English As Instructional Language In Technological Education In India

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by

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SUPERVISOR'S CERTIFICATE

The Thesis entitled ENGLISH AS INSTRUCTIONAL LANGUAGE IN TECHNOLOGICAL EDUCATION IN INDIA submitted by Mrs. Rosie George Maliakal, M.A., B.T., for the degree of Doctor of Philosophy embodies the research work done by her under my supervision. I certify that the work is original.

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C O N T E N T S

LIST OF ILLUSTRATIONS

P R E F A C E

This is an enquiry into the principles of the instructional role of English in Technological Education in India. I start with the assumption that a teaching programme in any situation has principles of its own to govern it, and that English-teaching as instructional language in technological education in India can be examined independently as such.

The definitive need for technology for India's progress and the determinate role of English in technological education in India necessitates a re-organisation in the teaching of English to science and technological students, in the direction of a practical approach to the teaching of English and a pragmatic objective for English Language Teaching programme. The English Language Teaching programme in technological education is, at present, not related and adapted to the precise needs of the student's major study, and, hence students with high proficiency in English find the programme lacking in purpose, and those with low proficiency not helpful.

As a teacher actively involved for a decade in the English Language Teaching programme in technological education, and, as one fortunate to have been a student of science, I have felt, with the students, the insufficiency of the programme and the need for a re-oriented pragmatic approach. There is, therefore, the need to explore the pragmatic approach to English Language Teaching in technological education with special reference to the Indian situation.

In technological education, even in the English-speaking world, the functional role of the language was emphasised as far back as half-a-century ago. In technological education in Germany and Russia the functional role of the English language is exploited for enabling students to use it effectively for library purpose. However, the work done on the functional approach to English Language Teaching by American and Russian scientists and technologists is not relevant to the Indian situation. In the American context English is their mother tongue as well as the medium of instruction; in the Russian context it is neither the medium of instruction nor the mother tongue; in India, it is the medium of instruction and not the mother tongue.

Drawing on my training, capacities, and experience, for what they are worth, I propose (i) to examine the principles governing the functional approach to English Language Teaching as instructional language; and (ii) to determine the pedagogical strategy. I shall confine myself to those problems which the students of technology genuinely have. My laboratory shall be the Birla Institute of Technology and Science, Pilani, since it has a cross-section of student population drawn from all over the country engaged in technological study.

To arrive at valid conclusions it is proposed to cover a fairly large spectrum of student population and English Language programmes. With the variety of courses, the different levels of proficiency in English, and opportunities for experimentation available at the Birla Institute of Technology and Science, I believe the study would yield rewarding results. As I expect the conclusions to be of fundamental importance in the teaching of English in technological education, they would undoubtedly be of immense value to technological education in India.

In 'technological education' I have included all facets of technological education as scientific and engineering studies. Hence, where the terms science, engineering and technology have been separately used, they have been thought of as complementary facets of technological education, and where technology alone has been mentioned, it is not exclusive of the others.

ACKNOWLEDGEMENTS

My work has been made possible by the new direction given to Research in the Institute in 1972 by Dr. C.R. Mitra, Director, Birla Institute of Technology and Science, Pilani. I owe to him the idea of breaking fresh ground in research in language by relating it to teaching. The work has been immensely facilitated by the new concepts and innovations introduced by him. I express my deep gratitude to him through my work, which, I hope, is itself an expression of the breakthrough he is trying to achieve in technological education in India.

I am grateful to Prof. Dee H.Barker, Brigham Young University, Provo, Utah, Visiting Professor, Birla Institute of Technology and Science, Pilani, for the valuable discussions I had with him in connection with my work. I am also grateful to Prof. Dee H. Barker and Dr.V. Krishnamurthy, Professor of Mathematics and Acting Deputy Director, for the opportunity to participate in the Workshop-cum-Seminar on Methods of Teaching conducted by them, which opened new avenues. I am particularly indebted to Dr.V.Krishnamurthy for his careful scrutiny of my work and suggestions offered for modification, which have brushed some tangles out.

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I thank Dr. R.C. Sharma, Dean, Faculty of Humanities and Social Sciences, Prof. T.S.K.V. Iyer, Acting Deputy Director, the Registrar Shri A.N. Bhargava, and the Development Officer Shri R.N. Srivastava for all the help rendered to me.

My special thanks are due to Dr. P.D. Chaturvedi, Head, Department of Languages, who faithfully supervised my work from start to finish. I record my deep gratitude to him for all assistance offered to me and for the valuable suggestions made.

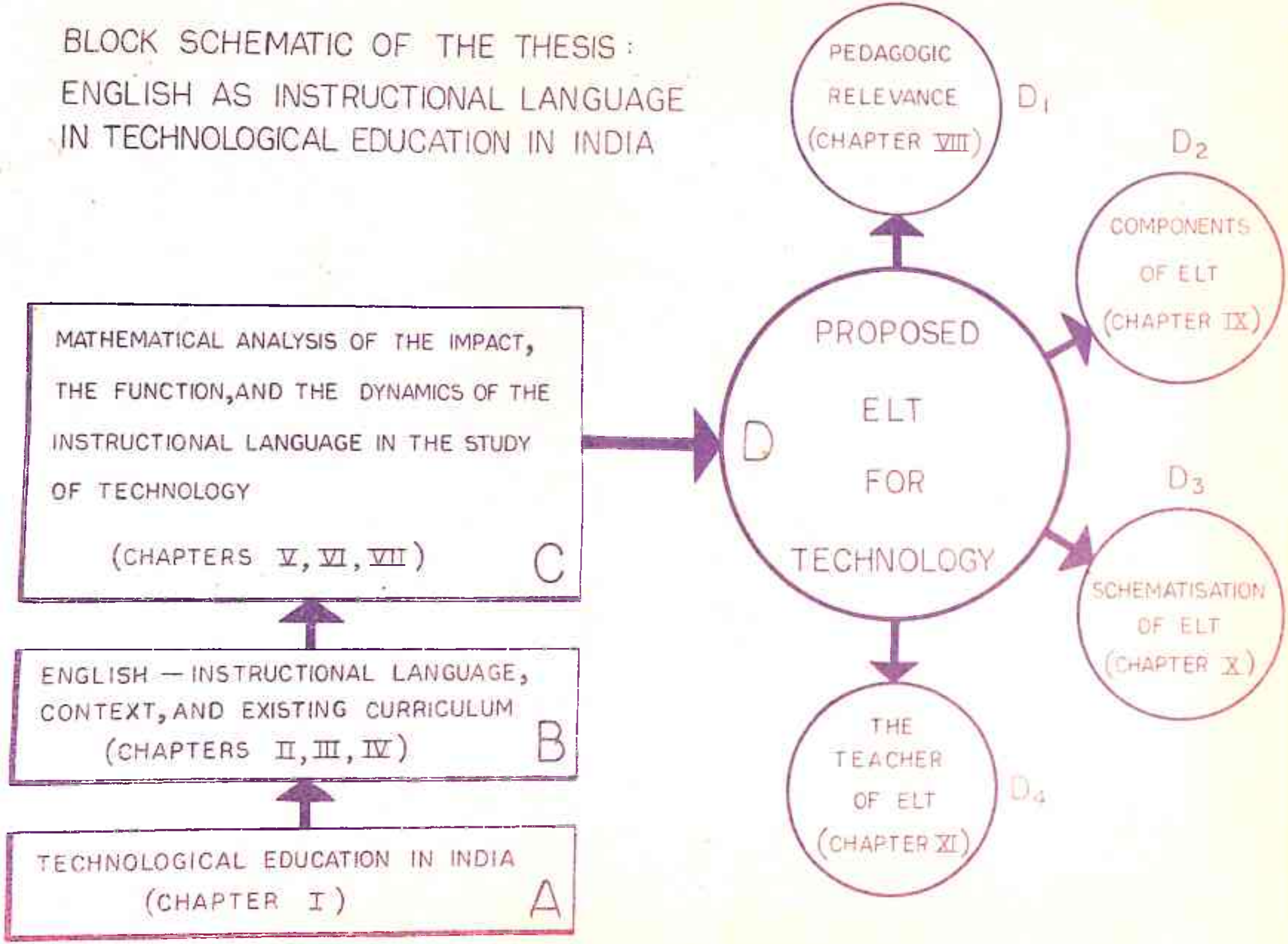
Lastly, I record the fact that I have drawn my inspiration for the entire work from my husband Maliakal Paul George. He has stirred my imagination, enlarged my comprehension, and added new dimensions to my perception of the problem. His contribution to the work is invaluable. To him thanks are redundant.

I take this opportunity to thank the University Grants Commission, New Delhi, for sponsoring my work with a grant of Rupees Two thousand.

Rosie George Maliakal

ROSIE GEORGE MALIAKAL

BLOCK SCHEMATIC OF THE THESIS : ENGLISH AS INSTRUCTIONAL LANGUAGE IN TECHNOLOGICAL EDUCATION IN INDIA



Chapter I

TECHNOLOGICAL EDUCATION IN INDIA

Technological Education has a history, and English as the medium of technological education in India has a historical accident. Therefore, the enquiry into the principles of the instructional role of English in technological education in India would rightly commence with a brief exposition of the origin and growth of technological education in India, and a flash-back into the historical factors that have necessitated a foreign language to continue to be the medium of instruction of technological education in India today.

During the end of the 17th century and the beginning of the 18th century Europe underwent a historical event called the 'Industrial Revolution'. This revolution not only influenced the socio-economic status of the western countries, but made its impact on the very fibre of civilisation- including education. Traditional, classical and theological studies gave way to science, engineering and technology to meet the demands of an industrialised society. The craftsmen and artisans of that era who were responsible for the making and maintenance of crude machines, especially for war and rarely for peaceful purposes, who belonged to the lower order of a less specialised society, and the genteel class who had knowledge of the sciences and were disciplined in organised thinking, merged their talents, to meet the challenges of the industrialised world. The interaction between the pure sciences and skills of the hand resulted in the reformation of the educational patterns. The scientific and technological education of today is a result of such a merger.

John Anderson's school for the general education of craftsmen and artisans founded in 1790, which later became the 'Royal Technical College of Glassgow', was the first engineering institution in Britain. In France at about the same time (1794) Ecole Polytechnique was founded. Germany, though it started late, built a chain of technical institutes which provided for the teaching of all grades of men from craftsmen to researchers. In the United States of America Bowdoin College was established in 1823 for technical studies. By the middle of the 19th century technical and scientific study formed the major part of university curriculum all over Europe and America.

India experienced the impact of the western industrial revolution only late. Indian artisans and craftsmen have been little affected by the industrialisation in the west. The technological and scientific progress that India attained prior to independence was designed to subserve the vested interest of the British rulers to run the administration of their colonial possession. They imported the ready-made technology from the west for construction of roads, buildings, railways, etc. This called for training Indians in some subordinate technical jobs, and technical schools were started for the purpose. Cooper's Hill College of Technology in Britain was supplying teachers for such technical schools and personnel as superintending engineers. It is stated that such technical schools were started in 1825 at Calcutta and Bombay but no authentic evidences are available. A technical school attached to the Gun Carriage Factory at Guindy, Madras, was started as early as 1842. At Poona a school for training overseers was known to exist in 1854.

ENGINEERING COLLEGES IN INDIA: The first engineering college in India was an autonomous institution named as Thompson Engineering College started at Roorkee in 1847, which offered diplomas in Civil Engineering that were considered as equivalent to degrees. This institute was later known as the Roorkee College. In November 1856 the Calcutta College of Civil Engineering was opened. This was re-named as the Bengal Engineering College in

1857. This college affiliated to the Calcutta University offered licentiate course in Civil Engineering. In 1865 it was amalgamated with the Presidency College and later, in 1880, it was shifted to its present building belonging to the Bishop's College at Sibpur. As the plans for a third Engineering College at Bombay did not materialise, the overseers' school at Poona was raised to the Poona College of Engineering affiliated to the Bombay University in 1858. In the same year the technical school attached to the Gun Carriage Factory at Guindy, Madras, was uplifted to the Guindy College of Engineering affiliated to the Madras University. All these institutions offered licentiate courses in Civil Engineering only. In 1880 when the need was felt for engineers in Mechanical and Electrical Engineering, these colleges started apprenticeship classes in these subjects. In 1887 the Victoria Jubilee Technical Institute was started at Bombay for training licentiates in Electrical, Mechanical and Textile Engineering. The Indian Institute of Science at Bangalore in 1915 offered certificate and associateship courses in Electrical Engineering headed by Dr. Alfred Hay. Jadavpur College of Engineering and Technology, started as a result of the Swadeshi Movement in 1907, offered diploma courses in Mechanical and Chemical Engineering in 1908 and 1921 respectively. There was general resentment against starting Electrical Engineering courses at the beginning of this century since there was very little demand for such personnel. The electrical industry was in its infancy and there was scope for employment of men only to do simple repair work and maintain electrical machinery which were a few in number, at hydro and thermal stations. As the electrical industry grew up need was felt for erection and construction of electrical machinery, and, in 1917 Pt. Madan Mohan Malaviya, the founder of the Banaras Hindu University, started courses in Electrical, Mechanical and Metallurgical Engineering. The two World Wars, particularly the second, accelerated the pace of development of technical education as one of the pre-requisites for survival. By the end of the thirtees Electrical, Mechanical and Metallurgical Engineering were started in almost all engineering colleges.[1]

In the period of disenchantment that followed independence, India realised the need for training engineering and technological men to build the country from scratch, to provide the bare essentials of life and to free her from want and disease. The factor that emerged from this awareness both as a concomitant and a consequence is a purposeful attempt by the Government of India to apply the resources of scientific intelligence

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1. The Report of the University Education Commission, Vol. I, 1949, Government of India, Delhi, pp. 219-226.

to the solution of her problems, to adapt known knowledge and techniques to different situations in the country, and a scientific approach to Man-power planning.

Since then in India, as almost everywhere else in the world, educational patterns have changed. As in everything else, revolutionary changes in the social structure have called for basic changes in the concept of education. As industrialisation based on technology became an essential organ of our civilization, it became imperative for India to give a new direction to her educational policies.

The Report of the University Grants Commission with Dr. S. Radhakrishnan as Chairman stated:

"Our leaders have drawn up ambitious plans for the industrialisation of our country involving expenditure of crores of rupees. They wish to improve communications, develop systems of irrigation, distribute electricity to villages. They have large schemes for the improvement of health and sanitation. If these schemes are to be realised, we have to increase the number of professional colleges, agricultural, medical and engineering to produce the requisite number of graduates and set up throughout the country technical schools which will supply the much larger number of technicians needed for the purpose. For a fuller realisation of the democratic principles of justice and freedom for all, we need growth in science and technology. The presence of the suffering millions, tired, discontended, mentally inefficient is a challenge to us. Where human action can remove the evils, inaction has the guilt of vice."[1]

Again, the Scientific Man-Power Committee, appointed by the Government of India in March, 1947, assessed the requirements for scientific and technical personnel

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1. The Report of the University Education Commission, Vol. I, 1949, Government of India, Delhi, p.45.

during the next 5 to 10 years (1947-52, 1952-57) to meet the demands of the various Government departments (Civil only, excluding Defence), for schemes for expansion of industrial and agricultural production, transport, medicine, education and other fields in accordance with declared policies of the Government of India. The need of the country was estimated to be nearly 27,000 (this includes Engineers, Architects, Metallurgists and Chemical Technologists) in 5-10 years, depending upon the speed of the constructive works undertaken. So the yearly demand was expected to vary from 5,400 to 2,700 per year. The outturn of Indian colleges was expected to be 1,130 per year. As the prospective supply would fall far below the demand, the demand according to the committee could probably be met if at least one or two of the proposed higher technological institutes were started as early as possible.[1]

Likewise, the All India Council for Technical Education at its first meeting held in April-May, 1946, considered the interim report of the Sarkar Committee and endorsed the opinion that to meet India's post-independence needs for high grade Engineers, Technologists, etc., there should be established four Regional Higher Technical Institutions in the East, West, South and North, on

1. The Report of the University Education Commission, Vol. I, 1949, Government of India, Delhi. pp.233-234.

the lines of the Massachusetts Institute of Technology.[1] The Commission appointed by the Government of India in 1948 with Dr. S. Radhakrishnan as Chairman recommended, among others:

(1) "that the existing engineering and technological institutes of the country should be regarded as national assets, and steps should be taken to improve their usefulness;"

(2) "that steps be taken to start without delay the higher technological institutes for training much needed engineer-scientists and design and development engineers;"

(3) "that in establishing new engineering colleges or institutes, special consideration be given to training which prepares students to become competent and self-reliant, who will have the initiative and courage to start new industries, even if on a very small scale".

So, it is for its immediate utility value, for its immediate relation to industry, agriculture, transport, communications and public health that technological education has been oriented and formulated for India.

Nearly two decades later the Kothari Commission reiterated the urgent need "to transform education, to endeavour to relate it to the life, needs and aspirations of the people and thereby make it a powerful instrument of social, economic and cultural transformation necessary for the realization of our national goals."[2] It stated in emphatic terms "A basic distinction between traditional and modern societies is the development and use by the

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1. The Report of the University Education Commission, Vol. I, 1949, Government of India, Delhi, p.241.
2. The Report of the Education Commission, 1966. Government of India, p.6.

latter of science-based technology which helps moderniza-tion of agriculture and the development of industries.... This close interlocking and interdependence between science and technology is a characteristic of the con-temporary world. In recent years, several countries have been able to raise their GNP very rapidly because of their investment in basic science, technology and educa-tion. We are at a crucial stage in the progress of de-velopment and transformation;........For the planned development of the national economy we need a large-scale expansion of enrolment in engineering and agricul-ture, and at the postgraduate level, in pure science sub-jects. The increase has to be several times the present enrolments."[1]

In its justified concern for training the much-needed personnel, institutions of engineering and techno-logy increased. The national commitment to technological education resulted in the establishment of the presti-geous institutions of national importance- the Indian Institutes of Technology, at Kharagpur in 1951, Bombay in 1957, Madras in 1959, Kanpur in 1960 and Delhi in 1961. Fig. 1 shows the growth in the number of engineer-ing colleges and institutions of technology in India from 1842 to 1974. Fig. 2 shows the enrolment to engi-

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1. The Report of the Education Commission, 1966, Govern-ment of India, pp. 6-9.

neering and technological institutions in India for the period 1924 to 1948 as reported by the University Education Commission, 1949. Fig. 3 gives the enrolment into the institutions of engineering and technology for the post-independence period. The rapid increase in the number of institutions and in the student enrolment reflect the phenomenal growth of technological education in the post-independence period. As against an annual admission of 3,000 students for the first degree in 1947, the admission capacity increased to 25,000 in 1967-68.[1] As against only 28 institutions for first degree in 1947, the number rose to 119 for degree institutions in 1974.

MEDIUM FOR TECHNOLOGICAL EDUCATION IN INDIA

Charles Grant, a Director of the East India Company, rightly predicted at the turn of the 18th century that the knowledge of the English language would serve for the people of India as "a key which will open a world to them of new ideas" and would in course of time play the same role as Arabic under the Muslim rulers. Indians having become themselves, in due course, teachers of English, together with the use of English in public business, in a matter of another generation, expanded its

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1. Indian Educational Documents Since Independence, 1971, The Academic Publishers (India), New Delhi, pp. 199-238.

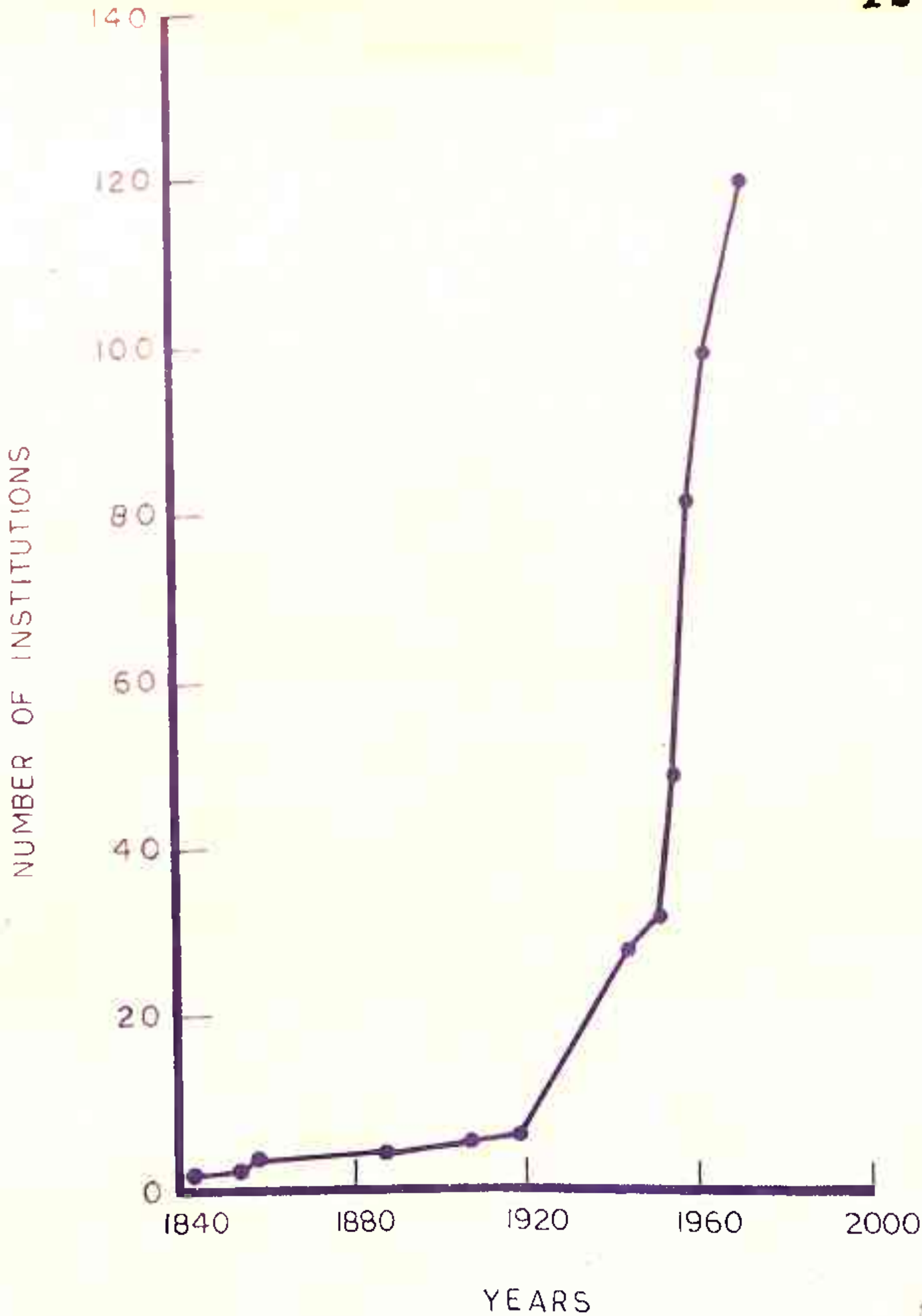

FIG. 1: GROWTH OF ENGINEERING COLLEGES AND TECHNOLOGICAL INSTITUTIONS IN INDIA.

influence throughout India, as predicted. The provision for the introduction and promotion of knowledge of the sciences in India, in the charter of the East India Company contributed to strengthen the influence. Lord William Bentinck's approval of Macaulay's Minute proposing the promotion of European literature and science amongst the natives of India and his resolution that the "great object of the British Government ought to be the promotion of European literature and science amongst the natives of India and that all funds appropriated for the purposes of education would be best employed on English education alone;" made English an instrument of science education and the medium of instruction.

Independent India faced, among other problems, the problem of the national language and the problem of the medium of instruction in the universities and institutes of higher studies. No other problem engaged educationists and politicians alike. Besides, the question became so sentimental an issue that it was difficult to consider it dispassionately.

Although objections to English were raised on the grounds that it was educationally unsound to make a foreign tongue the means of acquiring knowledge, that it developed a split-consciousness in the individual as well as in the nation, many advocated the continuance of English as a State language of India and as the language of higher education because it enabled inter-provincial understanding which is necessary especially in these days of fast travel, because it is an instrument for the continuance and fostering of the unity which it had helped to create, because it is the key to the fundamental ideas of modern civilization, to modern science and philosophy and the principal means of maintaining contact with the outside world.

Recognising that India needed scientific education and research for its development and for tackling successfully its problems of poverty and disease, it was felt that India adopt a policy regarding medium of instruction for science and technology, which will give speedy results. While advocating the desirability of employing Indian languages as media of higher education, India adopted English as the medium of instruction for technological education until the regional languages are fully developed to serve as medium of technological education. Thus the role of English as the medium of instruction of technological education in India is pragmatic, and the teacher of technology is concerned with the constraints imposed on him by the use of a foreign language, and the English-language teacher is likewise concerned with the problem of teaching English expressly for its use in learning technology.

Chapter II

ENGLISH AS INSTRUCTIONAL LANGUAGE IN TECHNOLOGICAL EDUCATION IN INDIA

English is not only an international political and business vehicle of communication but is, as well, an international technological vehicle of communication. The 1968-69 report of the British Council says:

> "English is the language most used for communicating facts, and so a main factor in scientific, technological and economic progress and the principal language of economic aid. Half of the world's scientific literature is written in it. It is the language of most computers; of nuclear laboratories in Brazil; of the Swedish ball-bearing firm SKF for its operations even within Sweden. It is the principal means of spreading ideas and values, the main language of salesmanship for Japan and Germany, and the prime language of debate in the United Nations."

Technologically self-sufficient countries like Russia, Germany and Japan whose languages are adequately equipped for technological content and communication, provide courses of study in English as a library language in order to enable their technologists share the technology of the English-speaking countries, and communicate their own technology to them. Although Russian, German and Japanese match English as an adequate, precise and effective vehicle of technological content and communication, they just cannot measure up to English as an effective means of international technological communication. Such a language is serving India as a pole to vault over the technological gap between India and the

West and certainly not as a mis-fitting crutch for limping our way through.

There are weighty reasons for English-language learning and teaching in higher education in India. Speaking on the language problem in India at the Central Institute of English, Hyderabad, on July 22,1963, Jawaharlal Nehru, the then Prime Minister of India, spelt out the reasons:

"English is a very widespread language and a very important language.....English is probably spoken by the greatest number of people. There is a good deal that other foreign languages have to teach us which no one language can teach us as well as English.....Now apart from the fact that English has a background in India which should be nourished and the fact that English is a very important and a very great language, spoken by a great many people all over the world.....it is of the utmost importance today to know what is heppening in the rest of the world. The windows of our minds should be open to them, and the best window is that of language ......Now the language link is a greater link between us and the English-speaking peoples than any political link or commonwealth link or anything else....."

The above reasons are weighty enough and boldly stated with clarity and emphasis by one who knew what he was saying. These reasons in themselves are sufficient for English to find a place in university curriculum in India. However, the reasons stated above do not speak for English as instructional language in university education. For the reasons mentioned by Nehru, it is possible to study English independent of it being the instructional language in university education in India.

English as the medium of instruction in technological education in India has a definitive role. English is the medium of instruction of technological education in India because (i) modern science and technology are essentially the product of the West, (ii) it is the language of authoritative standard texts, (iii) standard text-books in the Indian languages do not exist, (iv) Indian languages do not have as yet the scientific terminology, and (v) scientists and technologists cannot keep abreast of recent developments in the Indian languages.

Yet Jawaharlal Nehru's reference to English as the 'window on the world' when applied to the context of technological education is not meant to serve as just a library language. In India, in technological education, English is the mind's eye to see through the window. The inclusion of India under category II countries using English for special purposes is a sweeping generalization by Dr. B.M. Lott of the British Council in his article ENGLISH IN THE TEACHING OF SCIENCE AND TECHNOLOGY THROUGHOUT THE WORLD[1]. For technological education through the medium of English 'library language' acquaintance is most inadequate. When it is found that even near-native competence in English is inadequate for technological study, and when in English-speaking countries

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1. <u>CILT Reports and Papers, 7 December, 1971</u>, Centre for Information on Language Teaching and Research for British Association for Applied Linguistics, p.13.

itself special courses in English are offered for techno- logical purpose, it is being unrealistic to expect that acquaintance with a language for library purpose is sufficient to pursue a professional study to be followed by a professional career.

Peter Strevens in his article ALTERNATIVES TO DAFFODILLS[1] has pointed out that the organised instruction in English teaching at school is largely inadequate for the needs of technological education in non-English speaking countries. The reasons he offers apply only in part to India. His reasons are:

(1) "most of the English they were taught was irrelevant to scientific or technical work",

(2) "through electing to study or train in science or technology, rather than in the arts, in very many cases they were thereby relegated to shorter or less thorough instruction in English, or even to no English at all",

(3) "the teaching of English is organised on the assumption that English is an arts subject with general educational and cultural value, and that the most able learners will go on to study English literature at university level",

(4) "the teachers of English are trained in literature; the syllabuses and examinations generally lead up to a literary or pre-literary training, the teaching is informed by the values and symbols of literature",

(5) "the courses that set out to teach English for practical purposes of communication where such courses exist they are almost always reductions from the orthodox humanities courses, rather than newly-planned syllabuses for new categories of learners", and

(6) "much time is devoted to practices such as

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1. <u>CILT Report and Papers, 7 December, 1971,</u> Centre for Information on Language Teaching and Research for British Association for Applied Linguistics, pp.9-11.

the writing of essays (which are required to conform to a sub-literary genre) and reading texts selected from a short-list of accredited literary authors".

The first reason does exist in India. But it raises the question whether the scientist or the engineer in a non-English speaking country has the same role to play as a telephone operator or a tourist guide or a travel agent. Neither ~~is~~ the scientist nor the engineer is of the same category as a lathe operator or a welder. It has not taken into account the fact that no profession is nowadays a closed-guild as all professions once were. The man of science, the engineer, the medical doctor, the lawyer have to associate with their fellow-men apart from meeting them for professional purposes only. They need to be trained for the general purpose as well as for the professional purpose. Just as the need has arisen for popularising science so that the common man is acquainted with the discoveries in science and developments in technology by rendering them in the language of the common man, so also the professional men need to be trained for associating with their fellowmen in the ordinary areas of social communication. At the school stage the English taught as English need not be relevant to scientific or technical work. English relevant for scientific and technical study is acquired at school through the learning of science at school, which is necessary in India for students pursuing technological education at the post-school stage.

The reasons that students "electing to study or train in science or technology, rather than in the arts, in very many cases they were thereby relegated to shorter or less thorough instruction in English or even to no English at all" does not apply to India at all. On the contrary, children of the upper middle class elect to pursue science or technological study and receive their school education in good English medium schools acquiring near-native competence in English. Of students admitted to engineering and technological institutions in India 70% come from this category. It is true that of students who elect to do science or technological study, there are many who have not had any thorough instruction in English, or any English at all, but it is not because they elected to do science or technological study but because of national and political issues; the study of English is not compulsory in all Indian schools, and, in some non-English medium schools where English is taught, the instruction is perfunctorily given. However, those who elect to pursue science or technological study take up the study of science and mathematics at the school itself, not necessarily through English, and, are trained to some extent to the mental operations required in scientific inquiry.

Strevens' third reason is again not applicable to India. The teaching of English though not well organised, is not on "the assumption that English is an arts subject and that the most able learners will go on to study English literature at university level". The general assumption is that English is a language necessary for pursuing professional courses of study, especially science and technology, and the most proficient will generally take up science or technology at the university.

His fourth reason is partly true; the emphasis on literature is not there; instead the emphasis is on language, and the teaching is directed to the language aspects and not to the literary aspects, for the simple reason that when the language itself has not been learnt it is impossible to peep into the cultural and literary aspects.

Strevens' observations that the existing English-teaching programmes for the new situations are not oriented to the needs that have arisen, and that they are, in many cases, out-dated, are wholly true of the programmes offered in technological institutions in India.

There is much confusion in defining the objectives and determining the content of English language teaching to students of science and technology.

A major factor that is the cause of confusion is the assumption that command of general proficiency is adequate for scientific or technological education. Even in English-speaking countries scientists and engineers have found that command of the native tongue which is the language of instruction does not contribute to command of the functional usage of the language for scientific and technological needs. In the United States of America interest in the functional usage of English for scientists and engineers was awakened as early as the first decade of the century. T.A. Rickard of the University of California said half a century ago that the engineering profession should show more regard for language as one of its instruments of precision, and he was gratified to find that most American institutions of engineering offered a course in English, and many of them had special classes in the subject. Even Mining institutions awakened to the need for offering a special course in English.[1] In 1947 two teachers of English to engineering students at the University of Pittsburgh, W.George Crouch and Robert L.Zetler, went a step further when they strongly recommended setting up a special graduate teaching programme for potential teachers of English in engineering schools for enabling engineering students acquire command of the functional usage for engineering.[2]

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1. Technical Writing, T.A. Rickard, John Wiley & Sons, Inc., New York, 1947, p.vii.

2. J. of Electrical Engineering, December 1947, pp. 1182-84.

observation and experimentation and deals with the functional usage of language for scientific processes, quantification and specification. This difference in the approach is highlighted to stress that much of the confusion in defining the objectives and determining the content of English-language teaching is, in no small measure, due to the firm belief that English-language specialists alone have the professional experience of language teaching for the special language problems of scientists and engineers. On the contrary, it is the scientists and engineers who have the professional experience of the language problems of scientists and engineers.

Chapter III

THE INSTRUCTIONAL CONTEXT IN ENGLISH-TEACHING IN TECHNOLOGICAL EDUCATION IN INDIA

While the basic principles of English-teaching as a second-language and English-teaching as a foreign language are realised and accepted, English-teaching as instructional language is, at present, regarded as interchangeable with English-teaching as a foreign language to adult learners. The result is that the principles applied to English-teaching as instructional language are those applied to English-teaching as a foreign language, the only added consideration borne in mind being that the learners here are adults. The situation that exists in technological education in India is altogether different from that which calls for English-teaching as a foreign language or English-teaching as a second language. That the learners here are adults is not the only differentiating factor, though an important one but for reasons other than that which are being taken into account in the language material offered to them. The factors that make this situation distinct from the other two situations in India are:

1. Objectives of technological education;

2. the medium of instruction of technological education;

3. the role of the instructional language;

4. the motivation aspect of the learners;

5. the heterogeneous body of learners with proficiency in English at different levels; and

6. the time available for technological training.

1. OBJECTIVES OF TECHNOLOGICAL EDUCATION

Technological education is, to begin with, socio-economic oriented. Technological education for India has for its goal the pressing demands of the society. For a developing country like India technology is the pace-maker for progress. Technological education is therefore geared to its immediate utility value; for its immediate relation to industry, agriculture, transport, communication, public health, in short, public service. The education of students of technology is geared to the attainment of a pre-determined objective "to collate and disseminate effective ideas, methods, techniques and information as are likely to promote the material and industrial welfare of India, and to train young men and women able and eager to create and put into action such ideas, methods, techniques and information." (Prospectus, Birla Institute of Technology and Science, Pilani (Rajasthan).

2. THE MEDIUM OF INSTRUCTION IN TECHNOLOGICAL EDUCATION

English is the medium of instruction in technological education in India not only as a common basis of communication to surmount the linguistic diversity in India, but as the only language that makes study of science and technology possible at all in India. Hence Mr. Nehru, when addressing a meeting of the State Education Ministers, held at New Delhi, on September 2, 1956 said:

"It is patent to me that......manpower for industrial, scientific and agricultural purposes cannot be trained in any Indian language in the foreseeable future.......It is absolutely clear to me.......that the scientific and technological training has to be given in English."

3. THE ROLE OF THE INSTRUCTIONAL LANGUAGE

The instructional language is used

1) in the class-room lecture, where the student is introduced to the theory and to the instruments of operation;

2) in the books which are prescribed and referred;

3) in the reports of the student's practical works; and

4) in topical discussions, seminars and symposiums.

(1)-(a) In the lecture-classes at the undergraduate level of technological education the student is introduced to the technical instruments and aids, to the phenomenon at work in a particular situation, and to the derivation of the formula applied. When once the phenomenon is understood and the formula is derived, further knowledge is gained from actual practical work. The language used is mostly descriptive and is not succinct. The student's involvement in the use of the language in the class-room is in his comprehension , which is of minimal difficulty.

(b) At the higher levels (postgraduate) of technological education, language is just a link between long mathematical and physical derivations; and, as one advances, more notations and symbols take the place of the linking medium itself, and language gradually retreats to disappear. A few minutes' scrutiny of a blue-print is sufficient to give the engineer or technologist enough information that would go into pages of written material if translated into language.

(2) In books on technical subjects, language plays the same role as in the lecture classes but is precise and succinct. Here again the student uses the language for comprehending the information in the book.

(3) In the reports of the student's practical work the student uses the language to describe the tool or instrument or apparatus or the machine as the case may be, and to describe the object and procedure of the practical work. The practical work itself leads to results which are mainly numerical in form, which do not require the use of words for further processing. These figures obtained from experiments straightway go on to the slide-rule and graph-sheets of the student for computing. The student here communicates the information he has received partly through language and partly through mathematical computa-

tion. His involvement in the use of the language is in his self-expression which is of increased difficulty.

(4) In topical discussions, seminars and symposiums, the student's involvement in the use of the language is both in his comprehension and ~~self~~-expression. Herein he faces maximal difficulty as both these responses take place sequentially.

Thus language plays a definite practical responsive role in the instructional context.

4. THE MOTIVATION ASPECT OF THE LEARNERS

An important factor of the instructional context in English-teaching programmes in technological education in India is the psychological element: the psychology of adult motivation and the relevance of the programmes of study.

In order to be effective teaching programmes at all levels of education need to take into account the psychological factor of motivation. Motivation is the urge which initiates activity in order to realise a specific goal. Goal and purpose are necessary for activating a learner to a high degree of effort. At the immature level the instructors need to instil motivation which consists in providing immediate satisfaction from the activity itself that inflates the ego of the learner, but at the mature level they need to exploit the motivation already there in the learner which is the realisation of his goal.

In a technological university, of the factors determining the status of students as inherited potentiality, acquired capability, general intelligence, motivation, attitudinal orientation, cultural background, linguistic aptitude, to mention the major ones, motivation alone is a constant. Students in technological education have a positive attitude to learning. They are primarily career seekers. They are concerned with equipping themselves with adequate knowledge for the career they have in mind. That they are fully motivated is inferred from observed behaviour; in their earnest endeavour to attend all classes, to accept assignments and perform them, to meet their teachers for help and guidance, in their intense application to their study and in their consistently good performance in the subjects that equip them for their career; they have entered willingly on a long period of preparation during which they forego many immediate satisfactions and pleasures to attain their long-term goal; and, they meet willingly their difficulties and problems. They have drawn their motivation from the most potent source, namely, determination or the will to learn.

5. HETEROGENEOUS BODY OF LEARNERS

The student-input into an institution of engineering and technology is not a homogeneous group. They are heterogeneous in character, drawn from urban, suburban, and rural environment, of varied socio-economic standing, with cultural divergence as a result of the multi-cultural facet of the nation as well as from the fusion of cultures resulting from the displacement of people from static agricultural status to the dynamic industrial status.

The University Education Commission, 1966, reports that of the students admitted to institutions of technology in India in 1965, 87.2% students came from urban areas while the remaining 12.8% came from rural areas; 68.4% students belonged to the upper middle class while 31.6% to the lower middle class and others. Table I shows the socio-economic conditions of students admitted to technological/technical institutions in India in 1965 as reported by the University Education Commission, 1966.

In order to get a deeper insightinto the varied socio-economic standing and the multi-cultural facet of the student population, and to correlate the heterogeneous character of students to their proficiency level in English, I collected and analysed the bio-data of one hundred students at the Birla Institute of Technology and Science, Pilani, admitted in 1972, with whom I had personal contact for a whole semester during their First Year study. The analysis shows (a) 78% students had high general intelligence while 22% had low general intelligence as ascertained from their performance at school, at the Higher Secondary Examination or its equivalent,

TABLE I

THE SOCIO-ECONOMIC CONDITIONS OF STUDENTS ADMITTED TO TECHNOLOGICAL/TECHNICAL INSTITUTIONS IN INDIA IN 1965

Catego-ries.	Details	Institutions of Technology.	Regional Engg.Co-lleges.	Engineer-ing Colle-ges.	Polytech-nics.	Industrial Training Institutions (I.T.I's).	Other Techni-cal Institu-tions.
I.	No. of institutions covered by the study:	5	7	48	172	28	25
	Students from: (1) Rural Areas	12.8	41.2	34.1	44.4	58.8	31.7
	(2) Urban Areas	87.2	58.8	65.9	55.6	41.2	68.3
II.	Occupation of Parents:						
1)	Professional	7.2	10.9	8.7	7.7	4.2	11.3
2)	Service	61.2	37.3	34.6	32.0	18.6	38.6
3)	Business	20.1	17.7	21.2	19.1	12.5	22.4
4)	Agriculturist	4.3	23.9	22.4	28.6	43.1	16.0
5)	Others	7.2	10.2	13.1	12.6	21.6	11.7
III.	Income of Parents						
1)	Less than Rs.150/- p.m.	6.9	32.9	38.7	55.8	83.0	27.9
2)	Between Rs.151/- Rs.300/-	13.8	25.6	29.1	25.4	15.3	37.7
3)	Between Rs.301/- Rs.500/-	20.6	23.8	19.6	11.8	1.5	20.8
4)	Over Rs.500/-	58.7	17.7	12.6	7.0	0.2	13.6
IV.	Total no. of students	2,574 (100)	2,426 (100)	15,144 (100)	47,900 (100)	7,399 (100)	2,980 (100)

Source: Report of the University Education Commission, 1966, p.119.

at the Institute, and from personal contact; (b) the occupational status of the parents of 57% students was of the professional, semi-professional, managerial and service category while that of the parents of 43% was of business, clerical, farming and other category; (c) 66% students came from urban areas while 34% students came from suburban and rural areas; (d) the cultural status of 78% students was heterogeneous determined from the indistinctive social habits, values and attitudes of the community to which the individual belonged and from those of other communities which he has acquired and which have become integrated into his personality while that of 22% was homogeneous; (e) 73% students had a developed personality inferred from the organisation of the responses of the individual to various and varied stimuli while 27% students had an under-developed personality; and (f) 81% students were fully motivated while 19% were partially motivated as inferred from observed behaviour. I examined and analysed the results of the Placement Tests in English administered to students on admission to the Institute, for the period 1964-1973, to determine the distribution of the proficiency level in English based on the medium of instruction at school, and to correlate the proficiency level with the socio-economic status covering environment and occupational standing of parents. Figure 1 shows the heterogeneous

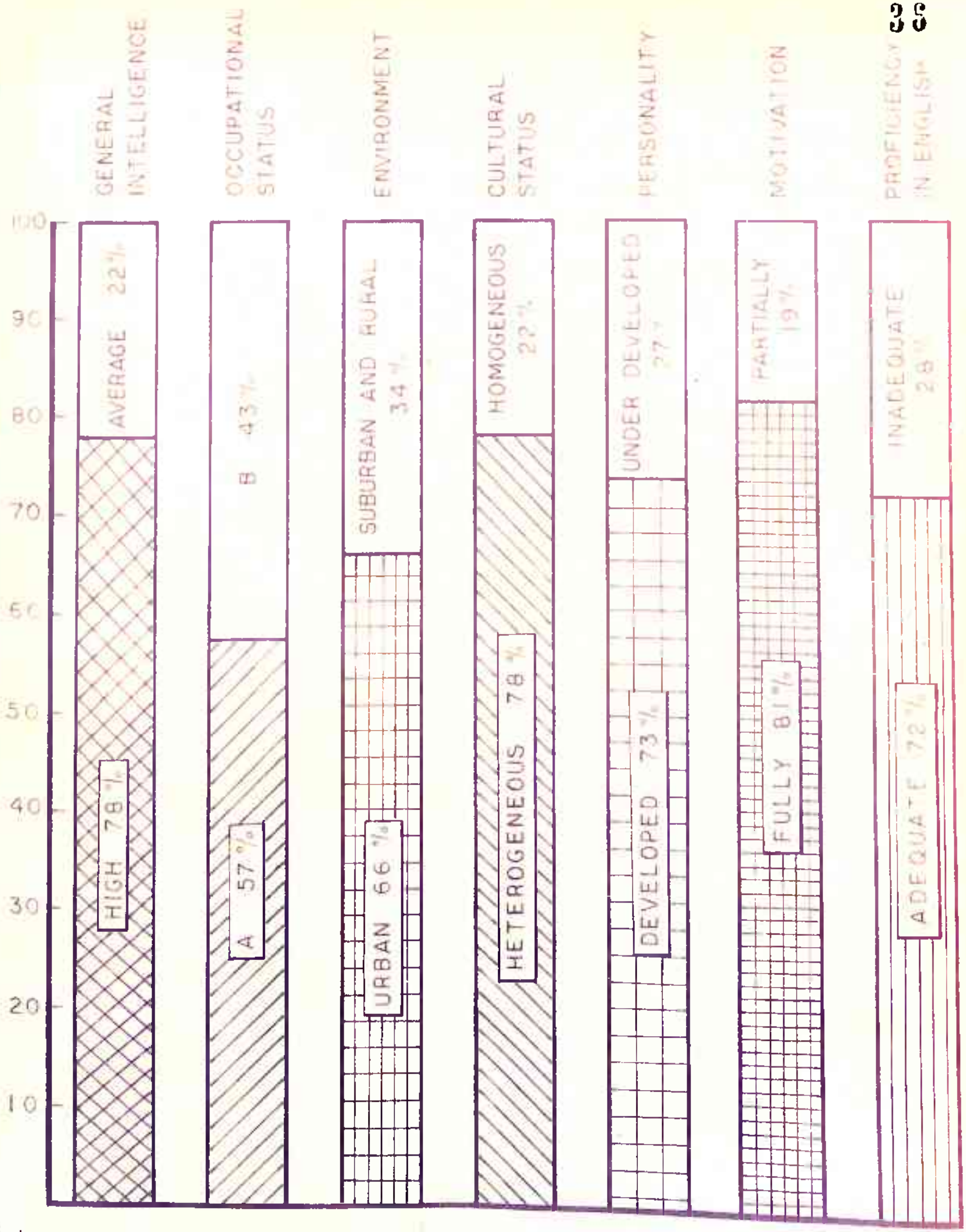

FIG. I: THE HETEROGENEOUS CHARACTER OF 100 STUDENTS AT THE BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI, FOR THE YEAR 1972, CORRELATED WITH THE PROFICIENCY LEVEL IN ENGLISH character of a sample of one hundred students admitted in 1972 to the Birla Institute of Technology and Science, Pilani, correlated with the proficiency level in English for the year 1972. Table II gives the distribution of the proficiency level in English of the student-input to the Birla Institute of Technology and Science, Pilani, based on the medium of instruction at school, correlated with socio-economic status, for the period 1964-1973. The heterogeneous character is most pronounced in their levels of proficiency in English. In 1972, 72% students, who had adequate proficiency, had proficiency, quantised on the basis of the Placement Test, ranging from 50% to 95%, and 28% students, who had inadequate proficiency, had proficiency ranging from 6 to 45%. There was a barrier between 74% and 80% indicating a marked difference between those with adequate proficiency and those with near-native competence. Fig. 2 shows the proficiency percentage in English versus percent of students for the year 1972.

6. TIME AVAILABLE FOR TECHNICAL TRAINING

Theophrastus said that time is the most valuable thing a man can spend, and Thomas Aquinas has rightly pointed out that our knowledge is enclosed in the order of time, either directly or indirectly; and so the time-factor enters into our calculations. All our programmes are therefore time-bound.

Time being a constant, it determines what aspects

TABLE II

DISTRIBUTION OF PROFICIENCY LEVEL IN ENGLISH OF THE STUDENT INPUT TO THE BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

YEAR	DISTRIBUTION OF ADEQUATE PROFICIENCY LEVEL							DISTRIBUTION OF INADEQUATE PROFICIENCY LEVEL						
	TOTAL PER-CENT	MEDIUM OF INSTRUCTION		ENVIRONMENT		OCCUPATIONAL STATUS		TOTAL PER-CENT	MEDIUM OF INSTRUCTION		ENVIRONMENT		OCCUPATIONAL STATUS	
		ENGLISH	VERNACULAR	URBAN	SUB-URBAN	A	B		ENGLISH	VERNACULAR	URBAN	SUB-URBAN	A	B
1964	72	53	19	47	25	41	31	28	6	22	18	10	16	12
1965	74	51	23	49	25	42	32	26	6	20	17	9	15	11
1966	74	50	24	49	25	42	32	26	5	21	17	9	15	11
1967	73	49	24	48	25	41	32	27	6	21	18	9	15	12
1968	75	48	27	50	25	43	32	25	6	19	16	9	14	11
1969	76	48	28	50	26	43	33	24	5	19	16	8	13	11
1970	74	49	25	49	25	42	32	26	5	21	17	9	15	11
1971	72	50	22	47	25	41	31	28	7	21	18	10	16	12
1972	72	49	23	47	25	41	31	28	6	22	18	10	16	12
1973	77	55	22	50	27	43	34	23	6	17	15	8	13	10

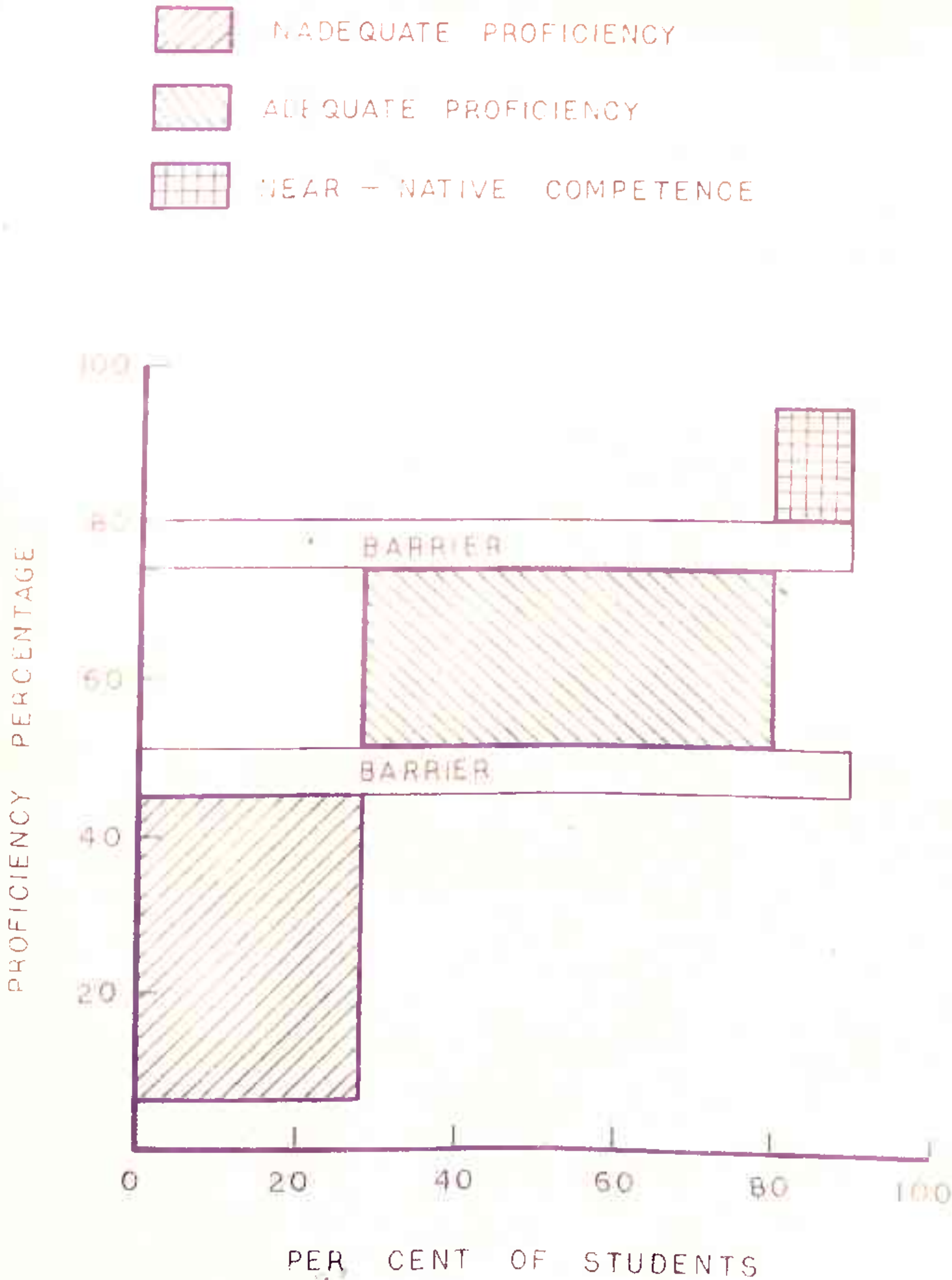

FIG. 2 PROFICIENCY PERCENTAGE IN ENGLISH PER CENT OF STUDENTS IN 1972

of a programme should receive priority, why certain aspects should receive priority and how certain aspects should receive priority. If the programme has a well-defined base and a well-defined target, time can always be made available; while, if the base and target of a programme are ill-defined, the target is tailored to fit on the time available. The time available for technological training is only five years. There is much to be done in these five years. So all the programmes of technological education have to be optimised.

The major study is so extensive, and, at the same time, intensive that it makes heavy demands on the student's energy and time. Unless the English programme is an important component of the engineering study, the student is bound to feel that he is wasting a lot of his precious time in learning something irrelevant. Therefore the English-language teaching programme should be meaningfully related to his major study. It should be carefully programmed so that it offers a course of maximal utility in the minimal time available.

Chapter IV

AN EVALUATION OF EXISTING ENGLISH LANGUAGE TEACHING PROGRAMMES IN TECHNOLOGICAL EDUCATION IN INDIA

In February 1973 a questionnaire enquiring into the content of the existing syllabi in English-language teaching was sent to all engineering and technological institutions in our country. The questionnaire also enquired into other details related to English-language teaching such as:

i) Number of teachers in the Department of English,

ii) Number of teachers trained in teaching English as a foreign language at the C.I.E.F.L, Hyderabad, or abroad,

iii) Is English compulsory and at what level?

iv) Number of years/semesters English is taught,

v) Number of contact hours per week for each course,

vi) Average number of students in a lecture class and in a tutorial class, and

vii) Number of students offering English during the current academic year.

Of 119 engineering and technological institutions in the country, 83 institutions responded.

The details of the syllabi offered and other related factors are analysed in the following Table (Table I).

TABLE 1

DATA ANALYSIS OF THE SYLLABI OFFERED IN INSTITUTIONS OF ENGINEERING AND TECHNOLOGY IN INDIA

I. Teacher-student ratio : 1:15 to 1:90

II. No. of contact hours per week:

Contact Nature	Lecture		Practical/Tutorial			
Contact Hours	1	2	Nil	1	2	3
Institutions percent	68%	32%	32%	38%	28%	2%

III. No. of students per class (i) Lecture 15 to 90

(ii) P/T 10 to 50

IV. Duration of the English Programme:

Semester	1	2	3	4	5	6	7	8	9	10
Institutions percent	6%	58%	6%	6%	6%	6%	4%	4%	2%	2%

V. Objectives of the ELT Programme:

Objectives	A	B	C	D
Institutions percent	82%	12%	4%	2%

A - No objective or vaguely implied objective.

B - "To impart the various language skills and to give practice in technical report writing."

C - "To promote the ability of students to express themselves clearly and effectively in writing and in speech; and to enable the students to acquire proficiency in communicating technical ideas through technical report writing."

D - Objectives defined at such a high level of abstraction that organisation of learning experiences seems not easy.

VI. Syllabus Pattern :

Pattern	A	B	C	D	E
Institutions percent	48%	38%	10%	2%	2%

PATTERN A : Mechanics of writing

1. Words
2. Expressions
3. Prepositions
4. Sentences
5. Punctuation
6. Common errors
7. Paragraph structure
8. Essay writing
9. Precis writing
10. Technical Reporting
11. Figures of speech
12. Indianisms

PATTERN B:

1. Detailed study of one to two text-books of the kind mentioned below (a few selections only):

(a) David Copperfield by Charles Dickens (abridged)
(b) A Farewell to Arms
(c) Huckleberry Finn
(d) Death of a Salesman
(e) Darkness at Noon
(f) Lord of the Flies by William Golding
(g) Prelude to English by L.A. Hill
(h) Strife by John Galsworthy
(i) From Harmony to Harmony

PATTERN C:

1. Same as Pattern B Plus
2. Non-detailed study of one to two of the kind of texts mentioned below:

(a) Collected Stories of Tagore
(b) Witness for the Prosecution by Agatha Christie
(c) The Hall of Fame
(d) Stories by the Fire-side
(e) The Woodlanders by Thomas Hardy
(f) Hurry on Down by John Wain
(g) Junior One-Act Plays of Today
(h) OLD WIVES' TALES by Arnold Bennet

PATTERN D:

1. Same as Pattern B/C Plus
2. Selections of poems

PATTERN E: Science based

The language of science and technology-register, pace style and special features. Technical vocabularies-the use of Latin and Greek prefixes and suffixes. Organisation and structure of scientific concepts-search for objectivity and clarity. Documentation and Reference Techniques. Oral communication of scientific data. Logical presentation of ideas. Presenting a seminar paper. Technical Reports, general principles of communication, mechanics of writing a report, format, presenting data by graphics. Informal, short reports, informational reports, analytical reports, special purpose reports including feasibility study. The Research process- Bibliographical tools.

The analysis of the content of the English-teaching programmes offered in the engineering and technological institutions in India, made available through the questionnaire yields disturbing discoveries:

(1) In the majority of cases the English-teaching programme is a perfunctory instruction evident from (a) the absence of any objective; (b) the fossilised content where even the OLD WIVES' TALES find a place, and (c) the slender teaching staff consisting of only one, or, at the most, two faculty members to man the department.

(2) In many cases the objectives are either vaguely implied or ill-defined, or defined at such a high level of abstraction that organisation of learning experiences is not easy.

(3) There is the assumption that the student-input is of a uniform proficiency in English with the result almost all institutions offer the same programme to all. Only three institutions in the country offer a remedial course to counteract the falling standards in English arising from the use of the regional languages as the media of instruction at the school.

(4) In not a few cases there is only a semblance of innovation by the mere substitution of material of general or literary interest with a mere anthology of scientific writing for teaching purpose, or the provision of a work-book based on scientific material, without any scientific theory or teaching philosophy to systematise the approach and the pedagogic strategy.

(5) Where the programme is related to the major study of students, the imaginative innovation is offset by its impracticability because the object of aiding students to comprehend the course content of their major study cannot be achieved when the teachers executing the programme have had no scientific background or training whatsoever, and are ill-equipped to comprehend techno-scientific concepts themselves.

(6) The analysis reveals that there is no synthesis in the structuring of the syllabi; there is no functional organisation of components that should synthesise a syllabus.

(7) Institutions with well-defined base and well-defined target devoted a longer period of time to the ELT programme than the others, in other words time was made available for reaching the target; with the others, the target was tailored to fit on the time available.

A few inferences that emerge from the analysis are as follows:

(i) In the first place there is no scientific theory or teaching philosophy to motivate teachers to orient themselves to the right approach.

(ii) Even where teachers wish to re-orient themselves, encouragement, inspirational guidance, and opportunities for enquiry and experimentation are wanting.

(iii) Institutions affiliated to universities are governed by the prescriptions of the university concerned. This explains why the syllabi are blue-printed and stereotyped, and lacking in intellectual and imaginative innovation.

(iv) Finally, the crux of the matter is, the teachers of English are English-language teachers exclusively.

Similar inferences would be drawn from the Panel discussion at the All India Specialised Institute for Teachers of English from colleges of Engineering and Technology held at the Birla Institute of Technology and Science, Pilani, in the summer of 1973. It throws further light on the attitude and approach of the teachers to the problem of English-teaching in engineering and technological institutions.

One member of the Panel said:

A. "What is needed for our students of science and technology is a course in English without making it too literary in quality or too scientific in content. When we speak of scientific or technical English we cannot be blind to the irrefutable fact that it is mostly the content and a few terminologies which make it look scientific or technical. The linguistic structures of the language are the same in science or literature. With a little more frequency of passive voice, the use of some performative verbs and the presence of scientific terms do not make a new English altogether.

When we devise a course in English for the students of engineering we must realize what their needs are. They must be able to understand their subjects without linguistic obstacles and to express themselves efficiently both in speech and writing. They must have sufficient command of English to reason, discuss and argue a point logically. It is a matter of common experience that those students who have a good command of English when they enter the engineering college do not have any difficulty in their subjects so far as the ability of comprehension and expression are concerned. It is not a kind of special English that gives them this ability, but the language as it is.

Therefore our main objective in giving a course of English to the students of engineering should be to give them a very good training in gaining command of the English language. What is the use of giving a student a specialised English when he has no English at all? A majority of the students who enter the engineering college are found to be lacking even the fundamentals of the English language. English text books on purely scientific topics with accent on 'Scientific English' will be just another science subject for them; for, there cannot be language without ideas and to draw a hard and fast line between content and language is unpsychological.

So I am for giving a two-year course in English for students of engineering. The syllabus must contain the following four units.

(i) Prose(general): to give them the ability to understand simple prose and express their thoughts and knowledge in both academic and non-academic life situations.

(ii) Prose(scientific and technical): to enable them comprehend scientific writing without difficulty and speak and write with greater efficiency in their subjects.

(iii) Spoken English: to enable them speak English with proper pronunciation, stress and intonation.

(iv) Remedial English: to enable them overcome their shortcomings and achieve the standard required."

B. Another said:

"It is necessary for us, the teachers of English in technical institutes, to view with seriousness the needs of technical students. We will have to make an attempt to deal with the problems of expression which the technical student has to face, it is necessary for us to relate the student's work in English to his other subjects. We will have to strive for achieving the instructional objectives for communicative competence in the Core Curriculum to be framed or developed by us. It is a question not only of doing our duty well, but also of our existence in technical colleges.

But can we, literature oriented teachers, fulfil this high expectation without any technical knowledge of the subject? Shall we not have to learn new attitudes in order to teach technical and scientific English? The answer to these questions is a categorical negative. We cannot but remember the saying: A little learning is a dangerous thing. We must certainly not attempt to teach a subject we know very little or nothing about. What we can and should reasonably do is to take the help of science and technical teachers while evolving the syllabus for different levels. We must decide what we can teach and what we cannot. All teachers on campus, including the subject specialist, must become in part teachers of English. Unless this situation is created, it is difficult to see how the problem can be solved. The teacher of English can concentrate on teaching structures and non-technical vocabulary involved and at the same time receive help from the linguist and the subject specialists. There is nothing wrong, if, in the meanwhile, he goes on adding to his own knowledge of science and technical subject. The quantum to be covered up is pretty wide. And the assignment of only two semesters to the teaching of English is like offering a few vitamin tablets to a third-stage patient of tuberculosis.

We have to evolve the common core of English which all the technical students must acquire. This will solve the problems of the lack of enough previous experience of English and that of expression of ideas in that language. We can, then, evolve integrated courses whereby, besides precision of thought and expression, the scientific and technical content can be taught with and through the language content. Here, we will have to collaborate with subject specialists and, if possible, develop text books directly out of the scientific content of the students' courses.

Suggested Syllabus

Without using much technical jargon, we can enumerate some of the essential items of the new syllabus.

Level I : Core Syllabus

(i) A text book designed specifically for achieving the instructional objectives for communication skills. Lessons should be followed by new type tests and exercises on language items.

(ii) The vocabulary introduced should help the student to read and comprehend books on subjects of scientific and technical nature.

(iii) Clearance of expression and sensible arrangement of material

Precis writing, paragraph writing, description of processes, classification, generalisation, explanation, definitions of technical terms. Controlled and guided composition.

(iv) Technical Description

Description of tools, workshop practice and drawings, occupations and job work done.

(v) Phonetic transcription and pronunciation and listening practice.

(vi) Mechanics of writing

Knowledge of the marks of punctuation, spelling, grammar useful for scientific and technical writing e.g. imperative forms, tenses, active and passive voice, direct and indirect narration, phrasal verbs, questioning, articles and prepositions. Constructions involving the uses of it, unless, although, whenever, etc.

Level II; Integrated Course

(i) Technical Correspondence

(ii) Technical Report writing, Project writing.

(iii) Summarising and Abstracting

(iv) Essay writing, Semi-controlled and free composition."

C. A third said:

"Before quantifying on the amount of English, it would be appropriate to examine whether there is a genuine need for English in engineering institutions. If we concede the need, how much and what kind of English do we need? Who shall define these needs - the engineering faculty or the English faculty? And finally, what component of English, the language or the literature, should we exploit to meet these needs?

The Education Commission, in its report, defined the role of English in new India, in unmistakable terms. English, it said, would continue for a long time to play the role of a library language, a language of reference. It will be a window looking on to the world outside and with the help of this medium we would have access to science and technology.

The role of English having been defined, it is obvious that it can only play a second fiddle in the changed context. In emphasising its role as a library language, it is understood English will be needed for reading books and comprehending the stuff that is written in English. Many linguists have doubted this proposition whether it is advisable to teach a language only for reading and comprehension. Shouldn't the other basic skills of speaking and writing also figure in the goals we set ourselves? The four basic skills may not be unitary in themselves, but they do serve as a guide to help us in defining our needs:-

1. Speak to whom and how? (Colloquially to friends and family? Semi-informally, in connection with one's profession perhaps to other Indians? to foreigners?

2. Understand what? (Teachers, textbooks, lectures.)

3. Read what? (Text-books, technical papers, novels, etc.)

4. Write what? (Letters? Official letters? Reports? Examinations?)

Teaching, it is increasingly realised, should be situationally contextualised, and the questions stated above help to define the situational needs of English as a foreign language or second language. We certainly do not wish to prepare the student for every possible exigency. Our goals must be realistic, and efficiency is possible only when constraints are imposed and a limited well-defined area is taken up. There is a drawback in this attitude, however, which we have to keep in mind. It is difficult, indeed impossible, to visualise all the possible situations a student will face, and new situations may explode upon him, rendering his language machine or limited language competence ineffective in confronting new situations.

The existing position with regard to attainment and proficiency in English at the school leaving stage also needs to be examined. It has been worked out that for effective communication to take place, a person must have an active vocabulary of 2500 words and roughly 275 structures. This is laid down as the target to be attained by a student when he leaves school and comes to the university. The reality, however, is far short of this requirement. Miss Helen Barnard investigated the attainment level of the students of the Ranchi University in a random survey and found that they had an active vocabulary of 900 to 1000 words and their mastery of simple structures was very inadequate. What is true of Ranchi area should be considered valid for many other areas in the country, leading to the conclusion that at most places wherever teaching through the English language medium is going on, effective communication does not take place. Higher education is in the grip of a real crisis, and this is true not only in areas like arts, the social sciences, natural sciences, but also in the medical and technical faculties. Poor communication means poor comprehension, and the substitute for the student in such a situation is to rely more on unintelligent memory than on understanding.

With this overview of the situation, and an outline of the general approach I have in mind, I propose an intensive course in English at all levels of the engineering programme. In the syllabus proposed, phonetics is not mentioned, but spoken English can be integrated into the programme as an incidental item in the presentation of teaching material.

First Year

Need: Science-based Texts.
Suggested text-books:

1. Factual English by Bruton
2. Easier Scientific English Practice by G.C. THOMLEY
3. Scientific English Practice by G.C. THOMLEY

The stress during the first year course would be on oral and written comprehension,grammar and usage, controlled and guided composition, description of simple situations or operations. Students should be required to read every month atleast five simple abridged books in the Longman's structural Reader series which have a graded range of vocabulary, and they should be asked to submit book reports on a prescribed proforma.

Second Year

Need: Science and Engineering based texts.
Suggested text-books:

1. The English we use for Science (R.A. Close)
2. English for Engineers (C.Brasnett)

In the second year, apart from extending the field of grammar and usage, and comprehension the teacher can forge ahead with free composition. Special emphasis should be laid on sentences, paragraph writing, description and explanation, special types of exposition such as: giving and writing instructions, letter writing and simple reports. Interpretation of texts (mainly scientific); note taking; summarising and precis writing may be taken up at this level.

The students should, in addition, be required to read atleast ten novels during the session, and make a report on a prescribed proforma.

Third Year

Need: English based on engineering texts.
Suggested text-books:

The structure of Technical English(Herbert)

By this stage, the requirements of formal grammar and usage will have been fairly well established. The suggested text book has grammatical exercises which will help to re-inforce what has been done before. In addition there is much in common in some of the vocabulary items of science and engineering with the world of the layman, and an extension of meaning of the concepts is desirable at this stage. Help can be had from the suggested text book.

Further reading in modern novels (atleast 10) to be followed by book-reports in the prescribed proforma.

Fourth Year or Final Year

The language of science and technology- register, pace, style, and special features. Technical vocabulary- the use of affixes. Organisation and structure of scientific concepts. Documentation and Reference-techniques. Seminar Paper. Technical Reports. Principles of communication. Various other reports- informal, analytical, special purpose reports and feasibility study. The Research process. Bibliographical tools.

Text for study:

The Background of Science(Anthony)
Ten novels for study and report writing.

In our search for the making of a good engineer, it is necessary to emphasise that his education does not stop the moment he leaves the portals of the university. The acquisition of knowledge and skill is a life long process and the attitudes he imbibes and carries with him are more important than the body of information furnished through the formal instruction programme. The training in language, the ability to communicate, is a part and parcel of his education in forming his attitudes, and by the end of four years, the engineering student will have cultivated wider interests and reading habits which will give him an insight into men and their motives, human problems and predicaments like the alienation of man from his environment, from the machine which gives him his daily bread, the conflict between classes, the struggle for survival or for power. It is these insights which will help the engineer to face the many challenges his profession is likely to confront him with."

VIEWS OF STUDENTS ON ENGLISH-LANGUAGE TEACHING PROGRAMMES

The evaluation of a teaching programme to be comprehensive and realistic needs to take into account the views of students.

The views of students who have taken the English-language teaching programmes at the Birla Institute of Technology and Science, Pilani, obtained through informal talks, discussions, straw-poll and through a formal opinion-poll show that a majority of the students of both near-native competence and adequate proficiency in English find the programmes excepting the programme on Report writing, unrelated to the needs of technological education. Of the four hundred and fifty students interviewed over a period of five years, that 17% to 24% feel that even a working knowledge of English is sufficient for them to receive technological education reflects the impact of the programme. Although 70% students felt that the implied objective of the programmes is to improve the student's linguistic ability, there were as many as 37% that stated that the programmes failed miserably in meeting the objective, and 10% students categorically stated that the programmes including the Report writing course wasted their time. 51% students wanted only the Report writing programme to be retained and the remaining programmes to be eliminated from the curriculum, 40% students wanted the total number of units of English study to be retained but the emphasis to be shifted to English for technology, and 2% students thought all English programmes should be offered on Audit basis. Fig.1 is a pie chart illustrating the views held by the four hundred and fifty students.

Excerpts from students' expressed opinion make revealing study. The excerpts incorporated are of students who have secured "A" grade in the English programmes.

"The ENGL A111 programme was a little below the standard of English a college student should know. Being a S.C. student and coming from a school where there was much more emphasis on English than is necessary at that age I found the programme two to three years behind in years. I mean something that we as school children did in the 8th or 9th standard. The practice classes were a mere waste of time where one had to write compositions on Diwali holidays and such trivial, irrelevant topics. The literature books were as already mentioned much below standard. The 'Prelude to English' was I think a farce. I mean we are not to be taught the language at this stage but to be kept in trim form. We are to learn something higher, improve on what we have learnt and not repeat what we learnt some years back. Then the book of three plays. Well we did something like that two years back and for S.C. we analysed novels.

After covering the ENGL A111 course I found that I had not gained any more knowledge. But had only repeated my previous learnings."

"I found the approach to this subject quite unimaginative. One was expected to do the same old things one had done years ago and that too with such lack of interest that it tended to be a drudgery. Another implication of the unimaginativeness of this course was that a student lost what interest he had in acquiring any more knowledge from the linguistic point of view. As it is, engineers and scientists are considered woefully devoid of the faculty to express themselves, there is no need to crush whatever interest a budding scientist has in improving his powers of expression."

"In my opinion the practice course of ENGL A111 is perfectly valid as it improves our English and makes it easier for us to cope with the difficult language that we may come across in our further study of any subject. But ENGL A111 theory course in my opinion is not required at all. Most students who come to BITS come to become scientists, engineers, etc. and not to be authorities on literature. Even if the authorities of the Institute think that a certain knowledge of literature is necessary, the prescribed books defeat the purpose. One of the prescribed books is of such a low standard that I won't be surprised if many schools have books of a higher standard. Thus I think that only the practice course of ENGL A111 should be there."

"A111 was an unnecessary course. It was aimed at improving the English of the average student and the better off vegetated. The text book of Prose was L.A. Hill's A Prelude to English, as thoroughly disgusting an anthology as any. The teaching, at least in one section, was dull and no one paid attention. Students were known to walk out when class was in progress and the instructor never knew it. The Drama portion consisted of two good plays by Barrie and Rattingan both (plays) murdered because of the teaching. The practice class consisted essentially to my perhaps over-critical eye of learning to answer questions about the economic policy of Japan, to write essays on 'How I spent my summer vacation' and to compose letters to your younger brother telling him about civilisation. The course actually had the audacity to tell you how to write letters to people close to you. I have always held that a 'personal' letter is a personal affair and the coaching should keep its nose out of it, the further out the better."

PIE CHART ILLUSTRATING THE VIEWS HELD BY FOUR HUNDRED AND FIFTY STUDENTS INTERVIEWED ON THE PROGRAMMES IN ENGLISH OFFERED AT THE BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI.

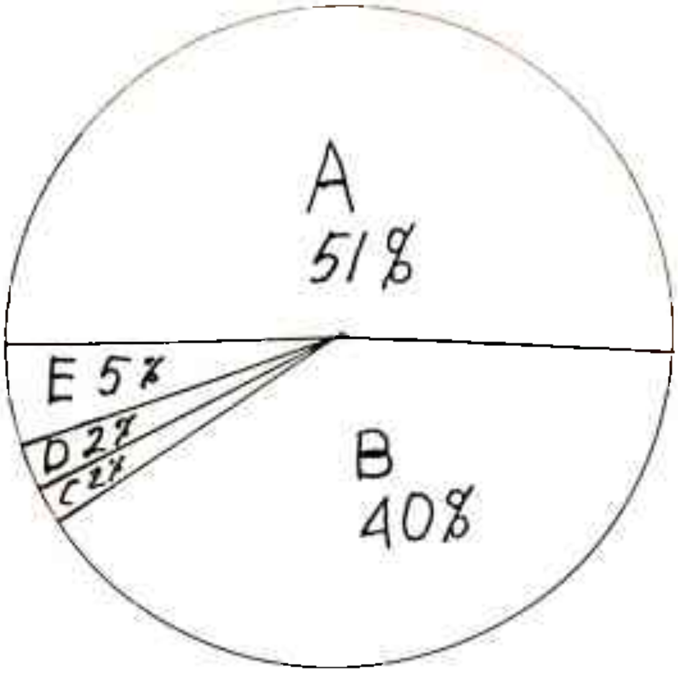

FIG. 1

A: Persons in favour of only the ENGL A2111 course and eliminating the rest from the curriculum.

B: Persons in favour of the same number of courses in terms of total units for English but shifting the emphasis to English for technology.

C: Persons in favour of having the programmes as they are without changes.

D: Persons reserving their comments.

E: Persons who think all the courses should be eliminated from the core curriculum, and to be offered on Audit basis.

(For Questionnaire see Appendix 'A')

WHAT IS AMISS

Education is a processed activity towards progression. There can be no progression if (a) there is no clear conception of the learning experience already with the learner at the take-off stage; (b) there is no clear, comprehensive and well-defined objective necessary for the take-off of the learner on his learning experiences;and (c) there is no clear conception of the kind of learning experiences or mental discipline to be imparted.

(a) What is seriously amiss with the existing ELT programmes is that there is no base or datum-line. There is no clear conception of the learning experiences already possessed by the students. The first task therefore is to determine the datum-line, which, in effect, would mean determining the proficiency level of the student-input through a Placement Test administered to students on admission.

(b) The target by statement or by implication of the existing ELT programmes in technological education in India is much too indefinite. The objectives as defined are general statements, vague generalisations, and descriptions of broad curricular areas. It is not sufficient to state, for instance, that the objective is "to promote the ability to express clearly and effectively in writing and in speech, and to acquire proficiency in communicating technical ideas through technical report-writing", because (i) self-expression is so complex a process that even in a technological area it ranges from expressing the content of the technological study verbally and non-verbally in oral and written form to expressing new ideas directly or indirectly associated with the major field of study originated by creative thinking; so complex is the process that it involves a series of phases each phase being a complex integration of skills, concepts and thought-processes; and (ii) expression at best is an inadequate vehicle of communication; much of the idea is lost in transit; a thought does not impinge upon the receiver's mind with the freshness and the vigour with which it issued from the brain of the transmitter. The objective should be formulated on the basis of the specific learning experiences that are desired. A clear and definite conception of the specific learning experiences desired to be produced should be the goal or the target.

(c) What is again seriously amiss with the existing ELT programmes is that the content of the ELT programmes in engineering and technological institutions in India is more or less the same as the content of the ELT programmes in advanced general education.

The content of the English language teaching programmes in technological education must be yet another component of engineering and technological study. This cannot be achieved by measures that are strongly linguistic in bias. Applied linguistics does break much new ground as an instrument of language-teaching, but its utility is more in English-teaching as a second language or as a foreign language and not in English-teaching as a component of engineering and technological study.

Chapter V

STATISTICAL ANALYSES OF IMPACT OF PROFICIENCY IN GENERAL ENGLISH ON PERFORMANCE IN TECHNOLOGICAL STUDY

A relevant study that needs to be made in the enquiry into the instructional role of English in technological education in India is the study of the impact of proficiency in the instructional language on performance and progression in technological study.

The appropriate approach would be the controlled experimental method in which only the factors under study are allowed to vary while as many as possible of the other factors are controlled. In which case, in order to study the effect of proficiency in the instructional language on performance in technological study, it would be necessary to have two groups, one subjected to a programme in the instructional language, and the other not subjected to it, under identical academic and non-academic conditions. But it is not possible to fully assess the factors contributing to performance and progression in technological study of a student. Often, many of the factors lie outside the scope and ambit of an academic institution. Factors like (1) socio-economic condition, (2) family set-up and environment, (3) emotional state, etc., are beyond the means of Faculty to estimate and control. The causes for the erratic academic behaviour of quite a few cases of students were found to be (a) unexpected financial crisis, (b) expiry of a near-relative, (c) home-sickness, (d) loss of self-confidence from failures in some subjects, (e) disagreement with a fellow student, (f) certain complexes that have been developed, etc. Factors which lie within the academic field include proficiency in the instructional language. Motivation for the chosen professional study is another factor which contributes to performance. The third factor within the academic purview is ability to study. Ability, though an important factor, is not independent. It depends on the overall effect of other factors. If other factors have favourable influences, ability naturally develops. All these factors would entail an unending series of processes which may not be encompassed within manageable limits for the experimental method. However, in lieu of it, certain aspects of the statistical method can be used, although, for such a study, data should be available in quantised forms as well as large samples should be possible in order to arrive at ~~[illegible]~~ inferences that would be reasonably reliable. ~~as well as predictable.~~

Data in quantised forms as well as large samples are available at the Birla Institute of Technology and Science, Pilani. Besides, it categorises students into two streams of adequate proficiency and inadequate proficiency in General English on the basis of a Placement Test administered at admission, in order to remove the linguistic deficiency in those with inadequate proficiency through an appropriate programme in General English. Furthermore, it offers three core programmes in General English in sequence to enable the student with adequate proficiency to "acquire working knowledge of the language in as much as it is the medium of instruction in the Institute."[1]

Proficiency in English is quantised in terms of letter grades which notation is itself qualitatively determined but is convertible into quantitative forms as each letter grade carries a numerical value. The five grades are 'A' for Excellent carrying 10 points, 'B' for Good carrying 8 points, 'C' for Fair carrying 6 points, 'D' for conditional pass carrying 4 points and 'F' for Fail carrying 2 points. The overall performance of a student is indicated by an index called the Cumulative Grade

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1. Bulletin of Programme of Studies, Birla Institute of Technology and Science, Pilani, 1973-74, p.A-1.

Point Average (hereafter to be denoted as CGPA). It is a weighted average of all the grades received by a student from his entry into the Institute upto and including the latest semester. It is computed as follows:

$$\text{CGPA} = \frac{u_1 g_1 + u_2 g_2 + u_3 g_3 \ldots\ldots\ldots}{u_1 + u_2 + u_3 \ldots\ldots\ldots}$$

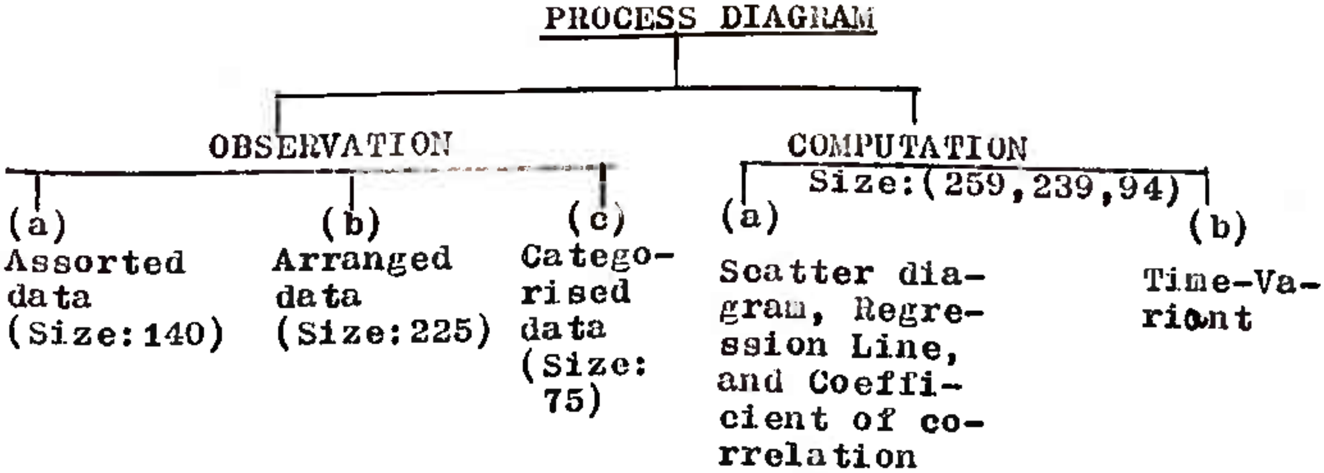
where $u_1, u_2, u_3 \ldots\ldots$ denote units of the courses taken by the student, and $g_1, g_2, g_3 \ldots\ldots$ denote numerical grade points of the letter grades received by the student.

Relevant measurements being readily available, the analyses are accomplished with ease.

STATISTICAL ANALYSES

As shown in the Process Diagram below, two kinds of analyses are being done. The first analysis is based

PROCESS DIAGRAM



on observation of data and the second is based on computation of the Coefficient of Correlation and fitting the Regression Line. Observation of data is done for (a) Assorted data, (b) Arranged data, and (c) Categorised data. Computation is done for (a) Scatter Diagram, Regression Line and Coefficient of Correlation, and (b) Time-variant.

The Process Diagram also shows the size of the sample for each study. A number of samples with elements varying from 70 to 250 have been studied.

1. BASED ON OBSERVATION:

(i) ASSORTED DATA

The data for a random sample unit of 140 students of consecutive Identity Number, of adequate proficiency in General English, for 8 semesters, is presented below. Table I shows cases of increase in CGPA by one and more points and Table II shows cases of decrease in CGPA, along with the grades in General English Programmes for three semesters. An observation of the array gives the following information: 25%(35/140) of the students alone have an increase in CGPA during the 8 semesters by one or more points; 20%(28/140) of the students have a decrease in CGPA; the remaining 55% of the students have negligible (less than 1 point) increase in CGPA (Table III).

A striking feature of students whose CGPA is increasing is that their grades in General English in the first semester and the average grade for the three semesters

TABLE I

CASES OF INCREASE IN CGPA BY ONE AND MORE POINTS AND GRADES IN GENERAL ENGLISH PROGRAMMES

Sl. No.	Identity No.	Grades in English Programmes I	II	III	C.G.P.A. I Sem.	VIII Sem.
1.	4	D	D	C	7.00	8.35
2.	5	D	D	C	4.80	7.25
3.	6	C	C	C	6.35	7.30
4.	7	C	C	C	7.25	8.14
5.	9	D	D	C	6.75	7.66
6.	12	C	C	C	6.35	7.84
7.	14	C	C	C	6.70	8.01
8.	17	D	C	C	6.30	7.27
9.	18	C	A	D	5.55	6.73
10.	25	C	C	B	6.45	7.77
11.	28	C	C	C	6.70	8.32
12.	50	C	C	D	5.45	6.88
13.	51	D	C	C	3.55	6.16
14.	52	D	D	C	4.55	5.49
15.	54	D	F	D	3.30	5.21
16.	55	D	D	D	4.00	5.47
17.	56	C	C	C	5.30	6.40
18.	58	F	F	D	4.40	5.54
19.	59	D	C	D	5.25	6.75
20.	60	C	C	W	3.70	6.26

TABLE I (Contd.)

Sl. No.	Identity No.	Grades in English Programmes I	II	III	C.G.P.A. I Sem.	VIII Sem.
21.	68	C	C	D	4.40	7.13
22.	69	D	F	D	3.42	5.47
23.	70	D	D	D	4.35	5.67
24.	71	D	D	D	5.25	6.43
25.	72	D	F	D	3.65	5.34
26.	73	C	B	C	4.05	5.48
27.	74	C	D	C	4.50	6.45
28.	75	D	F	C	3.55	4.63
29.	80	A	A	A	5.65	7.00
30.	99	D	C	C	4.00	5.08
31.	104	F	C	C	5.20	6.52
32.	107	B	C	B	4.10	5.36
33.	111	D	D	W	4.10	5.13
34.	115	D	F	D	4.70	6.85
35.	135	C	D	C	6.25	7.26

TABLE II

CASES OF DECREASE IN CGPA AND GRADES IN GENERAL ENGLISH PROGRAMMES

Sl. No.	Identity No.	Grades in English Programmes I	II	III	C.G.P.A. I Sem.	VIII Sem.
1.	10	C	C	C	6.00	5.01
2.	15	A	A	B	7.50	6.92
3.	19	C	C	B	7.15	6.97
4.	22	B	B	B	7.80	7.45
5.	26	C	B	B	6.80	6.79
6.	47	C	C	D	5.20	5.17
7.	53	B	B	C	6.05	5.87
8.	57	C	C	C	6.35	6.33
9.	63	A	A	C	6.35	5.25
10.	82	C	C	D	5.65	5.52
11.	95	A	B	B	7.60	7.46
12.	97	A	A	A	7.60	7.25
13.	100	A	C	A	6.35	5.72
14.	101	B	C	B	7.30	7.14
15.	103	C	D	C	5.65	5.15
16.	106	C	C	D	6.00	5.25
17.	109	C	D	D	5.10	4.68
18.	110	C	C	B	7.70	7.23
19.	117	C	A	D	6.10	5.42
20.	119	A	A	A	6.70	6.50

TABLE II(Contd.)

Sl. No.	Identity No.	Grades in English Programmes I	II	III	C.G.P.A. I Sem.	VIII Sem.
21.	126	A	B	B	10.00	9.72
22.	127	A	A	B	9.20	8.91
23.	128	C	C	C	8.30	7.85
24.	130	A	A	A	9.90	9.78
25.	132	B	B	B	7.55	6.80
26.	134	C	C	F	4.95	4.59
27.	137	B	B	B	9.15	8.91
28.	138	C	C	C	6.10	5.97

TABLE III

CASES OF NEGLIGIBLE INCREASE IN CGPA AND GRADES IN GENERAL ENGLISH PROGRAMMES

Sl. No.	Identity No.	Grades in English Programmes I	II	III	C.G.P.A. I Sem.	VIII Sem.
1.	1	C	C	C	5.65	5.96
2.	2	C	C	C	5.90	6.27
3.	3	C	C	B	6.80	7.20
4.	8	C	C	C	6.70	7.01
5.	11	B	C	B	6.75	6.89
6.	13	C	B	B	8.40	9.10
7.	16	C	C	D	6.35	6.60
8.	20	B	B	B	8.26	8.41
9.	21	C	B	B	7.85	7.93
10.	23	C	B	B	7.75	8.34
11.	24	C	C	C	6.90	6.94
12.	27	D	C	D	5.70	6.05
13.	29	B	A	B	8.25	8.91
14.	30	D	C	F	5.25	5.61
15.	31	B	B	B	6.30	6.74
16.	32	C	C	C	6.70	7.31
17.	33	C	C	C	6.70	6.81
18.	34	C	C	C	5.10	5.38
19.	35	C	C	C	4.05	4.51
20.	36	C	C	C	6.35	6.40

TABLE III(Contd.)

Sl. No.	Identity No.	Grades in English Programmes I	II	III	C.G.P.A. I Sem.	VIII Sem.
21.	37	A	A	B	6.60	6.61
22.	38	A	B	B	8.67	8.70
23.	39	A	B	A	8.62	8.63
24.	40	A	A	A	8.00	8.21
25.	41	B	B	C	8.97	8.98
26.	42	C	C	B	7.64	8.26
27.	43	A	A	A	9.38	9.43
28.	44	C	C	C	5.03	5.52
29.	45	C	B	C	6.97	7.41
30.	46	D	C	C	7.41	8.07
31.	48	B	B	B	6.30	6.54
32.	49	D	D	F	3.30	3.87
33.	61	D	C	C	5.95	6.19
34.	62	C	C	B	5.20	5.90
35.	64	B	B	B	6.30	6.90
36.	65	C	C	D	4.85	5.72
37.	66	D	D	F	4.80	5.28
38.	67	D	D	D	3.75	4.20
39.	76	A	A	A	7.90	7.92
40.	77	B	B	C	7.55	8.09

TABLE III(Contd.)

Sl No.	Identity No.	Grades in English Programmes I	II	III	C.G.P.A. I Sem.	VIII Sem.
41.	78	B	B	B	6.85	7.19
42.	79	C	C	B	7.15	7.32
43.	81	A	A	A	8.50	8.51
44.	83	B	B	B	7.10	7.31
45.	84	B	C	B	6.99	7.12
46.	85	C	C	C	7.05	7.57
47.	86	B	B	B	8.25	8.46
48.	87	B	B	B	7.90	8.04
49.	88	D	D	C	5.05	5.78
50.	89	C	B	B	6.35	6.67
51.	90	B	B	B	4.80	5.06
52.	91	D	C	C	4.35	4.97
53.	92	F	F	D	4.85	5.10
54.	93	C	A	B	4.25	4.31
55.	94	C	B	B	7.60	7.84
56.	96	A	A	A	6.55	7.44
57.	98	A	B	B	8.05	8.41
58.	102	B	B	B	4.20	4.86
59.	105	C	C	C	6.55	7.18
60.	108	B	B	C	3.90	4.00

TABLE III(Contd.)

Sl. No.	Identity No.	Grades in English Programmes I	II	III	C.G.P.A. I Sem.	VIII Sem.
61.	112	B	A	B	7.55	8.12
62.	113	D	D	D	5.15	5.60
63.	114	C	C	C	6.80	6.94
64.	116	D	C	C	5.60	6.12
65.	118	C	C	C	7.05	7.17
66.	120	C	C	C	5.70	5.76
67.	121	D	C	C	4.80	5.26
68.	122	C	B	C	6.68	6.98
69.	123	C	B	C	6.26	6.29
70.	124	C	B	C	5.78	5.81
71.	125	C	C	B	7.25	7.58
72.	129	C	C	C	6.70	6.71
73.	131	C	D	C	5.65	5.69
74.	133	C	D	C	6.80	7.20
75.	136	D	D	C	5.60	5.73
76.	139	D	C	D	5.50	6.18
77.	140	A	A	B	7.70	8.14

are low; it is 5.1 . The majority of students who have progressive CGPA have in General English D grade or C grade. Students with B and A grade who have increasing CGPA constitute only 1.4%(Fig.1). Most of the students whose CGPA shows decrease have high grades in General English programmes. The average grade in a General English programme for these students is 8.

It leads to the inference that a low grade in a General English programme is symptomatic of a high performance in technological study.

(ii) ARRANGED DATA

Another larger random sample of 225 students of adequate proficiency in General English, presented in an array below, further strengthens the inference already drawn. Histogram 1 shows CGPA distribution for the above sample for one semester. It will be noticed that the CGPA ranges 3 to 4 and 9 to 10 are thinly populated. Histograms 2,3,4 and 5 show under each English grade the distribution of students according to CGPA bands.

It is seen from Table IV that

(1) students of high grade in General English are mostly in the 6-7 and 7-8 CGPA bands; and

(2) the 8-9 and 9-10 bands are populated by a nearly equal number of students with A,B and C grades.

The inference is that those with high proficiency in General English do not generally score a correspondingly high CGPA in their performance in technological study.

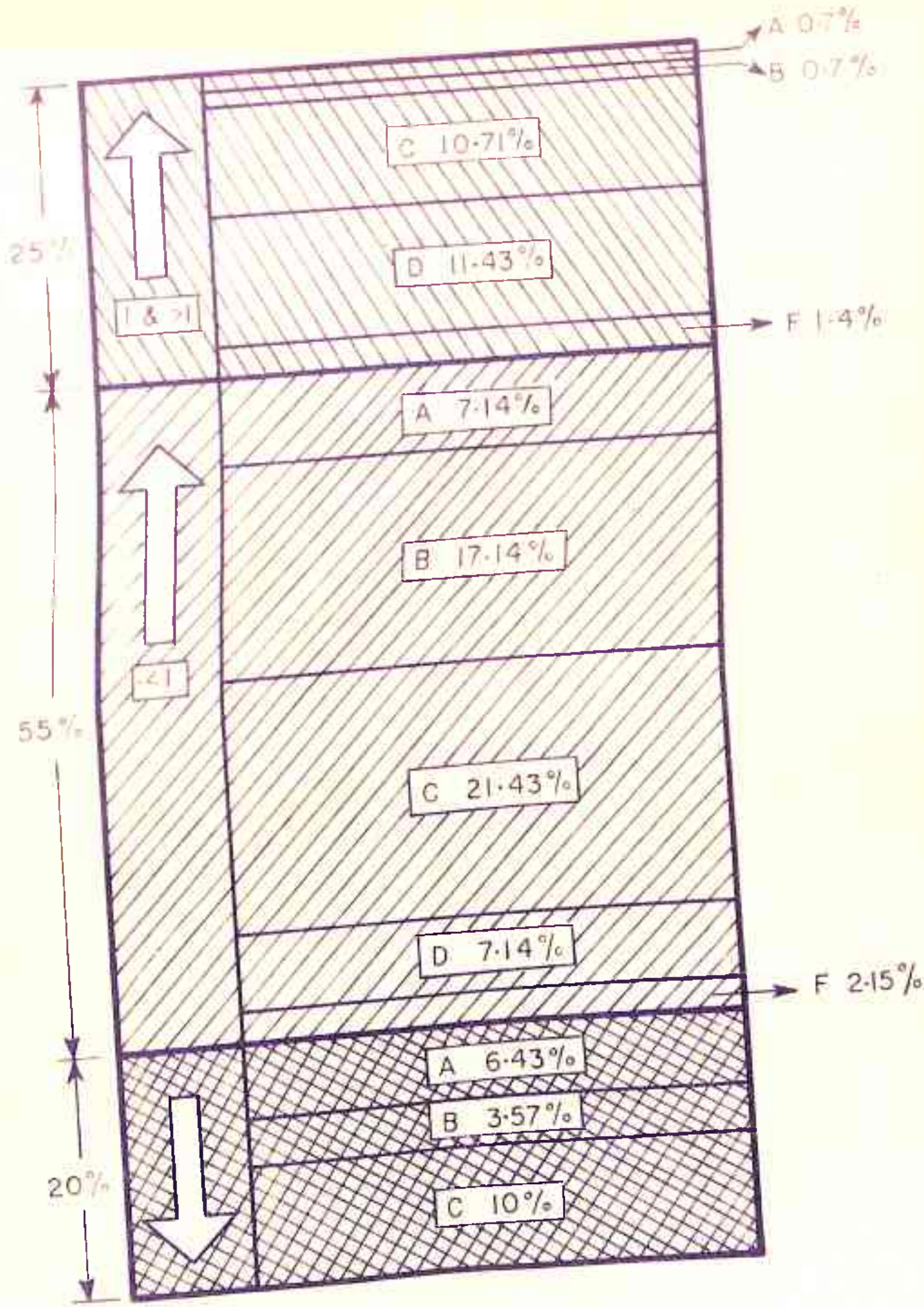
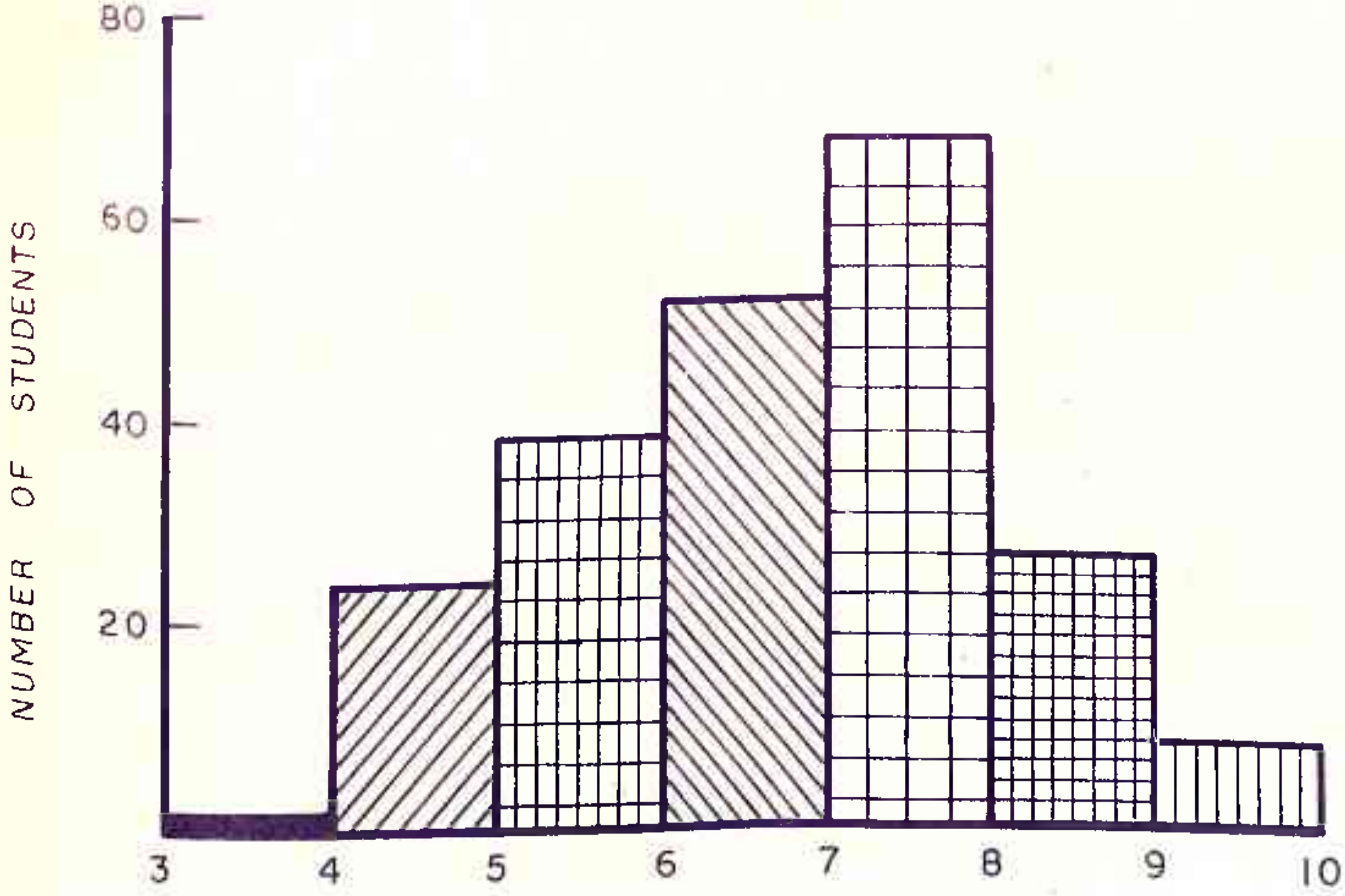


FIG. 1: PROGRESS IN CGPA FOR A 4 - YEAR PERIOD WITH ENGLISH GRADES AT START.

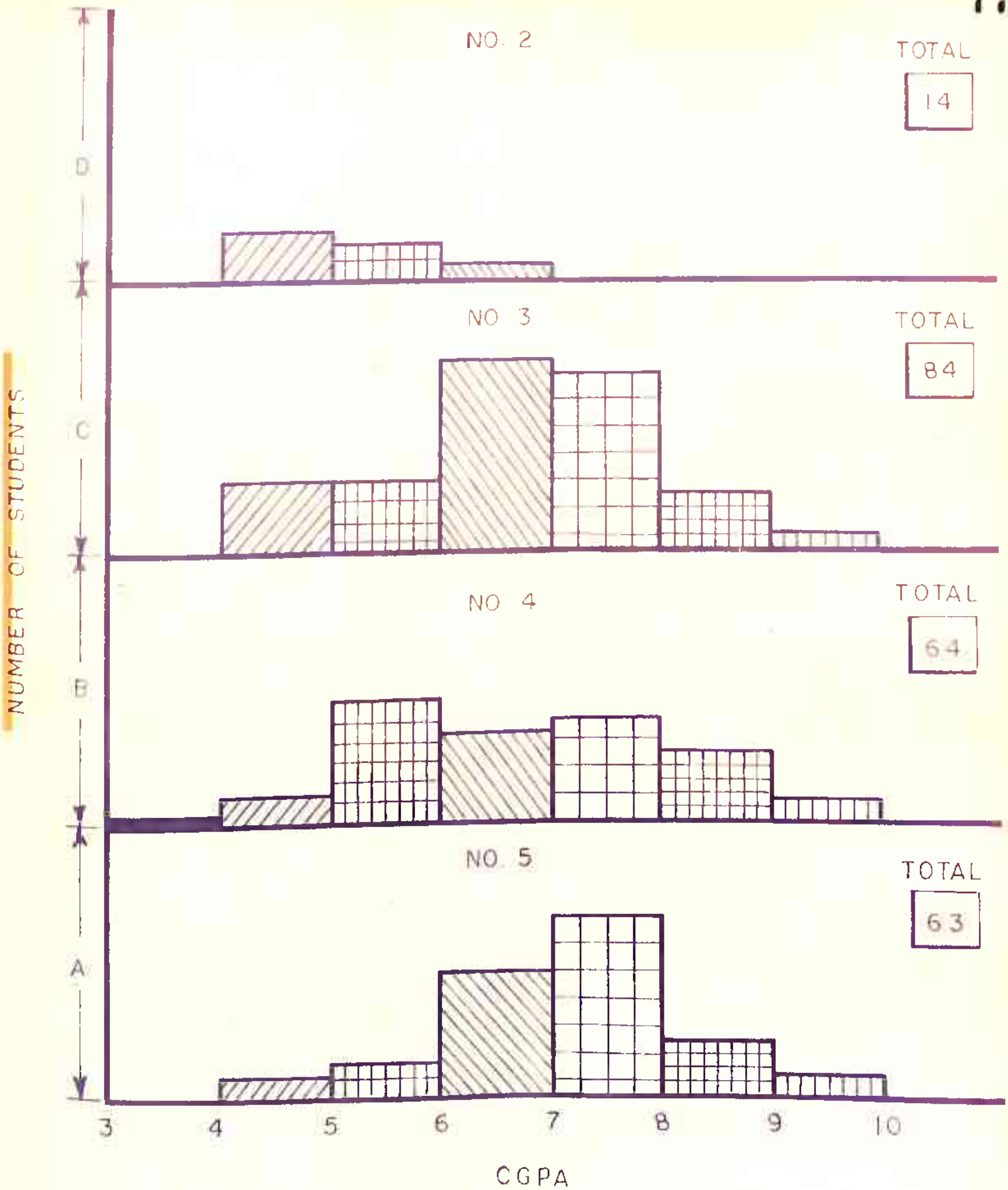
	3 — 4	4 — 5	5 — 6	6 — 7	7 — 8	8 — 9	9 — 10	TOTAL
D		7	5	2	0	0	0	14
C		10	10	28	26	8	2	84
B	1	4	18	13	15	10	3	64
A		3	5	18	26	8	3	63
TOTAL	1	24	38	61	67	26	8	225

TABLE IV: DISTRIBUTION OF CGPA ON THE BASIS OF GRADES IN ENGLISH



NO. 1

HISTOGRAM SHOWING DISTRIBUTION OF 225 STUDENTS IN THE DIFFERENT BANDS OF CGPA



HISTOGRAMS OF CGPA DISTRIBUTION FOR DIFFERENT GRADES IN ENGLISH

(iii) CATEGORISED DATA

Simple categorising of a random sample is also informative. Such a process involves the information and definition of some arbitrary compartments or groups. The population density in each group as well as their kind are guidelines in such a study. The following presents the categories of a random sample of 75 students of adequate proficiency in General English.

The first division of the sample is based on the nature of variation of the grade in General English programmes over the three semesters. This phase naturally calls for three classes: (1) those with increasing grade in General English for three semesters denoted by 'I', (2) those with level grade in General English for the three semesters denoted by 'L', and (3) those with decreasing grade in General English for the three semesters denoted by 'D'. Again each group may be sub-divided into smaller groups on the basis of the grades in General English programmes. The group with increasing English grade may be classified on the basis of the starting grade. Thus I_F, I_D, I_C and I_B show the different subgroups starting from the various initial grade as F, D, C and B respectively. The level group also may be sub-divided as L_A, L_B, and L_C showing that its grade remains at A, B and C. Similarly, the group with decreasing grade may also be classified further on the basis of its initial English grade as D_A, D_B and D_C which represents the initial grade as A, B and C.

It will be noted from Fig.2 that there are more cases of increasing English grade while cases of decreasing grade are very few. The average CGPA for each of the groups I, L and D is presented in Table V alongwith their average grade in English. Table VI represents the average CGPA for each sub-group I_D, I_C, I_B, L_A, L_B, L_C, D_A and D_B, along with their average grade in English. The variation over the three semesters is shown in the accompanying graphs. The graphs show the progression in time of the English grade as well as that of CGPA for comparison. Graph 1 represents the average for the sample. Graph 2 shows the variation (of average) for categories I, L and D. Graphs 3,4 and 5 show the changes in CGPA and English grades for the categories (1) I_B ,I_C ,I_D , (2) L_A ,L_B ,L_C and (3) D_A ,D_B respectively.

An inspection of Graph 2 reinforces the observations already made: (1) the relation between the two factors General English grade and CGPA is very weak; (2) an increase in the overall proficiency is to be expected mostly from low English grade students; and (3) where the grade in English is high, there is a tendency for the CGPA to decrease in the course of two to three semesters. However, such a decrease in CGPA is not very significant.

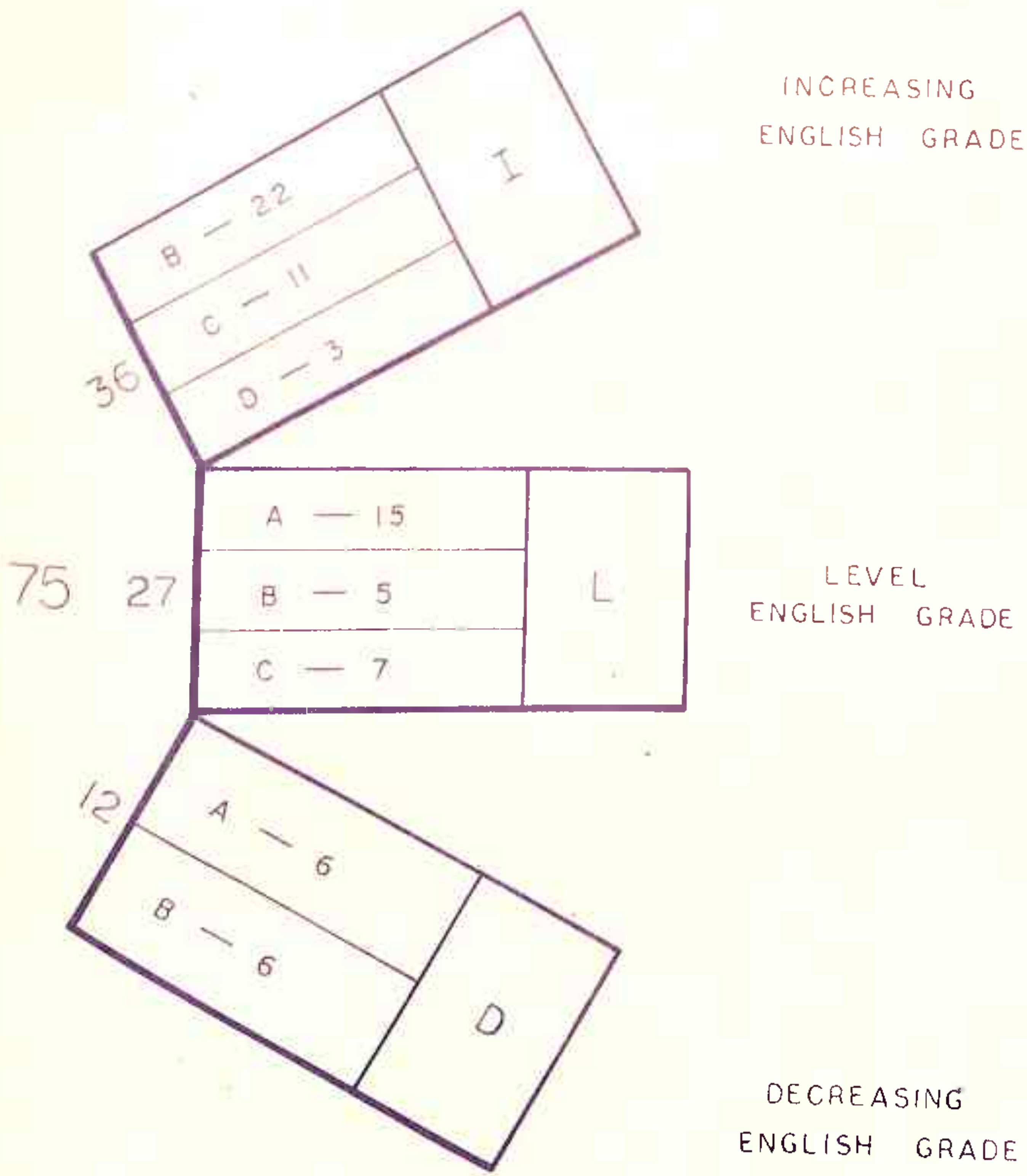


FIG. 2

BEHAVIOUR TREND OF A CATEGORISED SAMPLE

TABLE V

AVERAGE CGPA AND AVERAGE GRADE IN ENGLISH OF THE THREE GROUPS I , L , AND D

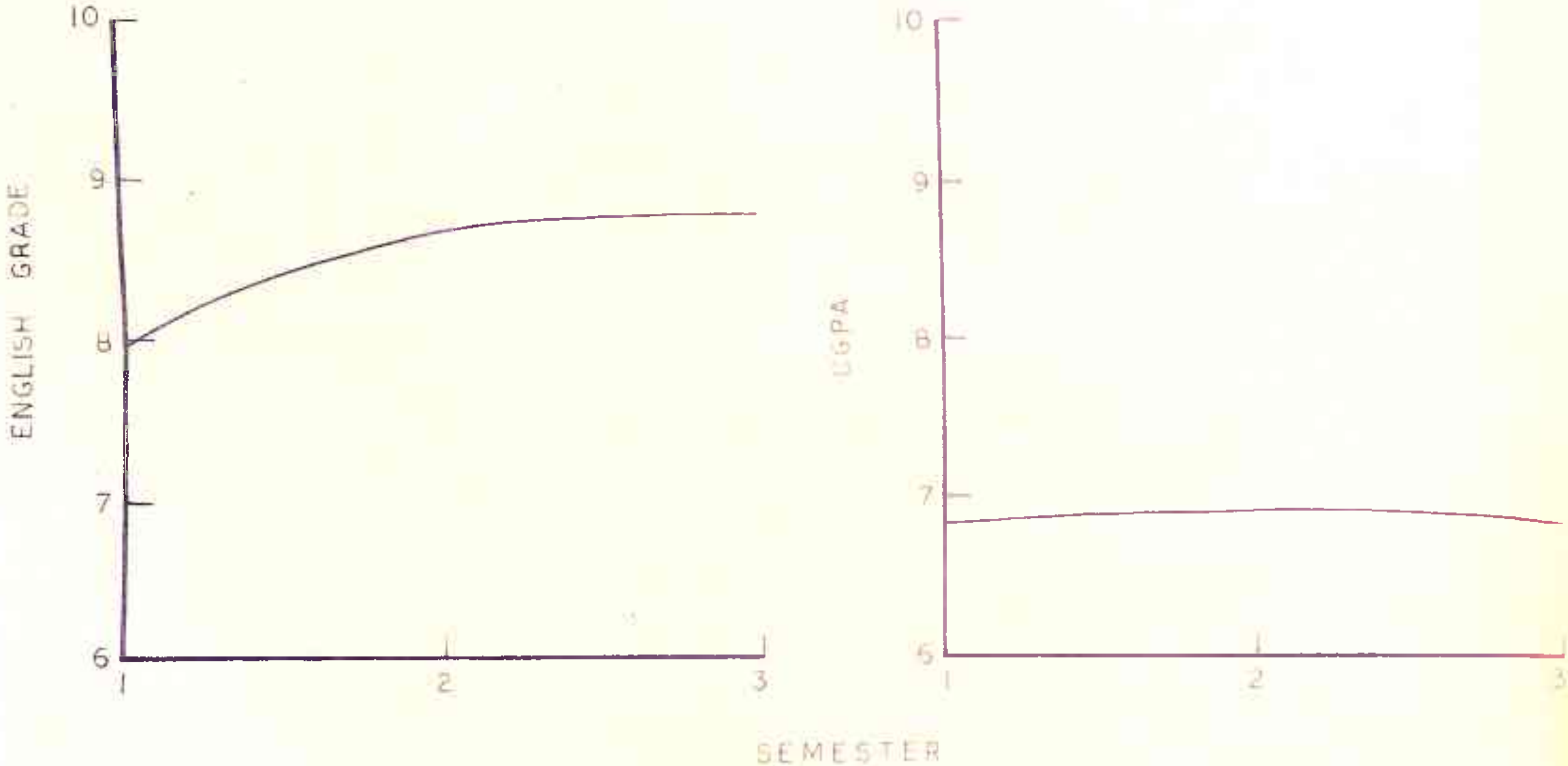
GROUP		SEMESTER I	SEMESTER II	SEMESTER III
I	GRADE	7.055	8.666	9.555
	CGPA	6.808	6.994	7.018
L	GRADE	8.592	8.592	8.592
	CGPA	6.386	6.382	6.846
D	GRADE	9.000	8.833	6.666
	CGPA	6.722	6.702	6.388

TABLE VI

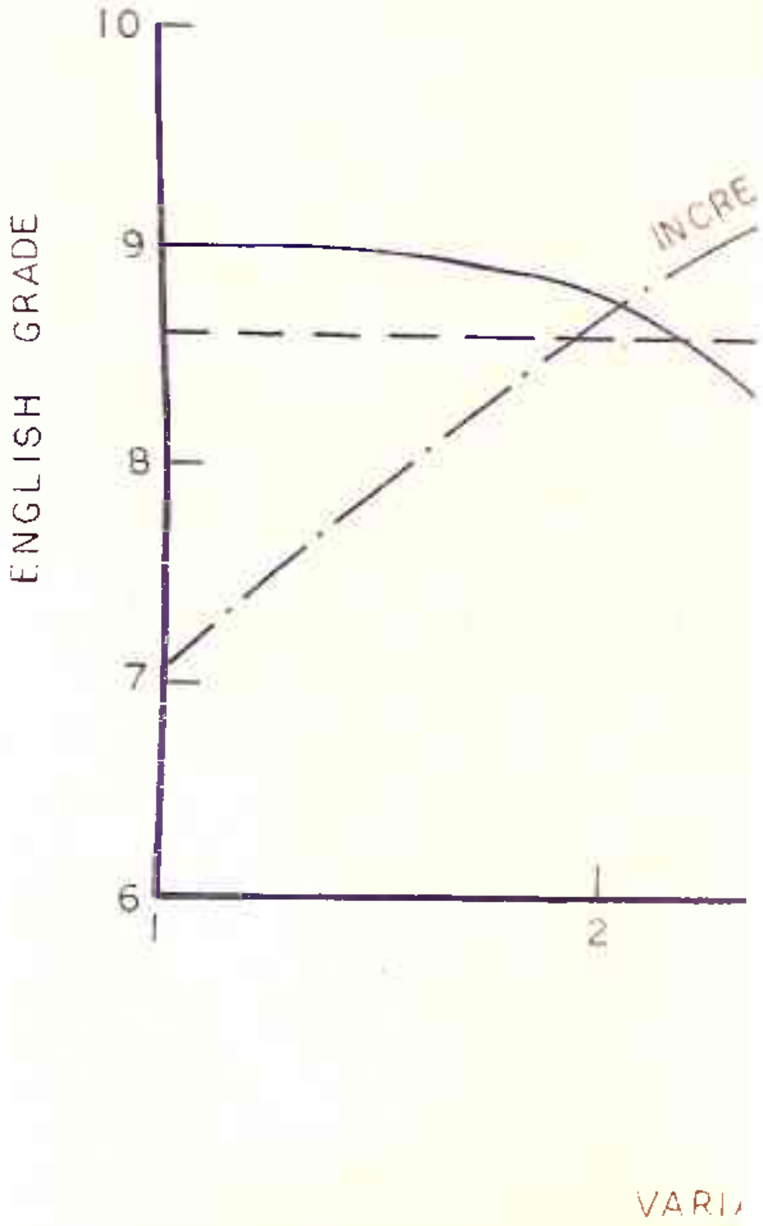
AVERAGE CGPA AND AVERAGE GRADE IN ENGLISH OF THE SUB-GROUPS OF GROUPS I,L & D

GROUP	SUBGROUPS		SEMESTER I	SEMESTER II	SEMESTER III
I	I_D	GRADE	4.000	7.333	8.666
		CGPA	4.876	5.646	5.910
	I_C	GRADE	6.000	7.636	8.909
		CGPA	6.672	6.979	6.968
	I_B	GRADE	8.000	9.363	10.000
		CGPA	7.139	7.185	7.194
L	L_A	GRADE	10.000	10.000	10.000
		CGPA	7.151	7.095	7.080
	L_B	GRADE	8.000	8.000	8.000
		CGPA	6.704	6.840	6.938
	L_C	GRADE	6.000	6.000	6.000
		CGPA	6.448	6.455	6.281
D	D_A	GRADE	10.000	10.000	7.333
		CGPA	6.898	6.931	6.680
	D_B	GRADE	8.000	7.666	6.000
		CGPA	6.545	6.473	6.096

GRAPH I



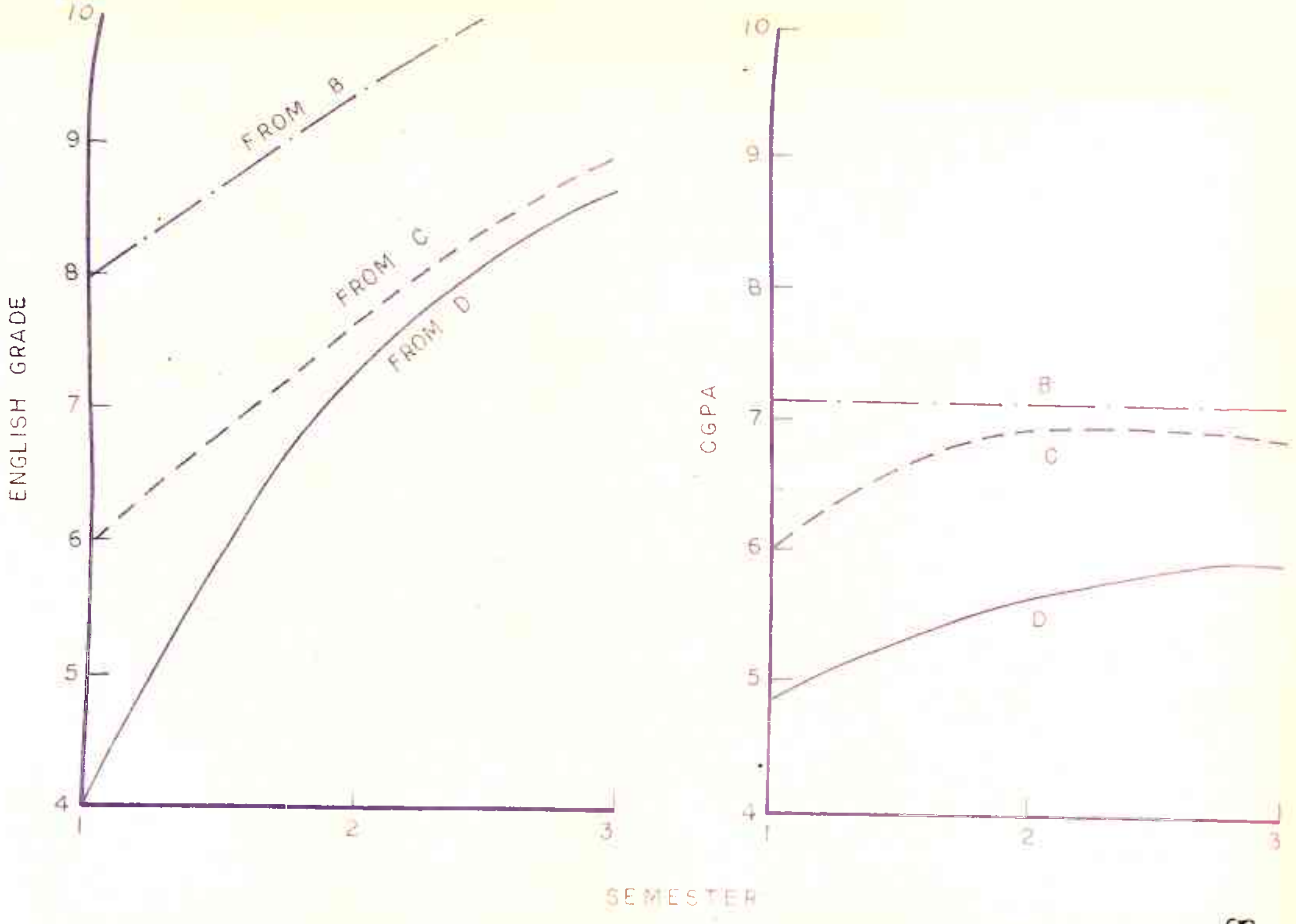
AVERAGE FOR SAMPLE OF 75 STUDENTS


ENGLISH GRADE
10
9
8
7
6
1
2
INCRE
VARI

GRAPH 2

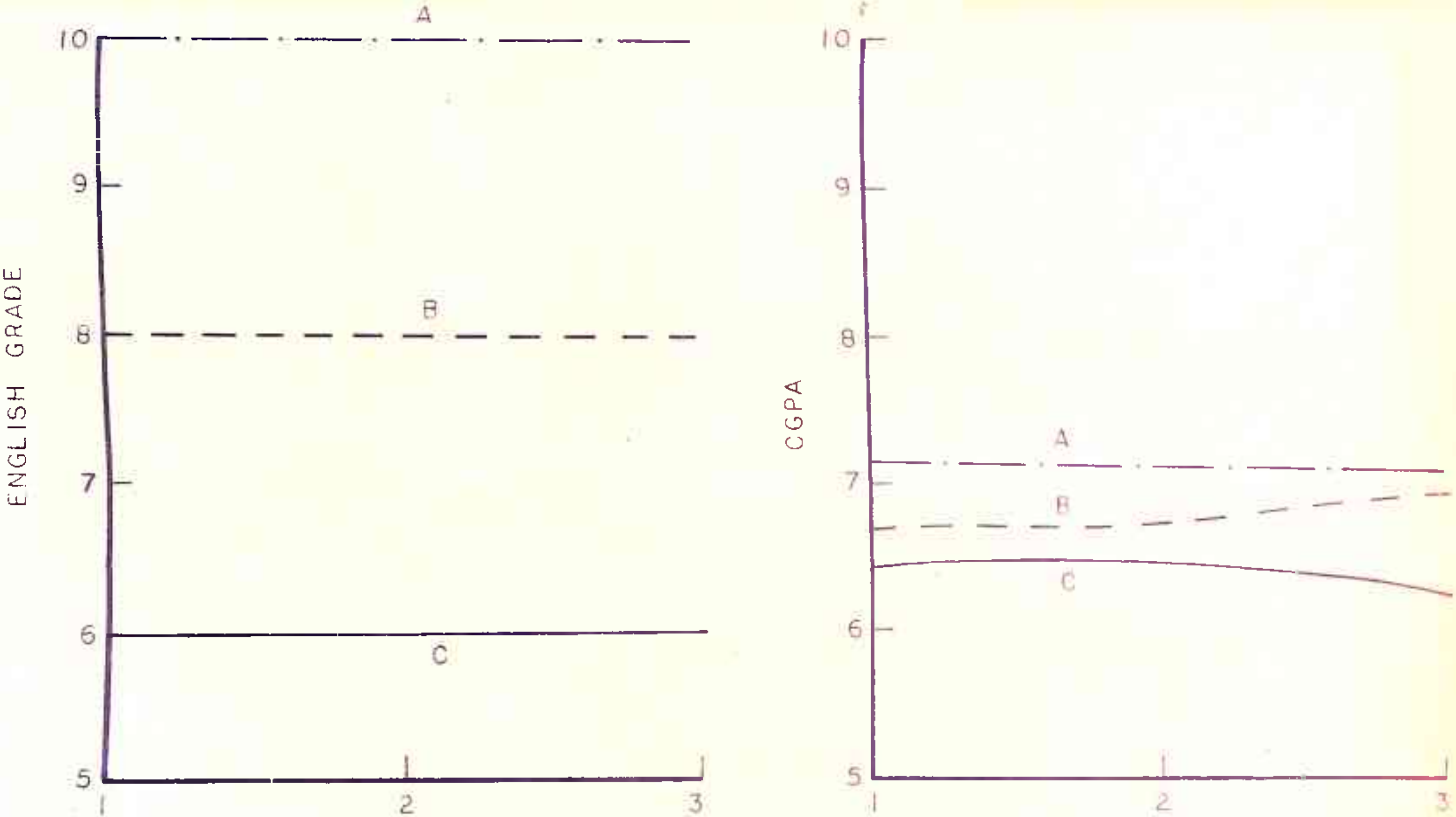
SEMESTER

ATIONS FOR CATEGORIES I, L AND D.



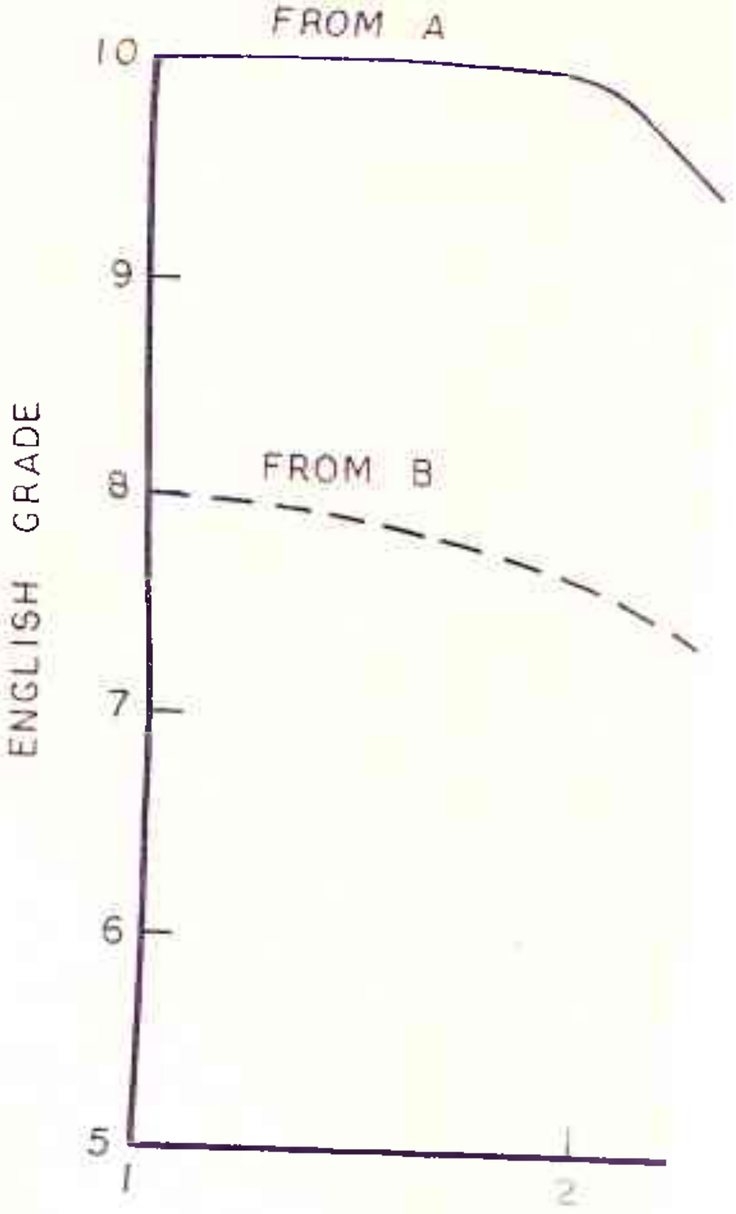
INCREASING ENGLISH GRADE

GRAPH 4

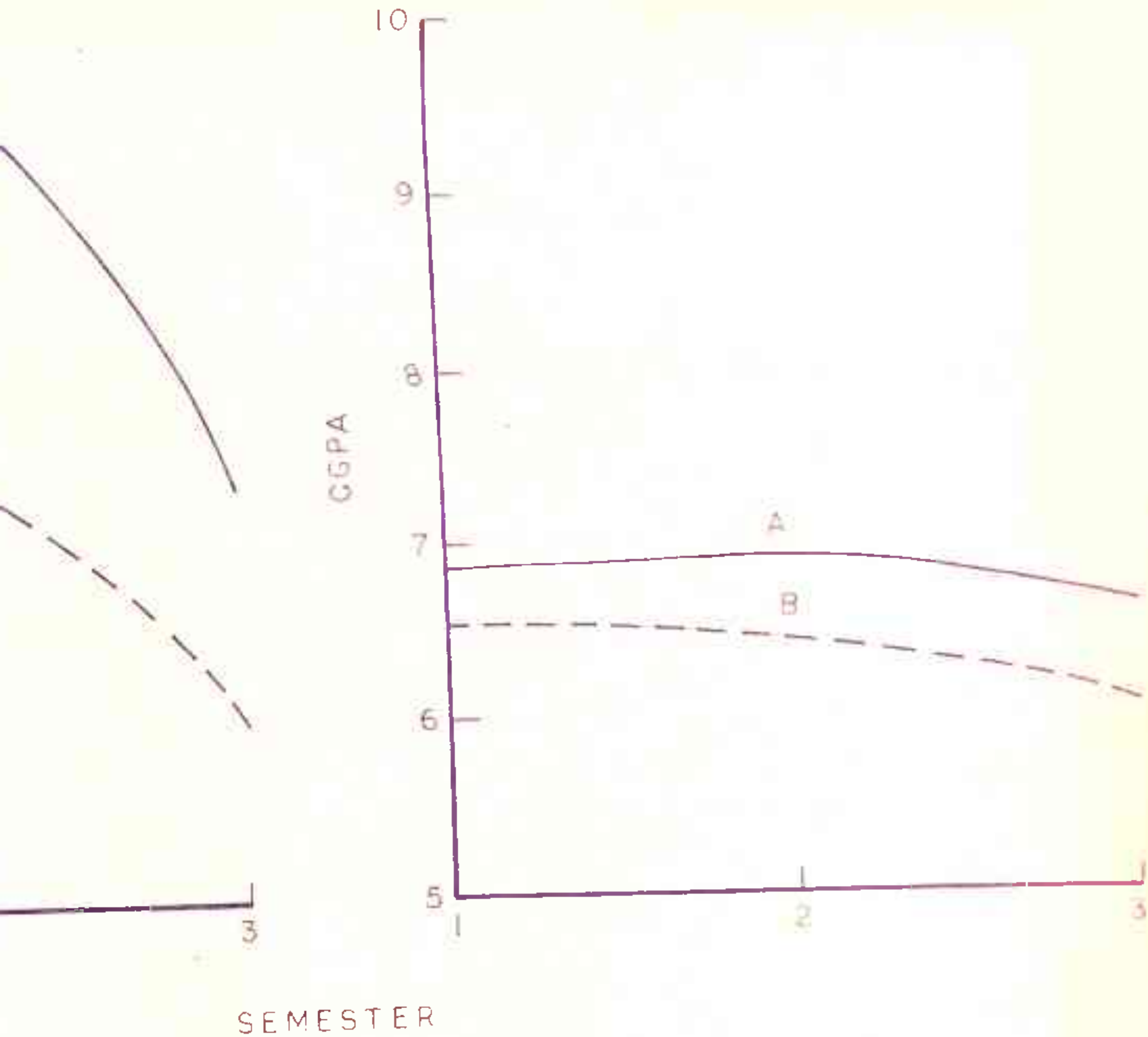


SEMESTER

LEVEL ENGLISH GRADE


FROM A
FROM B
ENGLISH GRADE
10
9
8
7
6
5
1
2

GRAPH 5



DECREASING ENGLISH GRADE

2. COMPUTATION:

(i) SCATTER-DIAGRAM, REGRESSION LINE AND COEFFICIENT OF CORRELATION

INTRODUCTION: Statistical evaluation of the impact of two quantised factors projects and facilitates

(a) the study of the trend of the impact and the effect of factors bearing on the trend;

(b) the measure of deviations from the trend;

(c) the comparison between one trend with another; and

(d) forecasting the future behaviour of the trend.

One of the mathematical expressions that fits a trend and allows us to draw not only the trend of a time series, but provides, also, in the trend equation, a concise definition of that trend, is usually represented by a general equation of the form

$$Y = A + BX + CX^2 + DX^3 + \ldots\ldots\ldots$$

where Y and X are variables and A,B,C,...are constants. However, if an examination of the Scatter diagram reveals only first-order relation, the equation is reduced to

$$Y = A + BX$$

One of the chief advantages of Statistical Analyses is to make a scientific study that is objective and logical. It enables the estimate of values of one factor with reference to the values of an associated factor. The analyses consist in the careful classification of facts, in the comparison of their relationship and sequences, and finally in the statement of a formula which resumes a wide range of facts. The statistical tool for discovering and measuring the relationship and expressing it in a formula is known as CORRELATION.

The method of Least Squares provides a convenient device for obtaining an objective fit of a straight-line trend line to a series of data. The method of least squares has two characteristics:

(1) The sum of the vertical deviations of the observed values from the fitted straight line equals zero. This trend is not the only straight line from which the algebraic sum of the deviations equals zero; any straight line other than vertical which passes through the point $\bar{X}$, $\bar{Y}$(arithmetic mean of the X values, arithmetic mean of the Y values) fulfils this requirement.

(2) The sum of the squares of all these deviations is less than the sum of the squared vertical deviations from any other straight line.

Correlation involves three types of measurements in the following order:

(1) The estimating, or regression, equation which describes the functional relationship between the two variables.

(2) The measure of the divergence of the actual values of the dependent variable from their estimated or computed values, called the standard error of estimates.

(3) The measure of the degree of relationship, or correlation (r), between the variables, independent of the units or terms in which they are expressed.

The coefficient of correlation is a measure closely related to the estimating equation and to the standard error of estimate. When stating the degree of relationship between two variables, it expresses in concise numerical terms which are independent of the units of the original data and the degree of relationship between two series. The coefficient of correlation is a number varying from plus 1, through zero, to minus 1. The sign indicates whether the slope of the line of relationship is positive or negative, while the magnitude of the coefficient indicates the degree of association. When there is absolutely no relationship between the variables, r is zero. If 'r' is positive, x and y are said to be directly correlated; if 'r' is negative, x and y are said to be inversely correlated. A value of 'r' that is near plus 1 or minus 1 indicates that the estimated value of the variation of the dependent variable is nearly as great as the observed value. The correlation is said to be negligible when the magnitude of 'r' is less than 0.2; when it lies between 0.2 and 0.4 the correspondence between x and y exists but is low; if the magnitude of 'r' is between 0.4 and 0.6 there is moderate correspondence. If 'r' in magnitude is higher than 0.6 the correspondence is significant. One measure of variability, called variation or total variation, is the sum of the squares of the deviations of the Y values from their mean. This total variation can be broken up into two parts: (1) that which has been explained by our line of relationship, and (2) that which we have failed to explain. The unexplained variation is the sum of the squares of the deviations of the Y values from their estimated values. The coefficient of correlation, 'r', is the square root of the proportion of the total variation in the dependent variable that has been explained by use of the estimating equation.[1]

REPRESENTATION

When two quantities vary in an almost linearly related manner, their variation is expressed in the general form

$$Y = A + BX$$

where 'X' is the independent variable and 'Y' is the trend value of the dependent variable. This relation represented by a graph is the 'regression' line.

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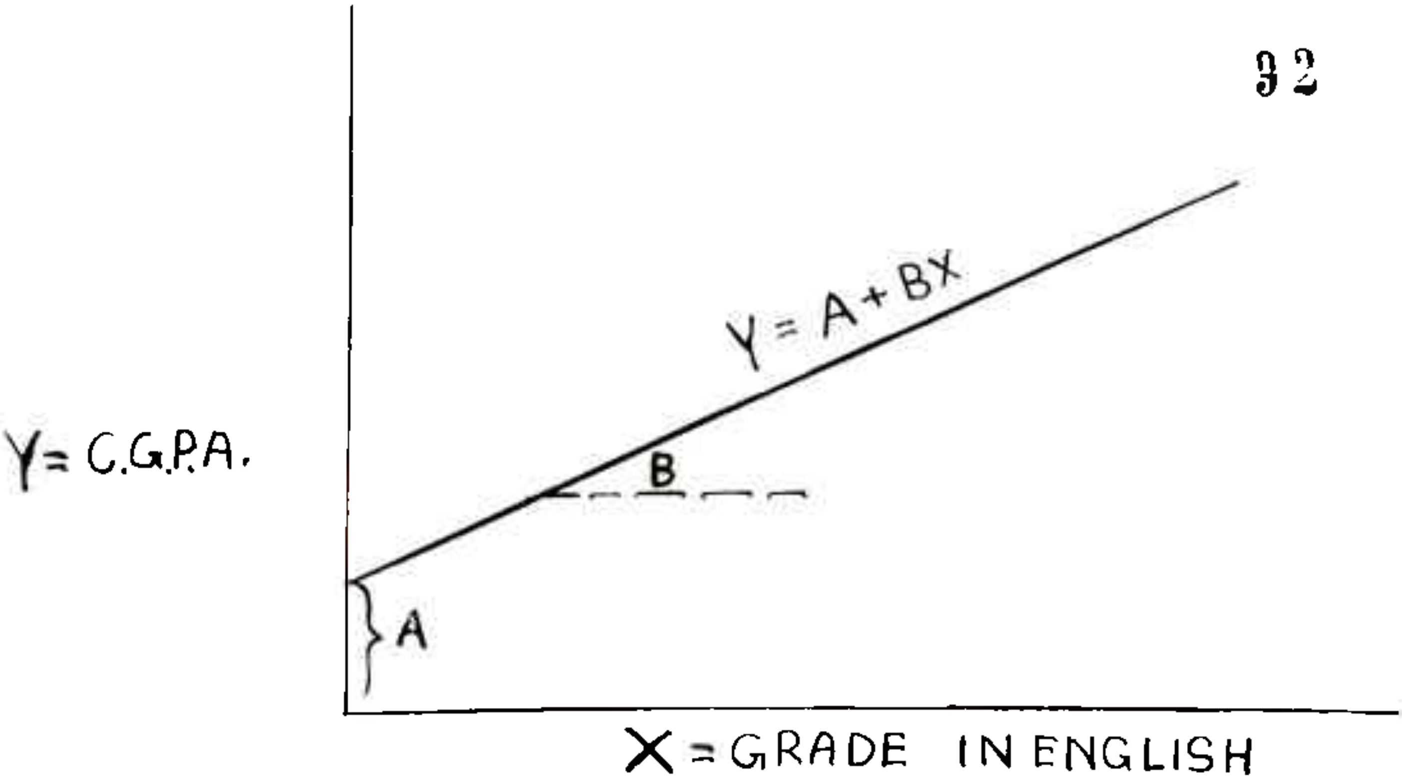
1. APPLIED GENERAL STATISTICS, Frederic E.Croxton, and Dudley J.Cowden, Sir Isaac Pitman & Sons, Limited, London, 1955, pp. 261-266, 451-462.



This line has a value for 'Y' when X=0, represented by 'A'. The slope of the line (gradient) or the tangent of the angle between the regression line and X-axis is denoted by 'B'. The slope of the graph of regression can also be arrived at without drawing the graph of regression by the LEAST SQUARES CRITERION. The formula for calculating the value of 'B' is:

$$B = \frac{\left(n\sum_{1}^{n} xy\right) - \left(\sum_{1}^{n} x\right)\left(\sum_{1}^{n} y\right)}{\left(n\sum_{1}^{n} x^2\right) - \left(\sum_{1}^{n} x\right)^2}$$

'A' is also calculated in a similar manner by the corresponding formula

$$A = \frac{\sum_{1}^{n} y}{n} - \left(\frac{B}{n}\sum_{1}^{n} x\right)$$

x and y representing one set of values.

The formula for determining the 'coefficient of correlation' is

$$r = \frac{n\left(\sum_{1}^{n} xy\right) - \left(\sum_{1}^{n} x\right)\left(\sum_{1}^{n} y\right)}{\sqrt{n\left(\sum_{1}^{n} x^2\right) - \left(\sum_{1}^{n} x\right)^2} \times \sqrt{n\left(\sum_{1}^{n} y^2\right) - \left(\sum_{1}^{n} y\right)^2}}$$

Note:

$$\sum_{1}^{n} x = x_1 + x_2 + x_3 + x_4 + x_5 + \ldots\ldots\ldots\ldots$$

$$\sum_{1}^{n} y = y_1 + y_2 + y_3 + y_4 + y_5 + \ldots\ldots\ldots\ldots$$

$$\sum_{1}^{n} x^2 = x^2_1 + x^2_2 + x^2_3 + x^2_4 + x^2_5 + \ldots\ldots\ldots\ldots$$

$$\sum_{1}^{n} y^2 = y^2_1 + y^2_2 + y^2_3 + y^2_4 + y^2_5 + \ldots\ldots\ldots\ldots$$

$$\sum_{1}^{n} xy = x_1y_1 + x_2y_2 + x_3y_3 + x_4y_4 \ldots\ldots\ldots\ldots$$

NUMERICAL COMPUTATION

NOTE: 1. The data is analysed only for first order relationships between English grade and CGPA.

2. Computation has been done on the calculator.

3. The English grades although discrete, for the computational accuracy, are assumed to have continuous values.

4. The figures are corrected up to four places.

PROCEDURE: (A SAMPLE OF ACTUAL COMPUTATION PROCEDURE IS PRESENTED IN TABLE XI)

(1) The grades in General English and the CGPA obtained by samples of students at the end of the first semester, second semester and third semester are collected and their frequency distribution table is prepared (Table VII).

(2) The coefficient of correlation and the estimating equation are calculated by the following steps:

TABLE VII

AVERAGE CGPA VERSUS SEMESTER

Semester	Grade in English	No. of students	Total CGPA	Average CGPA
I 1972-73	A-10	64	463.41	7.2408
	B- 8	88	585.57	6.6542
	C- 6	89	566.58	6.3661
	D- 4	14	69.91	4.9936
	F- 2	4	10.25	2.5625
		259		6.545
II 1972-73	A-10	87	615.56	7.0754
	B- 8	95	639.90	6.7358
	C- 6	53	323.21	6.0983
	D- 4	4	21.43	5.3575
		239		6.653
III 1973-74	A-10	47	336.26	7.1545
	B- 8	26	173.19	6.6612
	C- 6	21	130.50	6.2143
	D- 4	0	0	0
		94		6.808

(a) The following are tabulated:

$$\sum_1^n x, \sum_1^n y, \sum_1^n x^2, \sum_1^n y^2, \text{ and } \sum_1^n xy .$$

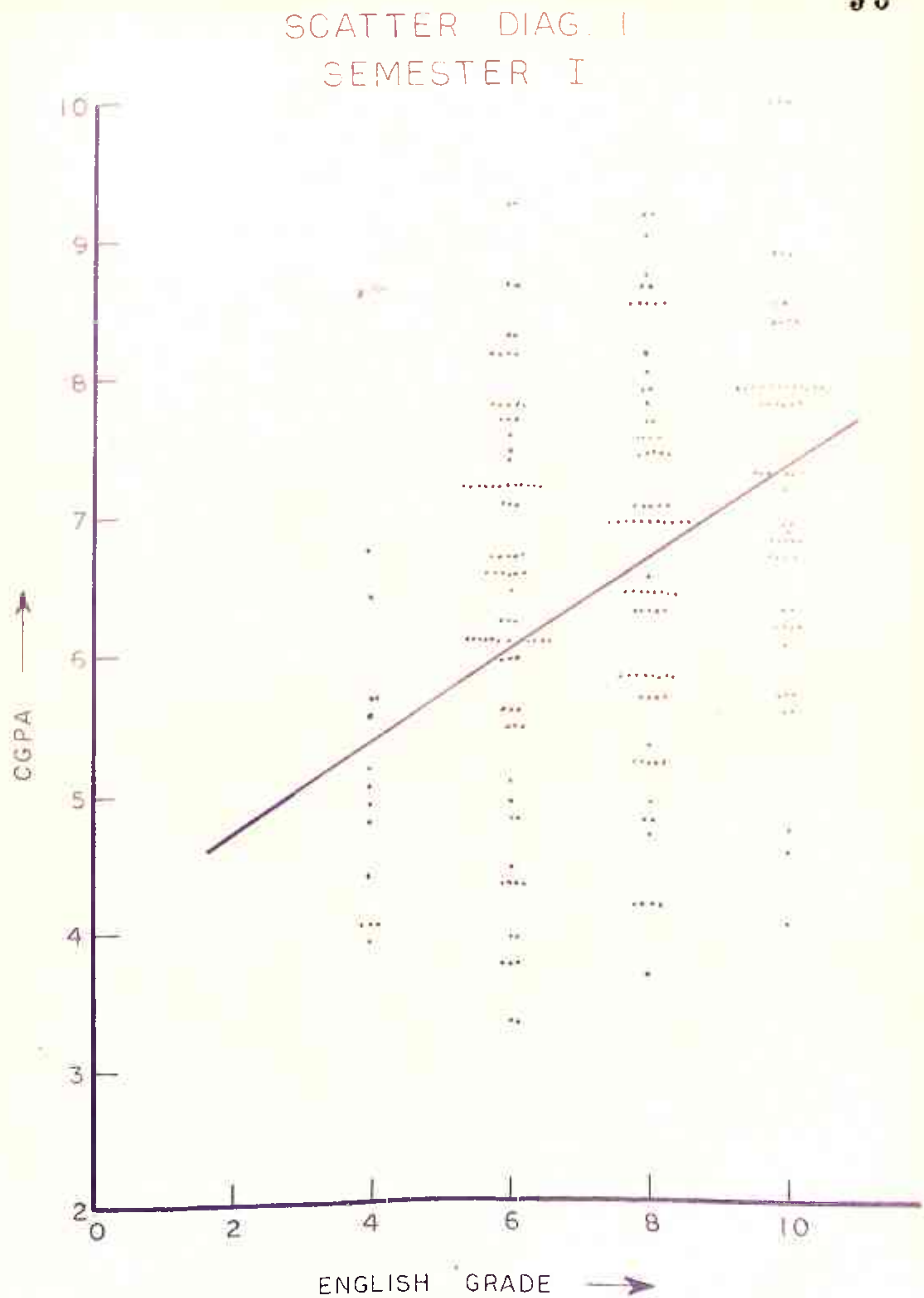
(b) The results obtained are applied in the formula for 'r'.

(c) The results of $\sum_1^n x, \sum_1^n y, \sum_1^n x^2, \sum_1^n y^2, \sum_1^n xy$ are applied in the formula for A and B.

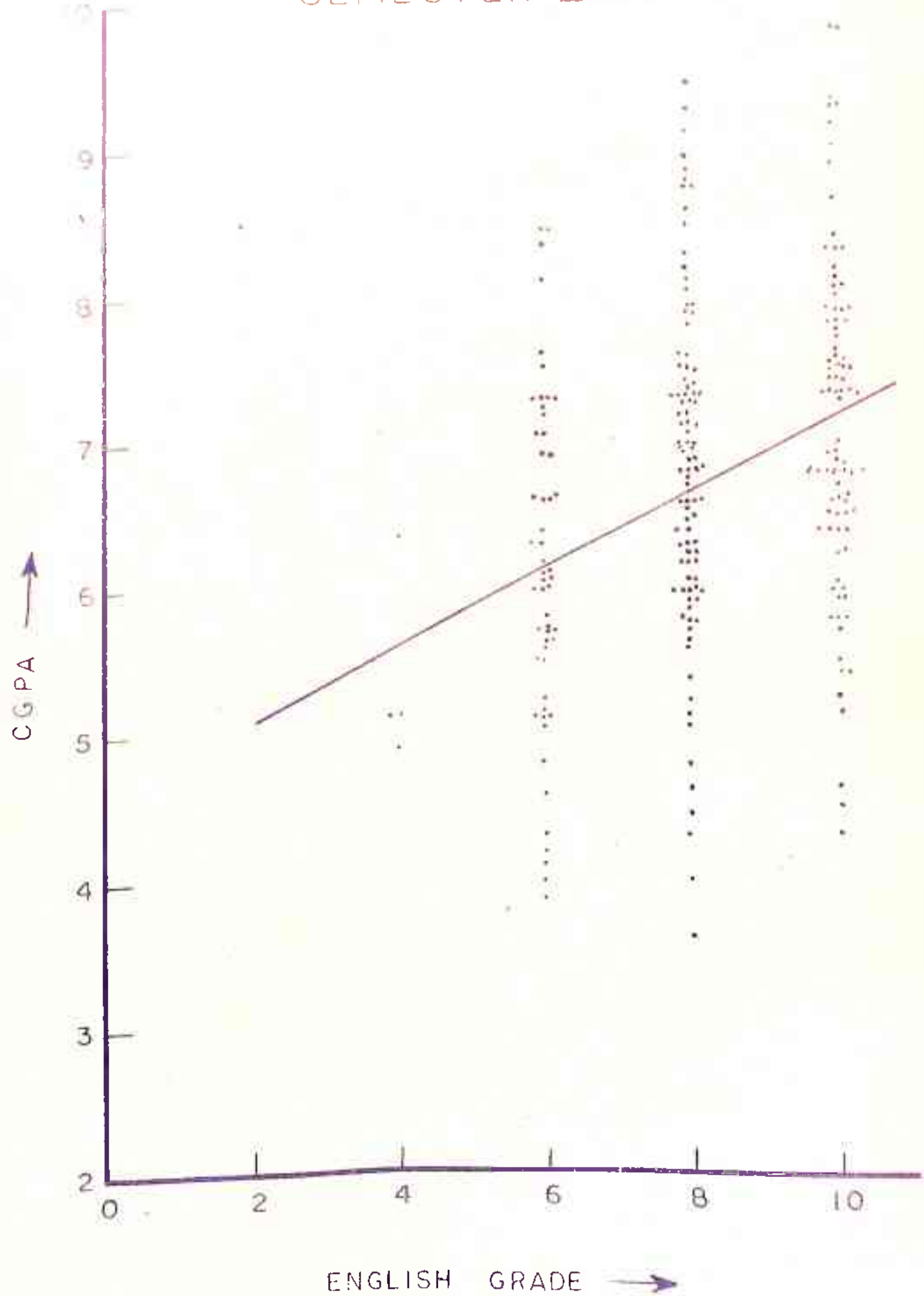
(3) The regression lines are drawn from the results thus obtained in the Scatter diagrams.

RESULT:

This statistical study examines the correlation between grades in General English and CGPA for three consecutive semesters during which the students take the General English programmes in the core curriculum, for one sample of students of adequate proficiency in General English. The sample for each semester although drawn from the same population is numerically different as there are withdrawals and because the third core programme in General English is offered only to half of the population at a time for administrative reasons. The sample studied consists of 259 students for the first General English programme in 1972-73, 239 students of the same population for the second General English programme in 1972-73 and 94 students of the same population for the third General English programme in 1973-74. The


SCATTER DIAG. I
SEMESTER I
CGPA
ENGLISH GRADE
10
9
8
7
6
5
4
3
2
0
2
4
6
8
10

SCATTER DIAG 2
SEMESTER II



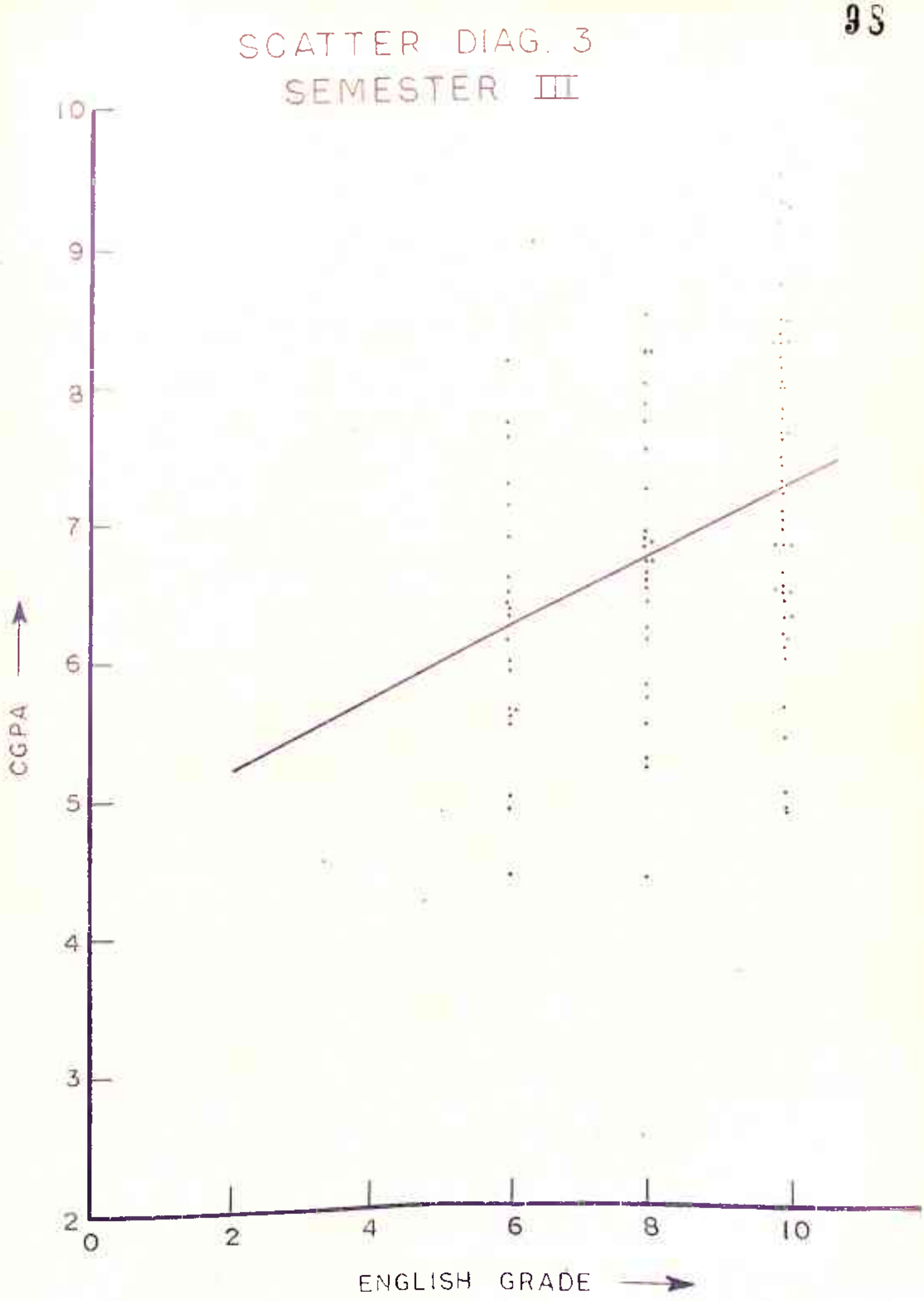

SCATTER DIAG. 3
SEMESTER III
CGPA
ENGLISH GRADE
10
9
8
7
6
5
4
3
2
0
2
4
6
8
10

Table below shows the results of the computation for the three samples:

Sample No.	General English programme	No. of students	Coefficient of Correlation	"A"	"B"
1.	I 1972-73	259	+0.2343	4.058	0.3319
2.	II 1972-73	239	+0.3874	4.661	0.2475
3.	III 1973-74	94	+0.5246	4.791	0.2361

It is observed that:

(1) The coefficient of correlation computed for the three samples shows positive values. The first-order regression lines (Scatter Diagrams 1,2 and 3) in all cases have a positive slope, although most individual cases in each sample are unexplained by such lines (outside).

(2) Secondly, the coefficient of correlation for the same sample of students computed for the different semesters shows an increasing value with time.

(3) Thirdly, the slope of the regression line decreases with time.

INTERPRETATION:

(1) The positive slope of the regression lines computed by the least squares method indicates a faint direct relation between grade in General English and CGPA. This is primarily due to the fact that in a number of cases included in the sample the increase in CGPA is accompanied by increase in proficiency in English. The cause and effect relation is obviously not existing in the first semester (ref: Scatter Diagrams) at all because the coefficient of correlation is negligibly small (compared to the units in the sample). The regression line is a representation of extremely few cases.

The scatter diagrams do not show any higher order of correlation between English grade and CGPA. Hence no attempt has been made to verify higher order relations.

(2) The time variation of CGPA and English grade is studied in detail.

For the purpose of measurement of time the unit chosen is 'one semester' for convenience. The second vital information presented by the analysis of variant data is:

(i) that the coefficient of correlation between CGPA and English Grade increases with time, and

(ii) that the average CGPA of a large sample also slightly increases with time (Table VII). The increase in the coefficient of correlation between CGPA and English grade is an indication that the two are assuming some sort of interrelationship. This clearly points to the fact which is otherwise also obvious that the study of technology through English helps to study the language as well - the converse phenomenon being ruled out as previously mentioned. Thus, even though the ELT programmes offered at present do not help the students in their major studies, there is a retro-effect of technology on the proficiency in English. It is this effect that develops the linguistic ability for further study of the major subjects. The linguistic proficiency thus gained from the study of major subjects has effective scope for technological use. Students with high technological proficiency acquire functional language proficiency as a result of the retro-effect.

The time variant analysis shows further that the average CGPA of a sample increases with time (Table VII). This is explained by the fact that as the students are taken through the semesters the non-relevant subjects are reduced. The students are thereby more motivated and put in more effort for the major study in which they are interested.

(3) The third finding that the slope of the regression line reduces with time is an indication that 'study' is a process like any other growth phenomenon, the characteristic feature of which is showing a tendency to saturate. The saturation in the present context is being shown by a reduction in incremental CGPA. Between the second and third swmesters most of the CGPA undergo rapid changes.

It is worth while to examine the correlation between the final CGPA and the overall proficiency in General English. The CGPA of the sample taken for calculation is that obtained at the end of the 4th year (8th semester), and the overall proficiency in General English taken is the average grade in English during the first 3 semesters. The value for 'r'=+0.33824' shows that there is some correlation between the performance in technological study towards the end of the academic care r and the overall proficiency in General English.

ANALYSIS OF DATA OF STUDENTS OF INADEQUATE PROFICIENCY IN GENERAL ENGLISH

In order that the statistical analysis of the impact of proficiency in the instructional language on performance and progression in technological study be comprehensive, the analysis is extended to students with inadequate proficiency in General English. That these students at the Birla Institute of Technology and Science, Pilani, go through the major study along with those of adequate proficiency in General English is an opportune situation for arriving at results from a comparative study.

The statistical analysis of the data for a random sample of 85 such students yields decisive results. The findings of the analysis are:

(1) the coefficient of correlation is+0.6615;

(2) they are found to perform in the major study as well as those with adequate proficiency in General English (Table VIII); and

(3) 12% (9/85) of such students who score an F grade

TABLE VIII

ACADEMIC DATA OF A SAMPLE OF STUDENTS WITH INADEQUATE PROFICIENCY IN GENERAL ENGLISH

Case No.	FIRST SEMESTER ENGL 001*	MATH 101	SCI 101	TA 101+	CGPA	SECOND SEMESTER ENGL 101%	CHEM 102	MATH 102	PHY 102	TA 102@	CGPA
	3u	5u	4u	4u		3u	3u	5u	3u	4u	
1.	B	A	A	A	9.63	C	A	A	A	A	9.47
2.	C	B	C	B	7.13	C	C	B	C	B	7.06
3.	C	C	B	B	7.00	D	A	B	C	B	7.18
4.	B	B	C	B	7.50	B	B	A	B	A	8.29
5.	C	A	C	C	7.25	B	B	B	B	B	7.65
6.	C	A	C	B	7.75	C	A	A	C	B	8.00
7.	B	B	C	B	7.50	B	B	B	C	B	7.59
8.	B	B	C	C	7.00	A	C	B	C	C	7.12
9.	C	C	C	B	6.50	C	C	B	C	A	7.00
10.	C	B	C	B	7.13	B	C	B	C	C	7.00
11.	B	B	B	B	8.00	C	B	A	C	A	8.18
12.	A	B	C	A	8.38	A	A	A	B	C	8.59
13.	B	B	B	A	8.50	C	C	A	C	B	8.00

TABLE VIII (Contd.)

Case No.	FIRST SEMESTER					SECOND SEMESTER					
	ENGL 001* 3u	MATH 101 5u	SCI 101 4u	TA 101+ 4u	CGPA	ENGL 101$ 3u	CHEM 102 3u	MATH 102 5u	PHY 102 3u	TA 102@ 4u	CGPA
14.	C	A	C	B	7.75	C	C	C	B	C	7.00
15.	C	B	C	C	6.63	C	A	B	B	B	7.35
16.	D	C	C	B	6.13	C	A	A	B	A	7.65
17.	B	B	B	A	8.50	B	A	A	A	A	9.12

* Make-up English Programme

$ General English Programme-I

+ Technical Arts

@ Technical Arts

in the Make-up English programme offered to such students have very low (3.720) CGPA (Table IX).

In Table VIII is seen the performance of the sample of students with inadequate proficiency in General English. Table IX shows the performance of the sample of students with inadequate proficiency whose performance in technological study is low. Table X presents the comparative performance for the two groups of students - adequate and inadequate proficiency in General English - for each of the subjects studied for two semesters.

(1) The high coefficient of correlation between proficiency in General English and performance in technological study for this category of students while their proficiency in the instructional language is inadeqate, shows that performance in technological study depends to a great extent on linguistic proficiency for those whose proficiency in the instructional language is inadequate. Stated otherwise, those with inadequate proficiency depend on the programme in General English offered to them, whereas those with adequate proficiency are less dependent on the General English programmes for their performance in their major study. This leads to the inference that there is a THRESHOLD PROFICIENCY in English required for technological study, and, as the inadequate stream attains the threshold proficiency, their performance in the major study rapidly improves. The rate of improvement when once the threshold stage is attained is much less

TABLE IX

ACADEMIC DATA OF A SAMPLE OF STUDENTS WITH PROFICIENCY IN GENERAL ENGLISH BELOW THE THRESHOLD LEVEL

Case No.	FIRST SEMESTER ENGL 001* 3u	MATH 101 5u	SCI 101 4u	TA 101+ 4u	CGPA	SECOND SEMESTER ENGL 001% 3u	CHEM 102 3u	MATH 102 5u	PHY 102 3u	TA 102@ 4u	CGPA
1.	F	C	F	D	3.75	C	F	D		F	3.61
2.	F	F	F	C	3.00	Withdrawn					
3.	F	F	F	D	2.50	D	D	C		C	3.81
4.	F	D	F	D	3.13	C		D		C	4.00
5.	F	C	D	D	4.25	D	D	C		C	4.71
6.	F	D	D	D	3.62	D	D	D		D	3.81
7.	F	D	F	F	2.62	D	F	D		D	3.10
8.	F	D	D	F	3.12	D	C	D		F	3.50
9.	F	C	F	F	3.25	D	F	F		D	3.10

* Make-up English Programme

% Make-up English Programme

+ Technical Arts

@ Technical Arts

TABLE X

AVERAGE GRADES IN MAJOR SUBJECTS OF THE TWO SAMPLES OF STUDENTS OF ADEQUATE AND INADE - QUATE PROFICIENCY IN GENERAL ENGLISH

Category	Adequate Proficien-cy	Inadequate Proficien-cy
English	10*	7.0‡
Maths.	4.5	6.0
Science	5.5	5.3
Physics	5.7	6.3
Chemistry	5.0	6.2
Technical Arts	3.8	5.7

*Core General English Programme

‡Make-up English Programme

dependent upon the proficiency in General English as evidenced from the coefficient of correlation of students with adequate proficiency.

(2) Students with inadequate proficiency in General English are found to perform in the major study as well as those with adequate proficiency. It may be inferred that during the study of technology the language of instruction has a RETRO-EFFECT on the proficiency in the language. The linguistic ability thus acquired from the retro-effect being functional in nature has a high impact on their performance in technological study.

(3) The 12% of students who have low English grade and CGPA substantiate that their performance in technological study is low because their proficiency in General English is below the threshold level.

(Table XI presemts the actual computation for this sample.)

TABLE XI

CALCULATION OF CORRELATION COEFFICIENT 'r','A' AND 'B' FOR MAKE-UP ENGLISH STUDENTS, 1972-73 I SEMESTER

Sl. No.	I.D.No.	ENGLISH Grade (X)	CGPA (Y)	X^2	Y^2	XY
1.	72XESO 20	D=4	6.13	16	37.577	24.52
2.	30	B=8	7.00	64	49.000	56.00
3.	34	C=6	7.13	36	50.837	42.78
4.	38	B=8	5.63	64	31.697	45.04
5.	40	C=6	7.00	36	49.000	42.00
6.	43	B=8	7.50	64	56.250	60.00
7.	45	B=8	7.00	64	49.000	56.00
8.	46	C=6	4.88	36	23.814	29.28
9.	51	C=6	7.25	36	52.563	43.50
10.	53	C=6	7.75	36	60.0625	46.50
11.	56	C=6	6.00	36	36.000	36.00
12.	66	B=8	7.50	64	56.250	60.00
13.	68	C=6	4.56	36	20.796	27.36
14.	80	B=8	6.38	64	40.704	51.04
15.	83	D=4	3.50	16	12.250	14.00
16.	86	C=6	5.38	36	28.944	32.28
17.	95	B=8	3.63	64	13.1769	29.04
18.	105	B=8	5.13	64	26.317	41.04
19.	40	B=8	7.00	64	49.000	56.00
20.	47	B=8	3.38	64	11.4244	27.04

TABLE XI(Contd.)

Sl No.	I.D. No.	ENGLISH Grade(X)	CGPA (Y)	X^2	Y^2	XY
21.	72XES 151	C=6	6.50	36	42.25	39.00
22.	54	C=6	7.13	36	50.837	42.78
23.	55	B=8	8.00	64	64.000	64.00
24.	88	A=10	8.38	100	70.2244	83.80
25.	89	B=8	6.88	64	47.3344	55.04
26.	97	B=8	8.50	64	72.250	68.00
27.	200	C=6	4.38	36	19.1844	26.28
28.	4	C=6	5.63	36	31.6969	33.78
29.	20	C=6	7.75	36	60.0625	46.50
30.	30	C=6	5.00	36	25.000	30.00
31.	36	B=8	7.00	64	49.00	56.00
32.	40	D=4	5.50	16	30.25	22.00
33.	52	C=6	5.88	36	34.574	35.28
34.	54	6=6	5.50	36	30.25	33.00
35.	55	C=6	6.63	36	43.957	39.78
36.	57	A=10	6.25	100	39.0625	62.50
37.	66	D=4	6.13	16	37.577	24.52
38.	70	B=8	8.50	64	72.25	68.00
39.	73	C=6	6.63	36	66.097	39.78
40.	95	A=10	8.38	100	70.2244	83.80

TABLE XI(Contd.)

Sl. No.	I.D. No.	ENGLISH Grade(X)	CGPA (Y)	X^2	Y^2	XY
41.	72XES 98	A=10	8.50	100	72.250	85.00
42.	300	B=8	7.00	64	49.000	56.00
43.	3	B=8	5.88	64	34.574	47.04
44.	5	C=6	8.13	36	28.940	68.78
45.	9	B=8	4.75	64	22.563	38.00
46.	26	B=8	6.25	64	39.0625	50.00
47.	32	B=8	8.38	64	70.2244	67.04
48.	38	B=8	6.38	64	40.7044	51.04
49.	39	A=10	7.88	100	62.0944	78.80
50.	61	C=6	5.38	36	28.944	32.28
51.	71	C=6	6.00	36	36.000	36.00
52.	73	F=2	4.25	4	18.0625	8.50
53.	76	C=6	7.63	36	42.250	45.78
54.	82	D=4	4.50	16	20.250	18.00
55.	99	C=6	6.50	36	58.217	39.00
55 (n)		378 ($\sum X$)	351.69 ($\sum Y$)	2756 ($\sum X^2$)	2348.898 ($\sum Y^2$)	2500.28 ($\sum XY$)

1. Applying in the formula for 'r'

$$r = \frac{n\sum xy - \sum x \times \sum y}{\sqrt{n\sum x^2 - (\sum x)^2} \times \sqrt{n\sum y^2 - (\sum y)^2}}$$

$$= \frac{55 \times 2500.28 - 378 \times 351.69}{\sqrt{55 \times 2756 - 378^2} \times \sqrt{55 \times 2348.897 - 351.69^2}}$$

$$= + \frac{4576.58}{93.2523 \times 74.1854}$$

$$= + \frac{4576.58}{6917.9591}$$

$$= + 0.66155$$

2. Applying in the formula for 'B'

$$b = \frac{n\sum XY - \sum X \times \sum Y}{n\sum X^2 - (\sum X)^2}$$

$$= \frac{4576.58}{8693.42}$$

$$= 0.526$$

$$\tan 0.526 = 27^\circ 45'$$

3. Applying in the formula for 'A'

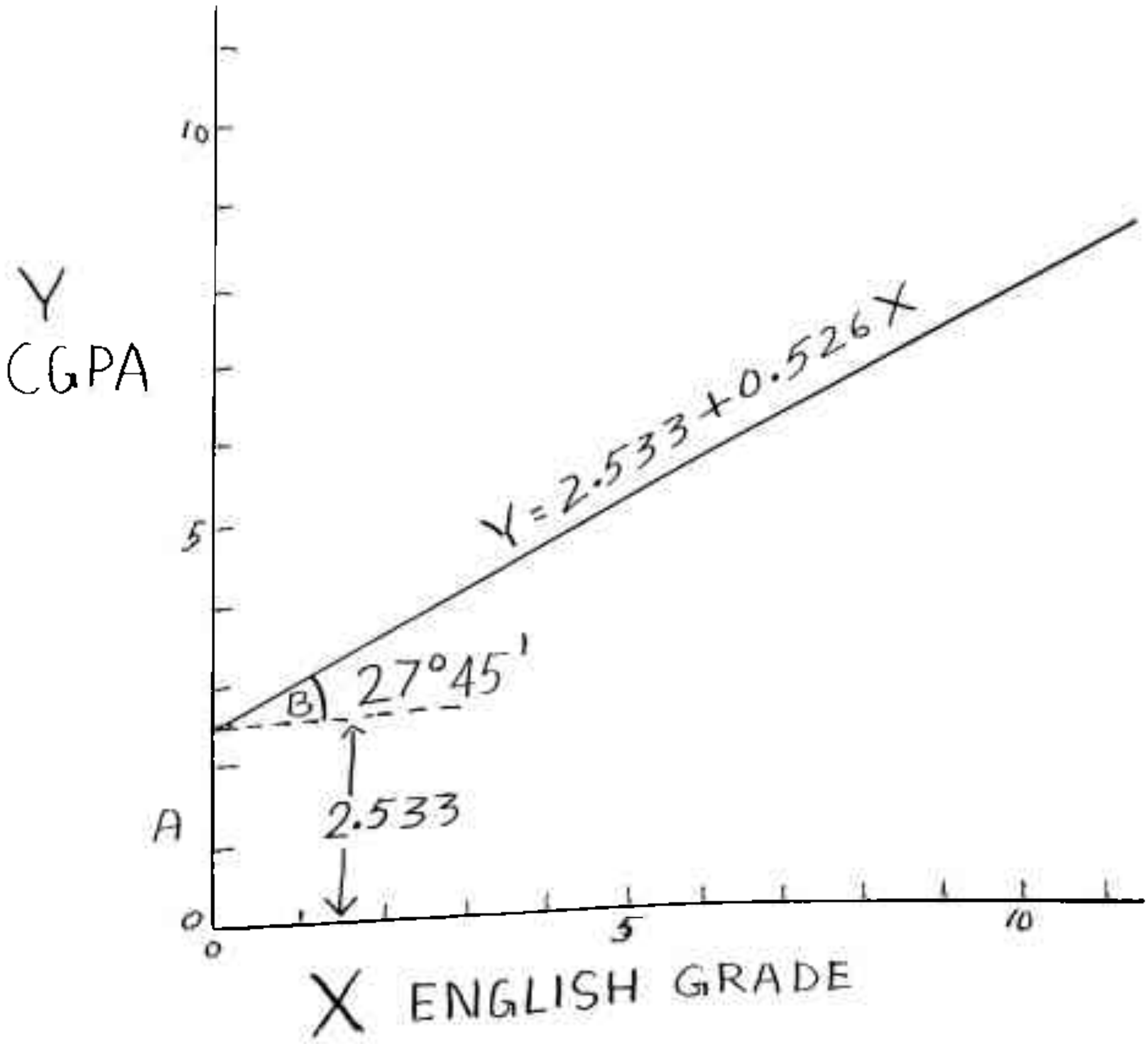
$$A = \frac{\sum Y}{n} - \frac{B}{n} \sum X$$

$$= \frac{351.69}{55} - \frac{0.526}{55} \times 378$$

$$= +2.533$$

4. The regression line therefore is drawn as below:

REGRESSION LINE : $Y = A + Bx$



CONCLUSION

The statistical analyses and the findings presented in this chapter are not exhaustive as only a limited number of samples have been studied, nor are they rigid, since the problem is many-faceted, and, as pointed out already, many factors lie outside the academic ambit. Nevertheless, the analyses satisfy the present context for they establish a decisive relation between proficiency in General English and performance in technological study. The broad-based findings are:

(1) A certain minimum level of proficiency in the instructional language, which I call the THRESHOLD PROFICIENCY, is essential for pursuing technological study.

(2) A high proficiency in General English is no indication of a correspondingly high performance in technological study; similarly, a low proficiency in General English does not necessarily predict a correspondingly low performance in technological study except in cases where the proficiency is below the THRESHOLD PROFICIENCY.

(3) The correlation between adequate proficiency in General English and performance in technological study is weak; while, the correlation between inadequate proficiency in General English and performance in technological study is both strong and high.

(4) The rate of change in performance in technological study is inversely as the proficiency in General Eng-

lish. Stated otherwise, students with higher proficiency in General English have a more stable performance in technological study.

(5) Students with proficiency above the THRESHOLD PROFICIENCY are not dependent on programmes in General English for studying technology; while, students with proficiency below the THRESHOLD PROFICIENCY are dependent on programmes in General English for studying technology.

(6) The study of the major subjects through English has a positive effect on the proficiency in the instructional language. This action taking place in the reverse direction, which I call the RETRO-EFFECT of the study of technology, is partly responsible for students with inadequate proficiency in General English performing well in the major study, and wholly responsible for the increase in the coefficient of correlation with time, of students with adequate proficiency.

(7) The RETRO-EFFECT of study of technology on proficiency in the instructional language is significant because of its FUNCTIONAL character. The language ability being acquired through this RETRO-EFFECT is the very ability needed for studying technology. This ability of the functional usage of the language develops along with the study of technology, and is directly dependent on the linguistic mastery in the instructional language of the instructors of the subjects of technology.

These broad-based findings are not only significant in themselves but are also pointers to the functional character of the instructional language in technological education, and, serve as guidelines for the kind of programmes in the instructional language to be offered in technological education.

This necessitates the examination of the function of the instructional language in the study of technology.

Chapter VI

FUNCTION OF THE INSTRUCTIONAL LANGUAGE IN THE STUDY OF TECHNOLOGY

The examination of the function of the instructional language in the study of technology must rightly consider what instruction is since the operative word is instruction, and examine the operation of the language for instruction.

COMMUNICATION VERSUS INSTRUCTION

Instruction is more than communication.

The word 'communicate' is derived from the Latin word 'communis' meaning common. It means to make common or to share. A thought can be communicated in a number of ways. Expressive movements as lifting of an eye-brow or any gesture as movement of the hand, communicate the ideas that provoke such movements. Our ancestors living in caves a million years ago communicated with one another without a spoken language. They whined to communicate complaints and discomforts; they whimpered to communicate fright and fear. Onomatopoeic sounds communicated the object with which the sound was related, and when combined with facial expression conveyed the feelings generated by that object.

Communicating with signs as events or things that in someway direct attention to, or are indicative of, other events or things, or communicating through language as a system of conventional symbols, has one basic factor in common, namely, the transmitter and the receiver have prior understanding of the import of the signs and the symbols; all communication takes place through an accepted convention and so immediate intelligibility is made possible. But instruction goes beyond the stage of mere understanding of the signs and symbols.

The word 'instruction' is derived from the two Latin words 'in' and 'struere'. 'INSTRUCT' is the participle stem of 'instruere' meaning to build, erect, set up, set in order, prepare, furnish with information, teach, to pile, etc. The Oxford English Dictionary says that the history of the word in English does not correspond with the sense-development in Latin. That may be a reason why the word is confused with 'to communicate'. The word 'instruct' as we have it, means to furnish with knowledge or information, to train in knowledge or learning, to teach, educate. 'Instruction' is therefore (i) the action of instructing or teaching, the imparting of knowledge or skill; education; information; (ii) the knowledge or teaching imparted; (iii) a making known to a person what he does not know. The Instructor be it a teacher or a text-book, enables another 'to pile up' what he does not know by directing the learner's observation, where possible, to an object or a phenomenon, and by directing his reason by the inferential uses of language, to move from what is known to the unknown, from premises to conclusions, from cause to effect, from data to target. This is done through recourse to a number of abilities as

(1) ability to recognise facts and have a command of facts,

(2) ability to abstract the qualities from things and become aware of new aspects of the world,

(3) ability to see how parts make up the whole,

(4) ability to classify information, to group things in the mind,

(5) ability to transform raw sensations or experiences into objects,

(6) ability to make analogies, to think abstractly, to peer into two worlds of the analogy for abstracting a general truth,

(7) ability to analyse operations, to see how sequences are made up of successive stages in order to control or understand events,

(8) ability to compare, induce and deduce, etc.

The instructor does not communicate in the strict sense of the term; he teaches. Incidentally the word 'teach' means to show. It is derived from the Germanic word 'deiknynai' meaning to show.

Communication is to EXPRESS one's ideas TO another; instruction is to IMPRESS one's ideas UPON another.

INSTRUCTION AS AN ENGINEERING SYSTEM

Learning is a mental process. It requires (1) understanding, and (2) assimilating what has been understood. In the learning process there are two 'members' involved: (1) the learner, and (2) the teaching 'member' as teacher, book, visual aid, experience, etc. Thomas Aquinas explains the teaching-learning process when he says that one person is said to teach another inasmuch as, by signs, he manifests to that other the reasoning process which he himself goes through by his own natural reason. And thus, through the instrumentality, as it were, of what is told him, the natural reason of the learner arrives at a knowledge of the things which he did not know.[1] The teaching 'member', as teacher, book, visual aid, experience, etc. teaches by proposing the data and the arguments and by showing the order in which the premises lead to the conclusion. The learning 'member' learns by the activity of his own natural reason when he perceives the data, the arguments and the order in which the premises lead to the conclusion, and finally assimilates what he has understood.

1. ST. THOMAS AQUINAS, Philosophical Texts, Thomas Gilby, Oxford University Press, London, 1951, p. 379.

The learner assimilates what he has understood only when the mind, like the body does with food, takes in knowledge and works on it. And, as the body absorbs the food it takes in and makes it part of itself through the process of assimilation, something is known only when the mind works on it to discover the rationality of the data and the arguments and makes it become part of his mental possession.

In this two-pronged activity, teaching as well as the learning activity takes place through the instrumentality of language. Language is the instrument by which ideas and concepts necessarily find a material expression by the media of grammar and lexis.

The instructional process is an engineering system by itself. Otto Jespersen[1] explains the operational mechanism of the instructional system when he says: "activity on the part of one individual to make himself understood by another, and activity on the part of that other to understand what was in the mind of the first". The operation of the instructional system is therefore in the 'understood' - 'understand' activity. This activity is dependent on (i) the actuating situation, (ii) the thoughts and ideas actuated by the situation which one individual desires to convey to another, and (iii) the abi-

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1. THE PHILOSOPHY OF GRAMMAR, Otto Jespersen, George Allen and Unwin Ltd., London, 1924, p.17.

lity of the other individual to understand what is conveyed.

In an engineering system energy in one form is converted into energy in another form for utility, and made available at another place and in another direction.

The three major operational steps involved in the processes of an engineering system from the generation stage to the utility stage are:

(i) the generation of energy by release of energy from a source and its conversion into energy that can be transmitted,

(ii) the transmission of the energy through a medium, and

(iii) the transformation of the transmitted energy into the form of energy required at the output for utility.

In a Steam Plant, for instance, mechanical energy is made available at the output by the release of chemical energy stored in coal at the input. At the generation stage the chemical energy in coal is released and converted into thermal energy. The heat generated is used to change water into steam. Steam is transmitted through pipe lines to the engine at the output where the thermal energy in steam is transformed into mechanical energy to operate the engine.

Two significant operational factors that make possible the conversion of chemical energy into mechanical energy are:

(a) energy cannot be transmitted without the help of a medium, and

(b) energy which is the cause for steam, is itself contained within the steam.

Another feature of the engineering system is loss of energy. At all the stages of the system loss of energy takes place with the result the available output energy is only a fraction of the input energy.

In the first process of the system, that is, generation of energy, all stored energy of the fuel is not made available for the steam. Should the fuel be burnt indiscriminately in the boiler much heat is lost in the flue gas and leakage of heat from the furnace. There is also loss from conduction and radiation. In the transmission process, heat energy is again lost by self-absorption, conduction and radiation of heat by the pipe lines. In the third process which is the extraction and re-conversion of heat into mechanical energy, transformation losses are very high: there is a rejection of heat by the steam-engine (because of condensation) besides conduction and radiation losses.

Similarly, in the instructional system which involves the 'understood-understand' activity there are three major operational steps:

(i) the generation of ideas in the mind of the teacher for conversion into expression that can be transmitted,

(ii) the transmission of the ideas through the medium of language, and

(iii) the transformation of the expression in language into ideas in the mind of the learner.

The two significant factors that make possible the ideas in the mind of one individual understood by another individual are:

(a) ideas cannot be transmitted without the help of a medium, and

(b) the medium which transmits ideas is itself the embodiment of ideas.

Another important feature of the 'understood-understand' activity is loss of ideas. At all the stages of the system loss of ideas takes place with the result the available output ideas is not equal to the generated ideas, which reduces the efficiency of the instructional system.

The time-worn joke about an old lady who, when asked to say what she meant, replied, "But how can I know what I mean till I say it" illustrates that ideas themselves are imperfectly generated in the mind. Even when ideas strike an individual's mind with clarity, in the conversion of the ideas into the language medium, much of the clarity of the ideas is lost.

In the expression of ideas for transmission to another individual, there is again loss of ideas. Language is but an inadequate vehicle of thought; much of the ideas is lost in transit. It is not enough to use language that may be understood but it is necessary to use language that must be understood. By illogical sequencing of ideas or linguistic units, or incorrect choice of grammar and lexis, much of the ideas is lost.

In the extraction of ideas from the expressed language by the second individual, there is much loss of ideas for these reasons: (i) the learner does not possess the mental ability for perceptual and conceptual processes, (ii) the learner does not exercise his mental abilities to receive new ideas, (iii) the language used by the first individual is not well ordered, (iv) there is illogical sequencing of ideas or linguistic units, and (v) the choice of grammar and lexis is faulty. Sankey Diagram/1 illustrates the functioning of the engineering system and the three losses incurred in the system. A similar diagram (Sankey Diagram 2) has been developed for the instructional system illustrating the three major operational steps in the 'understood-understand' activity and the losses incurred in the system.

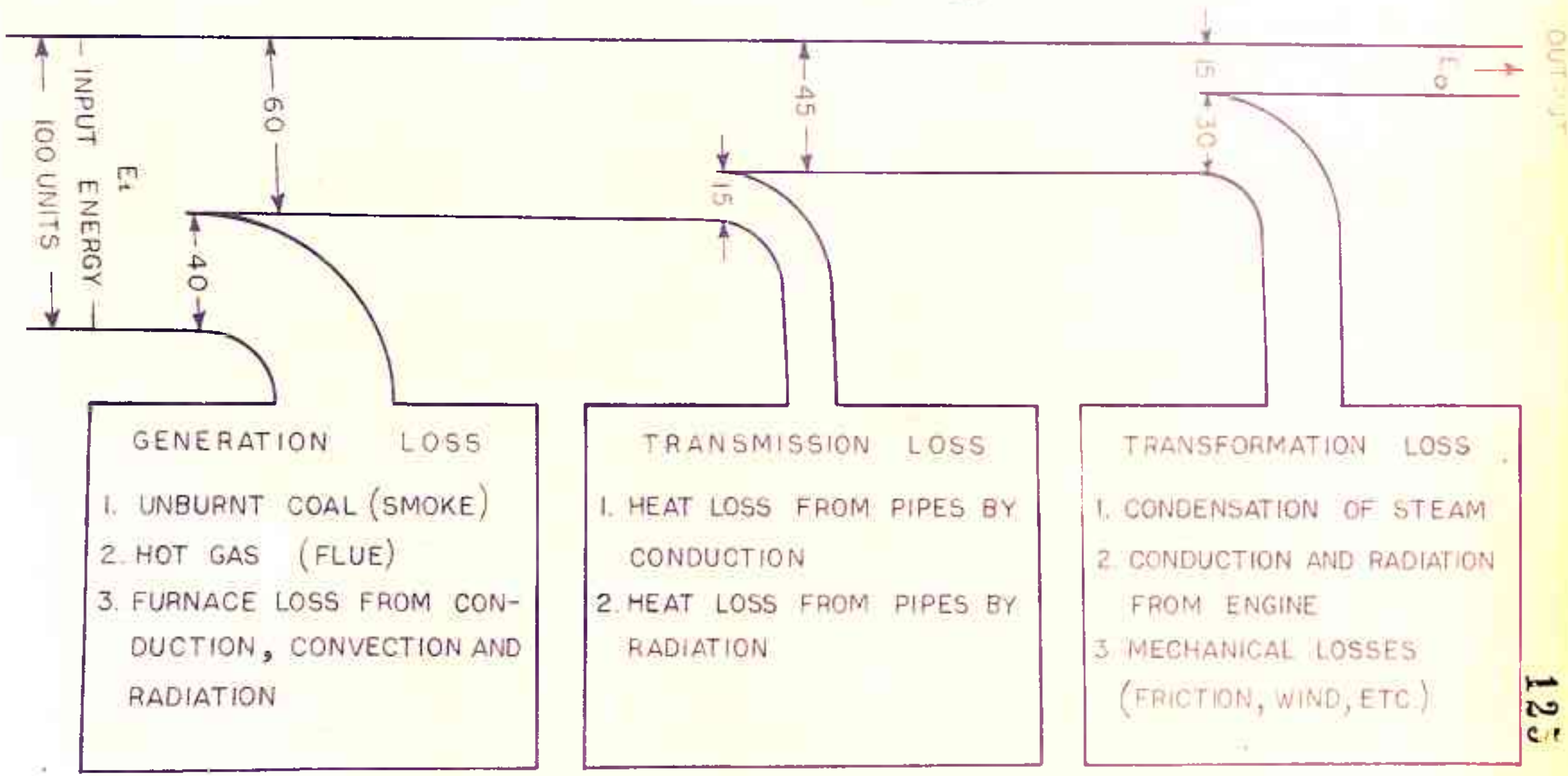
The analogy between the two systems is further striking in the tabulation below of the correspondences.

CORRESPONDENCES BETWEEN THE ENGINEERING SYSTEM AND THE INSTRUCTIONAL SYSTEM

		Engineering System	Instructional System
1. CONTENT		Energy (heat)	Ideas
2. MEDIUM		Steam containing energy is the medium of transmission of energy.	Language containing ideas is the medium of transmission of ideas.
3. PROCESSES	a)	Generation of energy and its conversion into steam.	Generation of ideas and its conversion into expression in language.
	b)	Transmission of energy through steam.	Transmission of ideas through language.

DIAGRAM NO.-1

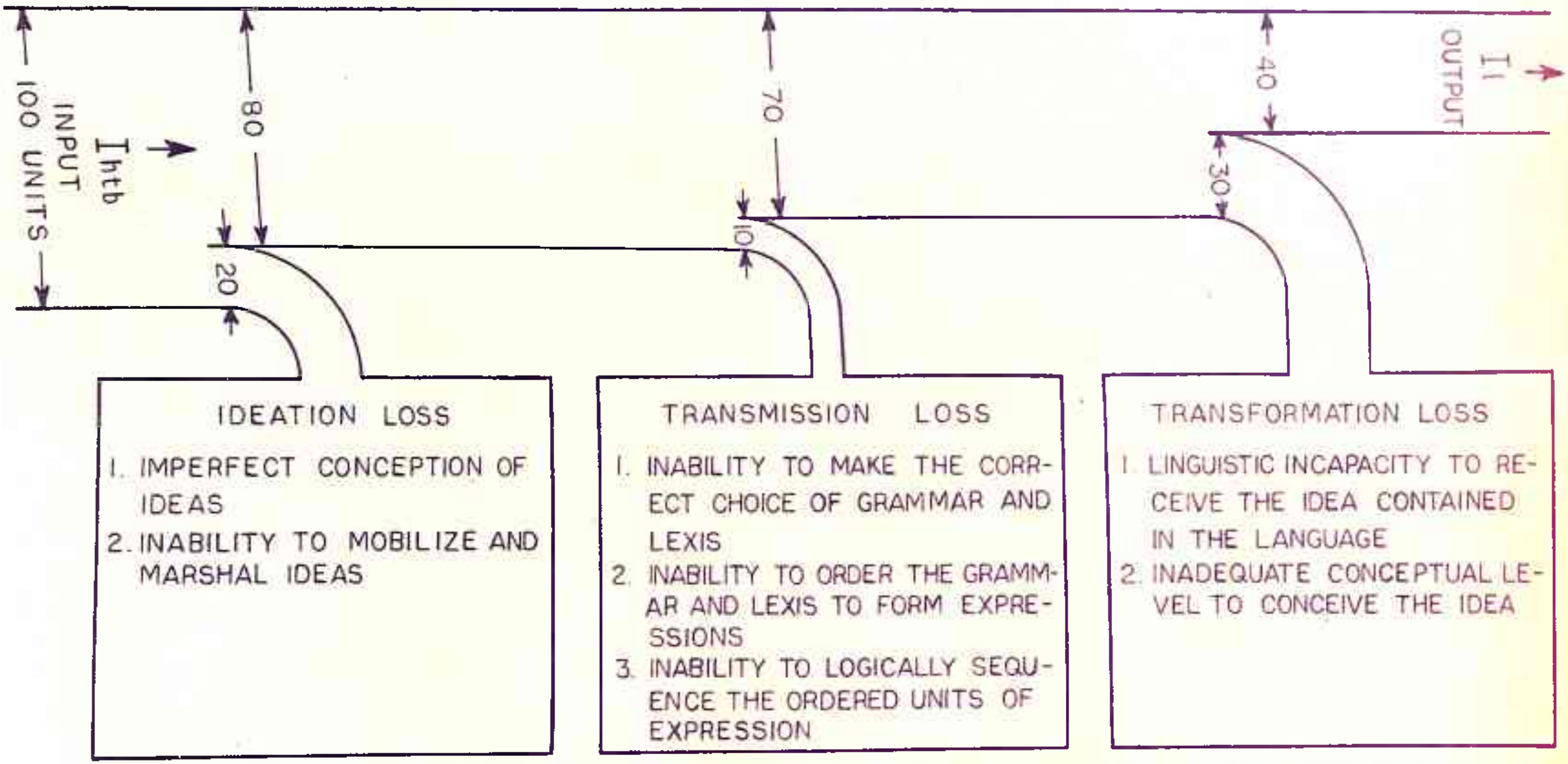
$$\text{EFFICIENCY} = \frac{E_i - E_l}{E_i}$$



SANKEY DIAGRAM FOR EFFICIENCY IN ENGINEERING (STEAM PLANT) SYSTEM

DIAGRAM NO. — 2

$$\text{EFFICIENCY} = \frac{I_{htb} - I_l}{I_{htb}}$$



SANKEY DIAGRAM FOR EFFICIENCY IN INSTRUCTIONAL SYSTEM

	Engineering System	Instructional System
	c) Reconversion of steam into mechanical energy.	Reconversion of language received into ideas.
4. SYSTEM EFFICIENCY	$\frac{\text{Output}}{\text{Input}}$ (Energy)	$\frac{\text{Understand}}{\text{(to be) Understood}}$ (Idea)

Item No.1 represents the corresponding basic material on which the operation is effected; item No.2 represents the medium of operation; item nos. 3-a, 3-b and 3-c show the corresponding processes of operation of the two systems; and item No.4 shows the corresponding system efficiency.

The analogy drawn is not so much to bring out the similarity between the engineering system and the instructional system, but to emphasise the crux of the issue - EFFICIENCY (which is the ratio between the output energy and the input energy) with which the engineer is concerned. In like manner in the instructional system the instructor is concerned with efficiency and the measures for optimising efficiency.

EFFICIENCY

The efficiency (η) of an engineering system is defined as the ratio of output energy to the input energy. The output energy (E_o) from a system is the input energy (E_i) less the energy loss (E_l) in the system.

$$\text{Thus, Efficiency } (\eta) = \frac{E_o}{E_i}$$

$$\text{As } E_o = E_i - E_l$$

Therefore $\eta = \frac{E_i - E_1}{E_i}$

The maximum ideal efficiency is attained when the loss (E_1) becomes zero, and its value is then unity; and when all the input energy (E_i) is lost in the system itself ($E_i = E_1$) the output is zero and the system efficiency is also zero.

That is,

$$\eta\, max = \frac{E_i - 0}{E_i} = 1 \text{ since } E_1 = 0$$

$$\eta\, min = \frac{E_i \pm E_1}{E_i} = \frac{E_i - E_i}{E_i} = 0 \text{ since } E_1 = E_i$$

The two extreme conditions of efficiency are never present in an engineering system. If the efficiency is zero it ceases to be a system at all; and a completely loss-free system is only a hypothetical situation.

The study of science, engineering and technology have the primary aim to improve the efficiency of systems. This calls for methods for reducing the losses in the system. Reverting to the example of the Steam Plant, energy is lost from the system at all stages namely generation, transmission and transformation.

When heat is generated by the release of thermal energy from fuel (coal) in the boiler, three important sources of energy loss are reckoned. In the first instance, the fuel is not completely burnt and the unburnt fuel escapes from the boiler through the chimney; secondly, the hot (flue) gases that go out carry a good part of the heat from the boiler; and, thirdly, loss of heat from the boiler by conduction, convection and radiation, bring down the generation efficiency in a steam plant. Technological skill is applied here to reduce the losses and improve the generation efficiency. Incomplete burning of the fuel is prevented by regulating the air supply to the burning chamber (furnace); secondly, the heat lost in the hot (flue) gases is recovered by economisers for pre-heating water or air required by the boiler; and heat loss by conduction, convection and radiation are prevented by thermally insulating the boiler. In the second stage, during transmission of energy by steam to the engine through metal pipes, conduction and radiation losses occur which are reduced by thermal insulation of the pipe line. In the third stage of operation of the steam plant, transformation, the main sources of energy loss are condensation loss, leakage of heat by conduction and radiation, and mechanical deficiencies of the engine. Steam condensation is reduced by super-heating the steam, while thermal insulation reduces heat loss by conduction and radiation; and energy loss at the engine is minimised by improving the design of mechanical parts like valves, piston, crank, etc.

In the instructional system where the three corresponding operations are (i) ideation, (ii) transmission, and (iii) transformation, I would define efficiency of the system as the ratio of, what has been understood by the student to what has to be understood. If 'I_{htb}', 'I_{hb}' and 'I_l' respectively represent the quantised forms of Idea-has-to-be-understood, Idea-has-been-understood and Idea-loss at the various stages, then the instructional efficiency (η) may be represented thus:

$$\eta\,(\text{instructional}) = \frac{I_{hb}}{I_{htb}}$$

$$\text{As } I_{hb} = I_{htb} - I_l$$

$$\text{Therefore} = \frac{I_{htb} - I_l}{I_{htb}}$$

$$\text{and } \eta\,\text{max.}(\text{instructional}) = 1, \text{ when } I_l = 0$$

$$\eta\,\text{min.}(\text{instructional}) = 0, \text{ when } I_{htb} = I_l$$

The aim of educational technology is to improve this efficiency by reducing the loss. At the ideation stage of the instruction the two main causes for the loss of ideas are due to (i) imperfect conception of the ideas which the teacher attempts to explain, and (ii) the inability on the part of the teacher to mobilise and marshal whatever ideas he has on a topic. In the second stage, transmission, three major causes are (i) inability on the part of the teacher to make the correct choice of grammar and lexis, (ii) inability to order the grammar and lexis, and (iii) inability to logically sequence the ordered units of expression. In the last stage of the system where the language is transformed into ideas by the student, two sources of loss are identified as (i) linguistic incapacity to receive the idea contained in the language, and

(ii) inadequate conceptual level to conceive the idea.

The instructional system having been determined, it emerges from the system itself that the language of instruction has a function that is specific. It is the instrument for the 'understood-understand' activity. In the study of technology the instructional language is the instrument for all the mental operations necessary for the intellectual activity beginning from the lowest cognitive level of recognising facts to the highest of reasoned argument.

THE ACTIVATING FUNCTION OF ENGLISH AS INSTRUCTIONAL LANGUAGE IN TECHNOLOGICAL EDUCATION IN INDIA

Experts on the teaching of English to students of technology in India, who have enunciated theories and written books prescribing the methodology and providing material for English-teaching to non-English technological students, hold the view that the English language plays an auxiliary role in technological education. By auxiliary role they mean that the language is used mostly to receive knowledge and information, and to a lesser degree to convey information associated with their technical studies.

J.P.B. Allen and H.G.Widdowson in TEACHING THE COMMUNICATIVE USE OF ENGLISH are convinced of the auxiliary role of the instructional language when they say:

"In recent years, English language teaching overseas has taken on a new character. Previously it was usual to define the aims of English learning in terms of the so-called 'language skills' of speaking, understanding speech, reading and writing, and these aims were seen as relating to general education at the primary and secondary level. Recently, however, a need has arisen to specify the aims of English learning more precisely as the language has increasingly been required to take on an auxiliary role at the tertiary level of education. English teaching has been called upon to provide students with the basic ability to use the language to receive, and (to a lesser degree) to convey information associated with their specialist studies. This is particularly so in the developing countries where essential textbooks material is not available in the vernacular languages. Thus whereas one talked previously in general terms of ELT, we now have such acronymic variants as ESP (English for Special Purposes) and EST (English for Science and Technology)."[1] In suggesting a different orientation to English-language teaching, they propose "a shift of the focus of attention from the grammatical to the communicative properties of the language. We take the view that the difficulties which the students encounter arise not so much from a defective knowledge of the system of English, but from an unfamiliarity with English usage, and that consequently their needs cannot be met by a course which simply provides further practice in the composition of sentences, but only by one which develops a knowledge of how sentences are used in the performance of different communicative acts. The approach which we wish to outline here, then, represents a move from an almost exclusive concern with grammatical forms to at least an equal concern with rhetorical functions."[2]

At the learning stage, even if the language is used mostly to receive knowledge and information, it plays more than an auxiliary role; it plays an activating role in that the language is used to activate the mind for the scientific inquiry. Knowledge and information are received not for mere passive reception but for building the edifice of scientific knowledge. Through an advertisement my son aged eleven years received the information that a clown is open for engagement for sports and schools. The kind of mental activity involved in receiving this information was just reception; on the contrary, in his science class when he learnt the elasticity of solids, the teacher took a piece of rubber band and stretched it; his verbal expressive acts were intended to make the learners observe that the rubber band became

1. To be published.

2. ibid.

longer; he next removed the pulling force and verbalised to let the learners observe that it regained its original shape. He then repeated the process with a load suspended at the lower end of a spring. He verbalised to let them deduce that solids possess the elastic property of regaining their original shape when the applied force ceased to act on them. His further verbalisation was intended to crystallise the ideas they had received into the concept of elasticity as the property of solids of regaining their original shape when the applied force ceases to act on them. The knowledge and information while being received through language aided by receptors involved the activity of the mind to observe, to perceive cause-and-effect relationship, to deduce, and finally to conceive the property of elasticity. In receiving information communicated, the intellect apprehends the intelligible content and comes to understand it. Receiving information is a receptive act while receiving instruction is a reactive act; the former is at the perceptual level only while the latter beginning from the perceptual level reaches the conceptual level; the substance received from information is stored at memory while the substance received from instruction is absorbed by intelligence.

In technological education students learn (1) the basic and fundamental laws at work in the physical world, and (2) the application of these laws and principles in practical situations. Knowledge is acquired in two ways: one, when the natural reason by itself arrives at the knowledge of a fundamental law hitherto unknown by discovery from experimentation; the other, when another person furnishes help to discipline the mind to acquire knowledge. In leading a student to discover fundamental laws a teacher follows the same method that a man adopts in finding things out for himself. The teacher instructs another by expounding his own processes of reasoning by signs which serve as instruments for the natural reasoning of the learner to arrive at conclusions previously unknown, and by proposing statements that are developed from self-evident principles. Students of technology build up their edifice of knowledge not always from self-discovery but by understanding the data, the arguments based on the data and the order in which the premises lead to the conclusion by the exercise of the reasoning power through the medium of language. The teacher enables a learner to know what he does not know by directing his observation, where possible, to an object or a phenomenon, and by directing the/ learner's reason by the inferential uses of language to move from what is known to the unknown, from premises to conclusions, from cause to effect, from data to target, through recourse to a number of perceptual and conceptual abilities for recognising facts, for abstracting the qualities from things, for seeing how parts make up the whole, for classifying information, for grouping things in the mind, for making analogies, for thinking abstractly, and for doing numerous other mental operations, through the use of language. Therefore, the instructional language for technological education does not simply play an auxiliary role but an activating role in that it activates the mind.

For activating the mind for the numerous mental operations required for the understanding and assimilation of technology, the function that the instructional language performs is cognitive activation. I call this language that brings about the cognitive activation, in other words, the 'understood-understand' activity for learning technology, FUNCTIONAL ENGLISH. I am in perfect agreement with Professor Reginald O.Kapp's specification of FUNCTIONAL ENGLISH as language which conveys bare factual information either by speech or writing, which is used for drawing inferences from facts, which communicates a scientist's subtle and penetrating reasoning. He rightly calls FUNCTIONAL ENGLISH "the language of logic, of all argument in which the appeal is to the intellect and not, as in poetry, to the imagination."[1] However, while Professor Kapp identifies FUNCTIONAL ENGLISH on the basis of its characteristic, or, its static property as language where every word and every

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1. THE PRESENTATION OF TECHNICAL INFORMATION, R.O. Kapp, Constable, London, 1973, p.23.

sentence is so selected "that it will meet the function assigned to it"[1], I identify FUNCTIONAL ENGLISH on the basis of its dynamic property, namely, its function.

TECHNOLOGICAL COMMUNICATION:

It is necessary at this context to indicate the nature of technological communication.

Technology is a highly evolved and progressed art. Therefore the communication of the art of technology also has a history and an evolution. At present the communication of technology exists in THREE well-defined planes: (1) the WORD-plane, (2) the MATHEMATICAL-plane and (3) the GRAPHIC-plane.

(1) The WORD-plane is the most fundamental and basic. It is in this plane that the 'language' as it is commonly understood has its role.

(2) The MATHEMATICAL-plane is used for communicating at a rapid rate. Ideas are encompassed in expressions. Here precision is more prominent.

(3) The GRAPHIC-plane has no high cognitive appeal. It is direct and explicit. Communication in this plane cannot assume multi-dimension as in the mathematical plane.

In technological communication one or more planes is used simultaneously. At the lower level of instruction the word-plane accomplishes almost all the communicating operations. The mathematical-plane of communication demands a good familiarity with the art of mathematics. Therefore communication in this plane is possible after attaining a cer-

1. THE PRESENTATION OF TECHNICAL INFORMATION, R.O. Kapp, Constable, London, 1973, p.20.

tain level of proficiency in mathematics, and mastering the symbols of it. Usually this plane of communication is resorted to at a higher level of comprehension since it has the advantage of being precise and comprehensive and can assume a number of dimensions. Yet, meaningful technological communication cannot entirely be carried out in this plane. Recourse to the word-plane, quite often, is essential. The graphic-plane is also not an independent plane for communication. Words are required in this plane for completeness of the communication. Since the graphic-plane is easier than the mathematical-plane, students are initiated into this plane at an early stage. However, its limitations prevent its use in advanced communication.

The advantages of technological communication existing in three different planes, W,M and G (word, mathematics and graphic) are too obvious. In the first place, the communication can resort to more than one plane so that transfer of idea is better accomplished. Secondly, if one is familiar with more than one plane, one will not find it impossible to communicate with another who is familiar in more than one plane.

Since the scope of the present thesis is confined to language, which is exclusively in the W-plane, it is not relevant to dwell on the M and G planes. But it may be said in this context that in the M-plane subjects like Applied Mathematics, and in the G-plane subjects like Technical Art have established strong foundations. Whereas, in the W-plane, Functional English has not so far emerged, not even been admitted and recognised, as a component of technology at large.

Chapter VII

MATHEMATICAL REPRESENTATION OF THE DYNAMICS OF FUNCTIONAL ENGLISH FOR THE STUDY OF TECHNOLOGY, THROUGH A PHYSICAL MODEL

Functional English belongs to the Denotative stratum of language which is not influenced by feelings, moods or emotions. Unlike the Connotative stratum of language which is distinguished by the element of suggestion where there is much that is implicit, the Denotative stratum is marked by explicitness and exactness, and has complete intellectual sincerity. In the Connotative stratum, much is left to the imagination of the recipient of the language; there are subtleties of conception in it and it involves complexities of presentation; it carries delicate nuances and ambiguities. The impression produced is not only by what is said expressly, but also by what is not expressed. The 'impression' in the Connotative stratum is the effect of expression and suppression, and varies from recipient to recipient depending on the sensibility of the recipient to supply what is suggested and what is suppressed.

Functional English for technology expresses orderly rationalised concepts and creates a particular and specific impression on the mind of the recipient. The impression does not vary from recipient to recipient as the denotation hasdefiniteness. The mechanics of Functional English has no flexibility; the framework of the language structured to embody a specific technological concept or idea cannot be dissociated from the idea without distorting the idea it contains. Thus Functional English for technology and technology form inseparable components. Further, at the operational lvvel, proficiency in Functional English influences the proficiency in technology by a DIRECT EFFECT, and the proficiency in technology helps to improve the proficiency in Functional English by a RETRO-EFFECT owing to the coupled nature of technology and Functional English. The two effects, DIRECT and RETRO, form the essential operating parameters of the instructional system for technology. The dynamics of the system is mathematically expressed, below, by analogy to a physical model.

The model is structured on the principle that where there is a cause-and-effect interaction as it happens in technological instruction where the two parameters, proficiency in Functional English and proficiency in technology are mutually dependent as well as interactive, the nature of the interaction has manifested an exponential characteristic.

For simplicity, the model considered is a Liquid Flow

System. Its cross-section is shown in Fig.1 and its side elevation in Fig.2.

A liquid is confined in a large reservoir with one of the walls, as shown, vertical and flat having a rectangular slot of unit width on it. A collecting vessel of rectangular shape is so mounted on a spring that one of its vertical sides slides on the wall of the reservoir thereby acting as a valve to regulate the flow of liquid through the rectangular slot. The mechanical arrangement does not permit the vessel to move in any direction except to slide vertically on the wall of the reservoir.

The action of this system is obvious. As the liquid fills the vessel, the weight of the vessel increases and it moves down pressing the spring. This action allows the opening to widen and more liquid to drain out into the vessel. The increased rate of flow of liquid accelerates the opening of the slot which again increases the rate of flow, and the process continues until the collecting vessel is filled and the liquid starts to overflow.

ANALOGY

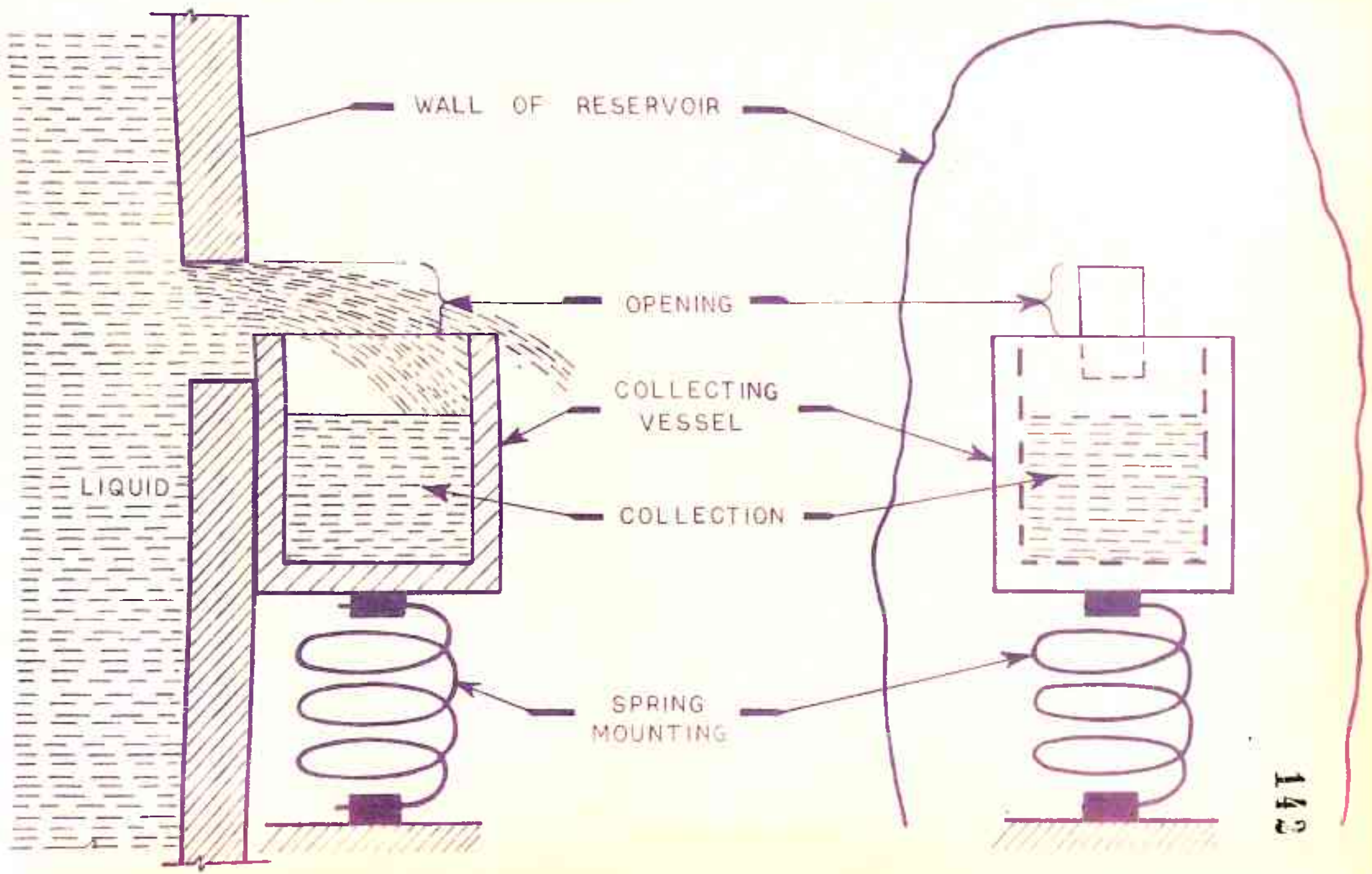
The reservoir with a large (almost infinite) volume of liquid is analogous to the huge and almost infinite volume of technological knowledge in any field. The collecting vessel represents the student with a finite capacity, who can learn as much as his capacity allows. Between the storage and the vessel is the wall which is analogous to the

FIG. 1

SECTIONAL VIEW

FIG. 2

ELEVATION VIEW



linguistic barrier. This barrier is opened due to the weight of the liquid in the vessel, which is the language proficiency. The compliance of the spring to the compressing force corresponds to the student's response . The various factors of the physical system are tabulated against the corresponding factors of the instructional system for technology as shown below:

PHYSICAL SYSTEM	INSTRUCTIONAL SYSTEM
1. Liquid having volume and mass.	1. Technology having technological content and the language in which it is contained (Functional English).
2. Volume of liquid (V).	2. Volume of technological content (τ).
3. Mass of liquid (M).	3. Functional English in which technology is contained (λ).
4. Density of liquid (D=M/V).	4. Functional English in unit technology or linguistic density ($\delta = \frac{\lambda}{\tau}$).
5. Area of opening of slot(A).	5. Proficiency in functional English (θ).
6. Rate of flow of liquid (Q=KA, where K is a constant).	6. Rate of exposition to technology ($\phi = \alpha\theta$ where α is a constant).
7. Part of flow that collects in the vessel (collection coefficient C).	7. Understanding coefficient of technology (γ).
8. Spring compliance (displacement per unit mass of liquid S).	8. Proficiency of Functional English acquired for unit language of technology understood (β).
9. Time 't' measured in any arbitrary unit.	9. Time 't'. Unit may be even one semester or part thereof.

OPERATIONAL ANALOGY

The large volume of liquid contained in the reservoir has, as any matter, (1) volume and (2) mass, related by the density of the liquid as D=M/V. In the instructional context technology has two components (1) the abstract technological content presented in (2) functional language. As in the case of the liquid where mass and volume are inseparably related, technology also has the abstract content inseparably present in the language structure. If the quantised technological content and the quantised language in a given sample of technology are represented by τ and λ respectively, then the linguistic density may be expressed by the ratio $\lambda/\tau = \delta$. The area 'A' of the slot on the wall of the reservoir represents the 'WINDOW' on the linguistic barrier with an area 'θ' to allow the passage of technology. 'θ' represents the mastery or proficiency acquired in the use of the functional language. The area of opening is directly related to the weight of the vessel and likewise the proficiency in the use of functional language is related to the language absorbed or assimilated by the student. The collecting vessel represents the ability of a student to acquire technological knowledge. The dimensions of the collecting vessel can be equated to the faculties of the student: broad-base, depth, and so on. Rate of flow of liquid 'Q' depends on three factors (1) viscocity of the liquid, (2) the area of the opening, and (3) the hydrostatic pressure at which it is delivered. It is assumed in the system that viscocity and hydrostatic pressure remain constants and that the factor to be considered variable is only 'A'. Hence, the rate of flow is proportional to 'A', or, using a constant K, Q=KA. An analogous condition exists in the instructional system. The rate of exposition to technology ϕ is subject to (1) the level of treatment of the subject, (2) the proficiency of the student in the functional language, and (3) the pressure at which the teacher delivers the content. It is observed in the physical system that the rate of filling is not 'Q' but less than Q. Only a part 'C' of Q is collected in the vessel after the spilling. A student is not generally able to assimilate the entire content of technology to which he is exposed. The fraction he assimilates is represented by a coefficient 'γ'. The rate at which the slot opens on the wall is a function of the two factors (1) the rate at which the weight of the vessel increases, and (2) the coefficient of the vertically downward movement per unit increase in weight (compliance of spring 'S'). A similar action is seen in the instructional system where the proficiency in the functional language increases due to (1) the rate at which the student understands the functional language from technology, and (2) the coefficient 'β' of increase in proficiency in functional language for unit language of technology understood.

Since the physical system and the instructional system are entirely analogous, either of them may be treated mathematically for establishing relations to represent the dynamic state. The more familiar physical system is therefore treated and the result is transferred to the instructional system.

Let it be assumed that the system started working at a time 'zero', and the initial opening area of the slot A_o which was made by an external agency by pouring a volume V_o of the liquid in the vessel. After a time 't', the state of the vessel and the slot are shown in the figure. The equation of this state may be derived as follows:

Area of the slot at time t	= A
Area of the slot at time zero	= A_o
Rate of flow from the reservoir	= K A
Rate of collection in the vessel	= K A C
Rate of increase in the weight of the vessel	= K A C D
Rate of displacement of the vessel due to the increase in weight	= K A C D S
	= Rate of opening of the slot
	= dA/dt

Therefore $\frac{dA}{dt} = K\ A\ C\ D\ S$

This is a differential equation of the first order in 'separable variable' form and may be solved as:

Separating the variable, $\frac{dA}{A} = K\ C\ D\ S\ dt$

Integrating both sides,

$$\log A = K\ C\ D\ S\ t + \log A_o$$

A_o represents the value of A at time t = 0 when the system commenced to function.

Therefore $\log A - \log A_o = K\ C\ D\ S\ t$

$$\log \frac{A}{A_o} = K\ C\ D\ S\ t$$

That is, $A/A_o = e^{K\ C\ D\ S\ t}$

$$\text{or } A = A_o\ e^{K\ C\ D\ S\ t}$$

Reverting to the instructional system, the linguistic proficiency at any time may be represented as:

$$\theta = \theta_o\ e^{\alpha\gamma\delta\beta t} \quad \text{.......Equation (1)}$$

In a similar manner the improvement in technological proficiency as a function of time may also be derived as follows:

The rate of technological content to which the student is exposed 'ϕ' $= \alpha\theta$

Rate of assimilation $= \alpha\theta\gamma = \frac{d\tau}{dt}$

Therefore $\frac{d\tau}{dt} = \alpha\theta\gamma$

Substituting the value for θ from equation (1)

$$\frac{d\tau}{dt} = \alpha\gamma\,\theta_o\,e^{\alpha\gamma\delta\beta t}$$

that is, $d\tau = \alpha\gamma\,\theta_o\,e^{\alpha\gamma\delta\beta t}\,.\,dt$

Integrating both sides,

$$\tau = \frac{\alpha\gamma\theta_o e^{\alpha\gamma\delta\beta t}}{\alpha\gamma\delta\beta}$$

'θ_o' may be expressed in terms of the initial technological proficiency τ_o since $\theta_o = \tau_o\,\delta\beta$

So $T = \dfrac{\alpha\gamma\delta\beta T_0}{\alpha\gamma\delta\beta} e^{\alpha\gamma\delta\beta t}$

Therefore $T = T_0 \, e^{\alpha\gamma\delta\beta t}$ ....Equation (2)

EXAMINATION OF THE MATHEMATICAL RESULTS

1. Expressions (1) and (2) have the same form which show that the two factors - (1) proficiency in Functional English and (2) proficiency in technology go on increasing at the same rate. Stated otherwise, the correlation co-efficient of the two factors in a time-varying context is plus one.

2. It is observed from the expression $\theta = \theta_0 \, e^{\alpha\gamma\delta\beta t}$ that (i) $\theta = 0$ when $\theta_0 = 0$, and

(ii) $\theta = \theta_0$ when any one or more of $\alpha, \gamma, \delta, \beta, t$ is equal to zero.

This explains that if the initial proficiency in Functional English is nil there cannot be any improvement in the language proficiency, and if any of the coefficients is zero, the linguistic proficiency remains at the initial level θ_0.

3. Normally the coefficients and time cannot assume negative values, although the magnitude of some of them may approach zero in certain cases where the student will not make any improvement.

4. The rate of improvement is considerably influenced by the initial proficiency, θ_0 being a factor of multiplication.

5. For rapid progress, with a given initial profi-

ciency in Functional English as well as technological proficiency, the values of α, γ, δ and β should be the maximum. The aim of a successful academic plan should be to optimise these coefficients.

NATURE OF THE COEFFICIENTS

K/α-This factor represents the viscosity of the liquid in the system and the hydrostatic pressure commonly known as the 'head' of the liquid column. In the instructional system the viscocity corresponds to the manner in which a subject is discussed - whether lucidly explained so that the idea can flow easily or in an unintelligible or incomprehensible manner.

The hydrostatic pressure is the pressure at which an information is forced into the student. Here it is implied that the level of technological content with the teacher should be much higher than with the student, so that there is forward flow of information and knowledge. Therefore the 'K' factor depends on the teaching 'member' as teacher, book, etc. from where the student is drawing his knowledge.

C/γ-The vessel as shown in the physical model does not collect all the liquid discharged from the reservoir due to various physical factors as the velocity of discharge, the opening of the vessel, etc. A corresponding situation exists in the instructional system where all the technological content transmitted to a student is not understood by him due to the teacher's speed of instruction, student's low capacity to receive, etc. The fraction of the technology that is understood by a student is represented by γ and is called the coefficient of understanding. In an ideal situation when the vessel is connected by a pipeline to the reservoir the value of C is unity where there is no spilling. An instructional system where the coefficient of understanding is unity is only a hypothetical situation.

D/δ -The mass of a quantity of liquid depends on its density in the physical system. In the instructional system, Functional English of a quantum of technology depends on its linguistic density which is the amount of Functional English contained in unit technology.

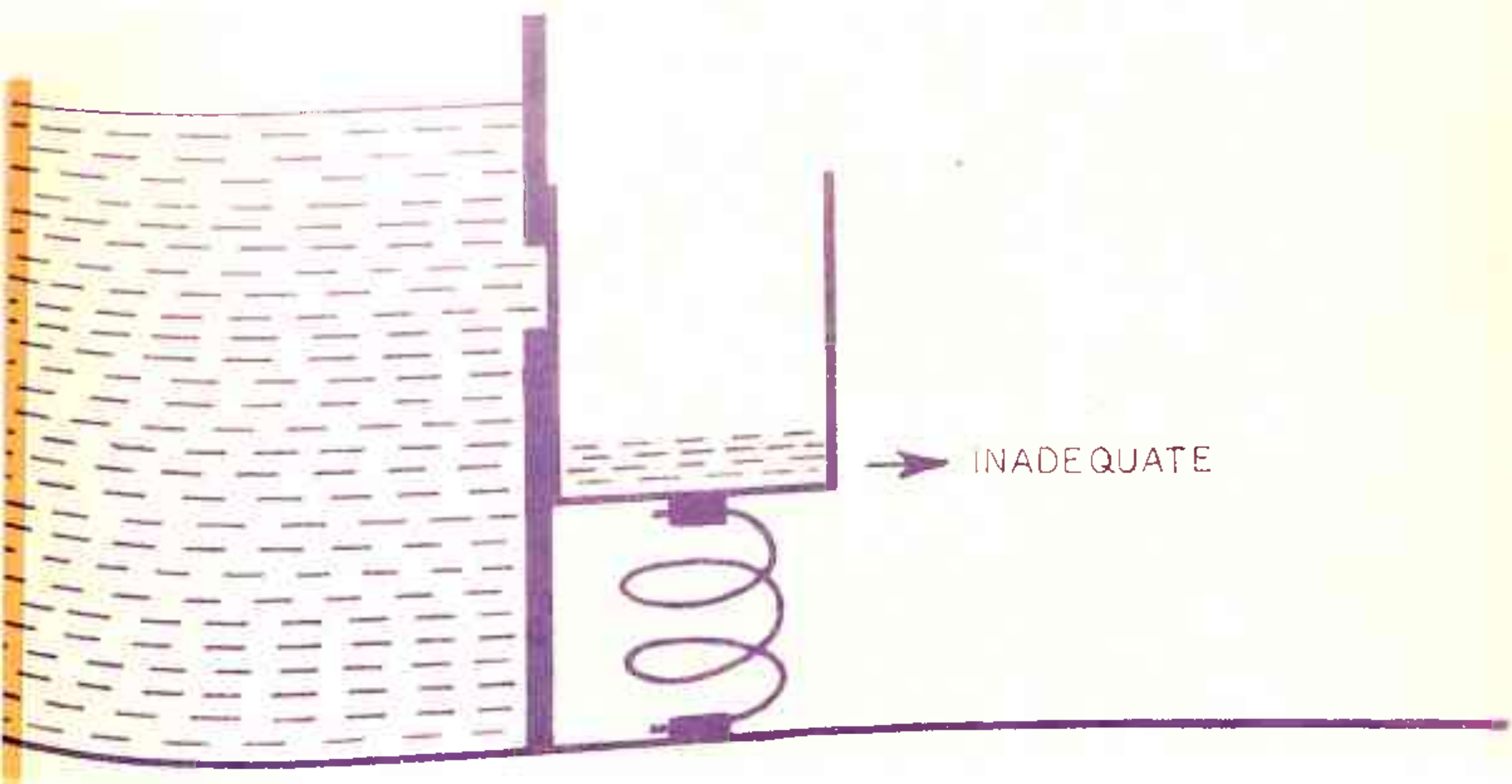
S/β -In the physical system the opening of the slot is proportional to the displacement of the spring which is due to the mass of the vessel. The mass which is the amount of matter is here analogous to Functional English in which technology is contained, that further opens the mind to understand more of technology. Proficiency of Functional English is acquired by assimilation of technological content and acquisition of the ability to use Functional English for technology.

DIFFERENT CASES OF PROFICIENCY DEVELOPMENT

All possible cases of proficiency development can be explained with reference to the model considered. However, only a few cases of interest to the present context have been taken up for illustration.

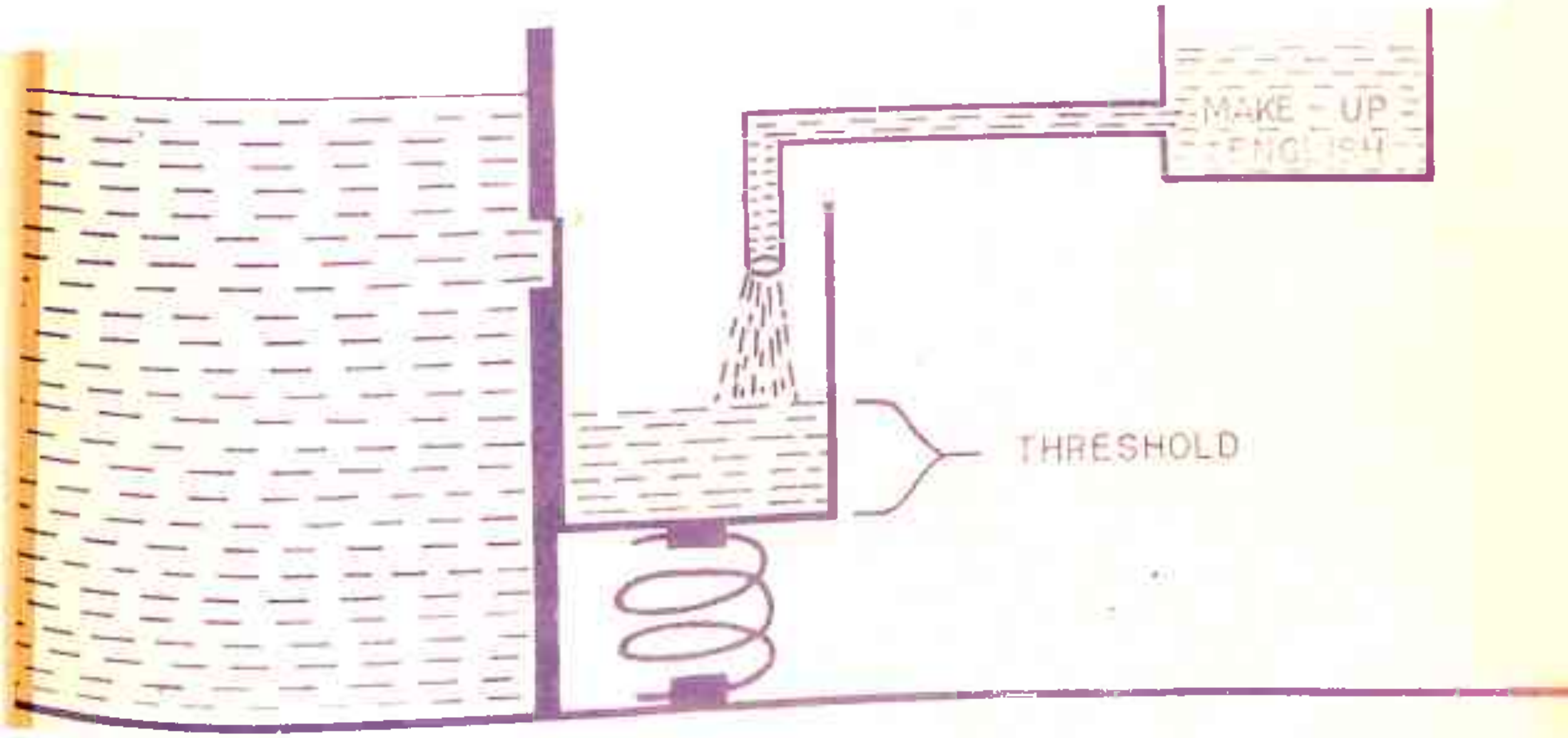
1. STUDENTS WITH INADEQUATE PROFICIENCY

The model schematic is shown below for the category of students with inadequate proficiency in Functional English.



In this case the initial language proficiency 'θ_o' for understanding technology is nil as shown by the model, where the slot is closed completely by the side of the vessel and no flow is possible. The vessel has insufficient mass of liquid to pull the vessel down and open the valve. Now, if some extra liquid is added by an external agency, the vessel will descend down. In the Birla Institute of Technology and Science, Pilani, the aim of the Make-up

English course is precisely to do this operation in the instructional system.

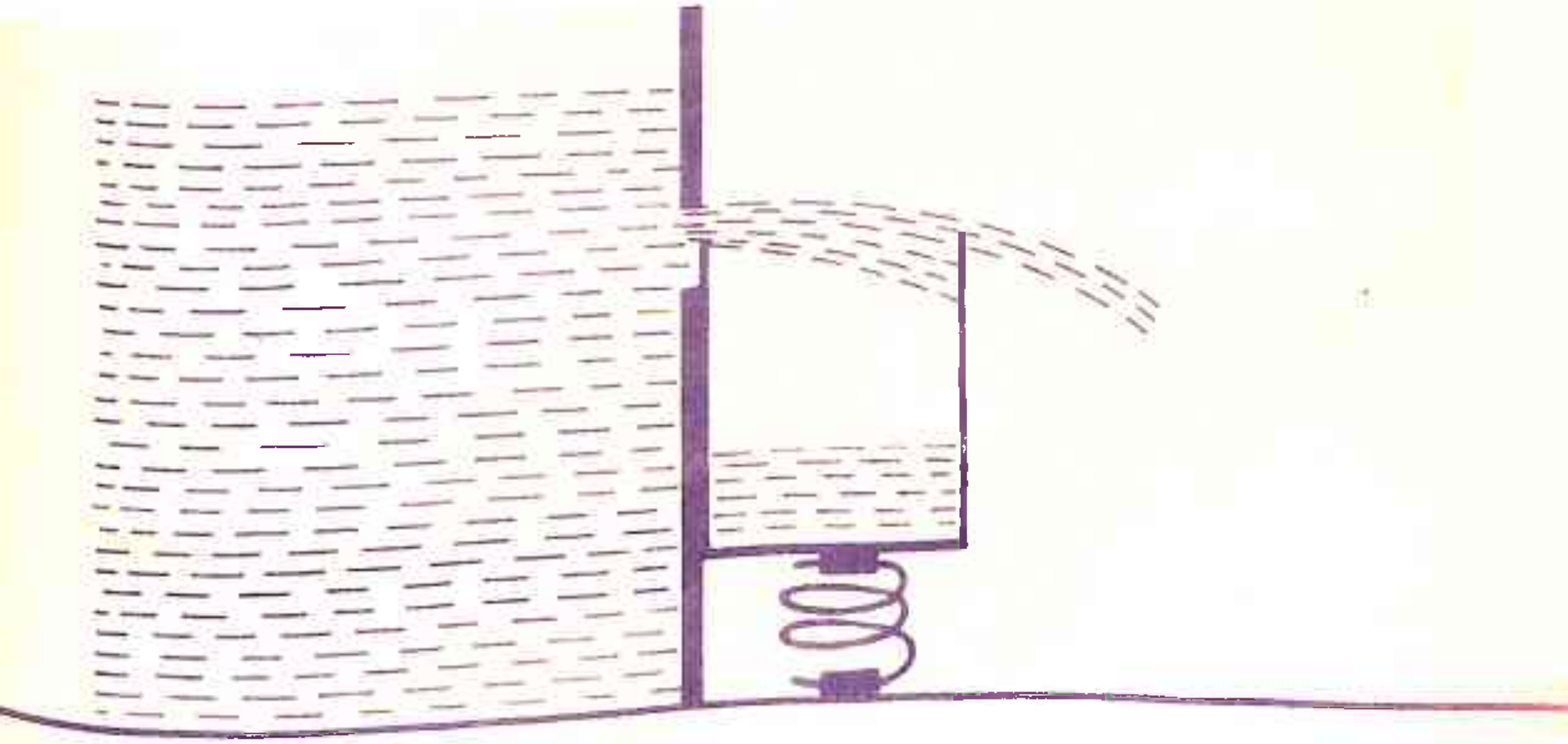


When the vessel has just opened the slot on the reservoir, the Make-up English is no longer needed since the system will reach a self-acting state. The stage at which the vessel attains the self-action, is called the THRESHOLD stage and the mass of the liquid in the vessel at the threshold stage is the threshold mass. This corresponds to the THRESHOLD proficiency in English required to absorb technology and start a regenerative cycle for learning technology and acquiring the ability to use the functional English for technology.

The statistical study also reveals such a state of performance. The Make-up students exhibit a high correlation coefficient between CGPA and English grade. This is due to the utter dependence of these students on the English programme for improving their CGPA. When once the threshold stage is reached, these students do not depend on any English programme which is evident from the low coefficient of correlation between CGPA and English grade for the category of students with adequate proficiency. They are dependent on the technological reservoir which supplies the linguistic ability as well.

2. THE MAJORITY BEHAVIOUR

The majority of the student-input to the Birla Institute of Technology and Science, Pilani, behave like the system shown below where there is already some linguistic proficiency above the threshold stage.



Although the average CGPA of a large sample of the student-input to the Institute increases only slightly through the normal 10 semesters for the technological programme, it is an indication that there is an interaction taking place between the proficiency in functional English and the assimilation of technology in students. The Liquid System is still a valid demonstration of the action and interaction between proficiency in functional English and proficiency in technology. In this context it is important to note that functional English in the WORD - PLANE slowly recedes from its role since symbolic language in the MATHEMATICAL-PLANE and GRAPHIC-PLANE slowly get into the technological system as time advances.

3. DECREASING CGPA

Among the various coefficients α, γ, δ and β, which determine the rate of proficiency improvement, α, γ and δ cannot assume negative values. But it may happen that β may change in the case of some students due to external influences which may be outside the academic ambit. Suppose the compliance decreases (that is, the stiffness increases) to such a state that the vessel is slighly lifted upward against the mass of liquid collected, the rate of flow decreases and the entire operation is reversed resulting in a decrease in the proficiency as time increases. The exponential relation

$$T = T_0 e^{\alpha\gamma\delta(-\beta)t}$$

explains the rate of decrease in CGPA.

4. LEVEL CGPA

Quite a few students have a steady CGPA throughout their academic career. This is a stage explained by the extremely low value for the product of the coefficients

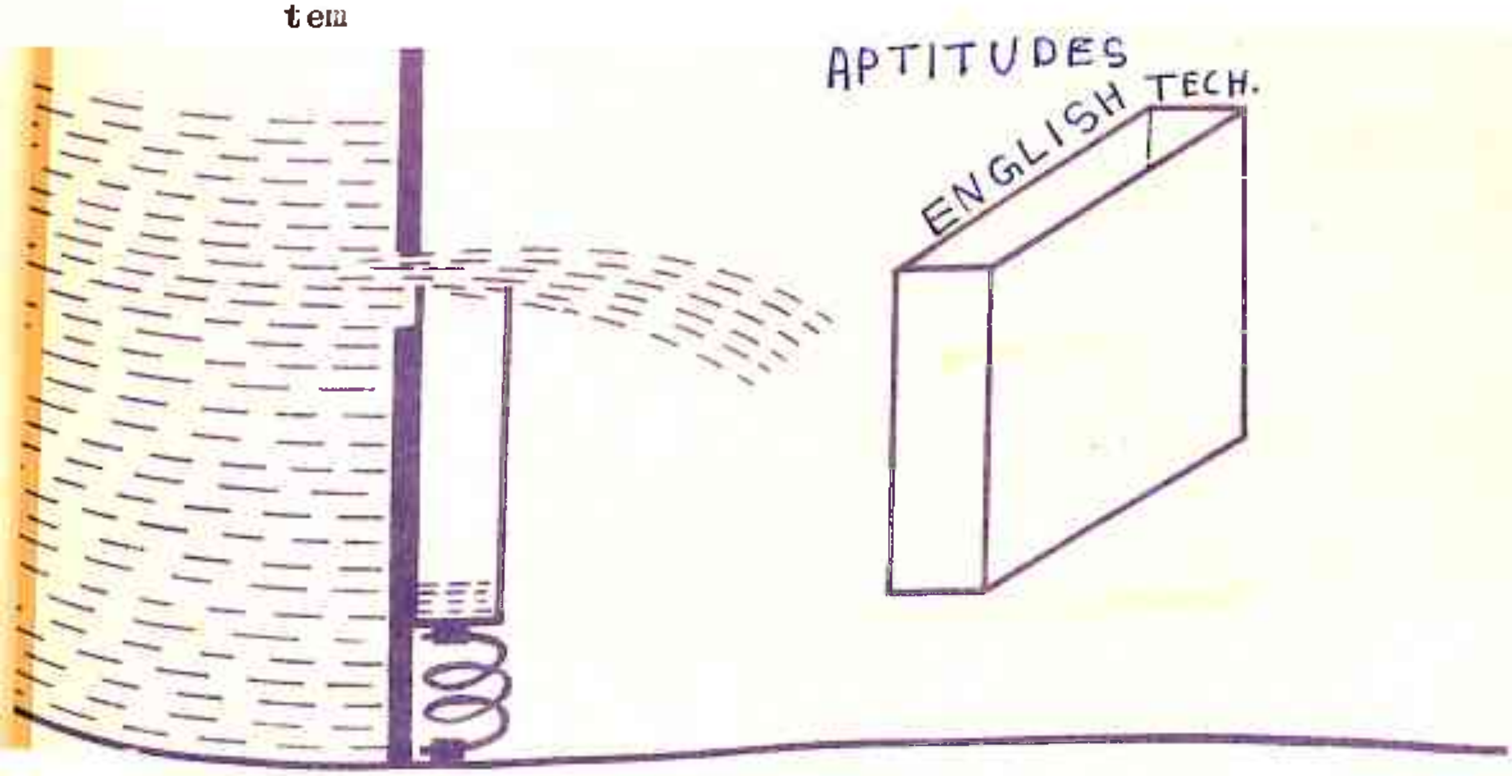
$$\alpha\gamma\delta\beta \simeq 0$$

so that $T = T_0 e^{\simeq 0}$

$= T_0$

5. HIGH GENERAL ENGLISH PROFICIENCEY AND LOW CGPA

In a few cases it is observed that students with a high proficiency in General English are not able to perform correspondingly well in technology. This state is represented by the following schematic of the physical system

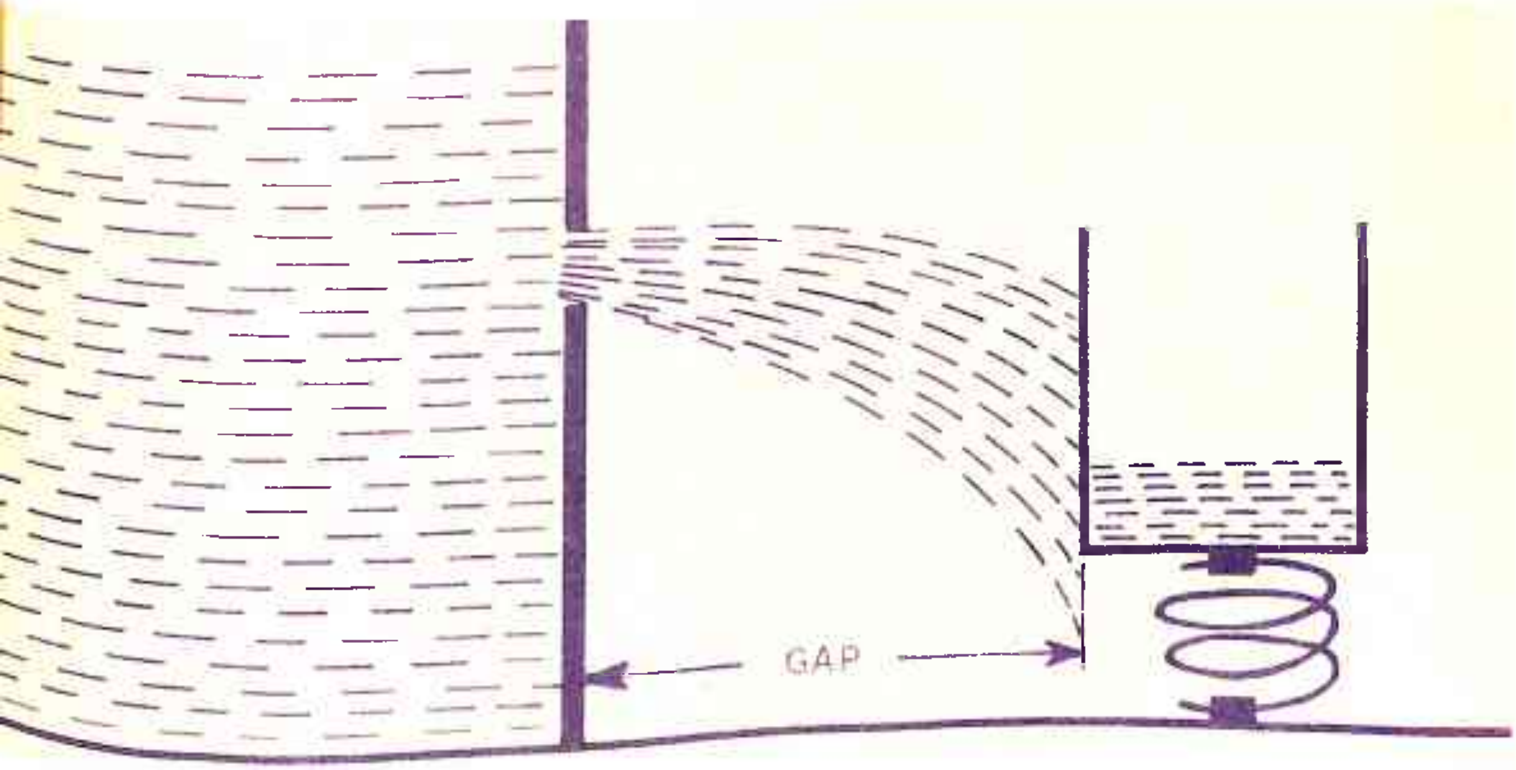


where although the opening is wide enough, the shape of the vessel is not suitable for the collection of the liquid.

The opening is long and narrow with the longer edge parallel to the wall of the reservoir. The liquid falls beyond the vessel. In order to collect the liquid, besides the volume of the vessel, its shape should be suitable. Such students are not adapted for technological pursuit. Perhaps they may do well in the study of arts.

6. PSYCHOLOGICAL GAP

Some students who are found fit, in all respects, for academic pursuit, fail badly in their efforts. The reason is obviously psychological. Such students develop and maintain a psychological gap with the teachers. This lowers their mental potentiality and even ruins their career. This case may be well illustrated by the schematic below where the vessel is removed a little distance from the reservoir.



servoir. It is noticed that the gap does not allow the liquid to flow into the vessel.

7. DEFICIENCIES IN TEACHERS

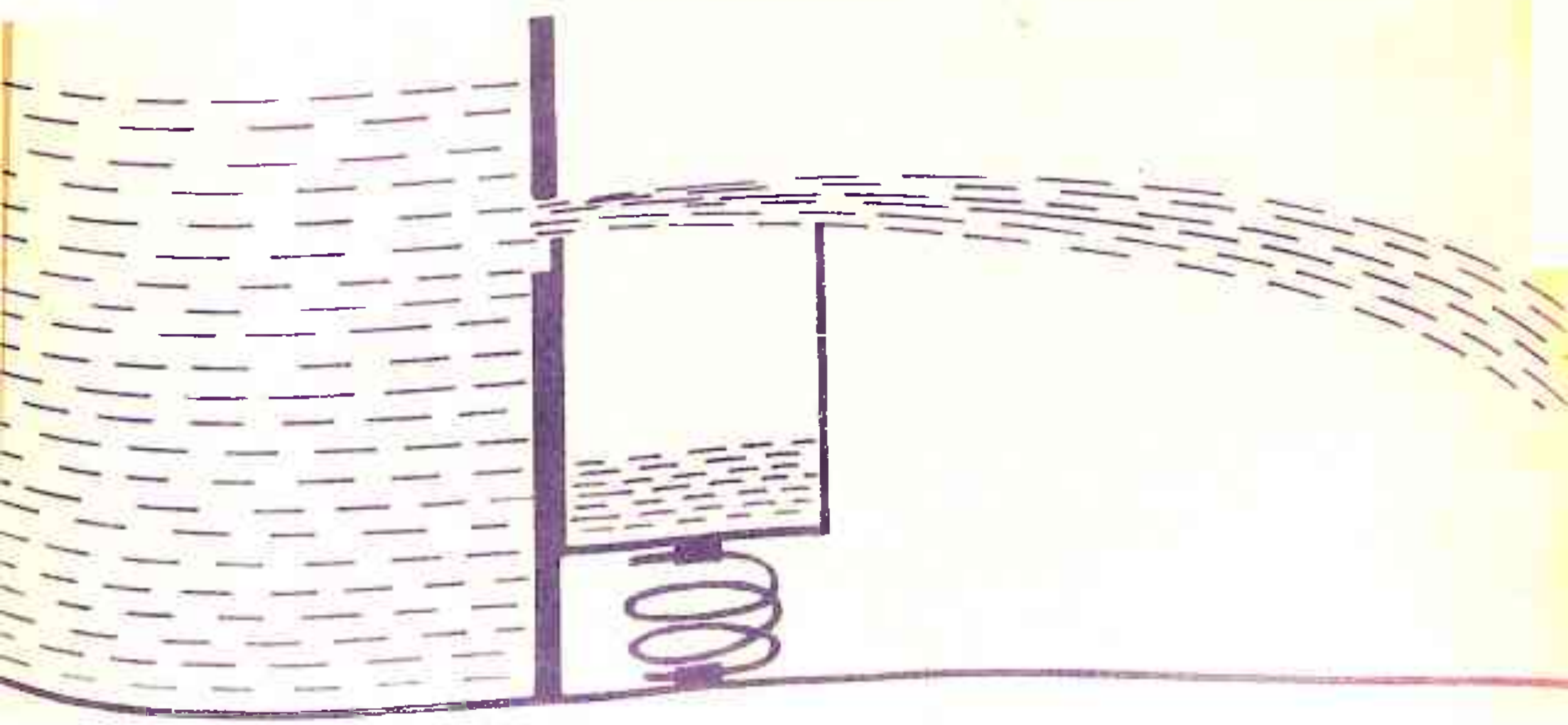
It is pertinent in this context to show how some deficiencies of teachers affect the students' proficiency.

a) LACK OF INFORMATION

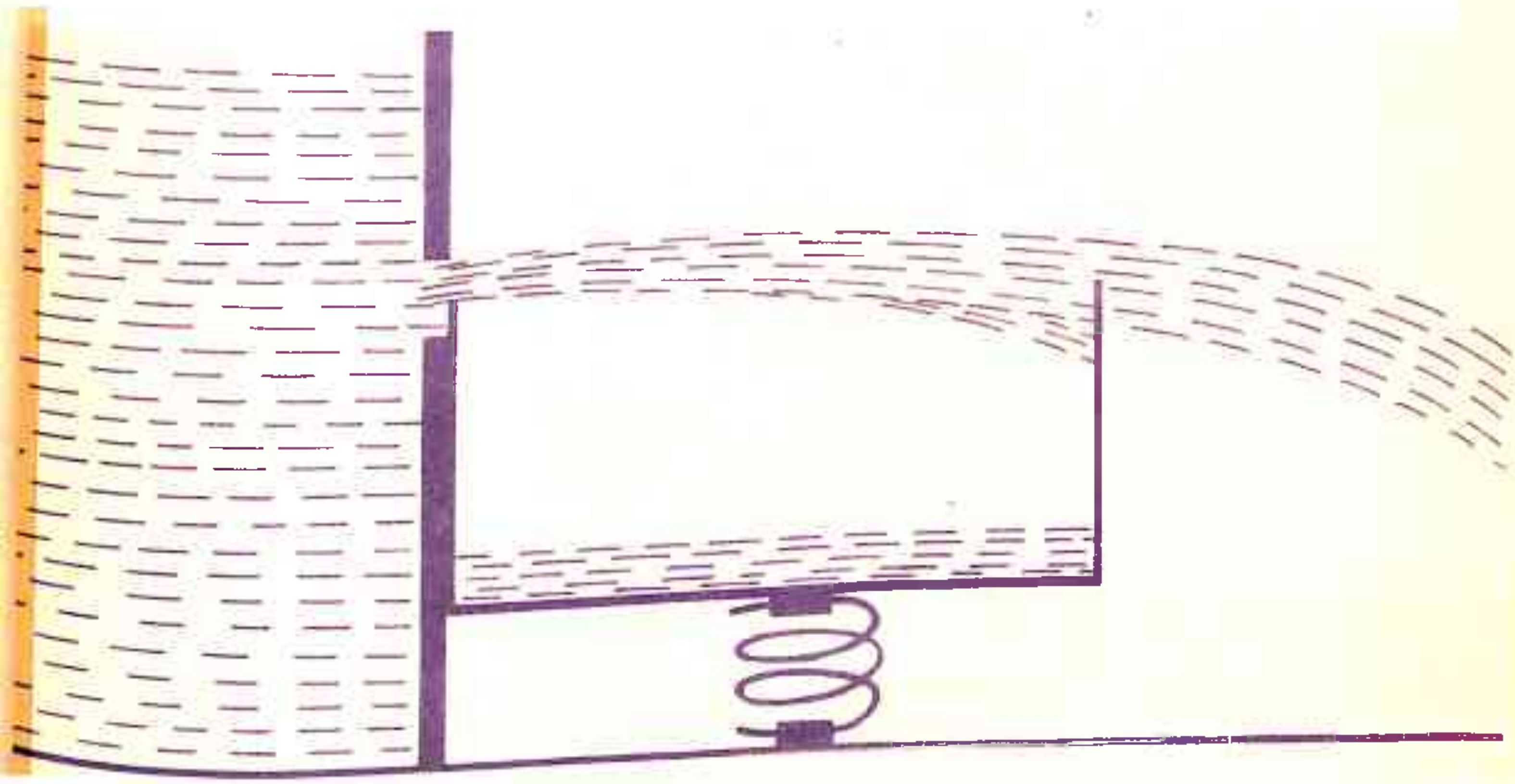
In order that there should be flow of liquid in the system, the level of liquid should be atleast above the slot. The rate of flow will depend on the 'head' of the liquid column, and, if the head is low, the flow is poor.

b) EXTRA BRILLIANT TEACHING

It is also observed in some cases that the teacher has had a brilliant academic career and has a good stock of information under high pressure. His rate of delivery of the subject is so high that the average students do not benefit by his teaching as shown below:



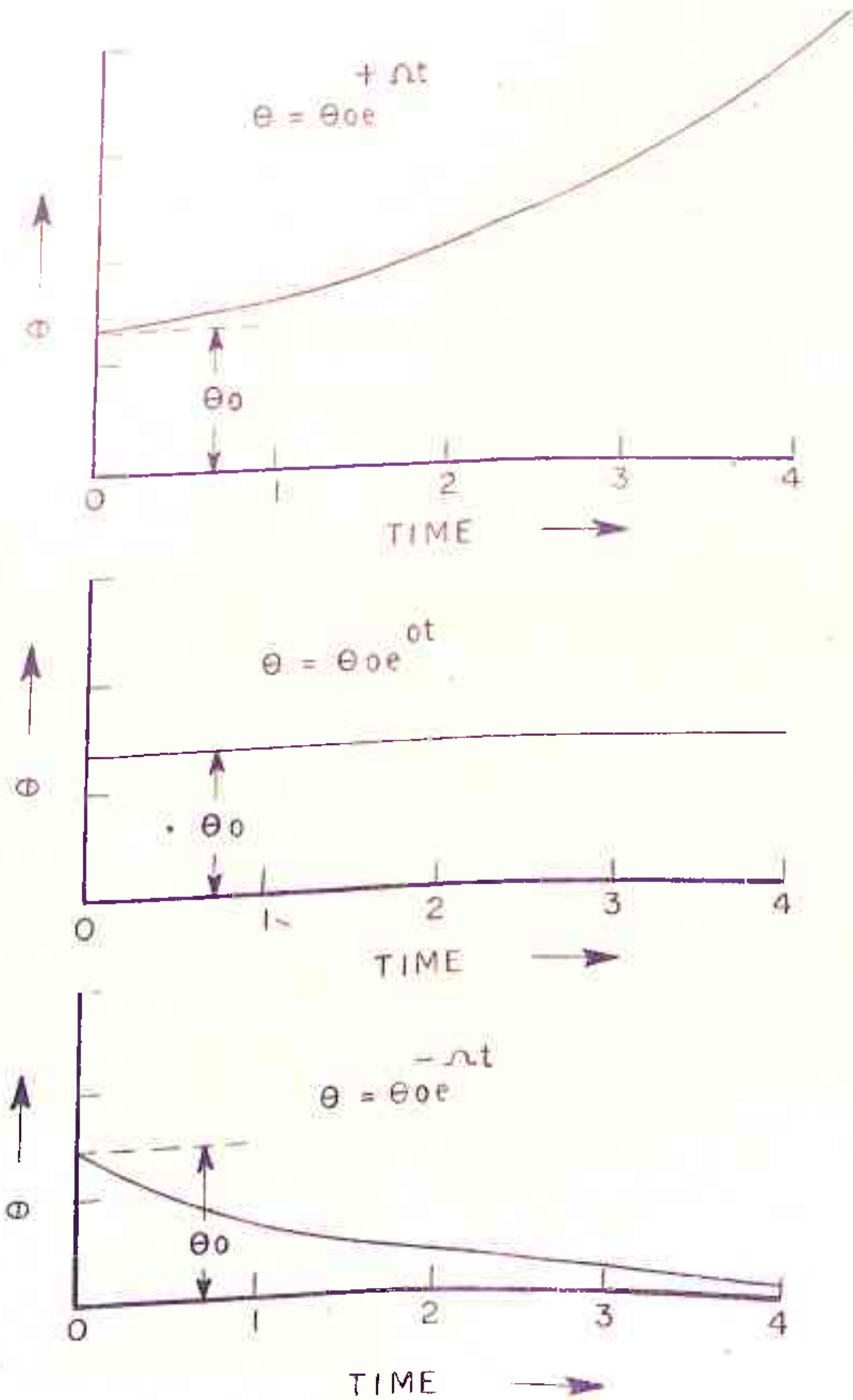
Whereas the above-average students can absorb some part (though small) of the material delivered by the teacher as shown below:



GRAPHICAL REPRESENTATION OF THE EXPONENTIAL FUNCTIONS

The general shapes of the exponential curves are shown below where Ω stands for $\alpha\gamma\delta\beta$. The three general cases are (1) Ω having a positive value, (2) Ω having zero or nearly zero value, and (3) Ω having a negative value.

GENERAL SHAPES OF EXPONENTIAL CURVES FOR +ve, 0 AND −ve VALUES OF Ω ($\Omega = \alpha \gamma S B$)



SCOPE OF THE APPLICATION OF THE MATHEMATICAL DERIVATIONS

The Mathematical Formulae derived representing the proficiencies in Functional English and in technology are reasonably dependable formulae, enabling prediction of the behaviour of an individual student, and possibly of a sample. The formulae enable the following evaluation and prediction :

(i) On the basis of the proficiency in technology (CGPA) for any two points on the time-scale, the exponential increment or decrement Ω and the initial proficiency in technology T_o can be determined.

(ii) If the proficiency 'T_n' in technology for a known period of time and the value of the exponent Ω are known, it is possible to predict the proficiency for any other point of time.

(iii) Although data for the behaviour in Functional English are not available, we may expect the interactive phenomenon to occur in/the students doing Make-up English programme which leads the student to the threshold proficiency.

(iv) The mathematical derivations do not account for the saturation phenomenon. Hence the formulae are applicable for the initial semesters only.

APPLICATION OF THE FORMULA (ILLUSTRATION)-INDIVIDUAL CASES

The general expression for the time-varying proficiency

$$T = T_o e^{\Omega t}$$

may be stated in the particular context where time 't' is measured in terms of semesters and proficiency expressed in terms of CGPA, thus

$$T_n = T_0 e^{-\Omega n}$$

where T_n is the proficiency at the end of the 'n'th semester and T_0 that at admission. If T_n is known for any two semesters of the progression curve, then ' Ω ' can be calculated thus:

if T_n and T_{n-p} are two CGPA's at intervals of ' p ' semesters, then

$$T_n = T_0 e^{-\Omega n} \quad \ldots\ldots 1$$

$$T_{n-p} = T_0 e^{-\Omega(n-p)} \quad \ldots\ldots 2$$

Equation 1 divided by equation 2 gives

$$\frac{T_n}{T_{n-p}} = e^{p\Omega}$$

that is, $p\Omega \log_{10} e = \log_{10} \frac{T_n}{T_{(n-p)}}$

$$\text{Therefore } \Omega = \frac{1}{p}\left\{\frac{\log_{10} T_n / T_{(n-p)}}{\log_{10} e}\right\}$$

$$= \frac{1}{p}\left\{\frac{1}{\cdot 4343}\right\}\left\{\log_{10} \frac{T_n}{T_{(n-p)}}\right\}$$

$$= \frac{2\cdot 303}{p}\left\{\log_{10} \frac{T_n}{T_{(n-p)}}\right\}$$

By substitution of the value of Ω in the general expression $T_n = T_0 e^{-\Omega n}$ the proficiency in terms of CGPA of a student for any other point of time (including at the time of admission) can be predicted.

Two cases of prediction of CGPA are illustrated below: (1) in the case of an increasing CGPA, and (2) in the case of a decreasing CGPA. The third case of level CGPA is not considered since the exponent here is zero. For convenience two initial CGPA's are considered in which cases n=2 and p=1. The expression is reduced to

$$\Omega = 2.303 \log_{10} \frac{T_2}{T_1}$$

The following table gives the data for the two cases:

I.D. No.	CGPA for semester I	II	III	IV
72XES040	7.00	7.18	7.22	7.43
72XES257	6.25	5.47	4.78	4.48

The actual values and the calculated values of CGPA are presented below:

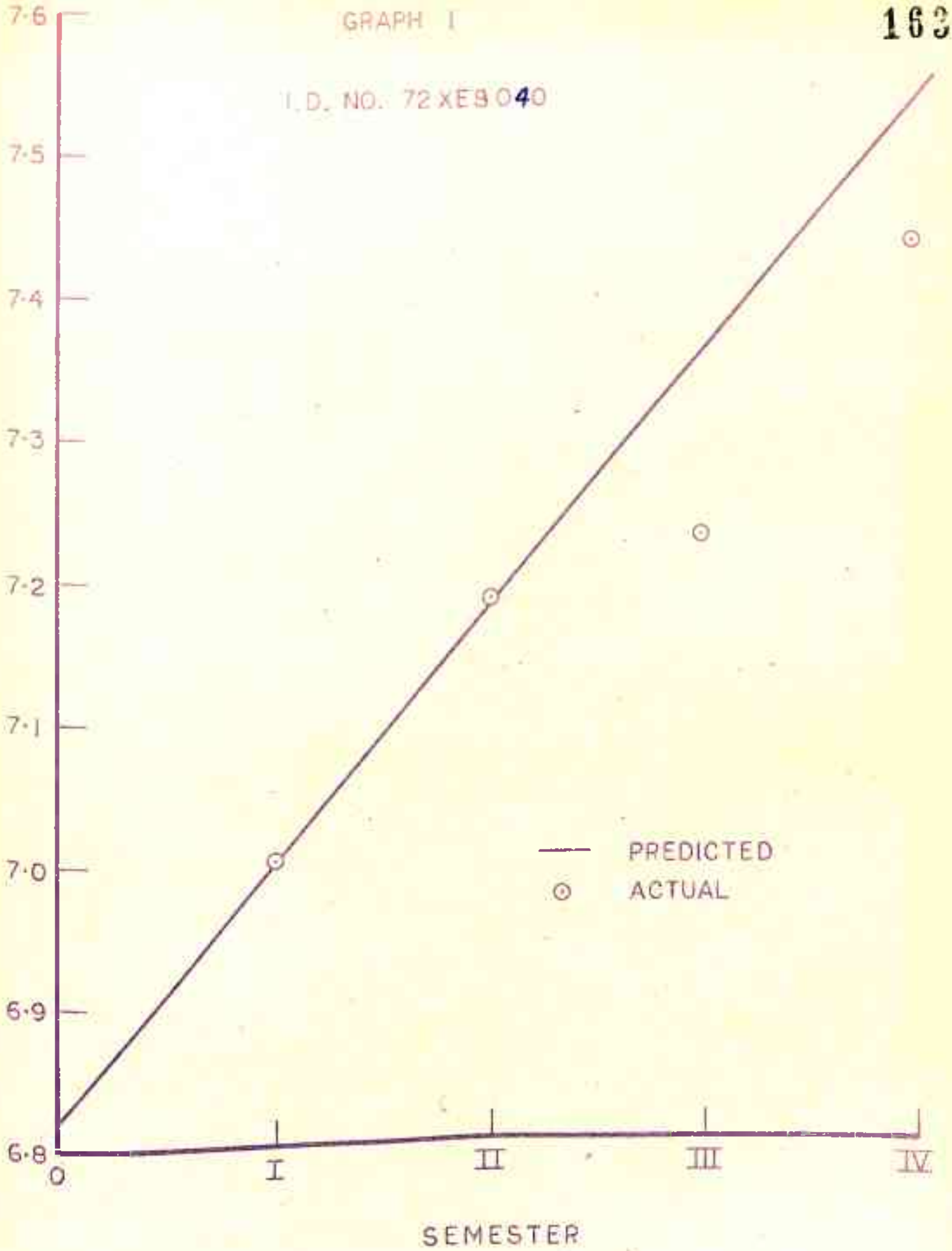
I.D.No.72XES040 Semester	Actual	Predicted	I.D. No.72XES257 Semester	Actual	Predicted
0	-	6.82	0	-	7.12
I	7.00*	7.00	I	6.25*	6.50
II	7.18	7.18	II	5.47	5.47
III	7.22	7.35	III	4.78	4.78
IV	7.43	7.53	IV	4.48	4.20

$$\Omega = 2.303 \log_{10} \frac{7.18}{7.00} = 0.025$$

$$\Omega = 2.303 \log_{10} \frac{5.47}{6.25} = -0.133$$

* Base for calculating other CGPA's.
'0' semester represents the time of admission.

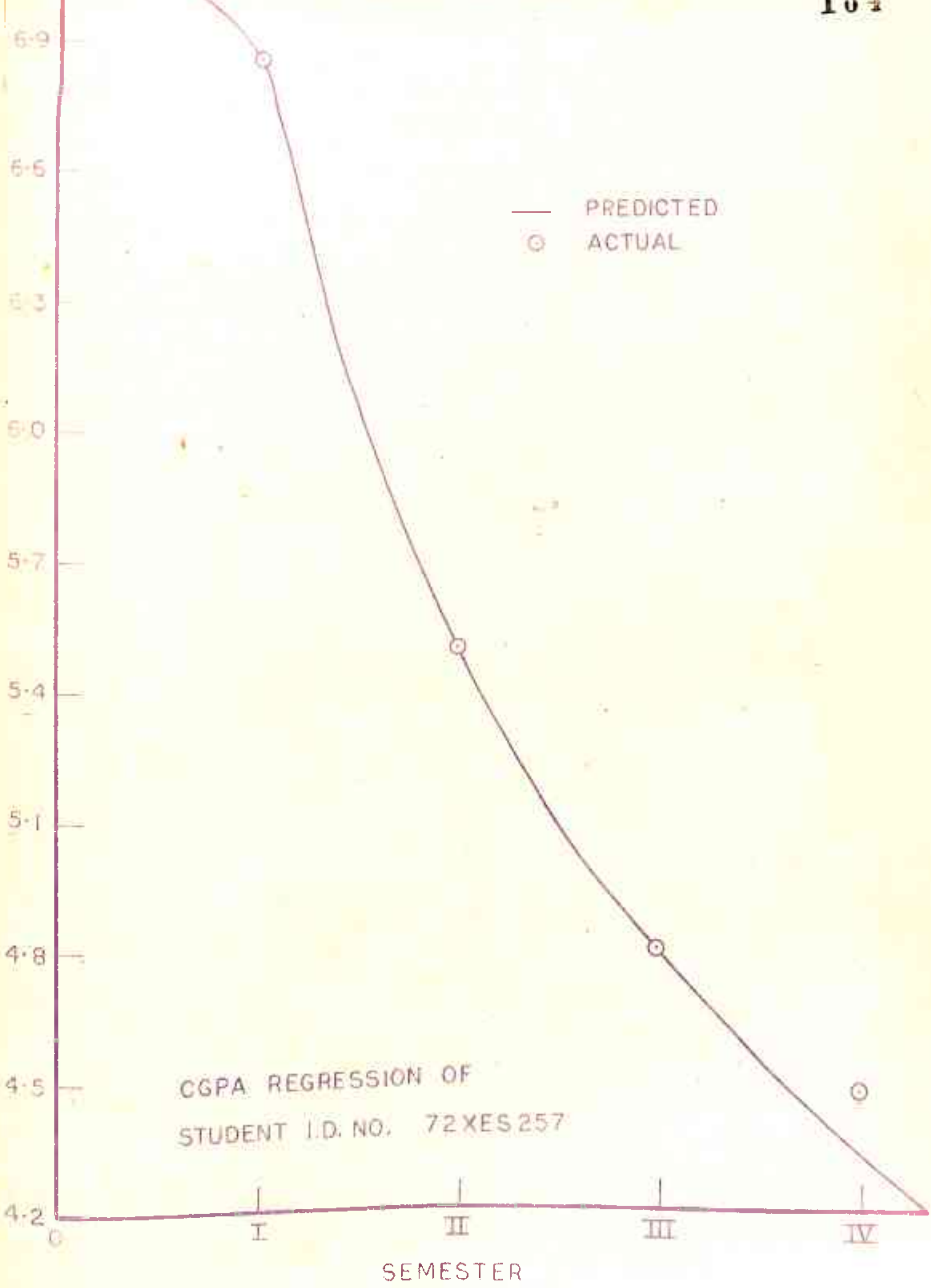
The agreement between the predicted values and the actual values in the two cases of (1) progression and (2) regression is presented by the graphs below.



CGPA PROGRESSION OF STUDENT I.D. NO. 72XES040

GRAPH 2

I.D. NO. 72XES257



APPLICATION OF THE FORMULA TO GROUPS OF STUDENTS

The exponent Ω is highly individualistic and discriminating. The components of Ω , namely, α , γ , δ , β , change vastly from individual to individual. Even in a large sample, it is rarely found that two students have the same or nearly the same value for Ω . If two students in a sample are to have the same value for Ω , the ratio of their proficiencies (CGPA) for the same period should be a constant. Expressed otherwise, Ω is the same for two students 'a' and 'b' if

$$\frac{T_{a0}}{T_{b0}} = \frac{T_{a1}}{T_{b1}} = \frac{T_{a2}}{T_{b2}} \cdots\cdots = \frac{T_{an}}{T_{bn}}$$

Further, even when two or a few students have the same value for Ω , their initial proficiencies may be different, thus giving two entirely different progression curves. Therefore, the prediction of performance of a group of students even with nearly the same Ω value has no practical bearing.

The exponent ' Ω ' being the same for both the equations representing the proficiency variations with respect to time, of technology and Functional English, in a given case, the value of Ω obtained from technological proficiency variation may advantageously be applied to Functional English proficiency variation. An illustration of this is not possible because (1) there is no Functional English programme offered at present, and (2) the correlation in the cases of non-Make-up English students is very low.

LOGISTIC CURVE:

It is seen that the acquisition of proficiency in technology where there is DIRECT and RETRO actions, is analogous to the liquid system already illustrated and the time-varying nature of the proficiency represented by an exponential function, valid for a few semesters only. Such an exponential function so far considered does not account for the saturating nature of the proficiency curve. If study is considered as a growth phenomenon, where the initial rate of change is rapid and exponential, and the rate of change declinesas time advances, it is appropriate to express the variation by the well known logistic curve. Such a curve which has the form of an expanded 'S' may be expressed in a general form in the technological realm as

$$\mathcal{T} = \frac{p}{1 + e^{a+bt}}$$

where a, b and p are constants in a particular case of a student. The maximum value 'p' which is the final technological proficiency attainable by a student may be predicted from his performance over a few semesters. However, such predicted proficiencies in a few cases computed do not show sufficient accuracy with the actual values, to be included in the present context.

CONCLUSION:

A characteristic of human beingsis that under defined conditions of learning stimuli, they will behave in a statistically predictable manner, although considerable variation is to be expected in individual behaviour from one person to the next. This statistical predictability is useful in learning something of man's responses to various stimuli; and the object of any mathematical analysis is to determine this. The mathematical derivations I have arrived at go beyond this group predictability-theyare able to predict individual behaviour with a great degree of certainty wherever there is the interaction.

The mathematical function $T_n = T_0 e^{-\lambda n}$ is not merely empirical but is valid and practical which has been substantiated in cases where there is the interaction of the DIRECT and RETRO-EFFECTS. In the absence of programmes in Functional English to produce the DIRECT EFFECT , the formula is seen to apply to the Make-up English cases, wherever there is that interaction of the DIRECT and RETRO effects.

Even if the study conducted applied to particular situations with extremely limited data which might be considered inadequate and not sufficiently randon, with many variables left uncontrolled, as my endeavour has not been to arrive at any absolute values but has been aimed at properly defining the problem of teaching and learning English in technological education, the results focussed by the dynamics of the interaction between proficiency in Functional English and proficiency in technology, are highly significant.

In conclusion I would like to point out that the mathematical derivations arrived at may require amendments in the light of (1) fresh data that would be available when Functional English programmes are offered to students, and (2) data to be collected of the proficiencies in Functional English and technology at all levels throughout the academic career of students.

Chapter VIII

PEDAGOGIC RELEVANCE

The analysis of the function of the instructional language in technological education has shown that it is the instrument for activating the mind for the study of technology. The mathematical interpretation of the dynamics of Functional English has substantiated the interaction between proficiency in Functional English and proficiency in technology. It follows therefrom that programmes in English, which have for their objective the definite aim of enabling students acquire linguistic proficiency INASMUCH AS IT IS THE LANGUAGE OF INSTRUCTION for technology, should be directed to Functional English. The implication is that those who do the programmes in English-Language Teaching for Technology (hereafter to be referred to as ELT for Technology) should be able to do their technological study decidedly better than those who do not do these programmes. The crux of the issue is therefore pedagogic.

Much work has been done in determining the nature and characteristics of English in science and technology (hereafter the term 'science' is used to include technology). The Russians pioneered the study of the English of science for a definite pragmatic purpose, namely, for automatic translation. The Institute of Precise Mechanics and Computing Technique and the Institute of Scientific Information of the U.S.S.R. Academy of Sciences, in its experiments made for translation of scientific and technical material from English into Russian, using the BESM Electronic computer of the U.S.S.R. Academy of Sciences, analysed (i) the structural peculiarities of technical English, (ii) the syntactical functions of the lexis ecomposing it, and (iii) the inter-relation of sentences in a text.[1] The orderly patterns in the language system in science and technology have been discovered and codified.

For pedagogic purpose, M.A.K. Halliday's 'Scientific Register'[2] heralded a decade-and-a-half of almost threadbare analysis of the English of science. C.H. Garwood and C.T. Leong of the University of London have examined the linguistic structures in Chemistry text-books and Physics text-books; their work project the grammatical structures and lexical items of most frequent occurrence in Chemistry and Physics. Descriptive linguists have identified and described the situationally differentiated language variety for the various situations and have pointed out the principal divergence between the technical or science register and that of the general register. J.R. Ewer of the

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1. AUTOMATIC TRANSLATION, D.Yu. Panov, Pergamon Press, New York, 1960.

2. THE LINGUISTIC SCIENCES AND LANGUAGE TEACHING, M.A.K. Halliday, Angus McIntosh, Peter Strevens, Longmans, Green and Co. Ltd., London, 1964.

University of Chile has studied the differences between the English of science and the English of the general situation, and has shown that the grammatical structures essential to basic scientific English are:

1. -ing forms replacing a relative
2. Infinitive as substitute for longer phrases
3. Words similar in form but with different meanings for the same function
4. Most prefixes and suffixes
5. Most structural and qualifying words and phrases
6. Compound nouns
7. Passives
8. Conditionals
9. Anomalous finites
10. Cause-and-result constructions
11. Words similar in form but with different functions
12. Past participle usage
13. The prepositional (two-part) verbs

A brief exposition of the description of the English of science, as accounted by various analysts, is undertaken here in order to provide the context for my views.*

CHARACTERISTICS OF ENGLISH OF SCIENCE

Scientific and technical texts have a number of special characteristics. The general characteristics are the following:

(1) A comparatively small number of words is used:- Russian scientists and technologists have established that a vocabulary of about a thousand words of a general nature

and another thousand words of a technical nature is sufficient to enable them to read American literature on scientific and technological subjects. They have shown that a vocabulary of only 952 English words is required to understand specialised mathematical texts as Milne's Numerical Solution of Differential Equations . An extract from it selected at random runs as follows:

"When a practical problem in science or technology permits mathematical formulation, the chances are rather good that it leads to one or more differential equations. This is true certainly of the vast category of problems associated with force and motion, so that whether we want to know the future path of Jupiter in the heavens or the path of an electron in an electron microscope we resort to differential equations. The same is true for the study of phenomena in continuous media, propagation of waves, flow of heat, diffusion, static or dynamic electricity, etc., except that we here deal with partial differential equations."[1]

(2) The number of possible meanings for words with multiple connotation is considerably reduced:-

For instance: <u>BAY</u> (i) Kind of tree or shrub with leaves that are spicy when crushed.

(ii) part of the sea, or of a large lake, enclosed by a wide curve of the shore.

(iii) (a) compartment between columns and pillars that divide a building into regular parts;

(b) extension of a room beyond the line of one or two

1. AUTOMATIC TRANSLATION, D. Yu. Panov, Pergamon Press, New York, 1960, p. 27.

of its walls; recess;

(c) side-line and platform in a railway station, used as a starting-point and terminus for trains, separate from the main lines;

(d) compartment in the fuselage of an aircraft.

(iv) deep bark, esp. of hounds while hunting.

(v) reddish-brown horse.

For technical purpose the connotation is reduced to two meanings:

(i) (Building) Any division or compartment of an arcade, roof, building, etc.

(ii) (Electrical Communication) - A row of racks on which is mounted a multiplicity of apparatus.

(3) The structure of the sentence is simpler than in other forms of writing; in all the scientific and technical material that I have studied, I had not come across a single instance of a structure using 'No sooner.......... than.........' or of a structure with a question-tag. It is simpler not in the sense the sentences are simple sentences. Very often the sentences are complex structures embodying six to ten subordinate clauses.

(4) The order of the words in the sentence is more standardised than in colloquial speech or literary prose.

(5) Introductory phrases like

'It may be said that.....'

'It might be stated that ....'

'It may be borne in mind that.......'

etc., do not occur in technical material.

(6)(a) Adverbs such as 'very', 'perfectly', do not occur. The over-emphasis suggested by these words raises a doubt.

(b) Adverbial connectives as 'however', 'therefore', 'nevertheless', 'moreover', are used sparingly.

(7) Qualifying words and phrases like, 'somewhat', 'on the whole', 'be this as it may', 'more or less', are excluded from technical language. It is said that these qualifying words and phrases are used by the British to disarm criticism.

(8) The same word is used or named over and over again for the purpose of clarity, rather than be replaced by words as 'the latter', 'it', etc. For example: "A solute that lowers the surface-tension of a liquid concentrates at the surface of the solution, but this process of concentration, called adsorption, takes a certain definite time to reach its full value. Now, if a film of the solution is stretched, a new surface is produced and this new surface at the moment of production po-

ssesses greater surface-tension than the rest of the surface, because the surface adsorption has not had time to reach its full value." The word 'surface' occurs seven times, and yet it does not sound a superfluous repetition.

(9) The use of the indefinite pronoun 'one' does not often arise in technical material; and the pronoun 'we' hardly ever is used.

(10) The numerous proposition- verbs, which form an essential part of the English language are used sparingly.

(11) Hyphenated compound words are used in a large number: as iron-furnace as opposed to iron furnace, paper-mill as opposed to paper mill, melting-point as opposed to melting point, etc.

(12) The split infinitive is sparingly used.

(13) In technical literature words of Latin and Greek origin abound.

SYNTACTICAL CHARACTERISTICS

PASSIVE CONSTRUCTION:

In scientific and technological exposition, WHAT is being done or has been done is stated and not WHO is doing or has done something. As these expositions talk or write about things and processes rather than about persons and their actions, impersonal sentences with passive verbs are generally used, except (1) when reference is drawn to particular scientists as :Einstein formulated the theory of relativity, and when instructions are given for a process or a procedure as :Remove the slide from your microscope and replace it by a transparent ruler with I mm graduations. Now measure the width of the field of view of the microscope.

The agent or doer or the person who performed the action is mentioned only in the following instances:

(1) Means, methods, ways of doing things.

(a) The reaction is accelerated by means of a catalyst.

(b) Electricity is transmitted by means of wires.

(2) Animals, plants, substances.

(a) Water is absorbed by the plant through its roots.

(b) The turbines are driven by high-pressure steam.

(3) Organisations, collections of people.

(a) Large quantities of oil fuel are used by modern industry.

(b) Weather reports are prepared by the Meteorological Office.

(4) Natural processes.

(a) The growth was affected by radiation.

(b) The failure of the pipe was caused by corrosion.

(5) Causal actions and processes.

(a) A condensation trail is caused by the passage of a particle through the supersaturated water vapour.

(b) The electrically charged plates are discharged by connecting them to earth by means of the earthing switch.

The infinitives used are generally in the passive form as:

(a) The polymer needs to be re-heated.

(b) This lathe was designed to be operated manually.

SIMPLE PRESENT TENSE:

In the English of science the simple present tense forms are predominant. They indicate permanent validity. For science deals with laws which are universally true, or phenomena which are true at all times and in all places as: Metals expand when heated and contract when cooled.

Equations and formulae when spoken, are read in the simple present tense. When universal statements are introduced by particular statements expressed in the past or future, the universal statements are expressed in the simple present tense as : Newton found that white light is composite.

Events are reported in the simple present tense because processes described always happen in the same regular way. Regular processes or events are described as though they were permanently or universally true.

C.H. Garwood, in his article THE TEACHING OF ENGLISH TO THE NON-ENGLISH-SPEAKING TECHNICAL STUDENT[1], has illustrated how the simple present tense form of the verb which is predominant in science texts, appears to indicate permanent

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1. ENGLISH LANGUAGE TEACHING, Volume XXIV, No.3, May 1970, Oxford University Press, p.248.

validity. He says:

"The modal forms of the verb are particularly frequent throughout the texts–may and can are frequent in scientific description to state physical capabilities: e.g. solid argon can crystallise/temporarily hard water may be softened by boiling. In theory work may and can often point to the possibility of the interpretation we may assume/it can be stated that...../This may have happened because the acid was used up too quickly.

Prediction of events is an essential part of science studies and the modal will is commonly used, as in water will enter or there will be an explosion.

Should, must, need not are used to indicate ideal requirement, warnings, necessity, or lack of necessity: e.g. the tube should be clean and dry/we must add the acid carefully/you must not touch it/this must be true/we need not use all the acid.

Statements of conditions and circumstances rely very often on subordinate clauses–chiefly if- and when-clauses: if the temperature rises more than two degrees the ice will melt/if the apparatus leaks, we must repair it/when the acid enters, it reacts with the mixture.

Explanations, purposes, and results are often shown by because (since, for) and so that clauses: We know it is carbon dioxide because the limewater turns milky./ The clip is closed so that the apparatus will function properly.

Hypothetical reasoning requires the use of special sequences of tense usually employing the 'past' forms of modals: e.g. If this were done, the sodium nitrate would be removed in solution./A solution could have been used for this purpose, if we had preferred it./A tremendous number of calories would have been used, if these quantities had been used.

Particularly we see the usefulness of such structures in theory and calculation work. In such work again we often meet the use of modal structure <u>must have</u>, indicating inevitable conclusion: it must have been a chemical reaction."

THE INFINITIVE TO EXPRESS PURPOSE OR FUNCTION

The purpose of an operation or process is expressed by using a phrase with infinitive or the verb as:

(a) The distillation of crude oil is carried out to separate a number of fractions.(purpose)

(b) An automatic safety valve is inserted in the feed-pipe to the still to cut off the flow of oil to the still if the rate of flow exceeds the normal operating rate.(function)

The passive infinitive is also used as:

This engine has been designed to be run at high speed.

Sometimes 'in order to' is used instead of 'to' alone as.

The steam pipes are completely insulated in order to reduce heat losses.

SHORTENING OF CLAUSES:

In order to be concise clauses are shortened in a number of ways:

(1) by using the appropriate participle as;

(a) 'Information which is received by the teleprinter is in the form of a five-figure code' is shortened to 'Information received by the teleprinter is in the form of a five-figure code.'

(b) 'The depression is causing the rain which has been reported in this area' is shortened to 'The depression is causing the rain reported in this area.'

USE OF 'AS' AND 'SINCE'

(1) 'As' and 'Since' are used to explain a cause as:

(a) As platinum is too expensive, silver is used.

(b) The metal is coated with silicone since silicone repels water.

(2) 'As' is used to refer to the time when something happens, or while something is happening as:

(a) As (when) the steam reaches this pressure, the valve is opened.

(b) As (while) the plastics pipe passes through the bath, it is cooled.

(3) 'Since' is used to refer to the time after which something has happened as:

Communication has become faster since the invention of the telephone. ~~was invented.~~

(4) 'As' is used with a past participle in a phrase which modifies a noun as:

The process, as originally developed, was a failure.

(5) 'As' is used with a noun in a phrase which modifies another noun as:

Pressure is expressed as kilograms per square centimetre.

(6) 'As' is used with a noun/pronoun after the word 'such' which modifies a previous noun as:

Some metals, such as tungsten and iridium, have very high melting points.

USE OF 'IF'

Statements expressing a condition and a logical consequence of the condition which state hypotheses, common in mathematics and in theoretical science use 'if' and 'then' after the condition(s) indicating the beginning of the consequence. When 'then' is omitted, the conditional clause follows the clause stating consequence as:

(a) If its temperature is raised, the pressure of the gas will increase.

(b) The pressure of the gas will increase if its temperature is raised.

In considering the result of an imagined action, the conditional clause precedes the clause stating the imagined action as:

If the solutions were mixed, a white precipitate would be formed.

In expressing hypotheses, if the consequence of the imagined action is certain, 'would' is used in the clause stating consequence as:

If the nerves were cut, no response would be observed.

If the consequence of the imagined action is uncertain, 'might' is used in the clause stating consequence.

When the truth of the condition is in doubt, 'should' is used in the clause stating consequence as:

If the food is sterile, there should be no trace of bacteria in this can.

MODIFIERS

NOUNS AS MODIFIERS

In the English of science modifiers and determiners are mostly nouns.

Modifying nouns are used:

(1) to indicate the substance of which something is made-

(a) paraffin wax - a wax consisting of heavy paraffin

(b) a bitumen surface - a surface made of bitumen

(c) a gas turbine - a turbine driven by gas

(d) turbine gas - gas which drives the turbine

(2) to indicate the purpose for which something is used-

(a) fuel oil - oil which can be used as a fuel

(b) a research laboratory - a laboratory used for research

(3) to indicate the object of which something is a part-

(a) the cylinder head - the head of the cylinder

(b) battery terminals - the terminals of the battery

(c) the turbine rotors - the rotors of the turbine

(4) to indicate, when the modified noun refers to an action, the object of the action-

(a) oil consumption - the consumption of oil

(b) wheat production - the production of wheat

(c) electricity generation - the generation of electricity

HYPHENATED MODIFIERS

A number of nouns and adjectives are often used in sequence to modify the final noun. Hyphens are used to join the words which are most closely related-

(a) a diesel-powered electricity generating station-a station which generates electricity and which is powered by diesel engines.

(b) soild-state physics - the physics of the solid state

(c) high-energy particles - particles of high energy

(d) a small-car-factory - a factory for making small cars and not a small factory for making cars

(e) a heavy-oil storage tank - a storage tank for heavy oil and not a heavy tank which stores oil

ADVERB MODIFIERS

Adverbs are often used in groups of modifiers-

(a) a securely anchored cable - a cable which is anchored securely

(b) conveniently situated oil refineries - oil refineries which are situated in convenient places

PROPER NAMES AS DETERMINERS

(1) Names of people are often used as modifiers-

(a) a Bessemer converter - a converter of the type developed by Bessemer

(b) the Kelvin scale - the scale invented by Kelvin

(c) the Compton effect - the effect discovered by Compton

(d) the Bohr atom - the atomic structure proposed by Bohr

In short technical language depends not so much upon a large vocabulary as upon the choice of words. There is only one noun that can express the idea, only one verb that can set that idea in motion, and only one adjective that is the proper determiner for that noun. Verbosity is a sign either of carelessness or of lack of time for care. It reminds of what Pliny wrote to a friend (1900 years ago) "I have not time to write you a short letter, therefore I have written you a long one".[1]

The latest data-processing devices developed primarily for analysis of scientific and technical literature used in IBM- (International Business Machines Corporation Electronic Computer No.705) is facilitating (i) Machine-analyses and indexing down to the simplest meaningful elements of any text, (ii) identification of the location of each word and its relationship with associated words, phrases, paragraphs and thoughts, (iii) determination of the frequency and structure of certain ideas and situation patterns, (iv) study of the several categories under which the elements of an expressed sequence of human thought is grouped, classified and described under the two major areas:-

1. Indexes and concordances of words, and
2. Literary statistics.

The machine-searching application initiating a new era of language engineering will soon provide us with an exhaustive description of the English language as it

1. TECHNICAL WRITING, T.A.Rickard, John Wiley and Sons, Inc., New York, 1947, p. 24.

exists in scientific and technical literature.

Such searching analysis of the language of science is necessary for the pragmatic purpose for which it began. But, for pedagogic purpose, a description of the language as it exists in scientific and technical texts, which exposes the static properties of the language in use in science, does not indicate the dynamic function of the language of science.

LIMITATIONS OF THE ENGLISH-THROUGH-SCIENCE APPROACH

Scientific material projecting the characteristics of the English of science is being recommended for teaching English to non-English speaking students of technology. Text books and work-books designed on science-based material are being increasingly used for English-language teaching in technological education in India. The promoters of English-through-science approach claim that they are teaching language and science, and maintain that the approach has for its principal object (1) the teaching of language functional in science, and for its specific object (2) the teaching of the linguistic framework and the vocabulary of science.

The approach to English-language teaching through science, in the first place, presupposes that language plays an auxiliary role in science or technological education, that is, language is used primarily to receive knowledge and information, and secondarily to convey information related to the major scientific studies. That this is a mistaken premise has already been discussed.* Secondly, the English-through-science approach is based on the hypothesis that it is possible to teach language severed from its content. (I use 'content' to mean the thought-content in a linguistic framework .) C.H.Garwood avers that the English language instructor can teach useful language framework "without worrying unduly about the complexities of technical vocabulary"[1] and content.

In his article ENGLISH TO THE NON-ENGLISH-SPEAKING STUDENT Garwood feels that the most obvious difficulty for the English-instructor is that of technical vocabulary because "No specialised vocabulary has precise and particular limits of meaning and the English teacher may fear to trespass where he is not sure of his ground."[2] The obvious difficulty is technical vocabulary no doubt but it is not because specialised vocabulary has "no precise and particular limits of meaning". If specialised vocabulary has "precise and particular limits of meaning", it is in science and technology. For example, in describing the earth, the scientist says 'it is an oblate spheroid'. The special terms 'oblate spheroid' have precise and particular limits of meaning, namely, slighly flattened at the poles, something like an orange, and nothing more and nothing less. The specialised vocabulary has a definite semantic content.

Garwood is of the opinion that if the structured patterns of words in use in the textbooks of science and techno-

* pages 131 — 135.

1. THE TEACHING OF ENGLISH TO THE NON-ENGLISH-SPEAKING TECHNICAL STUDENT, ENGLISH LANGUAGE TEACHING, Vol. XXIV, No. 2, Jan. 1970, p. 109.
2. ibid.

logy and in use in the lectures of an instructor are identified and correlated with varying kinds of situation in technical studies, then the English teacher may find himself able to teach useful language skills without worrying unduly about the complexities of technical vocabulary. I suggest that such linguistic frameworks can be found and that they do correlate with easily identified situations; and further that they can be graded according to the degree of language skill demanded in handling them: that they can be taught to the foreign learner with considerable advantage in removing language-learning burdens."[1] The identifiable "linguistic frameworks" cannot be correlated with varying kinds of situation in technical studies unless (a) the concept in the linguistic framework is understood by the learner and (b) the semantic content of the technical vocabulary used is comprehended by the English instructor. If he does not worry about the semantic content of the technical vocabulary, he does more harm than good, besides damaging his reputation.

Language though regarded as merely a convenient device for communicating pre-existing ideas or attitudes, is the vehicle of thinking itself. It is the basis for the thought process. Thoughts are forged in language. It is the medium for the mind to function, for the cognitive capacity. The human imagination depends on language which is a configuration in the mind of abstract symbols. The symbol is the tool which gives man his power, and it is the same tool whether the symbols are images or words or mathematical signs.

1. THE TEACHING OF ENGLISH TO THE NON-ENGLISH-SPEAKING TECHNICAL STUDENT, ENGLISH LANGUAGE TEACHING, Vol. XXIV, No. 2, Jan. 1970, p. 109.

The symbols are the configurations under which the mind gathers many particulars into one name or label. Concepts coded by single words function, in the linguists' jargon, as linguistic categorisation of experience.[1] Yet, words or labels in themselves do not assume a syntactical structuring; it is idea that determines the architectural ordering of the language material to give it a form. It is idea that binds the assorted words, fits the word that belongs to the thing described, places the word in its right position. It is idea that originates a sequence of words and sentences. If the thought is consecutive, it will place the sentences in such order that the succession of ideas leads naturally to a definite conclusion. Hence, the logical grouping of ideas conduces to clarity of expression.

Content-language relationship is analogous to mass-weight relationship. Just as weight cannot exist without mass, language does not exist without content; just as mass can exist without weight under certain conditions, even so can content exist without language under certain conditions. The common experience of everyone wanting to express some idea but being unable to find a satisfactory way to put it into words proves that thought without language is not impossible. The practical implication of this relationship is that if the learner has conceived of a concept through the functional language, he inherently acquires the linguistic ability to express that concept in it. If learners have diffi-

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1. LANGUAGE AND ITS STRUCTURE, Ronald W.Langacker, Harcourt, Brace and World, Inc., New York.

culty with the management of language for expressive acts, it is because the idea or the concept has not been correctly conceived. In other words, if the idea is correctly conceived, the linguistic framework in which the idea is to be set is suggested by the idea itself although it is possible to have linguistically correct framework with incorrect idea.

Experience supported by tests conducted for determining areas of difficulty for students pursuing technological education show that the difficulty experienced by students of technology in India is not so much due to linguistic deficiency or insufficiency as to ideational deficiency or insufficiency. A sample question of the test with student-responses analysed for language correctness and content correctness is illustrated below.

Question: "Probably the first alloy that was made was bronze, made of copper blended with about one part in ten of tin." What is bronze made of?
Answer the question from the information given in the above text.

TABLE

ANALYSIS OF STUDENT-RESPONSES

Total number of responses	384	
Number of correct responses	137	35.7%
Responses linguistically incorrect but content correct	64	16.6%
Responses linguistically correct but content incorrect	183	47.7%

Samples of answers made in the same linguistic framework are listed below:

1-Bronze is made of one-tenth of copper and nine-tenths of tin.

2-Bronze is made of nine-tenths of copper and one-tenth of tin.

3-Bronze is made of copper and one-tenth of tin.

4-Bronze is made of one part of copper and one-tenth of tin.

5-Bronze is made of nine parts of copper and one part of tin.

6-Bronze is made of one part of copper and nine parts of tin.

7-Bronze is made of one part of copper and one part in ten of tin.

8-Bronze is made of one part of tin and one part in ten of copper.

9-Bronze is made of one part of copper and ten parts of tin.

10-Bronze is made of ten parts of copper and one part of tin.

The analysis raises the following questions:

(1) Should the English-language teacher accept linguistically correct responses which are incorrect in content?

(2) Is the English-language teacher justified in claiming that his job is only to teach the language and not to teach science?

(1) If the English-language teacher accepts linguistically correct responses which are incorrect in content, he only strengthens the misconception of those who do not have the correct concept while exposing his ignorance to those who have, at the cost of his pedagogic function.

(2) The English-language teacher's claim that his job is only to teach the language and not to teach science is, I

think, not tenable because the ability to recognise and understand the mechanics of the language in use is not sufficient in itself. It is not independent of the perceptual and conceptual function. The recognition of the linguistic framework has to serve as instrument to grasp the thought-content.

Apart from the jeopardizing effect of the English through-science approach to students of science and technology, the scientific material adapted or edited for the purpose of serving as linguistic framework, obviously by non-scientific English-language experts, suffers from unpardonable technical inaccuracies. One such material chosen by the author "from works dealing with various aspects of engineering and technology and rendered into an English suitable for students whose knowledge of language was initially fairly elementary" is critically examined below, which is done solely for the purpose of substantiating my criticism. The text is ENGLISH FOR ENGINEERS by Clive Brasnett (Methuen Educational Ltd., London, 1968). Two passages have been studied. The lines of each passage are numbered for easy reference.

COMMUNICATIONS, Sections 1 and 2 (pages 9 to 17)

The text does not systematically expose the content. Neither is it a historical account. A novice can understand neither the basic principle nor the practical implication of telegraphy by reading the passage.

SECTION 1

(1) The author has provided a glossary of words and phrases

immediately after the passage in which they have occured, and the explanations given are stated to be contextual. The word 'connected' listed in the glossary is explained as 'joined'. The word 'connected' means 'joined' in line 62 but not in line 9. The word 'connected' is a wrong word to use in this context when 'connected' is explained as 'joined'.

(2) In lines 15 and 16 it is stated that 'the wire must be a magnet too'. This statement gives the impression that a wire is a permanent magnet.

(a) A wire is not a magnet at all. Only a magnetic field is produced about a wire when an electric current passes through it.

(b) A piece of iron also can "make a needle of a compass move by putting it near" due to force of attraction; while the piece of iron has no magnetic field of itself. Therefore it could be stated that THE WIRE MUST BE A PIECE OF IRON TOO.

SECTION 2

(3) In lines 4 and 5, it is stated that by operation of a key an 'electrical impulse' could be sent through the circuit. In all electric circuits a sudden flow of current is called a current pulse and not an 'electrical impulse'. An impulse is a pulse with impact.

(4) In Figure 2 there is a technical flaw in showing the polarity in the reverse order. Electricity flows from the positive pole to the negative pole in the external circuit. The polarity should be reversed in the diagram or the words 'wire' and 'earth' should be interchanged in lines 7 and 8. Besides, there is a language flaw in the use of the word 'back' suggesting that the current reverses to the battery

through the earth.

(5) The word 'buzzer' in line 10 is rightly explained in the glossary as an instrument that makes a noise like the noise 'buzz' made by a bee, but the telegraphic receiver does not make the sound of buzzing but makes a squeaking tick-tick sound, and it is technically called a 'sounder'.

(6) The verb 'are' in line 34 is grammatically incorrect. It should be 'have'.

(7) Lines 37 and 38 convey the idea that a message typed by a typewriter can be transmitted over a telegraph circuit.

(8) The word 'highest' in line 67 should be 'higher'.

(9) The explanation given for 'a paper tape' in the glossary is insufficient. The word 'long' should also be incorporated in the explanation; only then the idea of 'tape' is conveyed.

(10) The explanation given for 'reverses' raises the question 'on what'. It should be 'backward'.

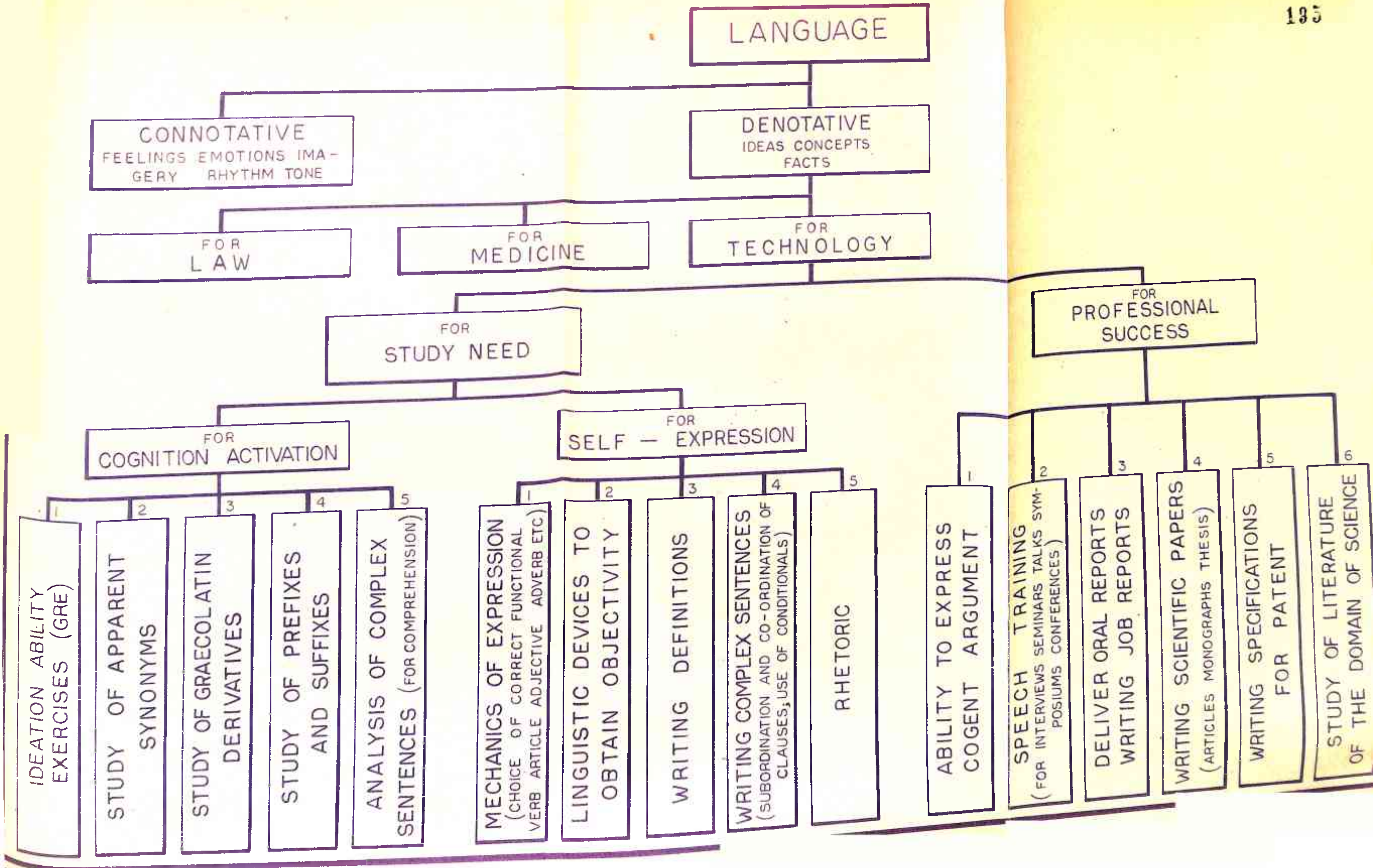
Even if the aim is to teach language and not to teach science or engineering, as long as the material chosen for teaching the language is technical, that technical material should be authentic and there should be no technical fallacy.

Chapter IX

ELT FOR TECHNOLOGY

Confusion exists in defining the object and determining the content of English-language teaching to students of science and technology in non-English speaking countries because a distinction is not made between English-language teaching for technology and study of English literature. The analysis of the syllabi of the ELT programmes offered in institutions of engineering and technology in India has already substantiated the existence of the confusion. M.Macmillan of the British Council, in his article 'TEACHING ENGLISH TO SCIENTISTS OF OTHER LANGUAGES' has rightly observed that English literature has no place in the curriculum of technological education in non-English speaking countries. However, I do not fully agree with his reason for excluding the study of literature from the curriculum in technological education in India. Mr. Macmillan thinks that it is beyond the linguistic capability of Indian students to appreciate and profitably study English literature. The ability of students both to understand and appreciate English literature is evidenced from a sample survey conducted at the Birla Institute of Technology and Science, Pilani. Of students

COMPONENTS OF LANGUAGE FOR TECHNOLOGY



of technology who took up a second level course in Poetry, 82.8% of students whose Cummulative Grade Point Average is between 8 and 10 scored 'A' grade in the poetry course. The impact of the course on their sensibility has been expressed in such terms as:

1. "I don't feel stagnant any longer."

2. "It leaves your mind full of interpretations to the point when you do not know which is the correct one."

3. "The course in Poetry has maintained a balance between my technical side and my humanitarian side with the emotional outpourings of man. It shows that inspite of leading such a mechanised life man yet is basically human and cannot be over-powered by machines. R.S.Thomas in his poems conveys the same message as Wordsworth. The poetry course keeps me from becoming a machine. It also exposes me to the soaring heights man's mind has reached and reminds me of the fact that to live successfully does not mean to live with or for machines. It has widened my knowledge and has shown how less it is."

4. "Though I was not a potential hater of poetry previously, I was not very much interested in poetry. But now, when I am only half way through this course, I find more pleasure in reading poetry and extracting its meaning."

5. "We are now possessed with a mind that looks at and appreciates the beauty that this materialistic world offers to us."

6. "The course satisfies a sort of hunger and thirst

in our soul and spirit. We are at a stage when we need to do such courses. Such courses in a way help us to develop the sense of humanity. Working on a machine always and being ignorant about the world around more often than not is likely to make a man himself a living machine without any emotions and sentiments. A man of this kind I feel is worse than a dead machine."

7. "The course provided a much needed relief from the lifelessness of the technical subjects."

8. "Poetry is meant to be read for enjoyment and not for dissection. Poetry is often torn apart limb from limb, its entrails pulled out ruthlessly and every little word twisted and turned mercilessly- and all in the name of interpreting it, reading between the lines and trying to show a non-existent symbolism."

Moreover, that Indian students of technology do wish to take up the study of English literature is fully borne out by the fact that a great many of them offer English literature as a free elective.

In technological education in India study of English literature has a place, as any other literature, for its humanising value, for bridging the gap between C.P.Snow's two cultures, and for making the technologist more a man and less a machine. This is realised by students themselves.

However, it is necessary to make a distinction between the study of English literature of the connotative domain and the study of English language for its functional usage in technology. Peter Coleman and Ken Brambleby of the British Columbia Institute of Technology have, in unmistakable terms, stated that "one fundamental cause of the obvious weakness in students' ability to communicate is the fact that the teaching of writing in the past has always been closely associated with the teaching of literature. Students are required to write the familiar essay, that is, to handle extremely subjective and abstract data quite early in their training in writing. This is equivalent to asking students to handle computations involving complex numbers before they are confident and competent in handling real numbers."[1] What was said of their 'past' is true of our present.

To serve as medium of instruction the object of teaching the language is entirely different from the object of teaching literature of that language.

Literature of a language belongs to the connotative stratum where the language employs word music, imagery, metaphor, symbolism. The writer in the connotative stratum "makes cunning use of understatement, overstatement, oblique statement, play on words, startling juxtaposition. He introduces into his descriptive passages sundry significant small details with the sole purpose of stimulating the visual imagination. By the use of evocative allusion he creates a desired mood; he plays on the reader's feelings. He masters a hundred subtle means to pile into a few sentences far more meaning than they might be expected to bear.

1. THE TECHNOLOGIST AS WRITER, Peter Coleman, Ken Brambleby, McGraw-Hill Book Company, New York, 1969, p.ix.

He sometimes refrains on purpose from being explicit. Instead of drawing inferences he leaves the reader to do so. By all kinds of artful device he arouses the expectancy of one thing, only to surprise, dramatically, with something else."[1]

In the denotative stratum of language to which the language of technology belongs, there is no word music, no imagery; metaphor proves misleading, "understatement, overstatement, oblique statement are all out of place; they are all the same thing as mis-statement. Anything that might create a mood would only spoil the reader's receptivity to facts and logic. Words must not be made to carry either more or less meaning than they do in common usage. If any expectancy is aroused it is usually a mistake to disappoint it; to do so deflects attention."[2] The technical writer appeals to men's minds. "As he writes he confers on the words the power to make those who read him think as he wills it"[3]

The role of English as a subject of study is different from its role as a medium of instruction of technology. Therefore its study as a language of culture and literature has objectives different from its study as instructional language of technology.

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1. THE PRESENTATION OF TECHNICAL INFORMATION, R.O. Kapp, Constable, London, 1973, p.26.
2. Ibid., p.27.
3. Ibid.

ELT for technology has to serve the object of enabling students acquire linguistic proficiency INASMUCH AS IT IS THE LANGUAGE OF INSTRUCTION OF TECHNOLOGY, with the implication that the students thus enabled would do their technological study decidedly better. It has to be related to the precise needs of technological study, as yet another component of technological education. The precise needs of the language of instruction for technological study are primarily heuristic, that is, understanding the data, the arguments based on the data and the order in which the premises lead to the conclusion by the exercise of the various mental processes so that the student is set to find out things for himself; this means that the language has to serve as instrument of thought, which it can do only by provoking the numerous mental operations for perceptual and conceptual functions. The need is cognitive activation. The second need is to serve as instrument of ~~self~~-expression for communication, for expressing a scheme of ideas, for transmitting in language the knowledge stored in the mind. Also the learner in technological education uses the language for communicating orally or in writing what he knows for tests and examinations while going through the educational process, for his professional training in oral and written responses, and for the interview with his prospective employer when he has to prove his technical ability through language initially.

Again, in his professional role the technologist has to speak in different kinds of situations: deliver an oral report, take part in a conference, give a talk at a meeting of the company's Executive Board. He needs to use the language for much of his business transactions through written reports. He would need the language for communicating ideas originated by creative thinking or for explaining and specifying any inventive ideas and prototypes he might design.

It is thus seen that there are three specific needs to be provided for in language training for students of technology:

1. to enable the student comprehend and assimilate technical knowledge,
2. to enable the student acquire ability of the mechanics of Functional English to express his technical knowledge and know-how in the WORD-PLANE; and
3. to provide experience of the language in the practice of the profession as:
    i) give oral and written reports on the results of work or study undertaken;
    ii) perform at an interview;
    iii) participate in a symposium, seminar or conference;
    iv) deliver a talk;
    v) write specifications of designs and inventive ideas; etc.

The first two needs concern the immediate present, although the present is to prepare for the future, but it is more immediate as it is intended to enable the student make headway in his study; the third concerns his future professional career.

ELT for technology to be meaningful and pragmatic ought to provide for all the three needs. ELT for technology is (1) two-pronged in its direction, (2) synchronic in action, and (3) heuristic in strategy. Of the two-pronged direction, one is directed to cognitive activation by training the mind for

i) the ability to understand the data, the arguments based on the data and the order in which the premises lead to the conclusion;

ii) the ability to interpret cause and effect relationships, to reason with facts;

iii) the ability to handle quantitative relations;

iv) the ability to interpret experimental data;

v) the ability to apply laboratory procedures to the problems arising in other situations;

vi) the ability to understand basic scientific concepts and principles; and

vii) the ability to apply these concepts and principles to familiar and unfamiliar situations.

The other is directed to ~~self~~-expression by the process of transformation of idea into language in speech and writing so that the denotation conveyed through language symbols is well defined. The two operations, one at the ideation plane and the other at the word-plane, need to be developed and strengthened not as two different operations but as one and the same process at work at the cognition level through the inferential uses of language. The communication ability to be promoted is the ability to state objectively an idea or a point of view. For professional need the ability to be developed is:

i) ability to receive accurately and critically the ideas of others;

ii) ability to react cogently to the ideas of others;

iii) ability to summarise ideas presented in group discussion;

iv) ability to question others without causing defensive behaviour; and

v) ability to use criticism with the least possible offence to the recipient.

The heuristic strategy achieves the desired result in compelling the student to understand the data, the arguments based on the data and the order in which the premises lead to the conclusion by the exercise of the reasoning process so that the student is set to find out things for himself.

IDENTIFICATION OF LANGUAGE COMPONENTS

Cognitive activation and effective use of language for technology is promoted by

i) Ideation Ability exercises,

ii) Study of semantic difference in apparently synonymous words,

iii) Study of words of Latin and Greek derivatives,

iv) Study of Prefixes and Suffixes, and

(v) Analysis of Complex sentences.

1. IDEATION ABILITY EXERCISES

Words are basic tools of reasoning. Ability to handle and manage words and word-structures facilitate cognition activation and transformation. In the instructional context in science and technology the teacher or the text-book enables another to know what he does not know, as already stated before, by directing his observations, where possible, to an object or a phenomenon, and by directing his reason by the inferential uses of language to move from what is known to the unknown, from premises to conclusions, from cause to effect, from data to target, through the ability to recognise facts embodied in statements and thereby have a command of facts, through the ability to abstract qualities from things expressed in statements and become aware of new aspects of the world, through ability to see how parts make up the whole through language, through ability to transform raw sensations or experiences into concepts and express the same in language, through the ability to classify information contained in verbal sets and group things in the mind, through the ability to make analogies from descriptions, to think abstractly and peer into two worlds of the analogy for abstracting a general truth, and through many other mental operations.

Exercises in Ideation Ability of the Graduate Record Examination[1] type are the kind of exercises that actuate the

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1. GRADUATE RECORD EXAMINATION APTITUDE TEST by David R. Turner, ARCO Publishing Company, New York.

mind for such operations through the inferential uses of language.

1. SELECTION OF CORRECT SYNONYMS

Exercises in the selection of correct synonyms enable the mind to grasp the content of words and establish the definitions of words. Exercises of the kind as in sample 'A' increase the awareness of the definite semantic content of words enabling one to become more definite in one's thinking.

Sample 'A'

Tick the letter against the word or expression which means the same as the word in capital letters. The first one has been done for you.

1. PRAGMATIC
   (A) smooth
   (B) absolute
   ✓(C) practical
   (D) bookish
2. ANHYDROUS
   (A) many-sided
   (B) carefully divided
   (C) multi-headed
   (D) destitute of water
3. ECOLOGY
   (A) environmental study of organisms
   (B) study of business
   (C) doctrine of final causes
   (D) science of family life

4. TURBID

(A) insubordinate

(B) distended

(C) muddy

(D) dissimilar

5. VIABLE

(A) not excusable

(B) open to corrupt influence

(C) easily pulverized

(D) capable of living

6. AMORPHOUS

(A) vase-shaped

(B) dusky

(C) formless

(D) pain-assuaging

7. BIFURCATE

(A) lie down

(B) examine closely

(C) divide into two

(D) translate

8. HOMOGENEOUS

(A) rare

(B) liable to prosecution

(C) of the same kind

(D) objectionable

9. PESTLE

(A) part of a flower

(B) contagious disease

(C) pounding instrument

(D) mixing bowl

10. DESICCATE

(A) loathe

(B) completely destroy

(C) violate

(D) make dry

11. CALYX

(A) gelatinous substance

(B) helmet

(C) soft palate

(D) external part of a flower

2. SELECTION OF ANTONYMS

Exercises in the selection of antonyms take the mind further into the import of words. They exercise the mind to know and better understand words by contrasting with antonyms. Exercises of the kind as in ~~sample~~ sample 'B' probe one's knowledge of words and strengthen one's flexibility in handling them and evaluating their semantic content; they increase the mental agility by fixing the concept of the words in the mind.

Sample 'B'

Tick the letter against the word or expression which means the opposite of the word in capital letters. The first one has been done for you.

1. INDIGENOUS

(A) elevating

(B) destitute

(C) insulting

(D) livid

(E) foreign

2. ANTIDOTE

(A) argument

(B) imagination

(C) indifference

(D) poison

(E) medicine

3. ANOMALOUS

(A) fidgety

(B) repetitions

(C) talkative

(D) not normal

(E) regular

4. DIMINUTIVE

(A) opposed

(B) gigantic

(C) partial

(D) small

(E) influenced

5. RELEVANT

(A) ingenious

(B) inspiring

(C) obvious

(D) inappropriate

(E) tentative

6. IMMUTABLE

(A) erudite

(B) object

(C) changeable

(D) fantastic

(E) aural

3. DRAWING ANALOGY

The two sides of an analogy are often quite different, and to see what is common one must think abstractly. With analogies one peers into two worlds at once abstracting a general truth.

Exercises in drawing analogy enable the mind to see a relationship between two items and apply this relationship to other items. Although the exercise deals with words, it is essentially an exercise in evaluating relationship to see the analogy and discerning a parallel analogy elsewhere. It promotes the mind to thinking clearly. Since a variety of relationship is possible between two items, the analogy exercises stir and stimulate the mind to active thinking with language serving as inference. In such exercises determining the relationship is in stages. Of the various relationships possible, determining the one that is an exact analogy develops the ability to compare and deduce which is essential to scientific analysis. The line of reasoning will have to shift for every single evaluation. Suppose the question comprised the following sets:

ARC: CIRCLE : : ?

(A) segment : cube

(B) angle : triangle

(C) tangent : circumference

(D) circle : cube

(E) cube : square

The evaluation leads to the relationship that the arc is a part of a circle and so the only other set that bears this relationshis is (B) where there is the PART: WHOLE relationship. Suppose the question was slightly changed as below:

ARC : CIRCLE :: ?

(A) segment : cube

(B) angle : triangle

(C) tangent : circumference

(D) circle : cube

(E) line : square

Now the line of reasoning leads to the evaluation that there is greater analogy between the key-pair and (E) and not between the key-pair and (B) because the angle is not so much a component of a triangle as a line is a component of a square as the arc is of the circle.

KINDS OF RELATIONSHIP

In analogy questions, the relationship between the first two words may be one of several kinds. Following are relationship possibilities.

1. Purpose Relationship

GLOVE : BALL :: (A) hook:fish (B) winter:weather

(C) game : pennant (D) stadium : seats

2. Cause and Effect relationship

(A) RACE : FATIGUE :: (A) track : athlete (B) ant : bug

(C) fast : hunger (D) walking : running

3. Part : Whole Relationship

SNAKE : REPTILE :: (A) patch : thread (B) removal : snow

(C) struggle : wrestle (D) hand : clock

4. Part : Part Relationship

GILL : FIN :: (A) tube : antenna (B) instrument : violin

(C) sea : fish (D) salad : supper

5. Action to Object Relationship

KICK : FOOTBALL :: (A) kill : bomb (B) break : pieces

(C) question : team (D) smoke : pipe

6. Object to Action Relationship

STEAK : BROIL :: (A) bread : bake (B) food : sell

(C) wine : pour (D) sugar : spill

7. Synonym Relationship

ENORMOUS : HUGE :: (A) rogue : rock (B) muddy : unclear

(C) purse : kitchen (D) black : white

8. Antonym Relationship

PURITY : EVIL :: (A) suavity : bluntness (B) north : climate

(C) angle : horns (D) boldness : victory

9. Place Relationship

DELHI : INDIA :: (A) Kanpur : Lucknow (B) Jaipur : Rajasthan

(C) Pilani : Jhunjhunu (D) Madras : Kerala

10. Degree Relationship

WARM : HOT :: (A) gale : paste (B) climate : weather

(C) fried egg : boiled egg (D) bright : genius

11. Characteristic Relationship

IGNORANCE : POVERTY :: (A) blood : wound (B) money : dollar

(C) schools : elevators (D) education : stupidity

12. Sequence Relationship

SPRING : SUMMER :: (A) Thursday : Wednesday (B) Wednesday:Monday (C) Monday : Sunday (D) Wednesday : Thursday.

13. Numerical Relationship

4:12:: (A) 10:16 (B) 9:27 (C) 3:4 (D) 12:6

14. Association Relationship

DEVIL : WRONG :: (A) colour : sidewalk (B) slipper:state (C) ink:writing (D) picture:bed

4. STATEMENT COMPLETION

An extended type of ideation ability exercises is supplying the word or words missing in a statement from a set of words or phrases. Such exercises require knowledge of the vocabulary and evaluation of the context expressed in the statement. With plausible alternatives, the exercise activates the mind to reasoning with words as in sample 'C'.

Sample 'C'

1. He hated his father so intensely that he committed.......

(A) patricide

(B) fratricide

(C) genocide

(D) matricide

2. The sculpture will convert this.......piece of clay into a beautiful bust.

(A) virulent

(B) amorphous

(C) taciturn

(D) salient

3. The day will come when.....will look upon us and our time with a sense of superiority.

(A) antiquity

(B) posterity

(C) carnivores

(D) ancestors

4. Her.....manner embarrassed the others at the party.

(A) affable

(B) tractable

(C) tactless

(D) gaudy

5. The.....professor put his wife out and went to sleep with the cat.

(A) diurnal

(B) dubious

(C) distrait

(D) absent-minded

Work-books designed on the model of GRADUATE RECORD EXAMINATION APTITUDE TEST by David R.Turner (Arco Publishing Company, New York) would tune the mind for the kind of mental operations required for technological study.

2. STUDY OF WORDS APPARENTLY SYNONYMOUS

Science and technology are precise subjects. There is need to train the mind attain precision of thought and expression. The basic unit of thought and expression is the word. It is the label to a concept or to an experience or to a scheme of ideas. It is necessary that the correct label is used for the correct expression of our ideas, opinions, observations, experience. We cannot do this by merely knowing how to spell a word and have a vague idea of the word concept. Word accuracy is important specially when there are several words with similar semantic content, which are mistaken for synonyms . The ability to distinguish between words of similar but not identical semantic content facilitates clear and accurate understanding and expression. Training should therefore be given in discerning the fine distinctions between apparent synonyms and choosing the precise word that fits into our scheme of ideas.

An exercise set to a class of students with near-native competence to distinguish the semantic content of the sets of apparent synonyms as look-see, listen-hear, study-learn, close-shut, engaged the class for one complete hour with the highest score at 6 out of 10. The table below lists the number of students obtaining the score zero to six.

Score	No. of students
6	13
5	16
4	44
3	12
2	14
1	14
0	12
Total	125

When the difference in the semantic content of these apparent synonyms was explained to the class, there were visible signs of appreciation. They had never thought earlier that 'look' is to direct the eyes to an object with deliberate attention and 'see' is to perceive the object; in seeing the light from the object merely falls on the retina. Similarly 'listen' is to direct the ears to a sound with deliberate attention but 'hear' is to perceive the sound; in 'hearing' the sound is merely received by the ear-drum. It is possible to hear and not listen (as it sometimes is the experience of students in a class!) as it is possible to see and not look.

Study of such words of most frequent occurrence in technology is necessary in order to make the correct choice of lexis. For example, 'attain' and 'achieve' are not synonyms: 'attain' is to reach ; 'achieve' is to realise what has been desired.

Illustrations: (a) Supersonic speed is attained by jet engines.

(b) Inter-planetary flights may be achieved (and not attained) by nuclear power.

To give another set of example the words 'contain', 'consist', 'comprise', 'compose', and 'constitute' are important 'content' words. They appear to be synonyms and yet have fine shades of difference; each of them has its particular context. 'Contain' is 'to have or hold within itself'; 'consist' is 'to be made up of' something and that something is not necessarily within. 'A vacuum tube contains a heating filament' means that there is a filament within the vacuum tube, while 'A vacuum tube consists of a heating filament' does not show the location of the heating filament. It is not necessarily within. 'Comprise' is a synonym of 'consists of'; it is incorrect to say 'comprise of'. 'The atmosphere comprises a number of gases' is correct but it is incorrect to say that 'The atmosphere comprises of a number of gases.' 'Constitute' is 'to form or make up' as in : 'Several different parts constitute a machine.' In the transposed position 'A machine is composed of ~~several~~ several different parts.' 'Compose' is almost a synonym of 'consists'; however, while 'consists' is used in the active voice, 'compose' is never used in the active voice in the technical context; it is always used in the passive voice as 'composed of'.

'Ratio' and 'proportion' are two common words which are confused one with the other. 'Ratio' refers to the relation between two quantities of the same unit. 'The ratio of 3 to 21 is the same as the ratio of 7 to 49'. 'Proportion' is the relation of one thing to another in quantity, size, etc. as in : 'A large proportion of the earth's surface is covered with water.' 'Percentage', 'percent' and 'ratio' are terms of precision; they should not be used in making approximations or rough estimates. They should be used with reference to exact figures. Examples of incorrect usage with the correct word in brackets are given below:

(i) A large percent of the oil lost will be recoved.(part)

(ii) This increased the percentage of impurities in the solution. (proportion)

(iii) The concentration is in the proportion of 20:1.(ratio)

Such errors are common in the self-expression process where the choice in lexis ranges over a set of apparently synonymous words. There is no specific rule for choosing the correct word. The skill of making the correct choice comes only with knowledge of the words that are apparently synonymous; the two should go together although

'Skill of the language is acquired by drill;

Knowledge of the language is absorbed by will.'

Exercises of the type as question No.3 on pages 177-78 of R.A. Kelly's THE USE OF ENGLISH FOR TECHNICAL STUDENTS (George G.Harrap and Co., Ltd., London) are intellectually stimulating and suited to the technological context.

3. STUDY OF WORDS OF LATIN AND GREEK DERIVATIVES

Nearly two-thirds of the words in the English language are of Latin derivation, and one-half of the terms in science and technology are of Greek origin. These borrowed words have worked themselves into the very fibre of the English language. The Graeco-Latin vocabulary with its highly inflexionable character is most suited for technical lexis. Greek borrowings meet adequately the demands of scientific description because a Greek compound is an excellent substitute for a lengthy description. Words of Latin and Greek origin are unavoidable in expressing ideas in science and technology as they make nice distinctions of meaning and produce the precision of thought and expression. They save time and release the mind for reaching quickly to the heart of a problem.

Besides, the Graeco-Latin vocabulary is so flexible that new vocabulary easily evolves with every advance in science. The function of the technical vocabulary being to designate concepts, specific objects and denote processes, when the right word has been arrived at, it secures exactness in nomenclature, and when universally understood by the class of people for whom it is intended, they acquire the precision of mathematics.

Study of Latin and Greek derivatives is necessary to an intimate understanding of the terms used for the precise expression of scientific and technological knowledge. It enables the student comprehend and convey intelligently the words of Latin and Greek origin used in science and technology for the precise expression of scientific ideas. A sound knowledge of the root of these words of common occurrence in science and technology gives the learner an insight into the concept for which the word is the label.

For example, if the student learns that 'photo' is the Greek word for 'light', 'syn' is the Greek word for 'together', and 'thesis' is the Greek word for 'to put', he is able to operate with the entire conceptual complex that the term 'photosynthesis' symbolises. If he learns that 'gen' is the Greek word for 'to be produced', when confronted with the term 'photogen' he is able to conceive that it is something that produces light. It contributes to directness and accuracy of thought and expression. Besides, the basic units of Greek and Latin are not many, and, yet, when one knows these basic units and the concepts for which they are labels, one can arrive at the semantic content of numerous other words made up of the basic units. So, the study of the Graeco-Latin derivatives makes learning easy and self-learning possible.

4. STUDY OF PREFIXES AND SUFFIXES

The basic word-corpus of the scientific domain is a small one. But the numerous affixes when appended to the stem-words expand them into a multiplicity of words signaling changes in meaning and relationship. The prefix is the morpheme appended to the stem-word at the initial position, and the suffix is the morpheme appended to the stem-word at the final position. The study of prefixes and suffixes and the way they alter the form of words to signal changes in meaning and relationship imparts insight into the working of the language. Their study enables the student to recognise the infinitely delicate system of relationship and interplay of words contributing to precision and exactness, and gives the student the ability to activate various forms of words for his needs. The knowledge of prefixes and suffixes gives him confidence to work meaningfully and gainfully with them and shows him how to achieve economy of expression.

CHAMBERS' TWENTIETH CENTURY DICTIONARY lists and discusses the prefixes and suffixes on pages 1324 to 1329. Interesting lesson units can be prepared with this material drawing examples from the vocabulary of science. Stimulating problems for solving could be set as the one below:

An inventor invented a switch for lighting tube-lights that have fused. Suggest a title for the invention that is precise and apt. (The title under which the item has been patented is A RE-ACTIVATING SWITCH FOR FUSED FLOURESCENT TUBE-LIGHTS. Discuss the import of the prefix 're' in re-activating.)

5. ANALYSIS OF COMPLEX-SENTENCE STRUCTURES

Although the language of science and technology is simple, the syntactical structures are not all simple sentences. Most often they are complex sentences. They are mostly simple in Instruction Manuals. Unless the relation of the clause-elements are understood, the exposition cannot be comprehended. Two texts picked at random, from a text-book of Physics for First year students, are reproduced below:

THE COMMON BALANCE

The Common Balance consists of a rigid beam AB, carrying a scale-pan suspended from each end, which can turn freely about a fulcrum O outside the beam. The fulcrum and the beam are rigidly connected and, if the balance be well constructed, at the point O is a hard steel wedge, whose edge is turned downward and which rests on a small plate of agate.

PROJECTILES

When a particle is projected into the air, the angle that the direction in which it is projected makes with the horizontal plane through the point of projection is called the angle of projection; the path which the particle describes is called the trajectory; the distance between the point of projection and the point where the path meets any plane drawn through the point of projection is its range on the plane; and the time that elapses before it again meets the horizontal plane through the point of projection is called the time of flight.

The analysis of a complex sentence breaks up the sentence into its dependent elements to show the mutual relation of these elements. The understanding of the content of a text depends on the understanding of the relation of the clause-elements. Exercise in clause-analysis is necessary to comprehend the content of a scientific text. In this exercise care should be taken to see that the exercise is not reduced to a grammatical exercise. Its aim should be to promote comprehension.

The comprehension of the text could be checked by verbal questions or by a sketch.

FOR SELF-EXPRESSION

In the transformation of ideas and thoughts into expressions and their transmission, the process at work is:

(i) mobilization and marshalling of ideas;

(ii) choice of grammar and lexis;

(iii) ordering of the grammar and lexis; and

(iv) sequencing of the ordered units.

The actuating situation in the technological context being a well-defined one, the ideas and thoughts activated by the context being fixed, the language of technology being denotative, the syntactical ordering of the words of the language in which the 'understood-understand' activity takes place, gives a definite direction to the formulation of the thoughts and ideas activated by the context. Their formulation is determinable not only because the context is fixed and the grammar and the lexis of the language is known, but because the possibility of meaningful choice in the grammar and lexis for the context is among a very small number of possibilities. In this well-defined context there is only one noun that can express an idea, only one verb that can set that idea in motion, and only one adjective that is the proper qualifier of that noun. The possibility of meaningful choice is restricted generally to lexis which ranges over a set of apparently synonymous words. Because the distinction between the apparently synonymous words is not made, the wrong choice of lexis is made. A few examples are given below with the correct choice in brackets.

1. The steamboat was discovered/invented. (invented)
2. This mineral is unsolvable/insoluble . (insoluble)
3. These formulae are applicable to the case/process (process) in which the concentrate is made. (What is meant here is not 'instance or example of the occurence of something', or 'circumstances or special conditions relating to a person or thing', etc., but a process.)
4. When meta-cinnabarite occurs/is found, (is found) there is usually some cinnabar with it. ('occur' is 'to take place' or 'happen;' it is not a synonym for 'is found'.)

Effective use of language for self-expression is promoted by

(i) Practice in the management of the mechanics of the language,

(ii) Use of linguistic devices to obtain objectivity,

(iii) Writing Definitions,

(iv) Writing complex sentences to describe an apparatus or an object, and to explain a phenomenon or a process, and

(v) Rhetoric.

1. MECHANICS OF EXPRESSION

The 'understood-understand' activity between two or more human beings is impossible by means of a purely arbitrary and isolated set of oral or verbal referents. What one invidual wishes to communicate to the other must be patterned and ordered to the word-order and structure-order of the language system in that context.

The linguistic structuring of scientific texts does not depend so much upon involved structures as upon the choice of the right verb, the right article, the right adjective, the right adverb or the adverbial phrase. The wrong choice ill-defines the thought and the needless word is an obstruction. One of the specific objects of the ELT programmes in technological education should be to train the learner to manage the mechanics of the language so that he makes the correct choice of the verb, article, adjective, adverb, etc.

ARTICLES

The omission of the article and the choice of the wrong article are the commonest errors commited by students.

The choice of the right article is important in the linguistic structuring of scientific texts as in any literary structure. A few examples are given below with the wrong article underlined and the right article in brackets.

(1) Reduce the loss in the residue to a minimum. (the) ('a' before minimum suggests that one does not know 'the minimum attainable'.)

(2) I used a process in which manganese oxide serves as purifier of the electroylte. (the) (As this is a particular process in the refining of zinc, the definite article is the choice.)

ADJECTIVES

Adjectives are often confused. The comparative degree of an adjective is used for the positive and vice versa. The proper use of adjectives and the use of proper adjectives is a linguistic necessity in the structuring of a scientific idea. The choice of the right adjective, that is, the one that belongs to the idea to be expressed, needs careful selection. A few examples are illustrated below with the wrong adjective underlined and the right one in brackets.

1. The procedure takes time; it may easily extend to as high as ten days. (long) (The idea of extension here involves length and not height.)

2. The return was small, because the capital was high. (large) ('high' is not the antonym for 'small' .)

3. This method is as perfect as any other. (good) ('good' and 'perfect' are not synonyms.)

4. The crude ore is not as good, but the concentrate is no lower, because it is cleaner. ('lower' is not the comparative degree of 'good'.)

Where more than one adjective may be needed to describe an object, each adjective should convey a distinct meaning.

Superlatives do not have a place in scientific exposition.

ADVERBS OR ADVERBIAL PHRASES

The choice of the right adverbial phrase is equally important. The intelligent use of the common adverbs contributes to definition of the idea and clearness of expression.

Examples:

1. The iron rods were heated to such an extent that the brazing was destroyed. (a degree) ('extent' is range, and is not a correct synonym for 'degree' meaning 'step or stage in a scale or process'.)

2. In fitting one piece to another, calipers are frequently used. (calipers are not used 'frequently'; they are commonly used.)

The position of the adverb needs to be stressed. It must be as near as possible to the word it modifies.

'VERY' has no significance whatsoever. It supposes comparison; it suggests exaggeration. The use of 'very' defeats the purpose of definiteness.It is an impediment to terse and perspicuous writing.

Examples:

(a) Gun-cotton is pressed into the requisite form in a wet state, in which condition it is very safe to handle. The 'very' weakens 'safe' because the over-emphasis raises a doubt.

(b) This scraper does not work <u>very</u> well in coarse material. Here 'very' suggests 'badly'.

ADVERBIAL CONNECTIVES

Practice in the use of the right adverbial connectives is necessary.

Examples: (The wrong connective is underlined and the right one is in brackets.)

(1) This method cannot be recommended <u>when</u> applied to slime. (if) (The idea of time in 'when' is not involved.)

(2) When the percentage of copper diminished to a point <u>where</u> (at which) the ores could not be profitably smelted.

ABSTRACT AND CONCRETE NOUNS

One of the commonest faults is the use of the abstract instead of the concrete. An abstract noun denotes quality, state, or action. The use of the abstract tends to circumlocution; it leads to obscurites. Illustrative examples are given below: (The 'abstract' phrase is underlined and the 'concrete' substitute is in brackets.)

(1) Such deposits of quartz are not valuable unless they are close to <u>cheap transportation</u>.(railroad)

(2) When tungsten ore occurs in disseminated grains, it is more difficult <u>of detection</u>. (to detect)

(3) As pig iron was used <u>for the precipitation</u> of the copper....(to precipitate)

(4) Much had been done <u>in the investigation and study of</u> the local geology. (to investigate)

(5) These alloyed metals are the most difficult <u>of solution</u>. (to dissolve)

The concrete noun is more exact than the abstract noun. Illustrative examples are given below:

	MORE EFFECTIVE
(1) A machine of considerable cheapness	A considerably cheap machine
(2) An effort to obtain further reduction in working costs....	An effort to reduce the working cost still further.....

THE PLURAL NOUN

The choice between the singular noun and the plural noun is a matter of haphazard choice. It is not easy to write clearly on scientific operations unless fine distinctions are made.

Examples: (The wrong verb is underlined and the right verb is in brackets.)

Forty barrels of oil <u>was</u> stored in the warehouse.(were)

The following words should be used in the singular form only:

cost, loss, depth.

George C.Harwell in his book TECHNICAL COMMUNICATION (The Macmillan Company,New York,1971) has a useful Manual of General Composition on pages 257-318 with illustrations drawn from technical subject matter.

The attention of students should be drawn to some common errors often committed in technical exposition as illustrated in the following:

(1) Displacement of adjectives that require a preposition after them, as in:(The displaced adjective is underlined.)

Add the flux in <u>equal</u> proportion to the ore.

It should be 'Add the flux in a proportion equal to the ore'. 'Proceed in a parallel direction with the crest of the range' should be 'Proceed in a direction parallel with the crest of the range'.

(2) The use of wrong preposition and its separation from its adjective, as in:

He indicated that more favourable conditions for the opening of the industry might be expected. It should be 'He indicated that conditions more favourable to the opening of the industry might be expected'.

(3) Placement of connectives without proper correspondence, as in:

This plant was either erected hurriedly or carelessly. It should be 'This plant was erected either hurriedly or carelessly'.

(4) Misplacement of adverbs, as in:

I purchased four pumps of 1000 gallons each. It should be 'I purchased four pumps each of 1000 gallons'.

(5) Splitting the infinitive, as in:

(a) It is necessary to always roast the ore before chlorination.

(b) He hoped to soon increase the output.

(c) It was necessary to partly fill the tank.

They should be rendered as:

(a) It is necessary always to roast the ore before chlorination.

(b) He hoped soon to increase the output.

(c) It was necessary to fill part of the bank.

(6) Separating the parts of a verb by an adverb or an adverbial clause, as in:

(a) We shall soon be treating 100 tons daily.

(b) The industry will, when it resumes operations, find that serious inroads have been made.

They should be rendered as:

(a) Soon we shall be treating 100 tons daily.

(b) The industry, when it resumes operations, will find that serious inroads have been made.

It is disregard of the laws of thought that entangles the ideas in a wilderness of words.

PUNCTUATION

A knowledge of the principles of punctuation is essential to effective and intelligible writing. The purpose of punctuation is to show the manner in which the writing is to be understood, to indicate the relations between parts of a sentence and between successive sentences. It marks logical relations in technical writing. It achieves clarity, proper distribution of emphasis, the desired kind of movement, and the different degrees of discontinuity. It is not enough for the student to know that:

A period marks the end of a sentence.

A colon is at the transition point of a sentence.

A semicolon separates different statements.

A comma separates clauses, phrases, and particles.

A dash marks abruptness or irregularity.

An exclamation marks surprise.

An interrogation asks a question.

An apostrophe marks elisions or the possessive case.

Quotation marks define quoted words.

He needs to know that:

(1) The colon suggests a sequel. It serves to introduce a specific statement, an amplification, an example, or a quotation. In technical writing it is mostly used for introducing an example.

(2) The term 'semicolon' is a misnomer for it is not a half-colon; rather, it is what its form indicates-a compromise between the period and the comma, the two marks of which it is constructed. Sentences grammatically independent but closely connected in sense are separated by semicolons. A semicolon is used in the following cases:

(i) When the conjunction in a compound sentence is omitted. For example:

He is not a mining engineer; he is the ore analyst.

Here 'but' or 'however' is omitted.

(ii) Before a conjunctive adverb that introduces a clause. Such conjunctive adverbs are however, therefore, nevertheless, accordingly, moreover, thus, then, so, and consequently.

For example:

The place was full of smoke; therefore the workers were ordered to leave the place.

(3) The dash is used for several purposes.

(i) It is used to indicate a break in the construction, whether intentional or not.

(ii) To insert a passage for parenthesis.

A phrase having no grammatical connection with the rest of the sentence requires marks of parenthesis, often called 'curves'.

For example:

His invention (see accompanying illustration) remedies the defect of the original device.

Short parentheses may be denoted by dashes, fore and aft; long explanatory interpolations are usually enclosed within curved lines, whereas explanatory additions to quoted statement are enclosed within square brackets. In technical writing the square brackets are mostly used to enclose the abstract. If a parenthesis comes at the end of a clause or sentence, it must be followed by the requisite punctuation. Sentences or clauses in parenthesis need no terminal punctuation of their known.

(4) The marks of quotation are used to indicate the beginning and end of a passage that is quoted; they are also used to mark words that are quoted. A quotation should begin with a capital letter if it is long, but not if it is in direct serial order or is a consecutive part of the author's text. The single 'quote' is employed for the titles of books and articles. For example:

He read a paper on 'The Thermo-Mechanical Curie Convertor'. The pairs of quotation marks should be used only to indicate matter quoted directly from a speaker or writer. The single 'quotes' are used also to indicate words that are unusual or are used in an unusual sense. For example, in the statement 'The plates of copper are hung by corrosion hooks in the acid', the term 'corrosion' requires single quotes, for without them it would seem an error, for 'corrosion' has nothing to do with 'hooks'; the term as used is a trade name for hooks that do not corrode.

(5) Of all the punctuation marks the comma is both used and misused more often than any other ~~mark of~~ punctuation mark. The comma should be used:

(i) To follow a subordinate clause preceding the main clause.

(ii) To introduce a clause that is supplementary or explanatory, and therefore not essential to the sense. For example: The mill, which was quite new, was destroyed by the gale. However 'The mill that was quite new was destroyed by the gale' conveys the idea that one mill out of several, namely, the newest of them, had been destroyed. The restrictive clause introduced by 'that' does not need commas to separate it.

(iii) To set apart an introductory phrase in a sentence. For example: To begin with, all drawings should be made of standard size.

(iv) To set off participial phrases.

(v) To set off a clause introduced by a conjunction, if the clause has its own subject nominative. For example: The ore is low-grade, but it is free-milling.

(vi) To separate adjectives that are coordinate, each playing an equal part. No comma is needed after an adjective that is superimposed on a unit. For example:

Heavy mineral oil

Solid cast-iron rollers

(6) The period marks the completion of a sentence.

(i) Abbreviations must be indicated by the period. For example:

6 in., 8 ft., 3 gal., 64 m.

(ii) Contractions must be indicated by the period. For example:

e.g. (exempli gratia = for the sake of example)

etc. (et cetera = and the rest)

viz. (videlicet = to wit)

Punctuation is not a minor matter to be neglected by the student of technology.

Only those of the elements of the Mechanics of Expression that need emphasis have been discussed.

2. LINGUISTIC DEVICES TO OBTAIN OBJECTIVITY

Technical exposition is objective. There is the misconception that this 'objectivity' is achieved by passive verbs and impersonal subjects. Under SYNTACTICAL CHARACTERISTICS in chapter VIII we have seen that passive verbs and impersonal subjects are generally used in scientific and technical expositon, because in such exposition 'what is being done or has been done is stated and not 'who' is doing or has done something. We have also seen the situations where the personal subject is used. Here are a few illustrations where the active verb is to be preferred to the passive as it contributes to better effect:

(a) An immediate closure of the mine was caused by the explosion.

The explosion caused an immediate closure of the mine.

(b) The ore is covered by a cap of leached monzonite.

A cap of leached monzonite covers the ore.

(c) The serious deficiency in dye-stuffs has been overcome with success by the chemists.

Chemists successfully overcame the serious deficiency in dye-stuffs.

The objectivity in technical exposition is obtained by a cummulative effect of a number of linguistic devices.

Technical exposition is characterised by

(i) the presentation of data which is verifiable by experiment or tenable by logic, and

(ii) the medium of presentation is language that belongs to the denotative stratum and is marked by definiteness, terseness and unambiguity.

(i)-(a) The data used in technical exposition is almost invariably fact, as opposed to opinion. It is therefore necessary for the student to be able to distinguish clearly between fact and opinion. That is not to suggest that opinions have no place in technical exposition. Two types of opinions do find a place in technical exposition, namely, expert opinion and opinion which represents the conclusion of an argument.

Students should be able to separate fact from opinion. The first stage in separating fact from opinion is by comparing statements which seem to be factual with statements which seem to be opinionative. The second stage involves thinking about how the apparently factual statements can be verified. The final test is always verification. Let us consider the following two statements:

No.1. This car has tremendous acceleration.

No.2. This car reaches 60 mph in 8.2 seconds.

Statement No.1 is an expression of opinion because the term 'tremendous' has no specificity; its meaning is arguable. While, statement No.2 is fact because it is specific and can be verified.

(b) Data used in argument should not be faulty. Arguments can be faulty if they are based on incorrect evidence, or the logical form of the argument is invalid.

The two main types of argument are Deductive and Inductive. The student should be enabled to recognise these forms of argument and construct them for himself. He should be introduced to the fundamentals of logic. He should be informed of linguistic devices that signal Inductive and Deductive arguments.

The components of a simple argument are (i) the premiss, (ii) the conclusion, and (iii) the word or phrase which suggests the relationship between them.

In the statement 'Prices are rising therefore wages must rise,' the premise 'prices are rising' is linked to the conclusion 'wages must rise' by the linking word 'therefore'. It is the link word which makes the statement an argument. If the link word is 'and', the statement becomes descriptive.

The most common signals for argument are:

LIST I	LIST II
(premise, then conclusion)	(conclusion, then premise)
hence	for
thus	since
so	because
implies that	for the reason that
entails that	in view of the fact that
which shows that	on the correct supposition that
proves that	assuming, as we may, that
indicates that	
consequently	may be inferred from the fact that
allows us to conclude that	may be deduced from
we may deduce that	
points to the conclusion that	as shown by
suggests very strongly that	as indicated by
~~suggests very strongly that~~	as is substantiated by
leads me to believe that	
bears out my point that	
from which it follows that	

Exercises of the kind given by Peter Coleman and Ken Brambleby in THE TECHNOLOGIST AS WRITER (McGraw-Hill Book Company, New York, 1969) trains the mind in logical thinking and provides the student with the appropriate linguistic devices.

(ii) Practice in identifying words of the denotative and connotative strata as the samples below are necessary to help students differentiate between them in order to use words of the denotative stratum.

SAMPLES:

(A) In the examples below, (a) label each sentence F for factual or O for opinionative, and (b) underline the words which most clearly reveal the factual or opinionative nature of the example.

(i) That is a crescent wrench.

(ii) That is a very useful wrench.

(B) Consider each of the alternative descriptions listed below as possible completions of the sentence given. If the completion would result in a factual statement, label the description F in the space on the right; if the completion would result in a statement of opinion, label the description O.

Nehru Street was ....

(a) crowded ....

(b) long ....

(c) paved ....

(d) straight ....

(e) dark ....

(f) deserted ....

(g) blocked off ....

(h) a dead end ....

(i) cold ....

(j) 150 yards long .....

(B) In the passages which follow, (a) underline the important words, (b) label the underlined words D or C, (c) estimate the proportion of denotative to connotative words, and (d) rank the passages in increasing order of factual content-that is, the passage with the highest proportion of connotative words will come first, and the passage with the highest proportion of denotative words will come last. (Use the identifying letter, a., b., etc., for your list.) Do not expect that all the words will necessarily fall into one category or the other.

(a) Walls are being covered with a new wallpaper that sticks without wetting or gluing. It is coated on the back with latex, a rubbery substance that will stick to a similar latex surface-and to nothing else. So a special latex liquid is spread on the wall with a roller, and the paper goes up quickly and cleanly.

New coatings, with many different uses, have been found for the surface of wallpaper. There is one that kills flies the moment they touch it. To it can be added a chemical that fills up the tiny crevices in the paper and prevents dirt from settling there.

(b) Super conductivity-the total disppearance of electrical resistance-is a strange property of matter that makes its appearance in the remote realm of temperatures close to absolute zero. It confounded the classical theory of electromagnetism when it was discovered some 50 years ago. It remained until four years ago an intractable riddle to the new quantum physics. Yet in a very few years from now superconductivity is going to prove to be a windfall to technology. Engineers are engaged in the design of superconductive bearings distinguished by the absence of friction, electric motors with extra-ordinary efficiency, tiny and reliable switching elements for computer circuits, magnetic lenses with unprecedented resolving power for electron microscopes, noiseless amplifiers and other devices with characteristics that approach ideal standards. In the future workers in other fields of engineering are sure to find that superconductors, insulated from their immediate environment in cold chambers, will provide unexpected solutions for an increasing variety of design problems.*

(c) First we took a bus to the railway-station, which is not far from the big shops, and then walked around the whole morning, looking in the shop-windows. We did not buy much-Ashok got some summer shoes for his wife, and I found two very good pipes which were quite cheap-but we greatly enjoyed ourselves. One of the things that we liked most was the way in which part of the town was built on the sides of very steep hills, so that some of the streets seemed to rise suddenly into the sky. I should not like to have to drive a motorcar up or down one of those streets, especially on a rainy day when the stones are slippery.

HOW TO BE DEFINITE

(a) One of the greatest enemies to objectivity is the

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* From THE TECHNOLOGIST AS WRITER, Peter Coleman, Ken Bramble-by, McGraw-Hill Book Company, New York, p.14.

use of the abstract instead of concrete. An abstract noun denotes quality, state, or action.

Abstract nouns are a taboo in technical exposition for they are non-descriptive. Words like 'value' do not contribute to objectivity. 'Value' is the worth or desirability of a thing; it is an attribute, not a substance. The concrete noun is to be preferred to the abstract. The concrete noun unburdens the statement of many useless words as in the following:

Pig-iron was used <u>for the precipitation</u> of the copper.

Pig-iron was used <u>to precipitate</u> the copper.

The use of the abstract tends to circumlocution; it leads to obscurities that mar precision. For instance:

Much has been done <u>in the investigation and study</u> of the local geology.

Much has been done <u>to investigate</u> the local geology.

(b) The ACTIVE voice of the verb should be used rather than the passive and the POSITIVE verb rather than the negative.

HOW TO BE TERSE

Exercises of the kind shown below enable students to have practice in being terse.

Rewrite the following statements replacing the group of words or phrases underlined with appropriate and unambiguous words:

(a) Many scientists believe that our universe is <u>becoming larger.</u>

(b) The gale caused <u>temporary stop</u> of work on the bridge.

(c) The deck of the new suspension bridge is streamlined to make wind effects small.

(d) Plastics polymers are sold commercially in the form of grains.

(e) Silver is one of the metals that can easily be drawn into wires.

This exercise should be done orally by the class. Only then plausible words suggested can be discussed by the teacher for the benefit of the class. For instance, if 'malleable' is suggested for (e) above, the teacher needs to explain that 'malleable' shows that the metal is capable of being beaten and rolled into a new shape but not that it is capable of being drawn out into threads. The word is 'ductile'.

HOW TO BE UNAMBIGUOUS

If words have to be structured into a meaningful pattern that communicates effectively, they must be well knit. The effectiveness of an exposition as a means of transmitting thought from man to man depends upon the relation of words to each other and of group of words to other groups as phrases, clauses, and sentences. To be understood beyond question, although the well-ordered thought-process would dictate the pattern of structuring and their sequence, the student should know not only what the words denote but how to build the sentences. He does choose his words aright but often constructs his sentences improperly. The proper marshalling of words is particularly necessary for scientific exposition. A disorder in the assembly of words in a non-scientific situation could be tolerated, but in a scientific context, it endangers the meaning. When confronted with a statement as: 'The police is looking for a gray motor-car driven by a woman who is thought to have a wire-less apparatus inside' the recipient has no difficulty in understanding that the wireless apparatus is inside the motor car and not inside the woman, although that is what the statement means as it stands. But, in a scientific ex-position, if a statement stated 'The samples were preserved for analysis in a paraffin-sealed flask', it raises the doubt whether the analysis was done in a paraffin-sealed flask, or whether the samples were preserved in a paraffin sealed box.

Exercises in proper construction, to be fruitful, should be directed to the technical write-up that the student has written. Inversion of ideas, stilted and obscure phrasing that are present in the write-up are the best examples to be handled by the Instructor for driving home the rules of syntax, the essence of which is logical order. There is an awkward inversion in 'Because a process is cheap does not prove it desirable', because the causal clause is made substantive. It is to be recast as 'A process is not desirable because it is cheap'.

It is necessary that the syntactical errors in technical write-ups of students be discussed with the student and corrected. Only then the student is able to understand and assimilate the syntactical rules of clause-construction. He realises the effort to be taken to structure his clauses so that the relation of each clause to the context is unmistakable, clauses that are instrinsically connected are kept as close together as possible, and clauses are placed in their logical order. He is enabled to comprehend the rule by recognising his own errors, and thereby learns how to follow the spirit of the rule intelligently, not mechanically. He learns to avoid the common errors that are frequently committed as the misuse of 'that' and 'which' the cause of much obscurity and confusion. The relative pronouns have distinctive functions, and the student of technology cannot express himself clearly until he has learnt to discriminate between these functions. For example, let us consider the following three statements:

No.1. The engineers who refused to submit were discharged.

No.2. The engineers, who refused to submit, were discharged.

No.3. The engineers that refused to submit were discharged.

These are not three ways of saying the same thing. The first leaves it doubtful whether all the engineers were discharged or only some of them. The second says that all of them were recalcitrant and that all were discharged. The third asserts that only the troublesome ones were discharged.

The Relative Pronouns serve for reference and connection. By poetic licence we may speak of a city 'whose past is lost in antiquity' but poetic licence is not permitted in technology. Hence it would be incorrect to say 'A smelter whose operations are profitable forms part of the enterprise'. Instead, we should say 'A smelter, which is being operated profitably, forms part of the enterprise'.

It is only with constant exposure to errors and a discussion on why and how to avoid them, that these rules of syntax become established in the mind of the student. He should know that 'whose' is used of anything with animal life or anything personified; 'of which' is used of anything without animal life; 'which' refers usually to things only, not to persons; 'that' refers to both persons and things; 'that' usually introduces a definitive or restrictive clause. He should know that he must use 'that' when he intends to define, and 'who' or 'which', with commas to set off the clause, if he intends to comment. He needs to know the variety of clauses introduced by 'that':

(i) It is required when a superlative is attached to the antecedent, thus-He was the <u>greatest</u> geologist that ever lived.

(ii) It is preferred with a word of exclusive or comprehensive meaning, such as 'only', 'any', and 'all'.

(a) The <u>only</u> mineral that I recognised in the ore was galena.

(b) <u>Anybody</u> that touches the overhead wires is in danger.

(c) He gave the names of <u>all</u> the mines that he had examined.

(iii) It is used after negatives.

(iv) The periphrases 'it is' and 'it was' call for 'that', because they introduce a pre-eminently restrictive clause.

(a) It is the alumina in the ore that makes it refractory.

(b) It was the fluctuation in the power that short-circuited the apparatus.

The use of 'and which' presents another common difficulty. This phrase is permissible only when it is preceded by another subordinate clause introduced by 'which'.

The chief difficulty is to discriminate between the use of 'that' on the one hand and of 'who' or 'which' on the other. There is the ~~idea~~ notion that 'that' and 'which' are interchangeable, that one is an ~~agreeable~~ acceptable variant of the other. Since 'that' also plays the part of an adverb, a conjunction, and a demonstrative pronoun, 'which' is preferred to 'that' when choice appears permissible. There is need for the student to understand the distinct functions of these relative pronouns. The main distinction is this: The function of 'that' is to introduce clauses that define or restrict; the function of 'which' is to introduce clauses that explain or supplement. Let us consider the following two statements:

(a) A process that will extract both the metals was adopted.

(b) The process, which is of recent invention, extracts both the gold and silver.

In statement (a) 'that' is used because it restricts the process. In statement (b) 'which' is used because the clause following is non-defining; it gives a bit of incidental information. The function of the defining clause is to limit the antecedent. 'Which' introduces a new fact about the antecedent, whereas 'that' introduces something about which the antecedent is incomplete and undefined.

The difficulty of technical communication is not to communicate but to communicate what one means; it is not to affect the recipient, but to affect him precisely as one desires. The business of technology is mainly carried on by means of communication and it should be unambiguous. Proper clause-construction contributes to clarity and eliminates ambiguity.

3. HOW TO USE LANGUAGE FOR WRITING DEFINITIONS

The technologist has to be exact in all his measurements. He should measure his language with similar exactness. The layman defines the earth as "a ball slightly flattened at the poles, something like an orange". The scientist defines it as "an oblate spheroid". Dr.Samuel Johnson, despite his pre-eminence, defined a network as "that which reticulated or decussated at equal distances with interstices between the intersections", while a fisherman defined it as "little square holes with string tied around them". Dr. Johnson's definition confounds our intellect as he has used terms that themselves need to be explained although he has defined 'definition' most accurately when he said: "To explain, requires the use of terms less abstruse than that which is to be explained, and such terms cannot always be found. For, as nothing can be proved but by supposing something intuitively known, and evident without proof, so nothing can be defined but by the use of words too plain to admit of definition." Dr. Johnson sinned against his precept because he did not use terms less abstruse as "such terms cannot always be found".

~~What is~~ The easiest to do in communication is to mislead others without even trying. The scientist, engineer and technologist have something to say and they need to say it in exact and unambiguous terms. Sir James M.Barrie rightly said "the man of Science appears to be the only man who has something to say, just now-and the only man who does not know how to say it". If this is true of scientists, engineers and technologists whose mother-tongue is English, it only emphasises the difficulty of the task, and lays stress upon the fact that students of technology in India should receive training in this mental exercise which calls for a special ideation discipline and linguistic discipline.

The word DEFINITION comes from the Latin words DE meaning 'with relation to' and FINIS meaning 'limit'. A definition therefore sets the limits or bounds to a scheme of ideas (concept).

(1) The meaning of something is delimited by choosing the right word. The right word conveys a given thought accurately and clearly. For instance, the words 'oblate' and 'spheroid' convey precisely the idea of a sphere flattened

at opposite sides. The phrase 'oblate spheroid' has exactness, precision, and is pointed, in describing the earth, while the phrase 'a ball slightly flattened at the poles, something like an orange' is loose and does not fix the idea. The student of science and technology cannot think of such precise technical terms and the situations where they are to be used without study of and practice and experience in the use of these words. The use of such precise technical terms minimises the interference that exists in man-to-man communication.

(2) Ideas pertaining to the concept of an object or thing are given a definite scheme by delimiting its properties. The general class to which the object belongs immediately suggests the pronounced qualities or characteristics of that class. In order to distinguish the object from all other objects in the class, the differentiating characteristics have to be determined. The perception of this differentiation is a difficult ideational exercise and its expression requires linguistic ability.

It is easy to define something when that something to be defined is intuitively known and is evident without proof. For example, if the something to be defined is 'light' we know what light is intuitively and we don't need any proof to show that light is the agency which makes things visible. But, when the something is not intuitively known, one has really to rack one's brains to give that something definiteness. How difficult it is is realised when attempting to define that most common place of all species MAN. Various renderings offered are Man is a living creature with two legs, Man is an animal which speaks, Man is a mammalian, Man is a living machine, etc.

We can give something definiteness by relating it to something else that is already known and has characteristics that are already familiar. The first consideration in doing this should be to decide the level of communication: Whether it is at the sub-speciality level or speciality level or professional level. Defining an acid as 'a substance with a sour taste which changes blue litmus to red' would be at the sub-speciality level; defining it as 'a compound containing hydrogen which can be replaced, directly or indirectly, by a metal' would be at the speciality level; and, defining it as 'a hydrogen compound whose aqueous solution contains hydrogen ions and no other positive ions' would be at the professional level. On deciding the level of communication, to construct the definition, the something followed by some form of the verb 'to be' or 'may be', or 'can be' is placed in a group or class or genus and differentiated or separated from all other members of the class by characteristics or properties peculiar only to that something and to nothing else. To organise the language structure so far as the something followed by some form of the verb 'to be' or 'may be' or 'can be' is the easiest. Placing the something in an appropriate class is also not too difficult. When this is done, it meets an important psychological need of every listener/reader, namely, he begins to feel he knows it. For example, in defining Man, that 'Man is an animal' is so far as we can go without structural difficulty and ideation difficulty. Now, determining the distinguishing features peculiar to Man is difficult ideationally. That 'Man is a biped' does not distinguish him from the birds. That 'Man is an animal which speaks' does not distinguish him from most animals that communicate with one another of the species, perhaps without loss of ideas! That 'Man is a mammalian' does not distinguish him from either the cow or the goat. That 'Man is a living machine' again does not specify any distinguishing characteristic. The definition of Man in Malayalam namely that 'Man is an animal that laughs and cries' perhaps marks some distinguishing characteristic, namely, that Man belongs to the genus 'animal' and is different from all other animals in that he alone is capable of experiencing joy and sorrow which is not the same as experiencing pleasure and pain which all animals do from instinct and not from a state of mind. Yet, perhaps this definition of Man is still not satisfactory. The definition that 'Man is an animal that makes tools' is more near the truth, it seems.

The differentiating feature can thus be too broad or too narrow. When it is too broad, it does not eliminate all other elements of the set. When it is too narrow, it itself becomes a class as 'Man is a human being'.

Determining the class to which the something belongs could be exasperating. The class too should be neither too broad nor too narrow. For example, in defining a watch, if we say that 'A watch is a machine', we are classifying it in a category that includes things unlike a watch as a sewing machine, a typewriter and an automobile. On the contrary, if we define a watch as 'a time-piece for carrying in the pocket or wearing on the wrist' the class becomes too restrictive.

The linguistic rendering of the ideation is only less difficult. A definition to be not only valid but also effective should not lack in grammatical parallelism. The class should be paralleled with the something to be defined. If it is a noun, the class should be a noun; if a gerund the class should be a gerund; and if an infinitive the class should be an infinitive. For example: A flying saucer is an object flying, or capable of flying, at great speed and at a great height.

Shucking is removing the husk from the grain of corn.

To shuck is to remove the husk from the grain of corn.

Parallelism should also exist between the elements that distinguish the something. For example, in defining a chair, if we say 'A chair is a movable seat with four legs and a back and designed for one person', two of the elements that distinguish the chair from all other members of the class are expressed as a prepositional phrase and the last element as a participial phrase. For all the elements to be paralleled the chair should be defined as 'A chair is a movable seat having four legs and a back and designed for one person' where all the three elements are expressed in participial phrases even though two elements are introduced by the present participle 'having', and the third element by the past participle 'designed'; this does not affect the parallelism.

The test of a correctly rendered definition is that when the class followed by the differentiating phrase or clause is transposed to take the place of the subject, the resulting statement has the same validity. For example, the definition of the chair as ' a movable seat having four legs and a back and designed for one person', in the transposed position becomes 'A movable seat having four legs and a back and designed for one person is a chair'; it is as valid as the previous case.

(3) Where the concept is involved, definitions often require explanation. For instance, in defining 'valency', the definition of 'valency' as 'the power of an atom to combine with other atoms' is elaborated as 'the property possessed by elements of radicals of combining with or replacing other elements or radicals in definite and constant proportion' and is often followed by the explanation 'An element has a valency of 1 if it joins with 1 atom of hydrogen, or with 1 atom of fluorine, or takes the place of 1 atom of hydrogen'.

The point has been laboured to stress both the ideation difficulty and the linguistic difficulty of the exercise. Students of technology would find the exercise of writing definitions a mentally challenging task disciplining them in the ideation process and in the linguistic structuring.

A lesson on writing definitions conducted for students with inadequate proficiency in English showed that the difficulty experienced by students of technology in India is not so much linguistic insufficiency as ideational incorrectness.

The lesson was aimed at teaching the students with inadequate proficiency in English, the linguistic mechanics of writing definitions. Even as the lession was announced to them, and, no sooner ~~than~~ the items to be defined were mentioned, than pat came the definitional form. The class did not need any instruction in this linguistic framework at all. Their responses showed that those who had clear concepts knew the linguistic mechanics of writing definitions. The result of the analysis of the responses is presented in the following Table.

TABLE

Analysis of the Response of 32 studemts.

Nature of response	No. of students
Right	5
Incomplete	7
Spelling error	11
Grammatical error	13
Ideational error	15

A sample of responses which are ideationally correct are given below, with the linguistic errors, wherever present, underlined.

Define Latent heat.

(1) Latent heat of a substance is defined as the heat required to change the state of that substance without changing the temperature.

(2) Latent heat is the amount of heat required to convert one gram of solid or liquid in liquid or vapour state without any change in temperature.

(3) Latent heat is the heat used by a substance in changing its state. (incomplete).

(4) Latent heat is the amount of heat needed to change the phase of 1 gram substance with constant temperature.

4. WRITING COMPLEX SENTENCES

The mode of explication of scientific phenomena and processes necessarily requires the inter-linking of the data, the arguments based on the data and the order in which the premises lead to the conclusion, or, the interlinking of the stages of a process. The synthetic mechanics of syntactical structuring that interlink the elements of an argument or of the stages of a process need to be practised. In synthesis the various small units of thought are combined into a longer ~~double~~ compound sentence by the coordination of clauses, or into a complex sentence by the subordination of clauses.

Practice is necessary in managing the mechanics of the language for writing complex sentences so that the composition is a well-balanced connected whole. Emphasis should also be placed on the use of 'IF' on which most scientific arguments are pivoted.

Construction of clauses has been discussed in some detail in the section 'Linguistic Devices to obtain Objectivity' under the sub-head 'How to be unambiguous'. (pages 241-246)

5. RHETORIC*

Good exposition is a natural expression of the activated thought and not merely ~~stringing together of~~ observing the rules of grammar. The best way to write well is not through blind absorption of the mechanics of language, but through clear conception of the ideas which have to be expressed.

Rhetoric is the art of organising ideas into effective exposition. Modern Rhetoric has shifted its emphasis from the art of embellishment (art of using words impressively in speech and writing) to the art of practical workmanship with words. The study of Rhetoric provides the necessary ability to discover the structure and dimensions of ideas, that make up an exposition. It examines what ground the idea covers, how many parts it has, how the parts are related, and how best to express them. It provides the necessary linguistic ability to organise sentence structure and phrasing, to organise lines of argument into the most effective pattern, to group matters of fact into units of related material with due regard to essentials of paragraph ordering. Rhetoric disciplines the mind with the sense of language and with the grasp of the organisational structure, with the awareness for rhetorical principles as unity, coherence and emphasis. Rhetoric conditions the mind to develop

* RHETORIC: DISCOVERY AND CHANGE, R.E. Young, A.L. Becker, and K.L. Pike, Harcourt, Brace and World, Inc., New York.

these rhetorical properties from an accurate analysis of the idea(s). Unity, coherence and emphasis are qualities which have to be perceived in the idea before they can be embodied in an exposition. Effective exposition is the result of effective thinking and not merely a matter of rules. Rhetoric involves the student into a full participation in the actual process of exposition, encourages an active and rational instead of a passive attitude, exposes the artistry, variety, intricacy and finesse of the workmanship with words and eventually reveals the magic world of language.

Cleanth Brooks and Robert Penn Warren discuss at great length modern Rhetoric in their book MODERN RHETORIC (published by Harcourt, Brace and World, New York, 1970). Although the book is written primarily for the general purpose, it well serves as a guide and reference book for the instructor of the ELT programmes in technological education since the basic principles governing ideation and expression are the same.

RHETORIC: DISCOVERY AND CHANGE by Richard E.Young, Alton L. Becker and Kenneth L.Pike, (published by Harcourt, Brace and World, Inc., New York) provides a coherent and comprehensive method of improving competency in self-expression in writing. The application of the linguistic theory tagmemics has developed new theoretical principles and problem-solving procedures. The book is particularly useful to ELT instructors in technological education.

George C.Harwell in his book TECHNICAL COMMUNICATION

(The Macmillan Company, New York, 1971) has aptly illustrated the rules of Rhetoric with particular reference to technical subject matter on pages 286 to 292.)

Although these components can be treated as independent elements for teaching/learning purposes, they are not to be viewed as isolated components in themselves; they form vital elements of an integrated programme, each contributing to the mental discipline required for technological education and equipping the learner with the ability of the language for receiving that education. The cumulative effect of these components would be appreciably experienced by the student when he has moved from the elementary processes of drawing analogies to the complicated and complex mechanism of ideation and self-expression. As the student moves from discovering analogies and patterns not dissociated from language to the phenomenal world of science and technology, he moves from the simple mechanism of word-pictures and ideation patterns, to the larger integrated patterns in the world of nature and the technological world of machine systems.

FOR PROFESSIONAL SUCCESS

The technologist's professional needs of language are diverse and varied. The majority of our technologists are going to hold key positions, if not in huge industrial complexes, at least in units, departments and sections of industries and industrial complexes. In their managerial roles, they would be called upon (i) to speak at meetings, seminars, and conferences; and, (ii) to write reports. These tasks require training and a discipline.

The ELT for technology must equip a learner for the technological career, and discipline him to transmit his special knowledge in such a manner that he is able to hold the line of mental communication between him and another at the same intellectual level, and that he is able to use the most effective modes of expression and offer cogent argument at discussion, thereby achieving economy of mental effort on his part as transmitter of his special knowledge, and requiring economy of mental effort on the part of the recipient of the transmitted knowledge. He needs to develop the art of public speaking; he must be able to hold the attention and interest of his audience; he must learn to be a clear speaker, with the voice which is fully under control.

The initiation exercises take the form of Pro-Seminar, Seminar and Symposium. These are means of exchange of ideas, of broadening the student's mental horizon and gaining experience in discussing an issue. The practice of examining a problem from every angle and of propounding one's ideas and objections is best gained through them. They are means of investigating and expounding concepts and ideas methodically. They are exercises in clarity of thought. In order that the discussion may be fruitful, the speaker must propose clearly and in precise terms his views on the subject. They are training in self-discipline as they require of every participant to set forth his view without prejudice or passion and to allow others to expound their views with equal freedom. They promote self-control, fairness of mind, politeness to let~~ting~~ others speak and not to interrupt~~ing~~ a speaker, and honesty in keeping to the essential points of the discussion.

The Instructor who functions as president, on whom largely depends the success of the discussion, by guiding the proceedings with prudence, without dominating it himself, through his questions, remarks, comments and proposals, shows new aspects of the problem which have not been thought of. These programmes, well conducted, are excellent means for exercising the mind for the kind of mental operations required in professional career later.

(i) PRO-SEMINAR

The practical exercises of the Pro-Seminar are intended to give the student the knowledge of how to find sources, the manner of quoting and citing books and periodicals, the method of taking notes and arranging bibliographical and documentary cards, the manner of using a library intelligently, etc. The direction of the Instructor will enable the student to learn to read sources correctly.

(ii) SEMINAR

In a seminar, an examination and discussion of some practical problem is undertaken, to be followed by critical discussion. The seminar is intended to stir the mind of the student for the heuristic activity. In the lecture classes he assimilates by attention and penetration what is given to him by others; in the seminar he has the opportunity to endeavour to discover something for himself; it arouses the latent energy of the student to learn for himself by being mentally energetic, and to react intelligently to an issue, to be objective while dealing with the opinion of others, moderate in proposing his own, and to strive for scientific probity.

(iii) SYMPOSIUM

An American author has rightly called the present age the age of symposiums. A good beginning in participating in symposiums should be provided by the ELT programmes. In a symposium, each student studies an aspect of a problem in great depth and presents a paper on it. This exposition forms the basis of discussion. When the paper has been read, the Instructor proposes for discussion its different aspects. Thus, the discussion may centre on the content, the force of the arguments, the pros and cons, or, on the form of presentation, the arrangement of the subject, the manner of reasoning.

The ability required to face an audience, however small, is not easy to acquire. It grows only with practice. A denial of this practice and experience to the student now, would be ill-equipping him for his professional career. The confidence that is needed for facing an audience has to be cultivated by experiencing the sinking feeling in the pit of the stomach when one faces an audience, and over-coming it. ELT for technology should give the student class-room opportunities for delivering talks, participating in discussions and in mock interviews.

There is no dearth of instruction available on the art of public speaking; however, these cannot substitute the act of speaking itself. As one learns how to swim by swimming, one learns how to make a public speech only by making a speech in public. He then learns that:

(i) he must speak only when he has something to say, especially in a deliberative assembly;

(ii) he must speak only what is relevant;

(iii) he must say only what he has considered well in his his own mind, in a well-ordered sequence;

(iv) he has to be clear and unambiguous; and

(v) he has to be brief.

1. ABILITY TO ARGUE

These initiation exercises would be fruitless if logic is not the base of discussion. The imposition of logic requires a thorough analysis of the argument which must be broken up into related fragments. The student should be enabled to use evidence in support of his argument. Arguments can be faulty if they are based on incorrect evidence, or the logic of the artument is invalid. ELT for technology should impart instruction that would enable the student

(i) to understand the nature and structure of argument,

(ii) to recognise and construct the two main types of arguments: Deductive and Inductive,

(iii) to base evidence on examples drawn from experience or analogy,

(iv) to identify fallacies in logic,

(v) to use the syllogistic form for the deductive argument,

(vi) to group the evidence and to state it before the conclusion in the inductive agrument,

(vii) to organise the argument in the most effective way to achieve the object of argument, namely, persuasion, and

(viii) to draw appropriate conclusions from adequate evidence.

Chapter 3 and chapter 7 of THE TECHNOLOGIST AS WRITER by Peter Coleman and Ken Brambloby (McGraw - Hill Book Company, New York, 1969) provide relevant help and useful exercises that give necessary practice to the student.

2. SPEECH TRAINING

One of the components of ELT for technology which aims at equipping the student for his professional career should be speech-training. Training in the art of public speaking would be incomplete without speech-training. Professor R.K. Bansal's research on THE INTELLIGIBILITY OF INDIANENGLISH, conducted at the University of London in 1964-66, has highlighted the features that make Indian English unintelligible to native English speakers; and, I would add, even to Indians. He has rightly said:

"English as spoken by educated people in India does not differ radically from native-English in grammar and vocabulary, but in pronunciation it is different from both British and American English. Even within India there are a large number of regional varieties, each different from the others in certain ways, and retaining to some extent the phonetic patterns of the Indian language spoken in that particular region. These regional varieties of English are sometimes not even mutually intelligible. In every region, however, "there are people who have shaken off the gross features of regional accent and speak a more 'neutral' form of Indian English. It is also true that in every region there are good speakers of English and bad speakers of English, "the terms 'good' and 'bad' referring to the degrees of approximation to native English and Standard Indian English "and also to qualities of clear, effective and intelligible speech"[1].

Even the best of educated Indian speakers betray a deficiency in the use of the English language for speaking when they use the disyllabic words with dual functions in their speech without making the pronunciation difference that exists in these sets of words.

The aim of the Speech-Training programme should be to enable the student, in the initial stages, acquire a good pronunciation, for the simple reason that clarity of expression in speech is greatly facilitated by a good pronunciation, stress patterns and rhythmic balance of the sentence.

The art of speaking well cannot be acquired from books. The student has to acquire the art only by imitating a model and by knowing the technique. Models are now easily available in the form of tapes to enable the student practise on his own. The Language Laboratory, if it is available, is a helpful place for speech-training classes. The facility that the Language Laboratory provides for recording speech and playing it back would enable the student to criticise himself and improve his accent, rhythm and intonation, without any embarrassment. A brief introduction to phonetics, a study of the sound system of English, rules for accentual

1. SPOKEN ENGLISH FOR INDIA, R.K. Bansal and J.B.Harrison, Orient Longman, 1972, pp. 3-4.

patterns and intonation patterns, accompanied by pronunciation drills, dialogue practice and delivery of talks, are necessary for the student of technology to be able to speak well. The following two books provide all the necessary material for instruction in Speech-Training, and practice:

1. SPOKEN ENGLISH FOR INDIA, R.K. Bansal and J.B. Harrison, Orient Longman, 1972.

2. ENGLISH PRONUNCIATION PRACTICE, G.F. Arnold and A.C.Gimson, University of London Press Ltd., London, 1970.

3. REPORT WRITING

Report-Writing could be made as challenging a programme as any other technological programme. There is at every stage much that the student has to discover and learn, beginning from what a report is to how to be terse and unambiguous in Report-Writing. He has to learn how to construct a questionnaire to collect his data, how to order his data, how to be objective and how to be effective.

A Report is a write-up conveying specific information properly classified and substantiated, marked by directness of treatment and economy of words.

Business management of any organisation, be it a primary school or an industrial complex, requires a systematic approach to both human and situational problems for efficient functioning of the organisation. This necessitates the recording of whatever information need to be passed round, business transacted, investigations conducted, operational policies arrived at, decisions taken, and of any other managerial action decided upon. These records or reports have not only an immediate functional value but are the edifices on which the present has evolved from the past, and the future to be evolved from the present.

With the expansion of organisation involving personnel so numerous that the employer does not know by face the majority of his employees, contact is maintained mostly through reports.

Although all reports are characterised by directness of treatment and economy of words, reports fall under various categories, the structuring of a report depending on (i) the nature of the information to be conveyed, and (ii) the purpose for which it has been sought. For instance, the following reports are all on persons, and yet they are structurally different:

(a) Bio-data,

(b) Progress Report,

(c) Confidential Report, and

(d) Certificate/Testimonial.

The Bio-data informs particulars of an individual; the Progress Report informs the Progression that an individual makes in a situation; the Confidential Report reports an employee's application to work, execution of work, and conduct as reported by the officer to whom he is directly responsible; the Certificate or Testimonial states the impact an individual has made on another who is generally his officer.

The categories of reports are diverse in structure. The following Table shows the categories of reports classified under my scheme of approach:

REPORT

PERSON

1. Biodata/resume
2. Progress report
3. Confidential report
4. Certificate/Testimonial

SITUATION

1. Letter report
2. Memorandum report
3. Bulletin report
4. Minutes
5. Sports' report
6. Annual report
7. Special report: (inspection, investigation, analysis, etc.)
8. Report of committee/commission
9. Scientific/Technical report.

The student has to be exposed to the format of each of these as well as to the model of each report. He has to have experience of writing each of these for a specific situation in which he is likely to be. Above all, he has to be exposed to the linguistic devices for obtaining objectivity, terseness and unambiguity. He needs to be helped with appropriate vocabulary for each situation. For instance, for writing a Confidential Report or a Certificate or Testimonial, he shall greatly appreciate help provided in the form of a vocabulary list as the one given below.

VOCABULARY FOR DESCRIBING PERSONAL CHARACTERISTICS

Note: The list and vocabularies may be extended to suit particular backgrounds and purposes.

	POSITIVE	NEGATIVE
ALERTNESS	Active	Apathetic
	Impressive	Impassive
	Lively	Indifferent
	Sensitive	Spiritless
ANALYTICAL ABILITY	Accurate	Blundering
	Explicit	Complicated
	Mathematical	Disjointed
	Methodical	Clumsy
	Precise	Obscure
APPEARANCE	Neat	Uncouth
	Refined	Ungainly
	Smart	Slovenly
	Tidy	Untidy
APPLICATION	Consistent	Dilatory
	Hard-working	Languid
	Diligent	Easy-going
	Indefatigable	Lazy
	Industrious	Slow
	Untiring	Sluggish
EXECUTIVE ABILITY	Commanding	Gentle
	Masterful	Lenient
	Powerful	Indulgent
	Strict	Soft
EXPRESSION	Clear	Ambiguous
	Concise	Circumlocutory
	Explicit	Confused

	POSITIVE	NEGATIVE
	Laconic	Involved
	Lucid	Long-winded
	Precise	Prolix
	Succinct	Vague
	Terse	Verbose
SPEECH	Clear	Mumbling
	Eloquent	Inarticulate
INITIATIVE	Confident	Inactive
	Energetic	Inert
	Enterprising	Indolent
	Intrepid	Lethargic
JUDGEMENT	Astute	Foolish
	Clear-sighted	Obtuse
	Discerning	Muddle-headed
	Shrewd	Stupid
RELATIONSHIPS	Cooperative	Unfriendly
	Cordial	Cross-purposed
	Helpful	Self-centred
	Sociable	Quarrelsome
	Understanding	Prejudiced

The actual practice in writing reports should be in gradual and graded stages as shown below:

(i) To formulate or define the topic of the report in such terms as the writer knows what is required of him. This is the first and essential step. The formulation of the topic clarifies his purpose in writing. The well-defined purpose will thereafter control and guide the data he needs to collect and how to order the data. When the purpose is clear to the writer in specific terms, it facilitates the selection and presentation of his material.

The definition of the topic is itself a two-stage process. It involves consideration of purpose and choice of lexis in wording. A proper formulation describes the topic, suggests its parts, limits it, and determines ~~predicts~~ the order of treatment. It serves as a map suggesting the route the writer ~~will~~ would take, and ~~will~~ preventing ~~writer~~ him from straying into irrelevant side issues. The reader also is enabled to see clearly the direction of development of the report.

Suppose ~~for instance,~~ that a letter requesting an outline of a company's policy ~~on~~ with regard to the return of faulty components is to be replied. The writer of the reply will have to first formulate the statement of his reply in such terms as:

The policy depends on the circumstances of purchase of components, the customer's qualifications to handle and install the components, and the length and type of service preceding component failure. The writer could then proceed in detail with each element of the formulation. The formulation of the topic forces the writer to consider carefully what his purpose is, and what method of treatment and ordering of available material will best promote that purpose. Exercises as the one below are useful:

(1) Selecting a Transistor Radio

(2) The operation of a Stapler

(3) Typing a Letter

Collective efforts of the class in helping one another define the topic of the report is a useful exercise. Individual answers when discussed by the group leads to a consensus as to the best answer. If the students, in estimating the correctness of each other's solutions, are required to state clearly the bases for their judgements, a very useful lesson in argument is learnt. I found that this exercise can sometimes require as much as one contact hour for the formulation of one topic, and students are greatly benefitted from this mental and linguistic exercise.

Other stages that prepare for the writing of the report are:

(ii) To write the Abstract to a report. This exercise in abstracting is indeed difficult mental operation. It disciplines the mind to do that kind of operation required for abstracting, and to select language appropriate for it.

(iii) To write the Introduction to the report.

(iv) To introduce the topic of the report to the class with a view to inform the class the line of approach of the writer. The discussion that follows is an important method of accumulating report material.

(v) To construct a questionnaire for collecting data for his report; and

(vi) To order the data under various sub-heads so that the shift from one to the other is smooth, continuous and logical.

At all the stages, the Instructor should guide the student to use the Denotative stratum of language, to be terse and unambiguous, to be logical, and to be objective. Before beginning to write reports, a useful exercise that helps the student in fixing the structure of a report and in arriving at appropriate measures for achieving objectivity is to require him to criticise and improve reports that have not been well written (collected from those of their predecessors).

Reports to be written by students should be concerned with concrete objects and events, with description of hardware and of processes. The model of a report that the Instructor would give his students should project the fundamental aspects of report-writing, namely: (a) the selection of the relevant data necessary for the development of the topic, (b) logical arrangement, (c) the appropriate format, and (d) the graphic aids to the report.

A useful means of establishing these aspects is to require the student present the outline of the draft to the class for collective analysis. The subsequent discussion followed by agreement and disagreement of the class along with the evaluation of the Instructor, gives the student ample practice for going about his job. The draft itself should be studied by the Instructor and returned to the student with his notes for incorporation.

The Instructor should also point out the graphical aids and the nature of such aids (tables, charts, diagrams) that should accompany the report, and the particular places where such aids are necessary. The student's knowledge of Technical Art would aid him in the proper construction of such aids. This presupposes that the Instructor himself knows the types of graphic aids and how to construct them.

THE TECHNOLOGIST AS WRITER by Peter Coleman and Ken Brambleby (McGraw Hill Book Company, New York) contains appropriate instruction material, and intellectually stimulating exercises for training in report-writing.

4. SCIENTIFIC ARTICLES

Although not all students of technology would be called upon to undertake original research and expose the results of their research, they would have to write scientific articles as monographs, theses, and specifications, sooner or later. Any scientific article can be written only after some research work, in the sense of a digest of work already available. The exposition of the findings of research must be done with the utmost objectivity. The writer should avoid giving the least suspicion either of partiality or of hostility; he should not dare say anything which is false nor fear to utter anything that is true. By his way of writing he should insure that readers get no wrong impressions or false perspectives. It would be against scientific ethics if he amassed references that favoured his view, and omitted or minimised references that pointed in a different direc-ttion.

There is much duplication of scientific endeavour and, consequently, unnecessary waste of time, labour and funds in India, because our researchers do not adopt the DYNAMIC IN-TERNAL METHODOLOGY. They do not begin from facts/or data that are already proved or established and problems that have already been solved, for the simple reason they have not taken the psins to consult the Science Abstracts, the Documentary sources, and other works of reference. In any research the scholar must know what information is already available on the subject of his inquiry.

ELT for technology should provide the necessary training for practice in the method of investigation, and for writing scientific articles. This training comprises the following:

(i) What and where are the sources of a scientific inquiry, and what is the bibliography related to the investigation: For the purpose of placing at the disposal of all concerned the fruits of centuries of intellectual activity, Bibliographies, Catalogues, Abstracts, Encyclopaedias, Scientific Manuals, Monographs, Concordances, have been published. The student should be set assignments that would necessitate the consultation of these sources, and that would acquaint him with all kinds of source material, including Bibliographies of Bibliographies or Bibliographic Indexes.

(ii) How to read books: Books should not be read as they come to hand, but according to a pre-arranged plan. It is advisable to begin with books of more recent date, in which will be found the solution of many problems which had been merely referred to in books of earlier date.

(iii) How to take notes: In the reading of the sources and subsidiary works one finds (a) bibliographical informa-
tion, (b) entire passages that postulate word-for
word transcription, (c) ideas connected with the work
in hand that it is necessary or conve
rise or cond
relevance to
purpose for some other work which we may eventually
undertake, or which are/of general interest; (e) ideas,
questions, problems suggested by the reading of the
book.

The notes should be taken on cards. While reading it
will be convenient to have at hand two or three kinds of
cards: (i) Bibiolography cards for bibiolographical entries
only, corresponding to the above (a); all the bibiolographi-
cal elements (and, if possible, short references to the
value of the work in question) should be given; (ii) Docu-
mentary cards (special), for the material of the nature men-
tioned above under (b) (c) (e); (iii) Documentary cards
(general), for ideas and notes for future works or matters

simply of general interest, corresponding to the above (d).

A scientific article is either of an experiment conducted, or of a project carried out. In either case, it should incorporate the description of hardware and the description of processes. In the former, the writer must enable the reader to visualise the hardware, its components and their respective positioning. The ultimate test of an effective description of a piece of hardware is, it should enable the reader reconstruct, or draw, the object and its position from the description.

An adequate description of an object must specify what material the object is made of, what size and shape the object is, with dimensions and measurements, what is the position of the object in the scheme, and what the function of the object is. The description must be so organised that it corresponds to the spatial organisation of the object in three dimensions. The organisation depends on the way the components fit together. The writer must specify the view of the object being given, whether it is the 'side elevation' or 'plan'.

Instruction in the description of hardware should be accompanied by models from the instructor, as :Describe a tin-can.

A tin-can is a cylindrical container of a suitable size, made of thin iron sheet coated with tin, having one end permanently closed and the other end provided with a lid that is openable or sealed, used for keeping perishable food products.

The description of processes states what happens in a device or system when it is in operation, and indicates its course and direction. The stages in the operation are enumerated in the order of a logical time sequence. It gives the instruction to the reader to carry out a particular task, and indicates the procedure.

Assignments as the following train the student for the kind of writing required in scientific articles:

1. Write a process description of the manufacture of hydrogen gas by the action of an acid on zinc.
2. Write an instruction for removing the wheel from a car.

THE TECHNOLOGIST AS WRITER by Peter Coleman and Ken Brambleby (McGraw-Hill Book Company, New York) introduces the student to the art of writing technical and scientific articles.

5. WRITING SPECIFICATIONS FOR PATENT

Specification writing is different from writing a scientific article. The scientific article is broad-based, descriptive information, which can be comprehended by persons not directly engaged in the same art. Specification writing is a specialised communication in one or more planes, which can be understood only by one directly engaged in the same art.

Written descriptions of materials and directions for their proper use in a particular project or process are called specifications. They have to be written for any engineering work be it construction, maintenance, or servicing.

In his professional role, every technologist would be required to specify details of materials used in projects and processes to be carried out or that have been carried out, and directions and instructions for the use of these materials. In the training of engineers and technologists, the ability to write specifications is acquired as part of the training given. Writing specifications is not usually a major problem for the technologist. With the specialist's knowledge that he has acquired, he has learned how to write these details for his requirements.

But, writing specifications for Patent, which a technologist would be required to do when he has need for it, as when he has originated a new invention, is not the same. The technologist has to write his specifications in such a manner that it enables 'any person reasonably skilled in the art to which the invention relates, to put the invention into practice without further assistance from the inventor, and obtain the results claimed for the invention.[1] The Patent Act of India says 'the language should be free from vagueness and ambiguity'. Writing specifications for Patent is specialised writing where the details are to be exhaustively and unambiguously explained in legally acceptable terms, and, yet, in a language that can be comprehended by any person.

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1. THE PATENT ACT OF INDIA.

A study of the Patent Act would be desirable for such advanced students of technology who have an inventive bent of mind. With practice, it is possible for one to acquire the art of writing specifications for Patent. The Patent specifications being documents and the key-stone for industries, it is necessary for technologists to be familiar with the language, content, and manner of exposition of specifications for Patent because industry uses Patents.

6. STUDY OF LITERATURE OF THE DOMAIN OF SCIENCE

There should be no need to lay stress upon the part that expression and exposition play in a technologist's life. It is through these he reflects the quality of his mind and the order of his method. The ability to state facts plainly, to write a terse report, and to convey information intelligently marks the technologist as well informed, careful in observation, accurate in statement, and equipped for scientific work. No technologist can attain proficiency without care and without method; least of all can he be expected to succeed without effort and self-discipline. This proficiency comes with acquisition of the skill of using the language by drill and absorption of the knowledge of the art of using the language by will. The 'will' for absorbing the knowledge of the art is developed by being exposed to the masterpieces of literature in the domain of science where words have been skilfully used as symbols in mathematics, and the method of approach is scientific.

The students of technology need to be exposed to good exposition both for acquiring good taste and for learning the art of good exposition. They have to read the great writers who illustrate the art of good expression and exposition. It is a fashion now to read cheap dialect stories with the result that many young scientists, engineers and technologists acquire incorrect language habits. As with students of Humanities, students of science, engineering and technology should be initiated to read the best writings. It is true that the best writings are 'literature' in the sense in which we generally use the term; however, this 'literature' does not belong to the realm of Humanities alone; the domain of science and technology too has its 'literature' that expresses words in the best order.

The domain of science and technology has its classics, which, if read, as our grand-fathers read the Bible daily and so acquired a felicitous style of expression and exposition, would enable our young technologists to imitate the art of the models. If they would subconsciously absorb the art, they need to read T.H. Huxley's essays, Froude's short stories, Aldous Huxley's novels, H.G. Wells' space-fiction. There is no dearth of masterpieces written by scientists themselves. In order to learn from them, they should read them intensively. T.H. Huxley said "Science and literature are not two things but two sides of the same thing". He means that the search of the scientist and the humanist alike is for truth and human well-being. It also means that scientists like Huxley see science both as an end in itself as a search for truth and also a means for promoting human happiness.

They have therefore interpreted science in relation to human life in a form so excellent that their works are the modern classics. Their works not merely project the technique of writing but serve as an instrument of great philosophic and social significance. The technologist's life, even though it is bound up with science and technology, is essentially a human life. The technologist needs nourishment for the spirit as every human being needs. This nourishment was hitherto drawn from religion, and from the study of literature and philosophy. In our century the myth of religion has been exploded; and, there is no need for the study of the ancient classics and the study of philosophy for drawing this nourishment. For, in the modern classics of the scientists, who interpret and guide in true humanistic values the new scientific culture which is with us, there is the right nourishment for the technologist.

In the twentieth century, science has entered into all forms of literature which makes the literature of the domain of science rich and varied. There is the literature on the themes of scientific research as Sir Charles Snow's THE NEW MEN and Fred Hoyle's A FOR ANDROMEDA. The fantasias of possibility and space-travel stories, ~~of possibility and space-travel stories,~~ in comparison with real and graphic accounts of actual space-travel, which they featured on a pseudo-scientific basis, may not have the same appeal now; yet, they serve to portray the penetrating mind that had fathomed the depths of science long before science uncovered the depths. The scientific dystopias like George Orwell's 1984 capturing the true inferno of our time, exposing how all the demonic aspects of our modern culture-science, technology, economics and politics - operate, cannot fail to capture the minds of our scientists and technologists. H.G. Wells THE MIND AT THE END OF THE TETHER is a good example of the exploding of the myth of progress in which science plays the saviour-role. Aldous Huxley's BRAVE NEW WORLD projecting society's disease, its symptoms, 'the utopia of scientists in the full horror of being' has a cathartic effect on the minds of the budding scientists and technologists.

The Pylon School poets (C.Day Lewis, W.H. Auden, Stephen Spender) have dealt with scientific and technological themes, and have drawn their imagery from science. There is poetry projecting the world of shattered institutions, strained nerves, bankrupt ideals, aesthetic and spiritual drought, the terrible dreariness and desolation of the great modern cities, anarchy and doubt, as in T.S. Eliot's THE WASTE LAND. There is the protest at man's misuse of science and technology as in THE UNKNOWN CITIZEN by W.H. Auden.

For those who have the sense of subtle perception for seeing through irony, there are plays of THE THEATRE OF THE ABSURD. Beckett's WAITING FOR GODOT AND Edward Albee's WHO'S AFRAID OF VIRGINIA WOOLF? sum up with peculiar vividness and forcefulness the malaise of the technological age. These writers compel us to think of the moral issues in the context of a technological world, of the moral significance of man's use of science, of the disbelief in man's ability to use science only for human good, and of the growing belief that science is rapidly becoming not man's servant but his master. Then, there is the saga of the outstanding deeds of heroic men and women, whose contributions are land-marks on the road of human progress, and who have been aptly honoured by Nobel Prizes. The Nobel Foundation's publication in English of the Nobel Lectures together with short bio-graphical notes and the presentation speeches of the award winners is a literary monument in the realm of science and technology. The lectures are masterpieces of prose for their lucidity, naturalness, precision and conviction. They po-ssess a biblical loftiness. The biographies are intellectually stimulating and spiritually elevating. They rank second to none for their humanising influence and for imbibing the scientific culture.

And so, to-day, the more the student of technology is exposed to the nature and potentialities of science in imagi-native literature, or, to the intellectual stimulation and spiritual upliftment in the 'Bible' of the domain of science-the Nobel Lectures-the more likelihood is there that its good influence would be felt sooner or later. Contemporary lite-rature that concerns with the moral and personal problems of human beings in the context of a technological world should figure in the core curricular programme for students of technology. If time is not available for an intensive reading of some of these books, at least an anthology of ex-tracts from these books should be prescribed. A good antho-logy that is available is SCIENCE AND LITERATURE in two series, edited by W. Eastwood (Macmillan and Co. Ltd., 1963).

CONCLUSION

A.S. Hill, Professor of Rhetoric, Harvard University, said "Every year Harvard sends our men some of them high scholars - whose manuscripts would disgrace a boy of twelve; and yet the college can hardly be blamed, for she cannot be expected to conduct an infant-school for adults!" To which T.A. Rickard, an eminent Mining engineer, reacted thus: "The cure is for engineering colleges to refuse degrees to students that show no regard for precision of language, meanwhile making an effort to remedy the effect by giving them the necessary instruction."[1]

Schools of Engineering and Institutes of Technology in USA have, since, remedied the 'disgrace'. They have evolved special courses for the use of language as an instrument of precision. These courses enable students of engineering and technology cultivate a proper standard of the language so that technical competency is joined with linguistic proficiency to communicate technical knowledge. It is time that Institutions of Engineering and Institutes of Technology in India take seriously the teaching of English to the students of technology.

The components that I have identified, are related to the precise needs of the student of technology in India. ELT for technology structured with these components would, I

1. TECHNICAL WRITING, T.A. Rickard, John Wiley and Sons, New York, 1947, pp. 2-3.

believe, enable the student do his technological study better while improving his linguistic proficiency, and equip him for his professional needs.

ELT for technology in India has to serve the object of enabling the student acquire linguistic proficiency INASMUCH AS IT IS THE LANGUAGE OF INSTRUCTION OF TECHNOLOGY, with the implication that the student thus enabled would do his technological study decidedly better than the student who does not do the ELT programme. To provide this ability it has to be related to the precise needs of technological study, which we have already identified as primarily heuristic, that is, understanding the data, the arguments based on the data and the order in which the premises lead to the conclusion by the exercise of the various mental processes so that the student is set to find out things for himself. The primary need of cognitive activation for heuristic function is served by one prong of the language functioning as instrument of thought for the numerous mental operations for perceptual and conceptual actions, and the second basic need of language for the student of technology is served by the other prong functioning as instrument of self-expression for communication through the established oral and verbal referents, the word-order and structure-order of the language system, and the mechanics of the language, so that the denotation conveyed through language symbols of ideas is well defined. The two functions of language, one at the ideation plane and the other at the word-plane, although developed and strengthened by two sets of components of ELT for technology, are synchronic in action in that cognitive activation takes place through language, and expression in language is of ideas generated in the mind. The synchronic action is at the very core of language, for language is meaningless without idea. Although idea can come into being without language, the moment language gets into action, it is the idea that is transformed into language.

Each of the components of ELT for technology only projects a certain ideational or linguistic feature that has to be specially developed and strengthened in the student. The compartmentalisation of the components does not, in any way, suggest that these components are independent. In each component the others interact, and, it is quite possible, that in treating one component several others get treated as well; and, it may well be, that those others need not be treated again. The components have been projected in compartments and each treated independently only for the emphasis that each should receive.

The three specific needs to be provided for in language training, namely,

(1) to enable the student comprehend and assimilate technical knowledge,

(2) to enable the student acquire ability of the mechanics of Functional English to express his technical knowledge and know-how in the word-plane, and

(3) to provide the experience of the language in the practice of the profession;

are thought of as three different needs only for teaching convenience and learning experience. It is obvious that each of the components concerns both the present need and the future need of the student, yet, the present is only to prepare for the future.

These components in meeting the precise needs of the student make ELT for technology meaningful and pragmatic, and collectively become another component of technological education.

I have referred to only one text for one component, and, in some cases, the same text for more than one component, contrary to the general practice of referring to a long bibliography for relevant material. Apart from serving as a mark of scholarship, the bibliography does not help the student in any way; besides, the teacher has to wade his way through the pile of books, and, in the end, not find much useful material. The one text I have chosen is both specific and comprehensive for more than one component. For instance, THE TECHNOLOGIST AS WRITER by Peter Coleman and Ken Brambleby (McGraw-Hill Book Company, New York, 1969) covers all the aspects of ideation and exposition concerning the technologist's field of work; and, it has intellectually stimulating exercises. A student who has worked his way through the book would receive the necessary training for his role, and the discipline for the kind of approach to the technologist's problems. In order to use the book, the teacher would have to do his homework properly. The high cost of the book is off-set by its pedagogic value.

Chapter X

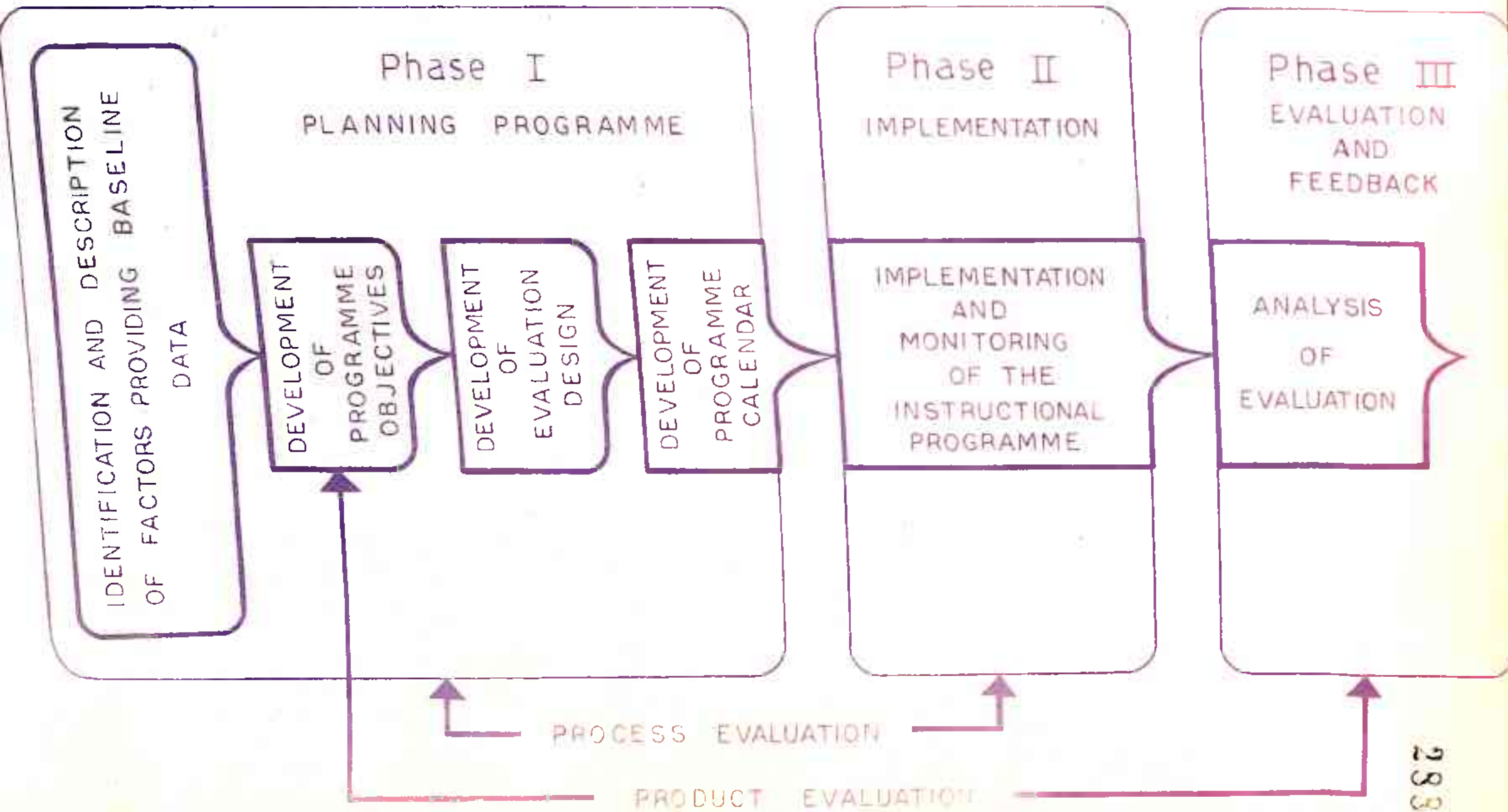
SCHEMATISATION OF THE ELT PROGRAMMES IN TECHNOLOGICAL EDUCATION

As in any other teaching programme, the programme of ELT for technology needs to be schematised according to the directing parameters: Context, Content and Control. We have considered the context of technological education and the factors that condition English language teaching in it. From this has emerged the object of English language teaching. The object of ELT has, in turn, determined the content or the curriculum appropriate for ELT for techno-logy. What now remains is the control of the ELT programme so as to achieve the object. The control naturally calls for a schematisation of the programme taking into account all the parameters of the situation and the concept of edu-cation.

The schematisation of any educational programme in-volves three phases.[1.2.3.4.] Fig.1 illustrates the schematic.

1. TAXONOMY OF EDUCATIONAL OBJECTIVES, Handbook I, Benjamin S. Bloom, David Mckay, Inc., New York, 1956.
2. TAXONOMY OF EDUCATIONAL OBJECTIVES, Handbook II, D.R. Krathwohl, B.S. Bloom, B.B. Masia, David Mckay, Inc., New York, 1964.
3. PREPARING INSTRUCTIONAL OBJECTIVES, Robert F.Mager, Fearon Publishers, Lear Siegler, Inc., Education Division, Belmont, California.
4. THE DEVELOPMENT AND EVALUATION OF BEHAVIOURAL OBJECTIVES, R.J. Armstrong, T.D. Cornell, R.E. Kraner, E.W. Robertson, Charles A. Jones Publishing Company, Worthington, Ohio.

FIG. 1: SCHEMATIC OF AN INSTRUCTIONAL PROGRAMME



The first phase requires:

(1) the identification and description of the specific factors that affect the programme;

(2) the development of the objectives of the programme;

(3) the specification of the evaluation design, and

(4) the development of a programme calendar.

The second phase is the implementation phase and the third phase is the evaluation and feedback phase.

PHASE I : PLANNING THE PROGRAMME

1. The key to identification and description of the specific factors that affect the programme is to find answers to the following four questions:

(i) What is the 'subject' factor? or Who is the subject of the instructional programme? (undergraduate, graduate, postgraduate, doctoral, research, or faculty, with other sub-determinants.)

(ii) What is the domain at which change is intended? (cognitive, affective, or psychomotor.)

(iii) What are the pre-requisite essentials, if required?

(iv) What is to be taught and when is it to be taught? (in what sequence?)

2. The objectives of the programme are arrived at following the identification and description of the specific factors that affect the programme and finding the answer to the question: What is the behavioural outcome intended? What is the specific growth desired?

3. The specification of the evaluation design naturally and easily follows the determination of the behavioural

objectives. The selection of the assessment procedures is only a matter of detail.

4. The programme calender summarises the salient aspects of the instructional programme, and establishes a schedule for the evaluation procedures.

PHASE II : IMPLEMENTATION

The successful implementation of the programme depends on the ability, attitude, and planning of the teacher. A schematic planning and description of activities as they ought to take place is a necessary concomitant of the instructional dimension. When structured as a format under the various instructional elements (organisation, content, method, facilities), the implementation of the programme and observation and recording of what actually takes place are facilitated. It determines the extent to which the programme is reaching the desired instructional outcome. It also enables any mid-course correction, if need be.

PHASE III : EVALUATION AND FEEDBACK

Although evaluation is built in the system, is the criterion for the formulation of behavioural objectives, is a component of the planned programme, is implemented alongside the teaching schedule, the results of the evaluation when analysed lead to conclusions for programme development, that entail consideration of

(1) those objectives not met through the actual programme activities,

(2) new or additional objectives which might further improve the given programme,

(3) significant changes to be incorporated in the programme to achieve the new objectives, and

(4) future evaluation procedures to measure the effectiveness of the programme.

Thus the evaluation and feedback processes ~~are an~~ are integral as well as ~~an~~ integrated parts of the instructional programme.

We have considered the variables of a teaching programme in the general context and the process of schematisation. We now have to identify the variables with particular reference to the context of ELT for technology.

1 -(i) THE 'SUBJECT' FACTOR OF ELT FOR TECHNOLOGY

The first variable to be determined is the 'subject' factor of ELT for technology, namely : Who is the 'subject' of the instructional programme?

The 'subject' of the ELT for technology is the adolescent of the age-group 16-17 years, who has completed one phase of his scholastic training, and is entering another in the belief that it is going to extend his frontiers of knowledge, with a much-coveted job as the terminal reward. He is one who has discovered himself and his potentialities; who is flattered at the idea that he has qualified himself for the pursuit of technology which he firmly hopes is going to develop him into an economically productive citizen.

The factor that specifically concerns ELT for technology is the proficiency level in English. For the core curricular programmes in English, the 'subject' is one who has adequate ability in the use of English. In the majority of 'subjects', the student with ability in the use of English is under the impression that it itself is a predictor of success in his technological study. In not a few cases, he may be one who is over-valuing his own linguistic ability; in a few cases, he may be one justifiably lacking it.

1 -(ii) DOMAIN OF GROWTH

The second variable to be determined is the domain at which change is intended.

The entire gamut of education is determined by the concept of education. The modern concept of education is that it is organised activity which brings about 'change' or 'growth' in the behaviour of the learner. The growth in the behavioural dimension is in three domains, namely, the Cognitive domain, the Affective domain, and the Psychomotor domain. The Cognitive domain is associated with behaviours which place primary emphasis on the intellectual process of the learner. The Affective domain is associated with behaviours which primarily emphasise attitudes, emotions, and values of the learner. The Psychomotor domain is associated with behaviours which place primary emphasis on neuromuscular or physical skills. (Fig.2)

For the language of instruction to be effective for the instruction given through it, it should be directed to the domain affected by the instruction. All instruction in

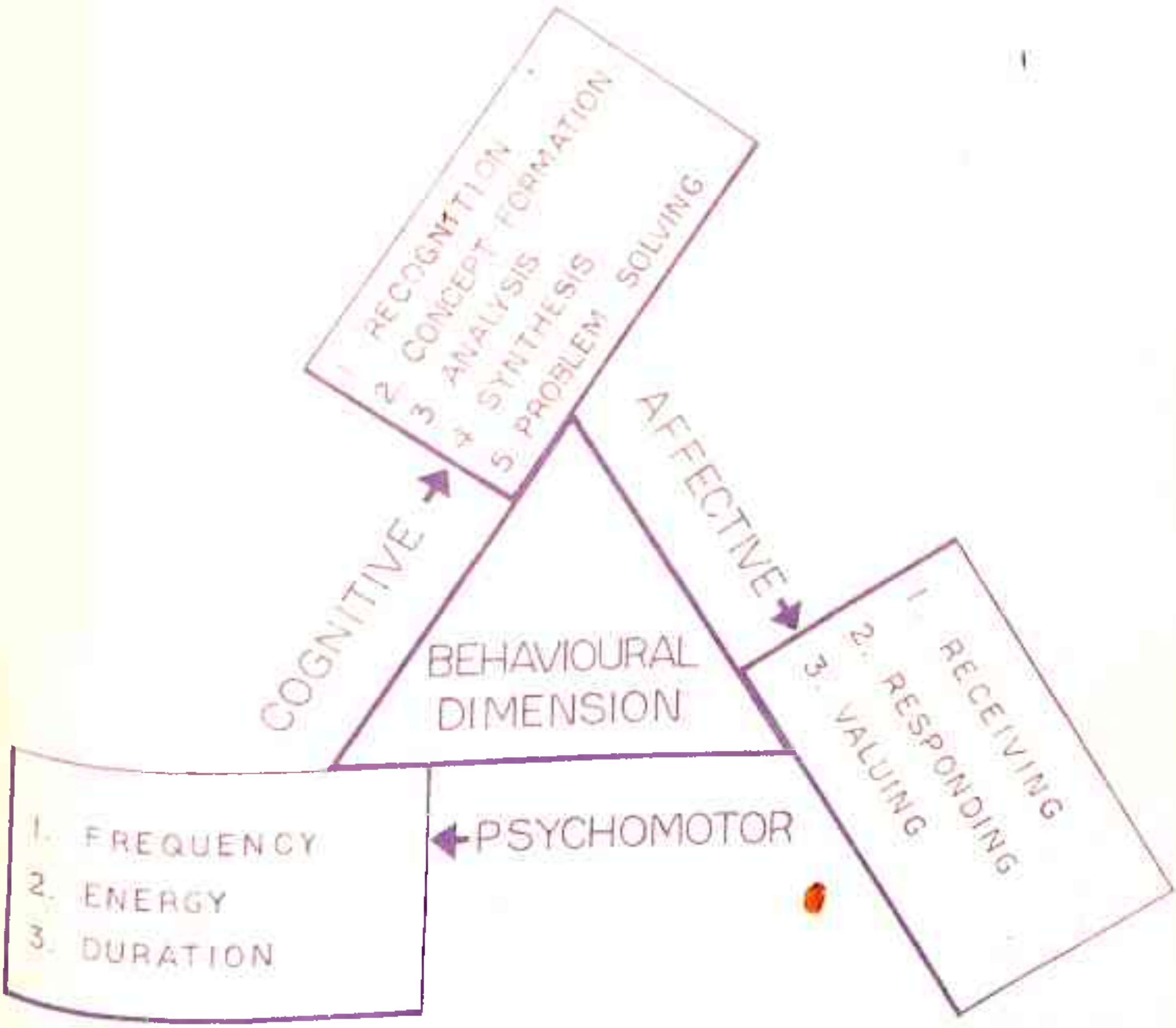


FIG. 2 : THE DOMAINS OF THE BEHAVIOURAL DIMENSION, AND THEIR LEVELS

technological education is at the cognitive domain which ranges from the simple process of recognition and recall of specific facts to the complex process of analysis and synthesis and, further, to the most complex process of problem-solving. The simple process of recognition which is at the lowest cognitive level, is the abstractive comprehension of the essential content of information communicated, and recall entails memory. Next in the range is the process of concept formation where experience is categorised and labelled. After concept formation follows the process of inductive and deductive reasoning. In the former, general laws are discovered from particular facts and a principle is arrived at by perceiving the relationships between given concepts; in the latter, conclusions are reached by reasoning from general laws to a particular case and a principle is reduced into its constituent concepts. The most complex of the cognitive process is problem-solving which entails all the thought processes of the cognitive domain. Now, the thought processes for instructional purpose do not function in a vacuum but through language.

If the objective of a programme in the instructional language is to enable the learner receive his instruction with facility and ease, the domain to come to grips with is the cognitive domain. ELT for technology has for its behavioural dimension the cognitive domain.

1 -(iii) PRE-REQUISITE ESSENTIALS

The third variable to be determined is: What are the pre-requisite essentials, if required?

The pre-requisite essentials of the 'subject' of ELT for technology is 'threshold' proficiency in English. This proficiency, as already defined earlier, is that minimum proficiency in General English that would enable the student to begin the study of technology through it, to absorb technology and start a cycle of self-action that is a regenerative cycle for learning technology, and for acquiring the ability to use the Functional English for technology.

Since the students admitted to technological institutions are drawn from diverse backgrounds with proficiency in English at different levels, there is need to categorise the students on the basis of the linguistic ability already with the learners.

CATEGORISATION AND PLACEMENT OF 'SUBJECTS'

It follows that the testing machinery for evaluating the linguistic ability already with the learners should be such as to place students into two broad categories of adequate proficiency and inadequate proficiency for the specific purpose of pursuing technological study through the medium of English. Such a test could be called the English Placement Test.

Placement Tests should be different from tests that aim at determining the general achievement of a class of students, or that measure the relative abilities of students for purposes of grading, or that diagnose areas of weakness. For placement of students into two groups of adequate proficiency and inadequate proficiency for technological study, they have to be specially designed.

The test should aim at determining the adequacy level in English for pursuing the study of technology. Such a test should be critical in the sense that it should test whether the student is able to do the kind of comprehending of data, reasoning from data, and other mental operations required for technological study. The test should aim at determining the linguistic ability for pursuing technological study.

A sample Placement Test (Appendix 'B') administered to one hundred students yielded the following data: (TABLE)

(i) there are two categories of students with a barrier between them;

(ii) the average score for the whole group is 27/50,

(iii) the average scores for the two categories are 37/50 for one group and 13/50 for the other, and

(iv) 43% of students are in the second category.

The Placement Test gives us two categories of 'subjects' for the ELT programmes: one category having adequate proficiency in English for pursuing study of technology, and the other not. It is obvious that the two categories of 'subjects' have to be treated in two different ways. It is necessary to mention here that the ELT for technology discussed so far/and identified is meant for the category of students who have been categorised as possessing adequate proficiency in English for pursuing the study of technology, TABLE

FREQUENCY DISTRIBUTION OF STUDENTS IN THE SAMPLE PLACEMENT TEST

FREQUENCY DISTRIBUTION			
Score	No.	Score	No.
		25	
50		24	
49		23	
48		22	
47		21	
46		20	2
45		19	0
44		18	6
43	5	17	5
42	6	16	1
41	8	15	1
40	1	14	2
39	1	13	7
38	3	12	6
37	4	11	6
36	9	10	3
35	3	9	2
34	8	8	1
33	3	7	1
32	2	6	
31	0	5	
30	2	4	
29	2	3	
28		2	
27		1	
26			
		Total	100

with the object of enabling them to do their technological study better and equipping them with the language ability for their professional needs later.

ELT for the second category of students is discussed at the end of this chapter.

1 -(iv) WHAT IS IT TO BE TAUGHT AND WHEN?

In the fore-going chapter we have already considered in detail the content of ELT for technology, which is related to the precise needs of technology. It only remains now to schedule the content so that the components are treated in a graded sequence. The components that have been identified are themselves graded in the order of progression on the cognitive scale. However, for teaching, it is necessary to distribute the components over a period of time that is required for the programme.

I propose a four-semester packaged programme of courses as the core curriculum, titled Engineering Communication I, Engineering Communication II, Engineering Communication III, and Engineering Communication IV; and, to meet the needs of those students who would be making original contributions to science and technology in the future, one elective course titled Engineering Communication V, to be offered as a fifth level course.

The outlines of the proposed courses are presented below:

ENGINEERING COMMUNICATION I

ELEMENTS OF FUNCTIONAL ENGLISH

Engineering Communication I is suggested for offering in the first semester of the first year. It is designed for a 3-unit programme requiring about 50 class-room contacts. Its components are:

(1) Models of scientific English to derive the characteristics of the denotative stratum of language;
(2) Logic, and use of language for logical thinking;
(3) Linguistic exercises in promoting ideation ability;
(4) Study of words apparently synonymous;
(5) Words of Greek and Latin origin that determine the denotative character;
(6) Prefixes and Suffixes that determine the denotative stratum;
(7) Prefixes and Suffixes for word-formation and vocabulary-expansion;
(8) Writing definitions;
(9) Rhetoric: Elementary;
(10) Comprehension for logical thinking (with multi-choice plausible answers); and
Analysis of Complex-sentence structures for comprehension.

ENGINEERING COMMUNICATION II

SPEECH TRAINING FOR STUDENTS OF TECHNOLOGY

Engineering Communication II is suggested for offering after Engineering Communication I. It is designed for 3-units requiring about 50 class-room contacts. Its components are:

(1) International Phonetic Alphabets;
(2) Phonetic transcription of words;
(3) Sound structure-syllables-stress;
(4) Di-syllabic words with dual functions;

(5) Poly-syllabic words: Rules for stress;

(6) Intonation patterns;

(7) Question-tags;

(8) Reading practice in the language laboratory;

(9) Art of public speaking: Instruction-How to express cogent argument;

(10) Practice in speaking - Talks (Individual);

(11) Group discussions;

(12) Practice in performance at Interviews: Model interviews;

(13) Reading of Nobel Lectures.

ENGINEERING COMMUNICATION III

REPORT WRITING-GENERAL

Engineering Communication III is suggested for offering after Engineering Communication II. It is designed for 3-units requiring about 50 class-room contacts. Its components are:

(1) Identify and determine the characteristics of reports;

(2) Categorisation of reports;

(3) How to be objective, terse and unambiguous;

(4) Logic as the basis of the structuring of a report;

(5) Reporting on self; Bio-Data-Résumé, Curriculum Vitae;

(6) Reporting on a person's conduct and application; Vocabulary for such reporting;

(7) Study of the structure of short reports as

(i) Letter-Report,

(ii) Bulletin Report,

(iii) Memorandum Report,

(iv) Minutes,

(v) Investigation Report;

(8) Constructing a questionnaire for collecting data for a report;

(9) Structure of a Project Report: Formulation of the Title, Abstract, Introduction, Body of the report, Conclusion, Summary; Other factors related to the report: Appendix, Acknowledgements, References, Footnotes, Bibliography, Numbering, and Headings; Writing a Project Report.

(10) Practice in structuring reports; Improving reports badly written;

(11) Presentation of the outline of the Project Report by every student, followed by a discussion.

ENGINEERING COMMUNICATION IV

SCIENTIFIC EXPOSITION AND SCIENTIFIC LITERATURE

Engineering Communication IV is suggested for offering after Engineering Communication III.

It is designed for 3-units requiring about 50 class-room contacts. Its components are:

(1) Rhetoric applied to technical exposition- parallelism, subordination, shifts, dangling modifiers, mixed constructions, etc.;

(2) Stating principles, theories, natural laws, phenomena, physical properties, operating characteristics, etc.,

(3) Description of objects, hardware;

(4) Explication of processes;

(5) Writing a Technical Report (on a Project undertaken, on the Practice School, plan lay-out of a small-scale

industry);

(6) Study of selected books of scientific literature.

ENGINEERING COMMUNICATION V

PATENT WRITING

Engineering Communication V is suggested for offering in the fifth level. It is designed for two units requiring about 35 class-room contacts. Its components are:

(1) The Patent Act;

(2) What is a Patent?

(3) Varieties of Patent- Ordinary, Priority, Addition, Secret;

(4) What may be patented?

(5) General procedure for obtaining a Patent;

(6) Filing the application with supporting documents;

(7) Proceedings after filing application for Patent;

(8) Patent write-up: Provisional Specification, Complete Specification;

(9) Each student to take up one technical model or prototype for Patent writing, and give a talk on the novelty of his claims for Patent.

2. BEHAVIOURAL OUTCOME OF ELT IN TECHNOLOGICAL EDUCATION

The organisation of any teaching requires, in the first place, the formulation of the educational objectives for which both the teacher and the learners strive. The most important and the most crucial aspect of a programme of instruction is identifying and defining the outcome of the programme.

Educational objectives should be more than general statements of purpose or descriptions of broad curricular areas. Educational objectives should be formulated on the basis of specific growth desired in the learner's abilities in a particular context. Without a clear, comprehensive and definite idea of the context and the specific growth desired in the learner's abilities, the learning experience cannot be organised.

The technological context is well defined; it is conditioned by the following factors common to all learners in this context:

(1) the learners are adults;

(2) they are career-seekers;

(3) the majority of them are fully motivated;

(4) the learning experience sought is scientific, engineering or technological;

(5) the period to be devoted to the learning is four to five years; and

(6) the instructional language is English.

In this context, what should be the ability desired to be developed for a programme in English? What is naturally suggested by the context for a programme in English is that (i) the programme should develop the learner's ability or proficiency in the instructional language to receive his technological knowledge, information and experience now; and (ii) to use the language for technological career later.

In other words, the English-language teaching programme must be related and adapted to the precise needs of the learner's major study now and career later. We have considered how ELT must be related and adapted to the precise needs of the major study. We have also identified the broad areas of ELT. We have examined the context and we know the content. For the control of the content so that it is properly and purposefully organised, the goal of ELT must be resolved into objectives.

Educationists rightly advocate that the purpose implicit in goals be made explicit as objectives by (1) describing the student 'behaviour' to be produced, and (2) by deciding how the 'behaviour' will be measured, and prescribe that the 'behaviour' to be produced to be described in terms of directly observable 'behaviour', and the 'behaviour' to be measured in terms of that directly observable 'behaviour'. They rightly want the emphasis to be placed on 'doing' that must be observable and not on any performance that cannot be observed. For example, let us consider the purpose of an instructional programme expressed in the following two statements:

(1) To enable the student to know the letters of the alphabet A ~~through~~ to Z.

(2) To enable the student to identify the letters of the alphabet A through Z and pronounce them singly and in combination.

The goal of the programme as stated in statement No.1 and in statement No.2 is, for all teaching purposes, the same.

But, statement No.1 only implies that the student will be able to identify the letters of the alphabet A through Z and may be pronounce them singly and in combination, but does not necessarily ensure that the student would perform what is intended; while, in statement No.2, the implied purpose is made explicit in terms of student performance that can be directly observed, measured and evaluated. It has the criterion of evaluation of the programme built in the objective itself thereby orienting the programme from the commencement to the performance aimed at and consequently gearing the programme to the intended instructional outcome.

Although suggestive of only physical activity the 'behavioural' concept does embody intellectual growth as the final outcome of education. All that the concept emphasises is that the mental activity must be described in some type of performance that can be observed, measured and evaluated. To illustrate, if the goal of an instructional programme in ELT is to develop the student's ability to draw analogies through the inferential uses of language, in determining the objective of the programme, the questions to be answered are:

(1) What is the student who develops this ability able to do which the student who does not develop this ability is unable to do?

(2) How is this development to be observed, measured and evaluated?

The answers to the above two questions determine the objective in clear, concise and overt terms, stating the performance intended as the outcome of the instructional programme, which is the criterion for evaluation. Suppose the answer to the first question is- The student who develops the ability is able to draw analogies, while the student who does not, is not able to draw analogies in the word-plane. To the second question if the answer is - It could be observed in an oral/a written response of the student to discover relationship in two schemes of ideas and discern a parallel analogy elsewhere, in the word-plane. The performance to be measured and evaluated is the oral or written response of the student. Therefore the objective of the programme that has for its goal the development of the student's ability to draw analogies/is: To enable the student discover relationship in two given schemes of ideas and discern a parallel analogy elsewhere, in the word-plane.

An academic programme does have an object even when it is not explicitly stated. However, the broad object cannot be reached in one leap or jump. It is reached or arrived at gradually in successive stages. Each successive stage that takes the learner closer to the goal needs to be identified. The ELT for technology has for its broad goal "to enable the learner do his technological study better", but each of the components of ELT for technology has some specific growth as the outcome of the learning experience. This specific growth which is the outcome of the learning experience, that can be directly observed, measured and evaluated, is the 'Behavioural Objective'.

The 'Behavioural Objectives' evolve from well-considered terminal behaviour. Besides, the explicit 'Behavioural Objectives' inform the student what is expected of him, and cause him to interact with appropriate subject matter. The statement of the Behavioural Objectives in clear and unequivocal terms denote measurable attributes observable in the learner, and the learner is enabled to judge for himself the validity of the criterion of evaluation, and appreciate or criticise his own performance. It is now possible to evaluate each teaching unit as well as the programme efficiently and there is sound basis for the selection of appropriate materials, content and instructional methods.

In their passion for accountability, educationists in America have reduced the teaching unit to the micro-level where the unit is required to take 10 to 15 minutes only. The concept of microteaching is to proceed in graded and gradual steps in the context of the objectives by developing one idea or skill at a time. It is a well-planned and time-scaled teaching where the complexities of the class-room situation are encountered in small stages ensuring step-by-step forward movement and facilitating continuous feed-back from students. Although the idea is under development and is primarily intended to give teacher-trainees teaching practice and confidence in handling a class-room situation, the application of the concept to ELT can be highly effective. From my initiation into microteaching at the WORKSHOP-

CUM-SEMINAR ON METHODS OF TEACHING[1] and subsequent application of microteaching. I am convinced that microteaching can yield productive results in ELT.

The other components of schematisation are matters of organisation and detail only; and hence do not require any special treatment.

MAKE-UP ENGLISH

As democratization has made it necessary for the country to adopt an egalitarian policy, it has become imperative for technological institutions not to deny admission to students with inadequate proficiency in English, who otherwise satisfy the requirements for admission.

The analysis of the distribution of the proficiency level in English on the basis of school, environment and occupational status of parents show that not all students who have studied through the vernacular medium are deficient in English. Of 288 students admitted to the Birla Institute of Technology and Science, Pilani, who were found to possess adequate proficiency in English, 76 came from vernacular medium schools. Again, of 112 students whose proficiency was found to be inadequate, 24 came from English medium schools. The factors contributing to this

1. From 28.3.1974 to 16.5.1974. Organised and conducted by Professor Dee H.Barker, Brigham Young University, Provo, Uttah, Visiting Professor, Birla Institute of Technology and Science, Pilani, and Dr.V.Krishnamurthy, Professor of Mathematics and Acting Deputy Director, Birla Institute of Technology and Science, Pilani.

are:

(1) the students from vernacular medium schools, with adequate proficiency in English, came from urban areas and from homes where they were constantly exposed to English; and

(2) those from English medium schools with inadequate proficiency in English have been to English medium schools only for an interrupted period, or to ill-equipped English medium schools.

The analysis of data of students of inadequate proficiency in General English showed that there was a high coefficient of correlation between proficiency in General English and performance in technological study for this category of students. The coefficient of correlation was +0.6615. The analysis also showed that they performed in the major study as well as those with adequate proficiency in General English (Table VIII). It was also seen that not all students did well in the special English course offered to them; and, the performance in the major study of the students who scored an 'F' grade in this course was low. The average CGPA for this section of students was 3.72 (Table IX). That their performance in the major study rapidly improved as their proficiency in General English improved established that a minimum proficiency in General English called the THRESHOLD proficiency was the prerequisite essential of the student who desires to pursue technological study. The analysis also revealed that about 12% of the students of the inadequate category whose performance in the major study is low, have not been able to attain the threshold proficiency level. It necessarily followed that students whose proficiency in general English is below the threshold level depend on the special English programme offered to them for their performance in their major study. This action was also borne out by the physical model illustrating the dynamics of Functional English for the study of technology, explained in chapter VII. The model required an initial mass of liquid in the vessel to pull it down in order to open the slot to initiate the flow of liquid. This initial threshold mass of liquid had to be poured by an external agency. In the instructional system, in the context of technological education in India, the external aid to make-up the deficiency of the language to reach a self-acting state may be called the MAKE-UP ENGLISH programme.

ELT for technology must perforce categorise the students on the basis of the linguistic ability already with the learners, into two categories: (i) those with above threshold proficiency in English, and (ii) those with below threshold proficiency in English, for beginning the study of technology through the medium of English, and, offer a MAKE-UP English programme for the second category to make-up the inadequacy in English.

Only three institutions of technology in India provide the Make-up English programme. The Birla Institute of Technology and Science, Pilani, is one of them. I have been associated with this programme for nearly a decade and, therefore, I speak from my personal experience.

As the Make-up English programme is essentially of the area of English language teaching to foreign students of a specific age-group, and, as this area is well developed, I shall not dwell on it. However, I offer certain broad outlines of the programmes.

OBJECT

The aim of the Make-up English programme is to remove the linguistic deficiency with the student so as to bring him to the threshold level that would make his technological education effective.

PEDAGOGIC STRATEGY:

The object of the programme can be achieved by making the programme oriented to language work, supplemented with practical work preferably in the language laboratory, or with such linguaphone aids that are available, for establishing language structures, and strengthened by tutorial instruction in small groups that would facilitate individual attention. The programme should provide ample practice for mastering the basic structures of English. Though the programme is skill-oriented, knowledge of the language norms for use of language is necessary as the student is mature and is able to appreciate the guidance they provide. However, as a grammar-oriented programme dissociated from context brings on boredom, grammar should be taught through interesting textual material. This material should not be drawn from science and engineering subjects, because the English-through-science mode, as discussed in Chapter VIII, has its dangers; besides, there being nothing new in the text, the student finds the repetition of the subject material equally boring. The text should be of the domain of science, which would incidentally introduce the student to the varied and rich literature in it. It should provide material for reading for pleasure and information, or for exposing the student to functional and imaginative writing. One set of books eminently suited for the Make-up programme is GUIDED ENGLISH FOR INDIA by D.H.Howe (Oxford University Press. Books 1 to 5). As the author rightly claims the set is comprehensive, well planned and graded. The varied and interesting textual material stimulates the student to read for both pleasure and information. The exercises provide ample practice and guidance for acquiring good language habits and skills. They promote comprehending and self-expressional ability, and widen the range of vocabulary. They provide practice in spoken English too. It would be necessary to do Books 1,2 and 3; if time permits Book 4.

The Make-up programme has to be intensive as much has to be done in a short time. A one-semester programme of five units with one contact hour a day for six days is required.

With books like GUIDED ENGLISH FOR INDIA as the base, if the Make-up programme could be schematised with well-defined Behavioural Objectives, and handled by competent and well-experienced teachers, the object of the programme can easily be realised.

EXPECTED PROGRESSION IN FUNCTIONAL ENGLISH CURRICULUM

The proposed curriculum for FUNCTIONAL ENGLISH is so structured that it is integral and self-sufficient, and does not have to take into account the RETRO-EFFECT of the study of technology on proficiency in the instructional language.

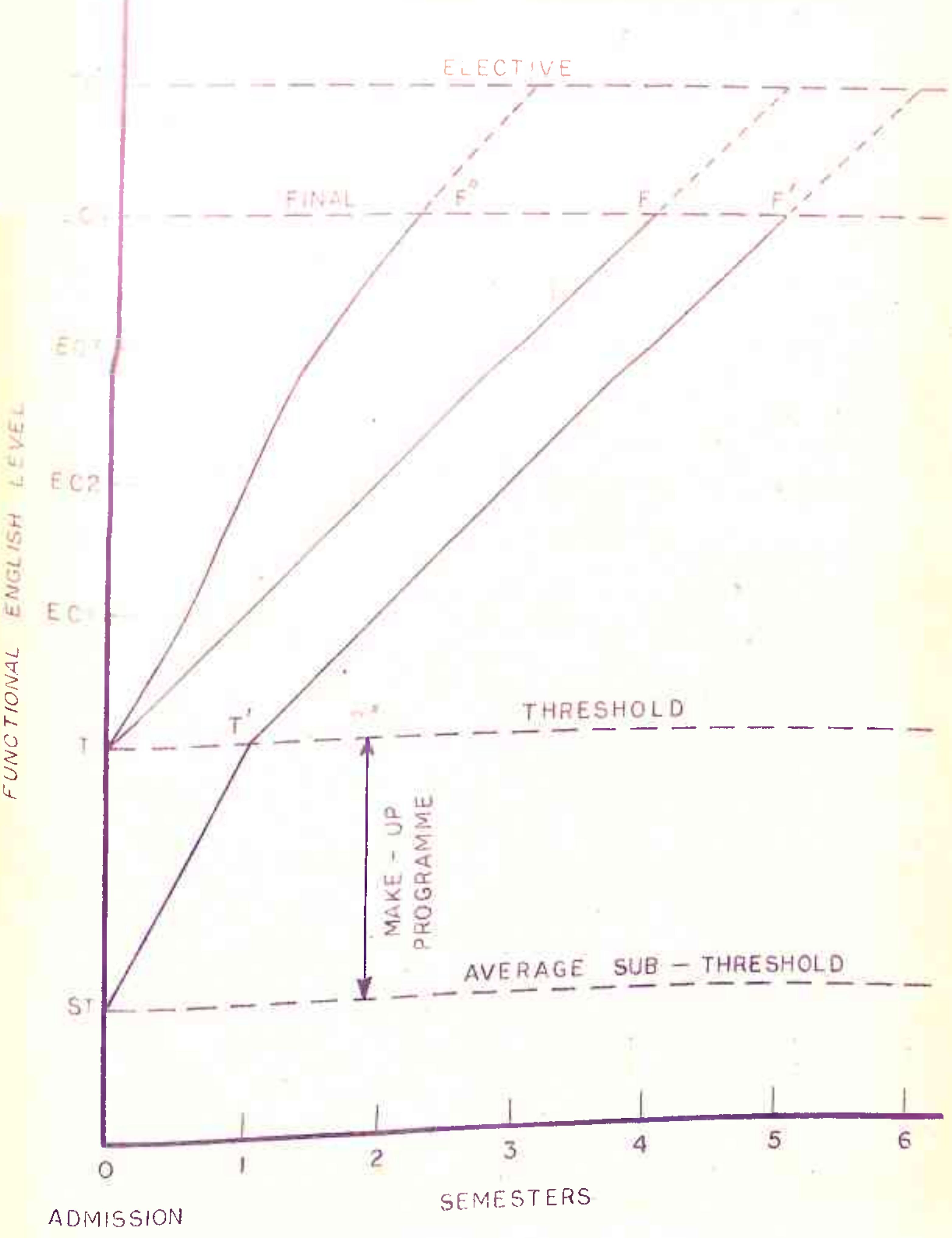
It is aimed at improving the student's proficiency in Functional English as a linear function of time, as shown in graph 1 by the straight line T-F, during the four semesters-the fifth course being offered as elective. At admission the student is expected to possess the minimum threshold proficiency indicated by 'T', and make progress as shown by the straight line T-F as a result of the ELT programmes distributed over four semesters.

The students who have sub-threshold proficiency and who are doing the Make-up English course to be followed by the core ELT programmes are one semester behind those with above threshold proficiency. If the average proficiency of a sub-threshold batch of students who are to do the Make-up programme, is represented by ST, their improvement is shown by the straight lines ST-T'-F', T' and F' being one semester behind.

If the RETRO-EFFECT of technology on language and consequent interaction between Functional English and technology is taken into account, progress in proficiency in English is represented by the initial stage (exponential part) of the logistic curve T-F".

GRAPH I

EXPECTED PROGRESSION IN FUNCTIONAL ENGLISH CURRICULUM



Chapter XI

THE TEACHER OF ELT FOR TECHNOLOGY

We now come to the most important and vital aspect of ELT for technology-the teacher. The teaching 'member' of flesh and blood-the teacher, transcends every other teaching 'member' as book, film, teaching machine because of the animating principle in him. He has a force of great potential, capable of handling the teaching situation in an infinite variety of ways; he has the power to convey intelligence in the inflexion of the voice, in the gesture of the limb, in the shake of the head; he is able to tell just by looking at his class whether his message is getting through, and is right on hand to offer clarification in case of doubt. He is the source of inspiration for the discovery of ideas, which discovery 'the boys' appropriate to themselves. He alone has that marvellous power to cause "the stream of awakening ripple and pass- to the boys, whose brightening souls it laves"[1]. His glance is enough for 'the boys' to "taste delightedly the grain

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1. THE BEST OF SCHOOL, D.H. Lawrence, A Choice of Poets, George G. Harrap and Co. Ltd., pp. 190-191.

of rigour"[1].

Yet, research has not identified with any degree of precision the qualities and attributes of an effective teacher. As Biddle says: "The problem of teacher effectiveness is so complex that no one today knows what the competent teacher is. Few if any facts seem to have been established concerning teacher effectiveness, no approved method of measuring competence has been accepted, and no methods of promoting teacher adequacy have been adopted"[2]. He has rightly pointed out that since all good teachers do not act in the same way or possess the same characteristics or use the same methods, there is no one best way of teaching, no formula to ensure teaching effectiveness, and no one standard by which it can be measured[3]. However, if there is one requisite for the effective teacher on which there is perfect agreement, it is that he should know the subject of his field. A teacher cannot be effective without adequate knowledge of his subject. For the teacher of English to be effective, he is expected to possess ability in (1) aural comprehension, (2) speaking, (3) reading, (4) writing, (5) language analysis, (6) knowledge of culture, and (7) professional prepara-

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1. THE BEST OF SCHOOL, D.H. Lawrence, A Choice of Poets, George G. Harrap and Co. Ltd., pp. 190-191.
2. EDUCATIONAL PSYCHOLOGY, Walter B.Kolesnik, McGraw-Hill Book Company, 1970, p.46.
3. EDUCATIONAL PSYCHOLOGY, Walter B.Kolesnik, McGraw-Hill Book Company, 1970, p.47.

tion. The degree of excellence in each ability that is normally expected is[1]:

AURAL UNDERSTANDING

Ability to follow closely and with ease all types of standard speech, such as rapid or group conversation, plays, and movies.

SPEAKING

Ability to approximate native speech in vocabulary, intonation, and pronunciation (e.g. the ability to exchange ideas and to be at ease in social situations).

READING

Ability to read and comprehend in one reading material of considerable difficulty, such as essays and literary criticism.

WRITING

Ability to write on a variety of subjects with idiomatic naturalness, ease of expression, and some feeling for the style of the language.

LANGUAGE ANALYSIS

Ability to apply knowledge of descriptive, comparative and historical linguistics to the language teaching situation.

CULTURE

An enlightened understanding of the English people and their culture, achieved through personal contact, preferably by travel and residence abroad, through study of systematic descriptions of the foreign culture, and through

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1. LANGUAGE TEACHING, Robert Lado, Tata McGraw-Hill Publishing Co. Ltd., Bombay, 1964, pp.230-232.

study of literature and the arts.

PROFESSIONAL PREPARATION

A mastery of the recognised teaching methods, and the ability to experiment with and evaluate new methods and techniques.

Now, a pertinent question that arises is - Is this preparation adequate for the teacher of ELT for technology? All this preparation is necessary but, for the specific task the teacher of ELT for technology has to perform, it is not adequate.

The object of ELT for technology cannot be achieved by a teacher who is temporamentally literature-oriented. Because of the predilections of such teachers, ELT for technology, even where it professes to enable the student acquire adequate working knowledge of the language inasmuch as it is the medium of instruction of technology, is heavily tilted in favour of literature, or, at the most advanced composition, comprehension and something with the semblance of report writing.

The undergraduate knows what he needs. He knows that he needs linguistic ability to enable him to understand and to make himself understood on matters related to his studies. So, he finds that the advanced general composition and comprehension which he is required to do now subject him to demands inconsistent with his interest and ability, and therefore waste his precious time.

With the literature-oriented teacher, a programme in ELT for technology as discussed and outlined here, can still cheat the student of very necessary instruction because a teacher can easily lecture on topics not germane to instruction in acquiring the specific language ability for the needs of technology.

The majority of teachers teaching English in Engineering Colleges and Institutes of Technology in India are literature-oriented with or without the training for teaching English as a foreign language. Most of the teachers in Institutes of Technology have had this training abroad. Many of those who have not had formal training have taken the short-term training at the Summer Institutes in English held by the University Grants Commission in collaboration with the Central Institute of English and Foreign Languages, Hyderabad, and the British Council to provide facilities for institutions to train their untrained staff.

ELT for technology in India needs a new type of teacher as it does even in English-speaking countries. As far back as 1947, W. George Crouch and Robert L.Zetler, both teachers of English at the University of Pittsburgh, suggested setting up a special graduate training programme for potential teachers of English in engineering schools. According to them the ideal teacher of English for science and technological education is a teacher who is trained both in science or engineering and in English. They do not imply that all teachers of science and technology possess the necessary language ability. Crouch and Zetler have testified that "too often even teachers of engineering subjects are indifferent to the problems of oral and written expression. By implication they encourage the student to neglect his English training and to concentrate on technical studies."[1] They recommended special graduate training for teachers of English in science/engineering education to give such men the highly specialised training they need, which, they said, was not merely training in the methods of teaching. According to them, the training should give the prospective teacher a thorough knowledge of the field in which he would be teaching by equipping him with the techniques needed for communicating his information to others. They find that the conventional training of the average graduate student in English aimed at developing a scholar who would know research methods, philology and a knowledge of English and American literary history, as well as specialization in some particular period of literature, is not suited to the preparation of a skilled teacher of engineering communications. They have advocated instead a knowledge of English grammar and the principles of composition as applied to technical writing; an overall acquaintance with his own, and with English literature; a broad knowledge of contemporary literature of the sort the engineer would need and want after he leaves school; and, an understanding of the principles of literary criticism. They require that he should know the bibliography in both the technical and the literary

1. TRAINING ENGLISH TEACHERS FOR ENGINEERS, J.of Electrical Engineering, December 1947, pp. 1182-84.

field; be well informed of developments in scientific and technical writing, so that he would be able to stimulate his students to read; and, by his own contributions to the technical journals, he should show that he can put into practice the principles he is teaching. They prescribe a certain number of courses concerned with teaching methods to form part of his graduate education. They recommend that he be required to take part in conferences relating to the teaching of English to engineering students-conferences at at which experienced teachers of English and speech as well as teachers of engineering and education would be present; and, as an aid to his thinking and reading, he should have access to a good library of engineering publications and magazines concerned with the subject material of English courses and the techniques of teaching. This was said in 1947. Since then education in the U.S.A. has provided for the training of teachers of English for engineering schools. The teaching of English for engineering communication has been taken so seriously in the U.S.A. that institutions of engineering and technology have promoted research directed to improving the strategy of engineering communication. The Institute of Electrical and Electronics Engineers devotes volumes exclusively for engineering writing and speech, and holds periodic conferences. At the 1968 International Technical Communications Conference sponsored by I-EEE Transactions, it considered among other subject areas education and training: writing, seminars, graduate programmes, training in oral communication, and management training.

And yet, the expository problems facing the graduate scientist ,engineer and technologist is so persistent that regular programmes in technical exposition for them ranging from a one- semester programme to a variety of short courses are held. A survey conducted by the Joint Engineering College Administrative Council Feedback Committee of the American Society for Engineering Education through a questionnaire asking graduate engineers to list the subjects in which they should have received training while at the engineering school or institute of technology showed that the respondents placed technical exposition second only to management practices.[1]

The core English programmes in many American universities for science and technology are now handled by teachers who are science or engineering graduates and trained in English. In most technological institutions, the management of the English language programmes is by a professor of an engineering branch. At the advanced stages of science and technology, the English language teaching programme is directed to the particular requirement of a specific branch of engineering and supervised by the professor of that engineering branch.

I am not suggesting that in India the ELT for technology should be managed by the engineering branch. The engineering branch has much ground to break to improve its own functioning; besides, it does not have the right kind of

1. I-EEE Transactions on Engineering Writing and Speech, Vol. EWS-14, 1971, pp. 42-46.

people yet to take up this responsibility. I am only drawing attention to the situation in the U.S.A., which is so possessed of the demands made by the English language for technology that it is perpetually breaking new grounds to find better and better solutions to the problems.

ELT for technology in India does not really need a different management. All it needs is a new type of teacher. This teacher is not required to be a specialist in linguistics as is believed. Kenneth L.Pike himself has said in unmistakable terms that no knowledge of linguistics is required of either teacher or student for using the language for the communicative purposes. What ELT for technology requires of the teacher are

(i) grounding in Logic and Rhetoric,

(ii) the scientific culture,

(iii) a mastery of the art of technical exposition, and

(iv) a comprehensive knowledge of the basic concepts of science, and an open mind to accept and absorb new scientific and technological ideas that are coming up every day.

(i) The need for the student to receive a grounding in Logic and Rhetoric has already been discussed. It does not need any elaboration why the teacher of ELT for technology is expected to have a more thorough grounding in Logic and Rhetoric.

I, therefore, move on to the other aspects.

(ii) The teacher for ELT for technology is not simply a drill-master. No doubt, there is much in the language that one has to be habituated to; it is, no doubt, the habit of using the language methodically, which is acquired by drill, that enables the user to foresee the part to be played by each word he uses and the place to be taken by each sentence he uses. However, language cannot be studied by itself as merely a tool. A purely philological approach to language teaching will not make ELT effective. Language is both a constituent and a medium of communicating a specific cultural pattern; and, the language teacher is essentially a culture teacher. The language of technology, its denotative function, depicts the culture of the scientist and technologist. The teacher of ELT for technology cannot be effective unless and until he shares the culture of the scientist and technologist and their approach to problems. The teacher should be oriented to scientific culture.

Culture is the cultivation of the mind. It is an inward condition of the mind and spirit. As civilization sets off man from all other animals, culture sets off man from other men. It is the basic beliefs, attitudes and values which become the way of life. The scientific culture is that complex whole which distinguishes the people of that culture from other men. It is reflected in the scientific attitude of mind, scientific approach to problems, in the curiosity to know the how and why of things.

H.G. Widdowson in his article LITERARY AND SCIENTIFIC USES OF ENGLISH[1], rightly emphasises that the teacher of ELT for science and technology should be "prepared to adapt

1. J. of ELT, Vol. XXVIII, No.4, July 1974, pp. 282-292.

his attitude to the new situation. They are aware of the literary uses of the language but not of the scientific uses which it is now their business to teach. Where the teacher is not prepared to adapt his attitude to the new situation, there is often an intrusion of literary content into courses which are meant to serve a specific vocational need. Where the teacher is prepared to make the necessary adaptation, he is frequently frustrated by his lack of knowledge of how language functions in scientific and technological communication". However, the attitude as recommended by Dr. Widdowson is within too narrow bounds. The scientist's questioning mind, penetrating insight, rational enquiry, critical acumen, patient effort, steady pursuit, open-mindedness or readiness to reconsider, impartiality, absence of pre-conceptions, are all ingredients of the scientific attitude. It is not enough for the teacher of ELT for technology to be just "aware of the scientific uses of the language" to share the culture of the scientist and technologist. He should be aware of not only the facts of scientific language but should have imbibed the humanism of the scientists. Science has its legends, its myths, its moral and aesthetic attitudes, its ethics. These are reflected in the science classics, lives and biographies of scientists, accounts of the discoveries of scientists, which expound besides the facts of science, the humanism of the scientists. The humanism of the scientist is as profound as the humanism of the humanist. When we hear an Einstein say that all ideas come from God, or "concern for man himself and his fate must always form the chief interest of all technical endeavours, concern for the great unsolved problems of the organisation of labour and the distribution of goods- in order that the creations of our mind shall be a blessing and not a curse to mankind"[1], we are moved by a

1. SCIENCE SPEAKS, Anne Dow, Oxford Univ.Press, 1973, p.182.

humanism that is too deep for words. The scientist is as human as anyone else, possessing the same human nature as that of the non-scientist, and deeply concerned with the same problems that concern the non-scientist. The teacher of ELT for technology should have a living interest in knowing about science and scientists, and the urge to read the science classics and the masterpieces of literature in the domain of science.

(iii) The teacher of ELT for technology is not an instruction manual. Technical exposition is both an art and a science. Merely telling the student how to express, expose and write is like telling one how to drive a car and how to operate the gears and the controls. A driving lesson to be of any use should be conducted on the road with the learner at the wheel. ELT for technology now places emphasis on fundamentals and format. As G.F. Paskusz[1] says:

"Yet, no matter what the specific technical writing activity at any particular college is, nor by whom administered, we may be certain that a considerable portion of this activity will be centred on such English fundamentals as spelling and grammar, and on communication fundamentals such as the structure of compound sentences and of paragraphs. This situation may be likened to a circuits or dynamics course in which a large part of the effort is concentrated on arithmetic, algebra, and a bit of calculus.

Communication is too often taught as if it were a science, that is, the teaching emphasis is on fundamentals. Communication is a combination of art and science; and, like engineering, it should be taught by repeated application of fundamentals under various sets of constraints, the exact form of the solution to any particular problem being dictated by the immediate logical considerations."

So the emphasis has rightly to shift to application of the fundamentals. The teacher cannot have mastery of the art of applying the fundamentals of technical exposition in sol-

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1. IRE Transactions on Engineering Writing and Speech, Volume EWS-3, No.2, July 1960, p.60.

ving expository problems if he has himself not put into practice the principles he is teaching by his own writing. He should have proven proficiency in exposition. Unless he has himself gone through the writing mill, and has experienced the problems encountered in such a task, he cannot understand the expository problems of the student. Only then he can rise to any occasion to aid the student to apply the principles of exposition and communication.

(iv) As a society becomes more and more technologically oriented, the level of the general education in the sciences and technology gets raised. The level of the general education in the sciences and technology of the teacher of ELT should be higher than the common level. To play this role effectively, the teacher of ELT for technology should be informed of at least the basic concepts of science. The essential property of the basic concepts is their elasticity and their function, namely, they facilitate the understanding of new concepts. By elasticity, I mean, if one has comprehended a concept, he should be able to transfer the application of the same concept in various other situations to understand new extensions. The concept to be useful must be elicitable in a variety of situations. The concept of centrifugal force, for instance, must be elicitable in order to understand the escape velocity of a space-craft or the function of electron emission from an atom. Only if the teacher has the basic concepts of science with him, and is able to understand a discussion on simple scientific problems, he can be an effective teacher of ELT for technology. If, for instance, the student has an expository problem related to the simple pendulum. The teacher of ELT for technology should be able to comprehend the working of the simple pendulum. He will be able to comprehend it only if he has a clear concept of the following:

(a) conservation of energy,

(b) gravitational force and its constancy,

(c) knowledge that calculus offers solution to simple differential equations,

(d) damping, frequency and amplitude, and

(e) periodic and aperiodic movements.

The law of conservation of energy is maintained in the simple pendulum. The pendulum is a device in which the oscillating mass is subject to a certain amount of energy which is changing betweeen potential energy and kinetic energy. The frequency of oscillation depends on the gravitational force on the mass. It is a constant for a constant place for the gravitational force varies with latitude. Damping is the reason for the amplitude of the pendulum to reduce gradually and come to a stop. If there is no damping the pendulum should oscillate indefinitely. Frequency and time are same concepts expressed in different forms without resorting to a scale. Frequency is the inverse of the time period which is the time taken for one oscillation. The time taken can be calculated by calculus. The teacher of ELT for technology need not know calculus but he should know that with its help we can find the time period.

For the highly specific task that the teacher of ELT for technology has to perform, he has to be oriented to the technological milieu. We have seen that the instructional system is an engineering system. The engineer of this system is the Instructor. The teacher of ELT for technology directs his instruction to the engineering of the structure of the expression of the thought to fit the structure of the thought itself. He cannot therefore be concerned only with the correctness of the former and not of the latter. Even if his business is to teach language and not to teach science, he should know the basic concepts of science to be able to evaluate the correctness of both the structure of the expression and the structure of the thought. For instance, the statements "Motor-car engines may have four, six, or eight cylinders. These cylinders are usually mounted in a cylinder block on top of the engine" are grammatically correct but the content of the second statement suffers from a technical misrepresentation. Having said that the cylinders are constituents of the engine, they cannot be 'on top of the engine' and yet be an integral part of the engine. This misrepresentation has occurred because of conceptual inadequcy.

The teacher of ELT for technology should know not just how English functions in technology but how to teach those functional aspects. How English functions in technology has been almost thoroughly explored, but, how to teach the functional aspects of English in technology is another matter. The view held hitherto in advanced education that scholarship and teaching are identical is, fortunately, changing. It is one thing to know, and another thing to teach what is known. Although teaching presupposes knowledge of the content, knowledge does not necessarily predict the teaching ability. Teaching in this particular field is mainly centred on training. There is a two-phased function required of the teacher of ELT for technology: one is to train the mind of the student through the important territory of perception so that the mind of the student is subjected to the various phases of the cognitive functioning from reception of information to problem-solving in the domain of technology; the other is to provide the linguistic ability that would enable the perception of the student to the point at which understanding of the various elements and their relationships constitutes a unified understanding that approximates to what is communicated without any perception gap. For this highly complex task the teacher should have experience in projecting the working of his own insight by the techniques of using the language. In order to be able to direct the teaching to the cognitive level, the teacher of ELT for technology should have a deep understanding of cognitive functioning. He needs to know how to direct the teaching so as to enable the student to organise and reorganise perceptual patterns of the significant elements of a situation in order to achieve insight into the problem; how to make a previously vague and unstructured area become cognitively structured and specific so that the cognitive structures thus created and reconstructed afford insight

It is time that science and engineering graduates with marked ability in English are enticed to take up the training that would make of them ideal teachers of ELT for technology. It is a happy sign that already five percent of teachers of English in Engineering colleges and Institutes of Technology in India have the basic degree in science. To make a beginning in the right direction the existing Faculty should be given opportunities for receiving training for the specific task of ELT for technology through Specialised Summer Institutes held for them to give them the orientation to the technological milieu and the training for their specific task. The curriculum for such a programme should include logic, rhetorical strategies for technical exposition, concepts in science, scientific culture, scientific exposition, English as instructional language for technology, components of ELT for technology, how to teach what has to be taught, and educational technology applicable to ELT for technology.

Educational technology is a concept that has recently become current. It is destined to emerge as the great central humane discipline of the future. The concept is the result of the systems approach to education. The National Council of Educational Technology which was appointed in 1967 by the Secretary of the State for Education and Science of the United Kingdom, has defined this major new development in Education as : "the development, application and evaluation of systems, techniques and aids to improve the process of human learning." It is the application of scientific knowledge about learning, and the conditions of learning, to improve the effectiveness and efficiency of teaching and training. It is concerned with providing appropriately designed learning situations which bring to bear the best means of instruction for achieving the objectives of the teaching or training. Educational Technology is often taken to mean the method of presentation of Closed Circuit TV, Language Laboratories, Projection Equipment. This is an important aspect of educational technology so far as they make a controlled contribution to improving the effectiveness and efficiency of teaching and training. The prime concern being improving effectiveness and efficiency of teaching and training many other factors have to be integrated into the teaching system as training of teachers, choice of equipment, what is taught and how it is taught, the contents and strategies of teaching; the social organisation of teaching-size and types of grouping, organisation of teaching personnel, social climate; and the physical arrangement of the educational 'plant'. Educational Technology considers the best means to the attainment of educational objectives. Improving efficiency is an acknowledged object of technology. This concept when applied in educational technology means (1) decreasing the time needed to achieve particular objectives; augmenting the capacity of individual teachers by increasing the number of learners taught, without reduction in level or quality of learning, effecting economies in financial cost.

Educational technology is not confined to techniques of instruction with or without mechanical devices. It is an applied science, better, the study of sciences applicable in the field of education-the sciences being sociology, psychology, electronics aids, lighting, printing, photography , acoustics,management, architecture,building science,ergonomics (study of man in relation to his working environment), systems analysis and communications. Educational services have come to assume such proportions that it has become necessary to resort to the techniques of management which are now indispensable for the efficient running of large-scale industrial enterprises. Educational enterprise has to be treated in terms of large systems of men, machines, materials and money for the attainment of objectives that are clearly specified and known in advance. The teacher, the equipment, the aids and the buildings have to be regarded as a complete man-machine system in which all the parts must simultaneously be deployed to achieve an optimum level of operation for the benefit of the student. Educational Technology studies the interaction of the technological situation with the desired sociological pattern to meet to-day's demand for the education of children and adults. The ramifications of this man-machine system are varied as they are far-reaching.

The systems approach views an instructional situation in its entirety with all its ramifications, with all its interior interactions, with all its exterior connections and with full cognizance of its place in its context.

Secondly, for advanced programmes in Engineering Communication as in Engineering communication IV comprising scientific exposition in speech and writing a system of joint functioning of the Department of English and another Department of Engineering/Technology should evolve by which the teacher of ELT and the Engineering teacher are available to aid the student in the preparation of the technical paper and in the delivery of an oral talk on a topic of some special area in which he is working and suggest reading material to document his paper in acceptable bibliography. The guidance of the teacher of ELT for lay-out, organisation and English usage, and the direction of the Engineering teacher in the technical content and organisation,and their combined evaluation for grading as well as for offering critical comments would provide the student with valuable help that would greatly enhance his performance. It would also provide the two teachers opportunities for learning from each other.

Writing an engineering paper is becoming an intrinsic part of the engineering work, rather than a mere recording of results. The technical paper is emerging as an extremely valuable instrument in the technological world. It facilitates the high level technical activity by the organised and methodical means of communication offered by it. It guides intelligently in making decisions in areas covered by the report. The change in the role of science and technology from a significant source of power to a major instrument of power necessities that our scientists/and technologists need scientific information not only to equip themselves for their function but for the performance of significant duties that society has assigned to them. As these duties consume more and more time, scientists and technologists would be compelled to seek help for writing or editing their technical papers. The day is fast approaching when there is going to to be a heavy demand for personnel with the qualifications and competency required of the teacher of ELT for technology. The notion that they belong to the humanities will disappear. Their professional function and role will be recognised, appreciated and required by industry itself. This has already happened in advanced countries. When this happens in India a heavy premium will be placed on those who play their role with a high degree of excellence.

Chapter XII

CONCLUSION

English Language Teaching to students of Technology in India has so far not been purposeful as it has not been related to the functional need of the language for technological education. English Language Teaching has been the time-honoured programme with no definite and well-defined object as revealed by the striking similarity of its curriculum with the curriculum for the General English teaching programmes. Some enthusiasm has been displayed of late by a few in evolving an English teaching programme for technological students by presenting English through the material of science and technology. Some others have resorted to some 'Structural Method' of English teaching by presenting the structures and static characteristics of the English used in technology. Yet some others have conservatively clung to the conventional view that the English language has an entity apart from the subject of technology and that both cannot be taken together. They believe that the traditional English teaching programme is good enough for technological education. Such discordant views on the purpose and practice of English teaching when blended with a certain amount of political pungency have turned the entire programme of teaching English to technological students into a fruitless activity.

My attempt in this context has been to express a definite theory and propose a practice based on the study of the existing situation and data available. I have proceeded through the study of the problem of English Language Teaching in Technological Education in logically sequenced steps and determined that the functional need of the English language for technology is distinct and definite; and mathematically analysed the problem to arrive at empirical formulae; and expressed the results of my study in scientifically tangible forms with illustrative graphs, charts, models and tables.

The four distinct parts as presented in the Block Schematic at the beginning of the thesis constitute the preceding eleven chapters as a logical ordering of the theme. The thesis begins with an exposition of

A - TECHNOLOGICAL EDUCATION IN INDIA (Chapter I), and moves to the examination of

B - ENGLISH-THE INSTRUCTIONAL LANGUAGE, THE INSTRUCTIONAL CONTEXT, AND THE EXISTING CURRICULUM (Chapters II, III,IV). The third part comprises the

C - MATHEMATICAL ANALYSES OF THE IMPACT, THE FUNCTION, AND THE DYNAMICS OF THE INSTRUCTIONAL LANGUAGE IN THE STUDY OF TECHNOLOGY (Chapters V,VI,VII). And the fourth treats the

D - PROPOSED ENGLISH LANGUAGE TEACHING FOR TECHNOLOGY (Chapters VIII,IX,X,XI).

A - The history and pragmatic character of technological education with particular reference to India (Chapter I) shows that science and technology having become the primary need for India's economic and social progress, India requires that the educational system ensures an adequate supply of scientists and technologists. This has necessitated the re-organisation of the curriculum, and the selection and education of young people as potential additions to the nation's technical manpower, in order to meet the need for social relevance of the educational services. The rapid increase in the number of engineering institutions and institutes of technology and in student enrolment to them reflects the phenomenal growth of technological education in the post-independent period in India.

B - English as the language of instruction of technology in India, necessitated by a historical accident (Chapter II) is serving as a pole to vault over the technological gap between India and the West. However, the reference to English as the 'window on the world' when applied to the context of technological education is not meant to serve as merely a library language. In India, in technological education, the English Language is the mind's eye not merely to look but to see.

Accepting the fact that English is the language of instruction of technological education in India, the examination of the instructional context (Chapter III) shows the context is distinctively different from the context which calls for English Language

Teaching as a foreign language. The analysis of the existing English Language Teaching curriculum offered in technological education in India (Chapter IV) shows that it is non-discriminating.

C- The examination of the impact of proficiency in General English on performance in technological study by Mathematical Analyses (Chapter V) which is distinguished for the vigour and penetration of its logic, for its high seriousness, for its complete objectivity, and for its utter dependability, underscores the following striking behaviour trends:

1. A HIGH PROFICIENCY IN GENERAL ENGLISH IS NO INDICATION OF A CORRESPONDINGLY HIGH PERFORMANCE IN TECHNOLOGICAL STUDY; SIMILARLY A LOW PROFICIENCY IN GENERAL ENGLISH DOES NOT NECESSARILY PREDICT A CORRESPONDINGLY LOW PERFORMANCE IN TECHNOLOGICAL STUDY.

2. THE CORRELATION BETWEEN PROFICIENCY IN GENERAL ENGLISH AND PERFORMANCE IN TECHNOLOGICAL STUDY OF THE ADEQUATE CATEGORY IS WEAK; WHILE, THE CORRELATION BETWEEN PROFICIENCY IN GENERAL ENGLISH AND PERFORMANCE IN TECHNOLOGICAL STUDY OF THE INADEQUATE CATEGORY IS BOTH HIGH AND SIGNIFICANT.

3. THE RATE OF CHANGE IN PERFORMANCE IN TECHNOLOGICAL STUDY IS INVERSELY AS THE PROFICIENCY IN GENERAL ENGLISH. STATED OTHERWISE, STUDENTS WITH HIGHER PROFICIENCY IN GENERAL ENGLISH HAVE A MORE STABLE PERFORMANCE IN TECHNOLOGICAL STUDY.

These trends of behaviour are not only significant in themselves but serve as guidelines for the kind of programmes in the instructional language to be offered in technological education.

A pertinent issue raised herein is-If the object of the English Language Teaching (core) is to enable the learner acquire linguistic ability for doing his technological study, does it imply that the learner who does not do the programme in English Language Teaching is unable to do his technological study well? My study has shown that a sizable number of students with inadequate proficiency in General English are able to do their technological study as well as those with adequate proficiency. For this category of students-

4. THERE IS A HIGH COEFFICIENT OF CORRELATION BETWEEN PROFICIENCY IN GENERAL ENGLISH AND PERFORMANCE IN TECHNOLOGICAL STUDY. THOSE WHO ARE MAKING PROGRESS IN THE MAKE-UP ENGLISH PROGRAMME offered to this category of students to make up the linguistic deficiency, DO THE TECHNOLOGICAL STUDY AS WELL AS THOSE WITH ADEQUATE PROFICIENCY IN GENERAL ENGLISH, AND THOSE WHO ARE UNABLE TO COPE WITH THE MAKE-UP ENGLISH PROGRAMME ARE UNABLE TO DO THEIR TECHNOLOGICAL STUDY.

5. It leads to the inference that THERE IS A CERTAIN MINIMUM PROFICIENCY IN THE INSTRUCTIONAL LANGUAGE WHICH I CALL THE THRESHOLD PROFICIENCY REQUIRED FOR PURSUING TECHNOLOGICAL STUDY, and, it is found that as the inadequate stream attains the THRESHOLD PROFICIENCY, their performance in the major study rapidly improves.

6. THE probe has highlighted <u>AN INTERACTION BETWEEN STUDY OF TECHNOLOGY AND PROFICIENCY IN ENGLISH OF THE NATURE OF AN EXPONENTIAL FUNCTION</u>. It has been found that THE STUDY OF TECHNOLOGY THROUGH ENGLISH HAS A POSITIVE EFFECT ON THE PROFICIENCY IN GENERAL ENGLISH THE INSTRUCTIONAL LANGUAGE. I CALL THIS ACTION, TAKING PLACE IN THE REVERSE DIRECTION, AS THE RETRO-EFFECT OF THE STUDY OF TECHNOLOGY. This RETRO-EFFECT is partly responsible for students with inadequate proficiency in English for performing well in the major study.

7. THE RETRO-EFFECT of the study of technology on proficiency in the instructional language is significant because of its FUNCTIONAL character. The language ability being acquired through this RETRO-EFFECT is the very ability needed for studying technology. This ability of the functional usage of the language develops along with the study of technology, and is directly dependent on the linguistic mastery in the instructional language of the instructors of the subjects of technology.

8. The FUNCTIONAL characteristic of the language in the RETRO-EFFECT, in turn, has determined what FUNCTIONAL ENGLISH IS. I define FUNCTIONAL ENGLISH (Chapter VI) as the language that brings about the understood-understand activity, in other words, facilitates activity on the part of the student to understand what the teacher wants him to understand. FUNCTIONAL ENGLISH

for technology is therefore the language that brings about cognitive activation for the understanding and assimilation of technology.

9. The analysis of the instructional process as different from the communication process (Chapter VI) has characterised the language of instruction as an instrument of cognitive activation for the numerous mental processes required for learning science and technology by directing the reason by the inferential uses of the language, to move from premises to conclusions, from cause to effect, from data to target. It necessarily follows that the domain to which English Language Teaching should be directed is the cognitive domain.

10. The Dynamics of FUNCTIONAL ENGLISH for the study of technology, represented through a viable physical model (Chapter VII) analogous to the instructional system in technological education, demonstrates the coupling between Functional English for technology and the content of technology, and how at the operational level, proficiency in FUNCTIONAL ENGLISH influences the proficiency in technology by a DIRECT EFFECT, and the proficiency in technology improves proficiency in FUNCTIONAL ENGLISH by a RETRO-EFFECT. These two effects therefore form the essential operating parameters of the instructional system for technology. It is seen from the physical model by analogy that:

the student with a finite capacity and the faculty for learning requires at least the THRESHOLD PROFICIENCY in the language of instruction;

(ii) the RETRO-EFFECT of the study of technology improves the linguistic proficiency for the study of technology;

(iii) the intake of abstract technological content inseparably contained in FUNCTIONAL LANGUAGE is dependent on the 'WINDOW' on the linguistic barrier, that is, on the proficiency in FUNCTIONAL ENGLISH, which, in turn, is related to the language absorbed or assimilated both by RETRO-EFFECT and DIRECT-EFFECT; and,

(iv) THE RATE AT WHICH PROFICIENCY IN FUNCTIONAL LANGUAGE INCREASES $\frac{d\theta}{dt}$ IS A FUNCTION OF (a) THE RATE AT WHICH THE STUDENT UNDERSTANDS THE FUNCTIONAL LANGUAGE OF TECHNOLOGY '$\alpha\theta\gamma\delta$', and (b) THE COEFFICIENT 'β' OF INCREASE IN PROFICIENCY IN FUNCTIONAL LANGUAGE FOR UNIT LANGUAGE OF TECHNOLOGY UNDERSTOOD. $\left[\frac{d\theta}{dt} = \alpha\theta\gamma\delta\cdot\beta\right]$

11. THE MATHEMATICS OF THE PHYSICAL SYSTEM, BY SUPERPOSITION ON THE INSTRUCTIONAL SYSTEM, HAS RESULTED IN FORMULAE TO DETERMINE (1) THE LINGUISTIC PROFICIENCY 'θ' AT A TIME 't', and (2) THE TECHNOLOGICAL PROFICIENCY 'τ' AT A TIME 't'. THE EMPIRICAL EQUATIONS (1) $\theta = \theta_0 e^{\alpha\gamma\delta\beta t}$ and (2) $\tau = \tau_0 e^{\alpha\gamma\delta\beta t}$ HAVING THE SAME FORM SHOW THAT PROFICIENCY IN FUNCTIONAL ENGLISH AND PROFICIENCY IN TECHNOLOGY INCREASE AT THE SAME RATE. Stated otherwise, THE CORRELATION COEFFICIENT OF PROFICIENCY IN FUNCTIONAL ENGLISH AND

PROFICIENCY IN TECHNOLOGY IN A TIME-VARYING CONTEXT IS PLUS ONE.

12. It is observed from the equations that if the initial proficiency in FUNCTIONAL ENGLISH is nil, there cannot be any improvement in the linguistic proficiency, and, if any of the factors of the exponent is zero, the linguistic proficiency remains at the initial level. As the rate of improvement in linguistic proficiency is considerably influenced by the initial proficiency, for rapid progress, with a given initial proficiency in FUNCTIONAL ENGLISH as well as technological proficiency, the values of the factors of the exponent should be maximised. THE AIM OF A SUCCESSFUL ACADEMIC PLAN SHOULD THEREFORE BE TO MAXIMISE THE FACTORS OF THE EXPONENT.

13. THE MATHEMATICAL FORMULAE DERIVED representing the proficiencies in FUNCTIONAL ENGLISH and in technology are reasonably dependable, ENABLING PREDICTION OF THE BEHAVIOUR OF AN INDIVIDUAL STUDENT AS WELL AS THAT OF A SELECTED GROUP. The formulae make the following prediction or evaluation possible:

14. ON THE BASES OF THE PROFICIENCY IN TECHNOLOGY (CGPA) FOR ANY TWO POINTS ON THE TIME-SCALE, THE EXPONENTIAL INCREMENT AND THE INITIAL PROFICIENCY IN TECHNOLOGY CAN BE DETERMINED.

15. IF THE INITIAL PROFICIENCY IN TECHNOLOGY AND THE EXPONENTIAL INCREMENT ARE KNOWN, IT IS POSSIBLE TO PREDICT THE PROFICIENCY FOR ANY OTHER POINT OF TIME.

As data for the behaviour in FUNCTIONAL ENGLISH are not available, prediction is not possible for the behaviour of students in FUNCTIONAL ENGLISH. However, the formula is applicable to behaviour in the Make-up English programme which is FUNCTIONAL in character in that it leads the student to the THRESHOLD PROFICIENCY.

As the mathematical derivations do not account for the saturation phenomenon, prediction is possible only for the initial semesters.

D 1- The instructional language being the instrument for cognitive activation for the study of technology, and proficiency in FUNCTIONAL ENGLISH and proficiency in technology being interactive, it follows therefrom that instruction in English, which has for its object the definite aim of enabling the learner acquire linguistic proficiency INASMUCH AS IT IS THE LANGUAGE OF INSTRUCTION for technology, SHOULD BE DIRECTED TO FUNCTIONAL ENGLISH (Chapter VIII), and not to General English. The behavioural trend of students (C-1,2,3) of adequate proficiency in General English is contrary to expectation because the English is GENERAL ENGLISH. Hence there is a weak correlation between high proficiency in General English and performance in technological study.

1. IT FOLLOWS THAT A CURRICULUM BASED ON FUNCTIONAL ENGLISH FOR TECHNOLOGY WOULD ENABLE STUDENTS DO THEIR TECHNOLOGICAL STUDY DECIDEDLY BETTER THAN THOSE WHO ARE NOT EXPOSED TO THIS CURRICULUM.

2. However, there is the impression that a curriculum in English for science and technology, if based on a description of the properties of the language of science and technology, would achieve the desired object of enabling the student do his technological study decidedly better. A DESCRIPTION ON THE LANGUAGE OF SCIENCE AND TECHNOLOGY MERELY EXPOSES THE STATIC PROPERTIES OF THE LANGUAGE IN USE IN SCIENCE AND TECHNOLOGY. IT DOES NOT ENGAGE THE STUDENT IN THE DYNAMIC FUNCTION OF THE LANGUAGE OF SCIENCE AND TECHNOLOGY. For involving the student in the dynamic function of the language of instruction, the curriculum should be based on FUNCTIONAL ENGLISH.

3. In recent years ENGLISH THROUGH SCIENCE is being projected as the right curriculum for students of science and technology for imparting linguistic ability for the study of science and technology with the avowed object of teaching language and not science. The approach in believing that language can be servered from content is attempting the impossible. CONTENT-LANGUAGE RELATIONSHIP IS ANALOGOUS TO MASS-WEIGHT RELATIONSHIP. JUST AS WEIGHT CANNOT EXIST WITHOUT MASS, LANGUAGE DOES NOT EXIST WITHOUT CONTENT. By severing language from content, the English Language Teaching is insulating itself from blame for linguistically correct structures with incorrect content, at the cost of pedagogic malfunctioning. The ability to recognise and understand the mechanics of the language

in use is not independent of the perceptual and conceptual functions. The recognition of the linguistic framework has to serve as instrument for grasping the thought-content. Besides, in many cases, the scientific material adapted for the purpose of serving as linguistic framework suffers from unpardonable technical fallacies precisely because the editor has been guided by linguistic correctness only.

4. Coming to the crux of the study, namely, English Language Teaching for technology (Chapter IX), it has been shown that the instructional language being the instrument for cognitive activation for the study of technology, and the proficiency in FUNCTIONAL ENGLISH and proficiency in technology being interactive, the instruction in English aimed at enabling the learner acquire linguistic proficiency INASMUCH AS IT IS THE LANGUAGE OF INSTRUCTION FOR TECHNOLOGY SHOULD BE DIRECTED TO FUNCTIONAL ENGLISH.

5. FUNCTIONAL ENGLISH FOR TECHNOLOGY HAS BEEN IDENTIFIED AS THAT LANGUAGE THAT EXPRESSES ORDERLY RATIONALISED CONCEPTS AND CREATES A PARTICULAR AND SPECIFIC IMPRESSION ON THE MIND OF THE RECIPIENT. IT HAS DEFINITE DENOTATION. FUNCTIONAL ENGLISH BELONGS TO THE DENOTATIVE STRATUM OF LANGUAGE WHICH IS NOT INFLUENCED BY FEELINGS, MOODS OR EMOTIONS. IT IS MARKED BY EXPLICITNESS, EXACTNESS AND COMPLETE INTELLECTUAL SINCERITY. UNLIKE THE CONNOTATIVE STRATUM WHERE THE IMPRESSION PRODUCED IS NOT ONLY BY WHAT IS SAID EXPRESSLY BUT

ALSO BY WHAT IS NOT EXPRESSED, THE DENOTATIVE STRATUM CREATES THE IMPRESSION THAT IS WILLED.

D 2- To serve the object of enabling the learner acquire linguistic proficiency for the study of technology, English Language Teaching has to be related to the precise needs of technological study as yet another component of technological education. The precise needs of the language of instruction for the study of technology are primarily HEURISTIC, that is, understanding the data, the arguments based on the data and the order in which the premises lead to the conclusion by the exercise of the mental processes so that the learner is set to find out things for himself; this requires that the language has to serve as instrument of thought. The second need is to serve as instrument of self-expression for communication. A third need is to equip the learner with the linguistic ability for his professional needs later. Therefore English Language Teaching has to

(1) enable the learner comprehend and assimilate technical knowledge,

(2) enable the learner acquire ability of the mechanics of FUNCTIONAL ENGLISH to express his technical knowledge and know-how in the WORD-PLANE, and

(3) provide the experience of the language in the practice of the profession.

Thus it is seen that English Language Teaching for technology is (1) TWO-PRONGED IN ITS DIRECTION, (2) SYNCHRONIC IN ACTION, AND (3) HEURISTIC IN STRATEGY.

The primary need of cognitive activation for heuristic function is served by one prong of the language functioning as instrument of thought for the numerous mental operations for perceptual and conceptual actions. The second basic need of language is served by the other prong functioning as instrument of self-expression for communication, through the established oral and verbal referents, through the word-order and structure-order of the language system, through the mechanics of the language, so that the denotation conveyed through the language symbols of ideas is well defined. The two functions of language, one at the ideation plane and the other at the word-plane, although developed and strengthened by two sets of components of the English Language for technology, is synchronic in action in that cognitive activation takes place through language, and expression in language is of ideas generated in the mind. The three specific needs to be provided for are thought of as three different needs only for teaching convenience and learning experience. Each of the components of the English Language for technology only projects a certain ideational or linguistic feature that has to be specially developed and strengthened in the learner. The compartmentalisation of the components does not, in any way, suggest that these components are independent. In each component the others interact. Even where the components cater to the present need, it is obvious that the present is only

The primary need of cognitive activation for heuristic function is served by one prong of the language functioning as instrument of thought for the numerous mental operations for perceptual and conceptual actions. The second basic need of language is served by the other prong functioning as instrument of self-expression for communication, through the established oral and verbal referents, through the word-order and structure-order of the language system, through the mechanics of the language, so that the denotation conveyed through the language symbols of ideas is well defined. The two functions of language, one at the ideation plane and the other at the word-plane, although developed and strengthened by two sets of components of the English Language for technology, is synchronic in action in that cognitive activation takes place through language, and expression in language is of ideas generated in the mind. The three specific needs to be provided for are thought of as three different needs only for teaching convenience and learning experience. Each of the components of the English Language for technology only projects a certain ideational or linguistic feature that has to be specially developed and strengthened in the learner. The compartmentalisation of the components does not, in any way, suggest that these components are independent. In each component the others interact. Even where the components cater to the present need, it is obvious that the present is only to prepare for the future. The components in meeting the precise needs of the learner make English Language Teaching for technology meaningful and pragmatic. Four core programmes and one elective programme structured with these components (Chapter XI) are suggested for offering to students of technology- called ENGINEERING COMMUNICATION I, ENGINEERING COMMUNICATION II, ENGINEERING COMMUNICATION III, ENGINEERING COMMUNICATION IV, AND ENGINEERING COMMUNICATION V. The proposed curriculum for FUNCTIONAL ENGLISH is so structured that it is integral and self-sufficient without having to take into account the RETRO-EFFECT of the study of technology on proficiency in the instructional language.

D 3- The schematisation of the ENGLISH Language Teaching programmes in technological education (Chapter X), should provide for a testing machinery for categorising the students at input on the basis of the THRESHOLD PROFICIENCY which is the pre-requisite essential required of the 'subject'. Such a test should be critical in the sense it should test whether the student has that minimal proficiency in English that would enable him to begin the study of technology through it so that a cycle of self-action that is a regenerative cycle for learning technology is started. The category of students that does not possess the THRESHOLD PROFICIENCY need to be provided a MAKE-UP programme to make up the deficiency.

D 4- English Language Teaching for technology needs a new type of teacher. HE IS THE ENGINEER OF THE INSTRUCTIONAL SYSTEM IN ENGLISH. HE IS REQUIRED TO DIRECT HIS INSTRUCTION TO THE ENGINEERING OF THE STRUCTURE OF THE EXPRESSION OF THE THOUGHT TO FIT THE STRUCTURE OF THE THOUGHT ITSELF. He cannot therefore claim to teach only language and be unconcerned about the thought. There is a two-phased function required of the teacher: One is to train the mind of the learner through the important territory of perception so that the mind is subjected to the various phases of the cognitive functioning from reception of information to problem-solving in the domain of technology; the other is to provide the linguistic ability that would enable the perception of the learner to the point at which understanding of the various elements and their relationships constitutes a unified understanding that approximates to what is communicated without any perception gap. He needs to know how to direct the teaching so as to enable the learner to organise perceptual patterns of the significant elements of a situation, in order to achieve insight into the problem, how to make a previously vague and unstructured area become cognitively structured and specific so that the cognitive structures thus created and reconstructed afford insight into a situation, or guide action to solve a problem, through the medium of language. To play his role effectively he needs to possess a grounding in Logic and Rhetoric, the scientific culture, a mastery of the art of technical exposition, a comprehensive knowledge of the basic concepts of science and an open mind to accept and absorb new scientific and technological ideas that are coming up every day. It would be a great advantage if he has the ability to communicate in the graphic plane too.

It is time that science and engineering graduates with marked ability in English are attracted to take up the training that would make of them ideal teachers of the English Language for technology. The change in the role of science and technology from a significant source of power to a major instrument of power necessitates that our scientists and technologists need scientific information not only to equip themselves for their function but for the performance of significant duties that society has assigned to them. As these duties consume more and more time, scientists and technologists would be compelled to seek help for writing or editing their technical papers. For this task the new teacher of the English Language for technology is the right person. His professional function and role will soon be recognised, appreciated and required by industry itself. When this happens in India a heavy premium will be placed on those who can play their role with a high degree of excellence.

I hope that my enquiry into ENGLISH AS INSTRUCTIONAL LANGUAGE IN TECHNOLOGICAL EDUCATION IN INDIA bringing into focus striking behaviour trends, significant discoveries and interesting empirical predictions, and the findings based on them would become a solid base for new directions in teaching and learning the English Language for Technological Education.

QUESTIONNAIRE

SCOPE: This questionnaire attempts to determine the extent to which the English Language Teaching at BITS is related to the needs of technological education.

Strike out what is not applicable.

I 1. You come from a city/town/village.

2. Your medium of instruction at school was vernacular/English.

3. English is spoken often/occasionally/never at home.

4. With friends you converse always/occasionally/rarely/never in English.

5. Your proposed course of study is Humanities/Science/Engineering.

II 1. Courses in English taken so far are ENGL A011/ENGL A111/ENGL A112/ENGL A211.

2. You found ENGL A011/ENGL A111/ ENGL A112/ENGL A211 helpful and related to your needs/not at all helpful.

3. ENGL A111 was helpful/not helpful because

   (a) the content was good/bad, or relevant/irrelevant, and

   (b) the quality of teaching was good/bad.

4. ENGL A112 was helpful/not helpful because

   (a) the content was good/bad, or relevant/irrelevant, and

   (b) the quality of teaching was good/bad.

5. ENGL A211 was helpful/not helpful because

   (a) the content was good/bad, or relevant/irrelevant, and

   (b) the quality of teaching was good/bad.

III 1. Students of science and engineering do/do not need to study literature because ----------

2. If they need literature, the content should be --------
----

3. For technological education in India, English is

   (a) very essential.

   (b) is rather essential.

   (c) not at all necessary.

4. Do you favour having the programmes as they are without changes? YES/NO

5. You favour ENGL A111/ENGL A112/ENGL A211 courses as they [illegible] helpful for technological education, and suggest eliminat[illegible] the rest from the curriculum.

6. Do you favour the same number of courses in terms of total [illegible] for English but suggest shifting the emphasis to

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SAMPLE B

I-(a) Tick the letter against the word or expression which means the same as the word in capital letters. The first one has been done for you. (10)

10½/40

1. PRAGMATIC - (A) smooth (B) absolute (C) practical (D) bookish
2. ANHYDROUS - (A) many-sided (B) carefully divided (C) multi-headed (D) destitute of water
3. ECOLOGY - (A) environmental study of organisms (B) study of business (B) doctrine of final causes (D) science of family life
4. TURBID - (A) insubordinate (B) distended (C) muddy (D) dissimilar
5. VIABLE - (A) not excusable (B) open to corrupt influence (C) easily pulverized (D) capable of living
6. AMORPHOUS - (A) vase-shaped (B) dusky (C) formless (D) pain-assuaging
7. BIFURCATE - (A) lie down (B) examine closely (D) divide into two (D) translate
8. HOMOGENEOUS - (A) clear (B) rapid (C) of the same kind (D) glitter
9. PESTLE - (A) part of a flower (B) contagious disease (C) pounding instrument (D) mixing bowl
10. DESICCATE - (A) loathe (B) completely destroy (C) violate (D) make dry

11. [illegible]

2. The sculptor will convert this ---------- piece of clay into a beautiful bust.

(A) virulent (B) amorphous (C) taciturn (D) salient

3. They day will come when ------ will look upon us and our time with a sense of superiority.

(A) antiquity (B) posterity (C) carnivores (D) ancestors

4. Her --------- manner endeared her to the others at the party.

(A) affable (B) tractable (C) tactless (D) gaudy

5. The -------- professor put his wife out and went to sleep with the cat.

(A) diurnal (B) dubious (C) distraught (D) absent-minded

6. I destroyed all those papers, not then anticipating that I could ever feel any --------- about my first attempts at writing and reasoning.

(A) anachronism (B) reluctance (C) timidity (D) curiosity

II. Examine the relationship between the ideas in the pair of words listed against the numbers below. Consider each relationship critically and select from the five sets following each key pair the one that bears a similar or parallel relationship. The first item has been done for you. (10)

1- LOCK : KEY
(A) door : bolt
(B) window : hinge
(C) table : draws
(D) wall : nails
(E) shelf : books

2- ROAD : BITUMEN
(A) roof : tiles
(B) wall : plaster
(C) pillar : stone
(D) floor : carpet
(E) river : water

3- IRRIGATION - RIVER
(A) agriculture : plants
(B) crop : pests
(C) sowing : plough
(D) cultivation : farmer
(E) manure : fertiliser

4- HAMMER : NAIL
(A) spanner : nut
(B) saw : timber
(C) anvil : hammer
(D) pliers : bolt
(E) chisel : wood

5- MACHINE : FORCE
(A) engine : steam
(B) coal : fuel

6- HEAT : CONDUCTION
(A) temperature : thermometer
(B) light : sun
(C) electricity : wires
(D) gravity : earth
(E) engine : steam

7- PAPER : WRITE
(A) graphite : pencil
(B) chalk : board
(C) duster : erase
(D) table : books
(E) chair : sit

8- CYCLE : ROAD
(A) aeroplane : [illegible]roller
(B) train : rail
(C) car : engine
(D) ship : harbour
(E) boat : port

9- BULB : SOUND
(A) radio : [illegible]
(B) television : entertainment
(C) bulb : light
(D) fan : [illegible]ulator
(E) heater : radiation

10- URANIUM : ENERGY
(A) radium : radio activity
(B) atom : nucleus
(C) heavy water : cooling
(D) proton : chain reaction
(E) electron : heat

11- ISLAND : [illegible]
(A) sand : desert
(B) mountain : ocean
(C) city : meadows
(D) lake : land
(E) river : bank

XII Suggest what specific improvements might be made to better any five items of everyday use. (10)

OR

Write about any five things which operate basically on the principle of the simple lever.

OR

Define a hammer and describe it.

Crean :- which is used for pick up heavy loads.

Hammar :- which is used for break some thing.

Wheel :- which is 1 basic part of any carriage. wt carriage can not work

(5)

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IV. Mark each statement TRUE or FALSE.

F 1. A psychologist must also be a physician.

F 2. A biologist is interested in the housing conditions of people.

F 3. People become notorious for their good deeds.

T 4. Kind people are benevolent.

F 5. The numbers 5,6,7,8,9,10,11 are not in sequence.

V. Put the following sentences into proper sequence and re-write them in a paragraph titled LIGHTNING CONDUCTOR. (5)

1. At its lower end it should be in good connection with the earth, and to secure this it should be attached to a large earth-plate sunk in the earth to a depth sufficient to be always in wet soil.

2. It consists of an iron or copper rod or flat strip of about one-quarter of a square inch in section.

3. All conductors and large pieces of conducting material inside and outside the building should be connected to the conductor.

1. 4. The lightning conductor still in common use as a protection from lightning was suggested by Franklin over a hundred years ago.

5. It runs from the top to the bottom of the building to be protected.

6. At its upper end it is sharply pointed and, in order to resist the action of the atmosphere, the point-piece should be of cooper, thickly gilt at the point, or of platinnum.

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