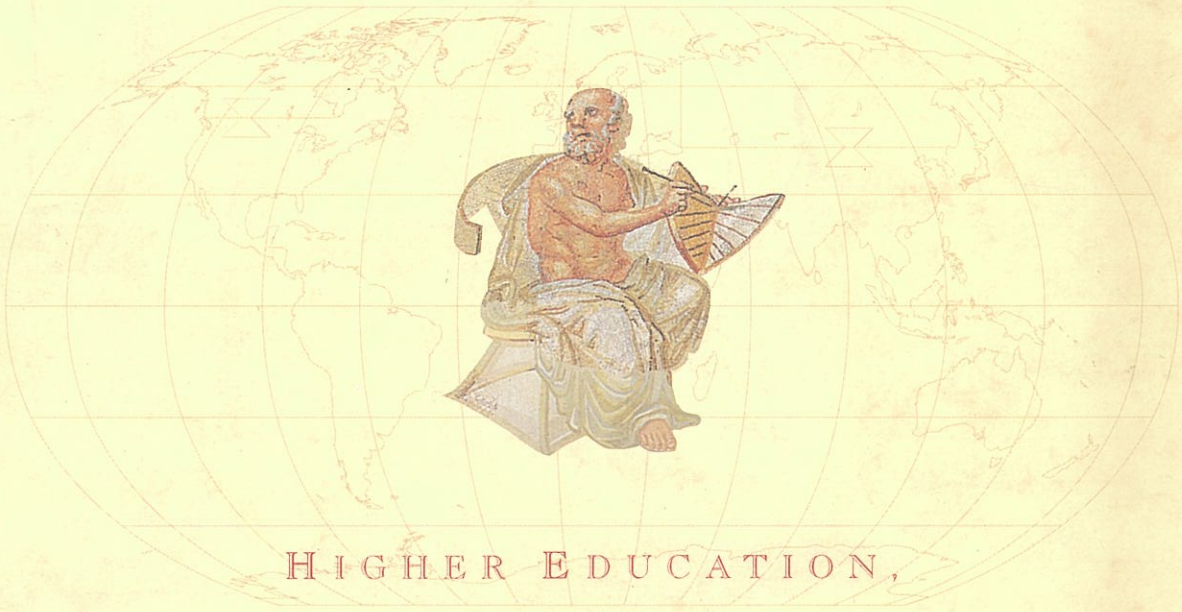
TÜSİAD

TURKISH INDUSTRIALISTS' AND BUSINESSMEN'S ASSOCIATION



HIGHER EDUCATION, SCIENCE AND TECHNOLOGY IN TURKEY AND IN THE WORLD

(Executive Summary)

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FOREWORD

TÜSİAD stands for "Türk Sanayicileri ve İşadamları Derneği" ("The Turkish Industrialist' and Businessmen's Association") which was founded in 1971 by a group of leading names in Turkish industry and business. TÜSİAD is an independent, non-profit institution whose primary purpose is to promote public welfare. TÜSİAD is scientific and objective in its researches. It is emphasised that this study does not necessarily reflect the views of the TÜSİAD members nor, of course, is it to be considered in any way whatever to be an official publication.

This book is the executive summary of the report titled "Higher Education, Science and Technology in Turkey and in the World", which was published by TÜSİAD in June, 1994.

TÜSİAD thanks to the authors, Prof. Dr. Kemal Gürüz, Prof. Dr. Erdoğan Şuhubi, Prof. Dr. Dr. h.c. A.M. Celal Şengör, Prof. Dr. Rüştü Kazım Türker and Prof. Dr. Ersin Yurtsever.

FOREWORD BY THE AUTHORS

The following is the English translation of the executive summary of a 341 page report containing five chapters in which the history and present structures of higher education, science and technology are analyzed in Turkey and in the world. Data are provided on related statistics in Turkey and on international comparisons in the form of 50 figures and 46 tables. The final chapter contains detailed proposals on the governance and financing of higher education and the measures needed to alleviate the demographic pressure on institutions of higher education with a view to reconciling quantity with the quality level required by an internationally competitive economy.

The report treats higher education, science and technology as parts of an indivisible entity which must be considered as essential constituent elements of the country's general economic polices. The final chapter, therefore, also includes detailed policy recommendations and proposals for an institutional structure required to implement such policies in the fields of higher education, science and technology.

The report contains 329 references and includes a table on the chronology of scientific and technological developments as well as the progress of institutions of higher education throughout history to enable readers to comprehend the evolution of the intertwined relationship among the three areas.

The underlying principle adopted at the very beginning of the preparation of this report must also be pointed out: when resources are scarce, choices have to be made and priorities established. Thus resources must be preferentially allocated to those institutions and areas where relatively quick results can be obtained, rather than spreading them thinly; efficient structure must be created to dispense such funds; revenue sources must be diversified and efficient structures must exist to manage such resources; and traditions must be challenged, all within a policy framework. It was always born in mind that the ultimate aim of all endeavours in higher education, science ad technology is to contribute, by generating value-added, to the the health, happiness and prosperity of the people, the taxes paid by whom constitute the major source of finance for such activities.

The authors finally wish to state their modest aim that this report will serve as a starting point for a much more productive public debate than has the

case been so far, eventually resulting in action at the political level. We also hope that the report will serve to carry the debate to a higher intellectual level, for up to now it has been dominated by subjective, pre-conceived and prejudicial slogans . As we challenge such shallow sloganeering, conventional views and established traditions, we invite the academic to challenge our views and the concerned lay community to participate in this debate.The generous and continued support provided by TÜSİAD and the very pleasant rapport that came into being between the authors and TÜSİAD representatives are gratefully acknowledged.

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EXECUTIVE SUMMARY

Mankind has reached an era that is called an Information Society by some or a Post Industrial Society by others, where knowledge has become one of the most important inputs and technology is defined as " a store of knowledge that transforms the basic inputs of industry such as raw material, energy, and information into goods and services". In other words, science, technology and well trained human resources figure among the main production factors. In this respect, higher education has an importance in itself as universities are the source of high level manpower as well as focal points for the development of new ideas. Therefore, examining the higher education system of country independently of its science and technology systems would lead to incomplete and sometimes even misleading conclusions.

In this study both the higher education system and the scientific and technological structure of Turkey have been examined within this framework and it has been established that presently all the relevant institutions are totally devoid of the qualities needed to lead the country towards the Information Society. In this report the higher education, science and technology structures of developed countries have been comparatively examined in order to formulate the policies and define the structure needed to fulfil the needs of Turkey in the near future.

The roots of higher education in the west go back to European universities in the Middle Ages. In Turkey, universities were not a development of the traditional Islamic higher education institutions, the Madrasas, but were copied from the west without any conscious effort to adapt and absorb them within our society. Understanding the development of universities in the west and in Turkey within their historical framework and determining their starting conditions will play an important role in the selection of an evolutionary model for Turkish universities. Only with such an approach will it be possible to diagnose the problems facing higher education in Turkey and devise correct and realistic measures to solve them. The historical development of higher education, science, and technology in the west has therefore been carefully analysed in this report.

The statistics on students and academic staff in the Turkish higher education system are published annually by the Student Selection and Placement Center (ÖSYM). There are presently 57 universities in Turkey of which 53 are operational and 5 are private. Statistical figures on students in higher education in the 1992-

1993 academic year are as follows:

A. UNIVERSITIES

Formal (full-time) Education:	
Faculties	390,114
4- Year higher schools	15,004
2- Year vocational schools	84,040
Night Courses with Fees	
Bachelor degree programs	7,551
2- Year programs (pre-bachelor)	3,989
Open Education (Distance Teaching):	
Bachelor degree programs	43,454
2- Year programs	303,691
Graduate-level programs	
Master's degree	33,463
Doctore degree	13,764
Art programs	223
Medical specialization	4,664

B OTHER HIGHER EDUCATION INSTITUTIONS

2- Year programs	1,474
Bachelor degree programs	9,190
Graduate-level programs	4,226
Total	914,847

In 1991-1992 the number of graduates with pre-bachelor and bachelor (2-year programs) degrees was 85,146, those with masters degrees numbered 4,318, and those with doctorates 1351; 795 specialized medical students graduated that same year.

As of 1992-1993 the total number of teaching staff in the universities was 37,580 of which 12,418 were professors, associate professors, and assistant professors and the rest instructors and research assistants. The teaching staff in other higher education institutions affiliated to the armed and security forces and health services was 903.

The two main bottlenecks in the Turkish university system are the following:

. The demographic pressure exerted by the young population and the lack of qualified teaching staff;

. The scarcity of resources as well as the cumbersome budgetary and decision making processes hindering the effective and efficient utilization of the existing resources.

The reasons which are creating these bottlenecks and their possible solutions are summarized below. It is important to compare certain statistical indicators on education in general and higher education in particular in Turkey for this purpose.

. Turkey is one of the few countries where compulsory and free primary education is only 5 years. The rate of children who do not continue after the 5th grade is 48.8% and the average period of schooling of the population older than 25 years is 3.5 years. This period is 12.3 years in the USA and 1.9 years in Pakistan.

. The existing formal (full-time) educational facilities are only able to serve one third of high school graduates. The gross enrolment ratio in higher education is 17.3% of which 10.1% are in formal higher education institutions. This ratio is 75% in the USA and 2% in China.

. The share of open education (distance teaching) in the Turkish higher education system in 42%. Turkey is second after Thailand where this ratio is 50%, and is followed by Jordan (39%). China (30%) and Namibia (23%).

The share of short-term vocational and technical training (2-year vocational schools) in the Turkish higher education system is 10%. This ratio exceeds 30% in many advanced countries, being 66% in Australia, 63% in Singapore, 44% in Japan and 37% in the USA.

. The number of students per teacher in the formal part of the higher education system is 24. Turkey is second behind Thailand which has a ratio of 29 students per teacher.

The share of private institutions withing the Turkish education system in general is 1.43%, and below 1% in higher education. This ratio is 81% in Japan, 74% in

Korea, 60% in India, 26% in the USA and 10% in Switzerland.The share of student contributions towards various student services is 1% of the total revenue of the higher education system in Turkey. This contribution should not be confused with tuition fees, which account for 26% of the total revenue of higher education system in Chile, 25% in Indonesia, 23% in Korea, 20% in Spain and Israel, 15% in the USA and the Philippines, 9% in Japan and Taiwan and 5% in India.

The total revenue of our universities from non-budgetary sources such as fees for services (revolving funds) and other sources is 19%. It is clear that the Turkish higher education system is essentially financed by public funds provided within the state budget.

The total education budget of Turkey for 1993 was 74.2 trillion TL of which 16.7 trillions were allocated to higher education. The share of higher education amounts to 4% of the consolidated budget, 22.5% of the overall education budget and 0.90% of the GNP. Considering the higher education budget and the number of formal education students only, the expenditure per student in 1993 was $ 2,776. This drops to $ 1,704 per student when the non-formal education (open education) students are included. This sum varies between $ 3,578 and $ 11,832 in developed countries. We believe that this comparison would be much more realistic if it were done on the basis of the budget figures and average exchange rate of 1994.

In summary, the share of higher education expenditure within the total public education budget of Turkey is similar in magnitude to that in developed countries. The share of higher education expenditure within the GNP, however, has only started to catch up in 1990 with that in developed countries. It can thus be concluded that the Turkish higher education system should get a bigger share of public funds, solely to make up for the past deficit.

On the other hand, the ratio of public expenditure per student to the per capita income is between 0.62 and 0.69 in Turkey. This ratio is 3.5 in Malaysia, 3.3 in China, 2.3 in India, 1.2 in Finland and 0.7 in the Netherlands. Thus we see that public funds available in Turkey for higher education are relatively less than those spent by countries with a similarly young population profile such as Malaysia, China, and India.

Funds devoted to research are quite limited in Turkey. The total budget allo-

cated for research in all universities was only $ 56 million in 1993 and serious research was carried out in only 4 or 5 universities.

The negotiated, incremental, line-item budgeting system used for higher education in Turkey is considered in the literature as the least efficient system of all.

All legal measures taken since 1933 have only served to perpetuate a "populist-democratic", rather than a meritocratic structure dominating the decision making processes, and a tacit mentality targeting "equality" among institutions and individuals without any concern for quality.

The Turkish higher education system is thus squeezed between the state bureaucracy on the one hand and academic oligarchy on the other.

It is necessary to critically examine the conditions peresently prevailing in the system in order to propose solutions to correct it.

The present structure of the Turkish higher education system has been summarized above in terms of certain quantifiable indicators. It is, however, also necessary to examine the mentality and the attitudes of the individuals, partaking in the system in order to realistically evaluate its starting point.

The roots of modern higher education in Turkey go back to the foundation of the Imperial Naval Engineers' School in 1773, later transformed into the Istanbul Technical University. A modern university system aiming at generating knowledge as well as teaching, however, was started only in 1933 by the transformation of Darülfünun into Istanbul University.

Since then, our academics with few exceptions, have focused on the transmission of existing knowledge and promotion on the basis of seniority, rather than by contributing to the generation of new knowledge and reflecting the latest scientific advances to teaching.

The Higher Education Law (number 2547) enacted in 1981, contrary to the goals it was meant to achieve, has only resulted in further extension of this mentality.

It is therefore imperative to adopt, before the onset of the 21st century, a scientific and technological policy framework, within which those of our universities which possess the adequate experience and manpower qualifications will be transformed into institutions able to generate universal knowledge and to train a cadre constituting highly creative human resource base required by the Information Society. Thus these institutions will enable our country to become a respected and outstand-

ing member of the international community and contribute to its competitiveness in the international markets.

Some of our universities have yet to reach the standards of the average western universities. It is therefore necessary to require exactly the same academic qualifications as those required of average teaching staff in the advanced countries.

In other words when evaluating institutions and academic staff, universal criteria should be used, and no allowance should be made for the conditions specific to our country.

Unless the basic feature of the system is so specified as an indispensable precondition, it will not be possible to achieve the desired goals.

A summary of the quantifiable standards that must be targeted for some of our universities to be designated as elite education and research universities is as follows:

. The student/teacher ratio should be decreased to 15 which is half of the present national average.

. The ratio of graduate students to the total number of students should increase to 50%.

. The annual expenditure per student should be nearly tripled to reach 9.00 $ at constant prices.

. The annual research budget of such a university should be gradually increased to $ 15 million at constant prices.

The number of scientists and scholars of international standards in our universities, though not negligible, is still well behind that in developed countries. It is therefore necessary to create incentives for academic staff with such qualifications to be concentrated in selected universities in order to create centers of expertise with the requisite critical mass of manpower.

The main function of the remaining universities, to be designated as mass education universities, should be to train medium-level manpower with the capabilities to apply the generated knowledge.

The solution to mass education should be sought in the 2- and 4- year vocational and higher schools subsector, where advanced educational technologies should be efficently used to supplement formal full-time education so that the demographic pressure exerted by our increasingly young population on our universities can be alleviated.

Below are figures pertaining to the Turkish higher education system as a whole that must be reached within the next decade so as to be able to catch up with the developed countries:

		1993	2003
Overall enrolment ratio into higher education ,	%	17	25
Share of open education,	%	42	20
Share of 2-year vocational schools,	%	10	30
Share of 4-year higher schools,	%	2	10
Share of faculties,	%	46	40

In other words, formal education should be emphasized and priority given to 2- and 4- year vocational and higher schools in order to cater to the growing demand for education.

In 1992 the population of the higher education age cohort was 4,850,000. Taking into consideration the mean annual population increase rate of 2%, this figure is expected to reach 6,000,000 in 10 years. In view of the overall targets summarized above, the profile of the Turkish higher education system after ten years should be as follows:

	1993	2003
Total number of students	836,303	1,500,000
Open education students	347,145	300,000
2-year vocational schools students	84,040	450,000
4-year higher schools students	15,004	150,000
Students in faculties	390,114	600,000

Two other important points to be considered are the number of students per teacher as well as the distribution of students according to fields of study. The overall figures should be as follows:

	1993	2003
Bachelor level student/teacher ratio	33	22
Overall student/teacher ratio	24	18

The figures of academic staff (professors, associate professor and assistant professors) and other teaching staff (instructors) within the decade should therefore be as follows:

	1993	**2003**
Academic staff	12.481	27.300
Other teaching staff	8.317	39.400
Total	20.978	66.700

According to these targets, during the next decade Turkey has to train nearly 50,000 academics of which 20,.000 will hold a doctoral degree, when one also takes into account the demand that is envisaged to come from the industry for manpower with doctoral degrees.

The total number of doctoral graduates in 1993 was 1,351. At first sight this figure seems adequate for the academic staff requirements of the next decade. Taking into consideration the fact that industry will have to employ some of these graduates in order to increase its competitiveness, it will be necessary to increase their number. ***The most important goal, however, will be to bring the quality of these graduates to an international level.***

Some of the academic staff should be trained abroad in subjects like new and advanced technologies, new fields in basic science that form the basis of such technologies, management, economics and some fields of teacher training within the framework of a determined planning policy. It would, however, not be realistic and useful to rely only on foreign sources without taking any action in Turkey.

It is thus evident that Turkey must designate some of her universities as elite education and research universities, not only to increase its capacity to create new knowledge, but also in order to train the academic staff needed to satisfy the growing demographic pressure on the university system.

The basic principles recommended to solve the existing problems and reach the above mentioned targets are summarized below:

. The higher education institutions should be separated into two groups, one providing mass education and the other focusing on elite education and research.

. The establishment of a meritocratic university structure where outstanding academic staff, who indeed deserve the title "scholar and scientist" on account of their scientific publications at the international level and their contributions to teaching, will have more to say in the decision-making processes.

. The inclusion of prominent lay citizens with outstanding accomplishments in the fields of science, culture, art, industry, finance and trade within the management of the academic system and its institutions (lay governance).

. The utilisation of modern management and financial analysis techniques within the university administration without hindering academic freedom; empowerment of the institutions with the required administrative, financial and academic decision making powers.

. The establishment of actual tuition fees combined with scholarship and low-interest loans in line with the principles of social justice and equality of opportunity; encouragement of revenue diversification by other means.

Empowering the institutions to dispose of their budgets and other revenues according to their own priorities and giving the administrators the authority to make final decisions in financial, administrative and academic matters so that existing resources can be used in the most efficient manner.

This study has examined the present situation in the Turkish higher education system and set, within a comparative international perspective, realistic targets for the coming decade and recommended a set of measures to be implemented.

This report has preferred to opt for a global vision in the determination of the rational measures to be adopted for the next decade, rather than detailed figures and recipes, especially in regard to manpower planning. The academic and administrative structures and decision making mechanisms within the universities have been examined, while refraining as much as possible from making detailed recommendations regarding implemetation.

It is believed that the best way to reach a target is to create the correct decision making mechanisms, and entrust the right people with the necessary authority.

The report contains proposals for radical changes such as the administration of

the universities by executives appointed by boards of trustees or similar lay councils in line with development plans devised by such governing boards the payment of additional remuneration linked to the performance of the academic staff, and the payment of real tuition fees by students. These proposals are based on the following facts:

. Until now, our universities have been managed by academics in line with administrative and financial plans prepared by the state bureaucracy. This has created a situation where on the average only one out of six faculty members produces publications of international level, and scientific, technological and socio-economic developments are not reflected in teaching within universally accepted norms. Our universities are thus in need of urgent and radical reforms.

. Today's contemporary university must be managed by modern methods and techniques when its functions and the financial resources thereby required are considered. It is therefore necessary to benefit from the expertise of lay persons with experience in such matters and to continuously interact with society and the market.

. It is not possible to grant resources to an institution without a mechanism of performance monitoring, evaluation and accountability in any country governed by a representative parliamentary democracy. Had it been possible to create the research university proposed by Wilhelm von Humboldt, where all faculty members would be internationally accredited scientists and scholars, self control mechanisms would have been the most efficient method to be used. Such universities do not exist even in developed countries, and we cannot even hope to establish such an institution in Turkey in the conceivably near future.

. Turkey's financial resources are limited. The share of the GNP allocated to higher education has only started to approach that in the developed countries in 1990. Under these conditions, the expenditure per student is still well behind that in developed countries. It would be a political choice to reduce expenditure in other fields and transfer this amount to higher education. Such a choice would be wise considering the young demographic structure of the country. Nevertheless, revenue diversification must be considered as an effective solution. The first and the most effective method that must be considered is a more efficent use of the

existing resources. University budgets should not be burdened with unnecessary details and should be in the form of a lump sum grant enabling these institutions to manage their own budgets and resources. For such a financial system to function efficiently and for objective monitoring and evaluation of its performance, it is useful to benefit from the experience of lay persons taking part in the decision making processes.

Higher education is a semi-public and expensive service. When the necessary funds are provided solely out of the public coffer, as is the case in Turkey, a hidden mechanism shifting funds from the lower to the higher income groups becomes operational. Therefore, tuition fees, calculated separately for each university and degree program must be established. Students with financial means should be charged for their education while scholarships and low-interest or interest-free loans should be provided to the bright and the needs in line with the principles of equality of opportunity and social justice. The very large sums paid for preparatory courses and private tutoring for the university entrance examination alone justify the application of the above mentioned system.

Our population will reach 75 million in a decade and the per capita income is foreseen to attain approximately $ 5,000 US at today's constant prices. If the ratio of public funds for higher education to GNP is targeted to reach 1.5%, the total amount of public funds allocated to higher education will reach only $ 5.5 billion in the next decade.

On the other hand, the total higher education budget required for an overall enrollment ratio of 25 % with an average per student expenditure of 5000 US $ will be $ 7.5 billion . The difference, required to attain the desired level of quality that is to create the capacity to generate new knowledge and to reflect the most recent scientific and technological developments to teaching as called for by competitiveness in the international markets, has to be met by students having adequate financial means. This sum is foreseen to be 25-30 % of the average expenditure per student.

The scientific development process initiated 2600 years ago in Miletus, on the Aegean coast of Anatolia, by Thales, Anaximandros and Anaximenes, continued with scientists like Copernicus, Brahe, Keppler, Galilei, Harvey, Steno, Newton, Lavoisier, Faraday, Maxwell, Darwin, Einstein, Wegener and Dirac, although the result of the same critical scientific thought, did not significantly interact with the

technological development process until the end of the 18th century. Technology has advanced thanks to the inventor's discoveries while science has sometimes lagged behind technology. The discovery of electricity, and the founding of the electricity industry on the basis of this scientific development, followed by the discovery of electromagnetic waves by Hertz,. of X- rays by Roentgen, and of radioactivity by Becquerel in the 19th century, created an avalanche of scientific advances, laying the foundations for the technological development of the 20th century.

Thus started a new era in which science paves the way for new technologies which in turn opens up new fields of scientific research, the results of which further form the basis for other technologies. In other words, the relations between science and technology has evolved into one of intertwined chain-like interaction.

Today science and technology are linked to each other in an indivisible way. New technologies such as electronics, new and advanced materials and biotechnology are based on such basic scientific fileds applied mathematics, solid state physics, material science and biology.

A summary of comparative statistical indicators on science and technology and the position of universities within the R&D system of Turkey are as follows:

. The ratio of expenditure for scientific and technological R & D activities is 0.33 % of the GDP. This ratio is 3.1 % in Israel, 2.98% in Japan, 2.78% in the USA, 1.99% in Korea and 0.86% in Spain. The threshold figure is considered to be 1%.. The number of personnel employed in R & D activities is 7 per 10.000 employed workforce. This ratio is 143 in Germany, 142 in Switzerland, 138 in Japan, 77 in the USA, 62 in India, 53 in Korea and 37 in Spain. The threshold figure is around 15.

. Turkey ranks first in terms of the share of universities in R & D activities with 69%, followed by 67% in Chile, and 51% in Mexico. This ratio which does not exceed 35% in developed countries, and is 20% in Japan, 13% in Switzerland and 10% in the USA and Korea. The share of the industry in the R & D activities is above 50% in developed countries, but only 20% in Turkey.

In summary, R & D activities in Turkey are mainly carried out by universities and essentially do not include technological research with a profit motive aimed at increasing market shares by making innovations.

These factors are also reflected to the outputs of the system in the following way:

The total number of scientific articles appearing in international scientific journals, which was 439 in 1980 reached 1758 in 1992, comprising 1651 articles in natural sciences and 107 articles in social sciences. Turkey ranks 37th in the wrold in terms of publications in natural sciences, i.e, in journals covered by the Science Citaiton Index. On the average only one out of every 6 academic staff publishes such international level scientific articles.

. During the same period, the annual publications in Spain went up from 4.165 to 13.853, thus upgrading the ranking of this country from the 20th to the 12 the position in the world; Korea jumped from 272 to 2.608 publications and from the 47th to the 30th position.

. The number of annual scientific publications in Turkey is 0.3 per 10.000 people; this ratio is 14.9 in Israel, 10.5 in the USA, 4.4 in Japan 3.6 in Spain and 0.6 in Korea.

. Turkey ranks among the lowest in the world with 0.09 patents registered annually per 100.000 people .

The main problems faced by Turkey in the field of science and technology are summarized below:

. Turkey has never formulated and implemented a science and technology policy in itself, let alone as part of the general economic policies of the country.

. The production sector totally relies on turn-key technology transfer with a minimal level of R & D activity: There are no mechanisms for supporting R & D in the industry by directly providing matching funds from public sources within program with specific targets; only indirect subsidies are provided.

. Public agencies have no long term procurement programs with advance notification of specifications of the items to be purchased, and no funds are made available to partially cover the development costs of such items. In other words, industrial R & D activity has never been stimulated by public procurement.

. Although it is neither prudent nor possible to strictly classify the functions of the various types of institutions comprising the R & D system of a

country, the following broadly indicative functional classification:

Universities: Basic scientific and applied research

Public institutions:

Applied research, generic and pre-competitive technologies, support services and technologies.

The private sector: Proprietary technologies does not exist in Turkey. Consequently no collaborative R & D programs are jointly carried out on generic and pre-competitive technologies in the critically important fields of electronic, new and advanced materials and biotechnology.

The budgets of public research center are totally provided out of public funds without any policy framework neither are their functions so defined. Consequently, activities in such centers inevitably tend to be on the basic research side, the results of which are "locked" within the institutions.

There is a duplication of similar research activities carried out in various institutions, caused by the lack of coordinating structures, and resulting in the waste of already scarce resources and manpower.

. There is urgent need for a realistic legislation in the fields of venture capital markets, intellectual property rights and competition laws.

All these problems presently faced by Turkey and other developing countries are similar in nature to those encountered by developed countries in the past. The following solutions are proposed for Turkey:

. A Commission for Science and Technology in the Parliament and the Ministry of Science and Technology should be established to tackle these problems at the political level, so that coherent policies can be formulated and implemented.

. A new public institution to be called the ***Turkish Technology Development Agency*** should be established in charge of financing R & D activities in the private sector by directly providing matching funds within a policy framework and with a view towards increasing the use of new and advanced technologies especially in those sectors where Turkey already has a competitive advantage.

. The functions of ***The Scientific and Technical Research Council of Turkey (TÜBİTAK)*** should be restricted to funding university research in priority areas determined within a policy framework; concentrating such research programs as will as intellectually driven basic research in flexibly structured units led

by prominent scientists and with long - term programs;

. ***Marmara Research Center,*** the main public R& D institution in the country, should be separated from TÜBİTAK and its activities should be restricted to generic and per-competitive technological R & D in electronics, informatics, new and advanced materials and biotechnology and various support services and technologies. A free-trade zone should be established right near this center which is open to foreign and local companies engaged in production based on R & D activities.

. Taking into consideration that telecommunications and computer technologies (software and hardware) are now closely linked to each other and that Intelligent, Broad band, Integrated Services Digital Networks (IN, B, ISDN) and Value Added networks (VAN's) will soon cover the world it is necessary to establish another public institution to be called ***Turkish Informatics Agency*** should be setablished with the following missions:

- Develop knowledge and expertise in these fileds as well as oter related to these subjects, such as High Definition Television (HDTV);
- Provide informationa and advice based on scientific and technological developments to the concerned public institutions, the decision makers and the public at large, on investments to be made, related procurement programs the specifications of the equipment to be used, and privatization activities in these and related fields;
- Promote the establishment of internationally competitive private companies and provide the necessary financing for their R & D activities in line with the needs of the and country investment and privatization programs thus diffusing new technologies related to the processing, storage and transmission of data;
- Financing of R & D projects aiming at the establishment of software houses and the diffusion of software technologies;
- Promote the establihment of private training institutions in computers and software, development and acrredit such institutions by monitoring their performance.
- Promote the development and diffusion of computer teaching at all levels of the education sector and establish standards and guidelines for the procurement of the necessary software and hardware;
- Prepare the standards for software and hardware to be purchased by public institutions, establish a Management Information system (MIS) for the public sector

and promote the establishment of private engineering and consulting companies which will provide these services. Establish the Patent and Technology Institute for activities related to intellectual property rights, and to promote and it necessary to finance technology assessment program and the transfer of new and advanced technologies.

. In addition to the above mentioned institutions and agencies, ***the National Productivity Center, The Nuclear Energy Agency, Turkish Standards Institute and Small and Medium Scale Industries Support and Development Administration (KOSGEB)*** should also be affiliated to the Ministry of Science and Technology. The ministry should follow up and coordinate R & D activities financed according to the priorities set forth within the framework of policies formulated ***by the Supreme Council on Science and Technology*** which is an already existing body chaired by the Prime Minister. (Please see the attached diagram)

. A second research center similar to taht mentioned above with a neighbouring free trade zone to specialize in new and advanced technologies, especially in informatics, should be established in the area between Middle East Technical University and the Beytepe Campus of Hacettepe University, providing technopark and incubation center services as well

Unless Turkey regards science and technology as basic constituent elements of her general economic policies with a view to developing local expertise and to obtaining a measurable share in the interational markets, especially in the fields of electronics, new and advanced materials and biotechnology, she is bound to face very difficult times in the 21st century.

Higher education, science and technology have been examined in this report as parts of an indivisible entity. It has been proposed to determine priorites within a policy framework set forth by the Supreme Council on Science and Technology according to the needs of the country and in line with scientific and technological developments. Besides these the repord includes proposals made concerning the requisite structures of universities as well as other public institutions and private companies to reach desired levels in all fields ranging from social sciences, medicine biotechnology, advanced technologies, environmental sciences and new materials. Special emphasis however, has been placed electronics and informatics which are belived to form the most significant infrasturcture in the Information Society. It will not be

possible to develop areas if these two fields are not given priority.

Given the present structure of higher education, science and technology in Turkey, it should come as no surprise to anyore that our exports have levelled off at around 15 million US $ per year and that we face similar amounate of deficts in our annual balance of payments.

Science, defined by Popper as ***"All endeavors whose resulting expressions can be refuted by observation"***, and the rational critical approach that follows from this definition has formed the basis of western civilization. Those societies which will fail to adopt this approach as a way of life and passively follow the scientific and technological developments briefly summarized in this report will soon start failing to even comprehend these development and will not even be able to transfer technology let alone develop it. Such societies are doomed at relative poverty and a marginal position in the international community, for the capacity to creatively generate new knowledge has throughout the history been the basis for mankind to sustain its being.

The main target for Turkey, therefore, has to be the training of an elite cadre of manpower with the capacity to generate new knowledge together with a boad stratum of intermedia human resources with the requisite capabilities to creatively use and apply knowledge in generating value added.

The following is the English translation of part V.3 of the fifth and final chapter of the report entitled, "Higher Education, Science and Technology in Turkey and in the World". This part consists of proposals for science and technology.

PROPOSALS FOR SCIENCE AND TECHNOLOGY

1. Main Features of the Recommended Policy

Main features of the recommended policy based on an analysis of that implemented in other countries as well as the conditions presently prevailing in Turkey are summarized below:

. A policy for science and technology should be formulated and implemented as an integral constituent element of the general economic policies.

. Science and technology should be represented at the political level.

. The state should play an active regulatory role without itself venturing into production.

. It is no longer possible to be competitive in international markets without engaging in scientific and technological R & D activities in the industrial sector. Indirect incentives will not be adequate to ensure this and it is necessary to provide direct financing from public funds directed towards targeted sectors and subsectors in either of the following forms:

- Matching funds, continuation of which should be linked to performance and which should be paid back according to a predetermined plan in case of commercial application of the results obtained. If not, the funds initially provided as loans should be converted to grants in case valid grounds exist;
- Equity capital;
- Funds for R & D activities related to public procurement programs.

. Although it is neither prudent nor possible to distinctly specify the functions of the various institutions and organizations comprising a national R & D system, a broadly indicative functional classification should be made as follows:

Universities : Basic scientific and applied research

Public institutions : Applied research, generic and pre-competitive technologies, support services and technologies

Private sector : Proprietary technologies.

It is already too late to implement the plans adopted in the past by other countries in the field of electronics, the main generic technology of today and the

future. What must be done now is to take risks and attempt to make a leap in this sector. The Integrated Services Digital Network (ISDN), to be followed by the Intelligent, Broad-Band Integrated Services Digital Network, (IN, B, ISDN) and Value Added Networks (VAN's) should be considered as the driving sub-sectors. There is a considerable accumulation of R & D and industrial experience in this field in our country. The following actions should be taken with a view to gaining a share in the international markets:

- Public procurement and related R & D programs should be prepared;
- Such programs should be open to a sufficient number of companies to ensure competition, while at the same time benefiting from economies of scale. The domestic market should be temporarily protected, but under no conditions should a market share be guaranteed to any company whatsoever;
- The funds needed for R & D by local companies should be provided out of public funds using direct funding mechanisms as well as indirect incentives and subsidies ;
- The program should also be open to companies with foreign partners possessing real R & D units in Turkey, whose majority of shares are owned by Turkish citizens or companies, and whose licence agreements do not include market restrictions.

. The second sub-sector proposed for achieving competitiveness and gaining scientific and technological expertise in the field of electronics is the development of the software needed by public institutions. Turkey cannot and should not enter the field of hardware. What should be done is to centrally prepare the equipment standards and develop common communication protocols. Two other areas that can be exploited to develop the software sub-sector are:

- Educational technologies (multimedia, computer education and related software),
- Banking and other service sectors.Turkey, while using the sub-sectors of telecommunication and software as a driving force, must take into consideration member countries of the Black Sea Economic Cooperation Zone (BSEC) and establish mutually beneficial scientific, commercial and technological relations with them. BSEC, besides having economic and commercial potential, can also open new horizons for Turkey for the following reasons:
- These countries presently constitute markets yet to be exploited in the fields or telecommunication and software.
- The great scientific potential of Russia would be complementary to Turkey's

industrial and commercial experience and knowledge. The accumulation of expertise in Turkey in such related fields as laser, coding theory, applied mathematics, solid state physics, fiber optics and optoelectronics can in noway be compared to that in Russia. Russia is aware that this knowledge constitutes her strength and worries that she might lose this potential due to the brain - drain, likely to occur in the event of industrial partnership with the west.

. Other important points to be considered in developing the electronics sector are the following:

- Turkey should not contemplate entering into the production of chips and semiconductors but should concentrate on Application Specific Integrated Circuit (ASIC) design;

- The needs of the defence sub-sector should be met by local means to the extent possible, but this sub-sector should never be considered as a driving force. Priority should be given to system design in all electronic sub-sectors.

- Although there is no point in starting R & D activities in the field of High Definition Television (HDTV) , it is necessary to follow the technological and commercial developments in this field. For this purpose, a "Commercial and Technological Assessment Unit" should be established for HDTV with the participation of all local producers in order to prepare local companies in this sub-sector to rapid changes in the production of TV components;

- Finally, Turkey should attempt to close the technological gap by reverse engineering rather than by indiscriminately allocating already scarce resources to R & D activities, and take advantage to the extent possible of being a "late-comer" and a "free-rider" in the electronics sector.

. Telecommunication and computer technologies can and should no longer be considered separately. There is a need to establish a new public institution called the ***Turkish Informatics Agency*** which will act as a respository of expertise, a source of information and known-how, as well as giving advice on investments and privatization programs and providing the necessary R & D funds in line with such programs;

. The use and diffusion of computer - integrated manufacturing should be encouraged in all sectors, but particularly in those where we already have a competitive edge. The transfer and adaptation of such technologies should be partly financed by public funds through the indexation of investment expenditures to export performance. The proposed ***Turkish Technology Development Agency*** should be

charged with this task, equipped with adequate legal authority and sound financial resources.

. ***Small and Medium - Scale Industries Development and Support Administration (KOSGEB)*** should be responsible for providing services to small and medium - scale enterprises, organizing sub-contracting services and developing links between such enterprises, vocational and technical schools and apprenticeship centers. The technology centers presently owned and operated by KOSGEB in the Middle East Technical University (METU), and ıstanbul Technical University campuses should, on the other hand, be transferred to the Turkish Technology Development Agency.

. The Turkish Technology Development Agency should also organize and finance R & D programs on generic and pre-competitive technologies jointly with universities, public research centers and the private sector in the fields of biotechnology, especially agricultural biotechnology, and new and advanced materials.

. The main duty of the ***Scientific and Technical Research Council of Turkey (TÜBİTAK)*** should be the planning and financing of university research. TÜBİTAK should, in addition to supporting such comprehensive R & D programs, and soliciting research proposals for basic and applied research in the universities;

- Use some of its resources to finance unsolicited research proposals prepared by academic staff on the basis of their intellectual curiosity;

- Establish long-term research units with a flexible administrative and financial structure under the leadership of prominent scientists whose scientific and scholarly credentials are well-established by their international publications and citations of such publications by others;

- Establish more structured and comprehensive R & D institutes within the universities with the purpose of forming critical masses of manpower in various technological and applied science fields. These institutes should be only partly financed by TÜBİTAK and should be forced / encouraged to find part of the funds they require from contract research. Such institutes should be very rapidly established in such fields as electronics, software, applied mathematics, solid state physics, production systems, new materials and biotechnology, and managed by experts brought from abroad if necessary.

- Start seed-money programs for junior academic staff and establish post-doctoral fellow and research associate positions within the universities.

. ***The Marmara Research Center*** should be separated from TÜBİTAK, become

independent and focus its activities on joint R & D programs in electronics, new and advanced materials, production systems, biotechnology, any applied research activity called for by such programs, and support services and technologies. The center should be only partly financed by public resources, and forced /encouraged to secure the main part of its operational budget through contract research and services.

. A free-trade zone, open to local and foreign companies engaged in the production of goods and services based on R & D activities and using new and advanced technologies should be established in the neighbourhood of this center.

. ***The National Metrology Center*** dealing with metrology, primary standards and calibration, presently affiliated to the Marmara Research Center should be granted an independent status.

. A second R & D center, focusing its activities especially on informatics, should be established in the area between the campus of the Middle East Technical University and Beytepe campus of Hacettepe University, with a similar free-trade zone right next to it. Technopark and incubation center services should be provided within this center.

. The documentation centers presently affiliated to TÜBİTAK and the Council of Higher Education (YÖK), should be united and organized as the ***National Documentation Center*** within the Turkish Informatics Agency.

. Effective and realistic legislation covering competition laws, venture capital markets and intellectual property rights, should be rapidly enacted, with an appropriate grace period for the latter. It is important to bear in mind the economies of scale while devising competition laws.

THE PROPOSED INSTITUTIONAL STRUCTURE

The proposed institutional structure including the various existing institutions as well as the newly proposed agencies are shown in the enclosed figure. Important features of the proposed structure are summarized below.

. ***Establishment of the Ministry of Science and Technology and a Parliamentary Commission on Science and Technology to enable action at the political level;***

. ***Avoiding duplication of efforts that cause inefficient use of scarce resources, such as in the case of the State Planning Organization (DPT) separately funding university research, an activity which should properly***

be carried out by TÜBİTAK;

. Organization of the institutional structure as called for by the hierarchy of the executive branch;

. Employing a minimum number of staff by the proposed ministry itself so that another cumbersome bureaucracy will not be created;

. Ensure that the governing boards of the institutions and agencies are composed of prominent scientists and industrialists; unite the presidency of the boards and the institutions in a single executive head, and extend the flexible administrative and financial structure of TÜBİTAK to all other institutions and agencies.

The various institutions and agencies shown in the enclosed figure should have the following basic functions in addition to those listed above:

a) The National Productivity Center:

To introduce and promote the diffusion of advanced technologies in all sectors.

b) KOSGEB

Its basic functions have already been listed above.

c) The Nuclear Energy Agency

Continue its present activities and functions

d) The Turkish Informatics Agency

- Establish a basis of expertise, know-how and data on informatics and related technologies such as Intelligent, Broad-Band Integrated Services Digital Network (IN, B, ISDN), Value-Added-Networks (VAN's), High-Definition Television (HDTV) and the software and hardware involved therein;

- Provide information and advice to the concerned public institutions decision makers and the public at large on the investments to be made, related procurement programs and equipment specifications, and privatization programs in these and related other fields, as well as on the scientific and technological developments in these fields;

. Promote the establishment of internationally competitive private companies and provide the necessary financing for their R & D activities in line with the needs of the country, investment and privatization programs thus diffusing new technologies related to the processing, storage and transmission of data;

- Financing of R & D projects aiming at the establishment and development of software houses and the diffusion of software technologies;

- Promote the establishment and development of private training institutions in

computers and software and accredit such institutions by monitoring their performance;

- Promote the development and diffusion of computer teaching at all levels of the education sector and establish standards and guidelines for the procurement of the necessary software and hardware;

- Prepare the standards of software and hardware to be purchased by public institutions, establish a management information system (MIS) for the public sector and promote the establishment and development of private engineering and consulting companies which will provide these services.

We wish to point out that the Office of Telecommunications in the United Kingdom (OFTEL) has similar authorities and responsibilities.

Higher education, science and technology have been examined in this report as parts of an indivisible entity. It has been proposed to determine priorities within a policy framework set forth by the Supreme Council on Science and Technology according to the needs of the country and in line with scientific and technological developments. Besides these, proposals have been made concerning the requisite structures of universities as well as other public institutions and private companies to reach desired levels in fields ranging from the social sciences to medicine, biotechnology, advanced technologies, environmental sciences, and new and advanced materials. Special attention, however, has been paid only to electronics and informatics which are believed to form the most significant infrastructure in the Information Society . It will not be possible to develop other areas if these two fields are not given priority.

e) TÜBİTAK

TÜBİTAK should also be responsible for the financing and coordination of projects within the framework of Cooperation on Science and Technology (COST) and similar scientifically oriented international collaboration programs.

f) The Turkish Technology Development Agency

This agency should also be involved in the following activities:- Prepare proposals for the direct and indirect financial incentives and subsidies to be provided for the development of an industrial structure based on scientific and technological R & D, recommend these to Supreme Council on Science and Technology for approval; evaluate and make decisions on applications for receiving such subsidies and incentives;

- Evaluate and make decisions on applications for assistance to R & D projects

outside of the established programs and provide the necessary financing to approved projects and programs of this kind;

- Take other necessary measures deemed necessary for the development and promotion of scientific and technological R & D activities within the private sector;

- Perform the financing and coordination of projects within the European Research Coordination Agency (EUREKA) and similar technologically and commercially oriented international collaboration programs.

g) The Marmara Research center

Its duties have been mentioned above.

h) The National Metrology Center

Its duties have been mentioned above

i) The Turkish Institute of Standards

- Preparation of secondary written standards;

- Promote the establishment and development of accredited private quality control laboratories, provide them with financing if necessary and accredit such laboratories by monitoring their performance.

j) The Institute of Patents and Technology

- Cary out research on intellectual property rights,

- Register patents and establish a patent data base,

- Promote the transfer of state-of-the-art technologies in order to increase the competitiveness of Turkish companies in international markets; prepare proposals for subsidies and incentives to promote the transfer of such technologies and submit them to the Supreme Council on Science and Technology for approval; evaluate and make decisions on applications made for receiving such subsidies and incentives.

k) The Turkish Academy of Sciences

Continue its present activities and tasks; participate in international academic exchange pograms, establish awards for outstanding scientific achievements.

The Ministry of Science and Technology should pay special attention to the following points in order to ensure the smooth and efficient operation of the proposed structure:

. Coordinate and follow up the results of R & D activities in priority areas determined by the Supreme Council on Science and Technology and for which financing is provided; act as the secretariat of this Council;

. Examine and evaluate the annual programs and draft budgets of all public insti-

tutions, including universities, involved in scientific and technological R & D activities and present them to the Supreme Council on Science and Technology together with its own views and recommendations;

. Prepare proposals on all measures to be implemented, comprehensive programs to be carried out, direct and indirect subsidies and incentives deemed necessary to promote scientific and technological R & D activities, and direct such activities to the targets set forth within a policy framework and submit these to the Supreme Council on Science and Technology for approval; follow up and coordinate such activities.

It is of course prudent to avoid the establishment of new ministries and public institutions. However, structures similar to that shown in the enclosed figure exist in nearly all developed countries. The most recent example is the establishment of a National Science and Technology Council in the USA, similar in status to the National Security Council and the National Economic Council, whose chairman has been given a cabinet-level position. All public research activities are subject to approval by this council. According to President Clinton, this new arrangement will help achieve the following results:

. Growth of the country's economy,

. Increase the competitiveness of the industry,

. Protection of the environment,

. Improvement of education,

. Creation of new jobs.

No one can deny that the above mentioned targets are indispensable for Turkey as well

.Higher education, science and technology have been examined in this report as parts of an indivisible entity. It has been proposed to determine priorities within a policy framework set forth by the Supreme Council on Science and Technology, according to the needs of the country and in line with scientific and technological developments. Besides these, proposals have been made concerning the requisite structures of universities as well as other public institutions and private companies to reach desired levels in all fields ranging from the social sciences, to medicine, biotechnology, advanced technologies, environmental sciences and new and advanced materials. Special attention, however, has only been paid to electronics and informatics, which are believed to form the most significant infrastructure in the Information Society. It will not be possible to develop other areas if these two fields are not given priority.

THE INSTITUTIONAL STRUCTURE RECOMMENDED FOR SCIENCE AND TECHNOLOGY IN TURKEY