JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF EDUCATION
THE ISLAMIC REPUBLIC OF PAKISTAN

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR EDUCATIONAL EQUIPMENT FOR THE N-W.F.P. UNIVERSITY OF ENGINEERING AND TECHNOLOGY, PESHAWAR IN THE ISLAMIC REPUBLIC OF PAKISTAN

FEBRUARY 1993

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PREFACE

In response to a request from the Government of the Islamic Republic of Pakistan, the Government of Japan decided to conduct a basic design study on the Project for Educational Equipment for the N-W.F.P. University of Engineering and Technology, Peshawar and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Pakistan a study team headed by Dr. Nobuaki Otsuki, Associate Professor, Faculty of Engineering of the Tokyo Institute of Technology and constituted by members of UNICO International corporation, from September 28 to October 17, 1992.

The team held discussions with the officials concerned of the Government of Pakistan, and conducted a field study at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Islamic Republic of Pakistan for their close cooperation extended to the team.

February 1993

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

February 1993

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Educational Equipment for the N-W.F.P. University of Engineering and Technology, Peshawar in the Islamic Republic of Pakistan.

This study has been made by UNICO International Corporation, based on a contract with JICA, from September 17, 1992 to February 17, 1993. Throughout the study, we have taken into full consideration of the present situation in Pakistan, and have planned the most appropriate project in the scheme of Japan's grant aid.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA , the Ministry of Foreign Affairs and the Ministry of Education, Science and Culture. We also wish to express our deep gratitude to the officials concerned of the N-W.F.P. University of Engineering and Technology, Peshawar, JICA Pakistan Office and the Embassy of Japan in Islamabad for their close cooperation and assistance during our study.

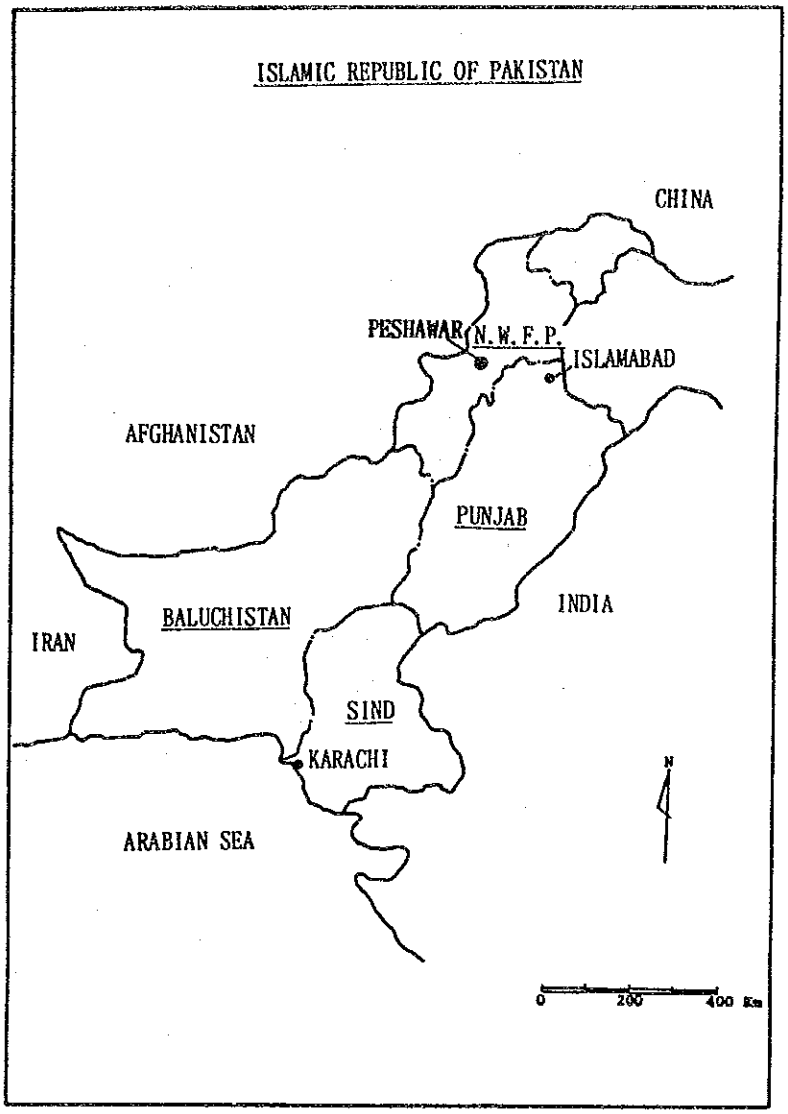
At last, we hope that this report will be effectively used for the promotion of the project.

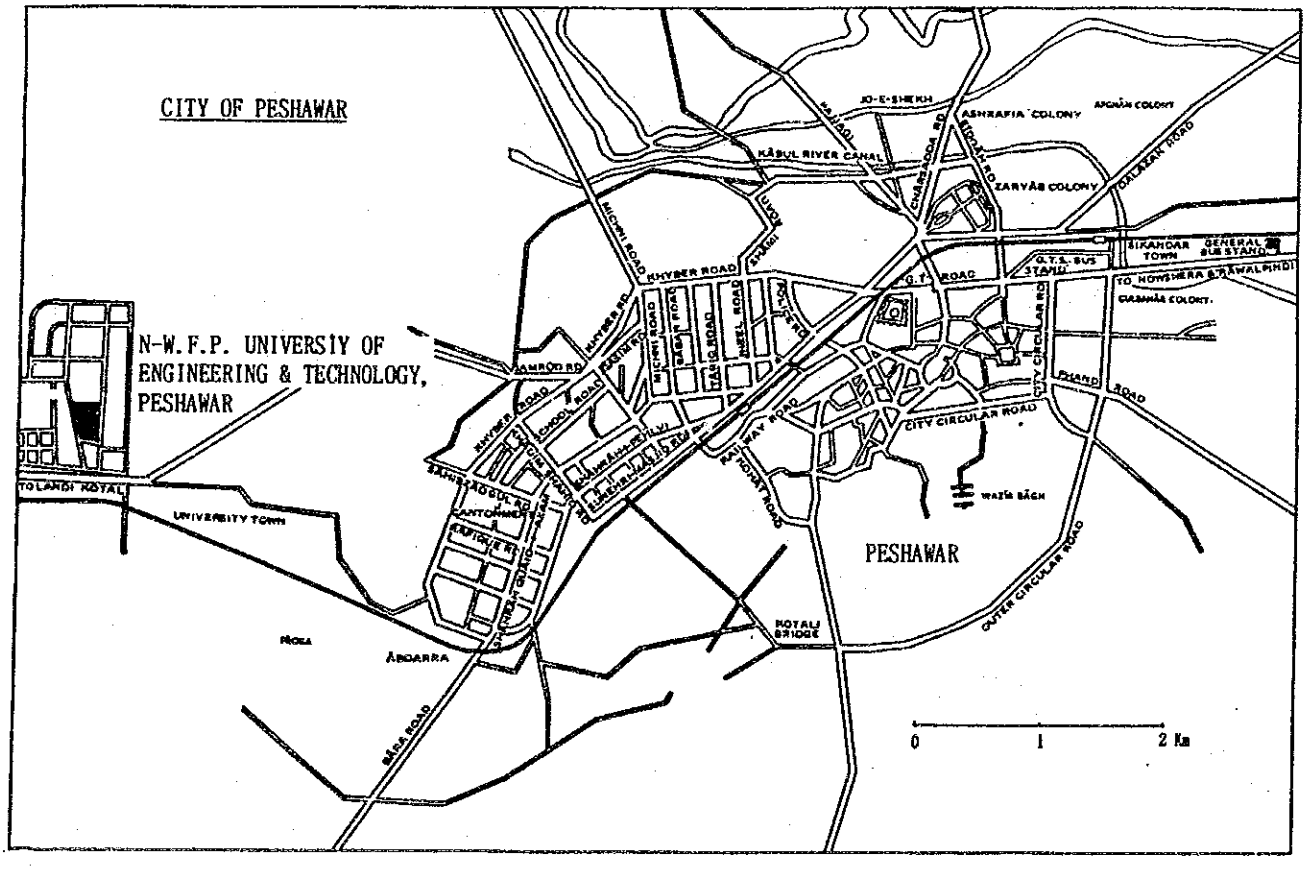
Very truly yours,

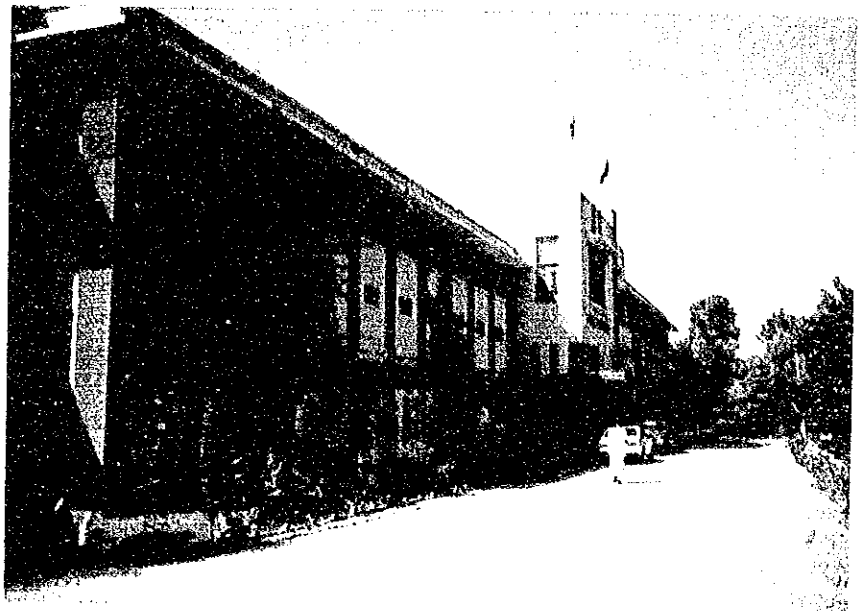
Shinji Kure

Shinji Kure
Project Manager,
Basic Design Study Team on
the Project for Educational Equipment of
the N-W.F.P. University of Engineering and
Technology, Peshawar
UNICO International Corporation

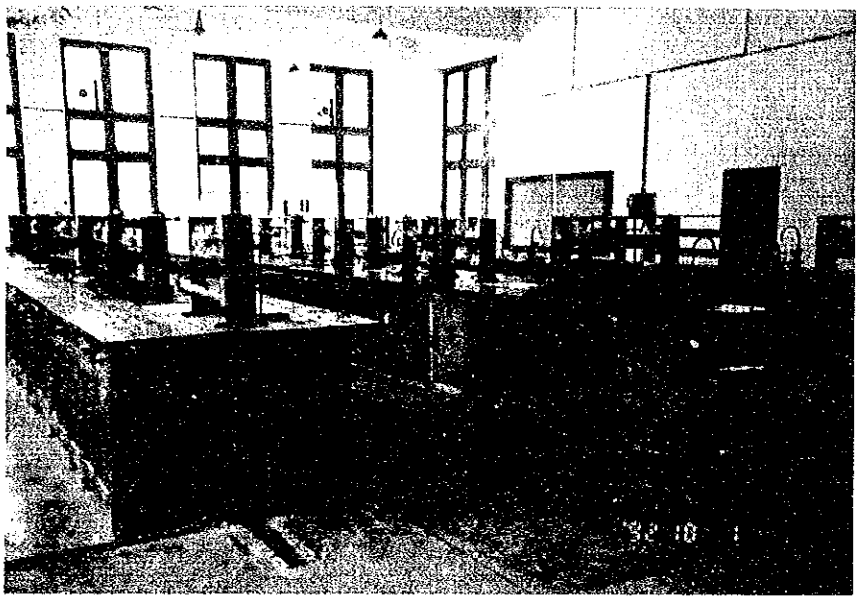
LOCATION MAP







Headquaters Building



Chemistry Laboratory

Computer Room

SUMMARY

SUMMARY

The Islamic Republic of Pakistan has been carrying out a series of Five Year Plans centered on the industrialization of the country since her independence in August 1947 to achieve two major targets; towards increasing self-reliance and poverty alleviation. The Government has been making efforts to improve the education and raise its level in these Five Year Plans. The current Seventh Five Year Plan (1988-1993) also places emphasis on the development of human resources through education and training, and the Government has taken measures to expand and strengthen the existing engineering universities.

The North-West Frontier Province is one of the four provinces constituting Pakistan and situated northwest in the country. A large portion of the Province is a mountainous and most underdeveloped area in the country. The literacy rate and the participation rate at the primary education level are below the country's average due to the high proportion of rural population. Consequently the participation rate at the higher education level is very low.

The Faculty of Engineering of the University of Peshawar was reorganized into the North-West Frontier Province University of Engineering and Technology, Peshawar in 1980 as a premier engineering education institution in the North-West Frontier Province to meet the increasing demand for engineering education. The engineering education in the Province began in 1952 when an engineering college was opened. The college was incorporated into the University of Peshawar as its Faculty of Engineering in October 1974. In October 1980 the Faculty of Engineering was separated from the University of Peshawar and became independent as the North-West Frontier Province University of Engineering and Technology, Peshawar. The University has six departments: the Department of Mechanical Engineering, the Department of Electrical Engineering, the Department of Civil Engineering, the Department of Agricultural Engineering, the Department of Mining Engineering and the Department of Basic Sciences. All the Departments (except the Department of Basic Sciences) have master courses. The University and its predecessors have provided a large number of engineers for the Province since it started as the engineering college in 1952 and have significantly contributed to the economic

development of the Province.

However, the experimental equipment of the University has hardly been augmented since the inception of the institution. Most pieces of equipment are old and obsolete, and do not serve education. The renewal and expansion of equipment is urgently needed. For the historical reasons mentioned above, the University resides in the buildings of the previous Faculty of Engineering of the University of Peshawar. The existing buildings do not have enough space to accommodate projected new departments and postgraduate courses. In these circumstances the University laid a plan of moving to a new campus and drew up a project to strengthen its academic facilities including equipment provision. However, the plan had to be revised several times because of financial constraints of the Federal and Provincial Governments. The final version was completed in 1991. Following the completion of the final plan, the Federal Government has requested the Japanese Government to provide a Grant Aid for laboratory equipment which requires foreign exchange for purchase.

Upon this request the Japanese Government decided to conduct a study on this proposal. The Japan International Cooperation Agency dispatched a Study Team for the Basic Design Study of the Project to Pakistan from 28 September 1992 to 17 October 1992. The Study Team had a series of discussions with the authorities of the Pakistan Government and the N-W.F.P. University of Engineering and Technology, Peshawar on the scope of the project, details of the request, arrangement of the project implementation in Pakistan, maintenance and management plans, share of responsibilities etc. The Team also collected necessary information on the University and the industries and research institutions which are related to the project.

The outlines of the study are mentioned as follows.

(1) The N-W.F.P. University of Engineering and Technology, Peshawar is one of the four national engineering universities and a premier higher engineering educational institution in the North-West Frontier Province. It has produced more than 5,000 engineers since its inception as an engineering college in 1952. It is an

important educational institution to the economic development of the Province as well as the whole country. At present there are about 1,200 students in the five Departments including postgraduate students and about 350 staff members including about 120 teaching staffs. In the course of time, the numbers of departments, laboratories and students have increased. However, the laboratory equipment has not expanded in quantity and quality in proportion to the increase of students and laboratories. Most pieces of equipment are old and obsolete. The laboratories are poorly equipped and do not serve higher engineering education.

(2) This equipment provision project is part of the plan "Strengthening of Academic Facilities of N-W.F.P. University of Engineering and Technology, Peshawar", which includes a move to a new campus. The original project was prepared in 1987. Since then there have been establishment of new laboratories and revisions of curricula and syllabi. These changes had not been reflected enough in the selection of equipment in the proposal. The present review finds that some items of equipment requested should be excluded from and some others should be added in the project.

Equipment which should be excluded is:

a) Equipment which is no more required in the syllabi revised after the preparation of the project in 1987.

b) Equipment which was purchased by the University since 1987 or can be purchased in Pakistan on the University's own funds.

c) Equipment which the rapid technological progress has made obsolete for educational purposes, or such type of equipment as is no more needed because other new type of equipment can be used instead of the proposed one.

Equipment which is not listed in the proposal but is considered to be added:

a) Equipment which is required in the laboratories set up after 1987.

b) Equipment which is required in the revised syllabi.

c) Such equipment as has more versatile functions and is considered to be more effective in education than the proposed one.

d) Personal computers and peripherals, which are indispensable for the present-day engineering education.

Some items of equipment in the proposal are presumed to be third country's products. It is necessary to take it into consideration to include them in the selection of equipment.

A basic plan on the provision of equipment for education and experiments at the N-W.F.P. University of Engineering and Technology, Peshawar was prepared based on the above mentioned considerations. The outline of the plan is as follows.

(1) Executing Agency: The N-W.F.P. University of Engineering and Technology, Peshawar.

(2) Plan of Activities: To provide the students of the University with higher engineering education using the equipment provided for the six Departments and the Workshop through this project, to produce engineers of high quality and to contribute to elevation of the level of technology, the industrial development and the economic development.

(3) Outline of the selected equipment is the experimental equipment which fits in with the present-day higher engineering education and helps students to learn underlying principles of engineering. In the selection of equipment, the priority is placed on replacement of the existing old and obsolete one. The criteria for selection of new equipment are; frequency of use, versatility and ease with operation and maintenance.

Table 1 lists the major items of equipment selected and the numbers of items by laboratory.

Table 1 Major Items of Equipment Selected

Laboratory	Major Items	No. of items
1. Department of Electrical Engineering		24
(1) Basic Electronics	Basic electronics trainer, Operational amplifier trainer, Transistor amplifier trainer, Power supplies teaching set.	4
(2) Digital Electronics	Logic principles, Microprocessor application trainer, Logic constructor, Analogue and digital system trainer, Analogue computing module.	5
(3) Power Electronics	Power electronics trainer, A-D/D-A convertor circuit trainer, Thyristor and diode circuit trainer, AC motor control equipment.	4
(4) Communication	Digital communication system, Microwave trainer, Telephony system tutor, Color TV trainer, Fibre optics kit.	5
(5) Power System	High voltage insulation testing set, Combined AC/DC machine, Capacitance and dissipation factor bridge etc.	6

2. Department of Mechanical Engineering		36
(1) Theory of Machines	FFT analyser.	1
(2) Metallurgy	Universal testing machine, High speed cut off machine etc.	3
(3) Fuel	Bomb calorimeter, Gas calorimeter etc.	5
(4) Automobile Engineering	Fuel injection pump tester, Test stand for electric/electronic systems, Air/fuel measuring equipment, Front-axle measuring stand etc.	8
(5) Production Engineering	Surface roughness measurement instrument, Flatness interferometer, Plug gauges & ring gauges, Mechanical comparator etc.	7
(6) Machine Drawing & Design	Strain amplifier demonstration and measuring system, Sectioned models of different geometrical solids, Bearing housing, Split bearing etc.	7
(7) Heat Transfer	Water/water turbulent flow heat transfer unit, Thermal radiation unit, Temperature measurement unit, Conductive heat transfer experimental unit.	4
(8) Power Plant	Water softening plant	1

3. Department of Civil Engineering		36
(1) Structural and Materials Testing	Universal testing machine, Structure testing machine (Jack system), Prestressing jack with gripping cones, Crack detection microscope etc.	7
(2) Concrete	Flexural strength testing apparatus for small beams, Creep test apparatus, Ultrasonic concrete tester, Poisson's ratio measuring apparatus etc.	7
(3) Soil Mechanics and Highways	Triaxial compression test set, Direct shear apparatus, CBR test set, One dimensional consolidation set, Unconfined compression apparatus etc.	14
(4) Hydraulics and Fluid Mechanics	Hydraulic bench, Sediment transport demonstration channel, Fluid friction apparatus, Laminar flow analysis table.	4
(5) Survey	Electronic total station, Theodolite.	2
(6) Public Health Engineering	Cooled incubator for BOD, Top loading electronic balance.	2
4. Department of Agricultural Engineering		43
(1) Agricultural Machinery & Farm Power	Double disc clutch, Hydraulic clutch, Tractor's electrical system model, Fuel supply pump (diesel) model etc.	21
(2) Soil and Water Engineering	Water quality testing kit, Pressure membrane apparatus, Salinity measuring instrument, Soil moisture meter etc.	22

5. Department of Mining Engineering		51
(1) Mineral Processing	Water distillation apparatus, X-ray fluorescence analysis equipment, Floatation cell, Roll crusher etc.	14
(2) Rock Mechanics	Direct shear test apparatus, Rock sample grinder, Core drilling machine, Strain gauge meter etc.	9
(3) Mine Surveying	Distance meter, Laser control theodolite, Automatic routine levels, Mining suspension theodolite etc.	9
(4) Drilling Technology	Marsh funnel, Wire line core barrel, Diamond bits.	3
(5) Mine Safety	Portable equipment for CO & CO_2 detection, Portable interferometer, Multigas detector, Oil flame safety lamp etc.	6
(6) Mine Ventilation	Wind tunnel with fan, Self contained breathing apparatus, Pipe friction/fluid friction apparatus, Digital luxmeter etc.	5
(7) Geology	Polarizing microscope, Geological thin section preparation apparatus, Crystal & atomic structure model set, Mountain models etc.	5

6. Department of Basic Sciences		35
(1) Physics	Microwave experiment set, Geiger-Muller counter kit, DC power supply, High voltage power supply etc.	6
(2) General Chemistry	Heating mantle, Laboratory centrifuge, Drying oven, Chamber furnace, Rotary vacuum evaporator etc.	11
(3) Analytical Chemistry	Atomic absorption spectrophotometer, Arrangement for potentiometric titrations, Electrolysis apparatus, Polarograph etc.	10
(4) Special	Distillation apparatus for fuel, Tar viscometer, Carbon residue tester, Abbe refractometer etc.	6
(5) Computer Room	Personal computers, Printers.	2
7. Workshop	Universal milling machine, Numerically controlled lathe.	2
TOTAL		227

The costs of the work (renovation of buildings etc.) to be borne by the Pakistan side are estimated to be about 3.9 million Rupees when the project is implemented through a Grant Aid of the Japanese Government.

The following results are expected to be attained when the project is realized by a Grant Aid of the Japanese Government.

(1) The project helps the University to provide the engineering education which not only teaches underlying principles but also keeps up with the progress of technology. Graduates educated in the improved environment are expected to contribute to the economic development of Pakistan, to increasing the competitiveness of Pakistan products in world markets and to raising the living standard of Pakistan people.

(2) The introduction of new equipment which reflects today's technological innovation requires not only the students but also the teachers to study the operation and maintenance of new equipment and other related techniques. This will activate the engineering education of the University and upgrade the technical capability of the University. Thus the reputation of the University as an excellent higher educational institution will spread in the whole country and attract better students. All this will contribute to the development of the University, to the industrial development of the Province and to the development of Pakistan.

(3) The introduction of new instruments of high performance will make it possible for the teachers to perform various kinds of experiments and testings. Requests will increase from industries for testing and contract research. Cooperation of the University with industries will increase and the University will be able to provide industries with better technical services and to expand technical assistance to public organizations.

The management and maintenance system of the project is evaluated as follows.

(1) The existing system of the University administration will manage

the project. There is no problem with the organizational structure and placement of personnel.

(2) The Director Finance is responsible for the assets of the University including equipment and for all financial matters including maintenance fees. The laboratory technical staff are in charge of the daily operation and maintenance of equipment. They are assisted by laboratory/shop attendants. There will be no problem with the maintenance of equipment provided the laboratory staff are trained properly in the operation and maintenance work.

(3) The cost of operation and maintenance of equipment will be covered enough with the Government Grant-in-Aid which constitutes main part of the regular budget of the University. The Government Grant-in-Aid is projected to increase every year about 14 % of the previous year's amount (about 7 million Rupees per year on the average). The maintenance fees of equipment will suffice and there will be no financial problem.

The project is expected to produce the above mentioned results and to raise the educational standard in engineering and technology. It will contribute to the development of industries in the Province and the development of Pakistan. These benefits justify to implement this project by a Grant Aid of the Japanese Government.

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CHAPTER 1 INTRODUCTION

Chapter 1 Introduction

The Government of the Islamic Republic of Pakistan has been carrying out a series of development plans centered on the industrialization of the country with two major targets; towards increasing self-reliance and poverty alleviation. The most important objective in the Long-Term Perspective Plan (1988-2003) is to sustain a stable economic growth by expanding the industrial sector. To achieve this objective it is indispensable to develop human resources through strengthening higher engineering education. The current Seventh Five Year Plan (1988-1993) places emphasis on the human resources development through education and training and aims to upgrade the quality of the existing universities and colleges and to improve and expand the facilities and equipment of these institutions.

The North-West Frontier Province University of Engineering and Technology, Peshawar, one of the four national universities of engineering and technology in the Islamic Republic of Pakistan had formulated a plan to improve and expand its educational facilities including a move to a new campus site a few years ago. However, the initial plan had to be revised several times due to financial constraints of the Provincial and Federal Governments. The plan was finalized in 1991 and the Government of the Islamic Republic of Pakistan has requested a Grant Aid of the Japanese Government to provide the University with the laboratory equipment, for the purchase of which foreign exchange is required.

Upon this request the Japanese government decided to conduct a basic design study on this project. The Japan International Cooperation Agency (JICA) dispatched a "Study Team for the Basic Design Study on the Project for Educational Equipment for the N-W.F.P. University of Engineering and Technology, Peshawar" headed by Dr. Nobuaki Otsuki, Associate Professor of Tokyo Institute of Technology to Pakistan for twenty days from 28 September to 17 October 1992 to study the background of the project, the details of the request and the present condition of the University.

The study team had a series of discussions with the authorities concerned with this project in Pakistan and visited the University, a few

factories in Peshawar and a research institute in Islamabad. The team collected necessary information and studied the scope of the project , details of the requested equipment, arrangement of the project implementation in Pakistan, maintenance and management plans, and scopes of work. Upon returning to Japan, the study team reviewed the propriety of the project, the optimum scale, the management plan and effectiveness of the assistance, and selected equipment, estimated the total expenses and drew up an implementation plan, in consultation with the authorities concerned.

The report summarizes selection of equipment to be included in a basic design of the project, an implementation plan, a maintenance and management plan, evaluation of the project and suggestions. The constitution of the study team, the itinerary, a list of the persons interviewed, the minutes of discussions are appended at the end of the report (Appendix 1-4).

CHAPTER 2 BACKGROUND OF THE PROJECT

Chapter 2 Background of the Project

2.1 Economy and Development Policy

Pakistan has been carrying out a series of development plans centered on the industrialization of the country since her independence. The emphasis was placed on creation of physical infrastructures in 1955-60. In the 1960's industrialization programmes were carried out centered on consumer's goods industries to substitute import. In the 1970's the industrialization process was stagnant because of the policy of nationalization of large scale enterprises. However, the Government took measures in the 1980's to encourage the private sector, to induce more foreign capitals, to promote export oriented industries, and to strengthen the industries which utilize locally available materials and some key industries. As the results of these measures, the industrialization of Pakistan has been accelerated. The real GDP increased about 6.4% per year on the average in the 1980's. For these few years the growth rates of the real GDP were stable around 5 % per year.

Agriculture including traditional cash crops such as cottons is the mainstay of Pakistan's economy accounting for about 27 % of GDP, employing about 51 % of the labour force. Agriculture provides such manufacturing industries as textiles and food processing with raw materials. Raw and processed agricultural products account for about 60 % of the export earnings. However, the contribution of agriculture to economy is dependent on weather and affected by the deterioration and mismanagement of irrigation facilities. To achieve a stable economic growth, it is necessary to develop manufacturing industries to complement the agricultural sector. The major manufacturing industries of Pakistan are light industries such as textiles, food processing, processing of agricultural products. Heavy industries such as steel, fertilizer, cement and automobile industries are also developing. The manufacturing sector accounts for about 17 % of GDP and employs about 13 % of the labour force, being the important sector of the economy next to agriculture.

The long-term Perspective Plan (1988-2003) prescribes two major targets; towards increasing self-reliance and poverty alleviation. The plan emphasizes

expansion of the industrial sector (manufacturing, mining, electricity & gas and construction) to sustain a stable economic growth. To improve the balance of payment, it is required to increase manufacturing value-added and to widen export possibilities through increased competitiveness in world markets. A shift in the industrial structure from agro-based and semi-processing industries to more capital intensive industries is stressed in the plan.

Negative factors in the Pakistan economy are rising trends in prices (the price increase rates per year were 6.7 % on the average in the 1980's), the budget deficit caused by poor revenues due to the inefficient and ineffective tax system and by the routine increase of public expenditures, and the balance of payment imbalances due to export restrictions and decline in workers' remittances from abroad. The major targets of the Seventh Five Year Plan (1988-1993) are to sustain an average GDP growth rate of 6.5 % per year (4.7 % in the agricultural sector and 8.1 % in the manufacturing sector), to encourage the private sector, to promote export and to reduce the budget deficit. To achieve these targets, emphasis is placed on the development of manufacturing, housing construction and agriculture. The creation of employment and the reduction of regional imbalance in economy have been important objectives in the Sixth and Seventh Five Year Plan. The industrial development is expected to contribute to achieve these objectives.

It is necessary to develop human resources of high quality in order to develop the Pakistan economy as projected. In order to increase opportunities for employment, the Seventh Plan envisages measures to increase the investment level in manufacturing, to promote small scale industries, to expand the national vocational training programme, and to enhance labour intensive industries. The development of human resources through education and training is required to upgrade the labour quality.

2.2 North-West Frontier Province

The North-West Frontier Province (abbreviated to NWFP) is in the north western part of Pakistan and is bordered on Afghanistan and China. The area is 74,521 km². A large portion of the Province is a mountainous area and the arable land is rather limited. The irrigated area covers only 6 % of the total area of the Province. The Province accounts for 13 % of the total population (which is estimated to be 117.32 million as of January 1992) and covers 9 % of the country's total area (796,095 km²). It consists of 14 districts including the Provincially Administered Tribal Areas (PATA), and the Federally Administered Tribal Areas (FATA) which consists of 7 political agencies and 4 frontier regions. The northern part lies in offshoots of the Himalayan range and is abundant in mineral resources. The industrial development is slow as in Baluchistan which is on the southwest of NWFP. Punjab and Sind which are on the east of the Indus River are more developed industrially. The manufacturers in NWFP registered by the Pakistan Factories Act are only 7 % of the registered in the whole country.

The disadvantage of NWFP is its geographical location. The biggest seaport of Pakistan, Karachi is 1700 km away from NWFP. Freight charges for raw materials and finished products in the trade with other provinces and foreign countries cost relatively high. The head offices of most of the commercial banks and development financial institutions are in Karachi and the business in NWFP is placed in a very inconvenient and unfavorable position. Skilled labour is not available in NWFP. The industries have to fetch skilled labour from other Provinces on higher salaries which enhance the cost of production. The industries of the Province, therefore, can not compete with the industries in the well placed Provinces.

The Federal Government has now constituted a committee in the budget 1991-92 in order to solve these problems. The committee has started to examine the sick industries and is expected to make recommendations for their rehabilitation.

2.2.1 Industry

NWFP has developed 11 industrial estates in Peshawar, Abbottabad, Dera Ismail Khan etc. Manufacturing industries such as wood, wood products, furniture; metal products, machinery, equipment; non-metallic mineral products; textile, apparel, leather; food, beverages, tobacco industries etc. have been established.

According to "Census of Manufacturing Industries 1985-86" published in 1989 a total of 8,365 manufacturers are registered by the Factories Act and 311 companies of the 4349 companies which replied to the census are located in NWFP. Table 2.1.1 shows a breakdown of the manufacturers in Pakistan and NWFP respectively.

Table 2.1.1 Number of Reporting Establishments by Industry Major Groups

	NWFP(A)	WHOLE COUNTRY(B)	RATIO:(A/B)%
Food,Beverages and Tobacco	72	799	(9%)
Textile, Apparel and Leather	140	1,441	(10%)
Wood, Wood Products and Furniture	17	78	(22%)
Paper,Printing & Publishing	11	192	(6%)
Chemicals,Rubber & Plastics	20	486	(4%)
Non-Metallic Mineral Products	23	137	(17%)
Basic Metal Industry	3	207	(1%)
Metal Products, Machinery & Equipment	25	932	(3%)
Handicrafts ,Sports, Other Manufacturing	0	77	-
Total	311	4,349	(7%)

Source: Census of Manufacturing Industries 1985-86

In terms of the number of employees the 311 companies in NWFP are grouped as follows; those with less than ten employees are 44 (14%), from 10 to 99 are 206(66%), from 100 to 999 are 50(16%) ,and 1000 and above are 11(4%). In terms of the ownership, individual ownerships are 131 companies (42%), partnerships 32 (10%), limited companies (public and private) 128 (41%), and public corporations (Federal ownership, Special Corporation , Provincial government establishment, Local body government establishment) 20 (6%). More than 80 % of the total are companies with less than 100 employees, and individual ownerships dominate. These features are common to the whole country of Pakistan. From these facts it is easily seen that the research and development investment in manufacturing is on a very low level. The role of engineering universities is critically important for the improvement of local industries. The N-W.F.P. University of Engineering and Technology, Peshawar has been providing manufacturers with competent engineers and technical services such as training of engineers of enterprises and contract researches.

2.2.2 Electric Power

At the time of the independence there was only one hydroelectric power station in Pakistan, the Malakand Hydroelectric Power Station of 20 MW in Jabban, Malakand in NWFP. This station was built upstream the Swat Canal in 1937 and its capacity was doubled with the construction of Dargai Dam in 1952.

The Warsak hydroelectric power station started its operation with the capacity of 240 MW in 1960. In 1962 a small station of 3 MW at Kurram Garhi in Bannu was built. The Tarbela hydroelectric power station started its operation with 800 MW in 1972 and its projected capacity is 4,500 MW at the time of completion. The total capacity of NWFP will be:

Jabban	20 MW
Dargai	20 MW
Warsak	240 MW
Kurram Garhi	3 MW
Tarbela (after completion)	4,500 MW
Total	4,783 MW

Source: N-W.F.P.University of Engineering and Technology

Of this generating capacity of NWFP, the electricity consumed in the Province is only approximately 600 MW. NWFP is less developed in industry than other provinces as seen from its relatively little consumption of electricity. The need of more development of industry in NWFP is seen from this. While the total demand in Pakistan is about 16,000 MW, the total generation is only about 7,000 MW, that is, the generating capacity meets only 50 % of all power demands. It is more needed to develop the electricity generating capacity of the Province.

NWFP has a big potential capacity of hydroelectric power, and it is noted that the Province and its engineers have been pioneers in hydroelectric power generation. The N-W.F.P. University of Engineering and Technology has been playing an important role in providing competent electric engineers and is expected to be further active in this field.

2.2.3 Mining

As mentioned before, the northwestern part of NWFP is a mountainous region and is abundant in mineral resources as is the neighboring Baluchistan Province. Geological surveys have confirmed the abundant existence of metals and non-metals of high grade. The major minerals which are most promising in quality and quantity are iron ores, copper ores, chromic ores, marble, phosphate ores, gypsum, soap stones etc.

The mineral production of NWFP in 1990-91 is shown in Table 2.2.2.

Table 2.2.2 Mineral Production of NWFP

	NWFP(A)	WHOLE COUNTRY(B)	RATIO (A/B)%
Antimony	41	128	(32%)
Aragonite/Marble	257,647	281,518	(92%)
Barytes	518	26,222	(2%)
China Clay	518	26,222	(77%)
Chromite	2,576	23,669	(10%)
Coal	41,604	2,872,414	(1%)
Fire Clay	370	120,038	(0%)
Flourite	260	1378	(19%)
Fuller's Earth	2,419	22,743	(11%)
Gypsum	141,975	468,278	(30%)
Lime Stone	1,952,709	9,008,941	(22%)
Magnesite	2,960	4,192	(71%)
Rock Salt	63,970	735,906	(9%)
Silica Sand	18,871	142,557	(13%)
Soap Stone	31,593	31,593	(100%)

Source: Pakistan Statistical Yearbook 1991

Other promising mineral resources in Pakistan include crude oil, natural gas, bauxite, sulphur etc. However, these minerals are not exploited in NWFP at present.

2.3 Present Status of Education

2.3.1 Outline of Education

Education is not wide spread in Pakistan. The literacy rate[1] is 26.2 % (male:35.1 %, female:16.0%), the second lowest next to Nepal in South Asia. The participation rate[2] at the primary school level is 66.3 % (male:83 %, female:42 %) of the age group. The participation rate at the middle school level is 44.6 % (male:58.9 %, female:29.4 %), at the high school level 27.2 % (male:36 %, female:17.2 %). The participation rate at the primary level is the lowest in South Asia. This is attributed to not only the institutional defects (shortage of facilities, shortage of teachers, poor quality of teachers, curriculum which is not attractive), but also the poverty and social customs (restraints in female participation in social activities). The participation rate at the secondary level education is increasing slowly, but drop-outs are estimated about 40-50% of the students. One of the reasons for a large number of drop-outs is attributable to lack of practical subjects in the curriculum. The Federal Government introduced subjects on agriculture and technology into the middle school curriculum and vocational subjects into the high school curriculum. However, these measures have not yet produced the intended effect on improvement of the situation due to shortage of qualified teachers. The secondary education as well as the primary education suffers from low quality and insufficient quantity of teachers.

Table 2.3.1 shows the numbers of the primary, middle and high & higher secondary schools, and the numbers of the students and teachers in these schools in Pakistan.

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1. Population Census 1981

2. 1991-92

Table 2.3.1 Students and Teachers in Primary, Middle and High & Higher Secondary Schools in Pakistan (1989-90)

	Schools	Students (in thousands)	Teachers (in thousands)	Student per School	Teacher per School	Student Teacher Ratio
Primary School	118,607	8,615	209.8	72.6	1.8	41.1
Middle School	7,161	2,397	68.2	334.7	9.5	35.1
High & Higher Secondary School	6,805	928	116.8	136.4	17.2	7.9

Source: N-W.F.P. University of Engineering and Technology

Notes: The school age is 5.
Primary School ; 5 years
Middle School ; 3 years
High School ; 2 years
Higher Secondary School ; 2 years

The literacy rate in the North-West Frontier Province is 16.7% (male:25.9%, female:6.5%) which is far below the country's average. This low rate seems to be attributed to the low school attendance of the children of farmers and nomadic tribes in the mountainous area. This is inferred from that the literacy rate is as low as 13.2 % in the rural area while it is 35.8 % in the urban area in the Province. The Provincial Government is making efforts to equalize opportunities of education, to build new primary and middle schools or expand the existing schools, and to raise the attendance rate to the average of the country.

Table 2.3.2 shows the numbers of students and teachers of the primary, middle and high & higher secondary schools in the Province in 1990-1991. About 75% of the teachers have been trained in teaching, but the remaining 25% have not yet been trained. The problems are shortages of educational facilities, of qualified teachers and of educational equipment.

Table 2.3.2 Students and Teachers in Primary, Middle, High and Higher Secondary Schools in NWFP (1990-91)

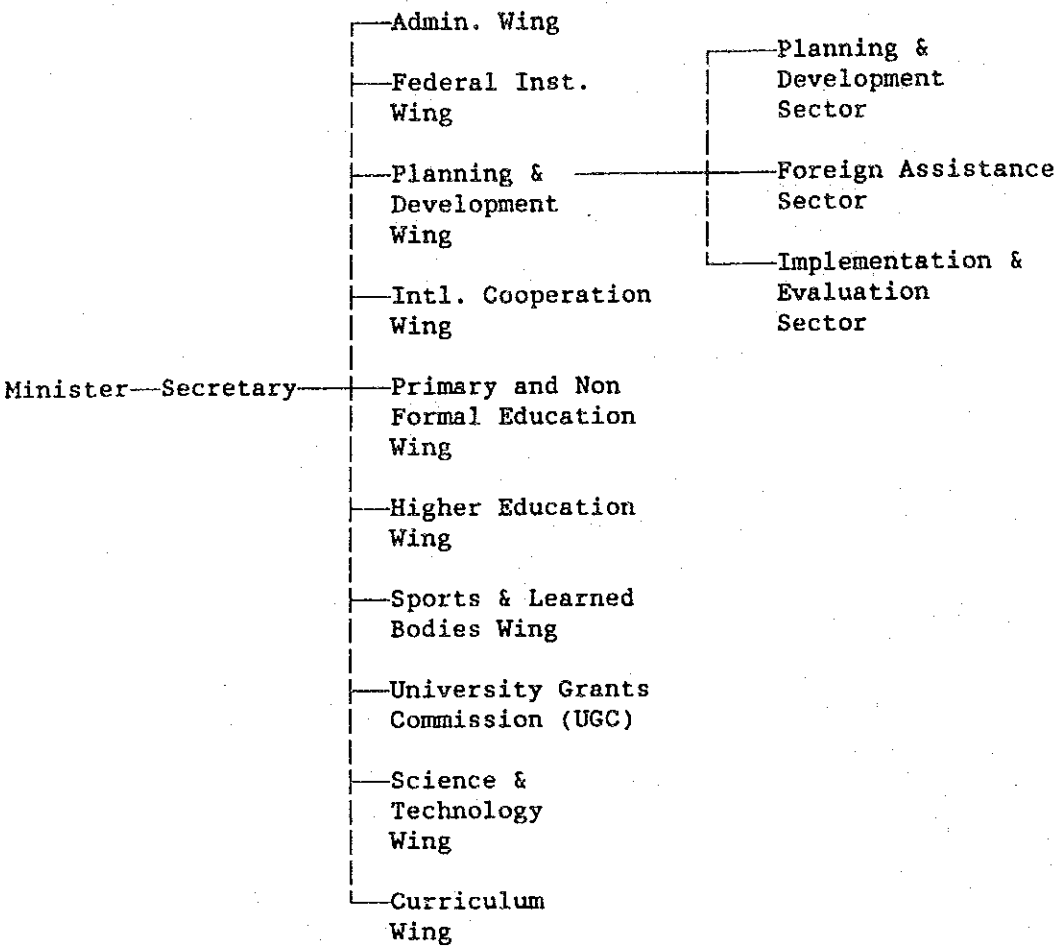
	Schools	Students (in thousands)	Teachers (in thousands)	Students per School	Teachers per School	Student Teacher Ratio
Primary School	10,615	1,102	32.4	103.8	3.1	34.0
Middle School	841	250	9.8	297.3	11.6	25.5
High & Higher Secondary School	1,039	396	17.9	381.1	17.2	22.1

Source: N-W.F.P.University of Engineering and Technology

2.3.2 Higher Education

The education in Pakistan is within the jurisdiction of the Ministry of Education of the Federal Government. Figure 2.3.1 is an organization chart of the Ministry of Education. Educational projects through international organizations and bilateral assistance like this "Project for Educational Equipment for the N-W.F.P.University of Engineering and Technology, Peshawar" is administered by the Planning and Development Wing and the University Grants Commission of the Ministry.

Fig. 2.3.1 Organization Chart of the Ministry of Education



The educational system of Pakistan comprises primary education (primary school of 5 years), secondary education and higher education. Secondary education is offered at three stages : grades 6-8 are offered in middle schools, 9-10 in high schools and 11-12 in higher secondary schools and intermediate colleges. Higher education institutions are classified into three groups ;degree colleges, general universities and professional institutions (engineering universities, medical colleges etc.) Degree colleges award a bachelor's degree after completion of 4 years' study (grades 11-14). General universities award a master's degree after completion of 4 years schooling (grades 13-16). Further 3 years are required to obtain a doctoral degree. The duration of post-secondary education varies in technical and professional institutions. A bachelor's degree in medicine requires five years of study after the intermediate course (in total 17 years schooling) and a bachelor's

degree course in engineering and veterinary medicine are of four years duration after the intermediate course (in total 16 years schooling).

There are 22 national universities at present. Fourteen of them are general universities, four are engineering universities , three are agricultural universities and one is a medical university. The enrollment in 1989-90 is 73,382, about 14% of which is female students. The number of teaching staff is 4,304 and the ratio of students to teacher is 17:1.

While the universities have postgraduate courses and are educational as well as research institutions, the most colleges take students completed a high school and provide intermediate as well as higher education. The general colleges are 575 and the vocational colleges (agriculture, engineering, medical, commerce, law, household management, education etc.) are 99 as of the 1989-90 educational year. Some of the general colleges award a B.A. degree on completing intermediate education of 2 years and college education of 2 years. The award of B.A. degree after 14 years of education is now rare in other countries. Generally it takes 16 years to graduate. In view that this system may produce inappropriately educated graduates, the Ministry of Education initiated a proposal to transform these colleges into institutions concentrated on the secondary education. Consequently a B.A. degree will be awarded to graduates only from the universities in the future.

Unemployment of graduates from universities and colleges is a serious social problem. This may be attributed to the rapid increase of university and college graduates as a result of the higher education policy which has placed emphasis on the quantity rather than on the quality of graduates, and to the fact that a relatively large number of students major in humanities and social sciences which provide less job opportunities. In these circumstances, the Seventh Five Year Plan does not allow to open a new university or college in the public sector and emphasizes on improvement of the quality of education. Especially the Government places emphasis on technical education in the science and engineering departments of higher educational institutions and intends to strengthen their functions as suppliers of manpower needed to advance industrialization.

At present there are only 4 engineering universities and 11 technical colleges that provide engineering education. The graduates amount to about ten thousand a year and are small in numbers compared with one hundred fifty thousand graduates from general universities and colleges. The facilities and equipment of these engineering institutions are old, deteriorated, not sufficient in quantity and of poor quality. It is difficult for these institutions to follow the rapid progress of science and technology of today. The very limited budget makes it extremely difficult for these institutions to improve their facilities and equipment. Most universities are said to be operated at a deficit. Consequently the Ministry of Education often requests foreign governments and international organizations for financial assistance to purchase equipment for the engineering universities and technical colleges. Japan has offered Grant Aids to Mehran University of Engineering and Technology, Jamshoro; Mehran University College of Engineering and Technology, Nawabshah; Baluchistan Engineering College, Khuzdar (the above three are under the jurisdiction of the Ministry of Education); National College of Textile Engineering, Faisalabad (under the jurisdiction of the Ministry of Industries); H.E.J. Research Institute of Chemistry of the University of Karachi; the Faculty of Science of the University of the Punjab; the Faculty of Natural Science of Quaid-e-Azam University, Islamabad (the above three are under the jurisdiction of the Ministry of Education) etc.

Expansion of higher engineering education at universities in Pakistan is one of the cores in the Long-Term and Medium-Term Plans. Education and training of engineering personnel improves all sectors of economy and constitutes a basis of industrialization. The expansion of engineering universities will improve the technical services (such as refresher courses for factory engineers, technical training, contract researches etc.) which the universities provide to local communities, and will make a significant contribution to the development of industry of Pakistan.

2.4 Outline of the N-W.F.P. University of Engineering and Technology, Peshawar

2.4.1 Overview

The N-W.F.P. University of Engineering and Technology, Peshawar was founded in 1980 as a premier engineering education institution in the North-West Frontier Province to meet increasing demands for engineering education. The engineering education in NWFP started in 1952 with the establishment of an engineering college which had undergraduate courses in electrical engineering and mechanical engineering. In 1953 a department of civil engineering was opened and in 1961 a department of agricultural engineering and in 1974 a mining engineering department. In October 1974, the college was incorporated into the University of Peshawar as the Faculty of Engineering. In October 1980 the Faculty of Engineering was separated from the University of Peshawar and became an independent university as the North-West Frontier Province University of Engineering and Technology, Peshawar. A master course in civil engineering was opened in 1983 and now all the departments have master courses.

The N-W.F.P. University of Engineering and Technology, Peshawar is located in the southwest part of Peshawar, the Provincial capital and occupies one part of a large university campus (the total area of 4,000,000 m^2, the population of about 20 thousand) which houses the University of Peshawar, the NWFP Agricultural University, Peshawar and Khyber Medical College, Peshawar as well. For the historical reason mentioned above, the N-W.F.P. University of Engineering and Technology, Peshawar resides in the buildings of the previous Faculty of Engineering of the University of Peshawar. However, the existing buildings do not have enough space to accommodate the projected new departments and postgraduate courses. The construction of a new campus is being planned and a site of about 1,600,000 m^2 has been acquired near Village Jalozai on the Pabbi-Cherat Road located 30 km southeast of Peshawar. This equipment provision project is part of a project "Strengthening of Academic Facilities of N-W.F.P. University of Engineering & Technology" planned by the University. The University requested a Grant Aid of the Japanese Government for the laboratory equipment which requires foreign exchange for purchase.

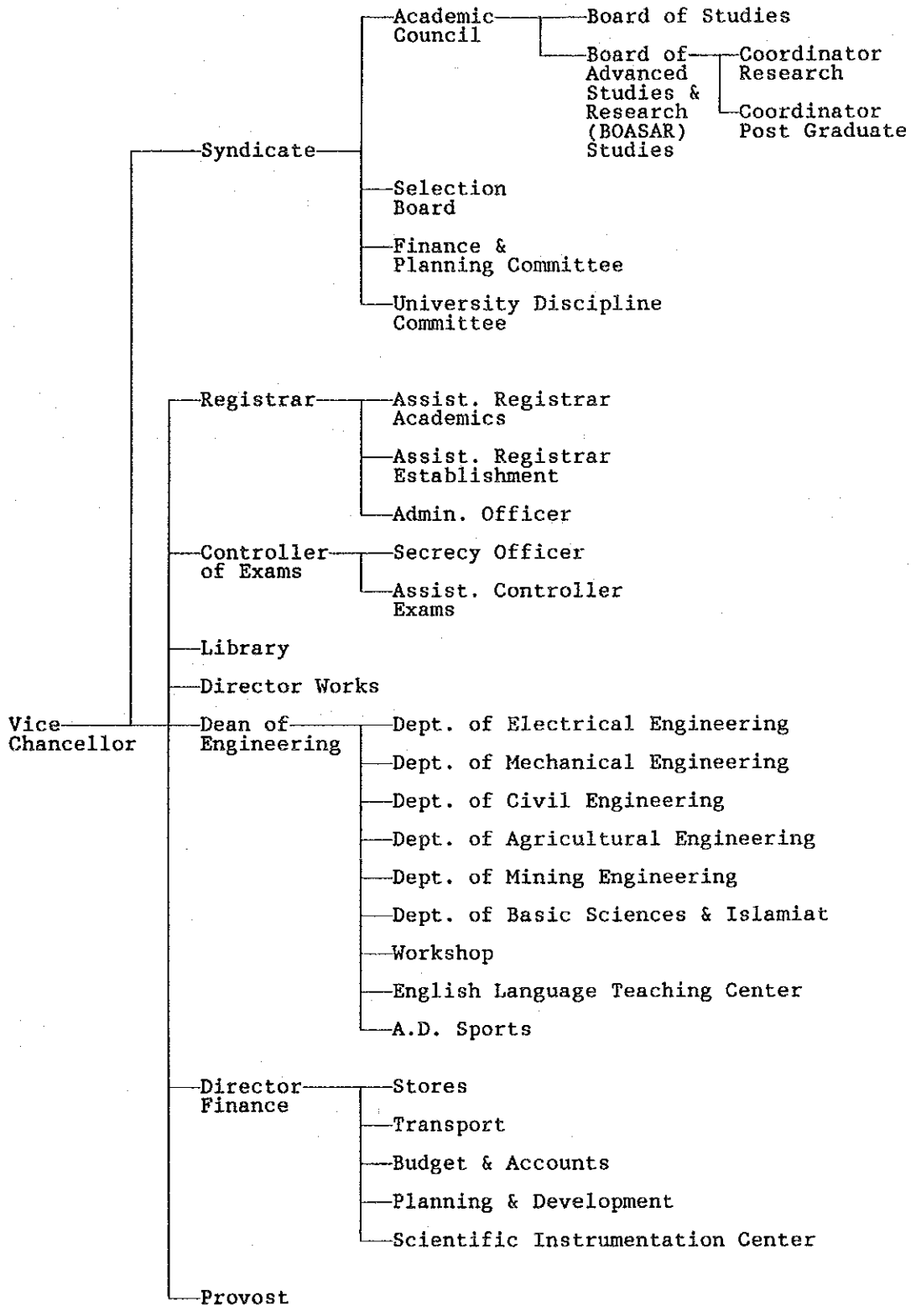
The campus area which the University occupies at present is about 65,000 m^2 and the student hostels and staff residences are scattered in the surrounding area.

2.4.2 Organizational Structure and Educational Activities

Engineering education in the University may be said to have started when the engineering college was opened in 1952. However, as mentioned before, the present organization was formed after the N-W.F.P. University of Engineering & Technology was inaugurated in 1980. Figure 2.4.1 shows an organizational chart of the University.

The Chancellor of the University is the Governor of the Province. The management of the University is the responsibility of the Vice Chancellor. The Dean of Engineering supervises all the departments. The Faculty of Engineering has the Department of Electrical Engineering, the Department of Mechanical Engineering, the Department of Civil Engineering, the Department of Agricultural Engineering, the Department of Mining Engineering and the Department of Basic Sciences which teaches subjects common to all the departments. The University Workshop, the English Language Center, and Sports Clubs are also under the supervision of the Dean of Engineering. Each department has several laboratories. Expansion and revision of curriculum to incorporate the progress of technology and the change of social needs requires reorganization of existing laboratories or establishment of new laboratories. The laboratories have increased in number since the time when the initial project was drawn up in 1987.

Fig. 2.4.1 **Organization Chart of N-W.F.P.University of Engineering and Technology, Peshawar**



The Board of Advanced Studies and Research (BOASAR) is an organ to advise the University of all matters relating to higher education and research. It consists of 19 members; Vice-Chancellor, Dean of Engineering, Registrar, one professor from each teaching Department, and eight eminent engineers and scientists, one secretary and Director of postgraduate education. It is also to frame rules and regulations for postgraduate degrees, to approve research proposals of M.Sc. students, to consider proposals for research by faculty members and award research grants, to monitor faculty research and to utilize the results of research.

As of October 1992, 1,159 students are enrolled in the undergraduate and postgraduate courses (ref. Table 2.4.1): 374 (32%) in the Department of Electrical Engineering, 290 (25%) in the Department of Mechanical Engineering, 383 (33%) in the Department of Civil Engineering, 76 (7%) in the Department of Agricultural Engineering and 36 (3%) in the Department of Mining Engineering. The female students are only 21 (2%).

Table 2.4.1 Class-Wise Enrollment of Students

(undergraduate:1991-92, postgraduate:1992)

	1 Year	2 Year	3 Year	4 Year	B.Sc. Eng.	M.Sc. Eng.	Grand Total
Dept. of Elec Eng.	100 (3)	90 (2)	82 (2)	91 (2)	363 (9)	11 (-)	374
Dept. of Mech. Eng.	86 (2)	79 (-)	61 (-)	58 (-)	284 (2)	6 (-)	290
Dept. of Civil Eng.	95 (2)	98 (2)	94 (4)	82 (-)	369 (8)	14 (-)	383
Dept. of Agri. Eng.	28 (2)	17 (-)	12 (-)	14 (-)	71 (2)	5 (-)	76
Dept. of Mining Eng.	18 (-)	7 (-)	5 (-)	3 (-)	33 (-)	3 (-)	36
Total	327 (9)	291 (4)	254 (6)	248 (2)	1,120 (21)	39 (-)	1,159

Source: N-W.F.P. University of Engineering and Technology

Note: The figures in parentheses are numbers of female students.

Foreign students amount to 57 in total. Table 2.4.2 shows a class-wise breakdown.

Table 2.4.2 Enrollment of Foreign Students (1991-92 in B.Sc.Eng.)

	1 Year	2 Year	3 Year	4 Year	Total
Dept. of Elec Eng.	7	3	4	3	17
Dept. of Mech. Eng.	3	3	3	2	11
Dept. of Civil Eng.	6	7	5	4	22
Dept. of Agri. Eng.	1	2	2	1	6
Dept. of Mining Eng.	-	1	-	-	1
Total	17	16	14	10	57

Source: N-W.F.P. University of Engineering and Technology

The breakdown by country is as follows: 23 from Jordan, 14 from Palestine, 13 from Afghanistan, 4 from Somalia, 1 each from Bangladesh, Sudan and Yemen.

The number of teaching staff is 105 at present. There are some vacant posts. The number of posts is 119 as indicated in Table 2.4.3. The academic qualifications of the staff members are shown in Table 2.4.4. The Ph.D holders account for 10 % of the staff, the M.Sc. or Eng. holders 46 % and the B.Sc.or Eng. 44 %. The University is to require M.Sc.or Eng. for the minimum qualification of its teachers. It is urgently needed to upgrade the quality of the teaching staff and to increase the quantity.

The staff members studying abroad for higher degrees amount to 21 as shown in Table 2.4.5. The countries in which they study are mainly the United Kingdom and U.S.A. The University of Strathclyde with which the University has established a link programme is in the United Kingdom.

Table 2.4.3 **Number of Teachers & Staff in Each Discipline (Professors, Associate Professors, Assistant Professors, Lecturers, Technical Staff & Assistant Workers)**

	Prof.	Assoc. Prof.	Assist. Prof.	Lecturer	Teachers Total	Technical Staff	Lab/Shop Attendant	Grand Total
Dept. Elec. Eng.	5	6	5	6	22	18	15	55
Dept. Mech. Eng.	7	1	5	8	21	25	16	62
Dept. Civil Eng.	6	5	6	5	22	27	15	64
Dept. Agri. Eng.	3	2	3	2	10	11	9	30
Dept. Min. Eng.	2	2	4	2	10	9	6	25
Dept. Basic Sc. & Islamiat	4	7	7	8	26	15	12	53
Workshop	1	0	0	1	2	28	9	39
Floating	0	2	0	0	2	0	0	2
Others	1	0	1	2	4	5	6	15
Total	29	25	31	34	119	138	88	345

Source: N-W.F.P. University of Engineering and Technology

Notes: The figures are the numbers of posts. The actual number of staff is shown in Table 2.4.4

Technical Staff; Instructor, Laboratory Superintendent, Principal Technician/Laboratory Technologist, Technician, Laboratory Assistant.

Table 2.4.4 **Number of Teachers by Qualification**

	B.Sc.Eng./M.A./M.Sc.		M.S./M.Phil.		Ph.D.		TOTAL
	Local	Foreign	Local	Foreign	Local	Foreign	
Dept. Elec. Eng.	5	-	1	10	-	4	20
Dept. Mech. Eng.	12	-	3	4	-	2	21
Dept. Civil Eng.	8		4	7		-	19
Dept. Agri. Eng.	3	-	1	6	-	1	11
Dept. Min. Eng.	7	-	-	4	-	1	12
Dept. Basic Sc. & Islamiat	10	-	5	3	-	3	21
Workshop	1	-	-	-	-	-	1
TOTAL	46	-	14	34	-	11	105

Source: N-W.F.P. University of Engineering and Technology

Notes: In Pakistan B.Sc.Eng.(graduate from engineering universities) is regarded as equivalent to M.A./M.Sc.(graduate from general universities). The University requires B.Sc. for the minimum qualification for its teachers.

Table 2.4.5 Staff on Higher Studies Abroad (as of September 1992)

	PhD	MA	Total
Dept. of Elec. Eng.	3	1	5
Dept. of Mech. Eng.	3	2	5
Dept. of Civil Eng.	3	2	4
Dept. of Agri. Eng.	1	1	2
Dept. of Mining Eng	2	3	5
Total	12	9	21

Source: N-W.F.P. University of Engineering and Technology

Graduates from the University (including its predecessors) from 1955 to 1990-91 amount to 5,482. The breakdown by subjects is shown in Table 2.4.6.

Table 2.4.6 Graduates from the University and its Predecessors (1955 to 1990-91)

Department of Electrical Eng.	1,802
Department of Mechanical Eng.	1,488
Department of Civil Eng.	1,937
Department of Agricultural Eng.	137
Department of Mining Eng.	118
Total	5,482

Source:N-W.F.P. University of Engineering and Technology

Table 2.4.7 shows the numbers of graduates after 1985-86.

Table 2.4.7 Output of Graduate Engineers

	1985-86	86-87	87-88	88-89	89-90	90-91	Total
Elec. Eng.	68	63	71	85	90	71	448
Mech. Eng.	78	73	70	72	67	66	426
Civil Eng.	102	73	64	90	71	74	474
Agri. Eng.	14	5	12	14	15	12	72
Mining Eng.	17	7	11	13	11	9	68
Total	279	221	228	274	254	232	1,488

Source:N-W.F.P. University of Engineering and Technology

About 70% of the graduates of the University work for governmental organizations, about 10 % in private enterprises and about 5% in self employment, as shown in Table 2.4.8.

Table 2.4.8 Job Distribution of Graduates

Government Organizations	about 70%
Private Enterprises	about 10%
Self Employment	about 5%
Studying Abroad	about 5%
Resident Abroad	about 1%
Unemployed	about 9%
Total	100%

Source: N-W.F.P. University of Engineering and Technology

2.4.3 Curriculum

The present curricula of the five Departments: Department of Electrical Engineering, Department of Mechanical Engineering, Department of Civil Engineering, Department of Agricultural Engineering and Department of Mining Engineering are shown in Table 2.4.9.

Table 2.4.9 **N-W.F.P. University of Engineering and Technology, Peshawar Scheme of Studies**

(1) Department of Electrical Engineering

Course No.	Course	MARKS Theory	Pract.	Total
	FIRST YEAR			
BSI 101	Mathematics A	75	-	150
	B	75	-	
BSI 102	Applied Mechanics	100	50	150
BSI 103-A	Applied Physics	60	-	100
	and Chemistry	40	-	
BSI 105	Islamiat and Pakistan Studies	100	-	100
BSI 106	Computer Programming	50	50	100
CE 112	Basic Civil Engineering	100	50	150
ME 121	Engineering Drawing and Graphics	100	50	150
EE 132	Basic Electrical Engineering	100	50	150
EE 133	Basic Electronics	100	50	150
	TOTAL	900	300	1200
	SECOND YEAR			
BSI 201	Mathematics A	75	-	150
	B	75	-	
CE 217	Hydraulics & Hydraulic Machinery	100	50	150
ME 225	Engineering Workshop	-	50	50
ME 226	Applied Thermodynamics	100	50	150
EE 231	Electrical Machines-I	100	50	150
EE 232	Electrical Circuit Theory	100	50	150
EE 233	Electronics-I	100	50	150
EE 234	Measuring Instruments and Utilization	100	50	150
EE 235	Power Generation	100	-	100
	TOTAL	850	350	1200

		THIRD YEAR			
BSI	301	Mathematics A	75	-	150
		B	75	-	
BSI	303	Project Planning & Management & Engineering Economics	100	-	100
EE	331	Digital Electronics	100	50	150
EE	332	Electrical Measurement	100	50	150
EE	333	Electronics-II	100	50	150
EE	334	Electromagnetic Fields	100	-	100
EE	335	Electrical Circuit Analysis	100	-	100
EE	336	A) Power Group a) Electrical Machines-II B) Communication/Electronics Group b) Principles of Communication Systems	100	50	150
		TOTAL	850	200	1050
		FINAL YEAR			
EE	431	Line Communication	100	50	150
EE	432	Control Systems	100	50	150
EE	433	Electronics-III	100	50	150
		Project	-	150	150
		A) Power Group			
EE	434-A	High Voltage Engineering	100	50	150
EE	435-A	Power System Engineering	100	50	150
EE	436-A	Power Transmission and Distribution	100	-	100
EE	437-A	Applied Electronics	100	50	150
		B) Communication Group			
EE	434-B	Electromagnetic Waves and Radiation System	100	50	150
EE	435-B	Communication Systems-II	100	50	150
EE	436-B	Microprocessor Systems	100	50	150
EE	437-B	Digital Signal Processing	100	-	100
		TOTAL	700	450	1150

(2) Department of Mechanical Engineering

Course No.	Course	MARKS Theory	Pract.	Total
	FIRST YEAR			
BSI 101	Mathematics A	75	-	150
	B	75	-	
BSI 102	Engineering Mechanics	100	50	150
BSI 103-B	Physics	100	50	150
BSI 104	Applied Chemistry	100	50	150
BSI 105	Islamiat & Pakistan Studies	100	-	100
BSI 106	Computer Programming	50	50	100
CE 112	Basic Civil Engineering	100	50	150
ME 121	Engineering Drawing and Graphics	100	50	150
WS 161	Workshop Practice	-	50	50
	TOTAL	800	350	1150
	SECOND YEAR			
BSI 201	Mathematics A	75	-	150
	B	75	-	
EE 131	Electrical Technology	100	50	150
ME 221	Applied Thermodynamics	100	50	150
ME 222	Workshop Technology	100	50	150
ME 223	Machine Drawing & Design-I	100	50	150
ME 224	Theory of Machines-I	100	50	150
ME 225	Fluid Mechanics	100	50	150
ME 228	Automobile Engineering	100	50	150
	TOTAL	850	350	1200
	THIRD YEAR			
BSI 301	Mathematics-III (A&B)	150	-	150
ME 321	Machine Drawing & Design-II	100	50	150
ME 322	Engineering Metallurgy	100	50	150
ME 323	Production Engineering-I	100	50	150
ME 324	Mechanical Vibration	100	50	150
ME 325	Power Plants-I	100	50	150
ME 326	Fluid Mechanics $ Hydraulics Machinery	100	50	150
ME 327	Advanced Thermodynamics	100	50	150
	TOTAL	850	350	1200

		FINAL YEAR			
ME	421	Machine Design-III	100	50	150
ME	422	Power Plants-II	100	50	150
ME	423	Heat Transfer	100	50	150
ME	424	Refrigeration & Airconditioning	100	50	150
ME	425	Industrial & Operation Management	100	50	150
ME	426	Production Engineering-II	100	50	150
ME	427	Automatic Control and Instruments	100	50	150
ME	428	Project	-	150	150
		TOTAL	700	500	1200

(3) Department of Civil Engineering

Course No.	Course	MARKS Theory	Pract.	Total
	FIRST YEAR			
BSI 101	Mathematics A	75	-	150
	B	75	-	
BSI 102	Applied Mechanics	100	50	150
BSI 103-B	Physics	100	50	150
BSI 105	Islamiat and Pakistan Studies	100	-	100
BSI 106	Computer Programming	50	50	100
CE 113	Engineering Materials	100	50	150
ME 121	Engineering Drawing and Graphics	100	50	150
EE 131	Electrical Technology	100	50	150
WS 161	Workshop Practice	-	50	50
	TOTAL	800	350	1150
	SECOND YEAR			
BSI 201	Mathematics A	75	-	150
	B	75	-	
CE 211	Strength of Materials-I	100	50	150
CE 212	Structural Engineering-I	100	50	150
CE 213	Fluid Mechanics-I	100	50	150
CE 214	Building Construction & Drawing	100	50	150
CE 215	Engineering Geology	100	50	150
CE 216	Surveying-I	100	50	150
ME 227	Mechanical Technology	100	50	150
	TOTAL	850	350	1200
	THIRD YEAR			
BSI 302	Mathematics	100	-	100
BSI 303	Project Planning & Management & Engineering Economics	100	-	100
CE 311	Strength of Materials-II	100	50	150
CE 312	Structural Engineering-II	100	50	150
CE 313	Fluid Mechanics-II	100	50	150
CE 314	Soil Mechanics	100	50	150
CE 315	Plain & Reinforced Concrete	100	50	150
CE 316	Surveying-II (field surveying is compulsory)	100	50	150
CE 317	Town Planning & Architecture	100	-	100
	TOTAL	900	300	1200

		FINAL YEAR			
CE	411	Irrigation Engineering	100	50	150
CE	412	Structural Engineering-III	100	50	150
CE	413	Hydraulics and Hydrology	100	50	150
CE	414	Soil Mechanics & Foundation Engineering	100	50	150
CE	415	Design of Concrete Structures (Selective Topics)	100	50	150
CE	416	Public Health Engineering	100	50	150
CE	417	Transportation Engineering:			
		a) Traffic & Highway Engineering	100	25	200
		b) Airport & Railway Engineering	50	25	
CE	418	Project	-	150	150
		TOTAL	750	500	1250

(4) Department of Agricultural Engineering

Course No.	Course	MARKS Theory	Pract.	Total
	FIRST YEAR			
BSI 101	Mathematics A	75	-	150
	B	75	-	
BSI 102	Applied Mechanics	100	50	150
BSI 105	Islamiat and Pakistan Studies	100	-	100
BSI 106	Computer Programming	50	50	100
CE 113	Engineering Materials	100	50	150
ME 121	Engineering Drawing and Graphics	100	50	150
AGE 141	Basic Agricultural Engineering	100	50	150
AGE 142	Soil & Water Conservation Engineering	100	50	150
WS 161	Workshop Practice	-	50	50
	TOTAL	800	350	1150
	SECOND YEAR			
BSI 201	Mathematics A	75		150
	B	75		
CE 213	Fluid Mechanics-I	100	50	150
CE 216	Surveying-I	100	50	150
ME 223	Machine Drawing and Design	100	50	150
AGE 241	Soil Physics	100	50	150
AGE 242	Principles & Practices of Water Management	100	50	150
AGE 243	Rural Electrification	100	50	150
AGE 244	Strength of Materials	100	50	150
	TOTAL	850	350	1200
	THIRD YEAR			
BSI 302	Mathematics	100	-	100
BSI 303	Project Planning & Management & Engineering Economics	100	-	100
AGE 341	Agricultural Processing Engineering	100	25	125
AGE 342	Farm Machinery & Earth Moving Equipment	100	50	150
AGE 343	Farm Irrigation System	100	50	150
AGE 344	Structural Engineering	100	25	125
CE 313	Fluid Mechanics-II	100	50	150
CE 315	Plain & Reinforced Concrete	100	50	150
CE 316	Surveying-II (field surveying is compulsory)	100	50	150
	TOTAL	900	300	1200

	FINAL YEAR			
AGE 441	Farm Power	100	50	150
AGE 442	Ground Water and Wells	100	50	150
AGE 443	Drainage Engineering	100	50	150
AGE 444	Project	-	150	150
AGE 445	Soil Mechanics	100	50	150
AGE 446	Irrigation Engineering	100	50	150
AGE 447	Design of Agricultural Machinery	100	50	150
AGE 448	Environmental Engineering	100	50	150
	TOTAL	700	500	1200

(5) Department of Mining Engineering

Course No.	Course	MARKS Theory	Pract.	Total
	FIRST YEAR			
BSI 101	Mathematics A	75	-	150
	B	75	-	
BSI 104	Applied Chemistry	100	50	150
BSI 105	Islamiat and Pakistan Studies	100	-	100
BSI 106	Computer Programming	50	50	100
ME 121	Engineering Drawing and Graphics	100	50	150
EE 131	Electrical Technology	100	50	150
MINE 151	Basic Mining Engineering	100	50	150
MINE 152	Physical Geology	100	50	150
WS 161	Workshop Practice	-	50	50
	TOTAL	800	350	1150
	SECOND YEAR			
BSI 201	Mathematics A	75	-	150
	B	75	-	
AGE 244	Strength of Materials	100	50	150
ME 225	Fluid Mechanics	100	50	150
ME 227	Mechanical Technology	100	50	150
MINE 251	Mineralogy & Petrology	100	50	150
MINE 252	Applied Explosives & Blasting Techniques	100	50	150
MINE 253	Mining Systems-I	100	50	150
MINE 254	Mining Surveying-I	100	50	150
	TOTAL	850	350	1200
	THIRD YEAR			
MINE 351	Structural Geology	100	50	150
MINE 352	Mining Systems-II	100	50	150
MINE 353	Design of Tunnels & Shafts	100	-	100
MINE 354	Mineral Processing-I	100	50	150
MINE 355	Mine Surveying-II	100	50	150
MINE 356	Mining & Petroleum Geology	100	-	100
MINE 357	Cement Technology	100	-	100
MINE 358	Mine Economics & Management	100	50	150
MINE 359	Fuel & Energy Resources	100	50	150
	TOTAL	900	300	1200

	FINAL YEAR			
MINE 451	Rock Mechanics Design in Mining	100	50	150
MINE 452	Drilling Technology	100	50	150
MINE 453	Mineral Processing-II	100	50	150
MINE 454	Metallurgy	100	50	150
MINE 455	Mining Laws & Safety	100	50	150
MINE 456	Mine Machinery & Material Handling	100	50	150
MINE 457	Mine Environment Engineering	100	50	150
MINE 458	Mine Project	-	150	150
	TOTAL	700	500	1200

2.4.4 Existing Equipment and Maintenance

Most pieces of equipment in the laboratories of the University were transferred from the Faculty of Engineering of the University of Peshawar when the University became independent of the University of Peshawar in 1980.

Soon after the Engineering College was founded in 1952, the Colombo Plan provided the College with basic equipment necessary for the electrical, mechanical, civil engineering departments and the workshop.

In the 1960's USAID (United States Agency for International Development) donated equipment to the hydraulic laboratory of the Department of Civil Engineering and to the Department of Agricultural Engineering. In the first half of 1980's USAID also provided equipment for the Department of Agricultural Engineering. In 1989 WHO (World Health Organization) provided the public health laboratory of the Department of Civil Engineering with equipment worth US$ 27,000. Besides the University has purchased a few pieces of equipment on its own funds.

As mentioned above many pieces of equipment were installed in a period of 1955-65, and are old and obsolete. These can not be used for experiments on recent themes which reflect the present-day science and technology. The quantity of equipment is not enough to cater the increasing number of students.

The laboratories are spacious and a few pieces of equipment are placed neatly in a spacious room. The instruments are clean and old machines are still operated in good condition. Enough technicians are assigned to each department and equipment is carefully maintained.

The number of the teaching staffs and technicians for the operation and maintenance of equipment is shown in Table 2.4.3.

The operating budget of the University including the maintenance costs of facilities and equipment is provided by the Ministry of Education through the University Grant Commission in terms of the Government Grant-in-Aid.

Table 2.4.10 shows the annual budgets of the past five years. As seen from this Table, the annual maintenance fees of equipment is about 0.3 million Rupees and the consumable expenses are about 0.3 million Rupees. The annual budget for purchasing equipment and materials is about 2 million Rupees. The annual utility expenses are about 8 million Rupees, and the annual maintenance and repair expenses of buildings, hostels and residences are about 2 million Rupees.

Table 2.4.10 Expenditure and Income of N-W.F.P. University of Engineering and Technology, Peshawar

(Rupee)

	1987-88	1988-89	1989-90	1990-91	1991-92
EXPENDITURE					
Personnel Expenses	19,891,048	20,589,859	20,177,407	22,352,430	30,371,264
Utility Expenses	5,335,146	6,673,281	5,709,672	7,081,400	8,032,036
Equipment & Materials	1,886,232	1,772,304	1,450,849	1,867,433	2,227,097
Maintenance Fees	151,238	219,223	225,786	275,918	328,215
Annual Maintenance & Repair of University Buildings, Residences & Hostels	1,860,293	1,920,210	2,935,802	1,996,341	1,349,328
Consumable Expenses	158,153	248,059	302,457	240,297	345,671
Other Expenses	2,740,373	3,725,062	3,811,681	3,909,512	7,435,393
Expenditure Total	32,022,483	35,147,998	34,613,654	37,723,331	50,089,004
INCOME					
Opening Balance	2,477,735	3,572,858	602,595	205,548	159,527
Govt. Grant in Aid	30,614,217	29,094,711	32,065,149	34,240,922	46,963,837
Own Income	2,503,389	3,083,024	2,151,458	3,436,388	3,211,742
Income Total	35,595,341	35,750,593	34,819,202	37,882,858	50,335,106
Closing Balance	3,572,858	602,595	205,548	159,527	246,102

Source: N-W.F.P.University of Engineering & Technology

2.4.5 Scientific Instrumentation Center

The Scientific Instrumentation Center was established in the University in 1983 with the assistance of UNDP. The equipment was provided by UNDP and the University provided the building and furniture. The workshops for electronics, precision instruments and glassware are now in operation and doing repair of instruments, testing and measurement etc. The Center repairs not only instruments of the University but also instruments of other universities such as the University of Peshawar, Khyber Medical College and NWFP Agricultural University, Peshawar. It also organizes seminars on maintenance of equipment for engineers of other organizations. The Center will give strong support to the maintenance of equipment.

2.4.6 Link with a Foreign University

The University established a link programme with the University of Strathclyde, Glasgow (U.K.) in 1983. The University obtained an approval of the Federal Government to receive assistance from U.K. The assistance sponsors the Programme in Soil and Water Resource Management of the Department of Civil Engineering and in Electrical Power Engineering of the Department of Electrical Engineering. The programme was further revised in February 1991. The revised programme includes provision of facilities of higher education in Strathclyde University for the teachers of the N-W.F.P. University of Engineering and Technology, Peshawar in the M.S. and Ph.D. courses in civil and electrical engineering, exchange of staff from either side, and provision of laboratory equipment. This is a five year programme commencing from 1990-91 and ending 1994-95. The capital cost is 18.8 million Rupees including a foreign exchange component of 17.7 million Rupees.

2.4.7 Others

In addition to usual educational activities, the University provides technical assistance (expertise, experiment facilities) to government bodies, and public and private organizations. It also provides library services.

Almost all the departments conduct research for public organizations by contract. Through these activities the University contributes to the development of the local communities.

2.4.8 Role of the University

As mentioned before the North-West Frontier Province generates more than half of the electric power of the country and has a big potential for further hydroelectric power generation. It is urgently needed to provide competent engineers in electrical, mechanical and civil engineering to construct and operate more facilities to meet the increasing demand of electricity.

The Province is also rich in many kinds of mineral resources. Exploitation of these minerals will evidently help the economic and social development of Pakistan. The demand for mining engineers is increasing year by year.

The mainstay of economy of Pakistan is agriculture. Education of agricultural engineers is essential for the development of agriculture.

The University has a critically important role in providing engineers in these fields. The expansion and renewal of the facilities and equipment of the University will help produce engineers of high quality and contribute to the development of the North-West Frontier Province, the development of the industry of Pakistan and the improvement of the people's living.

2.5 Outline of Related Projects

2.5.1 Plans for Improvement and Expansion of Engineering Universities

As mentioned before, the Long-Term Perspective Plan (1988-2003) prescribes two major targets; towards increasing self-reliance and poverty alleviation. The plan emphasizes expansion of the manufacturing sector to sustain a stable economic growth.

The major targets of the current Seventh Five Year Plan (1988-1993) are to sustain an average GDP growth rate of 6.5 % per year , to encourage the private sector, to promote export and to reduce the budget deficit. To achieve these targets, emphasis is placed on the development of manufacturing, housing construction and agriculture. The industrial development is expected to contribute to creation of employment and reduction of regional imbalance in economy.

The Seventh Five Year Plan envisages development programmes of human resources placing emphasis on education and training. One of the objectives is to enhance a level of technology. To achieve this objective, priority must be put on producing a sufficient number of engineers and scientists of high quality through education and training. The Seventh Five Year Plan does not allow the establishment of a new university in the public sector, but projects to upgrade the quality of existing universities and colleges. The Plan addresses itself to the falling standards in educational institutions, particularly those in science and technology and to the urgent need to expand and modernize the facilities and equipment for experiments and practice at the departments or faculties of science and technology.

"The Project for Educational Equipment for the N-W.F.P. University of Engineering and Technology, Peshawar", fits in with the objectives of the Seventh Five Year Plan and constitutes part of the project "Strengthening of Academic Facilities of N-W.F.P. University of Engineering and Technology, Peshawar" planned by the University.

Projects for the development of the engineering education in Pakistan approved by the Federal Government in the Seventh Five Year Plan are the following three.

Table 2.5.1 Projects for the Development of the Engineering Education in Pakistan (Seventh Five Year Plan)

No.	Name of Project	Location	Approved Cost (million Rupees)
1.	Development of University of Engineering & Technology, Lahore	Lahore	49.2
2.	Development Scheme of NED University of Engineering and Technology, Karachi	Karachi	46.821
3.	Strengthening of Academic Facilities of N-W.F.P. University of Engineering & Technology,Peshawar	Peshawar	100.946

Source: N-W.F.P.University of Engineering & Technology

2.5.2 Strengthening of Academic Facilities of N-W.F.P. University of Engineering and Technology, Peshawar

The "Strengthening of Academic Facilities of N-W.F.P. University of Engineering & Technology" project includes the following components:

1. Purchase of educational equipment.
2. Construction of girls' hostels.
3. Construction of a library and administration blocks.
4. Construction of residences for the staffs and mosques.
5. Acquisition of a new campus site.
6. Purchase of transportation facilities for students.

Ten years have already passed since the University was separated from the University of Peshawar and became an independent status university. It is still housed in the buildings of the previous Faculty of Engineering of the University of Peshawar in the campus of the University of Peshawar. It is a

matter of course that the University drew up the above mentioned plan for improving the academic facilities including move to a new campus because new departments, postgraduate courses and new laboratories have been set up and the present campus does not have enough space to accommodate facilities for these new courses. A move to a new campus is being planned. It will take time to complete the move of the whole of the University.

The provision of equipment in the request is considered to be the most urgently needed component of the whole project in view of the fact that the existing equipment is obsolete and the upgrading of higher engineering education is urgently needed in Pakistan.

Of the components listed above, girls' hostels, administration blocks, a library, residences for the staffs and mosques have already been built in the present campus. A site for the new campus has already been acquired. The completion of facilities and move of the whole University to the new campus is projected to take about 20 years.

2.6 Background and Outline of the Request

2.6.1 Background of the Request

The Islamic Republic of Pakistan has carried out a series of Five Year Plans centering on the industrialization of the country since her independence in 1947 and has made efforts to raise the level of education in these plans. The current Seventh Five Year Plan (1988-93) also places emphasis on the development of human resources through education and training, and has taken measures to expand and strengthen the existing engineering universities.

The North-West Frontier Province is one of the four provinces constituting the country and most underdeveloped. The literacy rate and the participation rate at the primary education level are below the country's average due to the high proportion of rural population. The participation rate at the higher education level is as low as 5.1% of the age group.

The N-W.F.P. University of Engineering and Technology, Peshawar is a premier higher educational institution in the Province which educates engineers and has five departments: Department of Electrical Engineering, Department of Mechanical Engineering, Department of Civil Engineering, Department of Agricultural Engineering and Department of Mining Engineering. Since its predecessor, the Engineering College was founded in 1952, a large number of graduates have been working for the Province and they have been instrumental in the economic development of the Province. However, the experimental equipment has hardly been augmented since the inception of the institution. Most pieces of the equipment are already old and obsolete, and do not serve the educational purposes. The renewal and expansion of equipment is urgently needed.

The Provincial Government has recognized the importance of human resources development in every walk of life. The University made a plan for expansion of the academic facilities several years ago. However, financial constraints of the Provincial and Federal Governments obliged the University to revise the initial plan several times and the final version was submitted in 1991.

The Federal Government has requested the Japanese Government to provide a Grant Aid for a component of the plan, namely the purchase of equipment for the laboratories which requires foreign exchange.

2.6.2 Outline of the Request

(1) Objective

Most pieces of the equipment in the laboratories of the University are old and obsolete. These are not suitable for conducting experiments on the themes of the present-day science and technology. The quantity is not sufficient to meet the increasing number of students.

The objective of the project is to provide equipment for experiments and practice necessary in the higher engineering education required in the curricula of the University. This project constitutes a component of "Strengthening of Academic Facilities of N-W.F.P. University of Engineering and Technology, Peshawar", a project drawn up by the University.

(2) Executing Agency

The executing agency of this project is the N-W.F.P. University of Engineering and Technology, Peshawar.

(3) Contents of the Request

The equipment requested by the Government of Pakistan is the equipment to be used for education and research in the laboratories of the University. The number of items of the equipment listed in the original PC-1 form is 655: 129 items from the Department of Civil Engineering, 75 items from the Department of Electrical Engineering, 99 items from the Department of Mechanical Engineering, 113 items from the Department of Agricultural Engineering, 120 items from the Department of Mining Engineering, 50 items

from the Department of Basic Sciences, 2 item from the Workshop and 67 items for research. Table 2.6.1 shows breakdown of the numbers of items by laboratory. A list of equipment requested is in Appendix-5 at the end of the report.

Table 2.6.1 Number of Items of Equipment Requested
(PC-1 Form, 1987)

Laboratory	Number
1. Department of Electrical Engineering	75
1) Electronics Laboratory	44
2) Communication Laboratory	4
3) Power System Laboratory	27
2. Department of Mechanical Engineering	99
1) Automobile Engineering Laboratory	23
2) Heat Transfer Laboratory	19
3) Production Engineering Laboratory	12
4) Fuel and Metallurgy Laboratory	17
5) Geometrical Drawing Laboratory	28
3. Department of Civil Engineering	129
1) Soil Mechanics Laboratory	53
2) Concrete Laboratory	25
3) Highway Engineering Laboratory	47
4) Hydraulics Laboratory	2
5) Survey laboratory	2
4. Department of Agricultural Engineering	113
1) Agricultural Machinery & Power Testing Laboratory	85
2) Agricultural Engineering Laboratory	28

5. Department of Mining Engineering	120
1) Mine Safety & Mine Ventilation Laboratory	9
2) Mine Ventilation Laboratory	6
3) Mine Safety Laboratory	14
4) Mineral Dressing Laboratory	31
5) Drilling Laboratory	11
6) Rock Mechanics Laboratory	12
7) Survey Laboratory	20
8) Geology Laboratory	10
9) Teaching Aids	7
6. Department of Basic Sciences	50
1) Physics Laboratory	7
2) General Chemistry Laboratory	16
3) Analytical Chemistry Laboratory	7
4) Special Laboratory	10
5) Unit Operation & Pilot Plant Laboratory	10
7. University Workshop	2
1) Workshop	2
8. Equipment for Research	67
1) Civil Engineering	14
2) Electrical Engineering	9
3) Mechanical Engineering	18
4) Agricultural Engineering	13
5) Mining Engineering	13
Total	655

CHAPTER 3 OUTLINE OF THE PROJECT

Chapter 3 Outline of the Project

3.1 Objective

As mentioned before, the Government of the Islamic Republic of Pakistan addresses itself to its most important task of sustaining a stable economic growth through expansion of the manufacturing sector in order to achieve the two major targets; towards increasing self-reliance and poverty alleviation. The development of human resources through education and training is indispensable. The Seventh Five Year Plan envisages development programmes of human resources placing emphasis on education and training. It is one of the important development objectives to raise a level of technology. The Seventh Plan intends to upgrade the quality of existing universities and colleges and to improve the academic facilities and equipment.

The N-W.F.P. University of Engineering and Technology, Peshawar has hardly augmented or renewed its experimental equipment since the foundation. Most pieces of the equipment in the laboratories are old and obsolete and can not carry on experiments in the subjects which reflect the today's rapid progress of science and technology. The quantity of equipment is neither sufficient to cater for the increasing number of students. The increase of students and teachers is causing shortage of classrooms, student hostels, residences of the teaching staffs. The present campus has little room for housing new facilities. Consequently the University had drawn up some time ago a plan, "Strengthening of Academic Facilities of N-W.F.P. University of Engineering & Technology" including expansion of educational equipment. However, the plan had to be changed several times due to financial constraints of the Provincial and Federal Governments and was finalized in 1991.

The objective of this project for educational equipment for the University is to provide the University with equipment for experiments and practice necessary for higher engineering education in the curriculum of the University as part of the above mentioned University plan.

3.2 Study and Examination on the Request

3.2.1 Justification of the Project and Study of the Request

As mentioned in Section 3.1 "Objective", the educational equipment in the laboratories of the University will be expanded and the engineering education will be significantly improved when the project is realized. As the consequence the project is expected to contribute to the development of the Province, the industrial development of the country, a stable growth of economy and increase of living standards in Pakistan. The project is considered to be an appropriate and highly necessary one.

The project is expected not only to raise the standard of higher engineering education of the University, but also to have the following effects on the University:

1) Strengthening of the higher engineering education which can incorporate technological innovation.
2) Improvement of education in general.
3) Strengthening of the role of the University in helping industries in technology.
4) Expansion of the technical assistance to public and private organizations.

3.2.2 Implementation and Operation

The project will replace old and obsolete equipment with new equipment, furnish equipment which is not available at present, and make it possible to give the higher engineering education fit for the present technology. A management system to implement the project already exists and it is not necessary to set up or reorganize the present one. All the departments are under the control of Dean of Engineering. The chairman of a department is responsible for the laboratories of the department and supervises the technical staffs of his department. The laboratory technical staffs are instructors, laboratory superintendents, principal technicians/laboratory technologists, technicians and laboratory assistants and are helped by

laboratory/shop attendants.

The number of students is about 1,200 including postgraduate students. The number of students per teacher is about 10 and this ratio is appropriate when compared with that of industrialized countries. The number of technical staff engaged in the operation and maintenance of experimental equipment is 138 and the laboratory/shop attendants amount to 88. The total staff of laboratories adds up to 226 (refer to Table 2.4.3). The number of technical staff including laboratory/shop attendants per one laboratory is about 6, which is enough for one laboratory. The technical staff members maintain equipment very carefully and the equipment installed in the 1950's is still working in good condition. Judging from the excellent maintenance condition, it is assumed that there is no technical problem with maintenance of the existing equipment. However, since this project is expected to introduce a lot of new instruments it will be necessary to train the technical staff in the operation and maintenance technique of these instruments.

The equipment to be provided through this project will be placed in the existing laboratories. At present these laboratories house only a few pieces of equipment and have enough space to accommodate new equipment. The expenses for remodeling laboratories, foundation work and utility work which may be necessary to accommodate new equipment will be covered by the budget approved by the Federal Government for "Strengthening of Academic Facilities of N-W.F.P. University of Engineering & Technology".

The Government Grant-in-Aid will increase every year after 1992-93 by about 14 % (about 7 million Rupees on the average) of the previous year's grant as seen from Table 3.2.1 "Annual Budget of the N-W.F.P. University of Engineering and Technology, Peshawar". This will cover the maintenance fees of equipment provided through this project.

Table 3.2.1 Annual Budget of the N-W.F.P. University of Engineering and Technology, Peshawar

(Rupees)

	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95
EXPENDITURES								
Personal expenses	19,891,048	20,589,859	20,177,407	22,352,430	30,371,264			
Maintenance Fees & Others	12,131,435	14,558,139	14,436,247	15,370,901	19,717,740			
Expdr.Total	32,022,483	35,147,998	34,613,654	37,723,331	50,089,004	54,560,000	61,107,000	69,662,000
INCOME								
Government Grant-in-Aid	30,614,217	29,094,711	32,065,149	34,240,922	46,963,837	55,200,000	61,704,000	70,010,000
Own Income	2,503,389	3,083,024	2,151,458	3,436,388	3,211,742			
Income Total	33,117,606	32,177,735	34,216,607	37,677,310	50,175,579			

Source: N-W.F.P. University of Engineering and Technology

3.2.3 Study of the Equipment Requested

Some problems with the requested equipment are summarized as follows (ref. Appendix-5, List of Equipment Requested).

1) The project for provision of equipment was prepared in 1987. Since that time there have been creation of new laboratories, reorganization of laboratories, and revisions of the curricula and syllabi. However, these changes have not been reflected enough in the selection of equipment. Some items should be excluded and some others should be added in the present circumstances.

2) Equipment which is considered to be excluded is:

   a) Equipment which is no more required in the syllabi revised after the preparation of the project in 1987.

   b) Equipment which was purchased by the University after 1987 or is available in Pakistan.

   c) Equipment which is now out of date for educational purposes or such type of equipment as is no more needed because of the rapid technological progress (other types of equipment can be substituted for the proposed type).

3) Equipment which is considered to be added:

   a) Equipment which is necessary in the laboratories set up after 1987.

   b) Equipment which is required in the revised syllabi.

   c) Equipment which has more versatile functions and is considered to be more effective in education than the originally proposed one.

   d) Personal computers and peripherals which are indispensable for the present-day engineering education.

4) A number of instruments in the request are presumed to be third country's products. The reasons for the selection of third country's products by the University are as follows:

a) In European and North American countries there are many manufacturers which are specialized in educational equipment.

b) These manufacturers in European and North American countries provide many kinds of good software (manuals, textbooks etc.) as well as hardware and their products are easy for teachers and technical staff to operate.

c) Most of the teachers of the University who received higher degrees abroad have studied in U.K., U.S.A. and other European countries.

d) The same kinds of third country's products were provided to the Mehran University of Engineering and Technology, the Mehran University College of Engineering and Technology and the Baluchistan Engineering College, Khuzdar through the Grant Aids of the Japanese Government and the University staffs could have easy access to information on these products.

On the other hand, Japanese manufacturers mass-produce products of high performance to be used in industries in order to gain maximum profit. Consequently, there are few Japanese products which are specifically made for educational purposes.

The following are the descriptions of equipment requested by each department.

(1) Department of Electrical Engineering

The full number of students in one academic year is 100, but an annual intake is about 90 in one academic year on the average. In the first and second year the students take eight courses each year. In the third year the students are divided into the power system group and the communication and electronics group. Seven courses are common to both groups and one course is a specialized one to each group. In the fourth (final) year the students are divided into the power group and the communication group. Three courses are common to both groups and four courses are specific to each course. In addition, a project is assigned. The courses of studies are listed in Table 2.4.9. The number of staff is at present 18 (4 professors, 6 associate professors, 2 assistant professors and 6 lecturers). Besides, four members are studying abroad.

The Department consists of the following divisions: basic electrical engineering, measurement, electric machines, basic electronics, digital electronics, power electronics, communications, power system, control system, high voltage system and computer. There are seven laboratory rooms: Measurement Laboratory, Electric Machine Laboratory, Electronics Laboratory, Communication Laboratory, Computer Laboratory, Control Laboratory and High Voltage Laboratory. In the Measurement Laboratory there are meters, bridges and other instruments for experiments in electricity and basic electrical engineering. They are all very old which were purchased in 1956. The Electrical Machine Laboratory is equipped with various kinds of motors and generators. It is relatively well equipped compared with other laboratories of the Department. However, all the machines are old ones which were installed in 1955. The Electronics Laboratory has audio oscillators, signal generators, oscilloscopes and several kinds of power supplies etc. Most of them were supplied in 1960. The Communication Laboratory has an antenna demonstrator, a communication experiment set and a microwave experiment set. The Computer Laboratory has a logic laboratory kit, a microprocessor learning kit, some ICs and so on. The High Voltage Laboratory has a DC generator of 50 kV, a high voltage (30 kV) AC testing kit, an impulse generator of 400 kV and some others. The most important fields in the Department are communication and power engineering as seen from the curriculum in the final year. The

existing instruments are carefully maintained and fully utilized. However, it is obvious that these are not suitable for learning the present day's electronics, communication technology and power engineering.

The equipment requested is for electronics, communication and power system engineering. The North-West Frontier Province is a place where the first hydroelectric power station in Pakistan was built. Construction of hydroelectric power station of big capacity is highly possible in this Province. Demand for electric power which is necessary for the industrial development and the improvement of living standard is rapidly increasing. The education of electrical engineers is one of the most important task in the Province to construct and operate electric power supply facilities. It goes without saying that telecommunication is essential for the economic development and stabilization of the people's livelihood in developing countries. In view of these points the selection will be justified for the equipment in power engineering, communication technology and electronics on which the above two fields are dependent.

Equipment in electronics is divided into equipment in basic electronics which is necessary for both power and communication, equipment in digital electronics which is mainly necessary for communication and equipment in power electronics which is necessary for power engineering. Most pieces of equipment requested in these three fields are tutors or trainer kits which consist of panels or boards equipped with necessary measurement meters and plug seats to be connected to various instruments or components and enable students to conduct a series of experiments in one subject (e.g. digital communication, operational amplifiers etc.). They are what is called educational training kits and in line with the purpose of this project. It is necessary to select a model which can do a series of experiments, be operated without difficulty and is durable. As mentioned before, the number of students in the Department is about 90 in one year and about 360 in total. It is necessary to provide an enough number of sets so that all individual students in one practice class can conduct his own experiment.

(2) Department of Mechanical Engineering

The Department can take in 100 students a year, but the actual enrollment of one year is about 75 on the average. The enrollment is increasing year by year and the number of the present 1st year student is 86.

There are nine laboratories. The laboratories are poorly equipped and the kinds of equipment are few. Most pieces were installed in the 1960s, are old and are not suitable for the education of the present-day engineering.

Most pieces of the requested equipment are indispensable for the basic engineering education. However, some pieces seemed to have been requested just for the reasons that they were novel and sophisticated even though they were not so effective or not necessary for student education.

The equipment in the request prepared in 1987 was for automobile engineering, heat transfer engineering, production engineering, fuel engineering, metallurgy and machine drawing & design.

1) Automobile Engineering Laboratory

The equipment of this laboratory is very little and the kinds are few, the only measuring instrument being a dynamometer. Most items of equipment requested are indispensable for the basic engineering education. However, the following items are considered to be not necessarily needed.

-Fuel injection gasoline engine test stand.

Since a fuel injection gasoline engine itself is not yet found widely on the market, the test stand is not necessarily required for education.

-Hydraulic dynamometer.

The laboratory has one.

-Test stand for electric systems.

This is a simple machine and can be constructed by themselves.

-Instrument for measuring and checking of wear in cylinder.

A micrometer can be substituted for it.

-Universal brake test stand.

This is not adequate for education because its test method is too sophisticated.

The diesel engine with turbo-super charger model was requested in addition because automobile engines with turbo chargers are becoming more common.

The turbo jet model, the air and steam nozzle demonstration apparatus, the supersonic wind tunnel and the turbojet engine test set in the request are instruments for aeronautical engineering in particular and are considered not necessary for the engineering education of this Department at the moment.

2) Heat Transfer Laboratory

This laboratory is very poorly equipped; only two instruments exist. The Department had not placed emphasis on heat transfer engineering which is a branch of thermodynamics.

Most items of equipment requested are for basic engineering education, but some are specialized ones.

The water/water turbulent flow heat transfer unit, the thermal radiation unit and the conductive heat transfer experimental unit are indispensable for learning three kinds of heat movement, namely heat transfer, radiation transfer and heat conduction. A temperature measurement unit consisting of

various kinds of thermometers is necessary to learn techniques of temperature measurement which are vital to heat transfer engineering.

The conductive heat transfer research unit is important to learn conduction of heat. However, this instrument is rather for research and is not in line with the purpose of the project. The fluidization and fluidized bed heat transfer unit is equipment to learn heat transfer in a tube which contains solid particles. The boiling heat transfer unit is for experiments on heat transfer of nucleus boiling and membrane boiling. The above two instruments are used in rather specialized fields of heat transfer engineering and too difficult for students to use. Therefore they are not appropriate to this project.

The thin film flush evaporator and the water cooling tower are not conformed to the syllabus.

The flow visualization wind tunnel, the two shaft gas turbine, the two cycle gasoline engine model and the planetary gear train model are for the power plant laboratory and for learning the combustion and flow of gas in engines. They are too specialized and not conformed to this project.

Good technical documents are available for the transmission torque of automobile clutch. In engineering education it is sufficient to study these documents. Experiments on clutches are not important in undergraduate education and the automobile clutch test unit is not indispensable.

The universal tensile testing machine is for the metallurgy laboratory and discussed in the section of metallurgy laboratory. The power press is already in the production engineering laboratory and should be excluded from the request of this laboratory.

3) Production Engineering Laboratory

The production engineering laboratory has undergone various changes in the course of reorganization of the University. The equipment of this

laboratory was transferred to the Workshop when it was expanded. As the consequence, the laboratory has no equipment at present, and is located in the Workshop separated from other laboratories of the Department. It is working in close collaboration with the Workshop.

Twelve items are requested, of which 11 items are instruments to measure shapes and only one item is a machine tool.

A set of plug and ring gauges is for measurement of hole sizes and of shaft sizes, and a set of block gauges is used in various kinds of dimension measurement. They are basic equipment and indispensable for machining work.

The surface roughness measurement instrument and the flatness interferometer are educationally important instruments to measure surface finish.

The profile projector is an instrument to observe magnified finished surface. It is not necessarily required because simpler methods can do.

The mechanical comparator and the pneumatic comparator are instruments to measure the difference between the test object and the standard. Both are important for the quality control in the production process and used for the same purpose. The pneumatic comparator is not suitable for education because its operation and maintenance are difficult.

The auto-collimator is an instrument with a telescope of high precision and a reflector and is used for the measurement of straightness, flatness, parallelness etc. of the test object. It is necessary to make machines which require very high degree of precision, but not necessary for educational purposes.

The laser beam machining unit is a machine tool of the most advanced technology and its operation and maintenance is not so easy. It is not appropriate to the University.

The laser center detector is for centering. It may be not necessary

because the use of dial gauge should be emphasized for centering in the engineering education of university.

4) Fuel and Metallurgy Laboratories

The equipment requested from these two laboratories includes 7 items for fuel experiments and 10 items for metallurgy experiments, in total 17 items.

a) Equipment for Fuel Experiments

The existing equipment is mostly not usable. The fuel laboratory has been nearly dormant for 15 years due to lack of teachers and the equipment has not been maintained properly.

The bomb calorimeter is for measuring calorific values of solid and liquid fuels. The gas calorimeter is used for gas fuels. Both are important for basic engineering education.

The oxygen bomb calorimeter is a calorimeter for solid and liquid fuels and used for the same purpose as the bomb calorimeter. So it may be not necessary.

The Saybolt viscometer is used for the measurement of viscosity of fuels and the cone penetration meter is for measuring the consistency of lubrication greases. These are necessary for basic engineering education.

b) Equipment for Metallurgy

The metallurgy laboratory is better equipped than other laboratories of the Department, but can not be claimed to be well equipped. Most pieces of the existing equipment are old and were installed in the 1960s. They are becoming unfit for use. The requested equipment is for heat treatment and material testing.

The universal testing machine which is requested from the heat transfer laboratory is to be used in the metallurgy laboratory. This is indispensable for the testing of tensile and compression of materials. This laboratory uses this machine to investigate the effect of heat treatment on the mechanical strength of materials.

The specimen mount press and the high speed precision cut off machine are needed to prepare a sample, the surface of which is observed with the metallographical microscope.

The digital thermometer was requested as an instrument to measure the temperature distribution inside the heat treatment equipment. However, the heat treatment equipment is in general designed in a way that the temperatures are to be homogeneous inside and it is not necessary to measure the temperature distribution inside. The thermometer installed inside the furnace may suffice for this purpose. Such being the case, a new digital thermometer is not necessary.

The specimen dryer is not necessarily needed because a similar type which still stands use is in the laboratory.

The metallographic microscope is not necessarily needed because a similar one is in the laboratory.

The micro-hardness tester is for special materials and is not appropriate for educational purposes.

The optical pyrometer is for measuring the intensity of radiation from a heated body above 700 °C. It is not so much necessary because this measurement can be made by the use of the thermocouple.

5) Geometrical Drawing and Design Laboratory

The laboratory has nothing but a blackboard. It requests 28 basic models for machine drawing.

However, only models for machine drawing are not enough for drawing education. Measuring equipment should be included. Installation of a strain gauge learning system is recommended. In the machine drawing and design it is important to understand the concepts of stress and strain. It is important to install equipment which helps learn these concepts in a concrete way.

Items which are available at a cheap price in Pakistan were excluded.

6) Others

Beside the above mentioned equipment, there were additional requests from newly established "theory of machines laboratory" and "power plant laboratory".

a) Theory of Machines Laboratory

It is very poorly equipped and almost empty. Equipment requested is important for structural analyses. However, some items are rather sophisticated and not adequate to undergraduate level education.

The FFT analyzer is used for dynamic analysis of machines and structures. It can quickly calculate autocorrelation, crosscorrelation, coherence functions, transfer functions etc. and is employed to deal with vibration problems. It is a very convenient and useful instrument. It is highly necessary as an essential instrument in the theory of machines.

The real time frequency analyzer is an instrument to obtain the frequency response of the test object when it is in the loaded state. Since the FFT analyzer has the same function, the real time frequency analyzer is not necessary.

The vibration monitoring system is to detect abnormal vibrations and to issue a warning. It is used for preventive maintenance of machines. It is considered to be too specialized for educational purposes and not to have educational effectiveness.

The structural analysis system is used for structural analyses, in particular for modal analyses. But it is too sophisticated and not appropriate for educational purposes.

b) Power Plant Laboratory

The water softening plant is necessary for the operation of a boiler which is included in the thermodynamics course. The well water of the University is hard. When this water is used as it is, it will shorten the life of the boiler. Therefore this plant is very necessary to soften the hard water. It is also used when softened water is required to operate other plants. It is also useful for students to learn the operation of water softening plant.

(3) Department of Civil Engineering

The Department can take in 100 students a year, but the actual intake is about 90 a year on the average. As of October 1992, the enrollment is 369 in the undergraduate course and 14 in the graduate course, the total being 383. The first year students number 95. Eight courses must be completed each in the first year and the second year (there is an additional course, Workshop Practice, in the first year). In the third year eight courses plus a mathematics course must be completed. In the final year eight courses must be completed including a project. The scheme of studies is shown in Table 2.4.9. The present number of teaching staff is 22 (professors 6, associate professors 5, assistant professors 6 and lecturers 5).

The following laboratories have requested experimental equipment.

1) Structural and Materials Testing Laboratory.
2) Concrete Laboratory.
3) Soil Mechanics and Highways Laboratory.
4) Hydraulics and Fluid Mechanics Laboratory.
5) Survey Laboratory.
6) Public Health Engineering Laboratory.

The Department was opened in 1953. The laboratories are equipped not so poorly, but most pieces of equipment are obsolete. In the 1960s, USAID provided the hydraulics laboratory with some instruments and in 1989 WHO provided the public health laboratory with equipment. The laboratory which has the largest number of instruments is the soil mechanics laboratory which has as many as 59 items of equipment, although some are out of order. Most items of equipment requested are for replacement of old ones.

The following comments are on the equipment requested including additional items requested at the time of this study.

1) Structural and Materials Testing Laboratory

The main machines requested are two universal testing machines (400 tons

and 100 tons) and a jack system structure testing machine. The laboratory has a 100 tons universal testing machine, a 10 tons universal testing machine (both are manufactured in 1953) and a 30 tons compression machine made in 1984. Therefore, the addition of 400 and 100 tons machines is considered not necessary. We recommend one 200 tons universal testing machine instead of two machines of 400 tons and 100 tons. The crack detection microscope is for detecting and investigating hair cracks in the concrete structures and is necessary for educational purposes.

Other items are for replacing the existing old machines and are highly necessary.

2) Concrete Laboratory

The main items requested are the flexural strength testing apparatus for small beams specimen, the creep test apparatus and the compression test set (100 tons). The laboratory has these three machines. However, they are all out of order and not workable. These kinds of machines are necessities. However, since the Structural and Materials Testing Laboratory is requesting a compression test set (100 tons), this laboratory can use that machine too.

The Poisson's ratio measuring apparatus is necessary to measure the Poisson's ratio of materials and the ultrasonic concrete tester is necessary to detect hair cracks etc. in the concrete structures.

3) Soil Mechanics and Highways Laboratory

The triaxial compression test set, the direct shear apparatus and the one dimensional consolidation set are necessary to replace the existing obsolete machines.

The electric unconfined compression apparatus is for measuring the shear strength of soil and is necessary for the education of soil mechanics.

The constant head permeameter, the falling head permeameter, the

motorized liquid limit device, the shrinkage limit determination device and the plastic limit determination device are for investigating and measuring the relation between soil and moisture contents which is dependent on the soil composition. The CBR test set is for simple tests of pavements. All these instruments are for replacing the existing ones.

The electronic balance, the field density test set and the dial gauges are instruments to measure soil characteristics and are necessary for the basic education of soil mechanics.

4) Hydraulics and Fluid Mechanics Laboratory

The main items are the hydraulics bench and the sediment transport channel. The hydraulics bench consists of various apparatus to learn principles of hydraulics. The sediment transport channel is an apparatus to learn the process of sediment transport in water. The fluid friction apparatus is to study fluid friction head losses and the laminar flow analysis table is to study fluid flow in a two dimensional plane. Both are necessary to learn basics of fluid mechanics.

5) Survey Laboratory

An electric total station and six theodolites with 1 minute accuracy are requested. The electronic total station is employed for precise surveying.

6) Public Health Engineering Laboratory

This laboratory was set up after the request was prepared in 1987. The requested equipment is only a cooled incubator for BOD and a top loading balance. Both are necessary for this laboratory.

(4) Department of Agricultural Engineering

The Department can take in 30 students a year. At present the enrollment is 71 in the undergraduate course and 5 in the master course, in total 76. The number of students is increasing year by year. At present 28 students are enrolled in the first year.

At the time when the list of equipment was prepared in 1987, there were only two laboratories. At present there are 5 laboratories.

The equipment requested is experimental instruments for the Agricultural Machinery and Farm Power Laboratory and the Soil and Water Engineering Laboratory.

1) Agricultural Machinery and Farm Power Laboratory

As mentioned before, the laboratory has instruments provided by USAID in the first half of 1980s and is better equipped than other laboratories. There are machine tools such as a lathe, a milling machine, a welding set, a dynamometer for measuring engine power, a pump design evaluation set, a hydraulic controls test bed, a tractor, a plow, a disc harrow etc. However, more instruments are necessary for education in a wide range of agricultural machinery.

Of 85 items requested, 59 items such as engine sets, carburetor models etc. are section models, small scale action models or panel type demonstration models. They are necessary to learn basic elements of agricultural machines. However, the crown wheel and pinion demonstration model is not practical and not necessary to learn the principles of this mechanism. The diesel fuel system with turbo charger has many parts common to the fuel supply pump (diesel). Therefore only the turbo charger model suffices for the purpose.

The instruction model of diesel injection pump distributor is not so much needed because similar models are included in the request. The farm tractor crawler type model and the differential gear box model are substantially not different from the existing sectioned tractor model.

Therefore they are hardly necessary.

The engine analyzer is for engine performance tests. These tests can be done using equipment of the automobile engineering laboratory. The motor scope is of similar one and not so much needed.

The implementing testing equipment is rather for research. This is not appropriate for educational purposes.

The camera and the slide projector are auxiliary equipment for education and similar ones already exist. These are not necessary.

The shearing machine, the bending machine and the rolling machine are machine tools for sheet metal. They are already in the Workshop. Their operation and maintenance is difficult at the Department. These are not so necessary.

The automatic filler is employed to place automatically the prepared food in the can and the semi automatic seamer for round cans is used to seal or close covers on the can. However, these machines are not fit in with the syllabus.

2) Soil and Water Engineering Laboratory

The laboratory is almost empty with only five items which were installed in the 1960s. The existing five items are soil drying ovens, a water distiller, sieves and a sieve shaker, a permeameter for compacted soils, and a centrifuge machine.

It is necessary to introduce measuring instruments for the education of soils and water engineering.

Of 28 items requested, 19 items are for soil engineering, 7 items are for water engineering and 2 items are electronic balances. Emphasis is placed on soil engineering and as a whole the request is quite adequate.

However, the Muctron scattering apparatus is obsolete and is being replaced with a sprinkler type apparatus. This should be excluded because the irrigation displays requested include a similar model. The Bouyoucus moisture meter and the cylinder intake tester are also out of date. The multi purpose water analysis meter, the water quality testing kit and the soil testing kit included in the request can be used instead of the above two instruments.

Meteorological equipment is requested in water engineering. However, it is not necessary because the chart recording rain gauge is enough for educational purposes in water engineering of agriculture.

(5) Department of Mining Engineering

The Department can take in 30 students a year, but the actual enrollment is about 8 - 9 every year. As of October 1992, the number of enrolled students is 33 in the undergraduate course and 3 in the postgraduate course, the total being 36. The first year students number 18. The number of students is increasing year by year. The first year requires completion of 9 courses including a workshop course and the second year requires completion of 8 courses. In the third year the students must take 9 courses and in the final year 8 courses including a project. The scheme of studies is listed in Table 2.4.9. The number of teaching staff is 10 (professors 2, associate professors 2, assistant professors 4, and lecturers 2). The Department is the newest one set up in 1974 and the number of students and teaching staff is smaller than other departments.

The existing laboratories are as follows:

1) Mineral Processing Laboratory.
2) Rock Mechanics Laboratory.
3) Mine Surveying Laboratory.
4) Drilling Technology Laboratory.
5) Mine Safety Laboratory.
6) Mine Ventilation Laboratory.
7) Geology Laboratory.

Four laboratories; drilling technology, mine safety, mine ventilation and geology are very poorly equipped. The mineral processing laboratory which is best equipped of all the laboratories has only 11 items of equipment. The rock mechanics laboratory and the mine surveying laboratory each have only 6 items.

The instruments requested by the Department are mainly practical ones. Comments on the request including the additional instruments requested at the time of this study are given as follows.

1) Mineral Processing Laboratory

The main instrument requested is X-ray fluorescence analysis equipment. This is employed to analyze contents of elements in minerals and indispensable for the analysis of minerals. A spectrophotometer and a X-ray diffractometer were also requested. However, the functions of these instruments can be preformed with the X-ray fluorescence analysis equipment. Therefore they are not so much necessary.

The wet sieve analysis equipment and the sets of sieves (ASTM & BS) are necessary for learning sieving. The spiral test rig is similar to the existing one and not necessary.

The floatation cell is indispensable for education. The floatation reagent is available in Pakistan.

The ball mill is similar to the existing one. The roll crusher is necessary for learning a primary crusher.

2) Rock Mechanics Laboratory

The main requests are a universal testing machine and a direct shear test apparatus. A universal testing machine is also requested by the metallurgy laboratory of the Department of Mechanical Engineering. It is recommended that these two laboratories share it. The direct shear test apparatus is necessary for measuring the shearing stress of rocks.

The core drilling machine, the core barrels and the rock sample grinder are necessary for preparing rock samples.

The Schmidt hammer is necessary for measuring the surface hardness of rocks and the strain gauge meter is necessary for measuring the strain of rocks.

3) Mine Surveying Laboratory

The mining suspension theodolite and the laser control theodolite are surveying instruments necessary for measuring horizontal and vertical angles. The former is a type suspended from the ceiling in a pit and the latter is a type controlled by a laser. Both are necessary for the mining surveying education.

The distance meter, the portable altimeter, the stainless steel tapes, the binocular and the automatic routine level are all necessary for field surveying.

4) Drilling Technology Laboratory

The wire line core barrel is useful for demonstration of the structure of wire line drilling machine. The various types of diamond bits are necessary for educational demonstration.

5) Mine Safety Laboratory

The portable equipment for CO, CO_2 detection, the portable interferometer and the multigas detector are instruments necessary for the underground mine safety and measure gas contents in the underground mine. They should be equipped for educational purposes. The wet and dry bulb hygrometer and the portable aneroid barometer are instruments necessary to measure the environmental factors in the underground mine.

The mine safety lamp is indispensable in coal mines. It is necessary to learn its structure and safety.

6) Mine Ventilation Laboratory

The wind tunnel with fan and the pipe friction/fluid friction apparatus are useful for learning fluid mechanics as well as mine ventilation.

The self contained breathing apparatus is survival equipment when

poisonous gases break out in the underground mine. It is necessary to learn how to use it.

7) Geology Laboratory

The polarizing microscope and the geological thin section preparation apparatus are necessary to prepare and observe mineral samples and should be equipped in the laboratory.

The crystal and atomic structure models are useful for learning crystal structures of minerals and the mountain models are useful for learning orogenic movements.

(6) Department of Basic Sciences

The Department of Basic Sciences teaches mathematics, physics, chemistry etc. which are the basis of engineering to all the students of the Faculty of Engineering (Department of Electrical Engineering, Department of Mechanical Engineering, Department of Civil Engineering, Department of Agricultural Engineering and Department of Mining Engineering). The subjects which the Department teaches are mathematics, physics, applied chemistry, applied mechanics, computer programming, engineering economics, Islamiat and Pakistan studies. The number of students in the first year is 330; about 90 in each of the Department of Electrical Engineering, the Department of Mechanical Engineering and the Department of Civil Engineering, and about 30 in each of the Department of Agricultural Engineering and the Department of Mining Engineering. The Department has experiment classes for about 1,000 students in the first, second and third year classes. The number of teaching staff is 26, of which the Ph.D. holders are 4, and M.S. holders and the equivalents are 11. It is the biggest Department in the Faculty.

There are seven units in the Department; Physics, General Chemistry, Analytical Chemistry, Special, Applied Mechanics, Unit Operation & Pilot Plant and Computer. There are four laboratory quarters; Physics Laboratory, Chemistry Laboratory, Applied Mechanics Laboratory and Computer Room. The Physics Laboratory has audio frequency generators, an oscilloscope, a spectrometer, apparatus to measure mechanical equivalent of heat, an apparatus to measure thermal conductivity and some measuring instruments, but it is very poorly equipped for a physics laboratory. The Chemistry Laboratory is equipped with only such routine apparatus as glassware (test tubes, flasks, beakers etc.), chemical agents and Bunsen burners. These are used in the wet process of qualitative and quantitative analyses. There are no instruments for the dry process and instrument analysis. The Applied Mechanics Laboratory is better equipped than other laboratories of the Department. Most apparatus are very old, but are carefully maintained and in working condition. The Computer Room has 14 IBM or IBM compatible machines for the student use and the students learn programming languages (mainly Pascal) and write programs for numerical calculation.

The requested equipment is for the laboratories of physics, general chemistry, analytical chemistry, special, unit operation & pilot plant. The Special Laboratory caters for the requirements of all other subjects and disciplines of other Departments. The equipment for the unit operation & pilot plant is planned to be used in the Department of Chemical Engineering which is to be opened in 1993. However, experiments on chemical engineering proper will not be given until the first group of students reach the final year course in 1996. Therefore it was decided not to include these items of equipment in this request.

Since the Department of Basic Sciences puts emphasis on the subjects which are the basis of engineering, priority is given to physics and chemistry (general chemistry and analytical chemistry).

The basic policy in selection of equipment is that it is employed in the experiments indispensable for learning basics of physics and chemistry. The selection criteria are:

The operation and structure of equipment are simple.
Not much too computerized.
Black box parts must be minimum.
Not so difficult to maintain.
To help understand underlying principles.

In experiments, students in a class are divided into two sections and each section is divided into two groups. Accordingly, one group comprises about 15 to 25 students. In deciding the quantity of equipment it is necessary to take it into consideration that about 15 to 25 students are engaged in one experiment at the same time.

It is necessary to consider the provision of personal computers for the student use although these had not been included in the original request. It is much too inadequate that only 14 computers are available to more than three hundred students in a computer programming course in the first year. The students in the second, third and final year also must use computers for numerical calculations and the development of simulation models. In order to

meet the minimum requirements of students at least about 30 more computers will be necessary.

(7) Workshop

The major responsibility of the Workshop is to provide the students with workshop practice. It is also doing works on request from outside organizations. Recently work ordered from the outside is becoming more important. The number and kinds of existing machines are not few. However, most of them were installed in 1955 and have been working for nearly 40 years. They are still in working condition owing to good maintenance. But the accuracy of machine is deteriorating because of long use.

Broaches and arbors of broaching machines are requested. But the existing ones still can be used. Parts for a centrifugal casting machine is due to be purchased on the University own funds.

The accuracy of the existing universal milling machine has deteriorated because of long use. We recommend the replacement of the universal milling machine and the installation of a numerically controlled machine tool, which is indispensable for the present-day machine tool education.

(8) Equipment for Research

Sixty-seven items of research equipment had been included in the original request. Equipment for research only was excluded because the objective of this project was to provide educational equipment. However, educational equipment which is also available for research is in line with the project and was deliberated over its appropriateness. This type of equipment is studied in Section 4.3.1 "Equipment Plan". Of the items which are selected for educational use, the following are similar to types requested for research projects.

Department	Items
Mechanical Eng.	Orsat gas analyser
Civil Eng.	Stain gauge, Set of sieves, Theodolite, Electronic balance.
Mining Eng.	Water distillation apparatus, Laboratory furnace, Thermostatic water bath, Electronic balance, High speed blender, pH meter.

3.3 Project Description

3.3.1 Executing Agency and Operational Structure

(1) Executing Agency

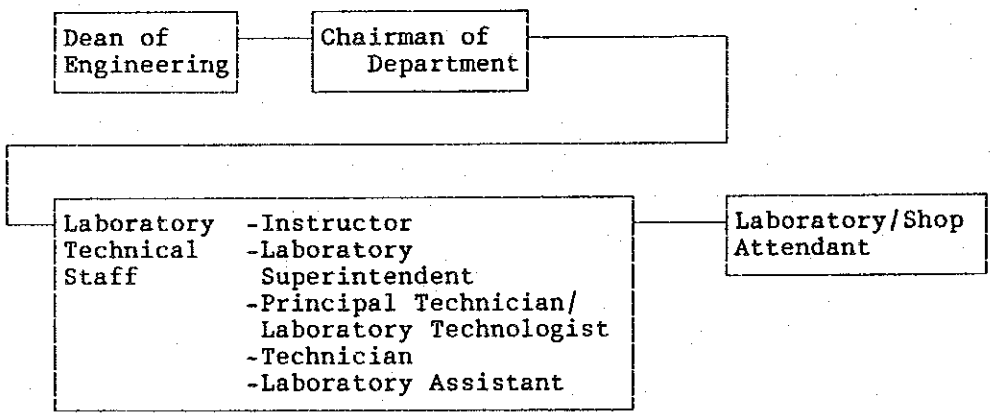
The executing agency of the project is the N-W. F. P. University of Engineering and Technology, Peshawar.

(2) Operational Structure

An operational structure of the project already exists. It is the existing administrative system of the University (ref. Fig. 2.4.1 Organization Chart of N-W.F.P. University of Engineering and Technology, Peshawar). The Faculty of Engineering under the Dean, the Director Works, the Director Finance and the Registrar are directly responsible for the project. The equipment provided is placed in laboratories of the departments. The Director Works is responsible for the works which may be needed to install the equipment to be provided, such as remodeling of laboratories, foundation work, electric work, piping work and so on. The Director Finance is responsible for the budget control for the installation works and all the financial matters including maintenance fees. He also assumes the charge of assets. The Registrar is responsible for the reorganizations of administrative system and the personnel management. The Faculty of Engineering is responsible for the operation and maintenance of experimental equipment. The Chairman of Department, who is under the Dean, supervises the laboratory technical staffs of his Department. The laboratory technical staffs are instructors, laboratory superintendents, principal technicians/laboratory technologists, technicians and laboratory assistants. These laboratory technical staffs take care of the operation and maintenance of equipment assisted by laboratory/shop attendants. The laboratory technical staffs assist teaching staffs in the instruction and supervision of students in experiments.

As mentioned in Section 2.4.2 "Organizational Structure and Educational Activities", the Faculty of Engineering has the Department of Electrical Engineering, the Department of Mechanical Engineering, the Department of Civil Engineering, the Department of Agricultural Engineering, the Department of Mining Engineering, the Department of Basic Sciences which teach subjects common to all the Departments, and the Workshop. Each Department has several laboratories. New laboratories are set up and existing laboratories are reorganized when the syllabus is revised, which is required to meet the needs of the times. The laboratories which have requested equipment in this project number 34. The administration of daily operation and maintenance is diagramed in Fig. 3.3.1.

Fig. 3.3.1 Operation and Maintenance System



3.3.2 Location and Condition of Project Site

(1) Location

The University is in Peshawar, the capital of the North-West Frontier Province. Peshawar is situated about 50 km to the border on a neighboring country, Afghanistan, and 1,728 km on the paved high way and 1,682 km on the Pakistan Railway to Karachi which is faced the Arabian Sea and has the biggest port facilities in Pakistan.

The University is located about 8 km southwest of the center of Peshawar and in a large school campus which houses the University of Peshawar, NWFP Agricultural University, Peshawar and Khybar Medical College as well. The total area of the campus is about 4,000,000 m², of which the University occupies about 65,000 m².

(2) Buildings

The buildings of the University are as follows:

Headquarters Building:	Administration Offices, Classrooms, Electric Engineering Laboratories, Civil Engineering Laboratories.
Dept. of Civil Eng.: Building 1	Civil Engineering Laboratories, Classrooms, Scientific Instrumentation Center.
Dept. of Civil Eng.: Building 2	Civil Engineering Laboratories.
Dept. of Civil Eng.: Building 3	Civil Engineering Laboratories.
Dept. of Elec. Eng.: Building	Electrical Engineering Laboratories.
Dept. of Mech. Eng.: Building 1	Mechanical Engineering Laboratories, Classrooms.
Dept. of Mech. Eng.: Building 2	Mechanical Engineering Laboratories.
Dept. of Agri. Eng.: Building	Agricultural Engineering Laboratories, Classrooms.

Dept. of Basic Sc. &: Mining Dept. Building	Basic Science Laboratories, Mining Engineering Laboratories, Mechanical Engineering Laboratories, Classrooms
Workshop Building:	Workshop, Mechanical Engineering Laboratories.
Library Building:	Central Library.

Most of the buildings were constructed in the 1950's and have been used since the foundation of the institution. The buildings are of one-story or two stories. Laboratories of one department are placed in several different buildings when one building dose not have enough space to house all the laboratories of the department (ref. Fig. 3.3.2 "Site Plan of N-W.F.P. University of Engineering and Technology, Peshawar" and Appendix 9 "Laboratory Plans"). Beside these buildings, a boiler house, clubs, residences for the teachers, student hostels and other auxiliary facilities are in the campus.

The laboratories are spacious and their ceilings are high. The ground floors are designed to support maximum allowable load of 900 kg/m^2.

The rooms in which computers are placed are air conditioned. However, most of the laboratory rooms are not air conditioned. The temperatures and relative humidities in the laboratories are approximately:

-Air conditioned rooms

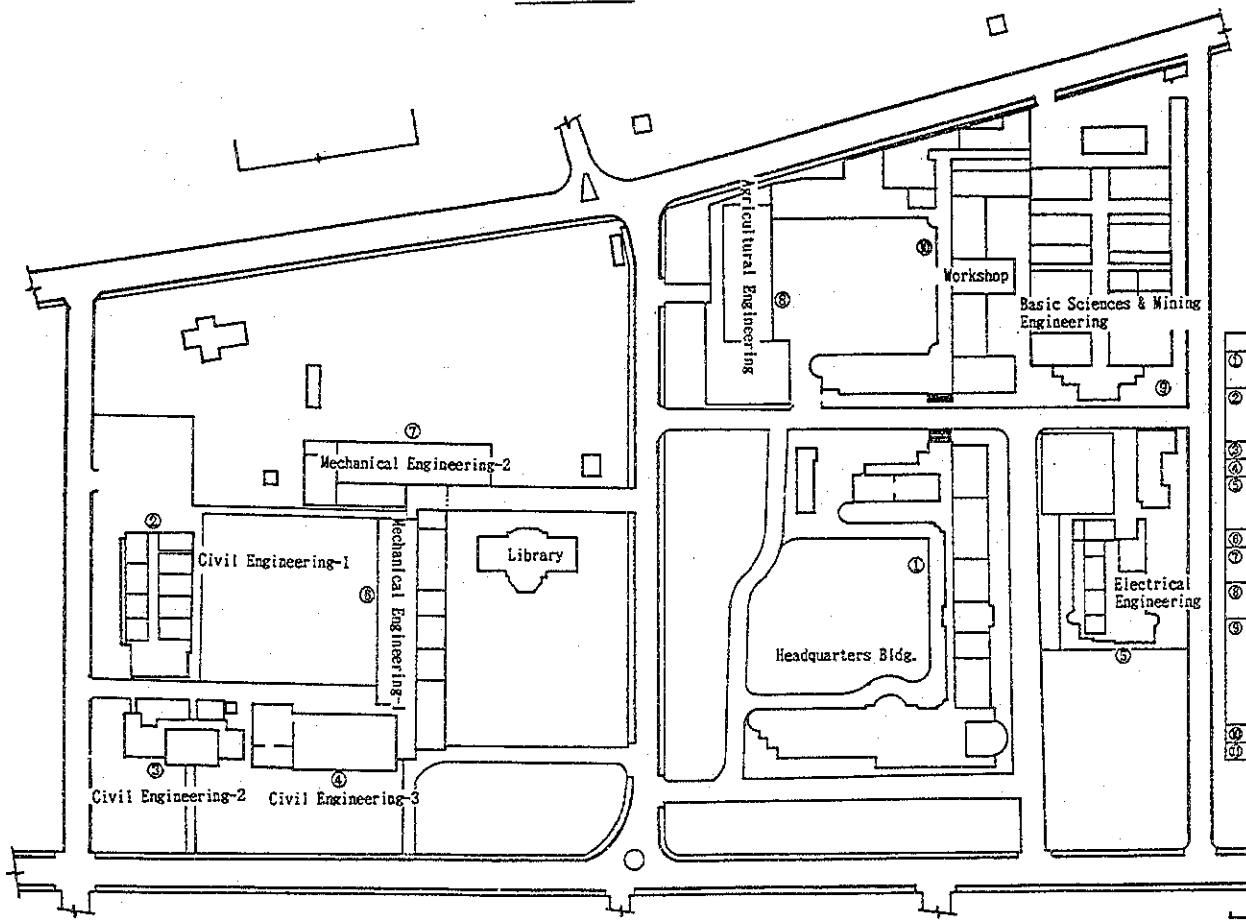
Maximum temperature: 26°C
Minimum temperature: 21°C
Relative humidity: Maximum 40 %, Minimum 30%

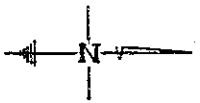
-Not air conditioned rooms

Maximum temperature: 35°C
Minimum temperature: 12°C
Relative humidity: Maximum 90 %, Minimum 20 %

N-W.F.P. UNIVERSITY OF ENGINEERING & TECHNOLOGY, PESHAWAR

SITE PLAN





EXISTING BUILDINGS

BUILDING	LABORATORIES & OTHERS
① Headquarters Bldg.	Administration Block, Materials Testing Lab., Soil Mechanics & Highway Engineering Lab., Classrooms, etc.
② Civil Engineering - 1	Survey Lab., Fluid Mechanics Lab., Public Health Engineering Lab., Scientific Instrumentation Centre, Classrooms, etc.
③ Civil Engineering - 2	Structural Testing Lab, etc.
④ Civil Engineering - 3	Concrete Lab., Hydraulics Lab, etc.
⑤ Electrical Engineering	Basic Electronics Lab., Digital Electronics Lab., Power Electronics Lab., Communication Lab., Power Systes Lab., etc.
⑥ Mechanical Engineering - 1	Theory of Machines Lab., Metallurgy Lab., Classrooms
⑦ Mechanical Engineering - 2	Fuel Engineering Lab., Automobile Engineering Lab., Heat Transfer Lab., Power Plant Lab., etc.
⑧ Agricultural Engineering	Agricultural Machinery & Farm Power Lab., Soil & Water engineering Lab., Clasroooms, etc.
⑨ Basic Sciences & Mining Engineering	Physics Lab., General Chemistry Lab., Analytical Chemistry Lab., Special Lab., Computer Room, Mineral Processing Lab., Rock Mechanics Lab., Mine Surveying Lab., Drilling Technology Lab., Mine Safety Lab., Mine Ventilation Lab., Geology Lab., Machine Drawing & Daign Lab., Classrooms, etc.
⑩ Workshop	Workshops, Production Engineering Lab., etc
⑪ Library	Central Library

100 m

(3) Infrastructure

1) Road

There are paved roads in 7 m - 12 m width around and inside the campus. Enough areas are kept in the campus for parking. There is no problem with bringing in the equipment into the campus.

2) Electricity

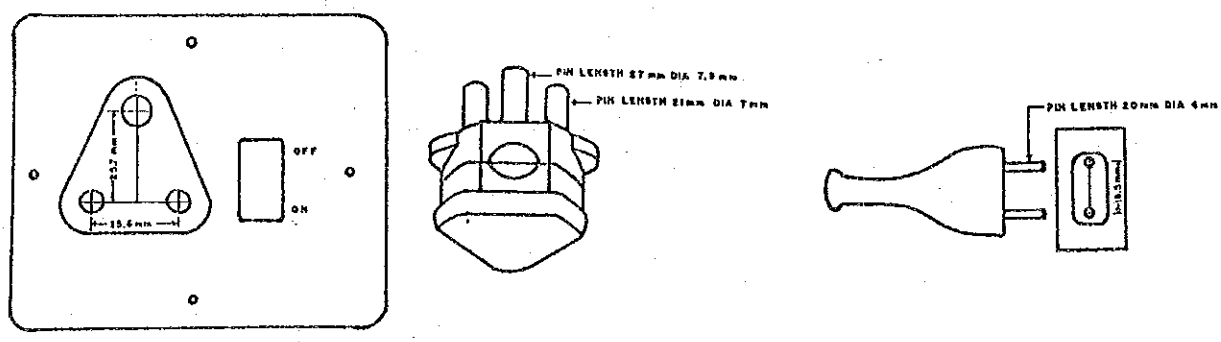
Electricity is supplied at 11 kV by Water and Power Development Authority (WAPDA) and transmitted to the University through a substation in the University of Peshawar. Then it is supplied to the Headquarters and Laboratories at the following voltages through transformers installed at three places in the campus.

3-phase	AC 440 V	± 10 %
1-phase	AC 220 V	± 10 %
frequency	50 Hz	± 10%

The total capacity is 600 kVA.

Shapes of the plugs and outlets are shown in Fig. 3.3.3. The electric facilities are conformed to the Pakistan Standards and international standards.

Fig. 3.3.3 Electric Plugs and Outlets



Regular load sheddings are operated in Peshawar and the surrounding area because of the shortage of electricity. However, higher education institutions like the University are exempted from this operation. At the time of peak of electricity consumption in summer, power stoppage for about 30 minutes sometimes happens. However, this stoppage does not affect much the experiments and practice in the University.

3) Water Supply

The University has its own water supply facilities from deep tube wells. The water temperature is 20°C-28°C. The water pressure is 1.4 kg/cm²g and sufficient amount of water is supplied. The water quality is good.

(4) Natural Conditions

The maximum temperatures, minimum temperatures, mean temperatures and relative humidities by month in the Peshawar area are shown in Table 3.3.1.

Table 3.3.1 Climate in the Peshawar Area

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Max. Temp. (°C)	20.8	23.8	30.6	31.7	39.4	41.9	39.2	37.3	36.6	31.5	26.3	20.7
Min. Temp. (°C)	0.5	0.5	5.2	11.2	16.9	17.2	23.2	17.0	18.3	11.7	3.4	0.3
Mean Temp. (°C)	10.7	12.2	17.9	21.5	28.2	29.6	31.2	27.2	27.5	21.6	14.9	10.5
Rel.Humidity (%)	63.0	62.0	65.0	62.0	53.0	53.0	67.0	71.0	68.0	61.0	61.0	64.0
Rainfall (mm)	27.8	38.6	68.7	41.0	23.7	8.0	45.2	38.2	23.5	13.2	15.3	26.3

Source: N-W.F.P. University of Engineering and Technology
Rainfall is taken from "Rika Nenpyou (Science Almanac, Japan), 1992 "

3.3.3 Outline of Equipment

As mentioned in Section 3.2.3 "Study of the Equipment Requested", the request was prepared in 1987. Since then there have been changes of the curricula and reorganizations of laboratories. Consequently some revisions and additions in the request were made at the time of this study. The following outline of selected equipment is based on the discussions the study team had with the University and includes additional equipment. The laboratories which request equipment under this project are listed in Table 3.3.2.

Table 3.3.2 Laboratories to be covered by this Project

1. Department of Electrical Engineering
    1) Basic Electronics Laboratory
    2) Digital Electronics Laboratory
    3) Power Electronics Laboratory
    4) Communication Laboratory
    5) Power System Laboratory

2. Department of Mechanical Engineering
    1) Theory of Machines Laboratory
    2) Metallurgy Laboratory
    3) Fuel Engineering Laboratory
    4) Automobile Engineering Laboratory
    5) Production Engineering Laboratory
    6) Machine Drawing and Design Laboratory
    7) Heat Transfer Laboratory
    8) Power Plant Laboratory

3. Department of Civil Engineering

1) Structural and Materials Testing Laboratory
2) Concrete Laboratory
3) Soil Mechanics and Highways Laboratory
4) Hydraulics and Fluid Mechanics Laboratory
5) Survey Laboratory
6) Public Health Engineering Laboratory

4. Department of Agricultural Engineering

1) Agricultural Machinery and Farm Power Laboratory
2) Soil and Water Engineering Laboratory

5. Department of Mining Engineering

1) Mineral Processing Laboratory
2) Rock Mechanics Laboratory
3) Mine Surveying Laboratory
4) Drilling Technology Laboratory
5) Mine Safety Laboratory
6) Mine Ventilation Laboratory
7) Geology Laboratory

6. Department of Basic Sciences

1) Physics Laboratory
2) General Chemistry Laboratory
3) Analytical Chemistry Laboratory
4) Special Laboratory
5) Computer Room

7. University Workshop

1) Workshop

(1) Department of Electrical Engineering

The selected equipment includes such educational training kits, tutors and measuring instruments as necessary for experiments on main themes in electrical engineering.

1) Electronics Laboratories

a) Basic Electronics Laboratory

Training kits of electronic circuits which are constructed by combining electronic circuit elements, amplifier tutors, and power supply teaching sets were selected.

b) Digital Electronics Laboratory

Apparatus which teach such basics of computer controls as logic principles, logic circuits, microprocessors, analogue and digital systems etc. were selected.

c) Power Electronics Laboratory

Training kits which enable students to perform such basic experiments in power electronics as characteristics of circuit elements, power electronic circuits, A-D/D-A converter circuits etc. were selected. Equipment to learn the AC motor control was also included.

2) Communication Laboratory

Training kits for learning indispensable subjects in modern communication systems were selected. They include a digital communication system, a microwave trainer, an optical communication kit, a telephony system tutor and a color TV trainer.

3) Power system Laboratory

AC/DC machines, apparatus for high voltage experiments (insulation tests, characteristics of dielectrics, measurement of insulation resistance etc.) and apparatus for the transmission of electric power (cable fault finders and a phase sequence indicator) were selected. These are necessary to learn systematically power system engineering.

Electronic apparatus will be placed in the electronics laboratories and the computer laboratory, the communication equipment in the communication laboratory and the power system equipment in the high voltage laboratory and the electric machine laboratory.

Table 3.3.3 lists the items of equipment selected, the purposes of use and the courses in which the equipment is required.

Table 3.3.3 Equipment for Department of Electrical Engineering and Purposes of Use

1) Basic Electronics Laboratory

Code No.	Item	Experiments/Practice	Course
EBL-1	Basic Electronics Trainer with Power Supply	Experiments in basic electronics : experiments on diodes, transistors and other semiconductor components, electronic circuits.	EE-133: Basic Electronics EE-233: Electronics-I
EBL-2	Operational Amplifier Tutor	Experiments on operational amplifiers.	EE-233: Electronics-I
EBL-3	Transistor Amplifier Tutor	Experiments on transistor amplifiers.	EE-233: Electronics-I EE-333: Electronics-II

EBL-4	Power Supplies Teaching Set	Experiments on power supplies of electronic circuits.	-ditto-

2) Digital Electronics Laboratory

Code No.	Item	Experiments/Practice	Course
EDE-1	Advanced Logic Principles	Experiments on teaching logic principles ; combinational logic circuits, sequential digital circuits, numeric display etc.	EE-331: Digital Electronics
EDE-2	Microprocessor Application Trainer	For teaching microprocessor applications using Z80, 68000 or Intel 8085 with application modules (temperature control, motor control, traffic lights, binary input output etc.).	EE-437-B: Digital Signal Processing EE-437-A: Applied Electronics
EDE-3	Logic Constructor	For experiments on logic circuits, construction of logic circuits using TTL, IC etc.	EE-331: Digital Electronics
EDE-4	Analogue Computing Module	For experiments on analogue computers in the control engineering, to solve differential equations.	EE-432: Control Systems

EDE-5	Analogue and Digital System Trainer Equipment	For demonstrating analogue and digital systems in control engineering and applied electronics in industry.	EE-432: Control Systems EE-437-A: Applied Electronics

3) Power Electronics Laboratory

Code No.	Item	Experiments/Practice	Course
EPE-1	Power Electronics Fundamentals	Experiments on power electronics ; characteristics and use of power transistors, diodes, thyristors.	EE-433: Electronics-III
EPE-2	A-D/D-A Convertor Circuit Trainer	Experiments on power electronics ;A-D/D-A convertor circuits.	-ditto-
EPE-3	Thyristor and Diode Circuit Teaching Unit	Experiments on diode and thyristor circuits.	-ditto-
EPE-4	AC Motor Control Equipment	Demonstrating AC motor control.	-ditto-

4) Communication Laboratory

Code No.	Item	Experiments/Practice	Course
ECL-1	Digital Communication System	Experiments on digital communications.	EE-431: Line Communication
ECL-2	Microwave Trainer	Experiments on microwaves and waveguides.	EE-434-B: Electromagnetic Waves and Radiating Systems

ECL-3	Fibre Optics Kit	Experiments on fibre optical communications.	EE-431: Line Communications
ECL-4	Telephony System Tutor	Used in demonstrating telephony principles.	-ditto-
ECL-5	Color TV Trainer (PAL)	Demonstrating PAL color TV principles.	EE-336 (b): Principles of Communication Systems EE-435-B: Communication Systems-II

5) Power System Laboratory

Code No.	Item	Experiments/Practice	Course
EPS-1	Combined AC/DC Machine	Determination of characteristics of AC, DC machines.	EE-336 (a): Electric Machines-II
EPS-2	High Voltage Insulation Testing Set	Measurement of dielectric properties of insulating materials (voltage source).	EE-434-A: High Voltage Engineering
EPS-3	Capacitance and Dissipation Factor Bridge	Measurement of dielectric properties of insulating materials of electrical apparatus.	-ditto-
EPS-4	Digital Insulation Resistance Tester	Measurement of insulation resistance of electric apparatus such as cables, motors, relays, control circuits.	-ditto-

EPS-5	Cable Fault Finders	Location of cable faults.	EE-436-A: Power Transmission & Distribution
EPS-6	Phase Sequence Indicator	Study of phase sequence of a system.	-ditto-

(2) Department of Mechanical Engineering

As mentioned before, the courses have increased in number and the laboratories have been reorganized during the past five years since the list of equipment was prepared in 1987. At present there are nine laboratories. Eight laboratories have requested equipment including two new laboratories; the theory of machines laboratory and the power plant laboratory.

1) Theory of Machines Laboratory

The laboratory is new. Only one item, a FFT analyser is requested.

The FFT analyzer is used for dynamic analysis of machines and structures. It can quickly calculate autocorrelation, crosscorrelation, coherence functions, transfer functions etc. and is employed to deal with vibration problems. It is a very convenient and useful instrument. It is highly necessary as an essential instrument in the theory of machines.

2) Metallurgy Laboratory

The universal testing machine is indispensable for testing of the material strength such as tensile and compression. In this laboratory it is used to investigate the effect of heat treatment on the mechanical strength of the test object. It is for common use of all the laboratories of the Department as it is very expensive.

The specimen mount press and the high speed cut off machine are necessary to prepare a sample of metal, the surface of which is observed with a metallographic microscope. Since the laboratory has not had these machines so far, it was not possible to prepare the sample. Both are highly necessary.

3) Fuel Engineering Laboratory

The bomb calorimeter and the gas calorimeter were selected as basic instruments for measuring amounts of heat generation in a substance. The Saybolt viscometer was selected for measuring viscosity of fuels and the cone penetration meter for measuring consistency of soft substances like grease. The Orsat gas analyzer is employed for the analyses of CO, CO_2, O_2 in exhaust gases of an internal-combustion engine.

4) Automobile Engineering Laboratory

The diesel engine with turbo-super charger model, the drum and disc brake model and the automatic transmission model were selected for demonstration models. They are useful for learning basic machine elements. Students can learn the hydraulic brake system using the drum and disc brake model.

The fuel injection pump tester is an instrument which allows the observation of fuel injections of the injection pump of diesel engine and measures the injection pressure. It is practical equipment for learning the functions and maintenance of a fuel injection pump. The air/fuel measuring equipment is for measuring the consumption of fuels and air in a gasoline engine, and important to estimate the engine performance. The front-axle measuring-stand with wish-bone suspension is an important instrument for measuring the basic design dimensions of camber, caster, kingpin inclination etc. which determine the performance of steering.

The test stand for electric/electronic systems is for testing alternators, generators, batteries, diodes etc. and necessary to learn the functions of electric and electronic systems. The trouble-shooting analyzer kit (electronic engine tester) is a basic set of measuring instruments to evaluate engine performance.

5) Production Engineering Laboratory

The mechanical comparator is an instrument for measuring the difference between the test object and the standard, and important in the quality control.

The surface roughness measurement instrument and the flatness interferometer are educationally important instruments for measuring the surface finish.

The set of plug and ring gauges, the set of block gauges, the taper plug gauges and the thread gauges of different sizes are basic gauges for measuring various dimensions such as hole sizes, shaft diameters, dimensions of screws etc. and are indispensable in machining.

6) Machine Drawing and Design Laboratory

The strain gauge demonstration and measuring system is a system which helps students to learn stresses generated by external forces exerted on the test object using strain gauges. It is very useful for students to learn the concept of stress and strain in a concrete way as well as to acquire operation techniques on the measuring instruments with strain gauges.

The following 6 items were selected for machine drawing models:

a) Sectioned models of different geometrical solids.
b) Simple bearing housing.
c) Split bearing with separate shells.
d) Piston with rings.
e) Connecting rod end with gib and cotter.
f) Big end assembly.

7) Heat Transfer Laboratory

The following items were selected. They are for learning temperature measurement and the heat transfer, heat conduction and radiation transfer which constitute the basis of heat transfer engineering.

a) Water/water turbulent flow heat transfer unit.
b) Thermal radiation unit.
c) Conductive heat transfer experimental unit.
d) Temperature measurement unit.

8) Power Plant Laboratory

The power plant laboratory is new. Only one item, a water softening plant, is requested.

The water softening plant is used for practice of the operation of a boiler in the thermodynamics course. It is necessary to have equipment to soften the hard water. It is used when softened water is required to operate other plants as well. It is also useful for students to learn the operation of water softening plant.

Table 3.3.4 lists the items of equipment selected, the purposes of use and the courses in which the equipment is required.

Table 3.3.4 Equipment for Department of Mechanical Engineering and Purposes of Use

1) Theory of Machines Laboratory

Code No.	Item	Experiments/Practice	Course
MTM-1	FFT Analyzer	Dynamic analysis of machines and structures. To calculate autocorrelation, cross-correlation, coherence functions, transfer functions etc.	ME-324: Mechanical Vibration

2) Metallurgy Laboratory

Code No.	Item	Experiments/Practice	Course
MML-1	Universal Testing Machine	Tensile, compression and bending tests of various materials.	ME-322: Engineering Metallurgy
MML-2	Specimen Mount Press	To press a metal sample in a plastic plate to observe the sample with a metallographic microscope.	-ditto-
MML-3	High Speed Cut Off Machine	To prepare a thin sample which is observed with a metallographic microscope.	-ditto-

3) Fuel Engineering Laboratory

Code No.	Item	Experiments/Practice	Course
MFL-1	Bomb Calorimeter	To measure amounts of heat generated by solid and liquid fuels.	ME-327: Advanced Thermo-dynamics
MFL-2	Gas Calorimeter	To measure amounts of heat generated by gas.	-ditto-
MFL-3	Saybolt Viscometer	To measure viscosity of fuels.	-ditto-
MFL-4	Cone Penetration Meter	To measure consistency of grease.	-ditto-
MFL-5	Orsat Gas Analyzer	Analyses of CO, CO_2, O_2 in combustion gases.	-ditto-

4) Automobile Engineering Laboratory

Code No.	Item	Experiments/Practice	Course
MAE-1	Fuel Injection Pump Tester	Measurement of the pressure and amount of injection when the fuel is injected by the injection pump.	ME-228: Automobile Engineering
MAE-2	Air/Fuel Measuring Equipment	Measurement of the amounts of consumption of fuels and air of gasoline engines.	-ditto-
MAE-3	Front-Axle Measuring Stand with Wish-Bone Suspension	Measurement of steering alignment.	-ditto-

MAE-4	Test Stand for Electric/Electronic Systems	To learn electric and electronic systems of automobile.	-ditto-
MAE-5	Trouble Shooting Analyzer Kit (Electronic Engine Tester)	A set of measuring instruments such as testers for the inspection of engines.	-ditto-
MAE-6	Diesel Engine with Turbo Super Charger Model	Instruction model.	-ditto-
MAE-7	Drum and Disc Brake (Panel Type)	Instruction model.	-ditto-
MAE-8	Instruction Model Automatic Transmission	Instruction model.	-ditto-

5) Production Engineering Laboratory

Code No.	Item	Experiments/Practice	Course
MPE-1	Mechanical Comparator	To measure the difference between the test object and the standard.	ME-323: Production Engineering -I ME-426: Production Engineering -II
MPE-2	Surface Roughness Measurement Instrument	To measure the surface roughness.	-ditto-
MPE-3	Flatness Interferometer	To measure flatness.	-ditto-
MPE-4	Plug Gauges Ring Gauges	To measure dimensions of hole sizes and shaft diameters.	-ditto-

MPE-5	Block Gauges	To measure dimensions of the object.	-ditto-
MPE-6	Taper Plug Gauge	To measure Morse taper.	-ditto-
MPE-7	Thread Gauges of Different Sizes	To measure the dimensions of ISO screws.	-ditto-

6) Machine Drawing and Design Laboratory

Code No.	Item	Experiments/Practice	Course
MMD-1	Strain Amplifier Demonstration and Measuring System	Measurement of stresses exerted on various parts of the model (tensile, compression, bending, torsion).	ME-321: Machine Drawing & Design-II
MMD-2	Sectioned Models of Different Geometrical Solids (1 set)	Models for machine drawing.	ME-121: Engineering Drawing & Graphics
MMD-3	Bearing Housing	-ditto-	-ditto-
MMD-4	Split Bearing with Separate Shells	-ditto-	-ditto-
MMD-5	Piston with Rings, Piston Rod and Nuts	-ditto-	-ditto-
MMD-6	Connecting Rod End with Gib and Cotter	-ditto-	-ditto-
MMD-7	Big End Assembly	-ditto-	-ditto-

7) Heat Transfer Laboratory

Code No.	Item	Experiments/Practice	Course
MHT-1	Water/Water Turbulent Flow Heat Transfer Unit	To learn heat transfer in turbulent flow.	ME-423: Heat Transfer
MHT-2	Thermal Radiation Unit	To learn radiative heat transfer.	-ditto-
MHT-3	Temperature Measurement Unit	To learn various temperature measurement methods.	-ditto-
MHT-4	Conductive Heat Transfer Experimental Unit	To learn the conduction of heat.	-ditto-

8) Power Plant Laboratory

Code No.	Item	Experiments/Practice	Course
MPP-1	Water Softening Plant	Plant to soften hard water.	BSI-104: Applied Chemistry ME-325: Power Plants -I

(3) Department of Civil Engineering

The selected instruments are for replacement of the existing old ones or are machines required for practice in the courses.

1) Structural and Materials Testing Laboratory

The universal testing machine and the structure testing machine, jack system were selected for the strength testing of materials and structures. The multipoint strain gauge and the multiplier switch to be connected to the strain gauge were selected for measuring strains produced in materials.

The crack detection microscope is for detecting hair cracks in concrete structures.

2) Concrete Laboratory

Mainly testing apparatus for concrete and other related materials were selected. They include a flexural strength testing apparatus for small beams specimen, a creep test apparatus, a Poisson's ratio measuring apparatus, an aggregate crushing test set and an ultrasonic concrete tester. Beside these, moulds and a thermostatic curing tank were selected for the preparation of concrete samples.

3) Soil Mechanics and Highways Laboratory

Most pieces of equipment selected are for replacement of the existing old ones. The selected items are a triaxial compression test set, a direct shear apparatus, a one dimensional consolidation set, a constant head permeameter, a falling head permeameter, a liquid limit determination device, a shrinkage limit determination device, a plastic limit determination device and a CBR test set.

Beside these, an unconfined compression apparatus, proving rings for compression machine and a soil density test set were selected for the basic education of soil mechanics. An electronic balance and dial gauges were also

selected as auxiliary instruments.

4) Hydraulics and Fluid Mechanics Laboratory

A hydraulics bench and a fluid friction apparatus were selected for learning hydraulics and a laminar flow analysis table and a sediment transport channel for learning water flow.

5) Survey Laboratory

Six theodolites were selected for surveying practice to measure horizontal and vertical angles. An electronic total station was selected for precise measurement of longitude and latitude.

6) Public Health Engineering Laboratory

A cooled incubator for BOD and a top loading balance were selected for basic equipment of this laboratory.

Table 3.3.5 lists the items of equipment selected, the purposes of use and the courses in which the equipment is required.

Table 3.3.5 Equipment for Department of Civil Engineering and Purposes of Use

1) Structural and Materials Testing Laboratory

Code No.	Item	Experiments/Practice	Course
CSM-1	Universal Testing Machine	Measurement of the tensile, compression, bending strength and other mechanical properties of materials.	CE-211: Strength of Materials-I CE-315:Plain & Reinforced Concrete CE-415:Design of Concrete Structures
CSM-2	Structure Testing Machine, Jack System	Measuring stresses and strains in concrete structures produced by applying vertical, horizontal and repeating loads.	CE-412: Structural Engineering -III CE-415:Design of Concrete Structures
CSM-3	Multipoint Strain Gauge	Measuring strains produced in structures.	CE-415: Design of Concrete Structures
CSM-4	Set of Sieves with Lid & Receiver	To classify sands and gravels to be mixed with concrete.	CE-315:Plain & Reinforced Concrete
CSM-5	Ten Channel Switch & Balance	To expand the range of the existing strain indicator.	CE-412: Structural Engineering -III CE-415:Design of Concrete Structures