lilly Endowment, Inc., an Indianapolis-based philanthropy created and supported by the family which founded the pharmaceutical house of Eli Lilly and Company. The Lilly Endowment has given away millions of dollars to charitable and development programs in the U.S.A. and abroad.

Youssoufou took the idea to Williams who studied it and secured from the Endowment a grant of $250,000 to buy equipment and put the first 1,100 acres under cultivation. World Vision International was asked to manage the project.

The first crop of corn, which produced abundantly without fertilizer in the rich soil, was within days of harvesting when the river, fed by heavy rains at its headwaters in Mali, overflowed for the first time in years. Although the fields were flooded, the crop was not lost because villagers, spurred by the memories of the recent hungry days, used canoes to harvest the fermenting corn.

But the floods were only a temporary setback. They could be controlled with simple dikes along the river. The important thing was that Winson's projections had been right. The land was rich. Water would make it produce. A year-round supply of the precious liquid was available in the river, and up-river canals could put it on the land without expensive pumping.

The project has exciting potential. At least two crops a year—conceivably three—can be grown on this fertile river lowland. The lands are remarkably flat and need no stump-removing or rock-clearing. If all the river lowlands within Niger were brought into production, it is estimated they would provide 50 percent of the grain requirements of the nation.

Williams is now looking for multinational partners to help fund stage two. The Niger government has given strong endorsement to the project. International funding bodies have expressed an interest in the cultivation of the entire lowland region when stage two—which is simply an expansion of the original 1,100 acres up to 12,000 acres—is completed.

Winson, who had no degrees but lots of practical savvy, is a hero in the country.

The project also has some important spin-offs. As the land is brought under cultivation, it will be turned over to the farmers in twelve-acre plots for continued agriculture production. New villages will have to be created in order to have enough people to work the land. Village resettlement, while respecting the rights of tribes who own land along the river, could bring better health, decrease infant mortality, improve the living standard, and bring an era of development to the lives of thousands of Niger's marginal rural families.

Health clinics and safe water supplies will be a priority in the settling of new villages. These can be done at a level which does not destroy tribal customs and traditions, for no one wants to Westernize the concept.

New industries will be generated, but not on a Western scale. They would be simple industries like carpentry, bricklaying, and well-digging to meet local needs. New schools and other community services would be required.

To cultivate his land, each farmer would probably step up to animal traction—using animals to help him plow in place of the short-handled hoe he presently uses. This would generate more simple industries—blacksmithing, plowmaking, welding, leathercraft.

The artisans for all these basic trades will be trained at a vocational school on the site of the Tara Valley project. This, too, is a long-held dream of Youssoufou who saw a perfect opportunity to wed the two projects. What better place to train tradesmen than in the place where their newly learned skills could be utilized in building communities?

The final ingredient in this development mix is the formation of marketing cooperatives to help each farmer dispose of the surplus he produces on his plot. The plan is for the government of Niger to buy the grain from the cooperatives and to arrange for its distribution and sale in the nonproducing areas of the country.

* Chap. 10 'What do you say to a hungry world?' by W. Stanley Mooneyham
Word Books (Publ.)

One Step Beyond

The Tara Valley project is, from beginning to end, one of the most exciting examples of total development I have seen anywhere in the world. I begin this chapter with it because it demonstrates some points which need to be made about this little understood, but critically important, subject of development.

First, development is a necessary step beyond relief. Most relief programs begin with emergency needs. The emergencies may be created by natural or man-made causes, but relief is an after-the-fact response. For example, if a river overflows every year, it would be patently stupid to mount a relief campaign annually for the victims. It would be better for all concerned to use some of the relief money to dike the river in order to prevent the floods next year. That is development.

Relief in poor countries must inevitably lead to development, for causes must be dealt with while the symptoms are being treated.

Second, development must start with people where they are. Too frequently the process starts with where the developer—usually an expert from a Western nation—thinks the people ought to be. For instance, an outsider in Niger might first of all think about producing crops for export instead of helping plan for crops for local consumption.

Then, too, it is very hard for a Westerner who is accustomed to the finest in machinery and technology to bring himself down to the level of the short-handled hoe which must be developed into animal traction. This erroneous reading of where people actually are on the economic and social ladder may be the cause of failure for more development projects than any other single factor.

To succeed in building people, development programs must also recognize economic realities. Again, the Western expert usually has available to him huge sums—relatively speaking—for feasibility studies, pilot projects, etc. Before the project is even begun, it is already far beyond the local economic standards. This is not to say that money is not needed—and sometimes a lot of it—but a project is almost certainly doomed to failure when measured by its impact on people if money is substituted for local input and initiative.

Which brings me to the next thing about the Tara Valley project. The one thing Youssoufou has insisted on—rightly—is that his own country must be recognized as the controlling element in the project. Decisions are not the unilateral prerogative of any outsiders connected with the project—the decision-making process is a partnership with the Nigerian voices carrying at least as much weight as those of the expatriates.

There must be strong indigenous involvement if development is to be maximally effective. Youssoufou got slightly heated when he said to me, "Why should foreigners think they know more about our country than we do? Our people have lived here for centuries. Why should outsiders think they can ignore us when discussions are held regarding our future?"

Development must aim at meeting total human need. Development is not just one thing. It is a balanced combination of many elements. In Niger, it would not be enough simply to irrigate the land. Or provide vocational training. These are only part of a total development package that embraces education, medicine, agricultural methods, pure drinking water, land reform and vocational training.

The problems contributing to underdevelopment must be attacked on a broad front. The ultimate goal of development must be the enrichment of the total man—mentally, morally, economically, physically and spiritually.

In a word, its objective is to produce self-reliance. Tragically, the present world systems are not designed to meet that objective. The income gap is widening, and for hundreds of millions of people self-reliance is only an impossible dream. Yet we dare not settle for less. The international basket cases must be made to walk again. No one wants to carry them forever. To the countries themselves, international charity is degrading, demeaning, dehumanizing.

The only answer to putting them on their feet and making them self-reliant is the right kind of development. Because it is so essential to global wholeness, we can no longer leave development to the so-called experts. Development, like the correcting of so many other social ills, is everybody's business. That's why men like Farlie Winson, Oumarou Youssoufou and Charles Williams can dare to dream about making Niger self-sufficient in food. It is this kind of international teamwork—combining the financial resources of those who have, with the strong and committed indigenous leadership to be found in every country, and coupling this with the practical know-how of a man who knows land, farming, and Africa—that can be the genius behind successful development projects.

Development Is about People

A *New Yorker* magazine cartoon showed a native chieftain, dressed in a grass skirt, relaxing in the shade of a thatched hut. An American visitor nurses his drink across a plain wooden table. The chief says: "Actually, we don't think of our country as *under*-developed so much as we think of yours as *over*-developed."

That's worth thinking about.

But what is the median point which divides *over* from

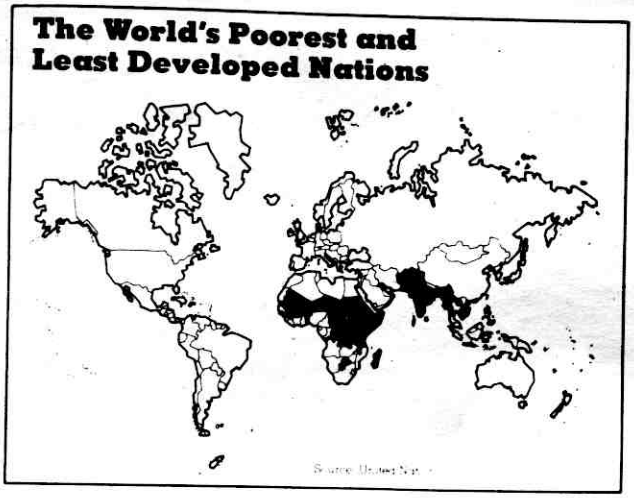


Figure 6

under? Many Westerners equate development with industrialization. Certainly many people in the Third and Fourth Worlds think of it in terms of the amount of consumer goods available. Not a few vaguely think of development as the process by which countries become as Westernized as possible. Perhaps the reason is that *developed* and *underdeveloped* are terms used almost synonymously with Western and non-Western nations.

Actually, development has nothing to do with industrializing or Westernizing. In fact, these things may impede true development.

Development is about people, not things. I know that countries need cement plants, plastics factories and heavy industry. But I also know that most often these high-investment ventures meet few people needs. Smoke-belching factories cannot be made the hallmark of successful development programs. Most often they do more for their owners and for the nation's GNP and its exports than they do for the masses of hungry and disfranchised people.

That is not meant to argue against the need for factories. I would stoutly argue, however, against considering factories the end of developmental goals.

Consider something said by Edgar Stoesz, an author and development worker, at a recent meeting of the Mennonite Economic Development Association. He contends that if development "is not for people, it is not worthy of the name." In his address to the conference, Stoesz said: "Development is the process by which people are awakened to opportunities within their reach (conscientization). Development is people with an increasing control over their environment and destiny. Development is people with dignity and a sense of self-worth. Development is freedom and wholeness and justice. Development is quality of life. Development is people living in the full realization of their God-given potential. Development is a liberated spirit. Development is people with rising expectations. Development is the new word for peace."

This concept of developing people instead of nations will require some fundamental rethinking. Conventional wisdom on the subject has proven to be virtually bankrupt. There are no more experts. Some monuments to their memory in the form of disproven theories or abandoned projects still stand, but the breed is dead.

Don't cry.

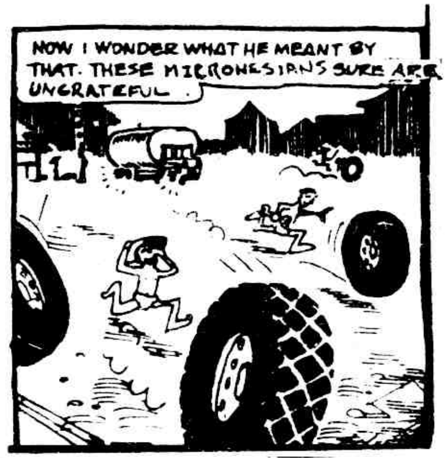
Joe Kimmins of the American Freedom from Hunger Foundation asserts: "Development is too important a process to be left to 'development experts.' In their fascination with economic growth—their rhetoric of concern for the common man notwithstanding—and in their obeisance to a conventional wisdom derived from experience with highly productive, industrialized economies, their vision of the future has become far too narrow and too self-defeating to be allowed to dominate."[1]

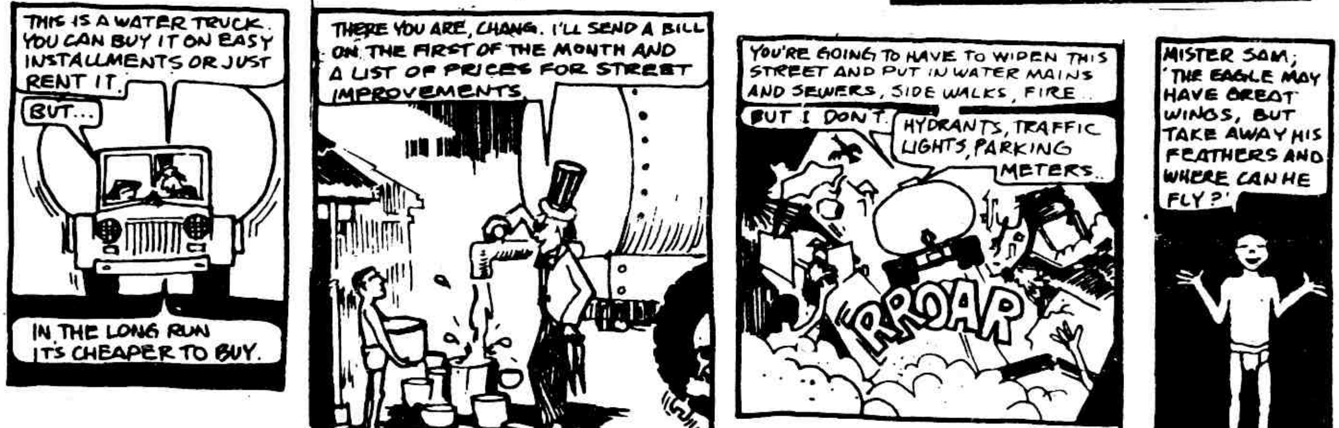
It may be helpful to take a look at one of those monuments—a disproven theory which got racked up by reality.

The Leak in the Trickle

It had a captivating name—the "trickle-down" theory. It had been around for a long time and seemed to have been proven beyond dispute in the Western societies. Although the name was new, the thesis was old, for Alexis de Tocqueville had made it the basis of his *Principle of Stratified Diffusion*.

"Trickle-down" was the way wealth had come to Europe and North America. This seemed to say that the most effective way of promoting everyone's development is to generate a nation's economic growth, and this is done by encouraging the best people—the educated, talented, dynamic elite—to make full use of their energies. As they led in economic development, the rest of society was supposed to benefit.





Almost all the experts held to this theory in the 1950s and 1960s. Aid programs were designed around this framework. Help the biggest and best and ultimately—somewhere at the end of the trickle—the least and poorest will get their share. So loans were made to start industries. Export businesses were especially favored because they contributed to the credit side of the national balance of payments.

The West thought it could have its cake and eat it, too. By financing industries and businesses which exploited the two things less developed countries had—raw materials and cheap labor—we thought we could maintain our life style and at the same time make it possible through trickle-down for the poor in these countries gradually to improve their living standard.

Guided by this kind of thinking, development projects were rarely aimed directly at the poor because the poor had less potential for growth. They remained objects of charity. They were outside the mainstream of development work. The stream would have to trickle to them through many economic and social strata.

The theory had only one flaw.

It didn't work.

There was a leak in the trickle. The educated, the landowners, the bureaucrats got richer while the poor became poorer. It was a paradox and unbelievable to the experts, but it happened just that way.

Referring to the poorest 40 percent in many developing countries, Robert S. McNamara, president of the World Bank, confirms that "development is simply not reaching them in any decisive degree. Their countries are growing in gross economic terms, but their individual lives are stagnating in human terms." [2]

Studies by the World Bank indicate that in ten countries with per capita incomes averaging $145, the poorest 40 percent of the people receive a per capita income of only $50 a year. In another ten countries with per capita incomes averaging $275, the poorest 40 percent receive only $80. In India, some two hundred million people subsist on incomes that average less than $40 a year.

Professor Tibor Mende, formerly a senior officer with the United Nations, points out that trickle-down did not work because the transmission belt from upper to lower classes was missing.

"The prosperity of the few," he said, "does not spread in concentric circles, as happened after the West's industrial revolution. The transmission belt is missing. This is largely so because, below a certain level, poverty cannot be attacked by indirect means." [3]

Growth, it is now seen, is not enough in itself. Economic indicators are not accurate measuring devices where the well-being of people is concerned. Because there are strong forces which work against the poorest in even the most fair-minded societies, a rising gross national product does not mean a more equitable distribution of wealth.

Under the trickle-down theory, it meant only a widening of the income gap, not a wider distribution of the economic resources.

Labor-Intensive vs. Capital-Intensive

Most contemporary development wisdom was born in the technological West, or has been largely influenced by it. I saw a perfect example of this on a small South Pacific island.

For years this tiny island with only a few hundred people had gotten by with a hand-operated telephone switchboard. It was totally adequate for the needs. And on an island where there aren't a lot of jobs, it provided employment for four operators. But some of the island fathers had been bitten by the technological bug from their exposure to the West and they wanted an automatic switchboard.

Application for a loan was made to the Asian Development Bank, a quasi-government agency. A costly study was made, the loan was approved, and the island telephone service was automated. Not necessarily improved; just automated. As a result, four people were unemployed and two of them had to leave the island in order to find work.

Yet this project was reported as a development "achievement." One cannot help but wonder what was really achieved when the project is measured against Mr. McNamara's words: "Development is about people. The only criterion for measuring its ultimate success or failure is what it does to enhance the lives of individual human beings." [4]

One of the reasons why the trickle-down theory didn't produce the desired results is that development funds were invested, for the most part, in capital-intensive programs—expensive projects designed to use modern technology and automation rather than people. In the developed West perhaps such a policy decision can be justified, but hardly in any over-populated and underemployed place in the rest of the world.

People not only need production; they need jobs. It was Mahatma Gandhi who said: "The poor of the world cannot be helped by mass production, only by production by the masses."

In 1974 World Vision entered into a well-digging and well-deepening program with the Andhra Christian Council in the Indian state of Andhra Pradesh. Rather than send in a well-drilling rig which could produce water on an assembly line basis, we urged our Indian counterparts to use as much local labor as possible to do the work.

It was slower. It was less efficient. But the projects employed thousands of people at the village level who had no work. The villages needed water, but the people also needed jobs.

During the height of the refugee problem in 1974 around Phnom Penh, Cambodia, a World Vision agriculturalist from New Zealand, Ben Webster, wanted to irrigate about two hundred acres for dry season rice farming. A canal several miles long was needed. Rather than do the job with a tractor, Webster hired twelve hundred of the idle refugees to dig the canal.

Capital-intensive means of production may be the answer in an educated, mechanized and technological society, but not in countries where the unemployment rate is chronically at 25 percent or more. Streamlined and efficient production may have to be sacrificed for the higher goal of providing jobs and incomes for the unemployed masses in the less developed countries.

On the outskirts of Tanzania's capital city, Dar-es-Salaam, sits the country's largest factory. It is a textile mill which produces *khanga*, the wildly colorful sheets of cotton which the women wrap around themselves as a garment. Nearly a thousand looms are set up in a hall the size of two football fields. The factory employs 4,700 people. It could get by with half that number by using more modern machinery, but there has been a conscious decision not to do so. Labor is not as expensive as machinery. Besides that, people need jobs.

Wouldn't you guess it? The Chinese set it up.[5]

For nonprofit humanitarian agencies such as World Vision, we have one temporary answer in what we call "task relief" programs. Unemployed villagers are paid to work on projects which benefit the entire community. In addition to scores of wells in the Indian states of Andhra Pradesh and Gujarat, many miles of road have been built in Bangladesh through such programs. Labor-intensive programs have been used to construct dams and water reservoirs in India and West Africa.

Task relief beats putting families on the dole. It saves the dignity of able-bodied people. And it puts food on their tables.

In all my travels, I have never seen anyone perpetually hungry who had money with which to buy food.

The Role of Aid

There are two ways by which money flows from country to country. One is trade. The other is aid.

We have already seen that the trade system is stacked against the less developed countries. It is rigged in favor of the wealthy West.

But what about foreign aid? Surely that is all in favor of the recipient country?

Guess again. Aid, too, is pretty much rigged to favor the donor country. Consider these facts.

First, more than half the financial assistance given by the United States is in the form of loans which must be repaid with interest. It is still called "aid," but it is not a gift. Some of the money goes to the World Bank and other regional quasi-government banks.

Second, over half of our foreign aid appropriation is for what we call "security assistance"—military purposes. Some forty-two cents out of each aid dollar is marked for "development assistance" and another six cents is given for "welfare and emergency relief."

Third, as has already been pointed out, most of the aid money is spent more in the commercial interest of the donor country than it is to alter the social and economic picture in the recipient country. As late as 1965, the then president and chairman of the World Bank, Eugene Black, pointed out that "foreign aid" was enormously beneficial to the donor nations in at least three ways:

"1) Foreign aid provides a substantial and immediate market for U.S. goods and services.

"2) Foreign aid stimulates the development of new overseas markets for U.S. companies.

"3) Foreign aid orients national economies toward a free enterprise system in which the U.S. private firms can prosper." [6]

A relatively small percentage of aid ever really goes to improve the life of the common, hungry people abroad. Indeed, most of it is spent in the donor country to purchase war matériel and other goods, or to pay for expensive studies done by American think tanks or academicians which tell the Third and Fourth Worlds what their needs are.

When Galo Plaza was secretary general of the Organization of American States, he described U.S. aid to Latin America in these words: "Most U.S. aid under the Alliance for Progress is not a gift [but] is in the form of loans that are being repaid. . . . it is not at all unreasonable to turn the picture around, and think about the benefits accruing to the United States as a result of what we call aid. . . . Nearly all this [the loans] is being spent in the United States on United States goods." [7]

Loans are valuable for certain development projects, but we would have a lot more credibility if we would stop trying to kid ourselves and our friends into believing that this reflects our altruism.

As Michael Hudson says, "The net flow of foreign exchange over time is not from the United States to aid-borrowing countries, as implied in the modern connotation of the term 'aid,' but from the borrowers to the United States. . . . So-called foreign aid is, indeed, feudatory. Aid has imposed vassalage on developing countries . . ." [8]

Aid certainly has a crucial role to play in development, but it needs to be honestly labeled and creatively used. The facts indicate that neither is happening on a very impressive scale right now.

How Generous Are We?

No doubt many Americans are shocked at this revelation of truth regarding foreign aid. And disappointed. We have always been proud of our generosity. We remember how we fed our enemies after both World Wars. We know that millions of dollars are given annually to domestic charities and to private relief and development agencies.

In personal giving, Americans are still some of the most generous people on earth. In 1971, voluntary contributions from the American public amounted to almost $890 million, or two-thirds of the total international voluntary aid. U.S. voluntary contributions were second only to those of Sweden.

The recent revelations about world hunger have once again touched the sensitive nerve of compassion for millions and there has been a great outpouring of money to private organizations.

But if development is going to be done on the large scale necessary to change the face of the underdeveloped world, governments and corporations must also do their share. After the rebuilding of Europe at the end of World War II through the highly successful Marshall Plan, the concept of aid began to change. Now it is only a shadow of its original form, but the terms and labels are still the same. Maybe the truth in packaging law should apply to government programs as well as consumer products.

Proportionately, our government gives much less now for economic aid than at any time in the past 25 years. In 1949 we were giving 2.8 percent of our gross national product. In 1975 it is .25 percent of the GNP. This means for every $100 of total national output, our contribution to overseas economic aid is about 25 cents.

The Food for Peace program is being cut back as a result of higher agricultural prices, a decline in congressional appropriations, and an increase in domestic consumption. Food aid for 1974 was cut by one-third of the 1972 totals, and half of that reduced amount went to Indochina. At the same time the United States and Canada were benefiting by nearly $10 billion from higher priced food exports. So the oil companies weren't the only ones increasing profits in those days!

Those who feel the U.S. federal government is subtracting from domestic programs to provide foreign aid should consider that in the 1975 federal budget, 49 percent is devoted to what is called "human resources" (including health, education and welfare), slightly over 29 percent for "national defense," almost 9 percent for "physical resources" and *1.38 percent for all development assistance programs overseas.*

Development assistance from all sixteen nations who are members of the Development Assistance Committee (DAC) averages only about .36 percent of their combined gross national products, according to Robert McNamara. This compares with a U.N. target of .7 percent. To reach this goal, the developed nations need commit only about 1.5 percent of the amount by which they will grow richer during this decade. This leaves them 98.5 percent of their increased wealth to use for themselves. The small amount asked for would hardly bankrupt a rich nation, but it could make a remarkable improvement in the development of the poorer countries.[9]

The U.S. Chamber of Commerce reports that in 1972 Americans spent approximately $11 billion on their personal care (including barber and beauty shops), over $8 billion to buy their shoes and keep them repaired, almost $48 billion on all forms of recreation, over $80 billion for new and used automobiles, and less than $3 billion for all forms of foreign assistance, much of which was military aid.

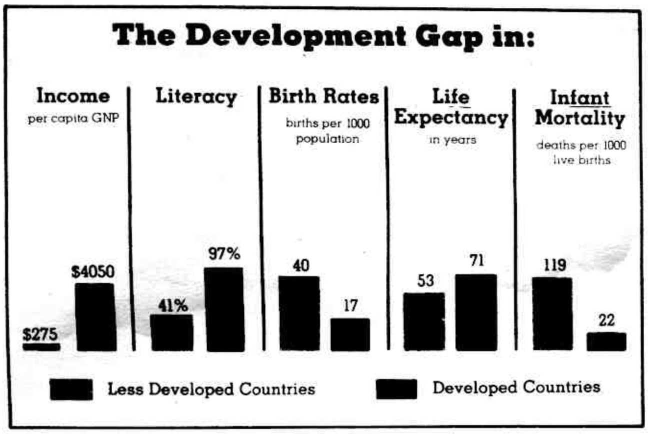


Figure 7

As generous as we may think we are, both personally and as a nation, the cold facts show that we still have a long way to go.

"No Choice but to Turn Inward"

When comparing income and life styles, people in the poorer nations may even feel they have the right to question our claim to generosity. With all our private and public aid, the income gap widens.

Development isn't keeping pace.

"The chase of Western living standards was illusory at best," says a senior economic advisor at the World Bank, Mahbub ul Haq. He says the average per capita income in the developed world now stands at $2,400, while in the developing countries it is $180. The gap, which is now $2,220, will widen by another $1,100 by 1980.

Short of a major transfer of resources—about which he is pessimistic—Haq says the developing countries don't have a breath of a chance of catching up.

His answer? "The developing countries have no choice but to turn inwards, much the same as Communist China . . . and to adopt a different style of life, seeking a consumption pattern more consistent with their own poverty—pots and pans and bicycles and simple consumption habits—without being seduced by the life styles of the rich.

"This requires a redefinition of economic and social objectives which is of truly staggering proportions, a liquidation of the privileged groups and vested interests which may well be impossible in many societies, a redistribution of political economic power which may only be achieved through revolutions rather than through an evolutionary change." [10]

That is strong medicine, but he is not the only one prescribing it.

A Third World View

In 1974, President Julius Nyerere of Tanzania spoke to this issue while on a visit to New Zealand. In a lecture given at Christchurch, entitled "Aid and Development from a Recipient's Point of View," he said: "The attack on world poverty is a vital long term concern for the rich. They need to participate in it because of their humanity, and out of self-interest. . . .

"Unfortunately there is no world government which could tax the rich nations for the benefit of the poor nations; there is no international equivalent of social security payments. Instead, we have an acknowledgement of the need for 'international aid.'

"There appears, however, to be some confusion, if not hypocrisy, on this subject. Some people seem to think that any transaction between rich nations and poor nations, which is not settled within a matter of days by a cash transfer, can be classified as 'aid'—quite regardless of the final advantage to one side or the other. I do not agree.

"I believe the term 'aid' should only be used when there is a real transfer of resources to the poor, for the purpose of raising living standards and narrowing the gap between the poor and rich nations.

"By my definition, military assistance would be excluded from the aid figures. It has little relevance to the poverty gap, whatever other justification it may have. Export credits and commercial loans should also be disregarded.

"Nor do I believe that private investment is aid. It is undertaken for the benefit of the investor; local benefit—if any—is incidental. And it is undertaken only in the expectation of a high rate of transferable profit; I am told that foreign investors look for an estimated 20 percent profit before establishing a new enterprise in African nations!

"In the international aid statistics the nearest thing to my definition is 'Official Development Assistance,' and it is worth mentioning that the proportion of the Gross National Product of the major rich nations which was devoted to this actually fell during the 1960s. As these countries themselves increased their wealth so greatly, the amount of money transferred annually did increase slightly.

"Although development aid is a very marginal item for rich countries, it may be important to a poor country. It can do things like village electrification where such an advance is otherwise impossible, but where the electricity will enable the development of village industries, the improvement of water supplies and so on.

"Aid can make a great contribution to development, provided it is given and accepted for what it is—a possible catalyst for local development.

"Poor nations insist that the aid should be given as an expression of partnership, and therefore without political strings being attached to it. Poverty has no ideology. . . . We feel very strongly on this issue; our independence is not for sale." [11]

The Bubble-Up Theory

Development, as it has been practiced for the past two decades, has thus far produced minimum achievements. Mahbub ul Haq says, "When you rip aside the confusing figures on growth rates, you find that for about two-thirds of humanity the increase in per capita income has been less than one dollar a year for the last 20 years." [12]

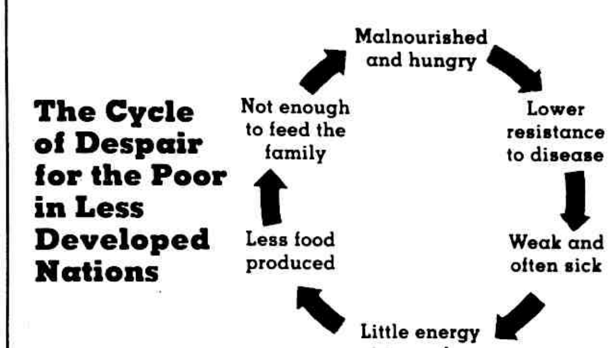


Figure 8

Since both time and experience have proven the trickle-down theory ineffective, let me register in with a theory of my own.

I call it the "bubble-up" theory. I think it has real merit. Development, says Gunnar Myrdal, is the "movement upward of the whole social system." [13] Yet development is not easily defined. It is more a process and direction than it is an event or activity. It cannot be measured by quantity of consumption as we are accustomed to doing in the West.

Most of the world now does not even have a standard of living. It can be called only a "standard of misery." Development must be concerned with qualitative change.

As E. F. Schumacher says in his book, *Small Is Beautiful*, "Development does not start with goods; it starts with people and their education, organization, and discipline. . . . development cannot be an act of creation, . . . cannot be ordered, bought, comprehensively planned . . . it requires a process of evolution."

He goes on to say that "development effort should bypass the big cities and be directly concerned with the creation of an 'agro-industrial structure' in the rural and small town areas." [14] The primary need is for millions of work places and a primary consideration must be to provide maximum work opportunities for the unemployed and underemployed.

What Schumacher is talking about is "bubble-up." You start with the masses at the bottom instead of the elite at the top. Interestingly, in March 1975 the World Bank announced a new policy which bears all the marks of the bubble-up theory. Keep in mind that for nearly twenty years the Bank has been putting its money into industrial development and big agricultural projects.

Now, according to a story in the *Los Angeles Times*, March 9, 1975, the prestigious institution will "double its lending for rural development in the next five years and shift the emphasis of its assistance in poorer countries to small, impoverished farmers, sometimes called the world's 'marginal men.' "

Between 1975 and 1979 the Bank plans to spend $7.2 billion for agriculture and rural development—up sharply over previous years—and some $3 billion of that will be for projects to benefit small farmers. The new style projects will provide a comprehensive program of credits, seeds, fertilizer, water, as well as health service and basic education for the small farmers who cultivate 40 percent of the land in developing countries.

I say bravo for the World Bank!

And bravo for Senator Mark Hatfield who said virtually the same thing in a 1974 address at the James H. Oliphant Forum in New York City. Calling for small farming units to be tied together by lending and marketing cooperatives, the senator from Oregon said: "This emphasis on relatively small operations replacing the present mix of landholding elite and a poor majority of peasants would accomplish several development goals at once: First, it would help stop the flight from rural areas to the even worse conditions of the urban slums prompted by the acquisition of small holdings by the elite and the replacement of the small farmer by technology he cannot afford. In turn, rural development in this fashion would foster rural employment by the maximum use of labor-intensive methods as much as possible.

"Rural employment would begin to create for the rural poor the small measure of prosperity that so enhances population control efforts. Finally, marketing procedures would be simplified, and distribution costs reduced, through the operation of cooperatives, to the benefit of rural producer and urban consumer alike." [15]

Bubble-up means starting where the people are and where the need is. More than 80 percent of the poorest people in developing countries live in rural areas.

In his book, *Crusade Against Hunger*, I. W. Moomaw tells about an interview with evangelist and Christian statesman, John R. Mott. The author talked about being an agricultural missionary, and he quotes from memory Mott's response: "The soul of Asian countries, especially, springs from their villages. Yet it is there that we find the greatest concentration of need and neglect. There could be no greater Christian summons than to work with these people for the reconstruction of life socially, economically, and spiritually. . . . But remember this—whoever engages in this work must feed on difficulties." [16]

The fact that the problems are complex does not mean they are insoluble. The problem is not technology or knowledge, but willingness to act.

Willingness requires a deep motivation. Developed nations have been involved in the lesser-developed world largely from political and economic motives, with a covering of altruism and a feeling of squaring of accounts because of colonial exploitation. But Christian motivation is deeper.

It arises from love, not guilt. It seeks to serve, not exploit. It requires no gratitude, only opportunity. It does not ask, "Am I my brother's keeper?" but "Am I brother to my brother?"

The ultimate goal of development is to provide a better quality of life for all the people on this earth.

Our concern is not necessarily that they should live in luxury, but that they should live at all. ⌘

C. THE PHILOSOPHY OF SOFT TECHNOLOGY *

1 Introduction

'Soft technology' was almost unheard of three years ago. Yet today the range of processes known as soft or alternative technology and biotechnics have become front page news. As Robin Clarke, founder of BRAD (Biotechnic Research and Development) puts it:

> If we now look round at the confusion left by half a decade of Earth Days, Stockholm Conferences and anti-Vietnam peace marches, what do we see? First, I believe, one lasting effect is that science and technology have taken a pounding from which they will not recover.
> (*New Scientist*, 11 January 1973)

As the new technology has developed, it has become increasingly clear that the old Faustian dream of endless 'progress' towards man's total domination of the earth has not been fulfilled. Industrial societies are realizing the penalities of scientific advance: cities where the simple act of breathing is equivalent in health damage to thirty or forty cigarettes a day, people killed and maimed by cars, vast sectors of mankind starving while a minority absorb the world's disappearing resources - and frequently poison themselves doing so. More and more people have begun to take stock of their real needs - food, shelter and energy - and to find simpler, less exploitative ways of satisfying these.

The city has become the focus of the environmental crisis: violence, overcrowding, delinquency and stress have become an accepted part of urban living. Faced with this apparent breakdown of the cities, planners and technologists have simultaneously been forced, by the recent Arab cutback on energy supplies, to reconsider the whole role of conventional technology. Energy has ceased to be a subject of abstract academic interest and the energy shortage is forcing more energy-efficient technologies into general use. Industrial urban societies are absolutely dependent on large, uninterrupted supplies of cheap energy. Since the renewable energy sources, such as sun, wind and biological energy, are in general dispersed, their optimum use requires as a first step population dispersion rather than the kind of centralization at present existing in the industrialized West. Other factors besides the energy crisis have stimulated interest in soft technology. Perhaps the most important of these has been the growth in environmental concern. 'Biotechnics' - the use of life-support systems that are biologically based or at least more compatible with natural systems - is an aspect of soft technology which reflects this concern. There is consensus among soft technologists, whatever their ideological persuasions, that our present high-energy industrial technologies are damaging our basic ecological support systems and must be modified.

The science of ecology ties together observations and principles that in many cases are intuitive. In nature there are limits: wastes have to go somewhere and have to be broken down for subsequent re-use - no one species can 'corner' all the food and resources in a given environment. When we look at present conditions in the light of these principles, we can see that the dangers are real and immediate. In the nineteenth century world population was less than one quarter of today's, and energy use was less than a fiftieth. Now, however, population pressure has led industrial societies to a state of 'auto-destruction' that demands new and real solutions. The time is ripe for the development of a diffuse, easily used technology at the level of the village and extended family. 'Hard' technology reached its apex in nuclear energy, a brilliant expression of technological skill that leaves a residue of toxic wastes lasting thousands of years. The new solutions, very simply, are technologies that can be used far into the future without these penalties - technologies of permanence.

2 The philosophy of soft technology

Nature knows best

Nothing is lost, nothing changes; only the form changes . . . (Anon)

One of the richest unifying themes in the philosophy of soft technology is that of 'Nature knows best'. Urban industrial society, as we know it, is unable to face the fact that its technologies and lifestyles are chipping away at the fundamental supports provided by nature. Species extinctions, overcropping, damage to water, air and even climate are a few examples from the long and growing list. The problem is that, when we run up an overdraft with Nature's supply and recycling systems, it is one that somewhere, at some time, has to be paid back. The Sahel disaster, the collapse of Peru's anchoveta stocks, and recurring famine and floods in Bangladesh are just a few recent instances of disasters caused by ecological imbalance. Even British farming has been affected by the slump in cheap protein supply from Peruvian anchoveta. Urban industrial societies are increasingly exposed to world industrial problems because of their dependence on world commodities.

Nature provides a rich source of models for man's technologies. Bionics, a design science using these models, already exists, although it is undeservedly ignored. There are many examples of successful artefacts and techniques that have come from models in nature. One good example is the solar collector recently designed by a company under contract to the US NASA agency. Perhaps ironically for an agency concerned mainly with space exploration, the solar collector is modelled on the eye of a crab - one of the earliest animal species on this planet. A crab has to see in conditions that are often very murky; its eye structure has therefore continually been genetically selected to maximize light absorption. This is also the basic requirement of a solar collector. By using nature's model, we can shortcircuit all the lengthy research that would otherwise be needed to design a solar collector from first principles.

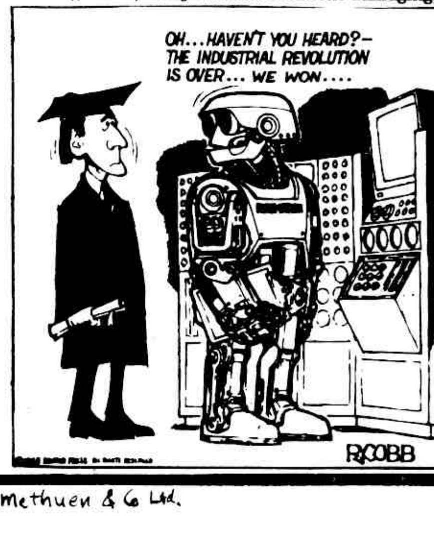
There are more surprising areas of bionics that are yet to be investigated and acted upon. One is the design and operation of methane gas plants (see section 3.4). Every cow is, in one respect, a highly effective methane gas extraction system. If we work out the potential gas yield of the vegetation ingested by a cow, it is as much as twice that of the cow's faeces and urine. The rest has been extracted *inside* the cow and vented as the cow moves around. The bacteria which make the gas live symbiotically in one of its stomachs. The amount of gas given out by Britain's cows in this way approaches, in fuel value, 2 to 3 per cent of the natural gas used each year. If we can learn how to simulate the gas-stripping stages of a cow's digestion we could potentially greatly improve the design and operation of methane gas plants.

Bionics promises many other fascinating and useful cues to the development of energy-efficient technologies. Examples include the underwater breathing performance of land animals that also go underwater; the building techniques, using no cement, of animals such as beavers; and the supportive bone structure of animals that can often give us profound insights into elegant and economic structures. To gain benefit from bionics we need to fuse many apparently unrelated disciplines like zoology, botany and building, but more importantly we have to acknowledge that the results of nature's long design struggle against gravity and entropy may provide direct solutions to our present problems.

Faust is finished

Big isn't beautiful - any more

Another strong unifying theme in soft technology can be summed up as a working distrust of the 'big is best' philosophy. It seems to many soft technologists that the cult of bigness has been given a very fair trial and has been found lacking. As we have learnt from disasters such as Aberfan and Flixborough, high-energy technology, as well as being crude, noisy and environment-damaging,



* Extracts from 'Why Soft Technology?' by Andrew MacKillop. Publ: Methuen & Co Ltd.

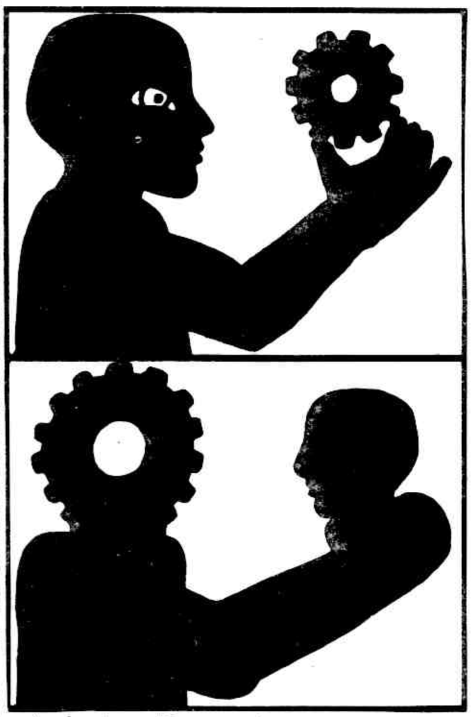
can be lethal when its delicate balance gets out of hand. Yet at present the thrust of economic development and 'progress' is relentlessly into larger and potentially more dangerous plant and installations. The nuclear fast breeder is probably the ultimate example; in the opinion of more and more people, not just environmentalists, fast breeders are little more than sodium-cooled, giant-scale plutonium dumps. The potential lethality of plutonium on the ton scale could make a serious breeder reactor accident so damaging that Flixborough would appear a penny banger by comparison. It is therefore not at all surprising that soft technology, in reaction against Faustian technology, should consciously seek quieter, lower-energy, simpler and safer techniques for satisfying human needs - and yet these techniques may often be based on scientific principles of elegance and complexity.

While Faustian technology is often paraded as 'efficient' and 'progressive' this is usually only by short-term economic standards. When we come on to the resource and energy cost of a technology and its support systems (capital plant, transport needs etc.) the heavy energy subsidy to large-scale high technology becomes apparent. Economically too, high technology is proving less and less desirable as energy costs mount and environmental damage reaches proportions where expensive restitution or 'cosmetic surgery' is needed.

Low energy technology

We live near the bottom of a thermodynamic well that begins at the fusion heat of the central sun, and plummets down to Absolute Zero

Soft technology is nearly always a synonym for low energy technology and this is in no way an accident. When we use a natural or semi-natural process - for example methane gas plants or solar heating - we employ processes that are used by other living things, or we involve ourselves with



natural systems. These are always energy-economizing because the path of evolution has continually been influenced by the need to accommodate gravity and counter entropy. The force of gravity is well-known (if little understood) but entropy is probably more important. It relates closely to gravity: just as nothing ever falls upwards, so energy is continually degrading towards a temperature of Absolute Zero. Even our sun will eventually burn out, and explode into a 'red giant' that will absorb our solar system; after that it will become cosmic dust at the absolute zero temperature of 0° Kelvin (-273° C). This may seem esoteric or even irrelevant, but in fact the effects of this constant *entropic* breakdown - a one-way energy path - have pervasive and strong effects on the nature of life itself.

Because of its pervasiveness entropy's effects on human affairs usually show themselves in a number of ways. One good example is the *unavailability* of a large proportion of the energy in a fuel used in any heat engine, such as a car engine. The total energy value of a fuel can be measured by completely burning the fuel in a rich supply of air and determining the heat liberated. When we use the same fuel in a heat engine, of whatever design, we find that it will give a certain horsepower for a certain time. This amount of energy can never be more than about 70 per cent of the fuel's energy and in practice is usually about half this (i.e. about 30 per cent). The first bite out of the fuel's energy is the one taken by entropy; it is a price we pay for trying to convert the fuel's chemical energy, via heat, into mechanical energy. A more dramatic example is when we use electricity to heat the filament of a light bulb; a mere 3-5 per cent of the electrical energy becomes light, showing that the higher the temperature of the process the greater our losses due to entropy.

Nature in evolution is a story of the battle against entropy. Because of the loss of available, useful energy each time a conversion takes place, life has evolved thousands of stunningly complex methods for conserving energy by using efficient and low-temperature conversions, and by minimizing the actual number of conversions. For example, the evolution of life forms in the sea took place faster and more completely than on land. The reason is that land animals have to deal with more gradients and suffer from a much larger gravity pull than sea life, which has the advantage of buoyancy. In the sea, life has a more even-temperature environment, and needs to spend less energy on heating, as well as against gravity, and for movement. It is therefore no accident that life systems in the sea often display four or five trophic levels (predation hierarchies) whilst land ecosystems rarely exhibit more than three; further the life forms of the largest bulk with the largest absolute brain size - whales - are sea animals. It is their pay-off for 'choosing' an aquatic life where entropy and gravity forces are at their minimum. It is notable that the biggest land animals still existing - elephants - have relatively tiny brains and are at the end of an evolutionary tree: this is because they have had to develop massive bone and muscle structures to counter entropy and gravity and have had little 'to spare' for developing their brains.

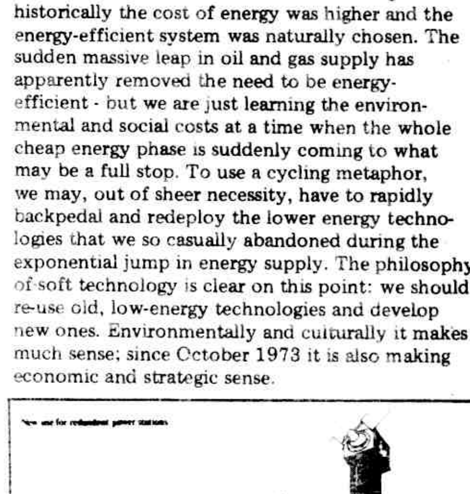
Any time we use high temperature/high entropy methods - for example, heating a house by electricity instead of direct fuel burning - we pay an extra entropy price. This is because we choose on convenience or other grounds to use a more inefficient (high entropy) process to satisfy a need. Soft technology is in many ways a recognition that the craving for short-term 'convenience' can be extraordinarily wasteful and in many cases has been taken beyond reason. This is given added force by another aspect of entropy; when we burn a fuel, for whatever reason, we are *reducing* the stock of easily available energy. If we tried to reconstitute the fuel we would find that the reconstituting cost more energy than the yield: entropy ensures that there are no overdrafts in the energy economy!

A simple and direct example of how we can use a low energy substitute for a process that at present uses vast quantities of high grade energy is in domestic water heating by solar energy. Solar energy (see section 3.2) comes from the most efficient fusion power plan possible; the sun is a safe distance away and of proven reliability. Although the sun's energy reaching earth is fairly diffuse, and of increasing seasonality as we move away from the Equator, the daytime receipt in summer at European latitudes amounts to several hundred kilowatthours on an average home's roof of about 100 m^2. Water heating solar collectors are simple and inobtrusive and in the summer months of April-September in the UK can heat water to more than 50°C on many days. While it would not be reasonable to expect the collectors to heat domestic water up to normal demand temperatures of 60-80°C, they can satisfy 60 per cent or more of the summertime baseload energy need.

Solar water heating is very much a low energy technology. The collector panels themselves do not reach a temperature of more than 80-100°C, in direct contrast to the conventional technology of water heating - for example, an oil-fired boiler with an internal temperature of over 500°C. The panels work by conserving an inevitable and natural heat gain, through insulation inserted beneath the panels and glass on top. In this way the relatively small amount of energy available is made useful. Because the temperature of conversion (solar energy - hot water) is relatively low, and the necessary support systems (basically only insulation and circulation pumps) are simple, the overall energy cost of the process is low, and by substituting a low entropy system for a high entropy one we are 'saving' available energy for other purposes.

There are many other examples in soft technology of this efficient use of low grade (low power or temperature) energy. In transport, for example (see section 3.9) the bicycle and train are pre-eminently low energy technologies at different levels of required social investment and organization. On a bicycle the low power available from the human body - an effective maximum of about 300 watts - is put to use giving an incredibly large amount of useful travel. On the energy value of a gallon of petrol, about 40 kWh, a cyclist can travel 1000 miles or more, albeit at slow speed. Trains require more energy of course, but because of their high weight and specially-built tracks with few inclines they can coast for miles using very little energy.

We are inclined to consider cycles and trains 'old fashioned', simply because they came before cars and planes and because they are somewhat slower, quieter forms of transport. But this points to a general 'evolutionary' principle of technology: in most cases the energy-efficient technique has preceded that which gives more convenience in terms of speed, flexibility or other consumer-desirable merits. The reason for this is simple: historically the cost of energy was higher and the energy-efficient system was naturally chosen. The sudden massive leap in oil and gas supply has apparently removed the need to be energy-efficient - but we are just learning the environmental and social costs at a time when the whole cheap energy phase is suddenly coming to what may be a full stop. To use a cycling metaphor, we may, out of sheer necessity, have to rapidly backpedal and redeploy the lower energy technologies that we so casually abandoned during the exponential jump in energy supply. The philosophy of soft technology is clear on this point: we should re-use old, low-energy technologies and develop new ones. Environmentally and culturally it makes much sense; since October 1973 it is also making economic and strategic sense.



Section VI ENGINEERING AND EDUCATION

A. FACILITATING LEARNING

It is impossible to cover here all that could be said about facilitating learning. The comments made here touch on just the organisational side of learning. **Peter Jarrad.**

1. In every type of engineering, the economics, efficiency etc. are a very important part. The whole of Methods Engineering including time and motion study, critical path analysis, research and all system design is bound up with finding the easiest, best way of accomplishing some task. Every effort is made to reduce the expenditure of time, energy and finance that is required for some project, and often this will determine whether the project will get off the ground.

2. **Facilitating learning is important for both staff and students. It is important because of the tremendous efforts that are put into the teaching-learning process due to the ever increasing level of knowledge. It is true that some staff lecture with a method which saves them time, but which may result in inefficient learning for most in the class. It is also true that many students also study very inefficiently with many hours lost. Some examples are given to illustrate inefficient teaching and learning methods.**

'One lecturer took the approach of writing up on the blackboard a complete, well-written set of lecture notes, about 4-5 foolscap pages every hour. During the year he gave two consecutive lectures where he gave out typed lecture notes. On these two occasions he found time not only to give the lecture, but also to go through an example which he wrote up on the board. This was possible simply because most of the lecturer's and students' time was not taken up by copying material onto and off the board. The written example on the board was not unduly long and served to 'interrupt' the lecture and provide a desirable break. Unfortunately he gave only two lectures like this.'

'Another lecturer often came in without any apparent preparation. His own notes consisted of a jumbled pile of odd scraps of paper, with no definite order. Every now and again, he would rise to his feet to draw a diagram or make some important point on the board. He admitted he was lazy, aren't we all, and if there wasn't a clear space on the board, he would often just draw over some other diagram. The year rolled by causing no end of frustration. At the end of the year, following a massive revision programme, it was possible to look through the notes taken (they were very much like the jumbled mess on the board) to find the most concise precis of the course. Unfortunately it had taken twice as long as necessary, to decipher what was required and to do the volume of work needed to understand the notes!'

'One student attended a series of lectures given by an extremely proficient lecturer. (Acknowledged by both staff and students.) The material was presented in an orderly, concise way and was explained well. Despite the best efforts of the lecturer to emphasize the fundamentals and the most important points, the student did not note these. The subject required considerable effort which the student did, but because he was unaware of the 'essentials' of the course spent many wasteful hours chasing unimportant points. Over the course of the year this had an effect and he subsequently under-achieved.'

'One student undertaking the course attended lectures, tutorials etc. and was reasonably interested in the course. As is usual there were times when he did not feel like working. However he would not break from the rigid timetable that he had set for himself and would continue to try to work. While on some of these occasions he accomplished a great deal of work, on many others he merely passed the time away while waiting for his break. Subsequently he spent many hours which were not profitably spent on study and which were of no value as recreation. Over the course of the year this had an effect and he subsequently under

There are many examples that could be found to illustrate the point that the teaching and the learning method can be extremely inefficient.

3. **There are many aspects to learning.**

- to gain knowledge or information,
- to ascertain by enquiry, study or investigation
- to receive instruction
- to fix in the mind
- to acquire understanding and skill.

The point in question is how to do this efficiently for all concerned.

4. There can be little doubt that the mind assimilates information logically, with order (brick-upon-brick). The missing link will prevent further understanding and comprehension. Some cannot grasp some of the links.

Memory is by association. One object is associated with another and when the former is rigidly fixed in the mind, the other can be recalled easily. The ease of recall depends on the degree or power of association between objects or facts. (Try remembering all the items on a tray by associating them one with another). Good concentration is important, the greater the concentration, the easier learning becomes.

5. Material thus presented orderly, logically will aid learning. Some can grasp several steps as one step. Thus there needs to be a compromise between the minimum and maximum steps possible. Noting needs to be sufficient so that the in between steps can be grasped by most. Conversely, notes that are too detailed make learning more difficult by camouflaging the essential points under a mountain of trivia. This applies to notes whether given by lecturers or taken from text books for personal use.
It is helpful to have alternate viewpoints. Perhaps the missing link is to be found in one presentation but not the other. Hence references (often of greater detail) are valuable.

Material that is jumbled requires deciphering and sorting. Material that contains information that is redundant must be separated out. While these are essential qualifications for many aspects of engineering, it is unfortunate if this takes up too much unnecessary time without helping in the process of learning how to sort.

With material that is jumbled it is possible to miss out chunks, which while adding to the total picture do not prevent building in other areas.

6. **Planning can be a means of reducing the time that is neither useful for study nor leisure. Many students spend time attempting to study when they should be relaxing. They accomplish very little usually. (Although initially, some self discipline is always needed to start.) They can then afford less time for leisure or other pursuits as their time spent in study was not truly effective.**

The danger of relaxing when one doesn't feel like working is that it is one way of accomplishing no work at all. However this may be monitored.

The following suggestions may be of value. Allocate a number of hours to each subject in a term (the number that would ensure the success you would like) and keep a record of the time spent. Don't count wasted hours.

Remember to allocate the time according to your abilities (more to weaker subjects) and according to priorities in subjects (don't spend time on unimportant topics).

It is likely that you will over estimate the time that you would like to do in a term. There is a physical limit. It is important however to ensure that the work done in each subject is proportional to the time you decided was necessary for success. ⌘

B. THE MOTIVATION TO STUDY

by Peter Jarrad

The original purpose underlying the research for this article was to try and justify a pilot study or research project into student attitudes towards study. In the haste of bringing the handbook out it has been necessary to cut out part of the argument and documentation which would be necessary to justify some of the assertions and conclusions. One day, but not in the near future, it may be rewritten to accomplish that purpose.

INTRODUCTION

Without wishing to generalize too much, I think it is true to say that many students lack the sort of motivation which would enable them to enjoy study and be successful at the same time.

While many students enjoy university life I am unconvinced that the study aspect is the significant factor contributing to such enjoyment. I think it is also true to say that many students ultimately find themselves compelled to study by external pressures, for example, assessment, fear of failure, society pressures rather than by internal desires and strengths, for example, interest in a field of knowledge and the desire to learn.

I have heard some staff comment on the apathy and disinterest shown by some students towards study and I think that this might be a typical observation amongst staff. But there is also evidence to show that most students attach considerable value or importance to their studies.

The apparent contradiction is that while students attach value to their studies there is very real difficulty in "getting down and doing it", or in another way to find the motivation. By this, I do not mean the time spent in "finding ones bearing' as with a homing pigeon prior to choosing a path of flight. I mean, the pigeon, having determined the path of flight, promptly flies to roost in the nearest tree.

The purpose of this paper is to show that a great deal can be done to help students 'get down and do it'. The major thesis of this article depends on the conclusions drawn by a number of studies into work attitudes.

A STUDY INTO WORK ATTITUDES

Historical Review

In 1958, following an examination of the literature (Job Attitudes, Review of Research and Opinion), Frederick Hurzberg (Professor of Psychology), Bernard Mausner (Professor of Psychology) and Barbara B. Snyderman (Research Associate) undertook a study in job attitudes.

The details of the study, the results and the implications were published in a book 'The Motivation to Work' (Wiley, 1959).

The major hypothesis was that the factors leading to positive job attitudes (satisfiers or motivators) and those leading to negative attitudes (dissatisfiers or hygiene factors) would differ. The study concluded that the hypothesis was true.

Criticism directed at the study was that no generalizations could be made because of the narrow base of the study (confined to engineers and accountants) and because the results might have been generated by virtue of the methodology of the study. However, since that original study, a large number of independent workers have verified the conclusions that Herzburg reached.

Herzburg has since written another book, 'Work and the Nature of Man', (Staples Press, 1968). In this book Herzburg considers the needs of man in detail, expands the Motivation-Hygiene Theory, discusses 9 other studies which verify the theory and concludes with the application of the theory into work practise.

The Motivation-Hygiene Theory

The original study was conducted using two hundred engineers and accountants from Pittsburg, U.S.A. They were asked to describe times when they felt exceptionally good about their work and when they felt dissatisfied with their work.

The essential result of the study was the discovery that the factors which affect job satisfaction (satisfiers or motivating factors) were separate and distinct from the factors which affect job dissatisfaction (dissatisfiers or hygiene factors). The researchers discovered that the satisfiers were associated with the worker's relationship to the job itself while the dissatisfiers related to the environment of the job.

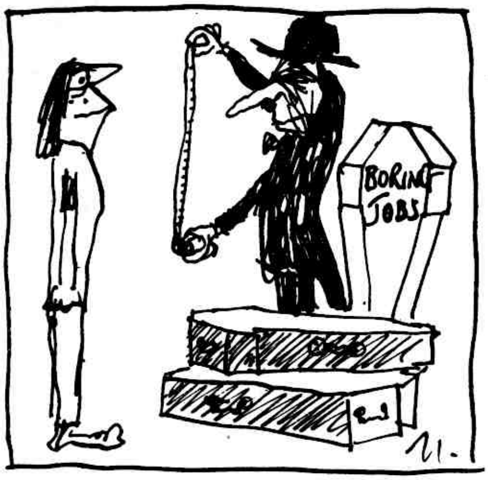
The significant factors which evolved are as follows:

Motivating Factors (Satisfiers)	Hygiene Factors (Dissatisfiers)
1. Achievement	1. Company policy and administration
2. Recognition	2. Supervision
3. Work itself	3. Salary
4. Responsibility	4. Interpersonal relations
5. Advancement	5. Working conditions

cont. PSO

Motivating Factors: The motivators, achievement and recognition occurred most frequently in events where there were good feelings about work; they resulted in a positive change in job attitudes which lasted only for a short duration, i.e. less than two weeks. The motivators, work itself, responsibility, advancement occurred less frequently but resulted in a change of attitudes which lasted for a long duration, for years in some cases.

Motivating factors lead to what Herzberg calls 'psychological growth', that is, they make a person feel as if he is really doing something, he is getting somewhere, he is achieving and his achievements are recognised. This is the experience of satisfaction. If these satisfiers are not part of the job then the job fails to satisfy. That does not mean there will be dissatisfaction, just that there will be no satisfaction in the job.



Other findings from the study indicated that these factors were effective in motivating the individual to superior performance and effort, hence the term motivator.

Hygiene Factors: The hygiene factors occurred most frequently in events where there were negative attitudes towards work and only rarely occurred where events led to job satisfaction. Researchers also noted that the hygiene factors consistently resulted in short duration change of attitudes.

Hygiene factors were so named because they were associated with conditions surrounding the job and were related to the individual's need to avoid unpleasantness associated with the work. In the environment where the hygiene factors are not a problem there will be a minimum of discontent or dissatisfaction, but it does not follow that there will be satisfaction with the work.

Conclusions:

Job satisfaction is realised only when the person experiences some sense of growth from the work. Such experiences may come from solving problems related to the work, reaching realistic goals despite difficulties, completing a quality job and receiving recognition for it, having responsibility for some actions and decisions, growth in job capability and so on.

Where work satisfaction is high some of the problems giving rise to dissatisfaction will often be ignored.

Where work satisfaction is low or absent attention tends to be focussed on the dissatisfiers. In response, efforts may be made to improve conditions but work satisfaction is not achieved by such changes. Dissatisfaction may be checked, but for work satisfaction to occur changes must be made to allow for personal growth.

THE ANALOGY BETWEEN WORK AND STUDY

The analogy between work and study is very close and in many circumstances the differences are insignificant.

To study is to work, of that there can be no doubt. Learning usually is both difficult and time consuming. Effort is required to understand new concepts and ideas, to develop new thought processes and to assimilate and remember new information. Time and effort are required to take information, understanding and ideas and to synthesise a solution to a problem, a new approach, product or a system. Very often, one uses the same processes and tools to accomplish very different tasks.

The significant difference between work and study lies in the degree of learning that is associated with a particular objective or task. Often the nature of work has a substantially repetitive element and the increase in knowledge and new experience is often small. This is different from the learning process which is characterised by the continual assimilation of new ideas with limited time for application and repetitive type tasks.

There are many cases where the characteristics which are present in work are identical with those in study and vice versa. In such cases work is study and study is work.

The conclusion that may be drawn is that study is a division of work.

THE IMPLICATIONS OF THE MOTIVATION-HYGIENE THEORY TO THE EDUCATIONAL PROCESS.

A number of questions arise. Is it possible for lecturers to teach a course which ensures that there can be little or no satisfaction in doing the work? Is it possible for courses to suffer because factors which lead to dissatisfaction are present?

Obviously the answer is yes. Student newspapers have continually provided protest about courses, the material taught and the approach taken by some lecturers to teaching. The current development of counter course publications by students at Australian tertiary institutions provide further evidence that students are not satisfied with some courses and in some cases are highly dissatisfied. On the other hand, many staff would comment on the unresponsive nature of many students, their apparent apathy to some courses and in some cases downright laziness.

Other, more important questions can be considered. What basis can be developed for evaluating courses, to ensure that they provide satisfaction for students doing the course while minimising those aspects which lead to dissatisfaction? It is here that the Motivation-Hygiene Theory may be of considerable value.

It is true of course that the theory was developed and applies most aptly to the industrial scene. Nevertheless, as study and work are related there should be little problem in applying the major thesis of the theory to the development of courses and to the teaching-learning process.

cont.

THE MOTIVATION-HYGIENE THEORY APPLIED TO THE EDUCATIONAL PROCESS.

Motivating Factors (Satisfiers)

Achievement. Achievement was one of the factors which occurred most frequently in those jobs which were found satisfying. It is understood in the sense of completing a task which is considered to be worthwhile or have meaning to the individual. Achievement resulted in changes of attitude which lasted for a short duration. That is, to provide continual satisfaction in the work it would be desirable to have a succession of smaller tasks rather than a task of considerable length. Some implications are clear.

If a student perceives that completing or success in a final exam is achievement, then the satisfaction resulting from such achievement may well have passed by the time the student comes to apply himself to further work, i.e. the following year. (However, most would recognise that directly following exams most students would be incapable of doing substantial work, even if satisfied!) It is important to note that satisfaction due to complet- or passing the exam does not help motivate the student to study for the exam.

In many cases the objectives of a course may be indiscernable to the student. The student may, through lack of information about the course and ignorance about the education process, be unable to recognise the achievements which are occurring throughout the duration of the course. Such students who lack the satisfying experience of achievement may well lose the incentive to work.

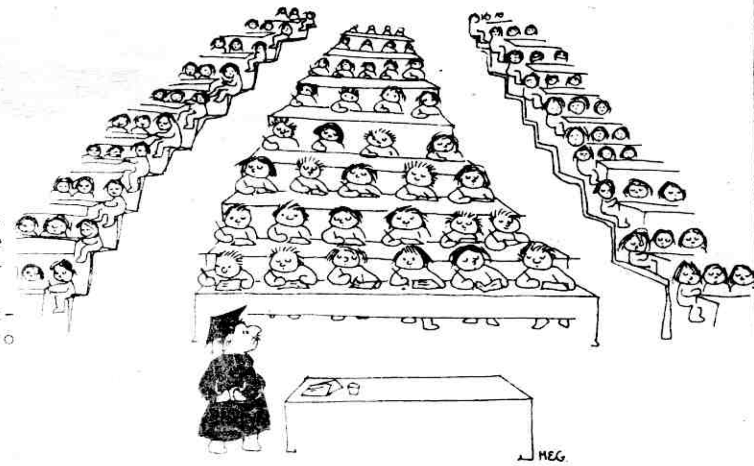
In many cases, substantial works (lectures, practicals and the like) may carry very little weight in the final assessment of a student's work. Many students will consider such tasks unimportant and find the work involved non-satisfying. This may be so even though such work may be vital to the completion of other tasks which are considered by the student to be important.

Many suggestions can be made to encourage the achievements which result in satisfying experiences and so encourage the desire to learn.

Wherever possible, courses could be constructed of easily discernable segments. Such construction should not be seen as trying to encourage the fragmentalization or compartmentalization of knowledge, but merely to help the student see the interrelationship of parts of courses. Where this is possible, achievement may be experienced following the completion of such segments. Students could be provided with outlines or synopses so that progress through a course may be seen as the progressive completion of a series of tasks.

Some of the students seem to think this place exists for their benefit.

An extension of such a construction may be seen in such courses where the 'core and option' approach is adopted. Here students can do work of more interest than that which may have been compulsorily assigned by having a rigid course with no choice. It is recognised that choice or the exercise of responsibility - discussed later in detail - permits a more personal approach to study which will usually allow personal growth to a much greater extent, hence greater satisfaction.



"THE ONE THING I'D LIKE TO STRESS TO YOU ALL IS INDIVIDUALITY OF APPROACH."

Most students will view achievement as occurring after the successful completion of a unit or section of work. Where it is possible for students to do this, e.g. terminal exams, mid-term projects, periodical essays, homework exercises and so on, the achievement permitted by such tasks may provide many satisfying experiences which may continually encourage the student to further work. It is recognised that most courses require an overall assessment to be made but most courses should be able to develop a reasonable mix of short and long term tasks which will allow this requirement to be satisfied.

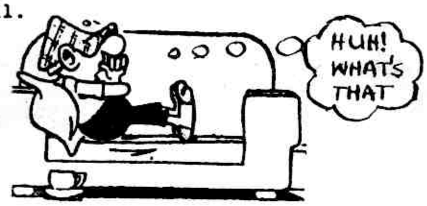
Recognition of achievement. Recognition of achievement occurred very frequently in those jobs providing satisfaction and was observed to cause a short duration change in attitude. Recognition of achievement may imply receiving credit for a particular task or realising that a particular task has been completed. In many instances recognition is closely linked with achievement. For example, a student may not experience the satisfaction of completing a worthwhile task until someone with greater experience recognises the achievement. The student may then enjoy the satisfaction of completing a worthwhile task and also the recognition resulting from the achievement.

As before, recognition of achievement must occur frequently if it is to provide continual satisfaction. Most students will see successful results as recognition of achievement and as before, those courses which use mainly final exams may provide satisfactory experiences, but they may come too late.

Positive feed-back to students is thus one important way of encouraging students to work. Courses which do provide for this feed back - by personal discussions and comments on work completed - will help provide the recognition that will promote satisfaction in the work. On the other hand, courses with little positive feedback may deny many students recognition that would promote satisfaction.

Recognition of achievement can be internal, that is, by the person accomplishing the achievement; or externally, that is, by others. Both provide for satisfaction from the work. It is to be hoped of course that as students proceed through a course they will rely more and more on internal recognition. This will come only as experience is gained in self-evaluation of work. Therefore, any efforts made in the direction of encouraging self-evaluation is likely to provide a dividend in helping a student to recognise achievement and thus internally promote the desire to learn.

Work itself. The nature of work itself was important in producing satisfaction and effected a change in attitudes of a long duration. The important point here is that satisfaction resulted when individuals did work that had intrinsic meaning for them. In such situations, the opportunity for personal growth is perhaps the greatest of all.



Some choice in the material studied is thus the most obvious way of providing satisfaction from study for a large number of individuals. The development of courses which permit some flexibility in the topics studied seems desirable. Again the 'core and option' approach may be mentioned. The development and use of assessment methods which permit the flexibility necessary to give individuals some freedom would also help. Such methods include research essays and projects, seminars, open ended practicals etc.

With the extent of knowledge as wide as it is, even with difficult practicalities to cope with, most subjects should be able to allow for a minimum of choice which will allow for personal growth.

Work itself was identified as an important factor which could even lead to the misinterpretation of one's feelings. Individuals who strongly sought for the motivating factors in work, i.e. strongly sought personal growth, often became disappointed to the point of considering themselves dissatisfied, rather than non-satisfied. Thus study where the nature of work is disappointing to the individual, may have a side effect more adverse than just non-satisfaction, possibly promoting student action.

Responsibility. Responsibility was consistent in producing job satisfaction and effected a change in attitude of a long duration. Responsibility implied the individual was given more complex tasks requiring new knowledge and ability and where ambiguities permitted decision making.

It is often claimed that university students are given more responsibility than at secondary schools. It is suggested that students are given the responsibility to decide whether or not they will go to lectures, complete exercises etc. and to organise their own time, study habits etc. While in some respects this is true, often it is just a token gesture for the effective decisions are already made. Heavy work loads, effectively compulsory lectures, practicals, examinations etc., rigid courses and timetables, work together to rob the student of the satisfaction from manipulating study to achieve the greatest effect with maximum efficiency.

Greater responsibility could be introduced into courses by allowing students greater choice in the area of topics studied and assessment methods used.

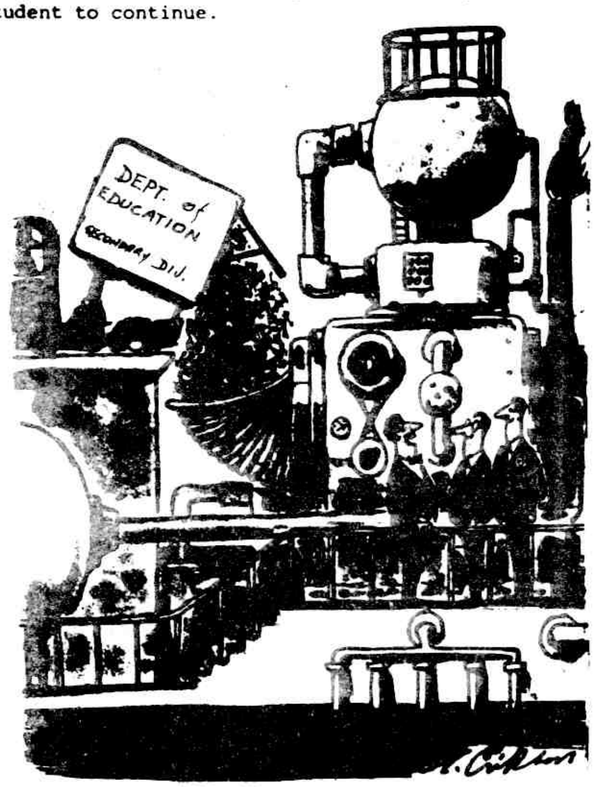
Students could be given more and more responsibility to study topics with less assistance from lectures. In suitable topics introductory lectures could provide the oversight required for study, leaving students to do the required reading, exercises etc. with limited help. Intermediate tutorials could provide for discussion and questions and final lectures could summarize the topic.

Greater responsibility could be given to students by formally assessing only some parts of a course while expecting students to study all parts of the course. In as much as this would increase the unreliability of assessment results, greater precautions would be necessary if the results were to be used for grading purposes. Using fewer and broader categories (e.g. 3-point scale) may be desirable.

Gradually increasing the complexity of the required tasks - longer and more detailed projects, problems etc. - is another way of giving a student greater responsibility. Courses which are limited in scope and depth may work against study satisfaction.

Advancement. Advancement was the remaining factor significant in producing work satisfaction. It was noted as a factor which could produce long term changes in attitude. Promotion to more complex work, to more responsible positions is one way of helping to produce satisfaction.

Undoubtedly this factor is fairly well catered for in the educational process. There can be little doubt that success and promotion contributes to the satisfaction that students find in study and thus helps motivate the student to continue.



"IN JUST FOUR YEARS WE'LL HAVE ANOTHER BATCH OF GRADUATES FOR YOU."

Satisfaction produced by this factor may be enhanced by intermediary steps in the process of yearly promotion. It is possible that students who proceed through courses by terminal units may well find greater satisfaction in work than students who proceed by years only. It is easy for students to interpret satisfactory results in units as advancement through the year, and will extrapolate results to predict success or failure. There is some evidence to suggest that some students under this system will stop working when sufficiently good results are obtained to guarantee over-all success. In this case, perhaps something may be said about the nature of the course, but the evidence is inconclusive either way.

Hygiene Factors (Dissatisfiers)

Here the implications of the dissatisfiers on the educational process are not quite so clear, mainly because students study under very different conditions to that of workers in external situations. Here research into study attitudes would reveal information of considerable interest and value, possibly identifying new factors significant in producing work dissatisfaction.

Dissatisfiers are associated with an individual's need to avoid or minimise 'pain' or discomfort from the work situation.

Perhaps 'Difficulty of Learning' is a new factor as yet unrecognised. Possibly it could be included under 'Working Conditions'. When staff facilitate learning, students do not become dissatisfied. When learning is made more difficult than students perceive it should or could be, they become dissatisfied.

Company Policy and Administration. This is most certainly analogous to University, Faculty and Departmental policies and administration. Which is most important will depend on the situation; the student and the circumstances of concern.

It undoubtedly covers the rules and regulations made by the various bodies, especially where students appear to be victimised in favour of staff interests, e.g. research vs teaching.

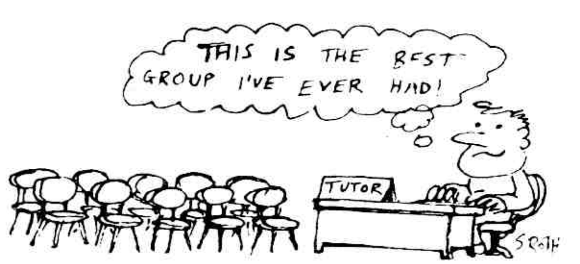
It may also include conditions imposed upon study to be done, assessment tasks, and imposed conditions relating to the presentation and organisation of lectures, tutorials, practicals etc.

Supervision. Most students do not find themselves closely supervised and thus dissatisfaction due to continual checking and lack of freedom is likely to be minimal.

However, if assessment is too often (this may be interpreted as a form of supervision) dissatisfaction may occur. Some students may consider supervision (or assistance) to be inadequate or hard-to-get, and this may cause dissatisfaction.

Supervision of practicals and similar occurrences may possibly be the most likely source of dissatisfaction. Supervision that is too close and does not allow the student to get on to doing the task is to be avoided, especially if the student feels a little foolish for not knowing quite what to do. However, supervisors can do everything possible to encourage students to ask questions and to resolve problems and in this way dissatisfaction is likely to be minimal.

Supervisors who are able to relate easily, openly and informally and who are prepared to become personally involved with students are at a considerable advantage to those who adopt a cool, abrupt and formal attitude.



Salary. The effect of salary is somewhat obscure, partly because most students neither get nor expect such a return, especially in the sense that other workers do. It is possible to equate salary with the living allowance received by some students from either government, business or parents. It could be that individuals who do not consider any long-term rewards to be of sufficient value will not take up study, and thus will not be so susceptible to dissatisfaction. On the other hand, as students find it harder and harder to make ends meet, the level of dissatisfaction may rise to the extent that students will protest in the street.

Interpersonal Relations. Some remarks relating to student-supervisor relationships have been made already in the section on Supervision.

The University is the sort of place where individuals can feel extremely isolated or become involved in a myriad of relationships with people of different philosophies, thoughts and backgrounds. While it is often very difficult for shy or retiring persons to break into some groups on campus it can be done. It seems doubtful whether a lack of fulfilling relationships and a general feeling of loneliness would be considered to be dissatisfaction, but it could be possible under some circumstances. Ways of helping to overcome this would be to have more personal enrolment proceedings, encourage small tutorials of the nature where students can discuss wide ranging issues and by supporting those activities where students can get to meet each other on more than just a study level. Personal interest in students is another way of helping to break down any personal barriers.

Dissatisfaction is most likely to arise from personality clashes. In as much as the University is a big place it is usually easy for most to avoid such clashes. This would normally be the case except where students are arbitrarily assigned into small practical, tutorial or problem-solving groups.

Working Conditions. This undoubtedly covers such things as workload, study facilities, availability of texts and references and possibly the standard of teaching and lecturing. Some of these aspects are well catered for when compared with work external to the university, and many problems could be solved if adequate communication occurred between students and staff. However, the resolution of some areas of dissatisfaction would require a re-evaluation of priorities and a rechannelling of time and finance.

CONCLUSIONS

It seems fairly clear that there is a direct link between study and work and that the Motivation-Hygiene Theory can be applied in many respects to the study situation. However, it must be mentioned that many other factors, external and internal to the individual, and important in promoting motivation, have not been covered. Such consideration was well beyond the brief of this article.

Further consideration of the teaching-learning process will certainly give rise to more examples of ways whereby students can achieve greater satisfaction and ways whereby dissatisfaction can be reduced. I have endeavoured to cover those which I think are important and could have a significant effect on students and their study efforts.

Undoubtedly, some research on this topic could well prove to be of significant value. Here it is hoped that the areas discussed will provide some helpful insights into the study-work situation and that some of the suggestions will be of sufficient value to be taken up

C. PARTICIPATIVE EDUCATION AND THE...

...INEVITABLE REVOLUTION

The following is a precis of the paper 'Participative Education and the Inevitable Revolution', by Albert R. Wight, published in the Journal of Creative Behavior, Vol. 4, No. 4, Fall 1970, p234-282.

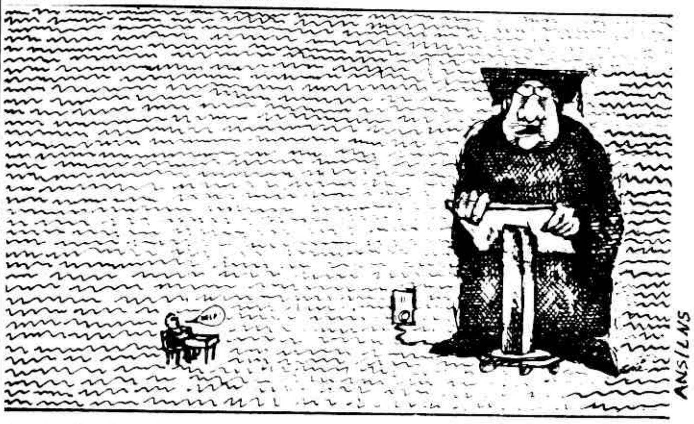
Change in education should not have to be brought about by fear. Educators should not have to be coerced into assuming the responsibility for reappraising the needs and goals of education and making the necessary changes.

THE NEED FOR CHANGE

Carl Rogers (1967)* stated that our educational system "cannot afford to develop citizens who are passive, whose knowledge is settled and closed, whose ways of thinking are rigid, who have no feeling for the process of discovering new knowledge and new answers". Julius Stulman (1968, p15) felt strongly enough about the inadequacies of the present system to say that "Any educational program based on the old traditional methods, with their antiquated concepts, would be miseducation .... It is conceivable that the methods used in teaching today are not only completely inadequate, but actually injurious." Indeed for "conceivable" here we should almost write "most probable".

And what of those who pass through this program? Chickering (1969, p285) cites several studies to show that "those who persist longest in college - compared with their peers who leave or who interrupt their education - are more authoritarian, more rigid, less creative, less complex". He added that "numerous studies of attrition show that the most creative and complex are the ones who leave."

THE TRADITIONAL CLASSROOM



And why do they leave? They get tired of seeing the lecturer in the center of the stage, retaining too much of the responsibility for the educational process. He determines the goals, decides and presents the content to be learned, tests for recall and understanding, identifies problems to be solved (usually problems with only one solution rather than real-life problems with many possible solutions), specifies the approach to be followed in solution, and evaluates the student's performance against his (not the student's) standards and criteria. The student is included very little in these activities and cannot, therefore, feel much responsibility for them.

* References are given in full in the original publication.

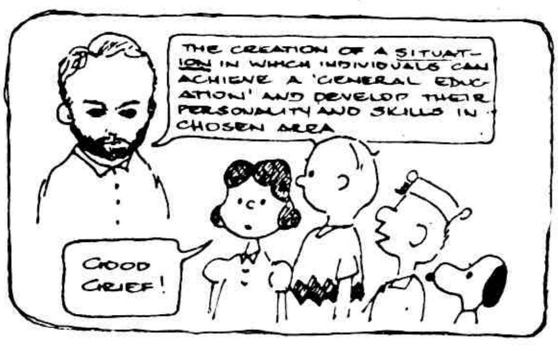
Traditional teaching methods, most of which are centered around the lecture approach, do not promote the kind of involvement and responsibility needed. Educators often complain about the lack of motivation, initiative, responsibility, vision, interest beyond assigned tasks, and imagination in their students, but they are only dimly aware of the fact that they, with their methods and attitudes, are creating and perpetuating this condition. Students weren't born this way.

PARTICIPATIVE EDUCATION : AN AVAILABLE ALTERNATIVE.

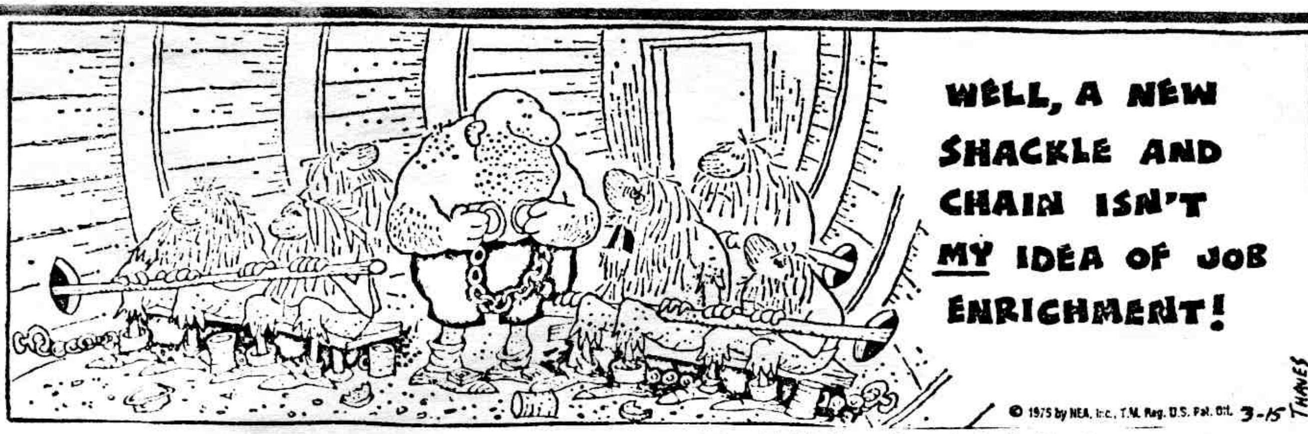
The name "Participative Education" was borrowed from the trend in industry toward "Participative Management" because it best describes what actually happens. The implication and intent are that the student is not the recipient of education but a participant in the educational process. The teacher, or instructor is not a transmitter of information, but a co-ordinator of learning.

Participative Education focuses on the process of learning, or preparing the student for the continued learning beyond his school experience.

For a specific course, the instructor establishes provisional objectives, but these are subject to modification through interaction with the students. Each student should see clearly how the goals of the course relate to his own overall goals. He should help define the specific objectives, should help identify meaningful problems within the scope of the class, should be actively involved in discovering what needs to be learned to solve these problems, and should seek this information himself, making use of any available resources. The problems he is given, or those he generates himself, should be meaningful in terms of his interests, concerns with life, or the requirements of his chosen profession. And in struggling to solve these problems, he should be developing the skills and understanding he will need to solve other similar or more complex problems later on, working alone or with others.



Against the traditional argument that the student is not equipped to define the goals of something he as yet knows very little about, that he lacks experience to identify problems or evaluate solutions, we hold that he will not learn how to learn, or learn how to solve problems if he is not allowed to become an active participant in the learning process.



Participative Education assumes that learning is facilitated:

* by trust in the student as a responsible person;
* when the student perceives material as relevant to his and the world's needs;
* by independent thinking;
* when the student learns by doing;
* when the student is allowed to make his own judgements, choices and decisions; when he is not given advice but is helped to explore alternatives; and when the teacher is not perceived as the final authority;
* when creavitity is encouraged and supported;
* by open communication, exchange of ideas, challenging, confronting and asking questions. (The lecture is a very inefficient teaching method - one-way communication inhibits learning;
* by informal, friendly relations with the teacher.

A student who manages to survive and succeed in the traditional system is poorly prepared to enter the real world in which he has to be able to actively learn on his own, to think, and to solve problems. The adjustment is often difficult to make, and requires considerable time. Employers blame the educators, educators blame the parents. Everyone blames the student.

THE FAILURES AND ACADEMIC STANDARDS

The objective of far too many universities is to maintain so-called standards of excellence - excellence arbitrarily defined as achievement on academic tests measuring recall of facts and principles transmitted through lectures and assigned reading. It is the student who must conform and meet the "standards of excellence", or drop by the wayside.

But the educator can no longer refuse to accept the responsibility for his product, the failures as well as the successes. Those who fail cannot help but lose self-esteem and self-confidence. With the emphasis on competition in the classroom, and grading on a curve, failure is ensured. Only a very small group at the top really succeed, and the very few at the top are often unbearable intellectual snobs, interpersonal failures, and emotional cripples.

Rather than a system that places emphasis on academic standards and intellectual abilities, we need a system designed to develop the whole person, the full range of potentialities of each individual student. Rather than competing with one another for grades in a lock-step system, students should be working together to explore, identify, and develop their individual potentialities, interests and abilities. (Compare this ideal with the situation at Adelaide Uni - ed.) In such a system, nearly everyone could succeed and find a place in society where he could contribute, achieve, be respected, and respect himself.

THE GOALS OF EDUCATION

The purpose of education should be to prepare the student for life, not just to provide him with a superficial exposure to the accumulated knowledge and values of the past and with the minimal skills necessary for acceptable performance in a given trade or profession.

According to Carl Rogers (1967), "Learning how to learn, involvement in a process of change - these become the primary aims of an education fit for the present world. There must evolve individuals who are capable of intelligent, informed, discriminating, adaptive, effective involvement in a process of change."

ROLE OF THE INSTRUCTOR

In Participative Education, the instructor serves primarily as facilitator, catalyst, and resource. Much as a coach, in the beginning he provides the rules and structure, he helps each person develop the skills and understanding to play the game or perform effectively, and he works with each individual to continuously improve his performance. He emphasizes co-operation and teamwork (although the objective might be competition with another team). But it is the player, not the coach, who plays the game, and in Participative Education the game is learning.

SUMMARY AND CONCLUSION

Participative Education is offered as an alternative to Traditional Education to achieve the objectives and satisfy the needs of a rapidly changing world.

Participative Education attempts to involve the student in meaningful experiences, experiences relevant to his future life and occupation, and to provide him with the opportunity and a methodology for learning from this experience. Students do not become dependent upon the instructor, but develop self-reliance, confidence in their own abilities, and, as a result, increased self-esteem. They leave school more mature,more sure of themselves, and equipped for life-long continued learning.

In the process of Participative Education, students learn how to learn, to solve problems, and to work effectively with others. Students who were educated through such a process could not help but be better prepared for the real world than are those who are subjected to the traditional approach to education. And the impact of such students on the world could not help but make it a better place to live.

D. THE UTAH EXPERIMENT

The following is a precis of the paper 'Implementing a Problem - oriented approach to Learning - An Application of Participative Education' by L. Dale Harris, Professor, Department of Electrical Engineering, The University of Utah. The paper was published in The Journal of Creative Behavior, Vol. 5, No. 1, First Quarter 1971.

Acting on the principles of Participative Education (see previous paper), and on the conviction that perhaps above most other disciplines;

> **"Engineering education should ...be a creative experience, stimulating the imagination of students and helping them prepare themselves for the unresolved contests and the new challenges of an imperfect world"; ..**

a rather extensive experiment was set up at Utah University to develop the practical applications of the theory.

The basic concept treated was that an improved engineering education can be built around an emphasis on the solutions of certain selected problems. The "problems" here, are significantly more than the exercises found in many engineering textbooks. The problem used is one to encourage a self-learning problem-solving approach; specifically it is such that it:

1. Is relevant as viewed by the student. He becomes emotionally involved and is motivated to solve the problem out of interest and excitement. He does not view the exercise of solving the problem as merely another assignment towards a course grade.
2. Demands imagination or creativity.
3. Challenges the student, yet falls within his range of capability.
4. Leads him to a desire to discover new principles, facts and techniques in order to arrive at a situation. Here the learner acquires content.
5. Leads to many different approaches and solutions generated by a group of students.
6. Sometimes presents a situation where the group is unable to find an acceptable solution.
7. Occasionally includes some data and facts that are not pertinent to the solution.
8. Is sometimes stated with insufficient data for solution.
9. Is occasionally rather simple and easily solved; sometimes the problem is rather long, requiring intermittent effort spread over a two-week period.
10. May require design or synthesis, or may require primarily analysis.

Most of these problems are generated by the instructor, since problems with the above characteristics are difficult to generate. Much of the instructor's total effort is invested in this area.

THE PROBLEMS SET FOR A PARTICULAR COURSE

Surely the engineering student must absorb the kind of content found in textbooks in order to solve the problems. He also needs this content in later courses and in engineering practice. However, it is important to keep in mind that ideally he should be motivated to understand content in order to solve problems rather than to absorb content for favorable recall at examination time.

A PROBLEM-ORIENTED APPROACH AT THE UNIVERSITY OF UTAH.

At the beginning of a course the student is presented with a set of problems. He is told that he will have completed the course when he solves the problems in a satisfactory manner. However, he is also encouraged to substitute other problems of his own making. In some, but not all of the classes taught by this approach, examinations are given.

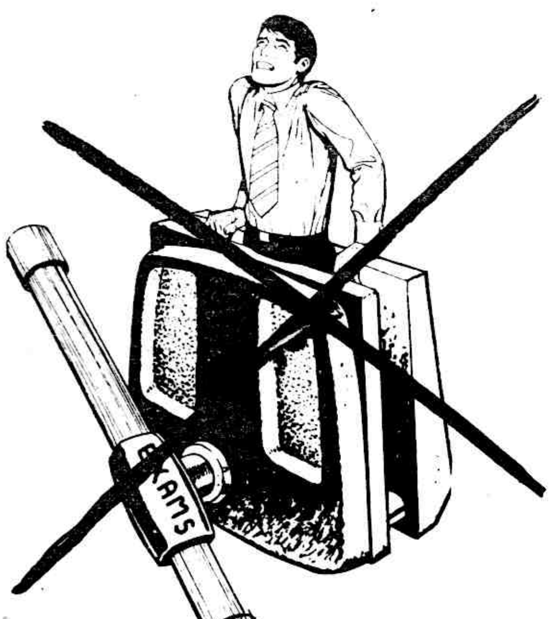
The number of lectures given in the problem-oriented approach is about forty percent of the number given traditionally. Attendance at lectures is voluntary, and the lectures are always closely related to one or more problems. Small group discussions (scheduled upon request by the students) are directed toward the solution of one or a few of the assigned problems. An advisor (the instructor or one of his student assistants) attends these discussions. Student-to-student and student-to-advisor dialogue develops.

Grading procedures and other factors encourage students to share in their ideas, approaches, and solutions. In the traditional approach, where grading is on the curve, a student often is discouraged from giving assistance to one of his classmates; but in the procedure described here, the student is encouraged to use all resources, including his classmates. Ultimately, however, he must, on his own, demonstrate his "qualification" on each problem solution.

In this procedure, the learner seeks whatever assistance seems appropriate to develop solutions: he searches pertinent content from texts and other written materials, participates in group discussions, seeks insight in the laboratory, informally discusses approaches with classmates, and otherwise uses appropriate resources. He proceeds at his own pace, and **when he feels he is prepared, he makes an appointment to present his solution to an advisor. Depending upon the procedure for the particular class, he may report alone or in a small group of perhaps two or three to defend his solution.**

There have been important variations in how problem solutions have been graded, but there is a strong tendency in these classes to give only three grades: A, B, and *Incomplete*. Because all of the students, teaching assistants, and instructor have a common goal (all students earn A or B grades on all problems), the traditional competition for grades is eliminated, and all persons involved are encouraged to cooperate with each other. Some students find their best resources for learning in other students.

Depending upon the instructor and the particular course, several different approaches have been used to evaluate the student's solution to a problem. In one common approach, a student has *qualified* on a problem only when he has earned an A or B on his solution. Two students wishing to qualify on a particular problem might meet with an advisor for a twenty-five minute period. Typically, the advisor would ask each of the students to evaluate his classmate's solution. Each has an opportunity to present and defend his own solution and also evaluate a classmate's solution. This procedure seems to lead to very effective three-way dialogue - two persons evaluating a third person's problem solution. If in one of these sessions the student does not qualify on a problem solution, he merely returns (no blight on his record) to another qualifying session. Failure to qualify is not *failure* in the ordinary sense.



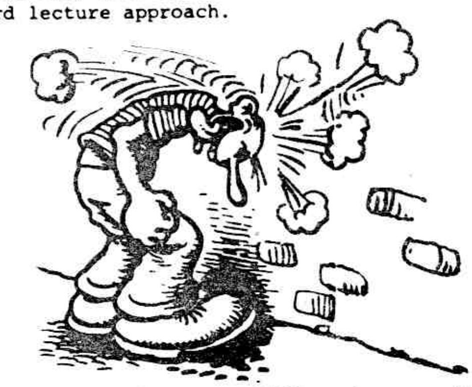
In procedures of this kind, many instructors see no need for recall examinations and base the final grade exclusively on the composite of all of the grades received in the qualifying sessions. If the student does not perform at least at a B level on a particular problem, he is not graded until he has reached it. At the end of the term, if he has not qualified on all problem solutions, he is given an *Incomplete*, which is converted when he does qualify.

The *A-B-I* grading system has been applied to only two classes that have been reported and two that are now in process. There are indications that the number of *I's* given will be tolerable. After-the-term "qualifying" sessions are not appreciably more expensive to schedule (so that students may clear *I's*) than are in-term sessions. However, the student has lost most of the advantage of both scheduled and unscheduled discussion with classmates and advisors, and he generally loses the continuity of the effort. If he wishes to take advantage of the regular procedures of the same class at a later offering, he merely makes informal arrangements without re-registering.

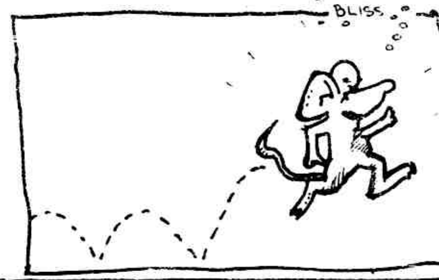
In these problem-oriented courses, the student is not assigned laboratory jobs in the ordinary sense. However, he is confronted with problem situations wherein he finds it desirable to use the laboratory as a resource in much the same way that he uses his textbook materials, his classmates, the computer, and other resources in reaching his problem solution.

EXPERIENCE WITH A PROBLEM-ORIENTED APPROACH

Each instructor in the department has been given the choice to teach each of his classes in his own way. Four instructors in the department now teach all of their classes with a problem-oriented approach. Three instructors have stated that as long as the choice is available they will never teach another class by the standard lecture approach.



How do students adapt to a different approach? Some students very carefully steer themselves into the problem-oriented classes, while others purposely avoid these classes. Some like the excitement and low-boredom level of the problem oriented classes; others find the frustration level too high. Many students are happy about taking a class by either approach, especially when they can select the instructor. All in all, student choice is moving towards the problem oriented approach. In some recent classes approximately eighty percent of the students chose that method.



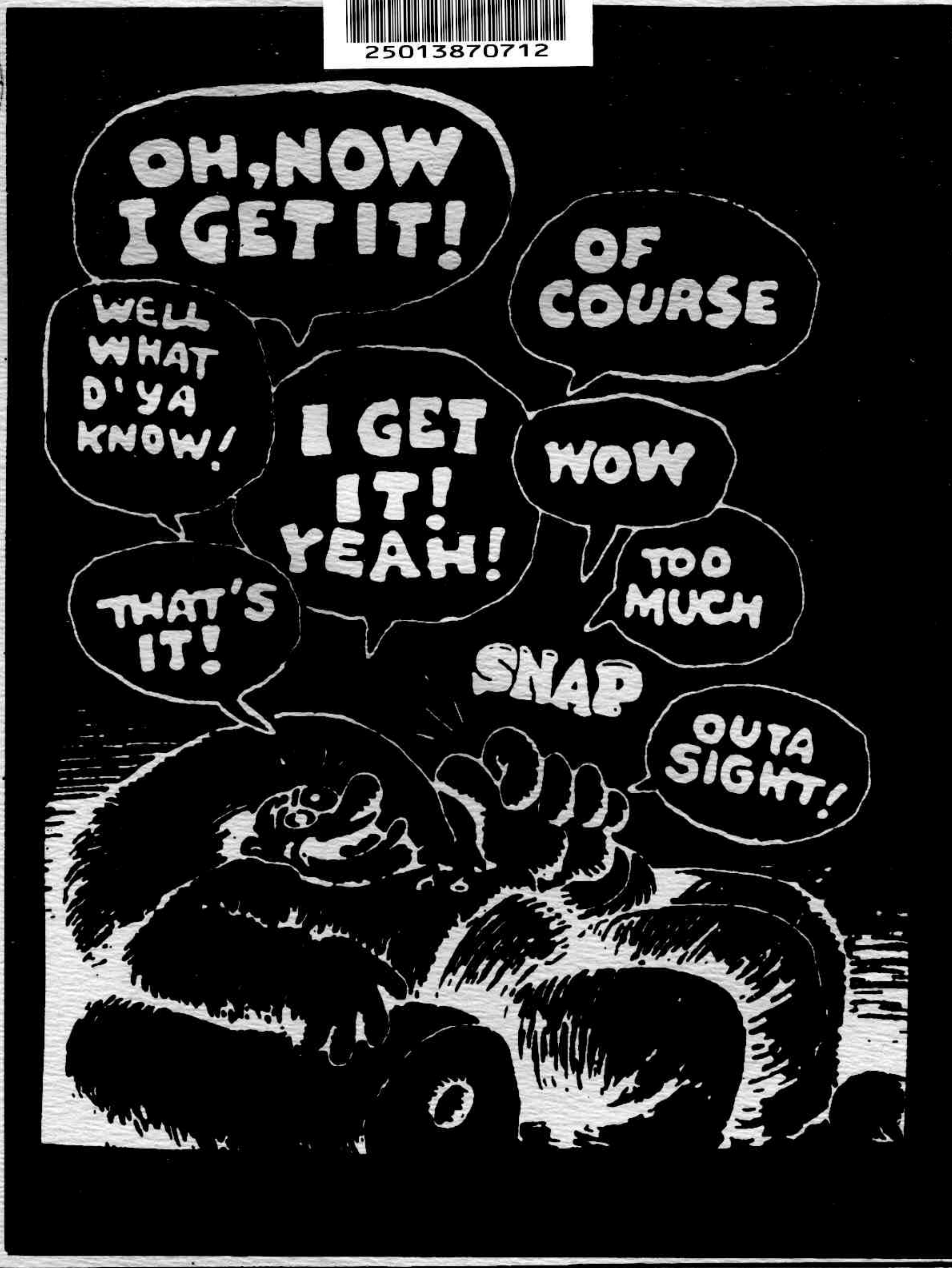
EPILOGUE

Exactly what this handbook achieves yet remains to be seen. It is only a first attempt and much could be done to improve it. There are plans to evaluate this handbook and to incorporate the suggestions in the next edition. There are also plans to revise some of the material and prepare a booklet for secondary school students. In particular, special efforts will be made to encourage women to take up Engineering and thus promote a more wholesome attitude within the Faculty and eventually within the Profession.

There will always be a place for a student handbook, simply because there will always be new students who will be seeking help of some sort or another. It is hoped that those who have found the handbook helpful will be prepared to contribute in some way to the next edition. Only in this way will the handbook remain a valid expression of student concerns and be tuned to the most important needs of students.

If at some time you find yourself frustrated and alienated by the way the course is given or the underlying philosophy and you find yourself identifying with parts of this handbook, take heart, you are most certainly not alone. Your thinking is certainly a valid alternative, if perhaps in some ways the minority view.

However, unless action and involvement follows there will be few improvements made. In 1976, there are going to be changes in first year, some along the lines suggested by the first year students who took the time to evaluate last year's course and make suggestions. There are similar possibilities for every course. It will take effort and much constructive thinking, but the results will most certainly be worthwhile.



This handbook is part of wider programmes of the Education Group which has the aim of providing educational information and help to students who are either undertaking or going to undertake a course at Adelaide University. Eventually it is hoped to have a student handbook for every Faculty.

Another complementary booklet is also being produced and will be available early in 1976 (Orientation Week). It will be called 'The Learning Booklet', is written for students and will provide information on aspects of the educational process, for example, curriculum processes, informal and formal learning, assessment and so on. It hopes to provide students with information which will enable them to take a greater responsibility in their own education.

The Education Group would welcome new members and if you are interested, contact Peter Jarrad, Rm. M209, Dept. of Mechanical Engineering, or Peter Love via the Student Activities Office.

THE OFFICIAL UNOFFICIAL

ENGINEERING HANDBOOK