T.A. FARRENT.

THE ENGINEER—

MAN of DESTINY

A Summary of the Proceedings of the N.U.A.U.S. Engineering Faculty Bureau Symposium in May, 1958, at the Adelaide University.

THE ENGINEER—

MAN of DESTINY

Editors: Ian Flower
Bob Davis

Assistant Editor: Michael Isaachsen

Business Manager: John Bateup

A Summary of the Proceedings of the N.U.A.U.S. Engineering Faculty Bureau Symposium in May, 1958, at the Adelaide University.

- The Facts -

Most reputable dictionaries will define a Symposium as being something along the lines of "a drinking party, a merry feast, a collection of papers on the one subject" — so obviously there was more to "The Engineer — Man of Destiny" than the sort of thing you'll read about in the rest of this booklet. We all know of the shocking results of all work and no play and so the Symposium organisers arranged a rather strenuous programme of relaxation for their thirty six interstate visitors.

These happy fellows arrived on Monday night to be welcomed at a Smoke Social, where they were shown films, given supper, invited to sample the local ale and exhorted to hurry up and pay for the rest of the week's activities, which they dutifully did. After this they were allowed to return to their billets, and had a few hours of rest before the opening address the next day.

As the morning and afternoon were fully occupied by the presentation of papers, Tuesday evening was the ideal time to have a dance. This was held in the new Refectory, with bevies of beautiful nurses (plainclothes) in attendance — details of the latter part of the evening are not on record.

Some of the less hardy souls were observed to be weakening under the strain by the Wednesday morning's lecture session, but this had been anticipated, so there were no papers presented on Wednesday afternoon.

An Educational Trip was offering for those who wished to improve the mind, and surprisingly large numbers of Greasers went down to see the Railway Workshops at Islington. It was here that the organisers had their first triumph and managed to leave about a dozen blokes to walk home in the rain — but they didn't seem to mind, and didn't even blink when they were refused a refund on their bus fares, so there must have been compensations on the way back to the city.

Wednesday night was left free, so again there were bevies of beautiful nurses in attendance . . . .

Thursday was also free of social obligations, and most people rested in preparation for the next day, although some of the lucky blokes who were still on speaking terms with their feminine friends arranged a quiet little evening at Luigi's.

Friday — ah, that was the day! Sixty surprisingly fit Engineers climbed aboard two tourist buses and set off for the Barossa Valley. The sun was shining, birds were singing, Engineers were singing — and the programme was to be mainly a study of Fluid Mechanics. The first stop was at the Gorge Kiosk, where one busload decided to examine the properties of a small rope suspension bridge and proved that is could have three points of contraflexion and still stay together. Then on to the South Para Reservoir to look at water, and have lunch a little further along the road.

The afternoon was the time — a visit to Gramp's Orlando Winery, where not only were students shown the lovely stuff, they were compelled to gather in the tasting room and actually drink the stuff. This led to the first casualties of the day, but who cared?

Angaston was the next port of call, and the Brighton Cement Co. showed the party over their works and fed them with a large afternoon tea. This servea as an appetizer to the Farewell Dinner at the Vine Inn, Nuriootpa, where the boys really warmed to the task and made the publican rub his hands together gleefully. What a night!

And so the week drew to a close — with the definition of "Symposium" faithfully followed.

History of THE PROFESSION

by Professor F. B. Bull, M.A., B.Sc.

By taking for the title of this Symposium "Engineer — Man of Destiny" it is clear that the organisers have unbounded faith in the future of engineering and engineers. That engineering will become even more important few can doubt, particularly when one considers the amazing advances which have been made over the last few decades. So startling indeed has been the progress over the last 50 years that one might be tempted to feel that engineering itslf has no roots further back than say the Industrial Revolution. This superficial view is really very far from the truth and our profession had its origins in the very earliest times when man first began to live in organized communities.

Our forefathers in the profession were not always graced by the name of "engineer," indeed the word coming from the same Latin source as does our word "ingenious" is of relatively modern application. Whether called "Engineer" or not, the breed is clearly recognisable right from the time of Tubalcain who was, as we may find in Genesis 4 (R.V.) "A forger of cutting instruments of brass and iron."

It is true that we know very little of these early engineers as individuals; even when recorded history began to acknowledge their works the names of the engineers themselves were suppressed so that some ruler or politician could claim the glory. Thus we read of the Pyramid of Cheops or the Temple of Solomon but who the engineers concerned were, is unknown. (This phenomenon is not altogether unknown in more recent times!).

It is not until we reach the times of ancient Rome that any clear picture of the work of individual engineers emerges. Men like Vitruvius who in the early years of the Christian Era wrote his "De Architectura Libri Decem" would easily qualify as an engineer. These ten books gave a comprehensive account of engineering and architectural activities practiced at that time. Frontinus, a fellow countryman of Vitruvius, was another of these early engineers who has left us a personal record of his activities and achievements. Frontinus was in charge of the water supply of Rome. He put down his experiences and gave an account of the technical practices in use at that time in his book "De Aquis Urbis Romae."

Later in the mediaeval times the engineer appears in the building of the great cathedrals, many of whose individual works are known. Outstandingly the most advanced engineer of the Middle Ages was Leonardo da Vinci whose work on such problems as heavier-than-air flight, armoured fighting vehicles and submarines was so far ahead of his time. To say that Leonardo was an engineer is perhaps a little glib, since this unique man was an astronomer, geologist, biologist, scientist, philosopher, doctor, poet, painter and sculptor and can be claimed by amost any one of the learned professions. Nevertheless it was mainly on account of his engineering talents that Leonardo sought and obtained employment with Count Sforza under whose patronage he served 16 years and carried out many works of civil and military engineering.

The employment of those who we would now recognise as engineers by wealthy patrons was a practice which survived until comparatively recent times. Indeed only with the emergence of a recognised profession of engineer were those who practised as engineers able to achieve financial independence.

Perhaps the last of the great engineers to serve under the old patronage system was James Brindley (1716-1772) who for many years served the Duke of Bridgewater in the development of coal mines owned by the Duke. Brindley worked on the eve of the Industrial Revolution. His great contribution was the liberation of internal communications by the building of canals, in all over 360 miles of them. Brindley himself received virtually no formal education and remained almost illiterate throughout his life. Nevertheless he successfully evolved locks, he managed to build many miles of canals through tunnels in the hills and even built an aquaduct to carry one of his canals over a navigable river.

Brindley's canals effected a revolution in transport. Before their time there was no practical method of cheap inland transport. The roads were virtually useless and railways unthought of. It is true that the pre-eminence of the canal system was short lived, but it served its purpose in triggering off the subsequent great changes in communication systems brought about by later engineers. For example, the work of Telford and Macadam was soon after to restore the roads to an effective means of communication for the first time since the departure of the Roman Legions. In their turn the roads were superseded in the next century by the railways arising out of the pioneering work of Stephenson. It is interesting to note that the process is now tending to go in reverse and road transport is now giving a serious challenge to the superiority of the railway. One idly wonders whether canals themselves will be revitalised to complete the cycle!

One factor more than any other was responsible for the emergence of modern engineering. This was the discovery of a cheap and effected source of making iron and subsequently of making steel. We find it difficult in our modern age to think of engineering without plentiful and cheap ferrous material. But before the 18th century iron was anything but plentiful and far from cheap. It was not for mere opulence that we read of one of the Viking kings that his sword had a cutting edge of the finest steel backed with gold. It was probably the cheapest arrangement! So long as iron had to be smeltered with charcoal in small furnaces and subsequently worked by hand, the limitations were obvious. Only when means were found of using coal for smelting could any permanent industry be established. A further prerequisite was the need for efficient communications to bring in the raw materials and carry away the finished products. Rapid development took place along these lines in the latter half of the 18th century and large iron plants were established, so that the production of iron rose many fold in a few decades. The revolution in iron production made possible the work of such great men as Watt, Trevethick, Murdock, Telford, Stephenson and many other. The profession began rapidly to become organised. It was John Smeaton (1724-1792) the builder of the Eddystone Light, who first adopted the term Civil Engineering to distinguish his activities from the military sense of the word then commonly accepted. That the profession rapidly became accepted can be seen from the fact that whereas Brindley in 1765 was paid 3/6 a day for his work for the Duke of Bridgewater, John Rennie in 1815 was able to command seven guineas a day for his work. It is true that the outraged Paymaster of the War Office (for which Rennie happened to be working at the time) pointed out that this was more than the Army paid Field Marshals. Rennie replied that he was a Field Marshal in his own profession and assumed that if one of the Army's own Field Marshals would have served the War Office's purpose, he supposed they would not have called upon him.

The earliest attempts to create organised Societies of Engineers were only partly successful. Smeaton himself was the leader in one such attempt. He called together "The Society of Engineers" who met in London at regular intervals and discussed engineering matters over a meal. This was disbanded due to internal dissension in 1792. In the Midlands the group called "The Lunar Society" although not restricted to engineers was much patronised by them — among other prominent members of this group was James Watt of steam engine fame. The first successful society of Engineers was the Institution of Civil Engineers first founded in 1818. By the efforts of the first President, Thomas Telford, the Institution received its Royal Charter in 1828, and has flourished to this day.

With the organisation of engineering as a recognised profession, the situation as we see it today was rapidly established. So that now engineering is accepted as an essential part of modern civilisation.

In this brief review I have wandered back over some 5,000 years to show you that our roots do go deeply into the past. It is right that we should pay our tribute to our forefathers in engineering by whose labours we stand on the brink of whatever destiny may decree.

MODERN ENGINEERING HISTORY

by C. E. Hall, B.E.,
Consulting Engineer.

The invention of a practicable steam engine about the year 1800 was one of the outstanding landmarks in the history of mankind as well as in engineering, for from it have flowed those immense technological developments which, in the last 150 years, have altered so profoundly our whole material civilization.

Admittedly much ground had been prepared previously in the construction of buildings, bridges, dams and roads, things dependent on the basic science of Statics, but after 1800 the accent was on dynamics with its practical manifestations in the forms of prime movers, ships, rail, road and air transport, leading to intense study and developments in the cognate sciences of electronics and metallurgy.

The story of these developments is the history of modern engineering, and while history is a record it is also a flux, a restless interaction between the human mind and its material surroundings, having its roots in the past, continuing and developing and if we are wise enough to read its lessons, offering signposts for our future course and progress.

An engineer faced with some problem in development tends to seek for a formula or plot a graph which will indicate the trend or posibilities which need to be explored but history is too complex a subject to deal with in this manner and yet, there exist concepts in other sciences which enable us to form some idea as to where our efforts are leading and provide a pattern or framework for future moves. In this connection it is useful to apply to engineering developments basic ideas from other sciences, for example the biological notions of evolution, environment, mutation and the fundamental idea of the survival of species.

In engineering, evolution is the theme of all progress, it hits us in the eye every time we meet a model T on the road, every time we see a plane in the air; mutation when we change a design from wood to steel or aluminium or plastic; environment in the comparative development of South Australia and the Northern Territories. But such comparisons should not be pressed too far, for survival in engineering depends on economy and that product will survive which provides the greatest satisfaction for the least expenditure of material, time or effort. Moreover in engineering the rate of evolution is immeasurably faster than the rate of biological evolution.

It has taken many millions of years for dogs to evolve to their present form, and their function — to keep off intruders — has been developing over thousands of years. Rockets, on the other hand, which serve the same function, have been developed during the last two decades and in many respects transcend their biological prototypes. Admittedly we still have some research to carry out before we can put two rockets in a shed and expect to see a litter of rockets in the course of time but nevertheless automation and biology warn us of the possibility.

These biological concepts help us in some measure to understand how, between 1800 and 1960, the more technically advanced nations have changed from agricultural communities to industrial communities and in this revolution the engineer has played a predominant part.

The vast diversity of engineering proceses and products has led to increased specialisation. On the face of it the men who build bridges, the electronics men, the shipbuilders, the chemical engineers are engaged in totally different spheres of activity and have little in common.

What is there which sets engineers apart from politicians, doctors, lawyers, actors?

To me it seems that the engineer is one who transforms or in some measure helps to transform the raw materials of nature into forms more useful to mankind and in these days acts as the essential link between the exact sciences and the crafts.

He is one who lifts the physical burdens from the shoulders of humanity and makes the earth a more pleasant place to live in.

Engineering can be and is a fascinating and absorbing pursuit, but it behoves an engineer to remember that he is a part of humanity and that an understanding of human relations is necessary to his evolution and progress.

Of the achievements of the engineer over the past 150 years libraries of books tell the story, from the horseless carriage to the diesel electric locomotive, from James Watt's first engine to the 275,000 K.W. turbo generator and from Faraday's experiments with a magnet and a coil of wire to our present globe encircling telecommunication systems.

But even now these achievements are slipping back into recorded history; already dawns to-morrow, the nuclear age, the age, maybe, of interplanetary travel.

In the past the Engineer has faced and met the challenges thrust upon him and we can be sure he will equally be ready to deal with the challenges of the future.

THE PRESENT POSITION

by W. F. Patterson, B.E., A.M.I.E. (Aust.).
Design Engineer E.T.S.A.

There seems to be world wide acceptance of the fact that there is a marked shortage of engineers, with varying degrees of seriousness in different countries.

The Working Committee for the Development of Supporting Technical Personnel in reporting President Eisenhower's Committee on Scientists and Engineers, states that modern industrial nations need to produce 200 engineers per million population per year.

It is going to be some years before the necessary number of engineering graduates becomes available to industry, despite active steps now being taken.

The present level of advertising in Australia gives one a definite impression that there is an appreciable shortage. This impression is confirmed by enquiries to the Commonwealth Employment Service and by some of the larger employers.

Even if we are prepared to assume that there is no shortage at present the rate of increase in the number of graduates each year is negligible and it becomes obvious that we are heading for greater difficulties in future if some prompt and effective action is not taken.

All countries concerned realise that some positive action is essential since standards of living are inextricably involved with engineering progress.

This thought is expressed in the Presidential Address at the Annual General Meeting of the I.E.A. given at Canberra by Mr. R. W. Parsons, M.E., the Principal of the S.A. School of Mines under the title, "The Engineer and his Education." — I quote:—

"It is probably true to say that the high standard of material comfort which modern society enjoys — and so largely takes for granted — is due to the work of the engineer in giving practical expression to the discoveries of modern science, the results of which, during recent years, have been so far-reaching and on such a scale, that it is extremely doubtful whether the advances in engineering technology have been commensurate.

Each new use to which the results of scientific and technological research are put serves to confirm that their field of influence is almost boundless, and strengthens that conviction that, in the short term, we have more to gain from the application of what is already known than by further basic discoveries in the field of pure science.

When viewed from the standpoint of an over-expanding field of applied science, the subject of the engineer and his education may rightly be considered to be one of perennial interest, while from the viewpoint of many nations of the world, impoverished by wars and now struggling desperately to increase their industrial productivity and to regain some of their lost export trade, it may well prove that the extent of their economic recovery, and indeed their survival, may be dependent upon the imagination, skill and ingenuity with which their programmes in engineering education are planned."

The problem is being attacked in a number of ways, among the most important of which are:—

1. Educate the Public in an increasing awareness of the dependence of our future prosperity on an adequate supply of engineers.
2. Provide scholarships and financial assistance to students.
3. Expand educational facilities.

There is another obvious difficulty; we must have more and more teachers to cope with these students. Further, the intellectual level and training of these teachers must be of an increasing standard since the level of a student's education is dependent on the talent of his teacher.

4. Guide competent students to an interest in the profession.
5. Make better use of the engineers we have.

I quote from "The Electrical Review"—

"Engineers themselves realize that if they were relieved of much routine they would be able to devote more time to real engineering. Some engineers might increase their usefulness by being free to develop their skill and talent without unnecessary hinderance. A project is sometimes delayed because the engineer may not have enough time to give it the attention it deserves."

There is still a failure by the general public to discriminate between the engineer and the engine driver, just as for many years the architect and the builder were regarded as being the same. Today the differences are gradually being realised.

Whilst most engineers derive a good deal of satisfaction from the results of their professional efforts it would be idle to pretend that monetary reward does not play an important part in this.

On their salaries, engineers come out fourth following doctors, lawyers and dentists in that order. The break-down of income shows a rather different picture. Only 10% of engineers get over £3,000 a year, 38% of engineers earn from £1,500 to £2,000 and another 38% from £2,000 to £3,000. Fewer engineers are in the under £1,500 class than in any of the other professions considered. Australian engineers reach their maximum salary between 40 and 44 and maintain this to retirement. Earnings of doctors, dentists and lawyers begin to fall after 55. Engineers in the top bracket are all sole practitioners or partners. They are well ahead of those in Commonwealth State and Municipal Service.

In this country the Institution of Engineers Australia is the main engineering fraternity. It appears that the majority of professional engineers are members. The activities of the Institution are limited to culture, education and ethics. Working conditions and salary rates for professional engineers are the special interest of the A.P.E.A. It will be realised that the I.E.A. includes all professional engineers, employer, employee and private practitioners, whereas practically all of the A.P.E.A. members are engineers in employment.

In a country where the principle of industrial arbitration is so firmly established it becomes absolutely essential to have some body to represent the interests of the professional engineer in the Commonwealth Courts. At the same time, being a body whose membership is limited to professional engineers it is actively engaged in the crusade for the public recognition of the Engineer.

There are at least two other bodies offering membership to engineers for representation in the industrial arbitration field. However, neither of these bodies have attracted much interest from professional engineers since the membership is open and is not restricted to professional engineers.

They are:—

(i) The Association of Architects, Engineers, Surveyors and Draughtsmen of Australia, and

(ii) The Electrical Trades Union of Australia.

However much we might envy the professional regard and recognition accorded the medical profession we must recognise that it would be difficult to obtain the same recognition for engineers.

To enhance the engineer's contribution to society, and to merit the voluntary acclaim which we seek, all engineers young and old must give continuing attention to three key features — Responsibilities, Relationships and Qualification.

The Engineer's Place in Society

by Arthur W. Meadows, M.A., Ph.D., F.B.Ps.S., F.I.S.

Head of Psychology Dept., U. of Adel.

Although we may reproach people for talking about themselves, nevertheless it is the subject they treat best. Perhaps on these grounds this address on the Engineer's Place in Society would have been given much better by an engineer. However, an audience of engineers in training may be interested in the views of people like myself who come from the Social Sciences and who are supposed to know something about the social behaviour of people including engineers.

Let me commence by saying that the work of the professional engineer captures the imagination of youth very early, and while some converts stay to make engineering their life's work, others pass on to different fields and yet retain some elements of what is, in fact, a romantic view of the engineer's place in society. People embued with romanticism see the engineer not only as a man of destiny, but as **the** man of destiny, that is they see him as the centre of a world with advanced systems of communications, elaborate mechanical services and human wants being satisfied by touch button controls. Such is the paradise that engineers may attempt to make for us but "of such stuff are dreams made," for although this may be a factually correct view of the future, it is only a partial view. If, as a result of this imaginative view, the engineer sees himself as the primary provider and man of destiny, he will be disappointed when men's reactions to him do not accord with the gifts he and his profession have provided or made possible.

It is true that society wants all the amenities the engineer can provide, but this does not mean that the engineer will become the key man in society. Neither engineers, nor social scientists, nor philosphers will be kings because the engineer's view of society and the social scientist's view of society and the philosopher's view of society are partial views. Taken each by themselves they present a romantic view of the world. Dazzled by romance the engineer may take for granted his place in society and engrossed in the desire to bring about the welfare of society he may forget that no man can, at any time, gain the complete support of all men, for what he sees clearly is "a good thing for humanity." Men do not readily agree about such things as what is "good" for society any more than they agree about what is "true" or "just." Clearly then the engineer's place in society as a man of destiny will be an important one but he will have to share his views, to compromise and sometimes to wait, before the world will accept what he can clearly see to be a "good" thing.

In contrast to the romantic view of the engineer's place in society, is the view of the realist. The realist engineer may believe that in order to convince people of his value to them, all he has to do is to point to the amenities he provides and to the facts of living, in order to convince people of his point of view and of his worth. Psychologists have shown that man has appetites and emotions which require satisfaction, against which the display of fact or the appeal to reason are without power. Some cynics have said that of all the ways of defining man, the worst is the one which makes him out to be a rational animal. The engineer's place in society as a realist would seem to be one in which, as an engineer, he does not lose contact with the other man's point of view, or with the ordinary newsy and prosaic ways of men. He should not become like the famous doctor described by Fishein as "an expert surgeon, brilliant pathologist, uncanny diagnostician. but somewhat rusty on advanced cigarette testimonials." At the best man is on occasions a reasonable being with emotions and instincts in control, but at the worst the average man is an irrational creature who is looking for either home atmosphere in a hotel, or hotel service at home. Clearly the engineer's place in society is to advance man's material welfare while, at the same time, taking into account the irrational and supra-rational elements in his nature.

Turning now to the engineer's place in society as an educated individual, it seems clear that through his associations in a University, the engineer will have developed interests and perhaps even skills widely remote from his professional purposes. We assume this because we know that it is the function of the University to give this kind of education in spite of the specialised divisions in the teaching programme. We also assume that a man's capacity as an engineer will have included something in addition to utilitarian skills. One assumes that the engineer will have read outside his subject and read widely and critically, remembering in this connection that while reading made Don Quixote a gentleman, believing all that he read made him mad. Allow me to further emphasise the point by adapting a saying of John Stewart Mill's that "men are men before they are engineers, and if the Universities make them capable and sensible men, they will make themselves capable engineers." There is perhaps one note of warning required. Specialization is a part of social evolution. No man can know everything well so that attempts at broadening the education of an individual may finish up as dilettantism. Whatever may be the definition of the whole education of man it must include the cultivation of special abilities and in one sense the whole man is a specialist because if he is not we must suspect that he is then merely a nostalgic ideal.

The fourth view of the engineer's place in society is one in which the engineer plays the part of a professional person. But what is a profession?

Briefly we may say that a profession is a vocation in which a professed knowledge of some department of learning or science is used in its application to the affairs of others. A profession is not only the possession of a body of knowledge, it is also the possession of an educational process based on the knowledge for which the members of the profession have a recognised responsibility. Additionally a profession must have a standard of qualifications for admission based not only on training and proven competence but also on character, that is a profession expects a standard of conduct based on courtesy, honour and ethics which guide the professional member in his relations with clients and the public. The engineer's place in society as a professional person is one in which he contracts to serve society over and above all specific duty to client or employer in consideration of the privileges and protection society extends to him. Every engineer should take seriously his professional role in society in agreement with Bacon who said, "I hold every man a debtor to his profession from the which as men do of course seek to receive countenance and profit, so ought they of duty to endeavour themselves, by way of amends, to be a help and an ornament thereunto." At the same time I would advise engineers against becoming narrowly professional, that is over concerned with the internal affairs of the organisation and development of the profession as such. The professional engineer must constantly remind himself that the strength of any profession ultimately rests on the support its members can draw from the ordinary members of the community.

The engineer's place in society is logically determined by the view he holds of the complementary values of the individual and the group. In the broadest sense the view may be designated as either "individualist" or "collectivist" and it is very easy to become a bigoted adherent to either one view or the other. The engineer will find that as he moves into any social situation, the social atmosphere will be dependent partly on the group of people with whom he works and, to a limited extent, on himself. The reciprocal impact of individual and group has been analysed more recently by Reisman in his work, "The Lonely Crowd." Reisman's analysis, which applies more particularly to America, suggests that individuals, by virtue of their upbringing, tend to adopt either an "inner-directed" or "other-directed" type of mind. Briefly Reisman's theme is that only four decades ago men's characters were largely "inner-directed." Inner-directed persons were individualists, pioneers, with a belief in the virtues of the individual and the ethtc that man gets what he deserves — "hard work leads to success, laziness to the devil." It was the time when a church-goer favoured preachers who admonished the congregation for their sins in the belief that a few home truths would do his neighbours no harm. It was the time of the "self made man."

Now unfortunately many of the self made men were horrible examples of unskilled labour, who did not see until too late the incalculable harm of many of their financial policies. However, the economic depression and the Keynsian revolution, among other factors, contributed to the decline of unbridled individualism in business and finance. Again with the growth of urbanization, standardization, group bargaining and State Socialism, men became increasingly aware of the influence of the group and of party discipline and conformity to groups generally. In Reisman's terms an increasing number of people became **"other-directed,"** that is there was a tendency for the character of more people to be formed chiefly by their peers and contemporary events rather than by parents and individual proclivities.

While it is true that Reisman's analysis of present day American society is perhaps overdrawn, nevertheless contemporary conditions in Australia do provide examples of the "inner-directed" versus "other-directed" philosophies. Let us see how the psychological state of being either "inner-directed" or "other-directed" can develop.

Assuming that you have been brought up during the last three decades, no matter how much of an individualist you might be, if you live in close union with others the instinct to survive, let alone good sense, is likely at the time to make you emphasise the extraverted side of your nature. Present day society does not encourage one to be either alone or to isolate oneself for periods voluntarily. Isolates are now regarded as a species of crank. You many suggest that the suburbanistic group mindedness depicted is merely a passing phase and a mere surface expedient dictated by a necessity and not one of inner impulse. To disabuse you, consider the way in which the majority of present day parents reinforce group mindedness. Note how much parents see life as one of group action, and the emphasis they placed on the acquirement of the social skills of getting on with others. Parents themselves, have acquired more or less all these skills but it is a source of pride to them that the ways of group living, group organisation and group manipulation are becoming more a part of the general educational process. This adaption to the group is extolled because it has become more of a necessity, in a life in which everything changes more rapidly than before. Adaption has become the constant in the equation of life and those who stand out are no longer described as pioneers, resolute and firm-minded, but may often be termed pig-headed or anti-social.

It is true that there are still some people who behave as individualists and potential leaders in the community and that these types of people differ from their more conforming neighbours, but the question is in what respect do they differ? True they are more individualistic than the rest of their contemporaries but this is only a surface comparison. Psychologically these individuals and potential leaders now hold in a more distinct fashion **the group view of man as an extraverted social being** and, therefore, they too tend to equate the lone individual with the psychiatric patient. This theme of the increasing tendency of urban man to be "other-directed" rather than "inner-directed" has also been developed by H. W. Whyte in his book, "The Organisation Man," to quote — "We have learned not to be so introverted, one junior executive — a very thoughtful and successful one told me. Before we came here we used to live pretty well to ourselves. On Sundays, for instance, we used to stay in bed until about 2 o'clock reading the papers and listening to a symphony on the radio. Now we stop around and visit with people — or they visit with us. I really think we've broadened."

To paraphrase Whyte, "where once the majority of people liked to feel that they were in control of their own destinies, fewer people now cherish such notions. Most people see themselves as objects more acted upon system as by themselves. In a word they "accept" and if we do not find than acting, and their futures are therefore determined as much by the this comforting at least we should recognise that it would be very odd if they did not feel what is after all a sense of confidence, bred of a fairly benevolent environment, a permissive and benign paternalism in education with apprenticeship in life commencing under an expanding industrial economy."

But, to continue the theme — the old poor have been left behind and there has been, as a consequence, a greater equalising of social opportunities for the majority of the people. One of De Tocqueville's views now becomes particularly apposite — "The more equal social conditions become the more men display a reciprocal disposition to oblige each other." But this disposition towards egaliterianism, which eases social co-operation carries with it the defect prophesied again by De Tocqueville namely, "If

America ever destroyed its genius it would be by intensifying the social virtues, at the expense of others — by making the individual come to regard himself as a hostage to prevailing opinion — by creating in sum a tyranny of the majority."

It is not my purpose to suggest that the function of the engineer in society is to become a rugged individualist adopting again the catch as catch can methods of the nineteenth century, but to say prepare yourselves now for some of the more pervasive methods of group pressure towards conformity, and mass methods of persuasion coming into use at present which sap away individual reason, judgement and decisiveness of action.

Now is there any solution for the engineer in this conflict between individualism and the demands of groups in society? The engineer's dilemma is no different to that of other men and in this case there is no single solution unless we allow that both individualism with collectivism is the solution. As a practical engineer, however, you might well ask the question, what can you do about a social situation in which prima-facie it would appear than you can only gradually alter small details because of the pressures extered by that interdependent system called modern society. As Karl Manheim says, "the system too often gives to our acts only the scope of the mason replacing old bricks in a wall that is already built." But he goes on to say that "nevertheless there is spaced around the wall where new things can be done and where new activity is required, where, in fact, as much spontaneity is demanded of the new engineer's actions as in the first stage where primary freedom reigned."

To conclude then, I have tried to show the engineer's place in society as a romantic, a realist, an educated man, a professional person, and finally as perhaps one with other men being determined by either inner needs for self expression or by the pressures of society. Bcause you are the engineers of the future and the pressures towards conformity are very considerable, perhaps I might be forgiven if I urge you the more strongly, at this stage, to preserve and to nurture rational and enlightened individualism because as Jowett says in his introduction to Book III of Plato's Republic. "Whence has the progress of cities and nations arisen, if not from remarkable individuals, coming into the world we know not how, and from causes over which we have no control."

The National Dependence on the Profession

Part One

by S. E. Huddleston, B.Sc., B.E., B.Ec., A.M.I.E. (Aust.).
Assistant Manager E.T.S.A.

It is not difficult to show that the nation depends on the engineers. One merely has to imagine society deprived of its engineers. The engineer occupies the key role in the community because he is the senior artisan — the builder and the doer. He is a man who takes the resources of nature and modifies, moulds and adapts them to the use and enjoyment of mankind.

Our society is shaped by the activities of the engineer but in a primitive society this would not be so. Australia, being a young country, exhibits this fact very strongly. Without the engineer the cities, dependent for their existence on modern methods of transport, power supply and communication, could not exist, and it is almost certain that Australia could not even support the population of 10 million which it will soon exceed. However, the real importance of the engineer has only emerged in the last 150 years or less.

It would be a conservative estimate to say that more than half of our working population is directly engaged in engineering and allied trades. It would also be true to say that the whole of the working population is indirectly dependent on engineering.

Our society takes this situation for granted. There is never any doubt that if something has to be done, then engineers will be able to do it.

The engineer doesn't necessarily determine why things should be done. His essential job is to do them.

The engineer works for society — he translates into material products the ideas of society — he produces the things that society wants. This has two consequences.

Firstly, it develops a method of thinking in the engineer to which I will refer later. Secondly, it forms a quite definite boundary line of engineering activity. Within this boundary the engineer works to produce a given result as economically as possible.

However, engineers may operate outside of the boundary and, thinking that they are still engineers, operate inefficiently in the new environment. Also other groups blunder inside the boundary and deal with engineering matters when they are in fact still politicians, scientists, accountants or civil servants.

In a modern society a new discovery will initially be the work of a scientists. He may be directed in a general direction but his true aim is his own. When he makes his discovery that is his product. He will go no further. If he wishes to take it further he is no longer a scientist.

The engineer is motivated by society because he must make something that society wants and being an engineer he will find out what that is before he starts. If he gambles on whether society will want it or not, he is not an engineer but a businessman — an entrepreneur.

You have heard scientists talk about nuclear power stations being used to irrigate the dead heart of Australia. It is a scientist's job to deal in ideas — he doesn't have to put them into practice.

You have heard newspaper editors comment on the desirability of such things because ideas are news.

But you don't hear of engineers giving their opinions on the cost, reliability and practicability of such schemes because it is not an engineer's job to decide whether such things should be done or not.

The end is set by society and the engineer's job is to produce it economically and efficiently.

It is important than an engineer should recognise that engineering as such has well-defined boundaries. Not the least element of this importance is that he should recognise when it is his duty to drop the role of engineer and take up that of businessman, counsellor, administrator or even prophet.

I am satisfied that if engineers gave more conscious recognition to the fact that they are departing from engineering activity when in the course of events they are called upon to play these roles, then they would handle such things more easily.

In addition they would find less frustration in having to meet changes and delays which sometimes seem to be only whims of the section of society which is setting the goal for them to aim at.

In my opinion one of the short-comings of the engineering profession is that it is inclined to keep within its own boundaries.

I have wondered about the reasons for this and my conclusion is that an engineer's training leads him to a manner of thinking which encourages him to stay away from these activities.

During the years of his professional training and his early experience, the engineer deals almost wholly with the material things of pure engineering. Such things behave consistently, predictably and logically. The physical and chemical laws governing the behaviour of materials are accurate and usually well understood, but in any case an answer will emerge which is accurate and which will enable the project to be properly established.

Where a profession deals not with material things but with say human behaviour, the method of approach must be somewhat different.

When an engineer first mets this type of problem he finds himself not well-equipped to handle it. Such a situation usually first arises when, as he advances in his profession, he becomes more and more a controller of men and less and less a controller of things. As he advances still further, he reaches the stage where he deals not in material things nor directly with human beings, but with ideas. At this stage he is no longer an engineer in the true sense of the word.

Nevertheless, he has reached a position which in our complex society a majority of engineers will or should reach. You may say that an engineer must necessarily behave as an administrator, a manager or even a businessman.

It is my impression that the engineer first really meets his outside problems when he is placed in charge of a group of people who bring their own type of problems with them.

How well he will deal with these problems then depends largely on himself. Some people find the job easy. They have a natural aptitude for organisation, for handling people, for originating and expressing ideas.

But for most of us it requires education and perseverance. In my opinion the road is just a little more difficult for engineers because their early training does not inculcate flexibility nor the facility to discriminate between conflicting opinions on one subject.

You have heard that society needs engineers and scientists.

But society needs quite as urgently — I believe even more urgently — managers and leaders, people to direct the aims of society into desirable channels.

It is often stated that technology has nowadays outstripped sociology. But the man in the street is inclined to go further and attribute many of the ills of society to scientific groups. He completely overlooks the fact that scientific groups do not set their own goals.

I am sure you will agree that engineers handle engineering jobs very efficiently and it is reasonable to assume that society would benefit greatly if people with scientific training could become an important part of non-scientific groups.

There is a strong tendency nowadays in scientific education to attempt to reduce the "cleavage between those who follow the discipline of society and of the humanities and those who are eagerly pursuing the quest for scientific knowledge" by broader education for scientists and engineers. There is not nearly such a strong tendency for a move in the opposite direction, namely an injection of the scientific method into non-scientific education.

I have been talking a lot about society. Society consists of all social groups of which engineers are one. The composite of clergymen, farmers, lawyers, housewives, engineers, labourers, etc., makes up our society — our nation.

Is it reasonable then that we should talk of the national dependence on one particular group — on the engineer? Is not the engineer equally dependent on society?

Obviously he is.

Our modern society is extremely complex. Some thinkers have expressed surprise that it works at all, and indeed it frequently gets severe ailments.

Our society could not work without engineers, but neither could it work without doctors, lawyers, school teachers, truck drivers, farmers and bankers.

I consider that it is not a particularly profitable occupation to contemplate the dependence of society on any one of these groups. Unless of course, one is making plans to extract some benefits from society by exploiting one's key role in it.

Some social groups, indeed, have propounded for so long the theme of their own key role in the nation that they have persuaded other people to believe it.

I, therefore, agree that there are proper circumstances in which engineers should consider the national dependence on the engineer, and a proper place in which they should endeavour to convince other people of the fact.

My advice to young engineers which emerges from the thoughts of this talk, is this:—

> Make some conscious effort to prepare yourself for non-engineering activities. The collective intelligence of the engineering profession is not at present being used in the community to its full advantage. See if you can spare some time away from the study of technology to have a look at the intricacies of sociology. As a professional engineer you will frequently have non-engineering roles thrust upon you. Do not wait until they are thrust upon you — prepare yourself so that you are happy to seek them out and to handle them.

The National Dependence on the Profession

Part Two

by Mr. C. W. Corbin, B.E., M.I.E.E., M.I.E.Aust.

It is apparent that the responsibilites and duties of an engineer in this age are much wider than the tending of engines, even though this may be the opinion of the unthinking general public. It is therefore necessary for engineers to take a much broader part in the community than is generally the case.

To survey the role of Engineer in National Development, it becomes necessary to consider the present position and build up a picture of its shortcomings before considering the inevitable expansion and development.

Let us begin with our present surroundings, the engineering school of the Adelaide University. When I started my course the School had just emerged from the basement of the original building to the spacious quarters of what is now the Physics block. We had one Professor of Engineering and about thirty students in each year. The progress since then is apparent, but if projected forward at a similar rate the requirements of the engineering school may soon be the entire present set of University buildings.

Consider a further simple example. The requirements for electrical engineers. Power generated in Australia is doubling every 8 years and consequently a similar cumulative growth of engineers is necessary.

Added to the growth of science and engineering which is occurring throughout the world we have superimposed in Australia an immense National Development. In the last 10 years, spurred on by a population growth of 2 million and assisted by investment from abroad of £500 million, we have almost doubled our production of ingot steel and the number of people engaged in manufacturing has doubled. We have seen the commencement of five large oil refineries sufficient to process 8 million tons of crude oil per annum, and a further refinery is to be established in this State. It is apparent that there will be plenty of work for the engineer in these fields alone.

We, in Australia do not suffer from a shortage of food — our export surplus is the main factor that enables us to maintain a high standard of living. Much time has been given to the application of power in industry but are engineers spending sufficient effort on the use of power in agriculture?

Since the beginning of this century we have seen the invention and complete development of a number of projects, mostly regarded as completely impossible in the previous century. To us it may seem that there is very little left for engineering application, other than the further development of things now known. But of course, there are many daily problems, with which we are beset, that urgently need the attention of the profession.

I feel that it is high time, that more technically trained engineers emerged from their workshops and drawing offices to take a greater interest in general affairs. The Engineering training, which conditions the brain to a logical asessment of a problem and a rational solution, is ideal for other activities, such as the running of a business, school or church committee, town council or even Parliament. How many of our City Councillors or Members of Parliament in this State are engineer-trained. Probably none.

I do not infer that some of these pursuits are entirely neglected by the profession, but I think it is true that the place allotted to the engineer in the present organisation of society is inadequate and he rarely attains to positions of command. Though willing to collaborate in carrying out the projects of others, he seldom has the direction of those economic, administrative and political forces on which the progress and well-being of the community depend.

This state of affairs is, I believe, due to the tendency on the part of the engineer to specialise and to get wrapped up in his particular branch of the science. He fails to appreciate the need for a more general culture so necessary for success in the administrative field. We need only look to some of the examples of the past to see how an individual can be a leader in one field of knowledge without excluding all other interests. Leonardo da Vinci was outstanding as an artist, an engineer and for his researches in anatomy. Men such as this realised how best could be combined a knowledge of science, with a study of the arts and man in his environment to contribute to a common whole which we have called civilisation. We need to recapture this spirit to integrate the ability of the engineer into the problems of general living. Progress on these lines will improve the status of the individual engineer and of the community.

It is obvious that we are going to need more engineers. The shortage has been emphasised in the Western World by the recent accomplishments of the Russians. It is said that Russia has 280 graduate engineers per million of her population, U.S.A. has 130 and the U.K. 60. The figure for Australia is probably less, but it is encouraging to see that greatly increased finance is becoming available to boost up the output of University graduates. Of course the need does not finish here, as we need an ever increasing flow of technologists, tradesmen and skilled operatives. If the community realises the need, the funds will be made available; it is therefore essential, by such means as this series of talks, to give publicity to the rate of increase necessary.

If the training facilities are made available then we have to find the raw material, namely students, to process, and this proves some difficulty in a new and growing country such as Australia. I have two suggestions to make in this regard. One is to give more opportunities to migrants and the other is to develop woman power. Many young girls show aptitude for mathematics and scientific subjects but there is still a great deal of prejudice against women entering the engineering field: such prejudice used to exist but has largely been overcome in medicine and law. Of course, there is the marriage hazard which can restrict the value of women to the community as engineers. The opinion has been expressed in England that if a woman engineer could be employed for 4-5 years after training, it should be economic for her to be thus employed. I consider more attention should now be given to the employment of women at all levels in engineering, as a partial means of assisting and speeding up Australia's industrial development.

Another aspect that needs some thought is the future method of employment of engineers. At present we are tending towards a concentration of experienced engineers in Government or semi-Government instrumentalities. This has certain dangers, stemming from possible political control to bureaucracy and promotion by seniority instead of ability. The place of the skilled engineer in private enterprise, often on the administrative side, should be developed and guarded.

The use of engineers in a consulting capacity is sadly lagging in Australia in general and South Australia in particular. The firm of consulting engineers is a much more common feature in Great Britain, and this is a most economical method of applying the highest engineering skill to everyday problems. If we are to progress at the same rate as other more highly developed countries, then we must have more consulting engineers.

I have not touched on such important matters as the recent advances in electronics atomic or hydrogen energy or even space travel; in all of these matters engineers are already engaged in exploring new horizons which will lead to a way of life as yet unknown.

Unfortunately, the same advances have not occurred in human nature. The scientist is often blamed, illogically, for the destruction which may result from the misuse of the immense powers made available. Here again the logical engineer outlook may well assist the community to a saner collective behaviour and the ultimate abolition of war. If this were achieved then the engineer could truly claim National Dependence on his efforts.

Educational Needs

Part One

by Professor E. O. Willoughby, M.A., B.E.E., B.C.E.

The University's Role

Much confusion often exists as to what is the duty of the University in regard to education, and these few notes may be of assistance in clarifying the situation. The University should:—

1. Plan to educate for the future 15-20 years hence, when the graduate usually reaches senior status, or leadership.
2. Guide the studies of the student by proper selection of material, and give tutorial assistance.
3. Encourage self expression in seminars and student lectures.
4. Encourage staff research — this is necessary to vitalise all levels of teaching, as well as to contribute to basic knowledge.
5. Interpret and evaluate the importance of new developments.
6. Train students in research.

Students should realize that they educate themselves mainly by working through the investigations of the great minds of the past and present, and the best conclusion to graduation is at least a year of research to toughen the mental fibres and develop initiative and confidence, by testing one's own powers on a difficult problem with a minimum of external guidance and pressure.

Staff Needs — Types of Graduates Required.

Let us now consider the problems facing engineers.

From the community point of view, there is a need of large numbers of technologists to run factories, expand standardised equipment such as power lines, telephone facilities, water supplies and so on, and further to act as clerks of works and many other similar routine duties.

The bulk of this work requires only moderate academic ability, but good organising skill and reliable character are essential. It is an ideal life for those whose abilities are more of a practical and social nature.

Those responsible for the planning of the growth of technology and industry, have so exacting a task that it seems desirable that they receive special training. Nowadays the rate at which new ideas come forward, some of them very difficult to understand and assess, makes it essential that people in this class of work should be of outstanding academic ability.

One of the problems, however, is that at present it is very difficult to determine who these people will be within the first year at the University, due to the fact that many boys come to the University handicapped by indifferent secondary education. Some of them improve steadily and are first class by the time they reach the end of their course, and this is very true of a crowded syllabus such as engineering.

We is South Australia, due to the excellent relations between the University and the School of Mines, have arrived at a good solution to this problem and one which will improve as secondary education becomes more uniform and higher in level. The School of Mines runs a 3-year course in Technology, leading to the B. Tech. Degree, and some of the work which in the past 10 years has been undertaken in the engineering courses will now have to be transferred to this course, which will be more restricted in fundamental content, and give good training in design, workshop practice, so that the student is of immediate use in certain fields of technology on graduation.

In parallel with this, the University runs a 5-year course leading to the B.E. Degree, aimed at giving the student a much higher level of training in pure science, mathematics and engineering sciences than is possible in this more restricted course. In Adelaide the syllabus of this course is undergoing revision so that we can meet the more exacting demands of leadership in technology and administration.

This division of activities between University and Technical colleges or technical Universities seem to me an ideal arrangement, and by grouping the more brilliant together, we may achieve the stimulation and cross-fertilisation of ideas in a way achieved by some of the bigger American research Universities.

With the B. Tech. left to the technical colleges and technical universities, it would be the responsibility of the University to turn out leaders in industry and administration who are adaptable, ready to learn and alive to new development in science and technology and with a keen awareness of the social implications of these developments.

This may imply a drive to make secondary education more efficient and comprehensive, particularly in mathematics, science, languages and economics. It further may ultimately lead to the need on the part of the University to pay less heed to the immediate value of a graduate in terms of skills, and more attention to his ability to think out new problems, or cope with unusual situations. This will in turn entail on the part of industry an even greater need to train employees at graduate level — i.e. to play its part in the education of professional engineers.

From the viewpoint of breadth and administrative training, there is much to be said for a coverage of the introductory engineering subjects in civil, mechanical, electrical and chemical engineering, particularly if they are taught not only as a technology but as applied science in a way that forms a good basis for further study even if this is not to be immediately pursued at the University.

Research and Development Engineers.

In addition to the year or more of specialisation in their chosen field for those who aspire to leadership in technology, there is much to be said for extending the training in physics and applied mathematics in a way that makes the student capable of an intensive attack on a difficult problem. One can expect future leaders in technology and research to often have outstanding qualifications in physics or chemistry and mathematics as well as in engineering. To assist such leaders in technology, they are often provided in American industry with subordinate administrative staff to leave them as free as possible to study scientific problems, as if it clearly recognised that the success of the industry rests on the success of its technical divisions, particularly in the electronic and aeronautical research industries. These trends in the U.S.A. are likely to give an indication of one of the patterns of life here in 15-20 years time, if industrialisation in Australia proceeds at its present pace.

Administration.

One of greatest problems in engineering today is the efficient management of large industries and public utilities. Staff tends to build up according to Parkinson's Law* and it is no use trapping good engineers by cadetships if no scope exists for initiative.

Far better for the organisation to provide more scope for enterprise and benefit by the competition thus engendered, and the better leadership that results. The occasional mistake is often compensated for by the improved overall efficiency and we must learn to integrate achievement and errors in assessing performance.

Educational Needs.

Those of you who hope to attain leadership of large organisations will need to develop a sense of affairs, such as is developed by a study of human relationships and economics. The history of some of our institutions such as the church, law and the government are ideal examples of development of human relations, and there is little doubt that in future you will find that as leadership becomes more complex, many of our leaders will have degrees both in engineering and economics or the humanities.

Computers.

One great sphere of development that will affect all our lives in the next 10-15 years is the rapid development of computers for problem solving both in design and administration.

On modern analogue computers we can simulate very complex control, and dynamical problems as well as make most helpful models of the behaviour of economic systems. On data processing digital computers we can model numerically stream beds, electrical fields, and solve industrial and production problems by linear programming, a new tool in industrial planning. Further, much tedious clerical work in inventory control, payroll calculations, as well as the processing of scientific results, such as in rocket testing, can be automatically carried out on such equipment.

The lack of adequate data processing computers is one of the handicaps in post-graduate university research and teaching in Australia, and judging by American experience, the lack of graduates trained in these fields will be acutely felt as the degree of industrialisation increases and more capital becomes available.

Note all M.I.T. graduates are now trained in programming computers.

In conclusion, I hope that the future trend in engineering education will avoid the gloomy picture some paint of a society wherein most of the interesting engineering problems are solved by physicists, and engineers are controlled by accountants. Unless our future engineers are good scientists and have a knowledge of affairs, this will certainly be the case.

With the expansion of industry and public utilities, engineers can be assured of growing opportunities for congenial employment, but I for one would like to see more engineers consciously preparing themselves for community leadership, and I wish to congratulate the organisers of this Symposium in making a sound contribution to achieving this end.

* "Parkinson's Law or the Pursuit of Progress," C. Northcote Parkinson.

Educational Needs

Part Two

by Mr. G. Sved, Dip.Mech.E., Dip.M.G.

Lecturer, Civil Engineering Dept.

Education has been defined as what is left when all that has been taught is forgotten. That there is some truth in this statement—obviously given in jest— can be seen by noting that a very considerable part of the material taught by present day University lecturers is not material they learned in their own University days—actually very much of it has been discovered since those days. Hence, accepting tacitly that University lecturers are educated persons and disregarding the irrelevant question of whether they have actually forgotten what they learned, they were given something that stayed with them and a desire and (let us hope) an ability to learn. It is this "something" that we are trying to impart to the students —the desire and ability to extend the knowledge gained at the University, to lay the foundations for a professional experience based on critical analysis of situations encountered and in equally critical reading.

Several committees of the American Society for Engineering Education investigated the education of the professional engineer (Aims and Scope of Engineering Curricula, 1940; Engineering Education after the War, 1944, "Hammond Report;" Report on the Evaluation of Engineering Education, 1955; "Grinter Report"). Some of their findings can be summarised by noting the division of methods, approach, thought into two parts: scientific—technological and humanistic-sociological. The first deals with facts, with physical laws, and enables us to make "true or false" decisions; the latter works with values and helps us to make "good or bad," "right or wrong" judgments. The Hammond report lists the tools of engineering thought. Generic principles, expressing general physical laws, are coupled with basic assumptions (usually introducing some simplification helping us to get a tractable mathematical expression) and with empiricisms. The result of these combinations are expressed as derived principles, covering most of our everyday engineering formulae and rules. The results of our accumulated experience in handling these derived principles are laid down in specifications, standards, codes of practice.

Doherty sets* out the steps in the intellectual development from factual knowledge, involving memorizing only, through guided logical reasoning by following the work of others and through acquiring manipulative skill to independent logical reasoning, first with aims defined and steps guided, to truly independent logical reasoning.

The Grinter report suggests the following **approximate** division for engineering curricula:—

Basic Sciences (Mathematics, Physics, Chemistry)	25%
Engineering Sciences (Mechanics of Solids, Fluid Mechanics, Thermodynamics, Transfer Rates and Mechanisms, Electrical Theory, Nature and properties of Materials)	25%
Engineering Analysis and Design	25%
Humanities and Social Sciences	20%
Electives	10%

Some of the local factors that have to be remembered when trying to compare the conditions in Australia in general and in South Australia in particular with overseas practices and proposals are: (a) there are only limited opportunities for industrial post-graduate apprenticeship or training; (b) relatively high starting salaries for young graduates; (c) the 40 hour working week for the community in general; (d) the limited market for graduates, making an early specialisation undesirable; (e) the existing matriculation standards, varying considerably between the different States; (f) the structure of secondary schooling, with insufficient separation between the students proceeding towards a University career and those who will not travel the full distance.

Finally, it must be remembered that the education of an engineer may be divided into three parts: about 12 years before coming to the University, about 4 at the University, but 20 to 40 years (or more) after leaving the Alma Mater.

Acknowledgements

The editors wish to express their appreciation for the financial help given by the following organizations:—

Melbourne University Students' Representative Council,

Melbourne University Engineering Students' Club,

Sydney University Engineering Society,

Tasmanian University Engineering Society,

Western Australian Engineering Students' Club,

and also for the help given by the Secretaries of the Mechanical Engineering Department and Electrical Engineering Department of Adelaide University.

Your Career Ahead

by J. R. Dridan, C.M.G., B.E., A.M.I.E. (Aust.).
Engineer-in-Chief E. & W. S. Dept.

What is a career? One dictionary gives the several meanings as "a racecourse," "a race," "course of action," "manner of life." Perhaps too many engineers regard their career as a "manner of life" and before long become creatures of habit, in other words the regularity of their habits takes precedence over the importance of their work, while insufficient of us regard it as a "race"—a race to learn all we can and do all we can in our short life span.

Consider this meaning of career as "a race." Such an outlook may also have its disadvantages as it may imply great impatience and lack of balance. Perhaps some men can race through life, subconsciously obeying the rules of the game, but most of us are obliged to pause now and again to consult the rule book.

Perhaps the third definition of a career — "course of action" — is the best definition of the word in-so-far as an engineering career is concerned as the word "course" implies that the career is under control and the word "action" speaks for itself.

When a man has completed his university course he has been soundly trained in the basic principles of engineering and should also have a well balanced outlook if he has made full use of his opportunities. He should therefore have sufficient breadth of outlook to choose a course of action lying somewhere between a heedless race and a manner of life aimed mainly at security. A university engineering course is not designed to turn out a man who knows exactly where he is heading. In fact, I think the training is purposely designed to produce a graduate with a good basic training but with an open mind.

There are five main types of employment available to a graduate, viz., a government department or instrumentality, a large industrial organisation, a small industry, a scientific organisation or a consulting engineer's office. There are undoubtedly good opportunities with some of the smaller companies as a young engineer immediately becomes an important figure in the organisation.

There are now many opportunities in scientific and research organisations for engineers who lean towards the more scientific aspects of their profession. Possibly the greatest disadvantage of such employment is the "backroom" and cloistered nature of the duties. Neglect to develop and foster the human relationship aspects could later detract from the engineer's chances of occupying an important administrative position. Good opportunities also exist in consulting engineers' offices although generally speaking, a young engineer is of greater value to his employer and can therefore command a better salary if he has had several years of practical experience upon the works in which the consulting engineer specialises.

Those who graduate today are far more fortunate than those who graduated say 30 years ago. Or perhaps I should say that they are far more fortunate **if they do not seek to take advantage of the fact that there are ample jobs offering by adopting a lackadaisical attitude.**

The first objective of any graduate engineer should be to quash any idea that his training has been completed and to set about completing this training. Take for example the human relationships aspect. During his period of education, he has had few opportunities to learn what people in other walks of life are doing or thinking. This can be a great disadvantage which can only be corrected by working and playing with those who have had no training whatever and those whose training has been along entirely different lines.

No engineer can successfully supervise the activities of others unless he has some knowledge of the outlook and mental processes of those under him. Moreover a knowledge of the mental processes of those supervising **his** activities can be of great advantage to the young engineer.

Having gained post-graduate experience, the second objective of the engineer should be to select the road ahead of him, at the same time retaining sufficient elasticity of outlook to change over to another road if the first one shows signs of losing itself in a desert or a swamp.

One important fact to bear in mind in selecting an avenue for employment is that no particular type of employer has a lien over the best engineers. In government departments and instrumentalities there are good and indifferent engineers and in private industrial organisations there are good and indifferent engineers. Because of the creative nature of his profession the engineer has a great responsibility for if he does not exercise his creative talents in the interests of his organisation he can cause this organisation to fade, wither and die and imperil the employment of many others besides himself.

Having completed his undergraduate and post-graduate training and finally selected the road he wishes to travel, the engineer should exercise all the skill and initiative he possesses to advance along that road as quickly as possible, with due regard to the consolidation of his gains as he progresses.

Within a few years of graduation many engineers reach a stage where they are called upon to assume some supervising functions. As they advance further in their particular organisation these supervising functions gradually change to administrative functions.

However, it must be borne in mind that an engineering training **is not absolutely essential** to those administering certain undertakings, even if these industries deal primarily with the products of engineering skill. When the directors are selecting a man to occupy a senior position in their company they certainly take into consideration an engineering training **but this is only one of the point-scoring-attributes** and can easily be outweighed by other considerations, such as ability to supervise those beneath him, ability to work harmoniously with his equals, a sense of financial responsibility, an appreciation of economic factors, ability to present a good case verbally or in writing and that indefinable but important consideration — **personality.**

In other words an engineer has little chance of rising to the top on the points score of engineering ability alone and that he must also score points for other factors considered essential to the successful occupation of a top management position.

Another important fact is that engineering skill only remains an important consideration for so long as a man continues to possess and exercise that skill. Administrative duties may push engineering duties more and more into the background but it must be remembered that the backdrop is often just as important to the success of a play as the stage presentation itself.

Your Career Ahead.

You have chosen a profession from which you can derive a great deal or very little and this depends primarily upon yourself. A lucky chance may cause a vertical lift in an engineer's line of progress but if the engineer has neither the skill nor personal qualifications to sustain his new position, that line may swing to a horizontal path to be crossed by the paths of those who have risen steadily through sheer drive and ability. Generally speaking advancement in the engineering profession is not rapid and this is caused largely by the fact that an engineer is obliged to change his outlook as he advances step by step.

After each step he must acquire additional qualifications and improve his knowledge of personal relationships to qualify himself for the next step. No engineer can expect to succeed unless he is content to play a lone hand and occupy one of those comparatively rare niches which involves little contact with his fellow men.

It becomes increasingly obvious as one advances that services to the community and real services to oneself are synonymous. Some special effort to improve the lot of the community may not in itself add to a man's financial resources but it will add to his prestige and what is more, it will cause him a great deal of personal satisfaction.

One thing that a young engineer has to guard against is placing too much emphasis upon glamour or the outwardly visible signs of his activities. Some of the most important engineering works are those associated with harbour or river improvement but when the work has been completed and placed in service perhaps only ten per cent of the structure rears its head above the water line.

With the introduction of automation into industry the outlook is changing and in future an engineer's importance will be judged by the quantity and quality of the goods and services he can produce in relation to the labour he employs, not the number of men working for him as before.

In summing up, I can be quite definite on one point, viz. that a career in the engineering profession can be and is to most of those that take up this profession a satisfying and at times a thrilling experience. It is significant that while the engineering profession as a whole does not earn the same financial rewards as some other professions, few engineers envy those in other professions or would desire to adopt any other career if they could commence work over again.

In this talk I have tried to avoid giving advice and to confine my remarks mainly to some of the pitfalls in an engineering career and the experiences likely to be encountered in pursuing that career.

When choosing your first job do not follow the will of the wisp by seeking quick financial returns from an unsound employer but on the other hand do not place too much emphasis on security. Having started your career never be too proud to learn from those above you and also from those below you. Many bright ideas and good suggestions emanate from those who have not had the benefit of a university education. Most important of all, foster the human relationship side of your activities, for an engineer, possibly more than a member of any other profession, depends for his success upon the goodwill and understanding of those whom he serves, those who serve him and those with whom he works.

What the Future Holds

by Mr. H. J. Brown, B.Sc., M.E., M.I.E.

Let us consider first an already large and well established industry, the Electronics Industry, and speak to you on still further developments which can be expected.

No doubt there will continue to be a need for radio and television equipment for home entertainment, and for communication links both for local requirements and for world networks, but however it is in the field of commercial and industrial electronics that the demand is growing. Electronics are being applied to the control of machine tools in the workshop, the control of welding plants, the control of chemical processes and to the administration of large businesses. The electronic computer has passed from the laboratory as a tool for the research worker and is invading banks, insurance companies, statistics offices and large business concerns. It is taking over the job of clerks, accountants, store keepers and providing management with up to date information on the state of the business, enabling forward planning and intelligent management undreamed of as even possible previously. The full impact of computers is only now being dimly realised by large business concerns and these electronic brains promise to revolutionise commercial and government business undertakings.

Further, computers are leading to the concept of automatic factories where regular processes, such as in a chemical plant for example, can be fully controlled by a computer which continually samples the state of affairs and decides what to do to keep the process going at maximum efficiency. The computer is supplemented with electronic measuring equipment of many kinds, with tape recorders, punched paper tape units and various other devices.

Electronic computers are still in their infancy. The introduction of transistors and other semi-conducting devices will not only lead to further startling developments but will enable computers which now fully occupy a large room and use up so much power that airconditioning is necessary, to be made to fit on a desk. They will be able to do in a few hours the work which hundreds of clerks or girls would normally take weeks, months or even years to do, and at the same time give far more digested information when called for at a moment's notice.

Another field of work now in its infancy but which will go on developing and creating new industries and new avenues of employment is that of nuclear engineering. So far we have made the first timid step of producing heat by nuclear energy instead of by burning coal or oil. The processes for extracting fuel, the design and control of reactors and all the other engineering aspects of a nuclear power plant will change as experience is gained, and the cost per unit of electrical energy will be reduced.

There is still the even more promising field of harnessing the fusion process as used in the hydrogen bomb as against the fission process now being used. The first scientific break-through on harnessing fusion has recently been announced. This can lead to even more startling developments in the generation of electricity and to greater power at a cheaper cost, making electricity a cheap commodity almost like water. Industry would then be given a new lease of life with the use of power per head of population soaring up, and productivity reaching unforeseen heights.

Nuclear energy is also a necessity to exploit fully the promise of space travel now becoming a reality to a limited extent with chemical rocket fuels, but more will be said about this soon.

There is ample scope coming and indeed already here for chemical mechanical and electrical engineers, for physicists, chemists, mathematicians and nuclear engineers in these fields. Electronics and electronic computers play their part here too.

I shall mention just one more field with which I am associated — guided weapons for defence and the associated developments of rocket propulsion, upper atmosphere research, artificial satellites and space exploration. Here is an exciting new field involving almost every aspect of engineering and pushing at the limit of scientific knowledge. Billions of dollars in America and millions of pounds in U.K. and Australia are being spent each year on rocket motors and the vehicles which they drive.

Taking first the defence developments in guided weapons, this is now a very big business involving the aerodynamics of supersonic flight with large supersonic wind tunnels, the development of chemical rocket propellants, the intricate electronics of guidance, control, homing heads, proximity fuses, telemetry and computers, and the fine mechanical work of gyroscopes, actuators, fuel feed valves, hydraulic systems, torque amplifiers, aerial searching mounts and the many other detailed parts which go into such weapons. In the Civil Engineering field there is the need for large launching platforms, for accurate surveys to pin point places on the Earth's surface relative to each other and in different continents, for large steel structures, for stressing of missiles and emplacements, for hydraulic systems to feed liquid fuels of unusual properties, often at very low temperatures, and many other such details.

The engineering problems are tremendous, requiring a thorough knowledge of fundamentals and their application under conditions of high vacuum, intense cold, intense heat and stringent specifications of accuracy. There are new problems requiring a knowledge of gravitational fields, heat radiation, astronomy and the Earth's magnetic field which means that the Engineer must not only be able to think clearly in uncharted fields of design but must also be familiar with physics, chemistry and metallurgy to a far greater extent than before.

In all of these, and indeed in many developments I see coming in the future, the most important point to note is that engineers must have a thorough grounding in fundamentals, particularly physics and mathematics, and to some extent in chemistry, even if some of the practice of engineering is deleted from undergraduate courses and left to be learnt later by experience in association with engineers on the job. Going further, I, and many others with me are convinced that a much better education system is needed to cope with modern knowledge and the rapidly expanding Scientific

Age. The teaching of Science in the schools is antiquated and ineffective. It is still based on the thought of last century. Not only does the matter presented need complete revision but also the science teachers need a different education and a closer touch with modern thought.

In the Universities there is need for a re-appraisal of syllabi, for a closer link with research laboratories and engineering so that lecturers and professors are kept in touch with modern developments, and for a higher standard of lecturing aimed at developing the students' powers to the maximum extent. Most of our University departments are archaic, depressing, and out of date. They are still training students for the past and not for the changing future. The majority of lecturers have had little contact with progressive research laboratories or industries and there is a tendency to live in ivory towers set aside from the rest of the world.

There is a great need for a clear view of where our University technical departments are heading and for a higher standard of leadership in the Community. The Massachusett's Institute of Technology has already embarked on setting their house in order and in giving a lead to improved teaching of science in schools. It would be well for Australian University Technical Departments to study what is going on at this famous Institute. One must realise that the pace of scientific development and engineering application is increasing.

The gap between scientific research and its engineering application is now very small and often non existent. Often engineering design is proceeding while research in the laboratory is still progressing or even being directed by the requirements of the engineer as he meets new problems for which he has no immediate answer. Tennyson would not write today:— "Science moves, but slowly, slowly, creeping on from point to point."

You have an exciting future ahead. The eyes of the world are now on your achievements and your mistakes. With the possibility of unlimited cheap electric power even the ordinary established fields of engineering will grow. There will be more and better roads, bridges, buildings, motor cars, aeroplanes, ships, communications. There will be expanding manufacture with new products, new materials.

Already the scientist and engineers are becoming more important units in society. Their achievements are publicised in press, radio and magazines and I foresee them becoming even more important members of society.

But one word of warning. All of this will come about only if we solve the problems of living together on the Earth in peace, of living in harmony with our fellow men, and of finding happiness for the individual. Our material progress must be matched by a better educational system and by a greater concentration on the development of men's minds and the control of his emotions. The veneer of civilisation is very thin over the beastial instincts. There is a need for as much concentrated effort on assuring health and happiness to the individual as on material progress. As citizens let us fight for this objective as much as we, as engineers, push on with material progress. It is as important to raise the standard of happiness as the standard of living. What the future holds depends very much on our spiritual and mental development in parallel with our material development.

Jan 1963.

THE UNIVERSITY
ADELAIDE

Box 498 D, G.P.O.
'PHONE: 8 3211

Sir William (Henry) Spooner. KCMG? 1-I-1963; M.M.
1 West St Balgowlah. NSW.

Born 23-XII-1897.

EducN. Christ Church School Sydney.
Dip. Economics (Syd) & Commerce.
Fellow C. A.

Business Member Hungerford Spooner & Co.
(Chartered Accountants) Sydney.

Rec

Politics. Senator for NSW 1949, 51, 55, 61, 63.

Portfolios Social Services 19/XII/49 to 11/V/51
War Service Homes 11/V/51
A/cty Trade & Customs 30/IX/54 - 9/I/55
Commissioner, River Murray Comm 1956.
Dep. Leader of Govt in Senate 18/X/56 - 17/II/59
Leader " " " " 17/II/59 till now
Vice President of Ex Council 10/XII/58
Senate Standing Orders Committee 19/II/59
Austn Delegn to Commonth Parl Assn Conf Canberra 1959.

Recreation Golf. (Manly Club).