Prof. J.P. de Lange
Chairman of the Main Committee
HSRC Investigation into Education

RGN·HSRC

REPORT OF THE SUBCOMMITTEE: TECHNICAL AND VOCATIONAL EDUCATION

As Chairman of the Work Committee: Teaching of the natural sciences, mathematics and technical subjects, I take pleasure in submitting the report of the Subcommittee: Technical and vocational education to the Main Committee for consideration.

MR. J.B. HAASBROEK
CHAIRMAN

WORK COMMITTEE: TEACHING OF NATURAL SCIENCES, MATHEMATICS AND TECHNICAL SUBJECTS

REPORT OF THE SUBCOMMITTEE FOR TECHNICAL AND VOCATIONAL EDUCATION

It is my pleasure as Chairman of the Subcommittee for technical and vocational education to submit this report for consideration by the Main Committee. The final chapter contains a summary of the report.

I would like to take this opportunity to express my appreciation towards all the members of the Subcommittee for their contributions, and for the pleasant spirit of co-operation which led to the committee's unanimous acceptance of the report.

A special word of thanks to Prof. W.L. Rautenbach for the tireless manner in which he conducted his research which ultimately formed the basis of this report. A word of thanks also to Mr Z. van den Heever who was co-opted to take care of the secretarial work.

MR H.J.A. MOORE
CHAIRMAN

TATEMENT

his report has been prepared by the Subcommit-
ee: Technical and vocational education of the Work
ommittee: Teaching of the natural sciences,
athematics and technical subjects instituted by
ne HSRC Main Committee for the Investigation into
ducation.

his report reflects the findings, opinions and
ecommendations of the Subcommittee: Technical
nd vocational education and, where applicable,
hose of groups or individuals in the subcommittee
ith regard to matters about which there are dif-
erences of opinion. The findings, opinions and
ecommendations contained in this report do not
ecessarily reflect the point of view of either the
SRC or the HSRC Main Committee for the Investi-
ation into Education.

his report is regarded by the HSRC Main Commit-
ee for the Investigation into Education as a submis-
ion of the Subcommittee: Technical and vocational
ducation to the Main Committee. The point of view
nd recommendations of the HSRC Main Commit-
ee will be contained in its final report that will be
ubmitted to the Cabinet.

Human Sciences Research Council

Investigation into Education

Work Committee: Teaching of the natural sciences, mathematics and technical subjects

Report of the Subcommittee:

Technical and vocational education

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1. ORIENTATION

THE REQUEST

In June 1980 the Cabinet requested the Human Sciences Research Council to conduct an in-depth investigation into all facets of education in the RSA. The request to the HSRC read as follows:

"Your Council, in co-operation with all interested parties, must conduct a scientific and co-ordinated investigation and within 12 months make recommendations to the Cabinet on:

(a) guiding principles for a feasible education policy in the RSA in order to,

  (i) allow for the realization of the inhabitants' potential,
  (ii) promote economic growth in the RSA, and
  (iii) improve the quality of life of all the inhabitants of the country

(b) the organization and control structure and financing of education

(c) machinery for consultation and decision-making in education

(d) an education infrastructure to provide for the manpower requirements of the RSA and the self-realization of its inhabitants, and

(e) a programme for making available education of the same quality for all population groups.

The investigation must be conducted in the light of, among other things, the present educational situation, the population composition in South African society and the means that can be made available for education in the national economy. The investigation must cover all levels of education, i.e. pre-primary, primary, secondary and tertiary."

In accordance with the South African Plan for Research into the Human Sciences, the following plan of action was decided on.

(a) Prof. J.P. de Lange, Rector of the Rand Afrikaans University, would be appointed as research leader.

(b) After the necessary consultation a high-level co-ordinating committee would be appointed to guide and co-ordinate the investigation and guarantee its scientific character. Members of the committee would include representatives of interested government departments, the private sector as well as eminent scientists from all the disciplines able to make a contribution to the development of education.

(c) Representatives of education institutions would be invited to serve on the subcommittees and work groups of the investigation.

(d) All population groups would be involved in the co-ordinated conduct of the investigation.

(e) The investigation would be conducted in a spirit of positive co-ordination, i.e. the available research manpower both within and outside of the HSRC and all research activities which had either already been concluded or were still going on, would be included in the investigation on a basis of voluntary co-operation.

(f) The HSRC would undertake parts of the investigation itself, but would for the greatest part make its research structure available to contract researchers for the investigation.

(g) Priority would be given to the most pressing problem areas so that the investigation could be expedited and interim reports submitted to the Cabinet in good time.

(h) Where applicable, alternative solutions for problems in education would be submitted.

THE MAIN COMMITTEE

The Main Committee of the Investigation into Education, whose members were appointed by the Council of the HSRC, in their personal capacities, was as follows:

Prof. J.P. de Lange (Chairman)	Rector, Rand Afrikaans University
Prof. A.N. Boyce	Rector, Johannesburg College of Education
Dr S.S Brand	Chief, Financial Policy, Dept. of Finance
Dr R.R.M. Cingo	Inspector of Schools, Kroonstad circuit, Dept. of Education and Training
Dr J.G. Garbers	President, Human Sciences Research Council
Mr J.B. Haasbroek	Director, South African Institute for Educational Research, HSRC
Dr K.B. Hartshorne	Centre of Continuing Education, University of the Witwatersrand
Prof. J.H. Jooste	Director, Transvaal Education Department
Prof. S.R. Maharaj	Dean, Faculty of Education, University of Durban-Westville
Dr P.R.T. Nel	Former Director if Education, Natal Dept. of Education and Dept. of Indian Education
Prof. A.C. Nkabinde	Principal, University of Zululand
Mr R.D. Nobin	Inspector of Education, Dept. of Internal Affairs
Mr M.C. O'Dowd	Anglo-American Corporation of SA Ltd
Mr A. Pittendrigh	Director, Natal Technikon
Miss C.C. Regnart	Westerford High School
Dr P. Smit	Vice-President, Human Sciences Research Council
Mr F.A. Sonn	Director, Peninsula Technikon and President, Union of Teachers' Associations of SA
Mr J.F. Steyn	Hoofsekretaris, Tvl. Onderwysersvereniging and Secretary, Federal Council of Teachers' Associations.

Prof. N.J. Swart	Vice-Rector, Potchefstroom University for Christian Higher Education
Mr L.M. Taunyane	President, Transvaal United African Teachers' Association
Dr P.J. van der Merwe	Deputy Director-General, Dept. for Manpower; Deputy Chairman: National Manpower Commission
Prof. R.E. van der Ross	Principal, University of the Western Cape
Prof. F. van der Stoep	Dean, Faculty of Education, University of Pretoria
Prof. N.T. van Loggerenberg	Dean, Faculty of Education, University of OFS and Chairman, South African Teachers' Council for Whites
Dr R.H. Venter	Director, University Affairs, Dept. of National Education
Prof. W.B. Vosloo	Head, Dept. of Political Science and Public Administration, University of Stellenbosch

After the investigation had been in progress for some months, a request from the Department of National Education of South West Africa that it be granted observer status on the Main Committee was received. This was approved. From the fifth meeting of the Main Committee Mr J.A. de Jager, Secretary of the Department, therefore also attended meetings of the Main Committee.

At the beginning of the investigation Dr. S.W.H. Engelbrecht was appointed secretary and Dr F.P. Groewewald co-ordinator of the investigation. In due course the secretariat was expanded with the appointment of Dr D.J. van den Berg, after which the above-mentioned three persons acted as secretary-co-ordinators. Mr C.P. Serfontein was later appointed assistant co-ordinator. During the last phase of the investigation the secretariat was further expanded when Prof. J. McG. Niven of the University of Natal was seconded to the HSRC for three months, from February to May 1981. The administrative staff consisted of Mrs I.S. Samuel, Mrs A. van der Lingen, Miss J.M.M. Botha, Mrs S. van der Walt and other temporary staff.

OPERATIONALIZATION OF THE RESEARCH REQUEST

The operationalization of the research request resulted in the establishment of 18 work committees each being responsible for a different aspect of education. Although all the work committees were not identified at the first meeting, the following work committees were eventually established. (For each work committee the name of the Chairman is given who in all cases had to be a member of the Main Committee. The Chairman of the Main Committee is ex officio member of all the work committees.)

Educational principles and policy	Prof. F. van der Stoep
Education management	Dr K.B. Hartshorne
Education financing	Dr S.S. Brand
Education system planning	Mr J.B. Haasbroek
Curriculum development	Prof. F. van der Stoep
Guidance	Miss C.C. Regnart
Education for children with special educational needs	Dr J.G. Garbers
Building Services	Mr F.A. Sonn
Health, medical and paramedical services	Mr R.D. Nobin
Demography, education and manpower	Prof. P.J. van der Merwe
Teaching of the natural sciences, Mathematics and technical subjects	Mr J.B. Haasbroek
Recruiting and training of teachers	Prof. N.T. van Loggerenberg
Innovation strategies in education	Prof. W.B. Vosloo
A programme for education of equal quality	Prof. R.E. van der Ross
Legal matters	Mr M.C. O'Dowd
Educational technology	Mr A. Pittendrigh
Languages and language instruction	Dr P.R.T. Nel
Education bibliography	

Only in the case of the last work committee was a chairman not appointed from the Main Committee. Miss H.J. Otto of the HSRC library compiled the bibliography for each of the work committees.

During the last stages of the investigation a synthesis committee was appointed to consolidate the work of three work committees

especially, namely Education Management, Education System Planning and Education Financing. The chairman of the Main Committee of the Investigation into Education was appointed chairman of the synthesis committee.

THE COMPOSITION OF THE SUBCOMMITTEE: TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING

The Work Committee: Teaching of the natural sciences, Mathematics and technical subjects established a subcommittee: Technical and vocational education and training in November 1980.

The brief of the subcommittee was to survey vocational education and training in South Africa and to make general recommendations on the future development of this field within the framework of a comprehensive system of education.

The members of the subcommittee were as follows:

Mr H.J.A. Moore (Chairman), Transvaal Department of Education
Prof. W.L. Rautenbach (Vice-chairman), University of Stellenbosch
Mr Z.J. van den Heever (Secretary), Transvaal Department of Education
Mr L. Bentley, Technical Institute Pretoria West
Mr M.H. Mabogoane, Private Sector
Mr A. Ramsamy, M.L. Sultan Technikon
Mr F.R. Schmidt, Department of National Education
Mr J.D. Volmink, Peninsula Technikon
Mr M.J. Wijnbeek, Mabopane East Technikon
Dr D.J. van den Berg, Institute for Educational Research, HSRC
Mr C. Swanepoel (Secretary) HSRC
Mr M.G. Atmore, Anglo AmericanCorporation
Six meetings took place between November 1980 and May 1981.

Method of approach

As will be shown in 1.1, vocational education is not only an integral part, but also one of the most important parts of any system of provision of education in South Africa. Education in its totality is, however, very closely linked to the religious, social, political and economical values of any country. One of the first steps taken by the work committee was therefore to become conversant with both the future role of vocational education in a South African system of education and the overall role of education in a developing country like South Africa.

For this purpose, a working group was established, interfacing, between this subcommittee, and the Work Committee: Teaching of natural sciences, Mathematics and technical subjects

The members of the working group: Technical and vocational education and training were as follows:

Prof. W.L. Rautenbach (Chairman), University of Stellenbosch
Mr H.J.A. Moore, Transvaal Department of Education
Mr P.E. Spargo, University of Cape Town
Mr J. Nel, University of Stellenbosch
Mr P.E. Metcalf, Epworth High School
Mr M.C. Mehl, University of the Western Cape
Prof. J.R. Seretlo, University of Fort Hare
Dr D.J. van den Berg, HSRC
Mr C. Swanepoel (Secretary)

This working group accepted as working document "The Design of an Effective Educational System for Science and Technology for South Africa" by Prof. W.L. Rautenbach. This document analyses the basic problems of education in a developing country like South Africa where rapid cultural changes are taking place. It proposes an educational system with a vitally important vocational component. (See Appendix 1.)

Vocational education has an extremely wide range, from technical and industrial fields to commerce, agriculture and health services. At present, all fields served by vocational education suffer severe shortages in skilled manpower at practically all levels in South Africa.

The survey presented in Appendix 1 points out the similarity of the underlying problems in all fields of vocational education in South Africa. Hence it was decided to look in depth at technical industrial vocational education only. This is due to the crucial role this field has to play in the future development of the country: it has to improve the utilisation of natural resources and it is expected to be a major source of new jobs for a rapidly increasing population. It is at present also beset by severe shortages of skilled people, limiting both the utilisation of installed capacity and the expansion of the industrial sector. After visiting a number of industries and communities in South Africa, Prof. Rautenbach presented a working document, "Report to the Sub-Committee on Technical and Vocational Education and Training" (Appendix 2 of this report).

Subsequently, the two documents (Appendixes 1 and 2) were sent to a number of individuals and organisations for comment (see Appendix 3 for a list of persons/organisations approached and from whom comments were received). In general, the comments strongly supported both documents.

The problems confronting vocational education in South Africa were also set forth on the 6th of May 1981 at the HSRC Symposium on Education at the RAU.

The gist of Appendixes 1 and 2, as well as reaction to these documents and comments received after the Symposium, are incorporated in this document. For the sake of brevity not all the arguments advanced in the appendixes are repeated in the main report. It is, however, recommended that the appendices be studied after chapter 1, prior to continuing with the rest of the report.

The subcommittee would like to express its appreciation to numerous individuals and organisations that contributed valuable ideas and time during this investigation. Thanks are especially due to the Foundation for Technical and Vocational Education of South Africa and the Urban Foundation which contributed Prof. Rautenbach's salary for the first half of 1981 in order to enable him to devote sufficient time to this investigation. The Urban Foundation also arranged a number of very valuable meetings with industrialists and members of different communities in Johannesburg, Cape Town and Durban.

CHAPTER I

A DESCRIPTION OF THE GENERAL ROLE OF VOCATIONAL EDUCATION AND TRAINING IN THE OVERALL PROVISION OF EDUCATION

1.1 INTRODUCTION

Vocational education can be described as that part of education that prepares a person for a productive career in a particular field of endeavour and for life in general (it will later be recommended that the term "career education" should be used instead of "vocational education" (see 5.2.2.1)). Vocational education covers a large number of careers, ranging from the education of secretaries, nurses, teachers, to the wide field of technical vocational education for industry and agriculture. Vocational education is therefore directly responsible for supplying the input of trained manpower into an economy as well as for the development of manpower during careers. Vocational education therefore presents the logical endpoint of the whole process of education.

Before considering the relationship between vocational and general or preparatory education, it is important to note the difference between vocational education and vocational training. The latter is a much more limited term denoting the acquisition of specific skills needed to enable a person to cope with a well defined job situation. The former denotes a combination of general formative education and vocation training and generally constitutes a basis for on-going education.

The general purpose of education is to prepare the individual to develop his/her capabilities to such an extent as to be able to live a full and productive life in a given social and physical environment. To this end, it is necessary for the individual develop an adequate comprehension of and sensitivity to religious, moral, social, economic, political, scientific and technological values. It should also prepare the individual for coping with changes in the environment and prepare him for responsible participation in introducing needed changes. This definition makes vocational education an indispensible part of education as well as the final phase of education for most people.

In a strongly differentiated and specialised world, vocational education presupposes specialisation. Since the aptitudes and interests of children take time to become manifest during schooling, vocational education should be preceded by general preparatory education which should develop general skills and values needed by most of the pupils. The general preparatory phase of education should also reveal and develop special aptitudes, interests and skills of pupils to prepare them for meaningful differentiation in different areas of education.

A major problem concerning vocational education is related to the extent of differentiation needed for different career fields and the time (age or educational standard) that differentiation should start. This depends on some general principles of education to be discussed in more detail in 3.5 as well as the child's socio-economic and cultural background, its innate capabilities and the objective of the vocational education in a specific career situation, which is again related to the stage of development of the country, opportunities for employment, etc.

It is often instructive to subdivide education into informal, formal and non-formal education. Informal education includes the home, social and religious environment in which a child grows up and which shape his comprehension, system of values and skills during the most impressionable early stages of life. Informal education can only be indirectly influenced by any system of educational provision through the parents, community, churches, etc.

After completing a certain phase of formal education, the young adult becomes a productive member of society. This represents the start of non-formal education, consisting of learning on the job, self-study, attending special training courses, etc. It should be a life-long process in tune with a continuously changing environment, as well as with the natural maturing and ageing of the individual.

Vocational education should be an integral part of both formal and non-formal education as shown in Figure 1. It is also closely related to the manpower needs of the country, which are in turn related to the stage of development, available natural resources, economic

policy, social systems, etc. - i.e., the general environment.

The output of the educational system affects the general environment of a country, which in turn impinges, through informal education, on the input into education and resources available for education. These interrelationships are very complex and can be anything from directly to tenuously linked. If change in education is desired, the strategy for change should be very carefully thought out with due consideration of concomitant changes in closely related fields. The guidelines for evaluating and changing educational systems should be:

(i) basic educational principles;
(ii) the present and expected future properties of the environment of the system of education;
(iii) care should be taken not to let the present system of provision of education or vested interest contaminate the investigation of the system. These forces have, however, to be taken into account when a strategy for change is considered.

The approach in this report is first to look at the present South African environment and expected future tendencies (Chapter 1), followed by an assessment of the present role and shortcomings of vocational education (Chapter 2). The fundamental problems confronting education (especially vocational education) are discussed in Chapter 3. In Chapter 4 a general school system is described. Attention is given to a strategy for movement from the present to a more suitable system (Chapter 5), Chapter 6 contains a summary of the recommendations and fields in which feasibility studies and/or research are urgently required.

1.2 THE ENVIRONMENTAL MATRIX OF EDUCATION IN SOUTH AFRICA

South Africa is a developing country with a low average population density (approximately 22 people/km^2), rich natural resources, a reasonably well developed infrastructure and modern industrial and mining sectors. However, modern and traditional subsistence agriculture in underdeveloped rural areas exist side by side. The underde-

veloped areas are characterised by low agricultural productivity, relatively high population density and a rapidly growing population outstripping the under-utilised agricultural resources of these areas. Practically all communities and areas are directly or indirectly linked to the modern sector of the economy, by migrant labour, agricultural workers, a spreading of the money economy, or by the displacement of products produced by traditional technologies by those of the modern sector and the formal systems of education. This leads to rising expectations amongst all people and a strong consciousness of relative deprivation of those around the periphery of the modern sector. This is, for instance, the driving force behind the tendency towards rapid urbanization, clustering around industrially developed areas.

The basic developmental problems confronting South Africa are therefore the following:

1.2.1 Problems in the "modern" sector

The modern sector tends to rely on the copying of the industrial development of the Western world, which tends to develop capital-intensive mechanised and automated industries owing to a shortage of manpower, high wages and large markets created by affluence and conspicuous consumption. This approach leads to several difficulties in the South African environment:

(i) It requires a high average capital investment for each new job created (reportedly approximately R10 000 to R30 000 per job). It is therefore difficult to see how sufficient capital can be forthcoming to create approximately 1 000 new jobs per working day in the "modern" sector to combat unemployment in traditional sectors.

(ii) The modern sector requires a highly skilled and sophisticated work force. At the moment, it cannot even function at full capacity owing to a serious shortage of skilled people at all levels. This leads to escalation of salaries and production costs.

(iii) A relatively small internal market increases production costs, leading to protection of local industries and decreasing their effectivity and fuelling inflation. Owing to high wages and the scarcity of skilled people it is difficult to reduce production costs to such an extent that world markets can be sufficiently penetrated.

If this situation is allowed to continue, South Africa may find it increasingly difficult to compete in the world market for manufactured products, having therefore to rely on the export of raw material and energy. The high cost of uncompetitive import replacement industries will increase the rate of inflation as well as the relative deprivation of the majority of the population that is still living mainly outside the modern system. This can lead to severe social tensions and instabilities.

1.2.2 Problems confronting the traditional sectors

The basic problem confronting the people living in more traditional agricultural sectors is that their social structure is well adapted to a stable situation of low population density and a very slowly changing environment. At present they are confronted with rapid population increases together with under-utilisation of resources (mainly agricultural). This leads to a vicious circle which increases relative deprivation and social instability. As will be shown in paragraph 3.3, traditional cultures also do not provide appropriate environments and stimulation for informal education for children destined to undergo formal education in a modern educational system.

1.2.3 Solutions for the South African problem of development

The long-term solutions must be found in a restructuring of both the modern and traditional sectors in order to utilise the available physical and human resources for the development of all South Africa's peoples and the optimisation of South Africa's position in the world. This will require the modern sector to develop appropriate technologies and production processes to utilise abundant manpower resources and raw materials. This should enable South Africa to im-

prove its competitive position in world markets in selected fields. Extreme care should be taken not to establish capital-intensive import-replacement industries which may increase the rate of inflation except in the case of industries of strategic importance. Care should also be taken not to enforce rigidly the standards, rules and regulations of the "modern" sector on the changing modern, as well as, the developing traditional sectors, thereby stifling natural inventiveness in a rapidly changing environment.

People in the traditional sectors, again, should modify their systems of values and cultures in such ways as to utilise available resources better and to interface better with industrial and agricultural development. Although the "modern" sector should provide active assistance and encouragement, this development should basically come from within the communities themselves. Only in this way can mothers give an appropriate informal education to their children to bridge them into the mainstream of South African development. This will also ensure that the essential entrepreneur-talent be developed in all communities to contribute to the development of the country. It is already manifestly impossible for entrepreneurs to come only from the minority at present actively involved in the "modern" sector. Such a situation is also undesirable because all the peoples in South Africa have to contribute to the development of the desired commonality of purpose, which should form the core of an appropriate strategy of development in order that a smooth and constructive interface can be established between the "modern" and more "traditional" sectors.

Despite cultural and racial tensions, South Africa is inherently in a much better position to develop than most developing countries, since it has a positive rate of economic growth, rich natural and human resources and a viable infrastructure. Considerable formal and informal interaction is taking place amongst different population groups, a freer market system is being developed and racial discrimination is decreasing in the fields of economics. More viable political solutions are also being sought.

Whatever detailed political and economical solutions come about, the commonality of purpose interfacing the present "modern" and "traditional" systems will have to be a part. In this education will play

a decisive role, for, only by educating and training people with appropriate skills, systems of values and a commonality of purpose, will it be possible to achieve the overall development goal. Education should therefore have a major impact on the "modern" as well as on the more "traditional" sectors, taking the existing situations and values as point of departure, keeping the growing commonality of objectives and values in mind, while encouraging a diversity of approaches to these objectives. This will positively assist not only development, making available more resources for education, but will also assist in the creation of more appropriate political and economical structures thereby improving the environment in which education has to operate.

CHAPTER 2

EVALUATION OF TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING IN SOUTH AFRICA

The structure of the present system for technical vocational education in South Africa is shown in Figure 2. It is imbedded in a formal system of general academic education with, at present, the underlying philosophy that vocational differentiation and therefore vocational education starts after Std 10 or twelve years of schooling. Provision is, however, made for taking two technical subjects which can also lead to university entrance. About 14 % of White Std 10 pupils in the Transvaal follow this stream and about 0,2 % Blacks throughout the country.

For all population groups the most important objective is still to receive a professional education at university. Of White students only about half entering engineering courses ever complete them and those who do complete their courses, take on an average about 5,3 years to complete 4 year courses. About 900 - 1000 White engineers complete their courses per year and a few additional engineers from the rest of the population. This results in an overall shortage of engineers, which hampers development.

During the last few years considerable attention has been given to increasing the status and numbers of technikons in order to promote vocational education in technical fields after Std 10. The technikons concentrate on "sandwich courses" for the training of technicians: a semester on the job alternating with a semester at the technikon. Figure 2 shows that new and higher qualifications leading up to T6 are at present being developed at technikons to train technologists.

Apprenticeship is used to train skilled workers (artisans). Depending on the field, entrance requires the completion of Std 7 or a higher standard. Apprentices can present themselves for a trade test after about 2½ years if they have passed at least the trade theory on N2 level. On passing the trade test they become fully qualified, skilled workers. Having failed the trade test they can still reach

skilled worker status after a certain period of time has elapsed. Aprentices entering at higher scholastic levels can achieve higher qualifications such as N3, etc. and those with a Senior Certificate can enter the T-courses at a technikon.

The in-service training of apprentices originally took the form of the classical on-the-job training, while working under the supervision of a master skilled worker. This type of training is, however, falling increasingly into disrepute owing to a shortage of skilled workers, rapid development of new technologies and the large-scale dropout of apprentices in the traditional system. In many fields, institutionalised training of apprentices is fully or partially replacing the traditional system. Modern training methods, for instance, "Criterion Referenced Instructions", are being used and the results are satisfactory. The main drawback is that the overall training cost of a skilled worker lies between about R13 500 and R18 500 of which little can be offset against useful production during training. This is similar to the cost of a three-year university degree. The high cost militates against the training of large numbers of skilled workers by this means.

The actual rate of training of skilled workers and technicians for industry, to meet the demand for an economic growth rate of 4,5 % per year, is shown in Table 1 (see Appendix 2 par 2.2).

TABLE 1 : THE ANNUAL RATE OF TRAINING OF SKILLED WORKERS AND TECHNICIANS AGAINST THE REQUIREMENTS FOR A 4,5 % RATE OF GROWTH

	Rate of training	Requirements
Skilled workers	∿10 000	∿23 000
Foremen	∿2 000 (technicians)	∿9 500

As mentioned previously, the rate of training of engineers is also too low. However, there exists a general consensus in industry that the shortages at the level of the skilled workers and technicians are at present the most restrictive factors. In order to ease the perennial shortages of skilled workers it has become customary to fragment the work done by skilled workers into smaller units which can be mastered by semi-skilled people. Industry and mining houses

have achieved considerable success in non-formal technical training in these fields. In many fields this can lead to an effective mix of one skilled worker and six semi-skilled people. This high multiplication rate cannot be effectively utilised to supply new jobs owing to a shortage of skilled workers. Similar shortages of trained people, at all levels and in practically all fields manifest themselves both in the "modern" and more "traditional" sectors of the economy. This not only hampers development but increases inflation, reduces competitiveness on world markets and increases relative deprivation in South Africa.

Since South Africa represents an intimate mixture of first and third world economics it is difficult to find comparable countries. As far as rates of training are concerned, it is instructive to draw comparisons with Israel and Taiwan, both of which only started developing after 1948. Israel has a very diverse population with about 60 % of the present population springing from traditional cultures in North Africa and the Middle East. Severe problems of communication exist, exemplified by the saving that "Hebrew is a language taught by children to their parents". Taiwan started from a traditional feudal, rural country where Fuksinese and Japanese were used as languages, to become a rapidly developing industrialised country using Mandarin, imported by General Chiang Kai-shek and the people from mainland China, in education. Both countries are poor in natural resources and have had to rely on the development of their human resources. Information about the rate of training in technical fields per million population is given in Appendix 2, paragraph 4 for South Africa and Taiwan. The figures for Israel are very similar to those of Taiwan. From these figures the general conclusions can be reached that the rate of training for the total South African population falls short by a factor of between 8 and 10 compared with that of Israel and Taiwan. What is perhaps more surprising and disturbing is that the rates of training of South African Whites are in all technical fields nearly half of those of the Israelis and Taiwanese. South African Whites are in a much better economic position than the Israelis or Taiwanese and have had compulsory schooling as well as sufficient educational facilities for a considerable time. This discrepancy therefore points to fundamental problems in the system of education for Whites, which served as the blue-print for the se-

parate systems of education for the other groups. It manifests itself in the fact that despite large increases in provision of education, the system has not managed to produce the skilled people needed for development and has even failed to produce the skilled teachers needed by education itself.

The problem encountered in education in South Africa is, however, similar to problems experienced in most developing countries and will be analysed in more detail in the next chapter.

CHAPTER 3

ANALYSIS OF THE BASIC PROBLEMS CONFRONTING EDUCATION IN DEVELOPING COUNTRIES LIKE SOUTH AFRICA

3.1 THE NEEDS FOR MODERN SCIENCE, TECHNOLOGY AND MANAGEMENT IN A DEVELOPING COUNTRY

As described in Appendix 1 paragraph 2, the triad of modern science, technology and management have become the most powerful tools in the hands of man. They have enabled man to use energy and other natural resources to change his physical environment into that of the man-made industrial environment of the developed countries. This has increased the consumption of natural resources to unprecedented levels in the developed world, leading, on the one hand, to high levels of material well-being and on the other, to rising pollution of the environment, depletion of fossil fuel and other resources, and to the possibility of cataclysmic collapse of the present system. The social and value systems of the developed world have not adapted themselves yet to the effective and balanced use of these "tools" with tears in the social fabric of those systems becoming more evident as time goes on.

Whatever can be said about possible misuses of science, technology and management, there is no gainsaying the fact that they are the only and the most effective tools available to man to modify his environment in ways he chooses. The fact that these tools have not yet been well mastered and have not yet become part of the cultures in most developing countries, is one of the root problems of development.

3.2 THE CLASSICAL PARADIGM FOR SCIENCE TEACHING IN DEVELOPING COUNTRIES

The importance of the mastering of these tools is generally conceded by developing and developed countries alike. Since modern technology is almost completely science based (management is, to a certain extent also based on social and natural sciences), the following classical paradigm was developed for the rapid introduction of science and technology into traditional cultures:

Classical paradigm: Develop a mastery of science which will then lead to the mastery of technology which will again lead to development.

Implementation: Introduce modern academic education with a strong accent on the sciences in developing countries.

Results: In general the results were most discouraging. Only a few of the brightest pupils really mastered science. Those who were successful acquired an academic value system in the process which places greater value on fundamental research than on technical applications. The majority of the children cannot cope with academic science and completely drop out of the science-technology stream. Some managed to pass examinations in science and mathematics by rote learning. Many of these persons became science teachers, setting off a vicious circle of rote learning.

The information presented in chapter 2 shows that not one popula= tion group in South Africa has fully escaped this paradigm trap.

3.3 THE BASIC FALLACIES BEHIND THE CLASSICAL PARADIGM

The reason that the paradigm fails can be found in a well known principle of education: A child/person has to build up, through the senses, a range of concrete experiences of a specific environment before useful abstract concepts, giving a better insight and grasp of the reality of the environment, can be developed. This has to be an ongoing process with elementary experience followed by simple abstraction, with new experiences gained in the light of the available abstractions, again leading to abstractions at higher levels, etc. This process also takes place in the development of collective human knowledge. A good example is modern science, starting with experience and simple abstractions; it leads to contrived experience (experiments) followed by new abstractions (theory), leading to new experiments, etc. This process is also not only applicable to natural science, but to all human endeavour. A person for instance gains the necessary understanding and mastery of an economic system in which he/she has to live, exposed to simple parts of the system in order to finally establish a holistic view of the system on the level of

the abstraction needed. An interesting approach to this situation is the development of "The 6M Simulation Training Course" (6M = men, management, money, machines, materials and markets) by the NIPR of the CSIR. It uses models and artificial money to simulate in a concrete way the establishment and operation of a business in a free enterprise system. Its purpose is to give Black overseers a concrete insight into the working of a component of a private enterprise system they are working in, since this experience and knowledge are not yet part of their culture or school curriculum. It appears that Whites also benefit from this course.

Applying the above principle to the classical paradigm of science education, it is possible to see why it cannot work for the majority of children in a developing situation. A child who grows up in an environment which has little contact with modern science and insight into the workings of modern technology, establishes through informal education a value system and concepts which are very different from those developed by a child growing up in a culture including science and modern technology. That this has to be the case can be seen from Table 2 which compares a few concepts and values for traditional and modern cultures.

TABLE 2: A COMPARISON OF VALUES OF TRADITIONAL RURAL CULTURES AND A MODERN URBAN TECHNOLOGICAL CULTURE

Area	Traditional culture	Modern culture
Social structure	The status of an individual is fixed in the community by ascriptive factors such as descent, sex, race.	An individual can have high mobility depending on own initiative and capabilities.
Technology	Tends to use technological recipes.	Tends to base technology on scientific understanding.
Innovation	Tends to resist change and innovation while imbedded in own system. May even consider innovation taboo.	Community tends to encourage innovation.
The future	Considers the future to be determined by external factors that cannot be influenced by own efforts. Cause-and-effect relationships not well developed.	Considers that own initiative can influence the course of events. Tends to accentuate causal relationships.
Social relationships	Strong relationships with members of own group.	Weaker, but more diverse and wider ranging relationships with people from different groups and communities.

A child from a traditional rural type of culture or a culture which still has strong remnants of traditional values does not have a sufficient background of concrete experiences to develop the concepts needed for the development of science and mathematics. This then leads to the unsatisfactory results mentioned in paragraph 3.2.

It is therefore not surprising that the general cry for more and better science teaching, science teaching being related to technology and life, is not likely to improve drastically the mastery of either science or technology in developing countries if the classical paradigm is adhered to.

3.4 A PRACTICAL PARADIGM FOR THE TEACHING OF SCIENCE AND TECHNOLOGY IN A DEVELOPMENTAL SITUATION

This paradigm uses the following premise: Modern technology embodies the basic principles of science in artifacts and processes; these principles manifest themselves to the senses by the use of the artifact or process. These principles (laws) are much more deeply hidden by the complexities of nature and therefore more difficult to discover in nature.

New paradigm: Let a child/person first master simple technology in a field where natural aptitude and interest exist. These experiences are then related to the underlying science and mathematics to improve insight. This is then followed by experience of more advanced technology and deeper insight into and study of the underlying sciences, etc.

This paradigm is amply supported by educational theory, e.g. the experience based approaches advocated by classical educationists such as Pestalozzi, Dewey, Montessori and Kerschensteiner. It is also compatible with modern educational ideas such as those of Bruner and the German school represented by Wagenschein, Klafki and others.

Implementation: Introduce vocational education as a major component in the formal school system and use this teaching paradigm.

Results: The specific technology (technology must here be seen in the broadest possible context) is mastered, leading to the person being able to contribute as a skilled person to development. The sciences underlying the specific technology are also mastered to the extent that further effective non-formal continuing education along a career ladder becomes possible. The underlying concepts of modern technologies and sciences are mastered by many people, leading to introduction to the specific culture. (These results are substantiated by the effectivity of the educational systems of for instance developing countries like both Israel and Taiwan where about 70 % of all children in Senior Secondary School receive vocational education.)

3.5 GUIDELINES FOR EFFECTIVE DIFFERENTIATION IN A DEVELOPING SITUATION

As already pointed out in 1.1, vocational education implies specialisation and differentiation for coping with the complex world we live in. The general approach of the present South African academically oriented system is to postpone vocational differentiation for as many pupils as long as possible. This approach, in combination with the classical paradigm, has led to the majority of children leaving academic education at diverse points without either useful vocational skills or a system of values capable of coping with the environment in which they have to live. This results in shortages of skilled people despite rapid extension of educational facilities and a growing estrangement of people whose high expectations of education have not been fulfilled.

This problem can only be solved by effective differentiation, linking personal aptitude to career oppportunities in the world of work. For this purpose, a number of general guidelines can be developed to make rational decisions possible about the time for and degree of differentiation needed.

When educating a person to enter a certain career field, cognisance should be taken of the fact that to be successful, certain skills and appropriate values are needed. If the values and/or skills are not yet part and parcel of the existing culture or process of general preparatory education, the sooner they are developed in formal schooling the better. On the other hand, children develop at different rates and it takes some time before they manifest the manual, communication and numerical skills and insights into their environment to enable them, their teachers and parents to exercise a sensible choice of career field.

For the majority of children, especially in a developing situation, this differentiation has to take place shortly after puberty. At this stage, a child tends to model his/her system of values on adults, especially on teachers and instructors in vocational education. This stage therefore represents the last effective opportunity of modifying the values of the majority of children in a developmental situa-

tion to be in better accord with the world they have to live in. If missed, a person may still be trained in new skills but it remains highly doubtful if the systems of values of the majority can be changed at later stages in life. The same conclusion follows from another argument: A well developed human personality requires a moral code, religious belief as well as a career code including for instance diligence, accuracy, punctuality etc. These codes are only effective if they serve as built-in guidelines for behaviour. This can be achieved by developing them in conjuction with vocational skills in order that they become an integral part of the career skills of the individual. This implies that differentiation should take place no later than at the age of between 14 and 15 years, or after completion of Std 7. In South Africa and in other developing countries, there appears to be considerable emotional resistance to differentiation at this stage. The following counter-arguments are generally advanced:

(i) It is too early to assess the capabilities of the child. This is to a large extent true in an academically oriented system of education which may even actively discourage meaningful differentiation at this stage since it is not an objective of the system. This is, however, not true any longer in an educational system with the explicit objective of preparing children for sensible choices by actively encouraging the development of different skills and meaningfully orientating the child to its environment.

(ii) Choices of some vocational fields may lead to dead ends, and continuing general education instead of career education will lead to higher career mobility, even if not followed by an career education. This argument applies if vocational education is reduced to vocational training, which is probably happening in many cases in South Africa at present. Vocational (career) education as defined in this document represents a type of education that has the specific objective of supplying the necessary skills and values for the first steps in a career and for the subsequent acquisition of new skills and knowledge in a non-formal system of education. This provision

is vital since the concept that any person can be taught all the knowledge needed for a productive career, is obsolete. Knowledge tends to have a high rate of obsolescence. Thanks to the computer and modern communication, new knowledge is becoming generally available and continuing education in the non-formal field is essential to keep abreast with it. This builds a very large vertical as well as horisontal mobility into any career.

(iii) Very limited credit and recognition is given at present to apprentices who have obtained a Std 10 Practical or a Senior Certificate in a technical high school (they can do the trade test about six months earlier). There is therefore little motivation to enter the technical field of study. The problem is that the present technical field of study is virtually an academic high school with two technical subjects. The technical field of study is not planned to interface specifically with apprenticeship, the technikon or the university.

The major objections against differentiated education after Std 7 are therefore not against the principle of differentiation as such, but rather against shortcomings of the present system of education which does not offer clear-cut vocational choices at secondary level leading directly to careers and which also does not prepare children for differentiation. Introduction of large-scale vocational education will therefore not only require the introduction of vocational (career) schools, with suitable curricula, but will require the establishment of a balanced and differentiated system of education interfacing formal and non-formal education. This will be further discussed under the strategy for transition in chapters 4 and 5.

3.5.1 Differentiation for environmentally handicapped children

In a developmental situation many children drop out of school and rapidly lose many of the skills and much of the knowledge which they have acquired there. There are many reasons for this, for instance failure at school, little interest in a school curriculum unrelated to life, disinterest of parents, pressure to leave school in order to go to work or to look after younger children.

The most effective approach to this problem is to motivate the children by success achieved at school to complete a useful unit of education. The success should be tangible to the child, parents, teachers and community. This implies the mastery of skills considered important in the world of work and life, i.e. skills related to vocations.

Children who are severely environmentally handicapped should therefore make an earlier start with vocational education to enable them to master manual and other skills needed for success in the non-formal training to become semi-skilled operators in industry or to be productive in the less formal sectors. Those who are less handicapped can be streamed in a few subjects such as the second language and Mathematics in the primary school, with each stream attaining mastery at specified levels for specific purposes. The possibility should exist for such children to differentiate before Std 7 into a vocational field so that they can enter conventional apprenticeships after completion of Std 7. Care must be taken to interface these children as well with the world of work so that they can be further motivated by success.

3.5.2 The identification and development of gifted children

In a development situation many gifted children do not achieve their full potential especially since poor socio economic conditions make it difficult to continue schooling.

Indifferent schooling can also be a stumbling block. These children should therefore be identified at the earliest possible opportunity and be guided into the right stream and the right type of schooling in a differentiated system. As an interim measure bridging courses should be established at universities to enable students who have high potential, but who could not develop the necessary skills at school, to be successful at universities, and to attend bridging courses at universities where they can obtain those skills.

3.5.3 Differentiation of education to the middle level

Owing to problems similar to those mentioned in 3.5.1 and 3.5.2, stu-

dents with the capabilities of becoming technicians, teachers, nurses, paramedics, etc. very often do not realise their full potential. An additional problem encountered by these students is that the system of values of a skilled worker and technician differ. Should they therefore receive vocational education to become skilled workers, they would again have to change their system of values to become technicians. The solution to this problem is to develop an educational institution which bridges the student from say Std 8 to the secondary level, thereby establishing and developing the system of values for the middle level from the start. This is especially valuable for the education of teachers who have to acquire successfully the necessary cultural values in order to guide children through cultural changes (see Appendix 1, 3.4.4.2.1 and Appendix 2, 3.2 and 4).

6 NON-FORMAL EDUCATION FOR COMMUNITIES

One of the most crucial determinants of the progress of children at school is the support and understanding of the parents and community. This is more difficult to create in developing communities where many adults have had little or no schooling and where the values of traditional cultures are still dominant. In such a situation non-formal education of the community in basic literacy skills as well as in the properties of the "total" environment and the needs of children, can assist the progress of the children at school and prevent generation gaps from developing.

7 USING SKILLS ACQUIRED AS MEASURABLE OBJECTS FOR EDUCATION

A strong case can be made on educational grounds as well as the properties of the "knowledge" society, which the world is entering, for movement away from the traditional objective of transferring knowledge to a child during schooling to the development of a range of skills needed to interface with a modern world and to handle a diversity of readily available knowledge. This is discussed in more detail in Appendix 1, 3.3.2.1.

In the South African situation this approach makes it possible to set general skill standards which are not related to the cultural background of the child and which can be achieved in diverse ways.

This makes it possible to interface curricula better with the informal educational background of children while still achieving the same skill objectives.

CHAPTER 4

PROPOSED SYSTEM FOR THE PROVISION OF EDUCATION IN SOUTH AFRICA

4.1 GENERAL GUIDELINES

The structure proposed in Figures 3, 4 and 5 should be viewed as a blueprint of the system into which the present system should develop in time. It is based on the following general guidelines:

(i) Education has to bridge the essential cultural changes taking place in a developing South Africa (see chapters 1 and 3).

(ii) The system of education provided must be differentiated at secondary level with a well developed vocational component in order to provide for the aptitudes of children and to meet the developmental needs of the country. These needs include both those of the changing "formal" and "informal" sectors of the economy. General preparatory education will prepare the children for differentiation (see 3.5).

(iii) The general principle of education, that teaching should progress from the concrete to the abstract, will be adhered to. The new "practical" teaching paradigm (see 3.4) will be used in vocational education.

(iv) Informal, formal and non-formal education must be closely interfaced forming a system of education provision for individuals and communities which will be an on-going process through life.

(v) Resources for education are limited in a developmental situation and special attention should be given to the cost-effectiveness of all education.

(vi) The system for the provision of education must be viewed as a dynamic system capable of assessing future needs in order to prepare children, in time, to meet these needs. It should

also be able to modify its own structure to keep pace with changing requirements.

(vii) Present educational institutions and staff must, with suitable adaptation such as through in-service training, whenever possible, be used as "building blocks" of the new system.

4.2 PRE-PRIMARY EDUCATION

This phase of education can play a very important role in the modernisation of cultures by developing skills and values necessary for success in the primary school. It should be linked to non-formal education of the parents in order that the home environment should support the school. Effective ways of pre-primary education should be developed and tested before extensive programs are launched.

4.3 THE PRIMARY SCHOOL (Grade 1 to Std 4)

The objective of the primary school should be the development of the broad spectrum of skills essential for life in a modern technological type of environment (see Appendix 1, 3.3.2.1 and reference 1).

For environmentally disadvantaged children it may be necessary to have streaming in subjects such as Mathematics and the second language (see Appendix 1, 3.4.3). For those who are so severely disadvantaged that they will probably leave school before completion of primary school, a vocational stream, to prepare them for on-the-job training, may be the only solution. This stream should interface smoothly with opportunities in the non-formal sector of education (see 3.5.1).

4.4 THE COMPREHENSIVE JUNIOR SECONDARY SCHOOL (Std 5 to 7) (CJSS)

This school phase is the one which not only has to continue developing the general skills mentioned under the primary school, but must also enable the child, parents and teachers to assess the capabilities and potential of the child in view of differentiated education commencing in the senior secondary school. The curriculum should

therefore make provision for experience in at least one academic and one vocational subject. Other subjects must also be given and assessed in such a way that a spectrum of skills can be established for each child to help guide further career choices (see Appendix 1, 3.4.2). Vocational guidance must also play a very prominent role in this school.

Children who intend leaving school after Std 7 should receive intensive vocational education to be able to cope with regular conventional apprenticeship training or to train as semi-skilled operators (see 3.5.1).

.5 THE SENIOR SECONDARY SCHOOL (std 8 to 10)

.5.1 The senior secondary academic school (SSAS)

The specific purpose of this school is to educate for university entrance. Curricula should be brought in line with this objective in mind. Differentiation in this school should only be based on the needs of students who want to specialise in science, commerce, or the humanities. On completion of SSAS the student can continue education at university or tertiary college, including the technikon where a sandwich course is recommended owing to lack of technical experience during SSAS education.

.5.2 The senior secondary vocational (career) school (SSVS)

The specific purpose of this school is to provide vocational education to enable students to become skilled workers in different fields. In the case of technical vocational education it should be followed by six months to a year's experience in industry before doing the trade test. This approach will reduce the training costs of skilled workers to between 30 and 50 % of the present institutionalised training costs. (see Appendix 2, 2.1 and 3.1). Since the senior secondary vocational school is part of the formal system of education, many students will automatically be channelled into vocational education. It is envisioned that about 50 - 80 % of all students in Std 8 to 10 will eventually attend the senior secondary career schools. This type of

school should therefore make it possible to meet the country's requirements for skilled workers. The qualifications of these schools should receive full recognition in the public and private sectors.

The best students of the SSVS should continue their education at tertiary level at technikons, technical colleges, colleges for nursing, etc., where existing practical experience can reduce the course duration.

4.6 TERTIARY AND MIXED SECONDARY AND TERTIARY VOCATIONAL EDUCATION

4.6.1 The technical college and the technikon

It is envisaged that the technical colleges (technical institutes) and technikons will continue more or less to play their present roles (see figs. 3-5) in the proposed system. Some technical colleges could in time broaden out into "community colleges", also supplying the needs of communities for non-formal education. They also have the expertise to help start senior secondary vocational schools and can assist in the establishment of five year colleges (career colleges) mentioned in 4.6.2. As the demand for traditional type of apprenticeship will decrease with the establishment of more SSVSs, some technical colleges may develop into a combination of SSVS and career colleges.

4.6.2 The five-year college (career college)

The five-year college start after Std 7 with a five-year course for carefully selected students who have the aptitudes necessary for being educated to the middle level (technicians, nurses, paramedics, etc.). The relationship between this college and other institutions is shown in Figures 3, 4 and 5.

This college is especially suited for a developing country since it helps students with suitable aptitudes to achieve middle level qualifications. What is perhaps even more important, is that they enable students from puberty onwards to acquire the system of values appropriate to their careers at middle level (see 3.5.3).

In the South African situation these colleges can play a crucial role in training teachers with systems of values appropriate to the SSVS, CJSS and primary schools.

These colleges can be established in conjunction with a SSVS, a technical college, a technikon and even a university. Considerable savings can be realised by sharing equipment and/or staff with other institutions working in the same field.

The best students from the five-year college should be able to continue their education at other institutions such as technikons and universities, etc.

Similar colleges in Taiwan have demonstrated their value by doubling the rate at which technicians are trained (see Appendix 2, section 4).

4.6.3 The university

The universities should continue to play their present role in the proposed system. A major improvement will be that the SSAS will be more effective feeder institutions. The subsidy formula of the university should be changed in such a way as to limit entrance into university to students having high probability of success. This could for instance be done by putting the subsidy eventually on the output of the universities while safeguarding standards at the same time (see Appendix 1, 3.3.3). Too high an output in certain fields of study could be counteracted by establishing quotas for subsidy.

Owing to poor schooling some students, who have the aptitude to complete university courses, will not be able to meet the selection criteria. It is recommended that suitable bridging courses at the universities should be established for these students. Passing a bridging course will then enable a student to commence with university study in a given field.

The provision of post-graduate education in specialised fields should also be rationalised, especially in fields where the total South African need merits only one combined training and research institution. The concept of a group of minimum critical size in each such

field, keeping abreast of international developments in its fields, training a limited number of students and feeding information into the rest of the system, has considerable merit.[2] Such groups could be established as joint undertakings between one or more universities and research organisations.

The more effective use of the physical facilities of universities by dividing the academic year into three trimesters merits further investigation (see Appendix 1, 3.3.10).

4.7 NON-FORMAL EDUCATION

In the proposed system for the provision of education the non-formal system of education has a crucial role to play:

(i) The establishment of a well differentiated system of education at the secondary level requires on-going, non-formal education for people to keep abreast of new knowledge and processes and to advance in their careers. Otherwise ceilings are established in vocational fields which would scare students away from these fields.

(ii) To guide communities through cultural change, non-formal education is needed for adults and youths out of school to prevent too large educational gaps from developing between the school children and the adult population.

(iii) In a developmental situation many capable adults are working below capacity because they are illiterate, or because they have not received any vocational education.

What is termed supplementary education in Figure 3 has to meet these non-formal educational needs. It is recommended that supplementary education concentrate on the development of very basic general and vocational skills in order to interface the trainees with modular, on-the-job courses.

CHAPTER 5

IMPLEMENTATION OF A NEW SYSTEM FOR THE PROVISION OF EDUCATION FOR SOUTH AFRICA

5.1 INTRODUCTION

In order to meet the manpower requirements needed for balanced development in South Africa, it is essential to introduce vocational education at the senior secondary school level. This cannot be done in isolation since, for the SSVS to become an integral part of the system, the comprehensive junior secondary school should fulfil its role in preparing children for differentiation. The present general academic type of high school should therefore in time develop into separate SSAS and SSVS or senior secondary comprehensive schools and technical high schools should become senior secondary vocational schools.+ The non-formal part of education should also be guided and developed in such a way that it interfaces smoothly and augments the formal vocational education. At the same time the entrance requirements of the universities have to be changed in such a way that only students with a high probability of success are admitted, while bridging courses have to be established at the same time to assist students coming from disadvantaged schools. At the same time all existing education must be better adapted to the requirements of cultural change and the essential requirement of establishing a commonality of purpose and values in South Africa.

This change will have to be effected in a situation where gross inequalities, mainly on racial lines, exist in the present provision of education in South Africa. These inequalities would have to be rectified while the system of education is being changed in such a way that credibility is maintained with all population groups.

One of the main problems of developing vocational education at a rapid rate would be the severe shortage of teachers in this and the

+ Experience in other countries has shown that it is very difficult to change an academically oriented senior secondary school into a comprehensive one since academical values always tend to dominate. Better results are obtained in changing a senior secondary vocational school into a comprehensive one.

related field of Science and Mathematics. Since the acceptance of the senior secondary vocational schools by all population groups depends on good teachers and effective education, methods will have to be developed to optimise utilisation of teachers and instructors from industry, the qualified teachers available, the re-training of available teachers and, especially, the training of new vocational teachers.

This requires the development of a detailed strategy of change in which the crucial factors, which will put into motion the desired change in an irreversible way, will have to be identified. Once the process of change is under way a firm steering action will be required to maintain a steady pace in the right direction.

5.2 CRUCIAL FACTORS IN IMPLEMENTING PROPOSED SYSTEM AND RECOMMENDATIONS

From the point of view of implementing the proposed system of provision of education the following crucial factors, where changes must be implemented without delay, can be identified:

5.2.1 The establishment of a central controlling body for all education in South Africa (CCB)

The present divided control of education and the gross inequalities in the provision of education, mainly on racial lines, as well as the urgent need for the changes spelled out in this document make it imperative that a central controlling body for all education be established in South Africa. This body should be able to formulate general guidelines for education provision on the proposed differentiated basis and be in a position to exert the necessary influence to implement the guidelines while decentralising the actual control of the educational institutions. Its composition should be such that it can effectively use the available expertise in South Africa while being acceptable to the different population groups.

Recommendation 5.2.1: That a statutory central controlling body be established for the following purposes:

(i) To determine the general policy for education in South Africa.

(ii) To allocate resources from the Central Government in an equitable way to education.

(iii) To accredit organisations responsible for the running of educational institutions.

(iv) To maintain national standards for qualifications.

(v) To monitor the cost-benefit of education and the implementation of policy.

(vi) To supply funding to research and development work in education.

(vii) To maintain close contact with all sectors making use of the output of the system of education as well as those who influence education in order to assess future demands. (Future research in the field of education.)

This CCB should however be explicitly barred from running any educational institutions since this body should operate on a desentralized basis in close collaboration with communities.

Discussion: The complexities of the South African environment and the urgent need for systematic changes in the whole system of education require that general firm guidelines be set to guide further development of education while at the same time harnessing the interest, energy and resources of parents, communities and the private sector to achieve the goals set out for education. The proposed approach should be able to achieve these objectives if general acceptance can be gained for it in different communities, teachers and the private sector.

5.2.2 Crucial short-term actions needed for the rapid development of vocational education

5.2.2.1 The rapid establishment of senior secondary vocational schools

This must be done as rapidly as possible to provide the skilled workers needed for development and also to prevent the rapid expansion of uneconomical institutionalised training institutions in industry (see chapter 2).

Recommendation 5.2.2.1

(i) That an expert work group be established, consisting of people from industry, interested private foundations, technical colleges, technikons and educationalists to work out appropriate curricula and methods of education for technical vocational schools and for the education and re-education of teachers in these fields. This should also be done in fields such as administration, commerce, nursing and paramedical, and agriculture. Priorities, which define the most crucial needs, should be established to effectively utilise the limited manpower available for this purpose.

(ii) That industry (in private and public sectors) and private foundations that are interested, be requested to investigate the possibilities of establishing a number of pace-setting private vocational schools and career colleges (mainly for the training of teachers for vocational schools) with government subsidy. The possibility of using teachers and instructors from industry to start these schools should be investigated (see Appendix 2, 5.2.3). This could take the form of a feasibility study financed by industry. Should the establishment of private vocational schools prove feasible and necessary, the necessary structure for this must be established in the shortest possible time.

(iii) The Department of Manpower must ensure that no legal barriers exist against the use of vocational schools to educate skilled workers (artisans).

(iv) That the concept of vocational education be replaced by career

education in all fields and that the advantages of career education be given wide publicity (see Appendix 2, 5.2.6) in order to attract good students to career education.

Remark: *These processes should be set in motion as soon as possible, even before the CCB is established under the joint aegis of, for instance the HSRC and the Department of Manpower which can transfer it later as a joint project of the CCB and the Department of Manpower if so desired.*

(v) That as soon as (i) is completed, any existing suitable institutions, such as the present technical high schools, which lent themselves to conversion, be changed into SSVS complying with the curriculum requirements, being actively assisted by industry in the transition.

5.2.2.2 The essential role of the comprehensive junior secondary school

As soon as the CCB is established, it should give attention to the following:

Recommendation 5.2.2.2:

(i) That comprehensive junior secondary schools be established as separate schools as a matter of principle.

(ii) That the curriculum of these schools be developed in close collaboration with all the interested groups in academic as well as vocational education, in the formal as well as the non-formal sectors of education. This is essential in order to enable these schools to prepare children for differentiation starting in Std 8.

5.2.2.3 Improving the quality of academic education and balancing its output

Another task for the CCB will be the following:

Recommendations 5.2.2.3

(i) Alter the subsidy formula for universities in such a way that only students with good probability of success can enter (see Appendix 1, 3.4.4), and allow the universities to select their own students.

(ii) Subsidise bridging courses at universities.

(iii) Establish quotas for subsidy to universities in fields where drastic over-production takes place or can shortly take place.

Remark: *This approach is necessary in order to make it clear to all concerned that a differentiated system of provision of education is being implemented. A similar approach to that of the universities should be considered for the subsidisation of all tertiary institutions.*

5.2.2.4 Encourage the development of career schools and colleges including technical colleges and technikons

Recommendation 5.2.2.4:

(i) The CCB should use the requirements for accreditation and the provision of resources for education to encourage the rapid development of a well differentiated and well balanced system of education including subsidised private career institutions.

(ii) Special attention must be given to the training and retraining of teachers and the utilisation of existing institutions as well as the establishment of new institutions for this purpose in close collaboration with all bodies concerned.

(iii) The necessary advisory bodies to the CCB must be established to represent the interests of all career fields to advise on strategies for curriculum development, national and regional priorities and research and development projects in these fields.

CHAPTER 6

SUMMARY OF THE MAIN FINDINGS AND RECOMMENDATIONS

6.1 AIM OF REPORT

The report aims at providing a brief outline of the most important findings and supporting arguments contributing towards the following far-reaching recommendations concerning innovation in the educational system of South Africa. It is recommended that -

(i) the system for the provision of education be urgently and drastically changed to establish a differentiated system for the provision of education in which 50 to 80 % of the pupils will receive vocational education before Std 10. Vocational education should be incorporated into the formal and non-formal phases of education as an integrated and continuous part of the provision of education, and should, in a meaningful and economical way, make provision for continuing education during career development. Vocational education should also provide for the development needs of South Africa in all its developmental complexity (formal and non-formal sectors of the economy);

(ii) a strategy be developed for the utilization of the financial and manpower sources of the public and private sectors in such a way that vocational education can be developed rapidly and efficiently to relieve the serious shortages of skilled manpower as soon as possible. The whole matter should be approached with a view to obtaining the support of parents, communities, teachers and the private sector;

(iii) education at all levels be aimed at enabling pupils to modernize current cultures to such an extent that their value systems will adjust to the requirements of a developing South Africa.

6.2 SOURCES

1: Report of the work committee: Technical and vocational education including the following appendixes;

2: The design of an effective educational system for science technology for South Africa (Appendix 1), and

3: Report to the subcommittee on technical and vocational education and training (Appendix 2).

6.3 MOTIVATION FOR INNOVATION IN THE SYSTEM FOR THE PROVISION OF EDUCATION

6.3.1 Shortcomings in the current system for the provision of education

6.3.1.1 Inadequate pace of training in all fields of vocational training

It is the finding of the work committee that serious shortages of skilled manpower at all levels of the economy are seriously hampering the development of both the "formal" and "non-formal" sectors of the South African economy.

The "neglect" of vocational education at the secondary level in the rapidly growing system for the provision of education, is singled out as the direct cause of the labour shortage.

6.3.1.2 The "academic" value system of South African education

The South African system for the provision of education has always been aimed mainly at the preparation of pupils for university study, with the emphasis on general preparatory education up to Std 10 level, regardless of whether or not the pupils will continue their academic training after Std 10. A large part of the White population consequently enters the world of work without any occupational qualifications, skills or appropriate value systems. In the case of the other population groups, the percentage of pupils not continuing with tertiary education is not only much larger, but a larger percen-

tage of pupils also leave school without having obtained any academic or other qualifications, skills or useful value systems.

A characteristic of the academic value system is that the abstract world of ideas is often rated higher than the concrete world, which inter alia entails that the mastery of technology is based on scientific understanding since modern science forms the basis of modern technological development. As a result, manual labour and skills are often regarded as inferior.

The effect of this academic value system can be seen in the neglect of vocational training traditionally associated with manual labour.

As indicated in Chapter 2, the tendency of the "academic" value system to move from the abstract to the concrete is mainly reponsible for the high dropout rate of enigeering students at South African universities (see Appendix 2, 2.3).

6.3.1.3 Neglect of problems relating to cultural transition in education

As a developing country South Africa is undergoing more rapid change than other developed countries. Modern science, technology and management, man's most powerful aids towards effecting change in his environment, have not yet been assimilated into the cultures of all South Africa's population groups. A very large percentage of children are still raised in environments in which they do not gain sufficient experience of science, technology and management, which together form the basis of inter alia Mathematics and Science presented at an abstract academic level. This explains the shortage of skilled manpower, including teachers, in the technical scientific fields. An academic method of teaching discourages the majority of students from taking these subjects. The academic system of teaching also tends to place a high premium on the acquisition of knowledge. Because this knowledge often does not relate to the experiences of a child from a more traditional culture, the result is often rote learning instead of the development of insight. The development objective, namely the provision of skilled manpower with the necessary value system, insight and skills to contribute to the development of the country,

is therefore not achieved despite the spectacular expansion of the educational system. Should such a situation continue for a considerable time, it would later become virtually impossible to change on account of the vested interests involved. This means that the most important asset of any country, namely its human potential, cannot be properly developed or utilized despite the large-scale allocation of scarce resources to education.

6.3.2 Elimination of the shortcomings

6.3.2.1 The systematic relating of all abstract concepts to concrete experience

Apart from the non-applicable value system, the greatest problem in academic education lies in the tendency to move from the abstract to the concrete. The solution to the above problem would be to relate all abstract concepts in education as far as possible to the pupil's concrete experiences. In practice this means inter alia that since pupils in a cultural transitional situation often have not had certain concrete experiences or developed certain perceptual skills in their pre-school informal development, the school is compelled to assist in the development of these experiences and concepts to promote insight as opposed to mere book knowledge.

This problem often manifests itself in the study of academic Mathematics and Science at secondary level. A pupil of average intelligence but lacking concrete experience in modern science and technology, experiences great difficulty in mastering the abstract concepts of these subject fields. The solution would be to supplement the pupil's training in modern technology with the underlying mathematical and scientific principles. In this way the concrete experiences and abstract concepts are meaningfully related while the pupil is at the same time being prepared for a rewarding career.

6.3.2.2 The development of "essential skills" at school

As a result of inter alia the modern computer and communications media, knowledge will in future be increasingly freely available.

Young people will therefore be entering a complex technological world in which the ability to make sense of complexities and the optimal utilization of knowledge will be of prime importance. The skills required by this technological world have not yet been fully acquired by all South Africa's people, which implies that the educational system should assist in the meaningful development of the required skills and insights.

Since all pupils do not have the same aptitudes and interests, it is obvious that the same insights and skills cannot be developed in everyone. The aim should rather be to develop each pupil's skills in accordance with his abilities.

A second matter relating to this and of the utmost importance in all educational situations, particularly during rapid cultural transition, is the fact that success is the strongest universal motivational factor. This implies that to achieve the necessary success in the educational situation, each child should be enabled to master fully the skills required. It is equally essential however, that these skills should help to ensure success in the world of work. Since the modern world of work shows a strong tendency towards specialization, it is essential for the pupil to develop specialized skills for a suitable occupation. Differentiation is therefore required at school to ensure that only a certain set of skills is fully mastered. The majority of pupils require vocational training at school to enable them to enter the world of work. The minority of pupils require development of academic skills with a view to continuing their academic training at tertiary level. A sound value system includes the following: high morals, a religious concept and a vocational code incorporating diligence, accuracy, promptness, etc. These values are not meaningful, however, unless they have a positive effect on concrete actions. They should therefore be developed in conjunction with the more technical vocational skills to ensure their practical realization.

From an educational point of view the years immediately following puberty offer the final opportunity for this development. It is therefore essential that differentiated education should not be

postponed until a later stage - firstly to develop a pupil's interest and motivation through attainable success and secondly to enable his value system to take concrete shape in his vocational skills.

6.4 THE PROPOSED "END STRUCTURE" WHICH SHOULD BE AIMED AT IN THE SYSTEM FOR THE PROVISION OF EDUCATION

The system shown diagrammatically in Figures 1 to 3 aims at the elimination of the shortcomings discussed in 6.3.1. Current institutions will be used as far as possible, but with revision of the objectives of some. The system makes provision for a separate comprehensive junior secondary school (Stds 5 to 7) specifically aimed at preparing the pupils for differentiation at senior secondary level (App. 2, 5.2.6 and APP. 1, 3.4.2). Additions to the current school system are the senior secondary vocational schools offering vocational training in the fields of industry, agriculture, commerce, etc. with a view to placing a person with a Std 10 qualification on the first vocational level as skilled worker. In industry, one year's experience in the work situation should normally make it possible to qualify for the trade examination for the skilled worker. The 5-year vocational college aims at the efficient training of pupils who have the ability to enter the middle level (technical, nursing, administration, etc.) but are possibly adversely affected by problems relating to cultural transition (App. 1, 3.4.4.3). The vocational college will play a decisive role in the training of the large numbers of vocational teachers that will be required for the rapid development of vocational education. The system also makes provision for the use of the pre-primary school or phase with a view to cultural enrichment and the preparation of pupils for primary education (App. 1, 3.4.3). Primary school education should aim to develop essential skills, with clearly formulated objectives on each level (see par. 6.3.2.2). Streaming can be considered in the more difficult subjects in the case of environmentally handicapped pupils (with regard to socio-economic and/or cultural environment) who could otherwise experience difficulty in completing their primary education (App. 1, 3.4.2). In some cases it may already be necessary to introduce a vocation-oriented stream. The same applies to the comprehensive junior secondary school. Care should be taken, however, to ensure that the formal vocational training involves the pupil in the job and other opportunities existing for non-formal training (see par. 6.5.1 of this report).

The most important new function of the comprehensive junior secondary school (Stds 5 to 7) is to prepare pupils for differentiation.

The senior secondary academic school trains pupils specifically with a view to university education. These pupils can also be admitted to technikons and other tertiary colleges, but because they lack the applicable vocational training that SSVS pupils will already have gained, their courses may consist of sandwich courses, or take longer.

It is essential that the methods of entrance selection and financing of all tertiary institutions be revised so as to admit only students with a good chance of success, and that the institutions should collectively produce the right "mixture" of skills needed for development. It might be necessary to base subsidies on a quota system for example, in areas where serious over-training is occurring (App. 2, 5.2.4). To ensure that students with adequate potential but less well-developed skills (as a result of inadequate secondary education) will not be refused entrance to tertiary education, provision will be made for bridging courses of 6 to 12 months at inter alia universities (see Fig. 3).

Particular value is attached to the introduction of non-formal education that is closely related to formal education. The most important long-term objective in this case is continuing education, so that all skilled persons can keep abreast of developments in their fields and also achieve vertical and horizontal mobility in their careers. In the rapid cultural transition currently experienced in South Africa, non-formal education should in the short term assist communities in achieving the necessary cultural transition for the sake of their children's education. It should also assist in raising the productivity of illiterates and persons with no vocational training (See par. 4.7 of this report).

6.5 RECOMMENDATIONS REGARDING THE IMPLEMENTATION OF A MORE EFFICIENT SYSTEM FOR THE PROVISION OF EDUCATION

From a short-term point of view it is essential that secondary vocational schools and vocational colleges be introduced as soon as possible to fulfil the urgent need for both skilled manpower and vocational teachers. It is self-evident however, that large-scale vocational education can only succeed if the entire school system is adapted to ensure that pupils are prepared for differentiation at the junior secondary level. This requires that comprehensive junior secondary schools with appropriate curriculums be developed as schools in their own right and that primary education should pay more attention to skills. The senior secondary academic school should also relate more closely to the needs of universities.

As with all fundamental changes effected in complex related systems - the system for the provision of education is closely related to a variety of structures and values of the South African environment (see par. 1.2) - it is essential that key factors or actions capable of triggering off an irreversable process of positive change, should be identified (see par. 5 of this report).

6.5.1 Actions proposed

6.5.1.1 The establishment of a central controlling body for education

It is recommended that a Central Controlling Body (CCB) of a statutory nature be established (see par.5.2.1) to take responsibility for:

(i) the establishment of a general educational policy for South Africa;

(ii) the allocation of resources made available to education by the Central Government;

(iii) the accreditation of all organizations controlling educational institutions. No unaccredited organization will receive finan-

cial assistance for education from the CCB or the government;

(iv) the maintenance of national standards of certification;

(v) making available funds for educational research and development;

(vi) liaison between the system for the provision of education and public and private bodies that affect or are affected by education, in order to ensure that the educational policy keeps pace with the country's needs and potential;

(vii) monitoring the implementation of the educational policy by accredited organizations and the cost benefit of education at all levels.

The above body should be established as soon as possible to direct the general development of education at informal, formal and non-formal levels. The CCB may not be involved in the control of educational institutions however, since this body should operate on a decentralized basis in close collaboration with communities.

6.5.1.2 The urgent establishment of vocational schools

The following steps that can already be taken under the guidance of the HSRC and the Department of Manpower and in collaboration with the private sector are recommended (see par. 4.5.2. of this report).

(i) The appointment of a work group for the development of curriculums for vocational schools (work group composed from the ranks of industry, some government institutions, technical colleges, technikons, private institutions and education).

(ii) A feasibility study be conducted on the possible establishment of a number of leading private vocational schools, in order to utilize funds and manpower made available by industry and the government for the establishment of the first voca-

tional schools and the training of vocational teachers in private vocational colleges.

The feasibility study should be financed and conducted by the private sector.

(iii) An investigation into legislation impeding the training of skilled workers at senior secondary training schools.

(iv) Wide publicizing of the term vocational education in order to attract competent students and convince communities, parents and the private sector of the benefits involved.

(v) On completion of (i), the conversion of the current technical high schools into senior secondary vocational schools with the active assistance of industry.

6.5.1.3 The role of the comprehensive junior secondary school

As soon as the CCB has been established, arrangements can be made with the educational authorities for the establishment of the CJSS as autonomous bodies once an adequate curriculum has been developed. (See par. 5.2.2.2. of this report)

6.5.1.4 Improvement of the quality and balance of academic education (See par. 5.2.2.3 of this report.)

An important function of the CCB will be to enable universities to screen students themselves and to amend the subsidy formula of the universities (as well as other tertiary institutions) so that only students with a good chance of succeeding will be admitted. In fields in which too many persons are being trained, the subsidy can be subject to a quota. Subsidization of bridging courses at universities and other tertiary institutions will ensure that persons with the aptitude for university or other tertiary studies but who, owing to factors outside their control have not mastered the skills required, will be able to qualify themselves for selection.

The entrance requirements and curriculum of the SSAS should also be studied and brought into line with the entrance requirements of universities.

5.1.5 Promotion of vocational education at secondary and tertiary level (see par. 5.2.2.4 of this report).

The CCB can regulate some of the requirements for the accrediting of educational institutions and the financing of education in order to ensure the development of a properly differentiated system for the provision of education in which between 50 and 80 % of the pupils in Stds 8 to 10 will eventually be involved in vocational education. This implies the balanced development of SSVS and vocational colleges as well as current vocational institutions such as technical colleges and technikons.

The training of teachers and instructors for vocational education should also enjoy the highest priority.

It is also essential that the CCB together with the Department of Manpower establish the necessary advisory bodies at both national and regional level to ensure that vocational education will continuously comply with the country's needs.

REFERENCES

1. M.J. Wijnbeek. Education viewed as the development of skills, Proc. Cont. on Technical and Vocational Education in Southern Africa, Johannesburg, 30 - 31 March 1981, to be published.

2. Evidence submitted to the HSRC Investigation into Education by the S.A. Institute for Chemistry, the S.A. Institute for Physics and the S.A. Association of teachers of Natural Science.

FIG. 1. THE SYSTEM OF PROVISION OF EDUCATION AND ITS ENVIRONMENT

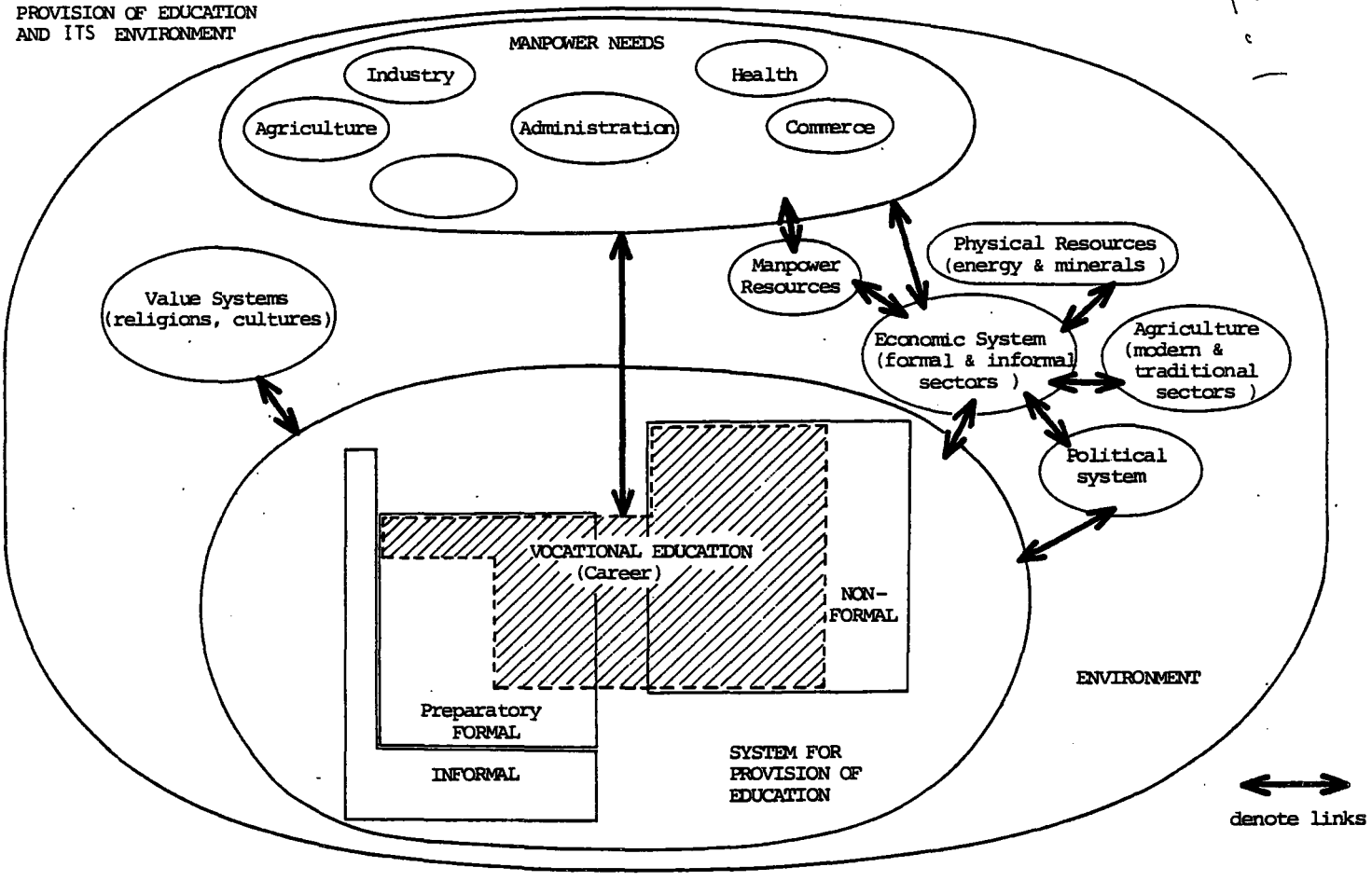


Fig. 2 OUTLINE OF PRESENT SYSTEM FOR TECHNICAL VOCATIONAL EDUCATION IN SOUTH AFRICA

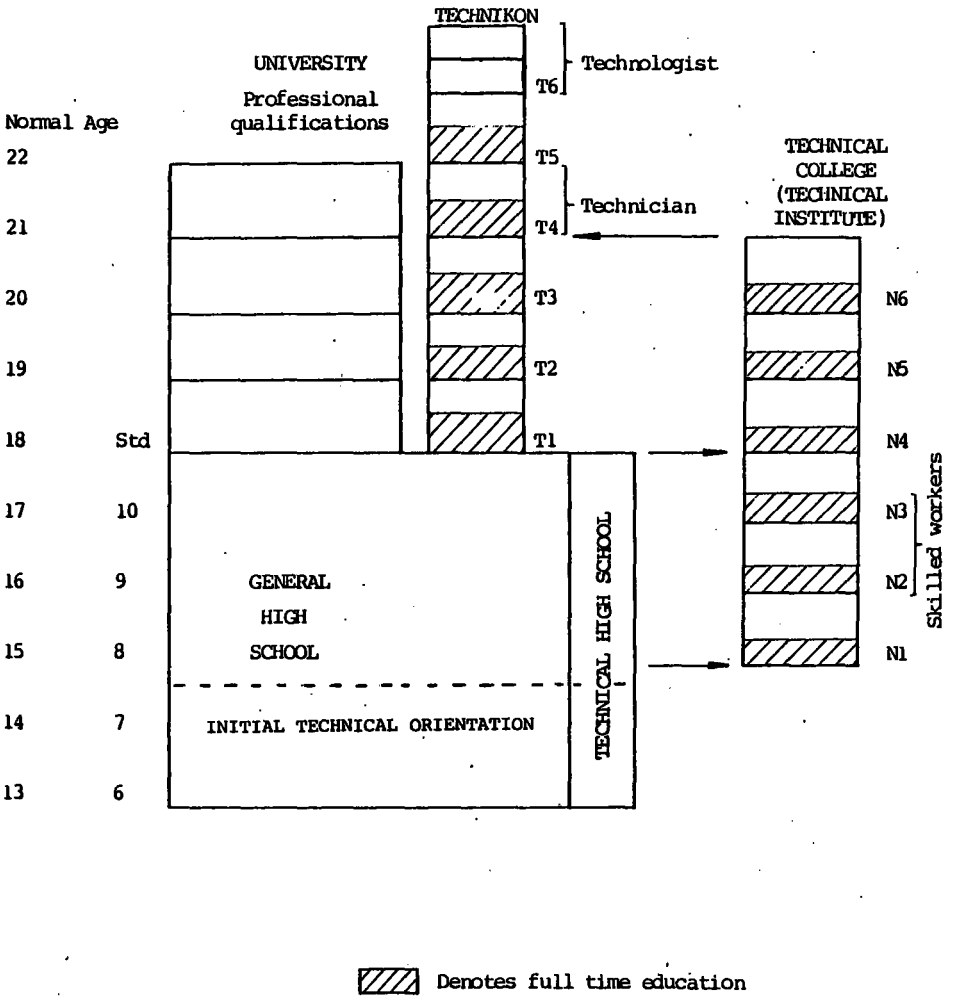
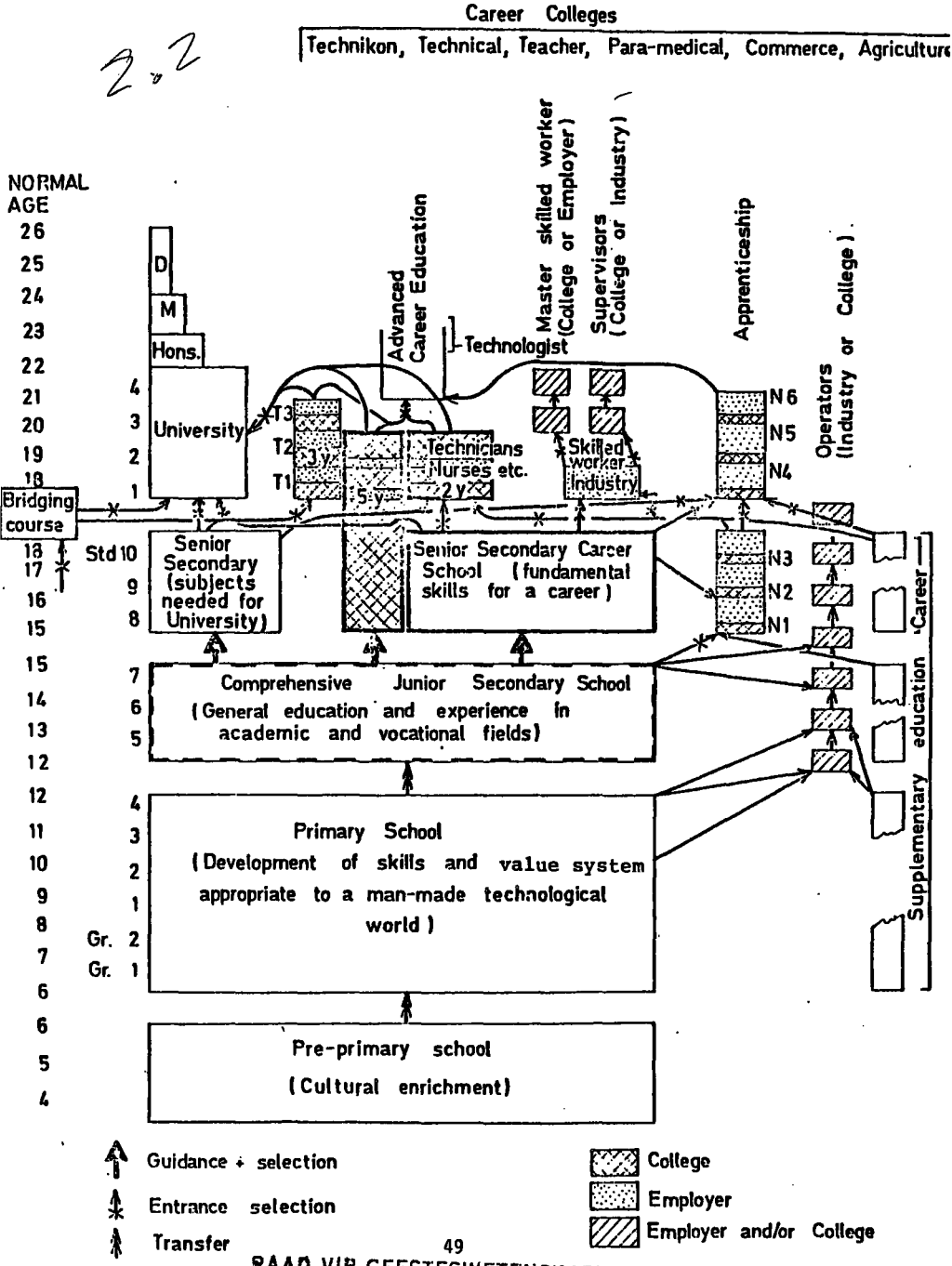


Fig. 3 PROPOSED "FINAL" STRUCTURE OF AN EDUCATION/TRAINING SYSTEM FOR SOUTH AFRICA



RAAD VIR GEESTESWETENSKAPLIKE NAVORSING
HUMAN SCIENCES RESEARCH COUNCIL

Fig 4 NEW CAREER INSTITUTIONS

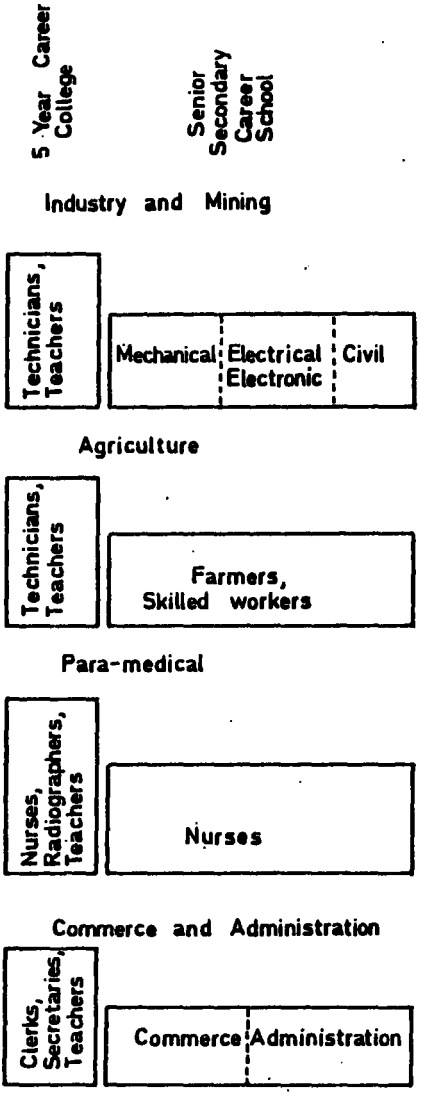
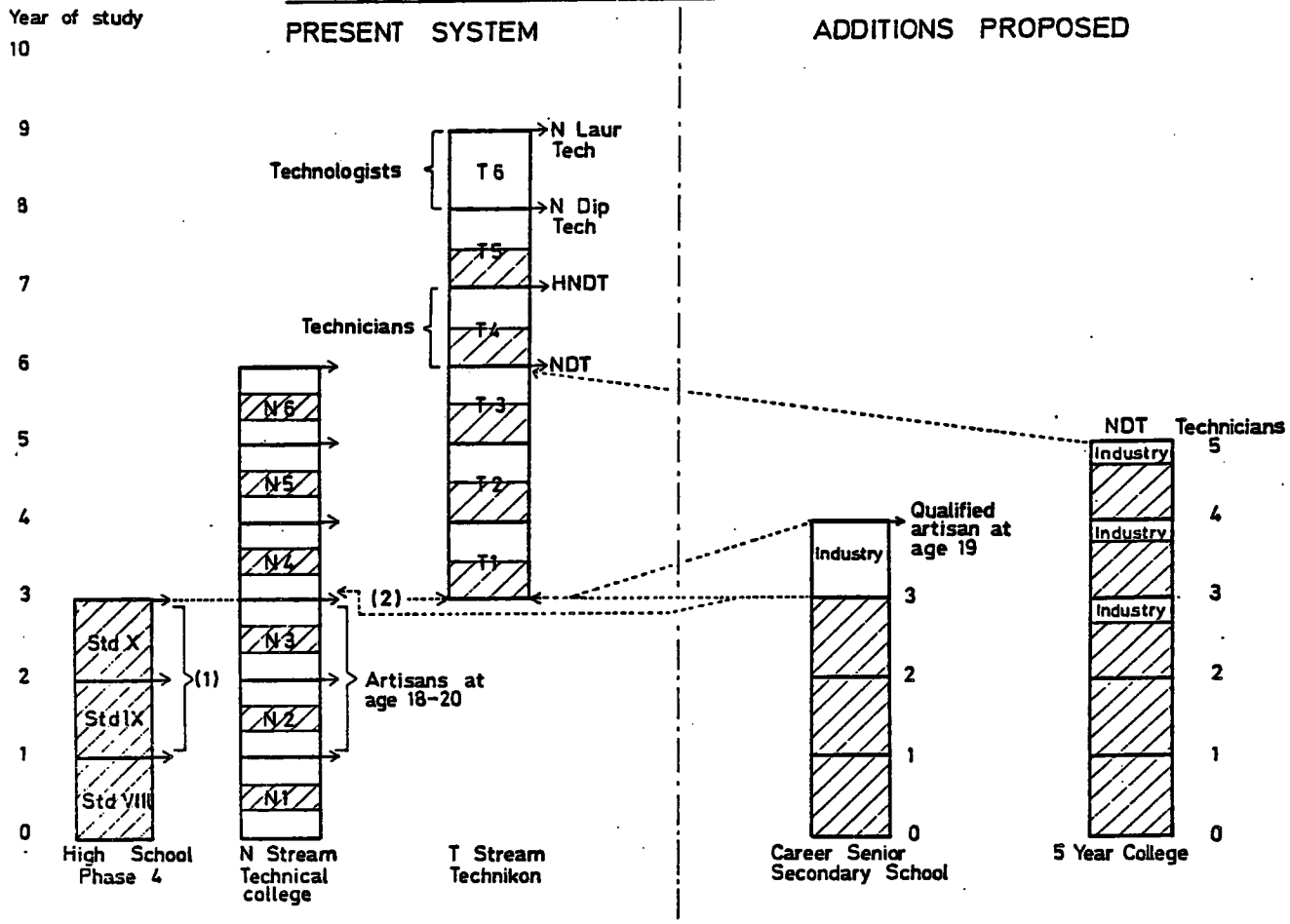


Fig. 5 TRAINING OF ENGINEERING TECHNICIANS AND ARTISANS



APPENDIX 1

THE DESIGN OF AN EFFECTIVE EDUCATIONAL SYSTEM FOR SCIENCE AND TECHNOLOGY FOR SOUTH AFRICA

1. INTRODUCTION

In history and archaeology two marked discontinuities, characterised by relatively rapid development of technology and culture, can be discerned. The first is the agricultural revolution which took place during neolithic times about 9 000 years ago when plants and animals were first domesticated. The second one is the Industrial Revolution which started around 1760 and which was fueled by the availability of large reserves of cheap fossil fuels. Each period of rapid change was inaugurated by the development of new technologies and was characterised by changes in value systems and culture. According to Peter Drucker[1], Alvin Toffler[2], and Sampie Terreblanche[3], we are again entering a discontinuity. The new technologies driving this revolution are the computer and modern communication which promise to make knowledge generally available and provide the new driving force for society. Even if one does not quite share the rather optimistic scenarios of Toffler and Drucker, it is already obvious that the fossil fuel reserves are rapidly being depleted and that fairly drastic changes will take place.

South Africa is in the interesting situation that, side by side, there exist people who still belong largely to the pre-industrial type of agricultural culture, the modern industrial culture, a sprinkling entering the knowledge culture and large numbers of people in transition from the less developed to the more developed cultures.

Since education always operates in a cultural* environment and since it has the possibilities of either accelerating or retarding cultural changes, careful attention must be given to the properties of cultural discontinuities in the planning of an efficient and effective

* The term "culture" is used here to describe the overall value system and outlook on life of an individual and other individuals with whom he has close relations.

educational system for a rapidly developing country like South Africa. As will be shown in the rest of the report, one of the main objectives of a system of education for South Africa should be the development of a general scientific, technical and managerial "literacy".

2. A SHORT DESCRIPTION OF THE DEVELOPMENT OF TECHNOLOGY, SCIENCE AND CULTURE

The development of agriculture and the domestication of animals heralded the start of civilisation as we know it. For the first time it was possible to produce, in a dependable way, limited surpluses of food which in turn freed some people permanently to devote their energy to specialised work in commerce, administration and the manufacture of more specialised tools. Although the muscle power of draught animals augmented that of humans considerably, the mechanical energy available to humanity was still very limited (one horsepower = 746 watts gives an indication of the continuous output of a horse working at a steady rate compared to 100 watts for a man under the same conditions). The prime energy resource was sunlight, and owing to its dilute nature and the very inefficient conversion of sunlight into food for man and beast by photosynthesis, large areas of pasture and cultivated land were needed to feed a given population. The density of human population could therefore only be high enough in very fertile river valleys to set appreciable numbers of people free from agriculture so that they could devote themselves to other tasks. The results was a slow development of culture and tool technology in which metal artifacts in time augmented those made from naturally occuring materials. Increasing commerce also created the need for more permanent records, which probably led to the development of the earliest form of writing.

The technologies on which these cultures relied were recipes or procedures which were probably stumbled upon and handed down from one generation to another as treasured possessions. Since survival of the system depended on the transfer of these time-proven procedures from one generation to the next, technology very easily became related to the overall view of the world, to magic and religion, and was

transferred intact as a part of tradition. This type of society has a very strong cohesive force in the form of its traditions and can effectively survive for long periods of time and remain intact if external conditions do not change too much.

Different technologies developed at different rates in diverse communities and trade and/or conquest diffused them in time. This led to a steady advance in all fields with iron taking over from bronze after the tin mines ran out.

As methods of transportation and administration slowly improved, larger empires became possible and trade started flourishing. Nomadic barbarian tribes outside the fertile areas improved their military striking power by being mounted on horses or camels or by using larger boats, and their numerous raids on the fertile areas also served to spread technology and civilisation.

The spread of Christianity through the Roman empire and beyond its borders led to more homogeneous culture being established throughout Europe. The small self-supporting independant Benedictine monasteries all over Europe provided safe repositories for the knowledge and culture of the Greeks and Romans through the dark ages when Europe was ravished by invaders and the Black Death[4].

During the Renaissance the introduction of printing made possible wide dissemination of knowledge and tools, instead of being mere extensions of human limbs, began taking on the form of machines capable of more complicated mechanical processes. Mechanisation of the loom at the end of the eighteenth century increased human productivity. Better power sources for power machines were developed in the waterwheel and windmill. Naval technology improved and Europe extended its domination over large parts of the world owing to its more effective technology. This added to both the material resources and the markets for the products produced by the machine.

Despite the advance of the technology, it still remained an art rather than based on science and natural laws. It was therefore possible for the guilds to maintain a "closed shop" for artisans and

the apprenticeship system under the tutelage of master craftsmen was very much in vogue. Technology, by developing better equipment for measurement contributed very much to the rapid advance of exact science which still operated as "natural philosophy".

The full impact of the industrial revolution really only made itself felt after the development of precision machine tools such as the lathe in the the 1870's and more advanced metallurgical processes leading to the production of steel. This made it possible to build larger and more efficient steam engines which in turn made the exploitation of large fossil fuel resources possible. This increased the energy available to humanity by orders of magnitude. (For each person in South Africa we have 0,8 kW of electrical energy available, which is the equivalent to the continuous manual work of 8 slaves. Each American has the equivalent of 25 "electrical" slaves working for him.)

The availability of machines and cheap energy had a tremendous impact on life and culture all over the world which introduced the following rapid changes in a very short span of time:

(i) Human and animal muscular energy were replaced more and more by various machines using fossil fuel as power source. This led to the mechanisation of agriculture with a concomitant drastic increase in agriculture productivity per farmer and an overall increase in producitivity per hectare; more hectares also came under cultivation in fertile areas because pasture for draught animals was no longer needed.

(ii) In industrialised countries large numbers of people could therefore devote themselves to pursuits other than food production. This led to urbanisation and a tremendous increase in manufacturing, exploiting the abundant natural resources of the planet.

(iii) With increasing support from the community, and more sophisticated instruments, science developed very fast. This resulted in technology finding a base in science and natural law. Technological recipes and processes were being understood and im-

proved and new technologies were being created by the development of science. A direct consequence of this was for example the development of synthetic dyes by chemists. The latter part of the eighteenth century was the heyday of the inventor, developing new machines and processes, and the entrepeneurs who created factories as well as new markets for manufactured products. It is interesting to note that practically all the inventions which led to present-day basic industries such as steel, chemicals, automobiles, aircraft, electrical generation and textiles were made before 1913.[5)]

The period from 1913 to about 1960 was characterised by an increasing rate of energy utilisation and the very rapid growth of industry in the industrialised countries. This created a demand for more highly trained people who could build, operate and maintain increasingly complex human-produced systems. Universal education was implemented as part of the fast growing government bureaucracy.

A new managerial class, consisting of people who could cope with the management of complex systems arose. With cheap and rapid transportation a world market developed as well as large multinational corporations. It also saw the rise of a new massive consumer goods industry where the conspicuous comsumption of previous elites spread to the masses in industrialised countries in order to expand the markets for products. In the underdeveloped part of the world, products of modern technology supplanted indigenous technology, and primary health care led to an explosion in population. In the developed world governments had access to large surpluses and governmental enterprises grew by leaps and bounds without necessarity being subject to effective control. This tremendous growth, which still continued despite the devastation wreaked by two world wars, was accompanied by unlimited exploitation of the limited resources of fossil fuels and without much regard to permanent damage being done to the biosphere by man-made contamination.

The second half of the twentieth century is showing a break or a discontinuity in the industrial development which took place during the last century. Development can no longer be subsidized by cheap fossil fuel. (It is estimated that the world has, at present consumption,

oil available for only 30 years and that the demand for coal in South Africa may already exceed the supply in 2030[6]. Also, contamination sets an upper limit to increasing exploitation of the earth's resources). Most of the industrialised countries have largely depleted their own natural resources and have to rely on supplies from other countries. Countries which have not yet become industrialised will find it more difficult to do so owing to increases in the cost of energy. On the positive side, however, technology in now clearly completely science based and humanity has accrued a tremendous resource in the form of knowledge which, with the rapid development of the computer and modern communication, is in principle available to all people who are capable of using it. We are already witnessing the development of a very fast-growing "knowledge industry" which will probably have as large or even larger cultural impact than the industrial revolution owing to the very high rate of change[7].

Because the use of knowledge enables humanity to conserve energy, to tap replenishable energy resources[8] and to introduce less energy-intensive production processes, the effective utilisation thereof could offset many of the problems created by more expensive energy.

THE EFFECTS OF RAPID CHANGE ON COMMUNITIES, AND THE PROBLEMS ENCOUNTERED BY EDUCATION

When major technological and cultural changes take place in a time span shorter than the average human lifetime, most adults find it extremely difficult to adapt themselves to changed conditions. This subjects them to severe stress and also prevents them from utilising new conditions to better their position. Although children start developing their cognitive processes in imitation of the culture in which they are growing up, they generally adapt themselves better to outside influences. In 1835 Andrew Ure presented the rationale for utilising child labour at the start of the industrial revolution in England by stating that it was "nearly impossible to convert people past the age of puberty, whether drawn from rural or handicraft occupations, into useful factory hands".[9] The implication is that the child has to acquire the necessary skills and value sysem needed for adult life while still relatively young if he/she is to be a productive person.

In a rapidly changing situation this can lead to conflict between parents and children, since if the parents do not know what is at stake, they and their representatives normally require their children to be brought up in their own value system.

Rapid development is disruptive, even in the culture which is responsible for it. It is, however, much more disruptive if an industrial culture impinges strongly on a non-industrial culture. Products produced by the non-industrial culture cannot compete with those from an industrial culture. This usually leads to a complete loss of local technology before it can serve as a base on which improved technology can be grafted. Examples abound. Imported textiles led to the demise of the weavers in India and cheap iron led to loss of the technology of melting iron in Africa, to name but two. Surprisingly the same replacement does not so easily take place in the fields of culture. The reason for this is that most traditional agricultural cultures have very unified concepts of life, world and religion. A child growing up in such a culture acquires a complete conceptual framework in which the concept of the world, underlying forces and humanity is very different from that of a child growing up in an industrial country.[10]

Cultural differences can even affect the way in which we perceive optical illusions.[11]

This explains why the usual strategy of introducing modern schools and curricula from industrialised societies in non-industrialised ones has yielded unexpectedly poor results,especially in the field of the natural sciences. This conclusion is corroborated by many reports stating "that the enormous investments in science teaching in underdeveloped countries have basically failed"[12], or that "simply a very small percentage of children from non-Western cultures who were exposed to systematic science-teaching courses did in reality absorb what they were taught" [13] or as another author puts it: "Here there is not concept of causality, at another place the idea of number is rather vague, somewhere space is considered an active agent and this hinders proper teaching of the foundation of mechanics".[14]

In the industrial culture science and technology have developed in close association. The very abstract concepts of sciences such as force, mass, charge, conservation laws, etc. find embodiment in many machines and processes which the child has been continuously in contact with since birth. This informal experience of "hidden curriculum" gives the child the necessary concrete background from which the underlying, more abstract concepts can be extracted. These children are therefore "capable of knowing things through action, thought, image and through symbolic linguistic representation".[15] The child from another culture starts with the basic disadvantage that he has another type of hidden curriculum and that he has not experienced technological things through action. The same problem appears to surround concepts needed for planning and management.

The abovementioned problems are probably the main reason why underdeveloped countries are developing so slowly despite the fact that knowledge and information has become widely available. The basic problem is that these countries do not produce enough people who can use knowledge effectively. Solutions to this problem can be sought along two major lines of attack. The first would be to try to relate the concepts of science to the concepts prevalent in the community where the science is to be taught, as suggested by Elkana [16]. There is no known example indicating the effectiveness of this approach. This approach will probably work to some extent in fields such as Psychiatry and Medicine, but it is very doubtful if it could be applied to sciences such as Physics, Chemistry, and Mathematics. A second approach which looks much more promising, and which appears to have been overlooked for some reason, is to start teaching a specific modern technology for which the child has some natural ability, around the age of puberty. This will automatically established a concrete experiential foundation from which the underlying abstract concepts of the sciences, forming the foundation of the specific technology, can be deduced. The child can therefore effectively be taught the sciences needed for the specific field of technology. This achieves several important objectives: The child readily finds employment, new technology is introduced into the culture and new products can be manufactured locally and the basic principles of modern technology, science and management are added with the least disruption to the indigenous culture which is equivalent to effec-

tively modernising it without destroying it. This type of approach was employed by both Taiwan and Israel after 1948, making them practically the only underdeveloped countries which have effectively modernised during the last fifty years.[17, 18]

Table 1 on page 84 shows that the rate of training in South Africa does not compare well with that in Israel and Taiwan. The implication of this is that South Africa has a very serious shortage of technically skilled people at all levels, which retards the human and economic development of the country. Even the White population, which has had long contact with Western countries and which is economically much better off than the population of either Israel or Taiwan, does not come out very well in the comparison. In a more detailed comparison of the training of engineers at universities one finds for instance that about 19 % of the first degrees awarded in Taiwan are in engineering. For Europe this is about 15 %, while for White South African universities it is only about 9 %. For South African English-speaking universities it is about 12 % and for the Afrikaans-speaking ones 7 %. This again illustrates the influence of culture since more Afrikaners have a rural background.

Another very serious problem results from the inadequate rate of training in scientific and technical fields. The expanding economy attracts trained people, causing serious shortages of teachers. With rapid expansion in education the imbalance between Science and Technology and the other subjects can only become worse if not promptly rectified.

The reasons for these problems are that all racial groups in South Africa have endeavoured to use only that part of the educational system of developed countries intended specifically for academic education, and have relegated essential technical and vocational education to a low level. E.G. Malherbe [19] states that vocational education in South Africa was originally developed for the poor, the defective and the delinquent children.

3. THE REQUIREMENTS FOR ADEQUATE EDUCATION AND TRAINING IN SCIENCE, MANAGEMENT AND TECHNOLOGY IN SOUTH AFRICA

3.1 EXPECTED FUTURE ECONOMICAL AND TECHNOLOGICAL DEVELOPMENT IN SOUTH AFRICA

South Africa is a developing country with a reasonably developed, industrial sector and a well developed mining sector. The largest part of the agricultural sector is developed, a good infrastructure is available and strong commercial links exist with the rest of the world. In comparison with the developed countries reasonably large fossil fuel deposits exist and more than enough uranium is available for nuclear power requirements. Large desposits of strategic raw materials are also avaiable.

In the industrial field the following areas of growth or potential growth exist in South Africa:

(i) The expansion of the traditional industries such as metallurgical, chemical, automotive, pharmaceuticals, textiles, etc. where the RSA has a potential edge on the developed countries owing to the availability of a large labour pool and more natural resources.

(ii) The extension of mining operations and the beneficiation of the material exported which should create strong points for further development.

(iii) The development of agriculture and industry in the remaining backward rural areas where large numbers of people can be drawn into the economy. This could lead to the development of appropriate technologies for developing countries which might find ready markets.

(iv) The development of new technologies in a limited number of fields where distinct advantages exist or where strategic considerations make it essential. Typical fields are petrol from coal, uranium isotope separation and defence technology.

3.2 FUTURE MANPOWER REQUIREMENTS OF SOUTH AFRICA AND PROBLEMS OF THE PRESENT SYSTEM OF EDUCATION

The main limitation to further development in South Africa is a shortage of skilled manpower at practically all levels and in all fields, as well as an over-supply of poorly skilled people who cannot find gainful employment. The result is that shortages increase the salaries of skilled manpower, induce rapid turnover of manpower and reduce productivity which make South Africa less competitive in world markets. This also retards the rapid socio-economic development needed to solve the country's problems.

The present system of education is to a large extent responsible for this situation. It is dominated by an academic value system which is more concerned with knowing than doing. Universities have expanded too fast and in an unbalanced way, leading to an oversupply of graduates in some fields and serious under-supply in other fields. Differentiation between academic, technical and vocational fields at secondary level is ineffective and many students at secondary and tertiary level are in academic streams for which they have little aptitude or liking. This results in bottlenecks in the educational system, high drop-out rates, lowering of standards, general inefficiency and an output not in line with the needs of the country. Practically no action is taken to cope with the problems of rapid cultural change and rapid expansions of education takes place without due consideration being given to the type and quality of the output of the system or the training of the teachers. The training of skilled workers is still geared to the apprenticeship system of the industrial revolution which is rapidly becoming obsolete owing to the advance of knowledge and a high rate of change. An apprenticeship system is also ineffective in communities where racial discrimnation is rife. The large bureaucracies which control education exert divided control over technical and vocational education at secondary level to the detriment of healthy development. Competition between bureaucracies in education makes it extremely difficult to establish and effective system of education. They are also not capable of finding sufficient numbers of qualified teachers and are seldom able to effect innovation in education. Parents and communities have very little say in or responsibility for education, and glaring in-

equalities in the funding of education for different groups makes education a political flashpoint.

To meet the needs of development in South Africa it is essential to expand education considerably within the next decades. The inherent defects of the present education system imply that extension of the system will probably be a bad investment which can very easily turn out to be counterproductive since it will probably strengthen vested interests in an inefficient system which will be even more difficult to reform in future. Expansion of education should therefore take place in a new system which, while utilising existing strengths and facilities, will bring the output of the educational system in line with the needs of development of South Africa for several decades. The basic criteria to be met by such a system of education will be given in 3.3 and a possible system will be described briefly in 3.4.

3.3 CRITERIA FOR EDUCATION AND TRAINING IN SOUTH AFRICA

3.3.1 The requirements of rapid cultural change

All population groups in South Africa are affected by it. Some are still on their way from traditional agricultural culture to modern industrial culture while some are undergoing the transition from the industrial to the "knowledge culture".

It is fundamentally important that problems owing to rapid cultural change be clearly defined and that effective solutions be found and implemented in the curricula, teacher training, differentiation, selection of students, collaboration with industry, the system of education and the control of education, etc.

Following the example of Israel and Taiwan it is essential that most pupils should in future receive career education after Std 7. (See App. 2). Report to the Subcommittee on Technical and Vocational Education, where the term career education is used for technical and vocational education.) As pointed out in 2.1, this is the most effective way of bridging cultural gaps. The essential missing parts of the hidden curricula should be identified and remedied from pre-primary school onwards.

3.3.2 The formulation of measurable objectives for education

One sometimes gets the impression that education has formed a subculture of its own which is even more resistant to change than the culture in which it is imbedded. Efficiency and effectiveness are very rarely measured. The objectives to be attained are generally couched in such vague terms that it is extremely difficult to determine to what degree they have been achieved. Meanwhile education has become one of the largest undertakings, absorbing vast quantities of resources. The tendency has been to extend the period of education under the assumption that "more education is better education". This assumption is open to serious doubt since it leads to an artifical extension of puberty and prevents the young adult from learning from experience in the actual work situation during his/her most formative years. With the present explosion of knowledge continuing education through most of a person's working life is needed to prevent stagnation during careers and to promote the necessary mobility in the economy.

3.3.2.1 Using skills acquired as measurable objectives for education

A practical solution suggested by Mr M. Wijnbeek (see Memorandum 1, pp. 90-92), is to set objectives for the skills that students should acquire during education. It is possible to subdivide the skills into fundamental skills such as cognitive, communication (verbal, reading, writing), numerical, manual, planning, management of information, etc. Different levels of skills can be specified for different stages of education and they can also serve to differentiate between different types of careers since each type of career has its own set of requirements for fundamental skills.* The child will start acquiring the fundamental skills from the pre-primary school onwards. At a later stage basic career skills will be acquired which will prepare the student to work in a field suited to his aptitude and interest. Thereafter more specialised skills can be acquired for specific types of work. Depending on the knowledge

* For the sake of clarity it must be pointed out that what is understood under skill here, is not manual skill only, but rather the combination of behaviour and basic knowledge which makes it possible to analyse and execute tasks quickly and efficiently.

and manual skill content of these skills they can either be acquired during formal education, jointly in the system of education and the work situation, in the work situation alone or at intervals during the development of a career.

The advantages of using skill requirements rather than competence in certain subjects are the following:

(i) It offers a more neutral basis for evaluation since it should not depend heavily on either culture or details of the curriculum.

(ii) It makes it possible to evaluate each subject in the curriculum to ascertain to what degree it contributes to the skills which should be acquired during a certain stage of development.

(iii) It focusses the attention of the teacher on the requirement that each subject should be taught in such a way as to enable the student to develop certain skills and not just to convey a mass of information about the subject.

(iv) Acquisition of skills instead of a combination of subjects makes it possible to differentiate curricula in order to cope better with cultural enrichment during education.

(v) It is possible to determine, in collaboration with the employers, the mixture of knowledge and skills needed for effective performance of work. The same applies to development of new or modified skills which should be acquired during a career.

(vi) Skill requirements can be set for entrance into different types or education, and training and remedial training can concentrate on skills which are lacking.

(vii) Clearly specified skill requirements will make adult education more effective in that other methods can be used to develop skills in adults than in children.

(viii) Evaluation of skills acquired can in some cases be used as a sensible basis for financial support to education.

(ix) Clear-cut specification of skills required will prevent the situation in which perhaps 80 % of the training of apprentices in some fields covers only 20 % of the actual skills needed while 20 % of the training covers the other 80 % of skills needed on the job.

(x) Skills can also be evaluated accurately and continuously under normal teaching conditions.

3.3.3 Cost-effectiveness of education

Since education is becoming a very expensive operation, it is essential to improve the cost-effectiveness of education and to monitor it continuously. A field in urgent need of attention is the cost-effectiveness of university and technikon education. A low percentage of students complete their courses in the minimum time alotted and many leave without either meaningful qualifications or skills*. The present university subsidy formula is largely to blame for this situation and should in time be replaced by a more generous subsidy based on the output of these institutions. The problem with the present subsidy system is that it is based on the number of students attending the institution. Such a new system will require that these institutions would be free to select their entrants, to establish limited bridging courses** to help disadvantaged students to gain entry into the institution without clogging it up, and a system according to which the institutions, professional organisations and employers can collectively maintain acceptable standards.

An essential corollary to the whole cost-effectiveness approach is that students should be positively guided to and selected for courses/careers for which they have the skills and interests ne-

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* About 60 - 70 % of students entering South African universities eventually qualify.

** This system operates well in Israel. See ref. 8.

cessary for success and for contributing to the development of the country. The ideal time for differentiation is during,

the age of about 15 years, after completion of Std 7.

At this age, the pupil tends to identify with the ethos and value system of the chosen field, which is very important, especially in the case of a cultural transition where the child may be the first of a family to enter a specific field.

This requires a comprehensive junior secondary school phase (Std 5 - 7) with a curriculum designed in such a way as to allow the child, teacher and parents to discover the child's aptitudes and skills in order to select appropriate further education and training and career opportunities. This implies that the senior secondary system (Std 8 - 10) should provide suitably differentiated education to cope effectively with a wide range of aptitudes and skills. It should prepare the majority ($\sim$ 50 - 80 %) of the children for a career directly after completion of Std 10, the remainder being prepared for tertiary education. Career education, starting at school, should be viewed as the first step on a career ladder with continuing education as the career develops. High achievers should also be able to enter tertiary institutions to study in their field of specialisation.

It will take time to move from the present poorly differentiated system of education to a more effectively differentiated one. Greater differentiation will make it possible to establish a modern vocational guidance system and to design appropriate curriculums for the comprehensive junior secondary school to assist with guidance. The advantage of this approach is that the majority of children will receive education appropriate to their skills and aptitude and that the present high rate of school and tertiary dropout will be reduced. More ideas about guidance and selection are presented in Memorandum 2, page 93.

It is very important that the whole system of education be designed in such a way that it be cost-effective. The structure should therefore have the freedom to reallocate its resources in time to improve its cost-effectiveness and people who are responsible for improve-

ments in cost-effectiveness should be duly compensated for their initiative.

3.3.4 Improving the effectiveness of highly trained teaching staff

With the present shortage in trained manpower it is reasonable to assume that a shortage in highly qualified teachers will persist for some time in a rapidly developing economy. This has very important practical consequences since it is possible, with the tremendous expansion required by education, that the ratio of pupils per skilled teacher may perhaps deteriorate rather than improve in future. This can only be countered in practice by drastically increasing the effectiveness of the competent person, something which underlay the rise in human productivity in all fields during the industrial revolution. This can be done by analysing the whole process of teaching and learning. It is basically the work of the teacher to teach, that is, to present knowledge and skills in the correct context so that the pupil can understand while the pupil should learn the essentials after understanding is achieved. A basic problem in present systems of education is that the teacher is also required to supervise the learning process. This can be solved by letting the teacher teach and by using less qualified people to supervice the learning process. This approach should be combined with modern teaching and learning aids whenever they can be gainfully employed and where they are culturally effective.

In South Africa such an approach will have the added advantage that the salaries of the effective teachers can be made competitive with those of private enterprise while the large numbers of poorly qualified teachers could in time become very useful supervisors of the learning process. In time the outstanding ones may developed into effective teachers in their own right under the tutelage of excellent teachers.

The improvement of the education system depends basically on the impact of the effective teachers. Every effort should therefore be made to train teachers who themselves have crossed the cultural gaps which exist in South Africa and who are therefore capable of guiding their pupils and assistants. The Taiwanese type of 5-year junior

college appears to be a very effective institution for this purpose.[18]

3.3.5 Provision for special advanced education

To develop fully, it is essential for South Africa to remain in contact with the latest developments in all fields of knowledge. In some fields a minimum effort will be needed since South Africa may not directly use knowledge in this field, apart from the cultural needs and the education of a very limited number of students. In other fields which have direct bearing on efforts crucial to South Africa, much larger efforts are needed in order to educate and train an appropriate work force and to do competitive local research and development work. These efforts however not only absorb large quantities of money, but also the best brain power of the nation. If allowed to proliferate, as has happened for several decades, one ends up with a number of sub-critical groups who do not effectively contribute to development. The solution to this is to identify fields of importance and to let institutions compete for the establishment of national and regional programmes. Such a programme must have clearly spelt out objectives such as:

(i) keeping abreast with the latest knowledge in a given field;

(ii) disseminating the knowledge in an effective way amongst users;

(iii) taking responsibility for an adequate training program in the specific field.

Such an approach could in time lead to the consolidation of existing sub-critical programmes into programmes of critical size, pooling the facilities of the universities, research institutions and the private sector. It will also rationalise the establishment of new fields of advanced education.

3.3.6 Unity and diversity in education

Since political differences cut very deeply through South Africa an education system which differentiates amongst groups would be unacceptable. On the other hand, practical differentiation to cope with cultural transitions, is essential for effective education. The solution to this problem appears to be to have a central educational authority which determines and co-ordinates the education

system only in so far that:

(i) it distributes funds of the central government for education;
(ii) it determines the overall structure of the educational system and the skills which should be developed by different components and institutions,
(iii) it accredits all educational institutions, but is not responsible for directly supplying any education - only subsidising accredited institutions (accreditation will keep regional education needs in mind);
(iv) it determines the cost-effectiveness of institutions.

This makes provision for a very wide variety of educational institutions under all conceivable types of control which would allow for community and parent involvement and the essential innovation needed in education. The present large bureaucracies can continue functioning on this basis provided they are accorded the same status as any new organisation. Parents and individuals will have the freedom of choice of institutions.

The reasons why a central educational authority is essential for the development of career education, especially in the transitional period between the present and the new system, is described in app. 2, 5.1.5 and 5.2.1.

3.3.7 Regional planning of education

The requirements to be met by education in different regions vary. Settled industrial regions and developing rural areas obviously have different needs and possibilities. This implies the establishment of a regional education strategy within which educational institutions will have sufficient freedom to provide education.

3.3.8 Motivation by success

One of the main points of criticism which can be levelled against the South African education system is that too many students are demotivated by failure instead of being motivated by success. The reason for this is that the rate of learning differs for different

children and that socio economic and home background also play a role. It is therefore essential to vary the learning pace for children in different subjects, for instance by streaming. This should, however, not imply a lowering of standards, but rather the solid development of skills appropriate to the child which will allow the child to achieve on his/her own in school and later in the adult world (see 3.4.3).

3.3.9 Moral support of the child by the family and community

During rapid cultural transition a child is subjected to added stress and needs maximum support from the community. It is therefore essential that the members of community should consider the school as belonging to them and that both child and parents should know that the school belongs to the community and not to some distant, inscrutable bureaucracy.

3.3.10 Better utilisation of expensive physical facilities

University, technikon, career and academic high school facilities and buildings are expensive. All of these can be more effectively utilised by using them for evening courses and/or special courses. Facilities from the private sector should also be incorporated.

A suggestion which should receive very serious attention, is that of using these facilities on a year-round basis by dividing the year into three trimesters. This has many advantages, for instance be enabling the students to do outside practical work in one trimester, by training more people with given facilities, by sandwiching military training, etc. [20]

3.3.11 Innovation

The education system should endeavour to turn out innovative people at all levels who can develop new approaches to the diverse problems of South Africa. Its approach to education itself should be innovative.

3.3.12 Contact with the world of work

It is essential that the education system be in continuous contact with the outside world in order to assess its role in formal, as well as in supplementary and continuing education.

3.3.13 Addition of science, technology and management to cultures in South Africa

The system of education should endeavour to introduce science, technology and management at all levels so that South Africans can cope better in modern technological environments.

3.3.14 Maintenance of effective standards of education and training

In a developing country, two factors complicate the maintenance of appropriate standards, These are:

(i) The very rapid expansion of education, leading to a shortage of qualified teachers and a possible lowering of standards. This can be offset by a positive effort to ensure that an appreciable percentage of bright children are identified and educated in order to be able to channel a reasonable fraction of them into education. During cultural modernisation in a developing country it is also essential for prospective teachers to undergo the necessary modernisation before they start teaching. This will enable them to guide children effectively through the same process.

(ii) Professional standards, transplanted from developed countries (communities), or vested interests of professional groups can lead to the establishment of unrealistic academic qualifications for entrance into training, or for journeing to professions and related professions. This can lead to artificial shortages as a result of the exclusion of people who could have met the essential requirements (see Appendix 2, 5.3.4).

4 A PROPOSED STRUCTURE FOR A SYSTEM OF EDUCATION FOR SOUTH AFRICA

The proposed structure (see Figures 1, 2 and 3) makes provision for general formative education followed by a differentiated system in the senior secondary phase. It also makes provision for the effective teaching of science, technology and management at different levels in order to introduce these in the South African culture. It is also structured to supply a balanced output of skilled manpower needed by the economy in a cost-effective way.

The structure presents a reasonable embodiment of the principles discussed in 3.3.1 to 3.3.14. Similar educational systems have already proved their value in developing countries such as Israel and Taiwan. The basic principle of effective differentiation has also been used by the systems of education of Switzerland, Holland, and Germany.

The purpose of this section is not to present the proposed system in fine detail but rather to highlight the properties of a more effective education system that could grow out of the present system in a natural manner. This growth will, however, not take place of its own accord, but will have to be carefully nurtured and guided. For this purpose, the Central Educational Authority, proposed in 3.3.6, is essential to the system's cost-effectiveness and rate of implementation in order to make a positive contribution to the solution of the very urgent developmental problems confronting the country.

At first glance, the proposed new structure may not appear to deviate very much from the present system. Some of the most significant differences are highlighted in what follows.

4.1 Differentiated education after Std 7

Std 7 is viewed as the end of the nine years of general formative education. Subsequently, education is differentiated between the senior secondary academic school (SSAS) and the senior secondary school (SSCS) for Std 8 to 10.

The purpose of the SSAS is to educate for continuing education at university. The career high schools have the purpose of providing children with the knowledge and skills necessary for a specific career after completing Std 10. It is envisaged that about two thirds of the time will be devoted to the development of general skills and theory needed in a given career field and about one third to general education. It is suggested that the general career skills be developed at school with more specialised ones added after school during on the job training. Students are expected to pass the standard trade test for artisans about a year after leaving school (App. 2, 3.1). Figure 2 shows that provision will be made for career schools specialising in diverse fields of engineering technology, commerce, agriculture, paramedical services, etc. (Figure 2, page 88).

It is important that career high schools should not be perceived as educational endpoints. Provision should be made for continuing education during a career, preferably in modular form, either in the work situation or in collaboration with educational institutions. Provision must also be made for students who do well in career education to continue tertiary education at technical college, technikon or university, with as little bridging as possible.

It is always in principle possible to combine an academic high school and a career high school into a comprehensive high school. Experience in Israel has, however, shown that it is generally preferable to establish comprehensive high schools by changing a career high school into a comprehensive high school. If an academic high school is changed into a comprehensive high school the academical values tend to be dominant if careful preventive measures are not taken. To give children a sufficient choice of career opportunities, comprehensive high schools should preferably be large.

During rapid population growth, leading to rapid extension of secondary education, separate academic and career high schools are probably the most effective way of changing from the present academically dominated system of education. For groups where the growth at senior secondary level is low, present academic schools will have to become comprehensive schools, or clusters of academic

and career schools will have to be established by changing the roles of some existing schools.

In a mature system of education, with fully developed career education it is envisioned that ∿50 - 80 % of the children in Std 8 to 10 will eventually receive career education. (At present it is about 70 % in both Israel and Taiwan.)

3.4.2 Preparation for differentiation - the role of the comprehensive junior secondary school (CJSS)

The comprehensive junior secondary school (Std 5 - 7) plays a crucial role by using a curriculum which does not only develop general skills, but which also makes it possible to discover the more specific skills and aptitudes of the child needed for sensible guidance and choices in the senior secondary phase. In practice this does not entail that the child should sample all possible courses, but rather that the curriculum should include examples of the more abstract academic approach as well as at least one vocational subject. Skills and aptitudes can then be assessed according to the way in which the child manages the tasks ranging from concrete to more abstract.

The CJSS will prepare the child to:

(i) continue education in SSAS, SSCS or five-year colleges (see 3.4.4.2.1);

(ii) enter apprenticeship training in fields where work experience and modular courses are sufficient;

(iii) leave school and start working at operator level after completing a modular course (see Figure 1, page 87).

Guidance will play a very important role in the CJSS and the South African cultural situation will require that very special attention be given to this field in order to best match the skills and aptitudes of the children with job and education opportunities.

The establishment of comprehensive junior secondary schools will postpone differentiation to the beginning of Std 8 instead of Std 6

as is customary in the present technical high schools. This will allow small and remote communities to maintain their own CJS schools which will allow children to remain in their own communities until the age of 15 years. Thereafter children will attend regionally planned career or academic high schools.

3.4.3 The role of the pre-primary and primary school

Both schools should have as primary objective the development of the skills needed in life (see 3.3.2.1). In a process of cultural modernisation the pre-primary school can play a very important role in identifying in each child essential skills which are not well developed. These skills can then be developed, using special enrichment programmes.

Apart from the general development of skills in primary school, modern technology should be introduced by enabling scholars to become conversant with the use of tools (boys and girls), modern materials and simple machines.

At primary school level, the rate of progress in certain subjects will depend on mental ability and socio-economic and home background. To enable pupils to progress and acquire well defined and useful skills, streaming is proposed for subjects such as second language and arithmetic. This implies that these subjects be presented at different levels in separate classes to which children are sent to from their usual classes. A child could therefore attent the A stream in English and the C stream in arithmetic etc. while the other subjects are taken by the whole class. This offers the opportunity of teaching homogeneous classes which is more effective. It also enables all children, including the very bright, to reach attainable objectives.

3.4.4 Tertiary education

3.4.4.1 University education

Further healthy development of the South African universities can be rationalised and made cost-effective by using a subsidy based on

the output of the university while allowing the university to select at entrance (see 3.3.3), subsidising bridging courses into the university (see Figure 1) and the establishment of output quotas in fields where overproduction tends to occur. Attention should also be given to the rationalisation of new courses (see 3.3.5) and the consolidation of sub-critical efforts (see 3.3.10).

3.4.4.2 The technikon and technical college

The present structure of the technikon and technical college (technical institute) and engineering technology is given in Figure 3, which is based on the Goode Report [23]. So far the main feeder institution of the technikon has been the academic high school, and students commence technical training with little practical experience. To rectify this, sandwich courses, with one semester course alternating with one semester in-service training are being used to good effect. This leads to 3 years of training. The introduction of career high schools should make it possible to reduce the in-service training leading to a course of about two years duration (see Figure 1).

The Goode Report recommends that a vertical extension of technikon training takes place by introducing advanced qualifications such as HNDT, N.Dip.Tech. and N.Laur.Tech. This approach is now being implemented. Preferably it should first be implemented at a few selected institutions so as not to over-extend the limited teaching manpower (see 3.3.3, 3.3.5 and 3.3.10). It is also advisable that horizontal transfer between the higher technikon courses and universities receive attention since the basic and engineering sciences are the denominators in advanced technology. The training of lecturers and teachers for the expansion of technical education and training at all levels should receive urgent attention.

The technical colleges and technical institutes are still mainly based on the apprenticeship system. There are at present worldwide indications that the classical apprenticeship system is being replaced by institutionalised training (Appendix 2, 5.3.5) and that the training of skilled workers should to a large extent take place within the career school (Appendix 2, 3.1). These tenden=

cies should receive very careful consideration when the expansion of technical colleges is considered. A strong case can be made for viewing the present technical colleges as embryonic community colleges which could in future supply a very wide range of educational and training services. This can range from modular courses for the training of apprentices in fields where apprenticeship training is still needed to courses for the advancement of artisans, as well as wide range of commercial, etc. courses needed by modern communities in adult and supplementary education. Technical colleges could also actively take part in the establishment of the first career high school.

A pressing need at present is to provide technical college training to apprentices from population groups who have only recently entered this field. More details of this problem are given in app. 2, 5.1.1.

In time, a subsidy formula based on output should be considered for all tertiary institutions (par.3.3.3) of this report).

3.4.4.3 The introduction of 5-year courses after Std 7

To meet the pressing needs of both cultural modernisation and the supply of manpower at middle management level it is strongly recommended that the example of Taiwan be followed by introducing 5-year cources, starting at Std 7 with selected students (appendix 2, 3.2.)

This type of course should be available in all fields of engineering technology, commerce, agriculture, nursing and other paramedical fields. In engineering technology it will reach the level of the present NDT courses. The reason why these courses have proved so effective in Taiwan are as follows: people who are to operate in middle management positions need, apart from technical skills also managerial skills, as well as an appropriate value system for the field they are working in. In a five-year integrated course it is possible to develop fully all these aspects in selected students who have to cross cultural gaps. When these students complete the five-year course, the cultural gap has been successfully closed and they are productive members of the community. This course is therefore especially well suited to the training of teachers in the dif-

ferent fields since having crossed the cultural gaps themselves, they are capable of guiding their pupils through the same transitions.

The five-year course will in time probably become the backbone course for closing the cultural gaps in the training of middle management and teachers for career high schools, as well as other schools. It should therefore, as soon as possible, become an integral part of the system of education in South Africa. Its establishment should enjoy very high priority.

In principle, the five-year course could be joined to diverse institutions such as technikons in certain fields, technical colleges, agricultural colleges, medical colleges, universities or even career high schools, especially for the training of teachers for career high schools. Whatever approached are used, it will be essential to select students carefully and to maintain high standards from the start.

3.4.5 Supplementary education

With still large numbers of illiterate adults and many people leaving school before even completing primary school, a system of supplementary education is essential (see Figure 1). The objective of this system is to enable adults to acquire basic skills (communication, literacy, numeracy, etc.) in the shortest possible time. To be cost-effective, supplementary education should, whenever possible, use existing educational facilities during evenings, weekends and holiday periods.

It is also expected that the vast majority of people who use supplementary education will try to continue their education in some field of career education. The acquisition of skills in supplementary education should therefore be strongly, but not exclusively, focussed on opportunities in career education and the world of work. Cultural modernisation should also receive attention in supplementary education in order to narrow generation gaps in developing communities.

3.4.6 Using facilities and expertise outside the system of education

The cost-effectiveness of education will improve if expensive facilities outside the system of education can be used whenever possible. This ranges from practical training on industrial systems to the use of part-time instructors, teachers and lecturers from industry, commerce, etc. as well as the undertaking of joint programmes to develop curricula and to undertake research and development in other fields.

3.4.7 The establishment of private organisations, responsible for a part of career education

The establishment of subsidised private organisation(s) on similar lines to those of ORT-Israel [8] would help to establish, with strong support from industry, commerce, etc., prestigious career high schools and 5-year colleges for teacher training. These institutions can then be used as pace-setters in the rapid development of career education in South Africa (Appendix 2, 5.2.3).

3.4.8 Vertical mobility of students

It is essential in all education systems, but especially so in developing countries, that students never feel that educational ceilings are erected in certain fields which make it impossible for the high achiever to continue with more advanced education without losing considerable time. If these barriers are effectively removed, students will more readily consider going to the SSCS. This can be achieved by:

(i) establishing university courses based on 5-year college and advanced technikon courses, and

(ii) introducing a bridging year (or shorter) for bright students who lack certain skills needed for entrance into university or technikon.

(iii) Students from the SSAS who do not gain entrance into the universities can apply for entrance to the technikons; owing to a lack of practical experience their technikon courses will be of longer duration, the choice of subjects in the SSCS should be such that bright students can acquire skills which will enable them to gain entrance either to universities (in their career field) or technikons.

(iv) Provision must be made for improving vertical mobility of skilled workers by offering evening courses in more advanced skills.

3.4.9 Development of specific skills as major objectives

Development of skills needed for the balanced life of the individual and for productive contribution to the community should be the major objective right through the whole education system. All subjects, even those considered "formative", should be evaluated to established which skills are to be developed by them. The skills under consideration are those skills needed to live in a man-made technological world.

The SSCS would for instance concentrate on the skills needed by a person who is going straight into a career (skilled worker) after leaving school as well as on a smaller number of people who will continue with career education at tertiary level. The same applies to university courses which should not only develop specialised skills but which should also require the development of general skills.

Assessment of the necessary skills firstly to follow a course of study and finally to follow a career, should serve as the basis of guidance and selection. The required skills should always be clearly spelled out (N.B.: subject skills are included).

3.4.10 Planning of education on a national and regional basis

A balanced system of education, providing the correct mixture of skills needed for development can play an important role in national as well as regional development. These development considerations should play a very prominent role in the accreditation of educational institutions. This must be the role of a central educational authority, advised by bodies representing regions.

4. TRANSITION FROM THE PRESENT SYSTEM OF EDUCATION TO A NEW SYSTEM

The most exacting part of the whole exercise of changing a system of education lies in managing the change in such a way that the final objectives continuously serve as clear guidelines while at the same time unleashing the latent innovative potential of teachers, communities, industry, commerce, etc. in the process.

In the present South African situation this requires a Central Educational Authority which can, by policy decisions, financial support and accreditation, guide the change effectively. The accredited bodies, which are responsible for the running of educational institutions should, however, have maximum freedom to innovate and implement objectives in the most efficient way. Accountability should, whenever possible, be based on the results achieved and not on the procedures followed.

The Central Educational Authority would make it possible to utilise fully all types of educational institutions to further the rapid development of career high schools needed to offer children a viable alternative to the present general academic education. It will also make it possible to guide the development of existing institutions towards the more effective system.

Another important function of the central authority would be to ensure that the quality of education does not deteriorate during rapid expansion of educational facilities. For instance, the number of career high schools should only expand at the rate at which competent teachers can be made available.

A strategy to rapidly expand career education and training and to increase its cost-effectiveness is given in app.2, par.5. It is based on the accreditation of educational institutes responsible for career education by industry, commerce, etc. as well as the establishment of private educational organisations in the field.

It is essential that the support of all communities and teacher organisations should be gained by clearly spelling out the objectives of the new system and proposing realistic time schedules for implementation. Effective use of the media, especially TV, should be made in informing the public about these matters.

W.L. Rautenbach
Stellenbosch
1981

TABLE 1 : A COMPARISON BETWEEN THE RSA AND TAIWAN

	RSA	Taiwan
Area	1 133 759 km^2	35 990 km^2
Population	∿ 22/km^2	∿ 470/km^2
GNP/person	∿ R1 800	∿ R1 200
Natural resources	Abundant	Very limited

	RSA		TAIWAN		
	Total population	Whites	1955	1965	1977
Population	∿24 x 10^6	∿4,4x10^6	∿9x10^6	12,7x10^6	∿16,9x10^6
Addition of people with a vocational Std 10 per million population per year	∿400-500**	∿2 015*	574	1 508	5 713
Addition fo 2-year vocational Std 10 training per million population per year	?	?	136	265	2 031
Addition of university graduates per million per year	∿523	∿2 514	213	650	1 756
Addition of graduate engineers per million per year	∿37	∿195			∿341
Addition of engineering technicians per million per year	∿78	∿424			∿876
Percentage of GNP spent on education	?	?	2,08 %	3,30 %	4,52 %

* Technical Std 10 + Commercial Std 10 + NTC 3

** Estimate

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FIGURE 1 PROPOSED "FINAL" STRUCTURE OF AN EDUCATION/TRAINING SYSTEM FOR SOUTH AFRICA

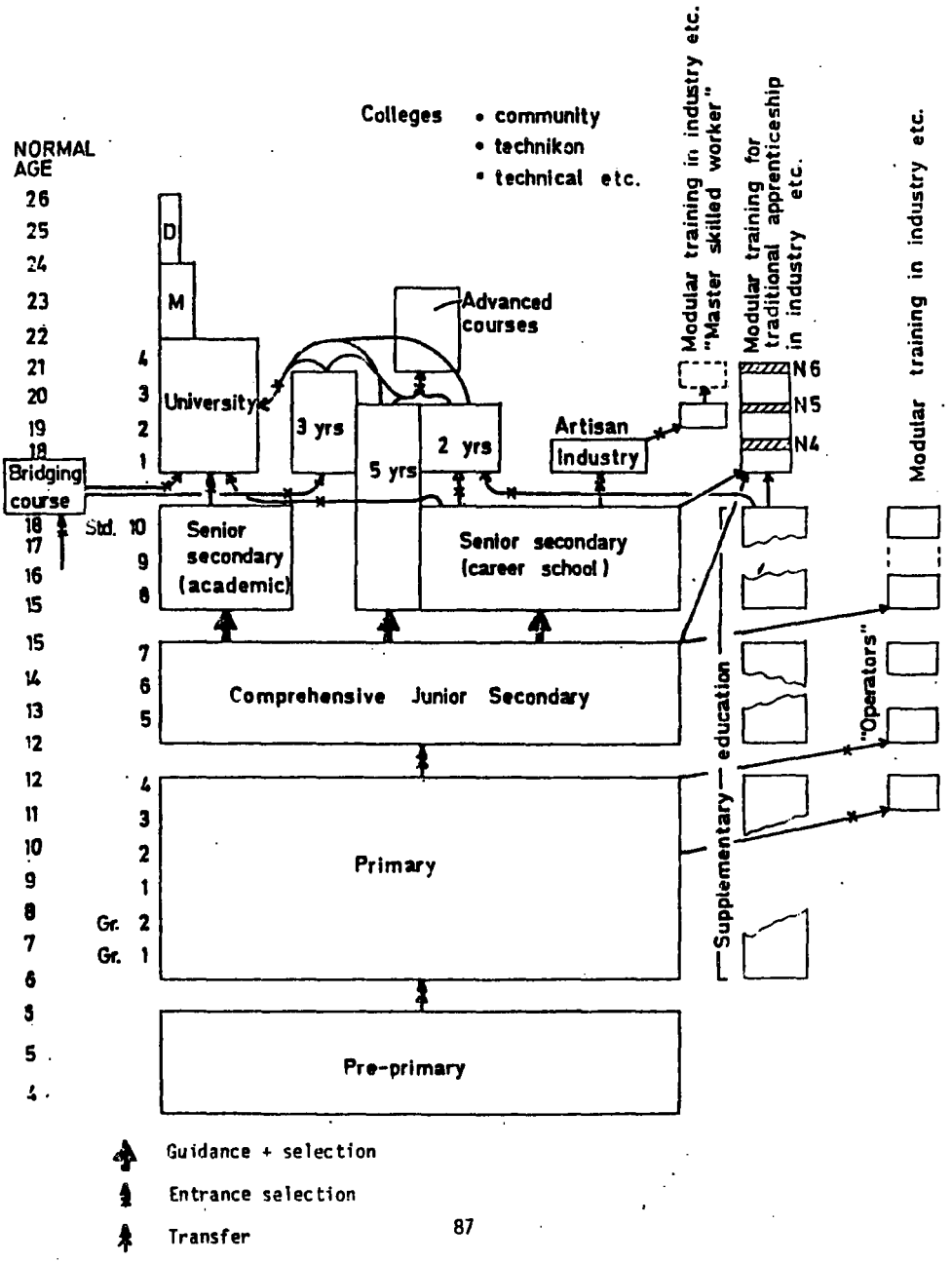
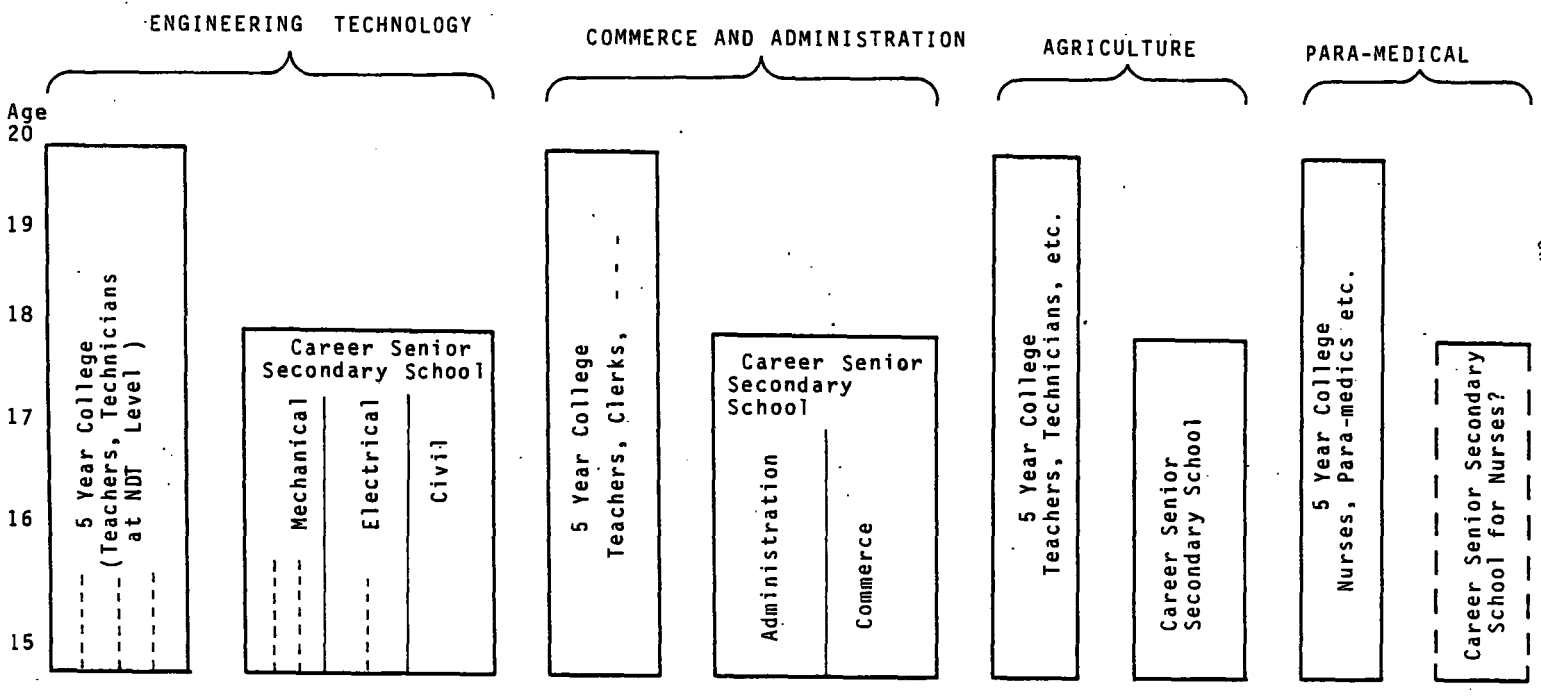
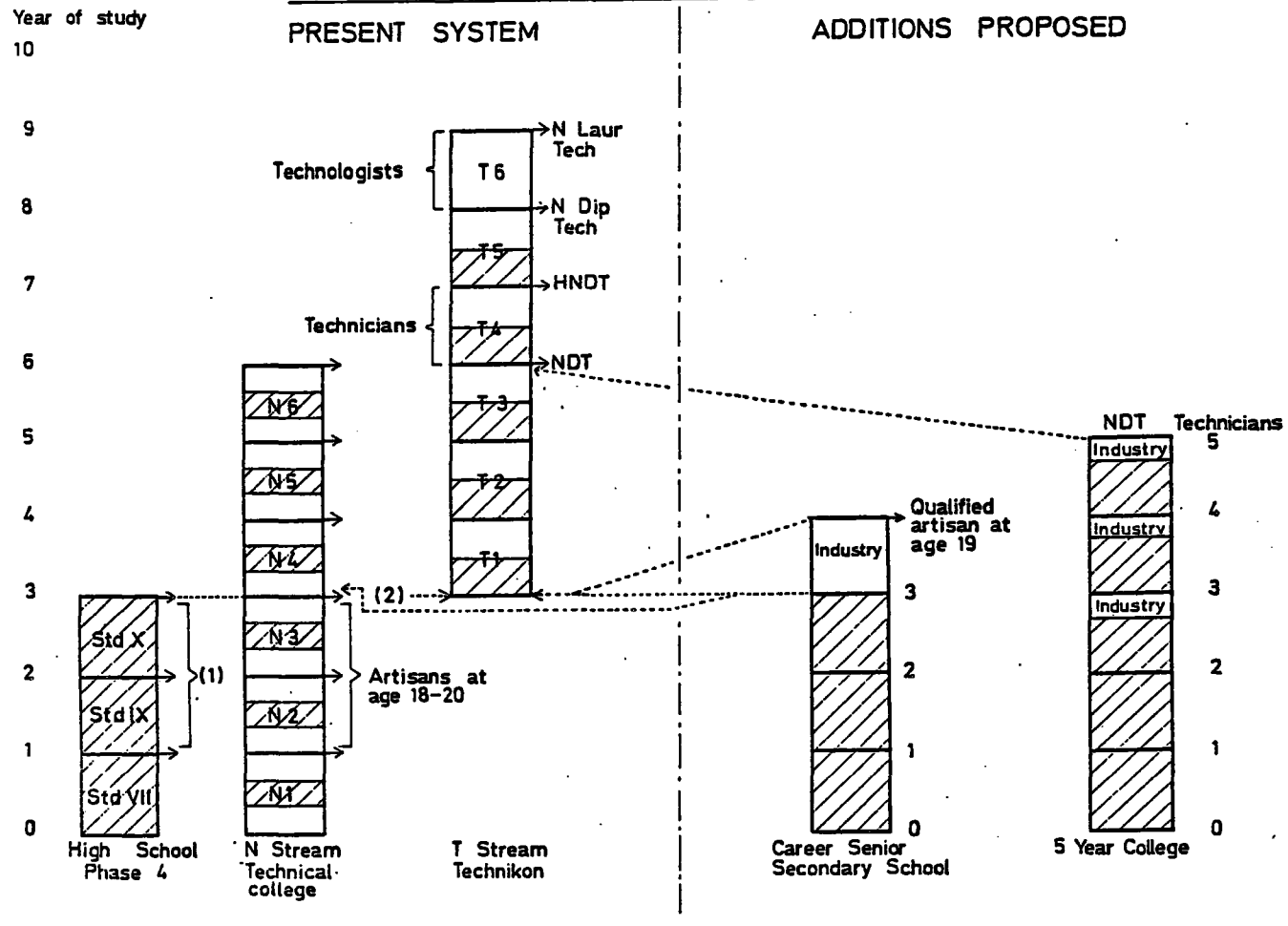


Fig. 2 Proposed Career Senior Secondary Schools and Five Year Colleges




Year of study
PRESENT SYSTEM
ADDITIONS PROPOSED
10
9
8
7
6
5
4
3
2
1
0
Technologists
Technicians
T 6
T 5
T 4
T 3
T 2
T 1
N Laur Tech
N Dip Tech
HNDT
NDT
N 6
N 5
N 4
N 3
N 2
N 1
Std X
Std IX
Std VII
(1)
(2)
Artisans at age 18–20
Industry
Qualified artisan at age 19
NDT Technicians
High School Phase 4
N Stream Technical college
T Stream Technikon
Career Senior Secondary School
5 Year College

MEMORANDUM 1

1. BASIC PROBLEMS RELATING TO TECHNICAL AND VOCATIONAL EDUCATION IN THE RSA

1.1 The South African educational system produces large numbers of persons who KNOW things but few who can PERFORM tasks. Vocation-oriented education means the training of persons in particular defined skills so that they can PERFORM tasks. These abilities should enable the person to market his skills profitably and to support himself and his dependents financially. The person should also derive satisfaction from his work and regard it as something that he ENJOYS DOING.

In the current system for the provision of education limited and unsatisfactory vocational education is offered at -

- technical high schools;
- technical colleges (apprenticeship and secretarial training);
- technikons;
- some private institutions (training programmes for employees);
- universities (on a very limited scale);
- in-service training courses, and
- special institutions such as nursing colleges, the Police College and Post Office College.

1.2 The aim of vocation-oriented education at schools, technical colleges, technikons and universities is not defined in terms of skills or tasks that can be performed, but rather in terms of knowledge transferred on the basis of a syllabus.

1.3 There is a severe shortage of both vocation-oriented institutions and vocational teachers.

1.4 The South African educational system does not produce the type of skilled manpower for which there is a demand. The school leaver usually cannot enter a particular occupation without having to undergo additional intensive schooling and orientation. Schoolleavers define

their abilities and career objectives in terms of where they are going to work (in a bank, at ISCOR, etc.) and not in terms of what they are going to do, what they want to or are able to do. (The closest definition might be:
"I am going to become an engine driver, motor mechanic, clerk, etc.")

1.5 The educational system for Blacks suffers from a serious lack of proper vocational guidance.

1.6 The current apprenticeship system based on practical experience in the work situation and theoretical training at a technical college is outdated and based on an artificial division of duties. Criticism indicates that the current technical test system does not meet the requirements, i.e. it evaluates the apprentice inefficiently in respect of the knowledge required to practise a particular trade.

2. BASIC REQUIREMENTS FOR EFFICIENT TECHNICAL AND VOCATIONAL TRAINING

2.1 Persons who have completed a vocation-oriented training programme should have the ability to perform certain tasks efficiently on the basis of skills acquired. These skills should be marketable and provide the basis of a livelihood in the widest sense of the word. Because the person should be happy in his occupation, it should be closely related to his expectations, abilities and interests.

2.2 Vocation-oriented education should be aimed at clear objectives defined as acquired skills complying with definitely established requirements. (It does not concern a particular job description but only the skills required.)

2.3 The particular skills acquired and mastered enable the pupil, on completion of his school career, to choose with confidence from a related series of occupations and job opportunities in the labour market.

Any additional specialized training that is needed can be undergone through in-service training in the work situation, at a particular educational institution or a combination of both.

2.4 Courses are structured and differentiated to adapt to

- the aptitude and ability of the pupil/student;
- the extent of the knowledge and skills to be transferred and acquired, and
- the length of the course.

2.5 All education is not necessarily vocation-oriented. Academic education, however, should be reserved for the intellectually highly gifted and all other education should be aimed at vocational training.

2.6 With a view to meaningful planning, the optimal utilization of manpower and effective vocational guidance and screening, it is essential that a thorough study be made of career opportunities in the RSA. Entrance requirements occupations for should be defined in terms of basic and specialized skills. Basic skills are those which make admission to a particular career field (i.e. a set of occupations) possible whereas specialized skills refer to the refinement of the spectrum of skills, required for a particular career. A sound system of education and training should make provision for both.

M. Wijnbeek
Pretoria
1981

MEMORANDUM 2

SUGGESTED METHODS OF GUIDANCE/SELECTION OF SCHOLARS AND STUDENTS IN THE EDUCATIONAL SYSTEM

In a developing country with limited resources the success of a new system of education will depend very strongly on matching human capabilities and skills to the needs of a rapidly expanding economy.

Up to the present, parental choice has been a dominant factor. Because education opportunities have been mainly in academic fields a tradition has developed according to which people tend to look down on other fields. This situation can only be changed effectively by changing the system in such a way that differentiation leads to positive results and not by enforcing strict selection procedures. The following mixture of strategies is suggested:

(i) Improving the quality and choices for career education at Std 8 - 10 level (technology, commerce, agriculture, nursing, etc.). This can best be done by joint efforts between the education system and industry, commerce, etc. leading to schools which are well equipped and staffed, and which meet the manpower needs of certain sectors.

(ii) A professional approach to career guidance by:

(a) training enough people in career guidance in South Africa,
(b) developing suitable psychometric tests,
(c) considering contracting guidance to organisations in the private sector,
(d) using the curriculum of the CJSS to enable students to follow "academic", general and vocational subjects in order to highlight their skills and natural aptitudes for themselves, their parents and the guidance teachers,
(e) an ongoing effort through the media (especially TV) to draw the attention of the children, parents and public to the opportunities offered by career education.

(iii) Differentiation can be promoted by suitable bursaries and job opportunities.

(iv) A strictly regimented selection system is not envisaged. It should rather be viewed as a passage leading to diverse outlets. All outlets will be open to students with broadly developed skills. As the skill distribution becomes narrower or shallower, some outlets are closed. The basic objective is always to match the skills and aptitudes of each person as closely as possible to the world of work to enable him/her to be a productive member of society.

(v) A selection system should work from university level downwards (see app. 1, 3.4.4.1).

(vi) Educational opportunities along a career ladder will prevent career education from being viewed as a field with educational ceilings.

APPENDIX 2

REPORT TO THE SUBCOMMITTEE ON TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING

1 INTRODUCTION

In October 1980 the Work Committee: Teaching of the natural sciences, Mathematics and technical subjects established a subcommittee on technical and vocational education and training and in November 1980 another subcommittee was established to design an educational model to meet the needs of science and technology. This led to a report to the model subcommittee entitled "The Design of an Effective Educational System for Science and Technology for South Africa"[1]), which supplies the background against which this report should be considered. It is recommended that this report be studied prior to reading the present one since the proposed structure forms the basis for this report.

It should be pointed out that the field of study covers a very large and complex area of education in South Africa. Technical and vocational education ranges from technical, commercial, administrative, agricultural to para-medical education. It straddles fields falling under the control of different educational authorities (provinces, DNE, Education and Training, etc.) as well as in-house training in industry and government departments etc. With the limited time and manpower available no claims are made to a comprehensive or exhaustive study of this field. The approach is rather to point out the neglect of vocational education and training in the past and to show that important modifications have to be made to the educational system to enable technical and vocational education to meet the developmental needs of a modern South Africa.

A target of 50 to 80 % of children in Standards 8 to 10 receiving vocational education in future is in line with the manpower needs of South Africa. This objective will however require considerable effort to achieve since the reigning academically oriented educational system will have to be modified and it is expected that vested interests in the present system may resist change. The severe shortage of well qualified teachers and instructors in this field is another restrictive

factor. It is, however, almost certain that if the crucial decision to develop vocational education at a very rapid rate in South Africa is not made very soon, the present system of education is going to perpetuate itself almost indefinitely because it will then dominate the present phase of rapid expansion of secondary and tertiary education. This will result in a fatal mismatch between the output of the educational system and the developmental needs of the country. Special attention is therefore given to a strategy of change which can channel resources from the present system of education, the government and the private sector to promote the development of high quality vocational schools. These schools will cover the whole vocational spectrum from technical, commercial to medical. Rapid and effective methods of training teachers for these schools will also have to be developed.

Because the active support from industry is crucial to the introduction of large-scale technical and vocational education, contact was made with industry and commerce in order to assess needs for skilled manpower.

Should the recommendations in this report be acceptable, a considerable effort will have to be made as soon as possible to produce a more detailed design of a system for technical and vocational education which could make optimum use of existing institutions, facilities and expertise both inside and outside the educational system. This will have to be undertaken in the closest possible collaboration with industry, commerce, etc.

Vocational education and training also encompass technical education and training as well as all the other vocational fields. This term will therefore be used in the rest of the report. A strong case will however be made out in 5.2.5 to use a new term "career education" in future since it carries a positive connotation compared to the negative ones which surround vocational education (see 5.1.3).

2 THE SHORTCOMINGS OF VOCATIONAL EDUCATION AND TRAINING IN SOUTH AFRICA

Owing to a lack of time and manpower, training for industry is used as

a "test" case to point out the major problems of vocational education. Similar problems, however, also occur in commerce, computer usage, agriculture, para-medical fields, etc.

2.1 THE COST OF TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING IN SOUTH AFRICA

In South Africa skilled workers are still trained mainly through the apprenticeship system. In most fields of technology it is no longer feasible for each apprentice to be taught by individual master craftsmen. Training is therefore becoming institutionalised in the industry itself. This implies that the apprentice, although receiving a salary, is not productive for the first three years of training, prior to the trade test. Table 1 shows that the cost of training under these conditions is rather high.

A similar situation exists for the so-called sandwich courses at technikons where the prospective technician alternates between a semester at the technikon and one of institutional training for a period of three years. At present this is the most effective way of training technicians since most have no experience in technology prior to entering the technikon.

TABLE 1: THE COST OF INSTITUTIONALISED TRAINING IN INDUSTRY

Artisan (3 years, technical college + institution)	R13 500[2)]
Artisan (3 years in institution)	R18 000[3)]
Technician (3 years in institution)	R19 500[3)]
Technician (4 years in institution, T4)	R24 000[3)]
Technologist (in institution)	R32 800[3)]
B.Sc. degree (3 years at university)	R16 000

The cost of training of artisans and technicians in institutions is therefore comparable with that of university education.

Since firms which train apprentices may easily lose up to 60 % to competitors after completion of training, the actual training cost per artisan retained is appreciably higher for the individual firm. In

practice, firms do receive tax rebates on training expenditure and in some cases assistance from training levies. This does not, however, change the training cost to the country.

In fields where the apprentice can be trained on the job with limited institutional training, the productivity of the apprentice offsets his salary, resulting in a lower training cost. Since most fields of technology tend to become more specialised and complicated the need for institutionalised training of skilled workers is expected to increase in future. Hence, the high cost of institutionalised training in South Africa bears closely on the expansion of training. However, it is possible to decrease the cost of this type of training (see 3.1) while still retaining its advantages.

2.2 THE SHORTAGE OF VOCATIONALLY TRAINED PEOPLE IN SOUTH AFRICA

It is generally acknowledged that the current expected future shortages in skilled manpower constitute a very severe restriction on economic growth and the development needed to draw large numbers of people into the economy. Table 4 indicates the estimated annual training needs for different categories of skilled manpower to maintain an average rate of growth of 4,5 % for the period 1979 to 1987. (Table 4, p. 117).

The implication is that about 23 000 new skilled workers and about 9 500 foremen should annually be added to the labour force. During 1978, 9 329[5)] artisans entered the labour force from the apprenticeship training, while about 2 000 technicians were trained. Obviously the shortfall is serious. Similar shortages prevail in the fields of nursing, commerce, civil service, etc.

2.3 THE EFFECTIVITY AND EFFICIENCY OF TECHNICAL VOCATIONAL EDUCATION AND TRAINING

The apprenticeship training for Whites has been rather wasteful in that only about 63 % of the apprentices of 1971 eventually became artisans[6)]. Although apprentices can do the trade test after three years of training, only an average of about 50 % pass. In some fields the pass rate can even be as low as 20 %. Those failing can reach artisan status by

virtue of lapse of time.

There are also indications that, although some trade tests are very good, some do not always cover the skills needed[7] in rapid changing situations.

South African universities have maintained a high standard for the training of engineers. However, only about half of the students entering these courses eventually qualify and those who do, take an average of more than five years to complete a four-year course. Insufficient numbers of engineers are trained to meet the needs of the country.

Although figures are not available, it is generally accepted that the drop-out at technikons is comparable with that of engineers at university. The rate of training is also too low.

This shows that the present system of education in South Africa has problems which have to be rectified at all technical levels. This also applies to other vocational fields.

PROPOSALS TO IMPROVE VOCATIONAL EDUCATION AND TRAINING IN SOUTH AFRICA

The general impression gained from recent discussions with industry is that the major shortage in technical manpower concerns the skilled worker (artisan) and to a lesser extent the technician. Although a shortage of engineers does exist in an absolute sense it is at present probably not as restrictive as shortages in the other two fields. At lower levels shortages of clerks, nurses, etc. also exist in fields where it may also be more restrictive than shortages at higher levels (for instance the closure of hospital wards due to a shortage of nurses, not doctors). This brings a crucial point to the fore. That is that an academically oriented system of education tends to train for the highest qualifications and does not produce a well balanced team to do the work. This situation has to be rectified if South Africa is to produce the effective mix of skills for development. In many fields skilled workers manage the work of semi-skilled people. A shortage of skilled workers will therefore restrict the rate at which semi-skilled people, of whom large numbers exist, can be drawn into the economy.

In Paragraph 2 the factors limiting the rate of training of artisans and technicians in the past have been identified as being:

(a) inadequate input into the training system,
(b) a high dropout during the training, and
(c) the high cost of training, which will become very restrictive when the rate of training increases.

These problems have, however, been mainly encountered in the education and training of Whites. Demographic projections show that many people from other groups will have to supply skilled manpower in future. Students from these groups will on the average have had less schooling than the Whites and will probably come from technologically less developed backgrounds. Hence, indications are that the training problems in the field of the skilled workers and technicians, computer programmers, clerks, nurses, etc. will probably become more severe and costly if a better system of education and training is not developed (see ref. 1: 2.1 and 3.3.1).

3.1 THE ESTABLISHMENT OF SENIOR SECONDARY VOCATIONAL SCHOOLS

These schools (or equivalent courses in comprehensive senior secondary schools) will provide vocational education in a wide variety of fields to selected scholars from Standards 8 - 10. Courses will be established in different fields of technology, agriculture, commerce, para-medical fields, etc. About 60 to 70 % of the teaching time will be used to develop the fundamental skills required to become a skilled worker in a given field. The rest of the time will be devoted to general formative education, a considerable improvement where the present apprentices receive no formal formative education. It is proposed that the three years of education at the vocational high school replace two years of institutional training of apprentices. After one year of on-the-job training, in which more specific job-related skills are developed, such a person could pass the trade test to become a skilled worker. This approach has the following advantages:

(i) Children with the right aptitudes and interests are channelled into vocational education and training, which will ensure pro-

ductive careers and a positive contribution to the development of the country.

(ii) The training cost of a skilled worker can be reduced as follows:

3 years at vocational school at a cost of R1 000 per annum	R3 000
1 year in institutional training	R4 500 - R6 000
	R7 500 - R9 000

(iii) The report to the model subcommittee pointed out that the only effective way of teaching science and mathematics to average children, who were caught up in a rapid transition from a more traditional to a technical culture, was to relate these subjects to concrete experience in technology in the field in which the child was specialising. This is borne out by experience in both Israel and Taiwan (see ref. 1: 2.1). The vocational school will therefore be more successful in teaching the science needed by technology than the present school system. It follows that it will be more effective in the training of skilled workers and technicians. The same applies to commerce, agriculture, nursing, para-medical fields, etc.

(iv) Children entering the vocational school at the age of 15 to 16 years are still at an impressionable age when they tend to model themselves on adults. They can therefore easily acquire the value system and work ethics needed in their field of specialisation from their teachers and instructors in the vocational school.

(v) Savings in training costs and improved horizontal mobility of students can be achieved if the underlying skills and knowledge common to different fields could be identified. Vocational education could then start at developing the underlying skills and differentiate at a later stage. This matter will have to be studied carefully in close collaboration with industry, commerce, etc.

(vi) The student who does well in a technical vocational school can proceed to tertiary education at a technikon or technical col-

lege. The student's extensive practical experience should enable him to complete the course in approximately two years instead of the present three years, thereby saving both time and money. Bridging into university courses in the field of specialisation is also possible.

3.2 THE ESTABLISHMENT OF THE SPECIAL COURSE TO EDUCATE AND TRAIN TECHNICIANS, TECHNICAL TEACHERS, ETC.

Although the purpose of the vocational school is primarily to produce skilled workers, experience in Israel[8] and Taiwan[9] shows that it is also a useful feeder institution for tertiary technical education. However, if a technician or teacher is trained in this way, he first has to change his value system to that of a skilled worker, which again has to be changed to that of middle management on becoming a technician or teacher. This can cause problems when children are crossing relatively large cultural gaps. The Taiwanese have solved this problem by instituting a five-year course for highly selected students after passing Standard 7 since 1965. The curriculum is so designed that the necessary practical, theoretical and general education is provided to turn out highly competent technicians, nurses, etc. after five years. At present this course trains more than half of the technicians in Taiwan, including the best. It is also very well suited to train people in the para-medical, agricultural and commercial fields because it relates science, mathematics and management to the concrete requirements of the field of specialisation. See Figures 1 and 3 of Appendix 1 for the place of the five-year course in the system of education.

By the addition of one or two years, the basic five-year training is very well suited to the training of technical and vocational teachers and instructors. The addition of science, technology and management to these courses practically guarantees that successful candidates modernise their culture. Teachers educated in this way are therefore well equipped to guide their pupils through the process of modernisation (see ref. 1: 3.4.4.3).

This type of institution has a very crucial role to play in the Southern African context. Academic Science and Mathematics taught by poorly

qualified teachers in many high schools develop wrong learning habits and value systems in prospective teachers. The five-year course, by preventing this, is probably the only effective way of breaking a vicious circle created by the strangehold that matriculation has so far exerted on our system of education. The same applies to the training of people in agriculture, para-medical fields, etc.

4 THE PERFORMANCE OF THE SENIOR SERCONDARY SCHOOL AND FIVE-YEAR COLLEGE IN PRACTICE

Like South Africa, Taiwan is a developing country that started out in 1948 with a poorly developed, predominantly academic school system and a weak economy after 50 years of colonial rule by Japan. By rapidly developing vocational high schools, tertiary technical education as well as high quality academic high schools and universities, Taiwan has succeeded in developing its human resources to such an extent that it is at present on the verge of becoming a developed country. This was achieved despite a shortage of natural resources and a current population density of 470 people/km^2. At present about 70 % of the children in Standards 8 to 10 follow vocational courses. Strict national entrance examinations are used to regulate entrance into tertiary educational institutions and drop-out is very low at this level.

The five-year college education, starting after Standard 7 with highly selected students, has been a resounding success since its inception in 1965. In 1979 it trained 8 000 technicians out of a total of 15 000 and 1 800 nurses out of 2 000[9]. More information on the Taiwanese system of education can be obtained from ref. 9.

In the fields such as nursing it is now systematically replacing the 3-year training at the vocational high school in Taiwan.

Table 2 compares the output of the South African and Taiwanese systems of education in technical fields.

TABLE 2: COMPARISON OF THE ANNUAL TECHNICAL AND VOCATIONAL TRAINING IN SOUTH AFRICA AND TAIWAN PER MILLION OF THE POPULATION

	SOUTH AFRICA		TAIWAN
	Total population	Whites	
Population	24×10^6	$4{,}4 \times 10^6$	17×10^6
Vocational Standard 10			2 430[10]
NTC 3	62[11]	215[11]	
SA Technical Standard 10	~ 250 - 300	~ 1 000[12]	
	~ 312 - 360	~ 1 215	
Technicians			
Diploma (1½ - 2 year technikon)	~ 42	229[13]	876[9]
Certificate (1 year)	~ 36	195[13]	
	78	424	
Engineers (4 years at university)	37[14]	195[14]	341[9]

Table 2 shows that Taiwan surpasses South Africa by far in all fields of technical training. The Taiwanese also surpass the output of the system of education for South African Whites in all technical fields. This substantiates the claim that the present academical type of general education practised in South Africa does not meet the needs of a country which is rapidly becoming more technologically oriented. Similar conclusions follow from a comparison between the South African and Israeli systems of education.[8]

5. PROPOSED STRATEGY FOR THE RAPID DEVELOPMENT OF VOCATIONAL EDUCATION AND TRAINING IN SOUTH AFRICA

5.1 PROBLEMS WHICH MAY RETARD DEVELOPMENT OF VOCATIONAL EDUCATION

5.1.1 The ad hoc approach to technical and vocational education

The tendency has been and still is to introduce technical and vocational education and training in a rather ad hoc way into education

and industry. Vocational education has therefore never become an integral part of a cost-effective system of education to develop the country and its peoples. A serious problem concerning the facilities for theoretical training of artisans was brought forward by industry. Although there are under-utilised facilities (technical colleges, technical institutes, technikons (T-courses)) in many areas, they are not in practice available to all apprentices. This even applies to small groups of highly selected apprentices from population groups that could not train as apprentices in the past. The institutions which should be able to supply this training are seriously understaffed and unable to cope. A rapid expansion of for instance technical colleges for Blacks does not appear to be a solution, since these will have similar staffing problems. Industries are trying to solve the problem in an ad hoc way by presenting their own courses under the auspices of the Technikon RSA. This has limitations since the T-courses are not offered as correspondence courses.

The solution to this problem appears to be to use existing facilities to capacity, to train sufficient teachers and instructors in the process, and to expand facilities in such a way that it is both economical and standards can be maintained.

The present lack of co-ordination can very easily lead to an over-extension of the limiting factor, that is the trained technical manpower, and a vicious circle may start again with poor teaching leading to poor training, low productivity and more poor teaching.

Any rapid expansion of vocational education requires it to become the most rapidly growing part of the general system of education. Rapid growth of this field requires the effective use of existing educational institutions such as universities, technikons, technical colleges and the existing technical high schools. The know-how and facilities of industry are also needed. This will require a new approach to educational policy and control of education in South Africa (see 5.2.1).

5.1.2 The predominance of "academic" values in education

This has led for instance to the development of the present technical

high schools which should have been schools training skilled workers. They should also act as feeder institutions to the technikons. They have, however, became hybrids, institutions between the academical high school and vocational high school, still mainly guided by the requirements of the JMB instead of the need of industry. According to Table 3 the percentage of children taking the available technical and commercial courses at high school, is, also low, especially in education for Blacks.

TABLE 3: PERCENTAGE OF CHILDREN TAKING TECHNICAL AND COMMERCIAL COURSES IN HIGH SCHOOLS

	Whites	Blacks
Technical	~ 11,0 %[15)]	~ 0,18 %
Commercial	~ 6,7 %	?

The same type of mismatch occurs in the para-medical field. Instead of gaining access into tertiary institutions by starting training in a vocational para-medical school, where the appropriate Science and Mathematics are taught, Standard 10 with academic Science and Mathematics is used as an entrance requirement to some fields in para-medical education. This creates artificial shortages in fields where there are more than enough candidates who could pass all relevant courses.

"Academic" requirements, which may not always be relevant to the work being done, can be used by professional bodies, which control the access to training or professions, to set up barriers which can create shortages in essential services in a developing country (also see 5.2.4).

5.1.3 The traditional low status of vocational and technical education

It has been the practice in the past to provide vocational education mainly to destitute, handicapped or delinquent children. A concerted action will be needed to establish high quality vocational educational institutions leading to satisfying careers for people from all population groups, before this negative association will disappear (see 5.2.5).

5.1.4 Lack of consciousness of cultural modernisation

The school system has tended to copy Western academic systems and has not given sufficient attention to ways and means of modernising more traditional cultures. Practically no curricula or teaching methods have been developed for this purpose.

5.1.5 The present unco-ordinated expansion of education and training in South Africa

The rapid population increase in South Africa is going to require large increases in facilities for secondary and tertiary education in the near future. When the shortcomings of the existing systems of education are taken into account it is very difficult to see how the needs for skilled manpower are to be met and how reasonable standards are going to be maintained. The shortage of adequately trained people coming from the educational system is also forcing industry to install their own expensive training facilities rapidly. If these developments continue unco-ordinated for some time it will be extremely difficult to change and rationalise the system at a later stage. The present growing phase needs co-ordination on a national level as soon as possible so that it can be guided away from obvious pitfalls (see 5.2.1).

5.2 THE STRATEGY PROPOSED FOR THE RAPID DEVELOPMENT OF VOCATIONAL EDUCATION IN SOUTH AFRICA

5.2.1 The establishment of a general educational policy and a central policy-making and controlling body of all education in the RSA

Considerations advanced so far show that the rapid and economic development of vocational education will only be possible if the development of education is well co-ordinated in future. This requires a central education body with the following functions:

(i) It should determine the general educational objectives at all levels of education for all communities in the RSA,

(ii) obtain resources from the Central Government for education and

allocate these resources effectively,

(iii) accredit organisations that supply education and colloborate with other organisations in the accreditation of vocational schools, etc. (see 5.2.2),

(iv) establish procedures for the accreditation of curricula and the maintenance of acceptable standards of educational qualifications,

(v) establish representative national and regional advisory bodies on education and training (this can be done in collaboration with other government departments, organised industry, communities, etc.),

(vi) monitor the cost-effectiveness of education, and

(vii) support research and development research and development in the field of education and training in South Africa.

This implies that schools and other educational institutions will be run by the accredited organisations. It is suggested that these organisations supply their services on a contractual basis to the communities they serve. In time this will enable parents and communities to have a choice of the services of different accredited organisations. This arrangement will prevent bureaucratic educational organisations from disregarding the interests and wishes of the communities they serve. It will also enable communities to play an active and responsible part in the establishment and running of educational institutions. This approach would become even more viable in future if groups of parents and/or communities could actually own their school buildings.

For vocational education this approach has the following advantages: It makes it possible to reach and implement a national decision to develop vocational education for all population groups. It also makes it possible to co-ordinate the activities of all the existing educational institutions to promote vocational education. On the other hand, the decentralisation of the control of schools, etc. makes it

possible to draw in active support from industry, commerce and communities for education at all levels (see 5.2.3). It will also be possible to co-ordinate education at a regional level to promote regional development and to look after the needs of more isolated communities by planning the distribution of specialised schools and by supplying hostel accommodation where needed.

5.2.2 Accreditation of vocational schools by industry and commerce

The existing technical high schools, for instance, represent a considerable investment in equipment and teachers. They could play a much more useful role if they could assume the role of technical vocational high schools and provide the training to meet the needs of industry. In practice this can only be achieved if the curriculum, training objectives and evaluation at these schools meet and continue to meet the needs of industry. It also requires that teachers and instructors should have the appropriate skills and knowledge to meet the needs of industry. This objective can be achieved by establishing, in close collaboration with industry, a body which can accredit each technical vocational high school. Such an arrangement will make it possible for graduates from vocational high schools to become skilled workers one year after leaving school (see 3.1).

Similar arrangements can be considered for commercial, para-medical and agriculture vocational schools, as well as for technical colleges, technical institutes and technikons.

5.2.3 The establishment of subsidised private educational organisations to provide vocational education

The healthy and cost-effective development of vocational education will only be possible if the main part of the very expensive institutional education of skilled workers takes place in the secondary school system. It also requires that the school system should be capable of expanding rapidly enough in this field to meet the needs of industry. There is little doubt that this approach could in the long run solve the shortage of skilled workers and that it will also contribute to an increase on the number of technicians owing to better preparatory education and training.

The crucial problem, however, is to find sufficient teachers and instructors to man newly established schools in order to assure industry that they can depend on the output of these schools and that they need not expand their very expensive institutionalised training of skilled workers. The obvious solution to this problem is to persuade industry to allocate, on a temporary basis, a part of the resources earmarked for institutionalised training to these vocational schools. This especially applies to instructors and equipment.

The most practical solution appears to be the establishment of a private educational organisation(s) on the same general lines as for instance ORT-Israel. The purpose of this body would be to funnel the contributions from industry to establish "model" vocational schools in different communities who want these schools. These schools would be planned to meet the most urgent needs of industry for skilled manpower. This organisation would also establish courses for the education and training of technicians, and especially teachers, making use of the equipment and expertise of the vocational schools whenever possible (see 3.1 and 3.2). The vocational high schools should receive an adequate subsidy† from the central educational body and be fully accredited. The controlling body of the private organisation should be representative of the different communities in South Africa so that it can serve all communities.

The advantages of this approach are as follows:

(i) Private educational organisations can be small and compact and goal-oriented and are probably in a better position to undertake the necessary innovation in vocational education and training in the multicultural South African situation than large bureaucratic organisations.

(ii) It is a simple matter for a private organisation to enter into contractual agreements with communities, industries and governments and since it has to receive support from all these bodies,

† ORT-schools in Israel are subsidised to an extent of ~90 %[8)]

it will be forced to meet its obligations.

(iii) The establishment of a private vocational education body would serve a major function in channelling resources from the private sector into an area where it can be of maximum benefit to the country and all communities. This will create a natural focal point for the existing privately funded organisations which are interested in promoting education and training as well as for the newly mooted Manpower Foundation.

(iv) Such an organisation will very rapidly take over the considerable expertise available on training from the South African industry and will also build up its own expertise on education and training in different communities. It could also benefit from curricula developed in other countries such as Israel and Taiwan, especially in the teaching of science and mathematics in vocational schools. This will enable it to offer invaluable educational services to other countries in Southern Africa. This could act as a general catalyst for development in the subcontinent.

(v) The organisation can establish educational institutions which can be pacesetters to other organisations in the same field. The same applies to the training of teachers.

(vi) Because one of the main objectives of this organisation is to meet manpower needs, and since industry will be very closely involved in establishing vocational schools, industry will probably collaborate by not trying to draw teachers away from these schools. This can be done in diverse positive ways.

5.2.4 Improving the quality of academic education and balancing its output

The writer is conscious of the fact that the training of high quality academics is essential for the development of South Africa. It is however doubtful if the present academically oriented system of education is meeting these requirements. The major problem appears to be that the present system draws children, who do not have sufficient academic

aptitudes, into the academical training system. This leads to a high dropout rate in tertiary education, a possible lowering of standards, and insufficient attention being given to children and students with academic aptitude. It is therefore proposed that the subsidy formula of all tertiary training institutions be based on the numbers of qualified people leaving the institution, instead of the number attending the institution as is the case at present (see ref. 1: 3.4.4.1). Exit standards can be safeguarded by universities, etc., collectively monitoring these in collaboration with professional bodies and organisations of employers. To be fair to people who may have had inferior schooling, a bridging year at university or technikon should be subsidised for those who show the necessary aptitudes but who do not quite meet the entrance requirements.

Such an approach also makes it possible for the central education body to set training quotas for fields in which there is an over-production of trained people.

The advantages of this would be the following:

(i) It will prevent the universities and technikons from being clogged up by students with insufficient aptitude and motivation to the detriment of those who really benefit from this type of education. This will eventually lead to an appreciable reduction in training cost per graduate.

(ii) It will make it natural for senior secondary high schools to differentiate their courses in such a way that the children can either continue education at a tertiary level or enter a worthwhile career.

(iii) It will also induce tertiary educational institutions to help to improve the quality of education of their feeder institutions which should improve the output of the universities and technikons appreciably.

5.2.5 Replace the concept 'vocational education' by 'career education'

As shown in 5.1.3, there are negative connotations associated with the term "vocational education". These are absent from the term as used in this document since the vocational high school really is the first step to a career, with opportunities for continuing education as the person advances along his chosen career. Introduction of the term "career education" instead of vocational education may help to solve this problem.

5.2.6 Publicise the advantages of career education

A decision to promote career education should be supported by positive publicity in the press, radio and TV to interest the children, parents and communities. Care should, however, be taken to establish suitable vocational schools to which children can go at the same time.

5.3 ADDITIONAL ISSUES WHICH SHOULD RECEIVE ATTENTION IN FUTURE

Once a new system of control is established for education, the following aspects should receive urgent attention:

5.3.1 Efficient use of the junior secondary school or phase (Standards 5 - 7)

The purpose of this phase is not only to complete the stage of general education, but to prepare the child to realise its own capabilities in order to make a meaningful choice in a differentiated senior secondary school system. Scholars should at least take one vocational subject at this level as well as a fully academic one to orient themselves.

In order to really fulfil its function, this should preferably be a separate school. If Standards 6 and 7 are part of a general high school, as is normal at present the situation, one has the following disadvantages:

(i) Scholars are induced to continue their studies at the high school irrespective of the differentiation available. That is why so many children end up with a general matric.

(ii) All junior high schools strive to become senior high schools and do not concentrate on their unique mission (also see app. 1: 3.4.2).

5.3.2 Developing skills at all levels of education

This concept, proposed to the Model subcommittee (ref. 1: 3.3.2.1) is strongly supported, because it gives a more sensible evaluation of the educational process than the evaluation of knowledge alone can give.

It is also recommended that the development of the manual skills needed by modern industrial society such as the use of tools, special materials, the operation of simple machines becomes an integral part of primary and pre-primary education.

5.3.3 Introducing technology into the academic high school

Technology should be introduced into academic education in such a way that all students, irrespective of their field of interest, should develop an insight into the role of technology in a modern man-made environment.

5.3.4 Balancing the interest of professional organisations

There exists a real danger that professionally registered bodies may so distort entrance and acceptance qualifications in their fields as to create artificial shortages. It can also prevent the natural development of the less advanced communities in a country like South Africa. In South Africa a general tendency has developed for all groups to seek professional registration to share in the advantages accrueing to registered groups.

It is therefore essential that the influence of such bodies should be strongly counterbalanced in education, as well as in the field of work reservation for professions.

.3.5 Changes to the apprenticeship system and removal of ceilings for skilled workers

The apprenticeship system is rapidly becoming outdated and is being replaced more and more by institutionalised training. Rapid technological change calls for in-career training of skilled workers, technicians, etc. Skilled workers should also be able to obtain training during their careers in order to become masters of wider technical fields with the addition of management skills. These developments should be studied carefully since they will, in turn, determine the fundamental education of a skilled worker. These tendencies also have to be built into labour legislation and the value system of trade unions for effective reallocations of labour to more productive employment as technology changes and/or certain resources diminish.

5.3.6 Teacher training

It is crucial that teachers who are trained for vocational schools, for vocational subjects in the junior secondary schools as well as for technology in the primary and academic high schools, should really understand the role of modern technology. It is also essential that science, technology and management become part of their culture. This will only be the case if the people training the teachers realise this fully and are capable of transferring this to the teacher in training. Considerable care should therefore be taken in the selection of appropriate teachers, curricula and environment for the training of teachers for vocational schools.

Although preference is given to the five-year courses in which large cultural transitions take place (see 3.2), technikons, technical colleges, universities could make very valuable and essential contributions. It is suggested that as far as vocational high schools, etc. are concerned, industry, commerce, etc. also play an important role in accreditation of teacher training institutions.

5.3.7 Manpower planning

Although there is little danger of overproduction of skilled manpower

in the initial stages of establishing vocational (career) high schools, the rapid expansion of these schools will require effective manpower planning for the whole country. A suitable computer simulation of manpower supply and demand, taking the existing and planned educational facilities into account, will be very useful for determining the future consequences of decisions.

The world is at present entering a "knowledge revolution" and rapid changes are to be expected in many fields. Since education has for such a long time remained constant very careful assessment of the future is essential for educational planning.

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Stellenbosch
1981

TABLE 4: TOTAL ESTIMATED TRAINING REQUIREMENTS (Initial plus development training) BY OCCUPATIONAL CATEGORY (1979-1987)

ORIGIN OF TRAINING NEED / OCCUPATION CATEGORY	TO ACCOMMODATE EMPLOYMENT GROWTH	ADJUSTMENTS FOR WASTAGE	ADJUSTMENTS FOR OCCUPATIONAL SHIFTS	ADJUSTMENTS TO PROMOTE PRODUCTIVITY IMPROVEMENT*	TOTAL DEMAND
Professional employees	284 614	112 295	103 616	1 295 218	1 795 743
Management	56 069	31 858	29 392	367 453	484 772
Office, clerical and sales employees	318 536	189 146	174 528	-	682 210
Foremen and supervisors	41 812	17 581	16 224	202 782	278 399
Skilled employees	56 951	66 791	61 632	385 186	570 560
Semi-skilled employees	432 774	368 909	340 400	-	1 142 083
TOTAL DEMAND	1 190 756	786 580	725 792	2 250 639	4 953 767

* Estimates are based on the mean employment level for the period 1979 - 1987

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14. Information supplied by the Scientific Advisor to the Prime Minister.

15. For Whites in Transvaal - private communication.

16. Private communication by M.J. Wijnbeek.

APPENDIX 3

Firms and persons to whom Appendixes 1 and 2 were sent for comment.

	FIRM/PERSON	COMMENT RECEIVED
1.	Mr J.A. Vorster, BIFSA	
2.	Mr J.H.D. Grotsius, SEIFSA	Yes
3.	Mr C. du Toit, Anglo American Corp.	Yes
4.	Dr J.H. van Huysteen, MIF	
5.	Mr R.G. le Roux, Huletts	
6.	Mr G. Steyn, Goldfields	Yes
7.	Mr S. Slagman, Textile Federation	
8.	Mr S.C.L. McGee, Armscor	Yes
9.	Mr A.P. van Wyk, Lion Match Corp.	
10.	Mr D.W. de Beer, General Mining Corp.	Yes
11.	Mr R.G. Stakianos, Civil Engineering Industry	Yes
12.	Mr Lombaard, Afrikaans Handelsinstituut	
13.	Prof. F.P. Retief, MEDUNSA	
14.	Dr H. Dryer, Dept. of Post and Telecommunications	
15.	Dr J. van Zyl, Federated Chamber of Commence	Yes
16.	Dr R.E. Robinson, Sentrachem	
17.	Mr M. Rosholt, Barlow Rand	Yes
18.	Mr D.A.J. Jacobs, Siemens	Yes
19.	Mr T.A. Conradie, Sasol	
20.	Mr. C. Saunders, Tongaat Group Ltd.	Yes
21.	Dr N. Statterheim, Noristan	
22.	Mr C. van der Pol, Hulletts	Yes
23.	Dr W. Backer, Timber Industry Manpower Services	
24.	Mr P.J. du Toit, UKOR	Yes
25.	Mr C.J.M. Prinsloo, ISCOR	Yes
26.	Mr R. Goss, SA Breweries	
27.	Dr van den Horst, Old Mutual	
28.	Mr L.A.O. Barth, Stellenbosch Boerewynmakery en Groep	Yes
29.	Mr J.D. Kritzinger, Transvaalse Suikerkorporasie	Yes
30.	Mr S.A.G. Anderson, AECI	Yes