BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR UPGRADING EQUIPMENT
FOR
SCIENTIFIC EDUCATION OF THE FACULTY
OF
SCIENCE, UNIVERSITY OF COLOMBO,
SRI LANKA
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF
SRI LANKA

APRIL 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR UPGRADING EQUIPMENT FOR SCIENTIFIC EDUCATION OF THE FACULTY OF SCIENCE, UNIVERSITY OF COLOMBO, SRI LANKA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

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PREFACE

In response to a request from the Government of Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a basic design study on the Project for Upgrading Equipment for Scientific Education of the Faculty of Science, University of Colombo in the Democratic Socialist Republic of Sri Lanka and entrusted the study to the Japan International Cooperation Agency (JICA).

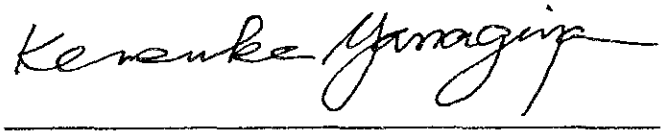
JICA sent to Sri Lanka a study team headed by Dr. Hajime Kato, Professor of Department of Chemistry, Kobe University, from December 4 to December 21 1991.

The team held discussions with the officials concerned of the Government of Sri Lanka, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Sri Lanka in order to discuss a draft report 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 Democratic Socialist Republic of Sri Lanka for their close cooperation extended to the teams.

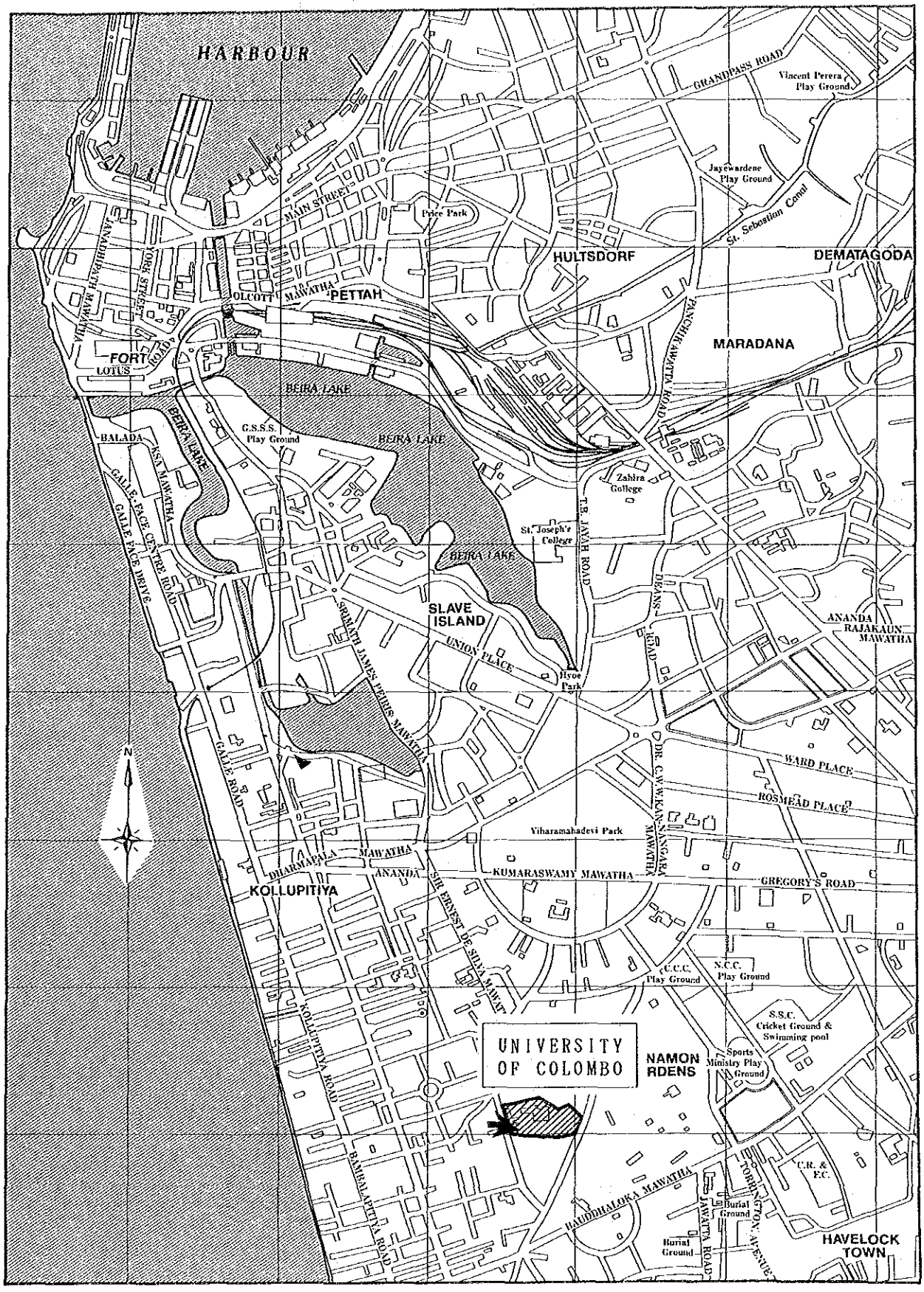
April 1992



Kensuke Yanagiya

President

Japan International Cooperation Agency


HARBOUR
GRANDPASS ROAD
Vincent Perera Play Ground
Jayewardene Play Ground
St. Sebastian Canal
MAIN STREET
Price Park
HULTSDORF
DEMATAGODA
OLCOTT MAWATHA
PETTAH
FORT
LOTUS ROAD
MARADANA
PANCHIKAWATTA ROAD
BEIRA LAKE
G.S.S.S. Play Ground
BALADA
KSA MAWATHA
GALLE FACE CENTRE ROAD
GALLE FACE DRIVE
Zahira College
St. Joseph's College
T.B. JAYAH ROAD
DEANS' ROAD
SLAVE ISLAND
UNION PLACE
Hyde Park
ANANDA RAJAKAUN MAWATHA
SRIMATH JAMES PERIRIS MAWATHA
GALLE ROAD
WARD PLACE
ROSMEAD PLACE
Viharamahadevi Park
DR. C.W.W.KANNANGARA MAWATHA
DHARMAPALA MAWATHA
ANANDA KUMARASWAMY MAWATHA
GREGORY'S ROAD
KOLLUPITIYA
SIR ERNEST DE SILVA MAWATHA
C.C.C. Play Ground
N.C.C. Play Ground
S.S.C. Cricket Ground & Swimming pool
UNIVERSITY OF COLOMBO
NAMON RDENS
Sports Ministry Play Ground
KOLLUPITIYA ROAD
BAMBALAPITIYA ROAD
BAUDDHALOKA MAWATHA
TORRINGTON AVENUE
C.R. & F.C.
Burial Ground
JAWATTA ROAD
Burial Ground
HAVELOCK TOWN
N

SUMMARY

SUMMARY

There are eight universities and one open university in Sri Lanka. They have organised the University Grants Commission (U. G. C) to represent them. The Ministry of Education and Higher Education is the government's administative office responsible for them.

The University of Colombo is one of the oldest universities together with the University of Peradeniya in Sri Lanka. Especially, the Faculty of Science of the University of Colombo is proud of having the oldest tradition for science education in Sri Lanka.

The University of Colombo was created by dividing the old Ceylon University. Before the time of separation, Ceylon University had a plan to relocate the whole campus from Colombo to Peradeniya. Because of this plan, new investment in the Colombo campus of the Ceylon University, which is the present University of Colombo had stopped. After the separation, a ten-year development plan for the Faculty was granted in 1975, and several new buildings have been constructed in the campus. However, because of lack of funds, adequate educational equipment has not yet been provided. The Government of Sri Lanka has requested the Japanese Government for a grant aid to improve this situation by providing scientific educational equipment.

In response to the request, the Government of Japan dispatched a basic design study team to study the Project for Upgrading Equipment for Scientific Education of the Faculty of Science, University of Colombo, from December 4 to December 21, 1991. After study in Japan, the Government of Japan again dispatched a part of the team to Sri Lanka to explain the draft report of the basic design to the Sri Lankan side from Feburary 21 to Feburary 28.

The team surveyed the background of the request, the adequacy of the Japanese Grant Aid for the requested project and the contents of the requested equipment. The team selected equipment which was urgent and very necessary for the purpose, with the collaboration of the Faculty. As a result of the study, after adding newly requested items, 404 items were selected as shown on the list.

The equipment is planned to be purchased with two successive financial years' funds, so that the list shows the amount of equipment for the first term and the second term respectively. Urgently need equipment, excluding items with a long delivery time were selected for the first term. Other highly needed equipment was selected for the second term.

Table Item numbers by Departments and Terms

Department	Item numbers			Description
	1st	2nd	Total	
Chemistry	54	36	90	NMR, HPLC, GC-MS, other analytical equipment, equipment for bio-chemistry including electro phoreses and other apparatus.
Physics	96	86	182	Xray diffractometey, radiation measuring instruments, ossiloscopes, & other student experiment equipment for optics, electronics electro-magnetisn & others.
Botany	39	11	50	Green house, plant growth cabinet, microscopes, SEM & others.
Zoology	52	16	68	UV-Vis Spectrophotometer, microscopes, incubator, cages for animals & etc.
Statistics & Computor Science	2	1	3	Personal Computor System, Optical Disk, Printer
Mathematics	3	1	4	Personal Computors, Astoronomical telescope & others
Radio Isotope Center	2	1	3	Furnace, Oven, Xray-flourecense System
Library	2	2	4	Personal Computor, Books
Total	250	154	404	

The required periods of work for 1st and 2nd phases respectively are:
2.7 months for detailed design and 10 months for procurement, transportation and installation of the equipment.

Industries with a high labor added value productivity such as machinery manufacturing, electronics, and fine chemicals, have not yet been developed in Sri Lanka. For this reason, the country suffers a brain drain and the country's educational success is not well reflected in its economic development. Sri Lanka should reconstruct its industries towards more labor added value production. The faculty of science has the responsibility to create competent scientists, for this purpose, namely for finding out new industries and new technologies to make Sri Lankan industries more productive and also more competitive in the international market.

As the Faculty of Science in the University of Colombo, has excellent students and teaching staff, the Faculty will be able to perform its duty to educate scientists for the invention of new high value added industries in Sri Lanka, when the Japanese Government provides adequate scientific equipment as a part of its aid to Sri Lanka.

When Sri Lanka succeeds in establishing higher value added industries, not only the highly educated people, but also the common people will be able to obtain an adequate income based on their primary and secondary education. Thus the consequence will benefit the welfare of the people as well as national economic expansion.

This project is viable and adequate as a project of Japanese Grant Aid. The Project has great significance for the friendship between Japan and Sri Lanka.

Contents

Contents

Chapter 1 Introduction

Chapter 1 Introduction

The government of Sri Lanka has implemented a ten-year Development Plan for the University of Colombo which was proposed in 1975. Based on this plan, the government has constructed new buildings for the Chemistry, Physics, and Biology Departments of the University of Colombo. Recently, the construction of the new building for the Computer Science Department has also been completed.

The plan, however, has been delayed due to the difficulty of funding as a result of the economic recession in Sri Lanka. The allocation for educational equipment has especially been hit hard.

Nevertheless, the manufacturing industries of Sri Lanka have grown steadily. As a result, the demand for better scientific education has been growing every year among the people.

Under such circumstances, the government of Sri Lanka has asked the government of Japan for a grant aid to secure educational equipment for the Faculty of Sciences of the University of Colombo.

In response to the above request, the Japanese government decided to carryout a study for the project.

Consequently, the Japan International Cooperation Agency (JICA) dispatched a study team headed by Prof. Hajime Kato of Kobe University to Sri Lanka from 3 through 22 December 1991 to examine the viablity of the project in the Japanese Grant Aid system.

The study team members remained in Sri Lanka from 4 through 21 December 1991. During their stay, they met with representatives of the Ministry of Education and Higher Education, the University Grants Commission (U.G.C.), and the University of Colombo and examined the situation of the country, the background for the need of financial assistance for educational equipment, the organizational structure for the implementation of the plan, the degree of need and urgency of the equipment, the specific allocation of the equipment, and the system of operation and maintenance of the equipment.

They further confirmed the undertakings to be shared by the Japanese side and Sri Lankan side for the implementation of the project. For reference, the members of the study team, a list of those involved on the Sri Lankan side, and the schedule of the survey are attached as an Appendix.

After the team returned, the results of the survey conducted in Sri Lanka and the information which had been collected were studied. Based on this, the purpose and background of the plan were clarified. Procedures for implementing the project and the contents of the educational equipment were determined, and the overall required budget was estimated.

This report explains the results gained from these surveys and the basic specifications of the equipment. While this report was being compiled, part of the study team was dispatched to Sri Lanka from 20 through 29 January 1992 to explain and discuss the contents of a draft of this report.

Chapter 2 Background of the Project

Chapter 2 Background of the Project

2-1 Background of the Project

The universities in Sri Lanka, acting together, have organized a University Grants Commission according to the law. This commission is in charge of promoting university education and allocating funds among universities. The members of this commission consist of renowned scholars and university professors who are appointed by the President of Sri Lanka. An administrative office of the commission has been formed which reports to the Secretary of the commission.

Each university is headed by a Chancellor and a Vice Chancellor. Both are selected by the President from scholars who have been professors at the university. In reality, the Vice Chancellor is in charge of the operation of the university.

At the same level as the Chancellor, each university also has a Council which consists of former Vice Chancellors, Deans of each faculty, professors appointed by the university's senate, and members appointed by the U.G.C. The council discusses and determines the policies and other important matters of the university.

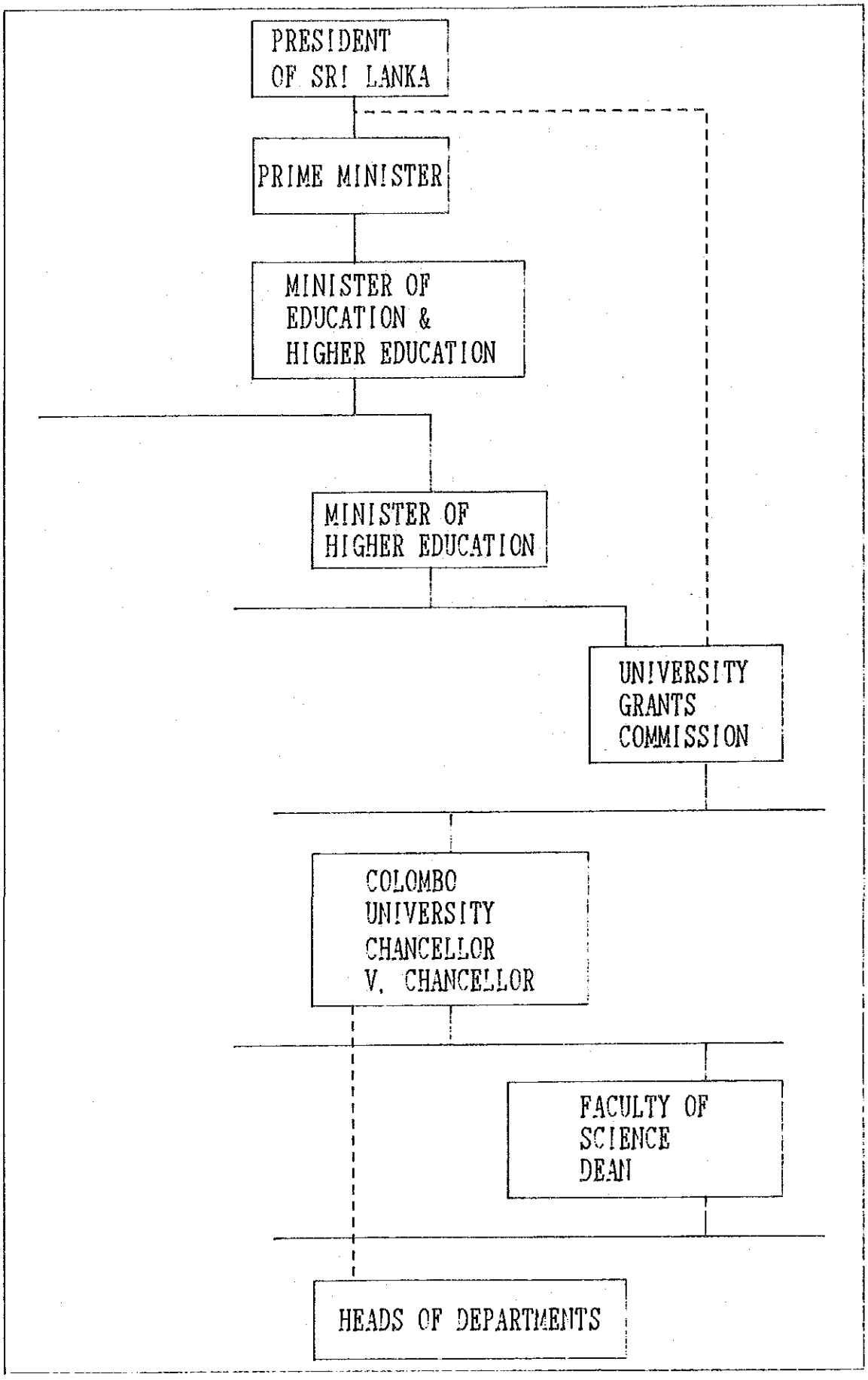


Figure 2-1 Administration of the Universities

In each faculty, a Dean is elected by the teaching staff and he is in charge of the entire administration of the faculty. Also for each department the vice chancellor appoints a head who is in charge of the department. Professors, assistant professors, and lecturers, are assigned to each department as faculty members. The number of faculty members who have earned the title of professor or associated professor is relatively small compared to that of universities in Japan. Lecturers from public institutions, research laboratories, and private companies outside of the university also provide education. In addition to these people, a large number of clerks, technicians, lab assistants, and general workers exists on campus.

In the case of this project, the U.G.C. will be responsible for the Srilankan side budget necessary for the University to implement, operate and maintain the equipment. The University of Colombo will implement the project and carryout the operation and maintenance of the equipment under the Chancellor and Vice-Chancellor of the University. The actual operation and guidance in operations given to the students and the maintenance work, are the responsibility of each instructor, however this is delegated by each Head of Department or Center, under the supervision of the Dean of the Faculty of Science.

In accordance with Ordinance 16 passed in 1978, the following eight universities and one open university were founded. The location of these universities is shown in figure 2-2. The four universities located in Colombo city and the surrounding district are the University of Colombo, the University of Kelaniya, the University of Sri Jayewardenepura, and the University of Moratuwa. Of these universities, the University of Kelaniya and the University of Sri Jayewardenepura have a Buddhist background. The University of Moratuwa is an institute of technology.

(1)	University of Colombo	6,508 students Arts, Law, Education, Science Medicine; 5 Faculties
(2)	University of Peradeniya	7,046 students Agriculture, Arts, Dental Science, Engineering, Medicine, Science, Veterinary Studies; 7 Faculties
(3)	University of Kelaniya	2,600 students Humanities and Social Science, Science; 2 Faculties
(4)	University of Sri Jayewarderepura	5,102 students Applied Science, Arts, Management Study & Commerce; 3 Faculties

(5)	University of Moratuwa	1,897 students Architecture, Engineering; 2 Faculties
(6)	University of Jaffna	1,080 students Arts, Science, Medicine, Agriculture; 4 Faculties
(7)	University of Ruhuna	3,489 students Agriculture, Humanities and Social Sciences, Medicine, Science; 4 Faculties
(8)	Eastern University	479 students Agriculture, Arts and Culture, Commerce & Management, Science; 4 Faculties
(9)	Open University	9,980 students Engineering Technology, Natural Sciences, Humanities and Social Sciences; 3 Faculties

The open university provides university level education through various media to those who have already entered the work force.

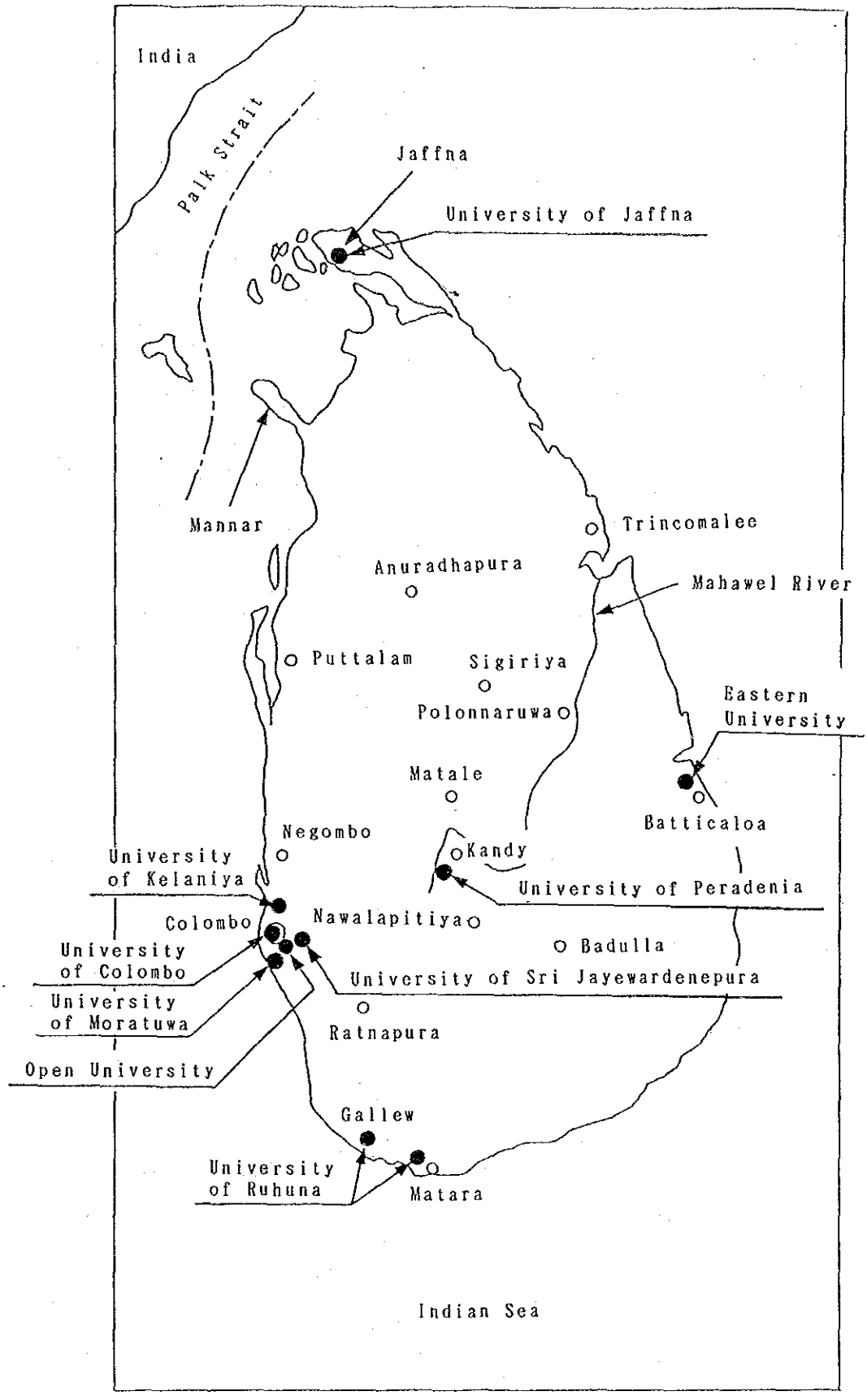


Figure 2-2 Universities in Sri Lanka

Sri Lanka government's total budget for 1991 is 138.0 billion rupees (about ¥450 billion). This includes the ordinary budget of 75.5 billion rupees and the capital investment of 63.5 billion rupees. The budget for the Ministry of Education and Higher Education is 4.162 billion rupees for the recurrent budget and 2.221 billion rupees for capital investment, which totals 6.383 billion rupees (about ¥20.7 billion). This is 4.6% of the entire government budget. As shown in the following table, the budget spent on education amounts to approximately three percent of the GNP. Although this value is not so high compared with other countries (refer to Table A-5), it is probably the greatest effort that can be made by a country which currently suffers from ethnic disputes.

The University of Colombo consists of five faculties, namely, Faculty of Arts, Law, Education, Medicine, and Science. The number of departments and students of each faculty are as follows:

(in 1988/89)

	Undergraduate	Postgraduate
Faculty of Arts	2,642	211
Faculty of Law	970	8
Faculty of Education	–	25
Faculty of Science	1,260	44
Faculty of Medicine	1,336	12
Total:	6,208	300

Source: University of Sri Lanka Hand Book U.G.C. 1991 Edition

Regarding the Faculty of Science, the University of Colombo has the largest number of students in Sri Lanka. The University of Peradeniya follows with 895 undergraduates and 95 graduate students enrolled in its six departments. The sizes of the Faculties of Science of the other universities is small compared to these two universities.

The total budget of the University of Colombo for 1991 was 114 million rupees, and 109 million rupees of this was supplied by the government. This is 1.7% of the budget of the Ministry of Education and Higher Education, which is 6.383 billion rupees as mentioned previously. The allocated budget will be spent on the items listed in the following table.

The expenditure for fuel and lighting is determined for the entire university and is not divided among the faculties. Consequently, when equipment is provided, an additional increase in the budget for electricity will be necessary to cover the increases in power consumption.

(Unit: Rs.)

Budget of the University of Colombo (for Academic Year: 1991)

General Administration Costs	15,164,037	
Undergraduate Costs	79,154,710	
Faculty of Arts		16,832,005
Faculty of Education		5,117,003
Faculty of Law		2,997,070
Faculty of Medicine		29,184,325
Faculty of Science		21,883,514
Examination Expenses		1,791,985
Affiliated Schools		1,348,808
Library	4,672,346	
Welfare	4,549,113	
Maintenance	8,895,039	
Land/Building		3,376,167
Electricity		3,978,288
Water		1,540,584
External Services	782,545	
Student Dormitory	802,294	
Total:	114,020,084	

Source: University of Colombo Programmable Budget 1991

Budgets of the University of Colombo between 1988-1991 are as follows;

(Unit: million Rs.)

Financial Year	Budget of the University of Colombo
1988	63.0
1989	73.8
1990	96.9
1991	114.0

The Faculty of Science of the University of Colombo consists of six departments and one center.

The number of students in each department will be given in Chapter 3 because the structure of the student body is somewhat complex due to the fact that they are divided into two groups which take either the biology course or the physics course for their first two years of study before being divided into their specialized fields. Currently (1991), the capacity for students is 120 for biology and 160 for physics. These numbers are planned to be 120 for biology and 240 for physics in subsequent years starting from 1993.

The following is an outline of the 1991 budget of the Faculty of Science:

(Unit: Rs.)

Manpower Costs	17,898,450
Travelling Expenses	165,000
Parts Procurement/Repairs	905,000
Maintenance	65,850
Communications	98,525
Subsidiary	42,000
Welfare	2,708,734
Total:	21,883,514

For the existing educational equipment, approximately one million rupees, which is the sum allotted for the purchase, maintenance and repair expenses, is sufficient to cover only the maintenance and repairs. However, when additional equipment is introduced through this plan, a substantial increase in the budget will be required.

The Budget of the Faculty of Science of the University of Colombo has increased between 1988-1991, as shown below;

(Unit: 1,000 Rs.)

Financial Year	Budget for the Faculty of Science
1988	12,803
1989	15,460
1990	20,573
1991	21,884

The University of Peradeniya and the Faculty of Science of the University of Colombo originated from the division of the former Ceylon University, which was upgraded from the former University College. The original plan was to establish the university by moving it to the current location of the University of Peradeniya. But there has been a change in plan, and the university has remained where it is today. For this reason, the modernization of the entire facility including the buildings and equipment has been delayed. The Ten year Plan of 1975, however, called for the facility to be renovated and the construction of an expansion to the buildings was started. However, since the funding was not enough to cover purchase of educational equipment, the plan proceeded without provision of the equipment required by the university. Consequently, there is very little educational equipment in the entire Faculty of Science and the quality of what does exist, is outdated.

The educational equipment is controlled by each department under the responsibility of the Head of Department. All equipment is registered on the equipment ledger, and once every year, the location and condition of each equipment is confirmed.

The budget and purchase of equipment are determined based on the requests from each department through the Heads of Departments Council that consists of the Dean and Heads of Departments. However, when it is necessary to replace small parts, for example, due to breakage, the purchase of the material may be decided by the Head of Department.

Storage spaces for the existing equipment have been secured within the buildings, and the equipment is strictly controlled.

The Department of Physics has two small workshops for electric and mechanical work. These workshops are used for simple repairs of equipment and for manufacturing parts of the equipment for the entire Faculty of Science. The present equipment used in these workshops is, however, completely obsolete, and replacements are included in the items requested in the project. Very few repair and manufacturing workshops exist in Columbo and so the workshops are highly depended upon.

The equipment is well managed overall.

Faculties of Sciences provide a major portion of a student's education in the Sri Lankan University education system. Seven universities, excluding the University of Moratuwa (a polytechnic university in reality) of the eight universities, excluding the open university, have a Faculty of Science. This number is large compared to the total of 2 engineering faculties, 4 medical faculties, and 3 agricultural faculties. The Faculty of Science also has a large student body that is comparable to that of the Faculty

of Engineering as shown in Table 2-1. Although the figures are somewhat old, Table 2-2 lists the results of a survey to determine the demand for professionals with various educational backgrounds. As this table shows, the graduates of the Faculty of Science are clearly in demand.

Table 2-1 Number of Students by Faculties

	Science	Engineering	Medicine	Agriculture
University of Colombo	1,260	–	1,336	–
University of Peradenia	895	1,535	614	842
University of Sri Jayewardenepura	207	–	–	–
University of Kelaniya	299	–	–	–
University of Moratuwa	–	1,805	–	–
University of Jaffuna	176	–	67	–
University of Ruhuna	283	–	110	76
University of Earstern	70	–	–	42
Total	3,190	3,340	2,127	560

Source: University of Sri Lanka Hand Book (1991)

Table 2-2 Demand for Graduates by Speciality

Specialty	Demand (Number)
Engineers	1,480
Architects	40
Technicians	7,950
Skilled Craftsmen	18,400
Doctors	1,800
Dentists	240
Nurses	3,620
Agricultural Graduates	470
Agricultural Technicians	1,000
Veterinary Surgeons	160
Science Graduates	7,920
Teachers	26,500

Source: Sri Lankan Mosaic (Ministry of Employment and Economic Affairs, 1975)

After an industrial foundation has been established, it is possible for industries to develop through education in specialized technologies in the field of engineering. However, in order for Sri Lanka to develop further, it must create new industries in which it has a comparative advantage in the world market. For this, scientific knowledge based on fundamental science would be more necessary than

engineering training. It can be said that the education provided by the faculty of science can be expected to produce competent individuals who are able to create new industries based on their scientific knowledge. The process of creating new industries require much trial and error. It is an inefficient process, but it is a path that Sri Lanka must pass through.

There are no records for the employment of graduates of the University of Colombo, because of disorders caused by ethnic riots in 1987-1989. However, an estimation of the employment of Faculty of Science graduates between 1989-1991, which was given by the University, is as follows;

1. Educational Professions	500
2. Public Services (Government)	35
3. Industries	165
4. Technical and Scientific Services	205
5. Other Services	15
6. Working or Studying Outside the Country	80
Total	1,000

2-2 Outline of the Request

2-2-1 Background of the Request

After the government of Sri Lanka divided the former Ceylon University into the University of Peradeniya and the University of Colombo, the government thought of the importance of expanding the University of Colombo as an university in the heart of the largest city in Sri Lanka, and in 1975, proposed a Ten Year Plan for the expansion and development of this university.

The government proceeded with this plan and started construction of new buildings for the Faculty of Science of the University of Colombo and new buildings for Chemistry, Physics, and Biology were completed. Construction of a building for the Institute of Computer Technology and the Department of Statistics and Computer Science followed. However, as a result of the financial difficulties caused by the stagnant economy of Sri Lanka, the overall construction was delayed, and the purchase of new educational equipment was barely able to proceed. Thus, both the quality and quantity of the equipment became insufficient. Even more important, most of the existing equipment is showing signs of deterioration due to frequent use.

In addition, the Faculty of Science of the University of Colombo is opening its doors to more students as part of the government's policy of expanding scientific education. In 1975, the number of students who were admitted entrance was 160; in 1985, it reached 280; and in 1993, it will increase to 360.

The government of Sri Lanka has requested the government of Japan to upgrade the educational equipment of the faculty under these circumstances.

2-2-2 Contents of the Request

(1) Objective

The objective of the Project is to upgrade equipment for the scientific education of the Faculty of Science of the University of Colombo, to vitalize the economy through scientific education.

(2) Agency responsible for the Project

The University of Colombo is responsible for administration and execution of the project under supervision of the U.G.C.

(3) Contents of the Project

The Project is requested to procure and provide the equipment necessary for the improvement of the laboratories, library and classrooms of the Faculty of Science, University of Colombo. The equipment is requested for the use of student's education and study. The equipment is requested for the following six departments, one center and a library;

1	Department of Chemistry	700 students
		57 teaching members
2	Department of Physics	317 students
		43 teaching members
3	Department of Botany	329 students
		41 teaching members
4	Department of Zoology	372 students
		39 teaching members
5	Department of Mathematics	1,300 students
		14 teaching members
6	Department of Statistics	684 students
	& Computer Science	23 teaching members
7	Radio Isotope Center	317 students
		10 teaching members
8	Library	

The numbers of students shown above are the numbers receiving lectures in each Department.

(4) Requested equipment

The Project requests equipment for student's experiments, training and lectures in the class room. Air conditioners and voltage stabilizers are included, but are limited to those necessary for the operation of the equipment.

Table 2-3 shows the outline of the equipment requested.

Table 2-3 Outline of Equipment Requested

Department	Number of Items			Outline of Items Requested
	Originally Requested	Newly Requested	Total	
Chemistry	72	21	93	NMR spectrometer, HPLC, FT-IR spectrometer, and other analytical instruments
Physics	221	4	225	X-ray diffractometer, Radiation monitor, and other equipment relevant to electronics, optics, etc.
Botany	27	10	37	UV-visible spectrometer, scanning electron microscope, various types of microscopes, Greenhouse and other culture growth related equipment
Zoology	60	12	72	UV-visible spectrophotometer, various types of microscopes, Transmitted electron microscope and other equipment used for animal raising
Mathematics	3	0	3	Astronomical telescope, Slide projector, Overhead projector
Statistics & Computer science	5	0	5	Personal computers, Printers, Optical disks.
Radioisotope Center	8	0	8	X-ray Fluorescence system, Furnace, Oven, Counter, Particle accelerator
Library	9	0	9	Personal computers, Copy machines
Total	405	47	452	

2-3 Outline of the Project Location

The campus of the Faculty of Science is located in an ideal environment surrounded by an exclusive neighborhood near the heart of Colombo city. The location of the campus and the position of buildings is shown on the map on the front of the report.

The Faculty of Science of the University of Colombo originated from the University College founded in 1921, and thus, the original buildings which are still in use today comprise about half of the entire buildings of the faculty. These buildings are showing signs of deterioration, but because of their solid structure, they can still serve their purpose today. However, there is no air conditioning at all. These buildings have relatively tall ceilings, and have ceiling fans. The buildings constructed since 1975 during the Ten Year Plan have simplified wall structures with low ceilings and no forced ventilation. Instead, the walls contain passages for natural breezes to enter. Thus, there is no central air conditioning in these buildings. Consequently, if there is a need to provide air conditioning when equipment is installed in these new buildings, the openings in the walls must be covered with plates, and the Sri Lankan side have promised to provide the construction work required for this. Air conditioning will be relatively easy to provide for the combined building of the Statistics and Computer Science Departments and the Institute of Computer Technology which was constructed after the Ten Year Plan, because it is enclosed with solid walls and the interior is separated by partitions. Central air conditioning does not exist in this building either.

Regarding power supplies, the buildings for the Zoology and Botany Departments have an electric power supply that is connected to a common distribution power line and there is no independent transformer substation. The power supply for the buildings of the Physics and Chemistry Departments, and the Statistics and Computer Science Departments comes from an independent substation that has a 800kVA transformer. Currently, the power consumption is small, so there is still sufficient power for additional equipment.

The electric system is a four-wire, three-phase 400V star-connected circuit. Single-phase 230V 50Hz power is distributed to each research laboratory.

Water is supplied from a water tank on the roof of the Chemistry Building. The tank is filled with water provided by the city's water system. The quality of the water is relatively good, and a drainage system is provided.

Chapter 3 Outline of the Project

Chapter 3 Outline of the Project

3-1 Objective

Since the industrial structure of Sri Lanka has a weak foundation and since its industries have a low value added content, the country's education successes have not been reflected in its industrial development. To improve this situation, this plan targets the Faculty of Science of the University of Colombo, which is engaged in the fostering of competent leaders who will possess the scientific knowledge indispensable for creating the Sri Lankan high value added industries. Thus, the purpose of this project is to provide educational equipment that is currently lacking both in quantity and quality, so as to improve the educational standards and thereby improve the industrial structure of Sri Lanka in order to contribute to the advancement of its economy.

3-2 Study and Examination of the Request

3-2-1 Appropriateness of the Request

Currently, people receiving higher education in Sri Lanka are not effectively employed for the advancement of industry, resulting in a severe brain drain. Although Sri Lanka outperforms other developing nations in the enrolment in elementary and secondary schools, the results of this also have not yet been utilized effectively. Thus, for Sri Lanka, a simple expansion of education cannot be considered as contributing to the advancement of society and the economy. Efforts must be made to break away from this situation and to work toward the establishment of a new economic structure for Sri Lanka.

Since relatively cheap labor is available in Sri Lanka, the textile and apparel industries were able to grow through the introduction of foreign technology and capital. In contrast, the development of industries with high added value, such as machinery, electronics, and high-end chemicals, has been extremely slow. Because of this, only a few companies are available to provide employment for graduates of higher education, thus, leading to a high unemployment rate for college graduates. If this problem can be alleviated in Sri Lanka and if the effects of education can be reflected in its economy, it would produce a dramatic increase in the GDP.

Since the Sri Lankan domestic market is small, industries that specifically target international markets must be fostered. However, Sri Lanka currently does not possess any prominent resources other than human capital and has been relying heavily on the introduction of foreign technology and capital, delaying any further improvements to its industrial structure.

The enhancement of scientific education is an important means for Sri Lanka to provide the required manpower to improve its industrial structure. This concept also applies to Japan when efforts are being made to enter the latest technological field. For this purpose, many of those who are conversant with basic scientific studies and with fundamental knowledge gained through scientific education can play an important role.

Currently, the Faculty of Sciences of the University of Colombo admits only those who have passed the GEC A-Level examination, which is the national university entrance qualification examination, with the highest scores. Thus, the entering students are highly qualified. In addition, most of the faculty professors are prominent scholars who have earned their doctoral degrees at post-graduate schools overseas after graduating from the Honors or Special courses at Sri Lankan universities in which only the brightest students are admitted. Positions exist for lecturers, and also most of them are people who have gained their doctoral degrees through the aforementioned process or those who will be awarded their doctoral degrees in the near future.

It is, nevertheless, obvious at a glance, that the educational equipment including that used for research is in extremely poor condition. Existing educational equipment is generally substandard. Except for a few items provided by foreign assistance, the equipment is outdated. It is, difficult to provide education for creating advanced industries if such equipment is used for study and research.

Since advanced industries have not yet been created in Sri Lanka, university students in Sri Lanka naturally lack the opportunity to come in contact with research, and inspection instruments commonly used by advanced industries, and even more important, they rarely have the opportunity to come in direct contact with products produced by these industries. The educational equipment existing in universities, consequently, has a greater effect on the students in Sri Lanka than is expected in Japan. Further, the introduction of modern research equipment for educational use in the faculty, implemented through this project, will certainly serve as the first step for the introduction of modern research facilities in various industries and public institutions in Sri Lanka.

Moreover, the universities of Sri Lanka at present are totally dependent upon foreign universities for the training of their professors. This is because the country lacks appropriate training facilities for university professors. Although this plan has not been designed to provide equipment sufficient for training professors, the execution of this plan will raise the standard of the faculty, and consequently, will be a step towards being able to provide this training within the country. In addition, the provision of modernized equipment will heighten the attraction of the university's teaching positions, and in turn, increase to a great extent the chances for intellectuals who have been leaving the country, to remain in Sri Lanka as faculty members. The economic effect of this is difficult to measure, but it is thought to be great.

Considering all the above circumstances, the execution of this plan will contribute greatly not only to the Faculty of Science but also to the entire Sri Lankan society and economy. Thus, it is an appropriate form of assistance to a developing nation for Japan.

3-2-2 Discussion of the Details for Implementation

If this plan is implemented, the granted equipment will be operated by the University of Colombo, however the Government of Sri Lanka will manage the whole Project including the necessary funding for the operation and maintenance of the equipment through the U.G.C. The equipment will be controlled by the Head of each department after installation and as each department has existing equipment, the storage space and management systems for the equipment have been well established. At present, existing equipment is all registered in the resources ledger and is inventoried once every year to confirm its whereabouts and condition. The budget for purchase of new equipment is determined by the faculties in each university. Each Department Head submits a materials-related budget to the Head of Departments Council where the use of the budget is determined. During the course of the survey for this plan, the Heads of Departments have participated in the selection of equipment and the same general procedures have been taken. The granted equipment will be managed as it has been by each department.

As stated in Section 2-1, the current budget for maintaining equipment is one million rupees (¥3.15 million), which is part of the Faculty of Science budget. This amount has not changed over several years because there has been no increase in equipment. However, when equipment is granted through this project, it will be difficult to maintain the equipment with this budget, consequently, it should be increased by an amount sufficient to cover the expenses of the newly provided equipment.

The budget of the Faculty of Science depends on the budget of the U. G. C. allocated by the government. The maintenance costs will not be necessary until a year after this plan is implemented since the manufactures of the equipment provide one year warranties. It may be difficult to make an accurate forecast of the national budget for future years. Nevertheless, according to the national investment plan mentioned earlier, a large increase is planned for the maintenance costs of facilities and equipment for the U. G. C. An amount that is sufficient to cover the costs of maintenance of the granted equipment has been announced (refer to Table A-6). Also the total amount of the necessary maintenance budget is assumed to be about 5 million rupees, which corresponds to less than 0.6% of the U.G.C's total budget and it is within reach of the U.G.C's financial capability.

Since workshops that are able to provide the proper repair services for the equipment do not exist in Sri Lanka, the University of Colombo has two small electrical and mechanical workshops in the Department of Physics. The workshops are used to produce accessories for the equipment and repair defective parts. Major repairs are probably difficult to perform in these workshops, but a lot of the minor repairs can be done and replacement of defective parts is, in fact, being carried out. The equipment used in these workshops is also showing signs of severe deterioration, and thus, their renovation is included in the Project. The implementation of this Project will upgrade the capability of these workshops to a great extent. Both workshops have a resident technician. A technician who has been educated and trained at a technical college and has earned the required qualification is assigned to each of them. Thus, these workshops can be said to be among the most trusted facilities in Sri Lanka for production and repair of educational equipment at present. Further, the Institute of Computer Technology (located in the same building as the Statistics and Computer Science Departments of the Faculty of Science) has a workshop to perform computer repairs and has technicians who have been trained through technical cooperation programs that Japan has provided. They can perform sophisticated repairs for the models that they have been trained for.

An estimate of the expenses required for the maintenance will be given separately in Section 3-3-5.

From the above, it has been determined that the equipment can be maintained by the Sri Lankan side.

3-2-3 Relation of the Plan to Other Foreign Aid

There are three kinds of foreign assistance being provided for educational equipment related to the Faculty of Science of the University of Colombo: the Chemistry Department receives assistance from Canada, the Radio Isotope Center receives assistance from the International Atomic Energy Agency (IAEA), and the Institute of Computer Technology receives assistance from Japan. The following is the conclusion of a discussion concerning the relationship of the above assistance to that provided by this plan.

The Radio Isotope Center engages in research into radiation for peaceful purposes and for the protection of the environment, and concurrently engages in the instruction of students in the Faculty of Science. Emphasis is given to practical instruction. Consequently, the educational equipment of the center consists of items for practical use provided by the IAEA. When compared to those granted by the IAEA, the radiometry-related instruments to be provided to the Department of Physics through this project are of a basic nature. In other words, the instruments provided by this project are for the enhancement of basic education which will be followed later by practical education at the center.

The purpose of the Institute of Computer Technology is to teach computer technology to graduates with non-computer science majors and to train them to use computers. Consequently, every year, they solicit applications to fill openings for 30 entrants from graduates regardless of the university, faculty, or department in which they have earned their degrees. Students who are accepted go through a year of study and training and are awarded a certificate as a computer operator. Taking the entrants for 1990, as an example, it can be seen that only four of the 28 entrants are graduates of the University of Colombo and that the other entrants were selected from graduates of other universities. Eight of these were non-science majors including one engineering major. A total of 60 trainees are selected in two groups of 30. The institute is equipped with a mainframe computer with a total of seventy terminals connected to it. The facility is in full operation most of the time for the education of trainees and for research by the institute. The facility is shared partially with the Statistics and Computer Science Departments of the Faculty of Science, but in actuality, there isn't much opportunity for these students to use the facility. Consequently, the equipment newly requested in this project would be required for the Statistics and Computer Science Departments to carry out education comparable to that offered by the institute.

Among the equipment granted to the Department of Chemistry by Canada is an atomic absorption spectrophotometer. Although this instrument has become very old, it has been well maintained and is still in working condition. An atomic absorption photometer, consequently, is not included in the requests for the Project. The other things granted by Canada were mainly glass ware, and this too does not overlap with the items requested in this project.

As is clear from the above examination and discussion, this project supplements the other three foreign assistance projects, and no part of it overlaps with the others.

In the case of the Departments of Chemistry and Physics, the project was designed so as to supply sufficient equipment to achieve an adequate standard. Since the quality of the teaching staff and students of both departments is very high, a large rise in the educational standard as well as normalization of education can be expected from this plan.

In the case of the Departments of Zoology and Botany, since the equipment was selected with a limitation on the quantity, even after equipment has been provided through this plan, the standard of the equipment can not be said to have reached an adequate level. However, equipment was selected that will surely present the greatest cost effectiveness in improving the educational standard.

The selection of equipment for the Radio Isotope center and the Mathematics, Statistics and Computer Science Departments was limited to items that are in especially urgent need.

The use of the library by the students is extremely high. Although the equipment selected for the library cannot be classified as scientific instruments, they have been selected based on their effect on the study and research of the students.

3-2-4 Study of the Requested Equipment

(1) Policy for Selection of Equipment

The equipment should be planned based on the curriculum of the Faculty of Science. For this reason, the current curriculum of each department was examined in detail. The small amount of equipment which already exists, was also examined, and overlapping was avoided so that the combination of the existing and planned equipment would provide smooth operation of the curriculum. The quantity of the equipment was determined by considering the condition in which the experiments and practical training are conducted, the number of students, and the number of teaching staff. These factors were also thoroughly examined, and each item of equipment was discussed before a decision was reached. The

equipment was selected according to the above method, and the specific selection was made according to the following basic policies:

1. The equipment must be educational equipment for undergraduate and/or postgraduate students of the faculty or needed for conducting research by the students.
2. The equipment must be limited to scientific educational equipment and relevant accessories and does not include facilities.
3. Facilities for the library and the minimum facilities required for the safe operation of the equipment, such as air conditioners, are included.
4. Also, equipment for the workshops to be used for performing repairs and production of parts is included.
5. Maintenance expenses for the equipment must be reasonable for the Sri Lankan side.
6. Based on the decision of the 1991 Annual Meeting between Japan and Sri Lanka, equipment for the Departments of Chemistry and Physics is given priority.

The educational benefit was not the only factor considered and the equipment was limited to those items which are urgently needed to suit the curriculum of the Faculty.

(2) Study of Equipment

The curriculum of each department is shown in Table 3-2, and the total equipment which will be available at the end of the Project namely the selected and existing equipment are listed together in the table in Appendix 6.

1) Department of Chemistry

Various types of equipment have been requested by the Department of Chemistry and they can be classified according to function as follows:

Spectrophotometric Analyzers

Spectrophotometric analysis is an analytical method for identifying substances, their molecular and atomic state and structure by detecting absorption or radiation of electromagnetic waves at specific frequencies. Several different types of spectrophotometers have been developed with a wide range of wave lengths. Spectrophotometric analysis is widely used because only very small samples are required for a relatively accurate analysis.

This method is extremely important in the field of chemistry.

Electromagnetic Analyzers

Nuclear magnetic resonance apparatus and mass spectrometers are typical electro-magnetic analysers. The nuclear magnetic resonance apparatus works by utilizing the resonance of an atomic nucleus in a magnetic field. It plays an important role in the identification of the structure of substances. It is used to analyze the structure of organic chemical compounds and has recently been used in various fields such as polymer chemistry, biochemistry and medicine. The mass spectrometer is used with a gas chromatograph to separate substances and analyze the structure of the separated substances, mainly in the fields of organic compounds, biochemistry, and medicine. The determination of moleculas structure requires the results of analysis by the combination of an infrared spectrometer, a nuclear magnetic resonance apparatus and a mass spectrometer, which are indispensable for modern chemical analysis practices.

Electro-chemical Analyzers

Typical electro-chemical analyzers are the polarograph, pH meter and ion meter. The polarograph is useful for analyzing component elements.

Separators and Distillation Apparatus

In the category of separators and distillation apparatus, there are gas chromatographs, liquid chromatographs, electrophoresis apparatus and various distillation and extraction apparatuses. Gas chromatograph analysis is a quantitative method to measure trace elements in a solution by using gas as the medium. It is one of the most important analyzing methods in the field of analytical chemistry. On the other hand, the liquid chromatograph is a method to measure small amounts of components in liquid solutions and is used for chemical substances which will become unstable when gasified or any substance with a relatively large molecular weight.

Apparatus for Testing and Measuring Physical Properties

Chemical analysis uses general purpose instruments including balances, thermometers, flowmeters, polarimeters, and colorimeters.

Chemical Apparatus for General Use

Typical examples of chemical apparatus for general use are dryers, incubators, stirrers, shakers, pulverizers, mixers, pumps, distillation apparatus, centrifuges, autoclaves, and so on.

The chemical equipment mentioned above is classified according to function, and the following shows the items required according to the curriculum.

(i) Organic Chemistry

In organic chemistry, carbon compounds are studied. Synthetic organic compounds are used widely in daily life. The students study the theory of various reactions and synthesis of organic chemicals in the lectures. The laboratory experimental course, for instance, provides experiments for the synthesis of organic compounds and the extraction and isolation of organic elements using chromatography. In addition, the course will provide opportunities to study the IR, NMR and UV. The equipment shown below is required and has been selected for the lessons and experiments in organic chemistry.

Optical and Spectrophotometric Analyzers

FT-IR Spectrophotometer

UV visible-spectrophotometer

Spectrofluorometer

Separation and Distillation Apparatus

HPLC

GC

Soxhlet extractor

Rotary evaporator

Apparatus for Testing and Measuring Physical Properties

Top-pan balance

Analytical balance

Digital polarimeter

Others

Vacuum pump

Flask shaker

Circulatory water bath with pump

Heating mantle

Pure water system

(ii) Inorganic Chemistry

In inorganic chemistry, the chemical reactions and properties of all the elements and their compounds are studied, with the exception of hydrocarbons.

Examples of experiments in inorganic chemistry are gravimetry and titrimetry of naturally occurring samples such as apatite and dolomite, and colorimetry and spectrophotometry to determine phosphorus in fertilizers, maganese in steel, etc. In addition, analysis of metal elements in oils, fats and sea water by atomic absorption spectrophotometry are included in the experiments in inorganic chemistry. The equipment shown below is required in the lessons and experiments.

Apparatus for Testing and Measuring Physical Properties

Analytical balance

Top-pan balance

Colorimeter

pH meter

General Use

Furnace

Constant temp. water bath

Stirrer

Vacuum dessicator

Rotary evaporator

(iii) Physical Chemistry

Physical chemistry is a branch of chemistry that deals with the analysis of underlying characteristics of chemical substances and with the interpretation of chemical phenomena by physical methods.

For example, in experiments in physical chemistry, reaction kinetics, activation energy, effect of ionic strength, thermodynamics, electrochemistry and spectrophotometry are studied. The equipment listed below is required for the lessons and experiments of physical chemistry.

Electro-chemical Analyzers

Polarograph

Apparatus for Testing and Measuring Physical Properties

Conductivity meter

Refractometer

Colorimeter

Viscometer

pH meter

Polarimeter

Melting point apparatus

Chemical Apparatus for General Use

Constant temperature water bath

(iv) Analytical Chemistry

Analytical chemistry is a branch of chemistry dealing with the analysis of chemicals by chemical methods.

The lessons and experiments in analytical chemistry cover the theory of analytical chemistry and experiments using methods such as titration, spectroscopy, extraction and distillation.

The equipment listed below is required for the analytical chemistry study.

Separators and Distillation Apparatus

Fluoresence detector

Micro syringe

Hand centrifuge

Low speed centrifuge

Apparatus for Testing and Measuring Physical Properties

Analytical balance

Turbidimeter

COD analyser

Oxygen electrode

Dissolved oxygen meter

pH meter

Others

Constant temperature water bath

Water still

Camera with micro lens

(v) Biochemistry/Molecular biology

In biochemistry, substances of living organisms are studied based on chemical theories. Specifically, it is a study that aims to explain the structure of substances that are found in living organisms and to investigate the phenomena of living organisms. The major subjects covered in the lessons and experiments of biochemistry and molecular biology are; Protein structure and function, Enzymes, Metabolism, Glucose storage, Lipids, Amino acids, Pyrimidines, Chemistry of blood, DNA, Chromosomes and genes:

The equipment listed below is required for the experiments of biochemistry and molecular biology.

Separations Apparatus

High speed ref. centrifuge

Ultra centrifuge

Micro centrifuge

Gel electrophororesis

Mini gel electrophororesis

DNA gel electrophororesis

Apparatus for Testing and Measuring Physical Properties

Top pan balance

Colorimeter

Chemical Apparatus for General Use

Freeze dryer

Electric autoclave

Clean bench

Orbital shaker

Stirrer

Vaccum dessicator

Blender

Heating mantle

Refregerating circulating bath

Others

Dry ice making machine

Liquid nitrogen dewar

Deepfreezer

Ultra-low temperature freezer

Concentrator

(iv) Equipment for several lectures and experiments

The equipment required for several lectures and experiments of the Department of Chemistry are listed below:

NMR

GC-MS

Slide projector

Overhead projector

Personal computer

2) Department of Physics

Equipment selected for the Department of Physics is outlined as follows.

(i) Electronics

Electronic circuits are widely and extensively used not only in industry but also in consumer applications. The fundamental knowledge of electronic circuits is indispensable to the economic development of Sri Lanka.

In the light of the rapid development of electronic engineering, it is highly desirable that developing nations build up expertise in this field. Selection of new equipment is made based on its performance and immediate application as well as its capability to keep up with changes in future.

Specific attention is particularly placed on logic circuit equipment for students to learn the principles of computers.

Applied circuits for semi-conductors and principles of computers

- Logic analyser
- Logic probes
- Experimental kits in electronics
- Microprocessor training kit
- Electronic training equipment system
- Logic trainers

Equipment for measuring circuit characteristics

- Oscilloscope, 300MHz
- Oscilloscope, dual trace, 20MHz
- Oscilloscope camera
- Digital multimeter
- Function generator

Equipment for the study of electronics in communications

- Microwave apparatus
- RF level meter
- AM/FM signal generator

Equipment for the study of electronics in general

- Hall voltage apparatus
- Plank's constant apparatus
- "Frank and Hertz" expt. set up

(ii) Electromagnetism

Electromagnetism gives the basic knowledge for studying electronics, and is necessary for understanding electric motors, generators, power transmission and power distribution systems.

Electromagnetism is a branch of physics in which the characteristics of electric currents and magnetism and the interaction between them is studied. Equipment was selected mainly with the aim of upgrading the experimental standard from the existing level.

General measuring instruments

Analog multimeter

Clamp meter

Magnetic fluxmeter

AC millivoltmeter

Potentiostat/Galvanostat

LCR meter

Equipment for simulating circuits

Regulated DC power supply, 1.2A

Regulated DC power supply, 5A

Capacitors, sub. standard variable

Oscillator 2Hz to 20MHz

Decade resistance boxes (0 ohm - 10Meg)

Decade resistance boxes (0 ohm - 1Meg)

Decade resistance boxes (0 - 100K)

(iii) Nuclear physics

Measurement of radiation emitted by radioisotopes is practised during nuclear physics experiments. Radioisotopes are widely used in engineering, biology, environmental protection and medical applications.

In this project, radiation measurement equipment that can be combined as a system based on the NIM standard (international standard of instrument for radiation measurement) have been selected.

Equipment for measuring radiation

- Geiger Muller counter expt. setup
- Semiconductor detectors
- Nuclear radiation expt. study set up
- Fast pulse generator
- Photomultiplier tubes
- NIM crate
- Fast pulse amp. (NIM)
- Discriminators (NIM)
- Charge sensitive amplifiers
- Charge sensitive preamplifiers (NIM)
- Linear gates & delay generator (NIM)
- Scalers - dual (NIM)
- Power supplies E. H. T. (NIM)
- Fast coincidence gates - 4 inputs (NIM)
- Amplitude to digital converters (NIM)
- Stretcher amplifier (NIM)
- Radiation monitor
- Time to digital converter 8-bit
- Multi channel analyzer
- Electronic delay generator

(iv) Solid state physics

Solid state physics is a science which studies the structure and characteristics of solids such as crystals and amorphous materials and is concerned with the basic theory of advanced materials like semi-conductors and ceramics.

Equipment which was selected consists of instruments for research into crystalline structure and photo semi-conductors.

Vacuum coating apparatus

Precision crystal cutter

X-ray diffractometer

Furnace

Ovens

(v) Optics and wave mechanics

Essential equipment will be provided because the existing instruments for optics and wave mechanics are in short supply and inadequate.

Lasers

Optical spectrometers

XENON lamp & Power Supply

Stroboscopes

Professional camera

Ultrasonic apparatus

Optical bench with accessories

Monochromator

High sensitive photometer

(vi) Meteorology

In the meteorology course, research is carried out on lightning and acid rain. Since these topics are frequently covered both in lectures and research projects for undergraduate students, equipment is selected for studying these subjects.

Spectrum analyzer

Digital hygrometer

pH meter

Weather station

Portable digital sound level meter

(vii) Mechanics, Thermodynamics and Other

In addition, equipment used in Mechanics, Thermodynamics and other subjects are listed below:

Travelling microscope

Analytical balances

Top-pan balances

Cathetometers

Peak hold digital thermometer

(viii) Computer Room for Physics

Computers are indispensable for the Department of Physics for processing experimental data, numerical computation (simulation) and theoretical calculations to compare with experimental results. Providing the Department with a computer system is valuable because students rarely possess computers in Sri Lanka. A computer room open to students has been newly established.

Microcomputer System

(ix) Lecture Room

There are many lectures in physics that require visual aids in order to demonstrate topics in concrete visual forms. The following equipment has been selected for this purpose:

Slide projector

Overhead projector

Large TV, VCR, video camera

Epidiascope

(x) Electronics Workshop

The Electronics industry in Sri Lanka is still immature, and few repair shops for electronic instruments are available. A workshop in the university thus becomes quite important. Improvements are mainly concerned with inspection equipment.

Curve tracer

Insulation tester

Soldering and de-soldering station

Electronic tool kits

Digital IC tester

Digital transistor IC tester

(xi) Machine Workshop

The machine workshop carries out repairs on equipment and produces parts for the Faculty of Science as a whole. In addition, physics students undertake simple practical work in the workshop. Since the tools currently available in the workshop are either obsolete or short of spare parts, it has hardly fulfilled its objectives. In this project, equipment has been selected to enable common types of repair work to be done:

Tools for metal cutting, grinding, machining and drilling

Centre lathe for metal

Micro lathe

Metal cutting band saw

Shaping machine

Bench grinder

Hammer drill

Power hack saw

Cutting off machine

Pillar drill

Portable thread cutter-electric

Portable electric drill

Milling machine

Tool and cutter grinder

Polishing machine

Machines for metal bending, welding, revetting and heat treatment

Hydraulic press

Pipe and tube bender

Plastic welding equipment

Riveter

Welding transformer

Welding torch

Spot welding machine

Electric oven (hardening)

Tools; cutters, drills etc.

Drill set

Complete took kits

End mills

Double end mills

Side milling cutters

Slitting saws

Wood working tools

Woodworking lathe

Electric sander

Jig saw

Routers

Planer

Angle grinders

Combination wood working machine

Saber saw

Dust extraction equipment

Other machines for painting, processing, treating glass ware and etc.

Coil winder

Mobile air compressor

Spray gun for painting

Glass cutting boards

3) Department of Botany

Equipment for the Department of Botany includes various types of microscopes, tissue and microbe culture related equipment, analytical and measuring instruments.

(i) General Biology

Microscopes for student use are the most basic instruments for studying plants. The lenses of most of the microscopes used by the Department presently have become mouldy. Cabinets with a desiccating capability have been provided for the student microscopes so as to reduce the risk of moulding. In addition, providing a large number of microscopes will certainly improve the level of practicals substantially. Dissecting microscopes, which are used for stereoscopic observation of plant specimens and structural examinations have also been selected since existing microscopes of this type are few in number and obsolete so preventing adequate experiments from being carried out.

Dissecting microscopes

Vacuum desiccator

Greenhouse

Pure water system

Student microscopes

Microscope cabinets

(ii) Plant Physiology

In plant physiology, the effect of fertilizers and soil on plants, and the metabolic functions of plants including photosynthesis and respiration are studied. A photosynthesis system, leaf area meter and quantum radiation meter photometer have been selected for monitoring photosynthesis.

Continuous flow analyzer

Freeze drying microtome

Freeze dryer

Variable volume dispenser

Fluorescence microscope

Rotary evaporator

Colorimeter

Oven

Photosynthetic system

Quantum radiometer/photometer

Leaf area meter

Photographic lab

Automatic microtome knife sharpener

(iii) Cell Biology

In cell biology, a phase contrast microscope has been selected for enabling detailed observations of live cells.

Phase contrast microscope

(iv) Plant Pathology

In plant pathology, a scanning electron microscope has been selected for microscopic observation of cells and plant tissue.

Scanning electron microscope

Stereo microscope

(v) Plant Biochemistry

In plant biochemistry, metabolism associated with producing proteins, the function of enzymes, etc. are studied, which provides basic knowledge for fermentation engineering. A UV-visible spectrophotometer have been selected as instruments for chemical analysis.

Orbital shakers

UV-visible spectrophotometer

Magnetic stirrers & hot plates

Soxhlet apparatus

Constant temperature water baths

(vi) Microbiology

Microbiology involves a study of bionomics and a study of specified microorganisms by separating cultivation. The study is valuable for the utilization of microorganisms for industry, and also for finding a pathogen and its preventive measures. Types of incubators for microorganism cultures, an auto clave and water distiller have been selected.

Freezer

Thermostatic orbital shaking water bath

Electric autoclave

Constant temperature incubators

Cooling incubator

Flask shakers

Clean bench

Portable pH meter

(vii) Environmental Science

This course studies conservation of the environment by assessing the effects of industrial development on the environment. DO meters have been selected for measuring the amount of oxygen dissolved in water.

Dissolved oxygen meters

(viii) Equipment for general lectures

Visual aids to provide illustrations and pictures are needed for the Department of Biology.

Projection screen

Overhead projector

Slide projector

4) Department of Zoology

Equipment for the Department of Zoology includes items mainly for histology, embryology and animal physiology.

(i) Histology/Embryology

Histology studies the structure and specialization of animal tissues, while Embryology is a science for breeding and propagation of animals. Applied research concerned with medical science, agriculture and fisheries is carried out. The equipment selected is needed for culturing microorganisms, animal organs and cellular tissue used in experiments and practicals, and microscopes. The existing microscopes for students in particular are few in number and their lenses are mouldy causing poor visibility, which interferes with the practicals. Also, moisture removing microscope cabinets are to be provided in this project for storing student microscopes in order to protect the lenses from mould.

Electric autoclave

Freezer

Cryostat

Stereo microscope

Top-pan balances

Analytical balances

Automated tissue processor

Phase contrast microscope

Constant temperature incubators

Student microscope

Microscope cabinet

Microtome, rotating type

Ovens

(ii) Zoo-Ecology

Ecology is applied to research on preservation of fish resources, outbreak of insect pests, etc. Instruments for analysing water and an inverted microscope have been selected in this project

Inverted microscope

Event recorders

UV-visible spectrophotometer

Dissolved oxygen meters

Temperature controlled cabinets

Dip coolers

Water samplers

(iii) Animal physiology

Animal physiology consists of the study of organs, cell functions, nerve cells and their systems. Equipment selected includes a CO_2 incubator, constant temperature water bath, instruments for measuring muscular strength and tissue culture. These items are fundamental equipment for experiments in studying the functions of living organisms.

Portable pH meter

Anxiety tester

Coulter counter

Ishihara card

Hot plate analgesia meter

Tail flick analgesia meter

Pressure analgesia meter

Haemoglutinometers

Cabon dioxide incubator

Constant temperature water baths

Organ baths

Kymographs and stimulator

Isometric force transducer

Low speed centrifuge

Turbidimeter

Hemadynamometer

Lick - counter

Animal balance

Electrocardiograph

(iv) Parasitology

A parasite itself not only harms the host but also causes disorders chemically by substances secreted by the parasite and may carry bacilli which cause infectious diseases. Parasitology includes an introduction to parasitism and studies of intestinal protozoa, haemoflagellates and the relationship between parasites and insects.

Fluorescence microscope

(v) Fish Biology and Fisheries

Fish biology and fisheries consists of the study of the classification of fishes, general views of anatomical features of a fish for its classification, characteristics of fishes in Sri Lanka and effective utilization of them. The following equipment has been selected for monitoring fish.

Aquarium thermostats

pH meter

(vi) Entomology

Entomology consists of the study of the extermination of noxious insects that damage the prime crops of Sri Lanka such as tea, coconuts and rice. Research is also conducted on controlling vermin by utilizing natural enemies as a part of applied entomology.

Dissecting microscopes are used to dissect insects while observing their stereoscopic image. The existing dissecting microscopes are obsolete.

Insect cage

Dissecting microscopes

(vii) Environmental Science

Environmental science includes practicing skills for observing wild animals, and studies to conserve the animal kingdom. Field binoculars have been selected for observing wild animals.

Field binoculars

(viii) Equipment for general lectures

A slide projector is needed for the Department of Zoology to show animals and their ecological features by illustrations and pictures.

Slide projector

(ix) Equipment for raising animals

Raising and managing experimental animals is an essential requirement. The Department has an animal house (75 m^2) for raising animals. However, existing cages are insufficient because some of them are damaged. The following equipment has been selected in order to provide additional facilities and renovate existing ones.

Plastic hamster cages

Straight-tube water bottle

Bent-tube water bottle

Small rabbit cages

5) Department of Statistics and Computer Science

(i) Computer Network

The Local Area Network (LAN) consists of two personal computers with high speed computing capability as the core equipment and ten personal computers as terminals to provide centralized computer processing. These personal computers can also be used as stand-alone units for dispersed processing. With this computer configuration, firmware composed of both hardware and software as a combined unit is taught. The

LAN is equipped with peripheral equipment such as 300 MB harddisk drives, laser beam printers, etc..

Microcomputer System

(ii) Optical Disk Drive

Optical disks are beginning to be more frequently used these days as an information storage medium, as database banks start to develop. An optical disk drive has been selected as up-to-date-equipment.

Microcomputer Optical Disk Unit

(iii) Printers

The eleven existing personal computers currently are hooked up to only one printer, which is not sufficient. Four sets of printers and printer-switchers, which enable one printer to serve three personal computers, have been selected.

Dot Matrix Printers (Para. Int.) w/Switches

6) Department of Mathematics

(i) Presentation Equipment

Presentation equipment is important for mathematics which often requires special expressions such as drawings, formulas, etc. to be displayed.

Slide Projector

Overhead Projector

(ii) Calculation and Verification of Results

Lectures will be followed up by calculations on a personal computer using mathematical formulas.

Personal computer with Coprocessor

(iii) Astronomy

Astronomy is taught as one of the applications of mathematics in the department. The existing astronomical telescope has been seriously damaged. It is highly desired even among the students to replace it.

12" Cassegrain Motor Drive Reflector Telescope

7) Radio Isotope Center

The existing equipment is relatively good in comparison with the other departments because of assistance from the International Atomic Energy Agency. Selection of the equipment for this department was limited to a case of equipment for preparing materials which will enable existing equipment to be used more effectively and for equipment that is required for preservation of archaeological cultural treasures in this country.

Furnace

Oven

X-ray Fluorescence system

8) Library

The library for the Faculty of Science is located on the 4th and the 5th floors of the new chemistry building, and is frequently used by the students. Biology-related literature is kept on the 4th floor and chemistry-, physics-, mathematics- and computer-related literature is kept on the 5th floor. The facility is under the control of two assistant librarians and a few other supporting people.

A personal computer with data-base capability has been selected to provide effective control of the materials in the library.

Copy Machine

Personal Computer

Overhead Projector

3-2-5 Technical Cooperation

Technical cooperation is not part of the scope of this project and so this plan can serve its purpose even if technological cooperation is not included. Nevertheless, technological cooperation is desirable for the following reasons.

It is difficult for the installation technicians to provide adequate guidance for the operation of the nuclear magnetic resonance analyzer, gas-chromatograph mass spectrograph, and scanning electron microscope during the short installation time. As a result of the survey, it has been confirmed that the Faculty of Science has staff members who have gained sufficient experience overseas in operating equipment similar to each of the above, but there are not many of them. Since these staff members have not received any systematic training, their ability is not necessarily adequate considering that maintenance and inspections are also required. Thus, in order to implement this plan smoothly taking these factors into consideration, it is desirable that technology is transfered for these instruments.

3-2-6 Decision for the Basic Design

As a result of above mentioned study, the effectiveness, viability and ability of the Sri Lankan side, has been confirmed. The Project is expected to have a good effect which conforms with the purpose of Japanese Grant Aid, and has been evaluated for adoption as a Japanese Grant Aid Project.

Consequently, the Project has been studied further since the basic design of the Project, as described in the following chapters.

3-3 Project Description

3-3-1 Organization for the Operation of the Equipment

After receiving the equipment, the U.G.C. will provide the necessary budget for its operation and maintenance to the University of Colombo through the Government of Sri Lanka. The University of Colombo will appoint the Dean of the Faculty of Science to control the equipment under the supervision of the Chancellor and Vice-Chancellor of the University. Repair work and the manufacturing of attachments for the equipment will be provided by the three existing workshops, namely the Machinery Workshop, the Electric Workshop and the Computer Workshop.

When the work is beyond by the capacity of these shops, it will be ordered to outside companies.

The equipment will be operated and stored by the Faculty. Operation and storage of the equipment will be done by a unit of each department, center or library, and the head of each unit will be responsible for that part of the equipment which is under his control.

Based on a suggestion by the chairman of the U.G.C., the Sri Lankan side is planing to organize a committee in which members other than the Faculty of Science are included to promote effective utilization of the equipment as well as monitoring its operation and maintenance. The committee will report to the U.G.C. and Japanese side on the condition and all aspects of the utilization of the equipment every six months.

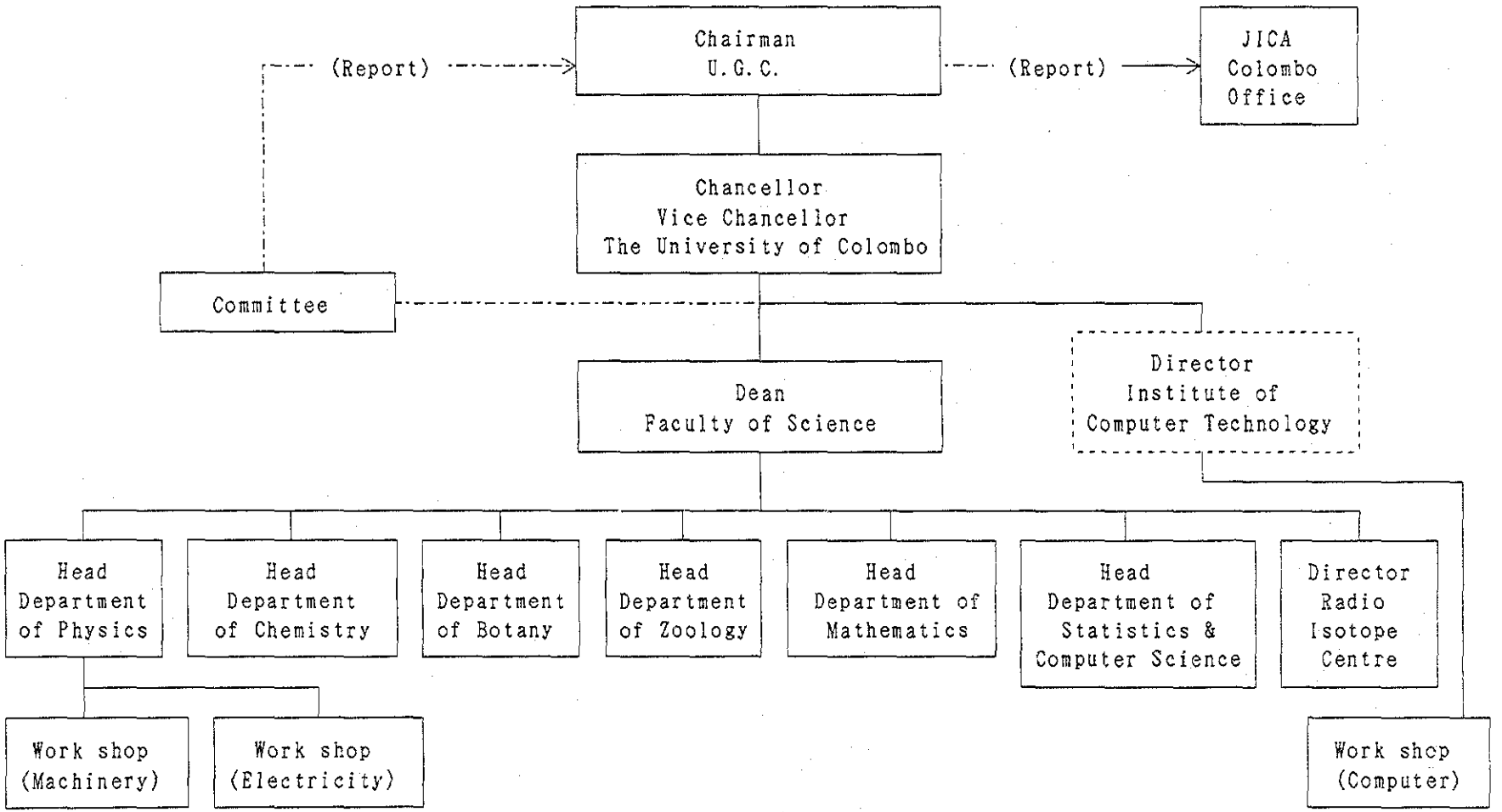


Figure 3-1 Administrative Organization

3-3-2 Plan of Operation

The equipment shall be operated based on the curriculum of the Faculty of Science, for the education of students by the teaching staffs of the Faculty. Accordingly, the numbers of students, the numbers of teaching staffs and the curriculum of the Faculty of Science are explained in this section to show the activity which is expected as a result of implementation of the Project.

The Faculty has a plan to increase the number of its student after 1993, and this fact shall be considered for the Project. Also the Faculty has included in its curriculum advancements of science such as bio-chemistry by the Department of Chemistry and Computer Science by the Department of Statistics and Computer Science, accordingly, the trends in scientific advances are also considered in the Project.

In addition to the items mentioned above, the U.G.C. suggests that the equipment shall be utilized effectively by emvironmental agencies, other universities and industries in the following way; the Faculty of Science will undertake measurements or analyses at the request of the outside users, the measurements or analyses shall be done by the students of the Faculty under the supervision of the teaching staff, the outside users shall pay an adequate fee to the University of Colombo, the fund collected by the fees shall be utilized for amortization and renovation of the equipment.

This plan is still taking shape on the Sri Lankan side, and further details will be given later by the Sri Lankan side, however it may strengthen good relations between the students and industries and public sectors, and so it will provide more opportunity for employment of the students after graduation.

The Sri Lankan side has a positive intention to utilize the equipment not only for university education but also for the national development.

(1) Number of teaching staff and students

The number of the teaching staff and students of the six departments for the Project is shown in Table 3-1.

Table 3-1 Number of Teaching Staff and Students by Department

	Department of Chemistry			Department of Physics			Department of Botany		
Number of teaching staff (Dec. 1991)	Professor		2	Professor		2	Professor		2
	Lecturer		7	Senior Lecturer		2	Associate Professor		1
	Lecturer (Part time)		8	Lecturer		9	Senior Lecturer		8
	Demonstrator		10	Technician		20	Lecturer		4
	Technician		10	Lab Attendant		10	Technician		7
	Lab Attendant		20				Lab Attendant		6
							Part time Lecturer		2
							Demonstrator		8
							Research Assistant		3
Total			57			43			41
Number of students		Present 1991	Planned 1993		Present 1991	Planned 1993		Present 1991	Planned 1993
	1st year	240	300	1st year	140	196	1st year	120	170
	2nd year	230	240	2nd year	100	140	2nd year	120	170
	3rd year (General)	160	210	3rd year (General)	50	70	3rd year (General)	60	100
	(Special)	20	20	(Special)	12	17	(Special)	10	
	4th year (Special)	20	20	4th year	12	17	4th year	10	20
	M. Sc. (1)	15	15	M. Sc. (1)			M. Sc. (1)	6	8
	M. Sc. (2)	5	15	M. Sc. (2)			M. Sc. (2)	6	8
	M. Phil (1)	5	5	M. Phil (1)	1	3	M. Phil (1)	2	3
	M. Phil (2)	5	5	M. Phil (2)	1	3	M. Phil (2)	2	3
	Ph. D.	0	6	Ph. D.	1	1	Ph. D.	3	6
Total		700	836		317	447		329	488

Note: (1) The number of students indicates those who attend lectures. Some students take courses in 2 or more departments.
(2) The apparent number of students is decreased as the final course is selected on and after the 3rd year.

Table 3-1 Number of Teaching Staff and Students by Department

	Department Zoology			Department of Statistics & Computer		
Number of teaching staff (Dec. 1991)	Professor		2	Professor		1
	Senior Lecturer		6	Lecturer		15
	Lecturer		3	Senior System Analysis Programmer		2
	Technician		6	System Analysis Programmer		3
	Lab Attendant		8	Lecturer, Statistics		2
	Part time Lecturer		4			
	Demonstrator		9			
	Research Assistant		1			
Total			39			23
Number of students		Present 1991	Planned 1993		Present 1991	Planned 1993
	1st year	120	170	1st year	120	170
	2nd year	120	170	2nd year	120	170
	3rd year (General)	70	100	3rd year (General)	305	376
	(Special)	10		(Special)	25	30
	4th year	10	20	4th year	21	30
	M. Sc. (1)	15	20	M. Sc. (1)	50	50
	M. Sc. (2)	15	20	M. Sc. (2)	43	50
	M. Phil (1)	5	7	M. Phil (1)		
	M. Phil (2)	3	5	M. Phil (2)		
	Ph. D.	4	6	Ph. D.		
Total		372	518		684	876

Table 3-1 Number of Teaching Staff and Students by Department

	Department of Mathematics				Radioisotope Center			Library
Number of teaching staff (Dec. 1991)	Professor		1		Supervisory Professor	1		
	Associate Professor		2		Senior Lecturer	2		
	Senior Lecturer		3		Senior Researcher	1		
	Lab Attendant		2		Technician	4		
	Part time Lecturer		3		Lab Attendant	2		
	Demonstrator		3					
	Lab Assistant		0					Staff 2
Total			14			10		2
Number of students		Present 1991		Planned 1993		Present 1991	Planned 1993	
		Applied Math	Pure Math	Applied Math	Pure Math			
	1st year	166+400	120	240+400	160	1st year	0	0
	2nd year	193+ 20	140	240+ 20	120	2nd year	0	0
	3rd year (General)	143+ 5	100	150	100	3rd year (General)	26	26
	(Special)	13		18		(Special)	10	10
	4th year	10		15		4th year	20	20
	M. Sc. (1)					M. Sc. (1)	0	0
	M. Sc. (2)					M. Sc. (2)	20	20
	M. Phil (1)					M. Phil (1)		
	M. Phil (2)					M. Phil (2)		
	Ph. D.					Ph. D.		
Total		1,310		1,463		317	76	

(2) Outline of Curriculum

1) Department of Chemistry

The Chemistry Department offers a common curriculum for the first two years, but from the third year, the curriculum is divided into the Bachelor of Science degree program (general) and the Bachelor of Chemical Science degree program (special). The Bachelor of Science degree program is completed at the end of the third year, but the Bachelor of Chemical Science degree program requires a total of four years of study.

The major subjects of the first two years of the Chemistry Department curriculum are physical chemistry, organic chemistry, inorganic chemistry, and analytical chemistry as well as laboratory courses for each of the fields.

In the third year of the Bachelor of Science degree program, in addition to courses in physical chemistry, organic chemistry, inorganic chemistry, and analytical chemistry, the students take courses in industrial chemistry, biochemistry, molecular biology, and topics. On the other hand, the third year of the Bachelor of Chemical Science degree program further deepens the technical contents through courses in spectrochemistry, inorganic chemistry, organic chemistry and physical chemistry with laboratory courses. In the fourth year, courses in advanced analytical chemistry, general chemistry, chemistry topics, and a research project are added to the curriculum.

The curriculum of the Master of Science degree programs is further subdivided into specialized fields, such as titration, chromatography, spectrochemical analysis, and atomic absorption spectroscopy.

2) Department of Physics

The Department of Physics, located in a new four-storeyed building, has courses for B. Sc. General Degree (a three year course) and B. Sc. Special Degree (a four year course). All students take the same course in their first two years. After completion of the first two years, either the B. Sc. General Course or B. Sc. Special Course is chosen.

The subjects taught in the first year are classical mechanics such as dynamics, fluid mechanics, thermal physics, wave theory including A.C. theory and geometrical optics. Electronics, electromagnetism and physical optics follow in the second year. Following these subjects on classic mechanics, modern physics, applied physics and applied electronics

are studied in the third and fourth year. Applied nuclear physics is studied for the M. Sc. as a postgraduate course.

3) Department of Botany

The Department of Botany provides courses for the B. Sc. General Degree with a three year term of study and the B. Sc. Special degree with a four year term.

Curricula are the same in the first two years. However, the course is divided into the General Course and Special Course after the third year. General botany, cytology, plant physiology, genetics, introductory microbiology and botany practicals are studied in the first and the second year. In the third year, the curriculum consists of plant pathology, general study of the environment, microbiology, biostatistics and practical exercises related to the respective subjects for the General course, and for the Special course, in-depth studies are conducted on each of the subjects. In the fourth year, advanced plant pathology II, quantitative genetics, plant breeding, advanced ecology, plant biochemistry and plant physiology are studied in addition to practicals on these subjects and a research project.

For the postgraduate, research programmes are offered for the Master of Philosophy (M. Phil) and the Doctor of Philosophy (Ph. D.) as well as courses for the Master of Science in Plant Pathology and Weed Science.

4) Department of Zoology

The Department of Zoology has curricula for animal classification, its ecology, embryology, physiology, genetics, evolution and environmental science including wildlife management, and also undertakes experiments and practicals on the respective subjects.

The undergraduate programme is separated into two courses; a general degree course with a three year term and a special degree course with a four year term. The same lectures are given in the first two years. However, the special degree course undertakes special studies on comprehensive zoology and environmental science in the third and fourth year after the course is separated in the third year. The Department offers research programmes for the Master of Philosophy (M. Phil) and the Doctor of Philosophy (Ph. D.) as well as course studies for the Master of Science (M. Sc.) in Environmental Science and in Fisheries Science.

5) Department of Statistics and Computer Science

The Department of statistics and Computer Science has been conducting courses in Computer Science for the award of the B. Sc. General and the B. Sc. Special degree. The Department also conducts Computor courses for students in other departments.

Introduction to Statistics and Computers is taught in the first year, and Statistical Methods, Numerical Methods and Computing are then taught in the second year. In the third year the courses are divided into General and Special courses. More than 90 percent of students take the General course for more practical application of statistics. The Special course is linked to computer applications. In the fourth year and for the M. Sc., it is further linked to basic computer applications such as Database Management, Computer Architecture, System Analysis, etc., and then to advanced applications such as Expert systems and Artificial Intelligence, Computer Graphics and Image Processing, etc..

6) Mathematics

The Department of Mathematics conducts courses in Mathematics for the award of the B. Sc. General and B. Sc. Special Degrees. The Department also conducts classes in Mathematics for the students from the other departments.

The curriculum for Mathematics is composed of Applied Mathematics and Pure Mathematics, from the first year to the end of the General course in the third year. Students from other departments or other faculties take the applied mathematics. In the Special course in the third year and fourth year, the number of students is reduced to less than twenty which continue to study Classical Mechanics and Quantum Mechanics, Electromagnetic Theory, and Relativity etc., in applied mathematics and to study an advanced Algebra, Analysis etc. in pure mathematics.

7) Radio Isotope Center

The Radioisotope Center was set up as a result of recommendations made by a preliminary assistance mission of the International Atomic Energy Agency. It was designed as a self supporting center with laboratory, library and training facilities.

Curriculum of the radioisotope center is as follows:

Radiobiology (for Biological Science students)

Applied Nuclear Science (for Physical Science students)

Table 3-2 Details of Curriculum

(1) Department of Chemistry

	1st Year	2nd Year	3rd Year (General)	3rd Year (Special)	4th Year	M. SC. Course
Lecture & Practicals	Physical Chemistry General Chemistry Organic Chemistry Inorganic Chemistry Chemistry Practicals	Physical Chemistry Analytical Chemistry Organic Chemistry Inorganic Chemistry Chemistry Practicals	Topics in Analytical Chemistry Industrial Chemistry Organic Chemistry Physical Chemistry Analytical Chemistry Inorganic Chemistry Chemistry Practicals Biochemistry Molecular Biology	Spectroscopy Inorganic Chemistry Organic Chemistry I Organic Chemistry II Organic Chemistry III Physical Chemistry I Physical Chemistry II	Analytical Chemistry Inorganic Chemistry Physical Chemistry Physical Chemistry & Theoretical Chemistry II Organic Chemistry Optional Topics General Chemistry	Titrimetry Gravimetry Thermal Analysis Electro Analytical Chemistry Chromatography Spectroscopic Methods of Analysis Analytical Atomic Spectroscopy Solvent Extraction and Ion Exchange Reagent Design Chemical Analysis of Food, Drugs & Pesticides Chemical Analysis of Minerals
Experiment	Inorganic Chemistry Organic Chemistry	Physical Chemistry Organic Chemistry Inorganic Chemistry	Laboratory Course Physical Chemistry Organic Chemistry Inorganic Chemistry Biochemistry (Scheduled)	Laboratory Course Organic Chemistry Inorganic Chemistry Physical Chemistry	Research Project	Research project

Table 3-2 Details of Curriculum

(2) Department of Physics

	1st Year	2nd Year	3rd Year (General)	3rd Year (Special)	4th Year	M. SC. Course
Lecture & Practicals	· General & Thermal Physics and Modern Physics Mechanics Fluid mechanics Surface tention Thermal physics · Waves and Vibrations, A.C. Theory and Geometrical Optics Waves and Vibration Geometrical Optics A.C. Theory	· Electronics and Electromagnetism I Electronics Electromagnetism · Electromagnetism II and Physical Optics Electromagnetism II Physical Optics Interference Diffraction Polarization Lasers	· Statistical Physics · Special Relativity and Introductory Quantum · Introductory Nuclear Physics · Advanced Electronics · Data Aquisition and Signal Processing Methods	· Advanced electronics · Data aguisition and signal processing methods	· Quantum Mechanic · Nuclear and Particle Physics · Solid State Physics · Atmospheric Physics · Special Topics · Mathematical Method	· Nuclear Physics · Nuclear Chemistry · Nuclear Biology · Radiation Detection and Measurement · Nuclear Geology · General Nuclear Science · Helth Physics · Nuclear Technics

Table 3-2 Details of Curriculum

(3) Department of Botany

	1st Year	2nd Year	3rd Year (General)	3rd Year (Special)	4th Year	M. SC. Course
Lecture & Practicals	Plant Diversity Organization of Plants, Plant Taxonomy & Economic Botany Botany practicals	Cell Biology and Plant Physiology Genetics, Introductory Microbiology and Environmental Science Botany Practicals	Plant Pathology Practicals Man and the Environment Practicals Microbiology Practicals Biostatistics & Experimental Design Practicals	Advanced Plant Pathology I Practicals Aspects of Environmental Science Practicals Advanced Microbiology Practicals Biostatistics & Experimental Design Practicals Advanced Botany I Practicals Advanced Botany II Practicals	Advanced Plant Pathology II Practicals Quantitative Genetics & Plant Breeding Practicals Advanced Ecology Practicals Plant Physiology Practicals Plant Biochemistry Practicals Essay Research Project, Seminar and Herbarium Practical Unit I Practical Unit II and Viva-voce Examination	Plant Pathology Weed Science

Table 3-2 Details of Curriculum

(4) Department of Zoology

	1st Year	2nd Year	3rd Year (General)	3rd Year (Special)	4th Year	M. SC. Course
Lecture & Practicals	Invertebrate Diversity Protochordates Vertebrate Diversity, Histology and Embryology Zoology Practicals	Animal Physiology Ecology and Evolution Zoology Practicals	Human and Mammalian Biology: - Theory - Practical Fish Biology and Fisheries: - Theory - Practical Parasitology: - Theory - Practical	Advanced Human and Mammalian Biology: - Theory - Practical Aquaculture: - Theory - Practical Shell Fish Biology: - Theory - Practical Insect Pest Management: - Theory - Practical Conservation and Wildlife Management - Theory - Practical Ornithology: - Theory - Practical Laboratory Techniques: - Practical Entomology: - Theory - Practical Evolution: - Theory Radiobiology: - Theory - Practical	Entomology I (Theory) Entomology II (Theory) Practical in Entomology Environmental Science I (Theory) Environmental Science II (Theory) Practical in Environmental Science Fisheries Science I (Theory) Fisheries Science II (Theory) Practical in Fisheries Essay Research Project Literature Review	Environmental science Fisheries science

Table 3-2 Details of Curriculum

(5) Department of Statistics & Computer Science

	1st Year	2nd Year	3rd Year (General)	3rd Year (Specail)	4th Year	M. SC. Course	
						Year 1	Year 2
Lecture & Practicals	Introduction to Statistics and Computing ・Part A Descriptive Statistics Probability Random Variables and Probability Density Functions Probability Distributions ・Part B Computer Organization Programing	Statistical Methods, Numerical Methods and Computing ・Part A Statistical Methods Infenes about Variance for Normal Data Errors *Other Distributions* Other Tests	Regression and Time Series Operational Research Statistics Applications II Practical Statistics Computer Applications for Biological Sciences Introduction to *Structured Systems* Analysis and Design Selected Topics in Computer Science	Stochastic Process Software Engineering File Organization and Database Management System Computer Architecture System Analysis and Design Data Structures and Algorithms *Microcomputer Applications* Deductive Reasoning, Logic Programming and Prolog Assignments Management *Advanced Inference* Deductive Reasoning, Logic Programming, Prolog and Introduction to Artificial Intelligence	Expert Systems and Artificial Intelligence Security and Networks Complier Construction Operating Systems Computer Graphics and Image Processing Assignments Project	Pascal Programming Data structures and Algorithms Files and System Analysis Software Engineering Operating Systems Computer Graphics Information Technology in Sri Lanka PROLOG and Expert Systems Projects	Compilers Computer Architecture & Network systems Intelligent Knowledge Based Systems and Data Base Management Systems Image Processing & Computer Vision Formal methods & Parallel Computing Data Security & Cryptography Project

Table 3-2 Details of Curriculum

(6) Department of Mathematics

	1st Year	2nd Year	3rd Year (General)	3rd Year (Special)	4th Year	M. SC. Course
Lecture & Practicals	• Pure Mathematics Foundations and Analysis Algebra and Geometry • Applied Mathematics Ordinary Differential Equations	• Pure Mathematics Algebra and Differential Geometry Analysis I • Applied Mathematics Mathematical Methods II and Classical Mechanics	• Pure Mathematics Algebra Real Analysis Complex Analysis • Applied Mathematics Mathematical Methods III Classical Mechanics Introduction to Astronomy	• Pure Mathematics Group Theory Real Analysis Complex Analysis • Applied Mathematics Mathematical Methods Fluid Mechanics	• Pure Mathematics Algebra I Algebra II Analysis I Analysis II Analysis III • Applied Mathematics Classical Mechanics and Quantum Mechanics Electromagnetic Theory and Reliability	

Table 3-2 Details of Curriculum

(7) Radioisotope Center

	3rd Year	
Lecture & Practicals	Radiobiology (for Biological Students) Natural radioactivity Uses of nuclear technics in food and Agriculture Application of water medicine and other industries Radiobiology	Applied Nuclear Science (for Physical Science Students) Properties of Nuclear Science Detection and measurement of radiation Nuclear Decay Application of Nuclear Technique Radiation Protection and Safety

3-3-3 Location and Condition of the Planned Site

The University of Colombo consists of five Faculties namely Arts, Law, Education, Science, and Medicine. All except the Faculty of Medicine are located in the same part of the city, four kilometers south-southeast of the Port of Colombo. The Rajakeeya Street passes through the north of the campus with the Reid and Thurstan Streets on the east and west sides of the campus. It is in an excellent environment in the neighborhood of a wealthy residential area called Cinnamon Garden. The Faculty of Science, which is being considered for this project, is located on a 50,000 square meter space on the south of the campus near a field. Every building of the department is located on the land allocated to the Faculty of Science. The equipment to be provided by this plan, consequently, will be installed in the specific laboratories in each of the science buildings. Figure 3-2 shows the layout of the Faculty of Science.

Each of the laboratories in the respective Departments, in which equipment is planned to be installed, has enough space, and electricity, is available from power outlets of 5 and 15 amps supplied at 230 V, 50 Hz single phase. Water is supplied to the University by the Municipal Water Service, and water is distributed to all of these laboratories where faucets are furnished. Both the Department of Chemistry and the Department of Physics have water-feed tanks installed on the roofs of the buildings of the respective Departments. Water is distributed to each of their laboratories through separate water-feed tanks. The capacity is about 10 m^3 or more for each of the tanks with a head of about 20 m for the New Chemistry Building and 15 m for the New Physics Building, which are sufficient for the supply of water.

Therefore each of the laboratories of the respective Departments meets the conditions for space and utilities required for installing the equipment.

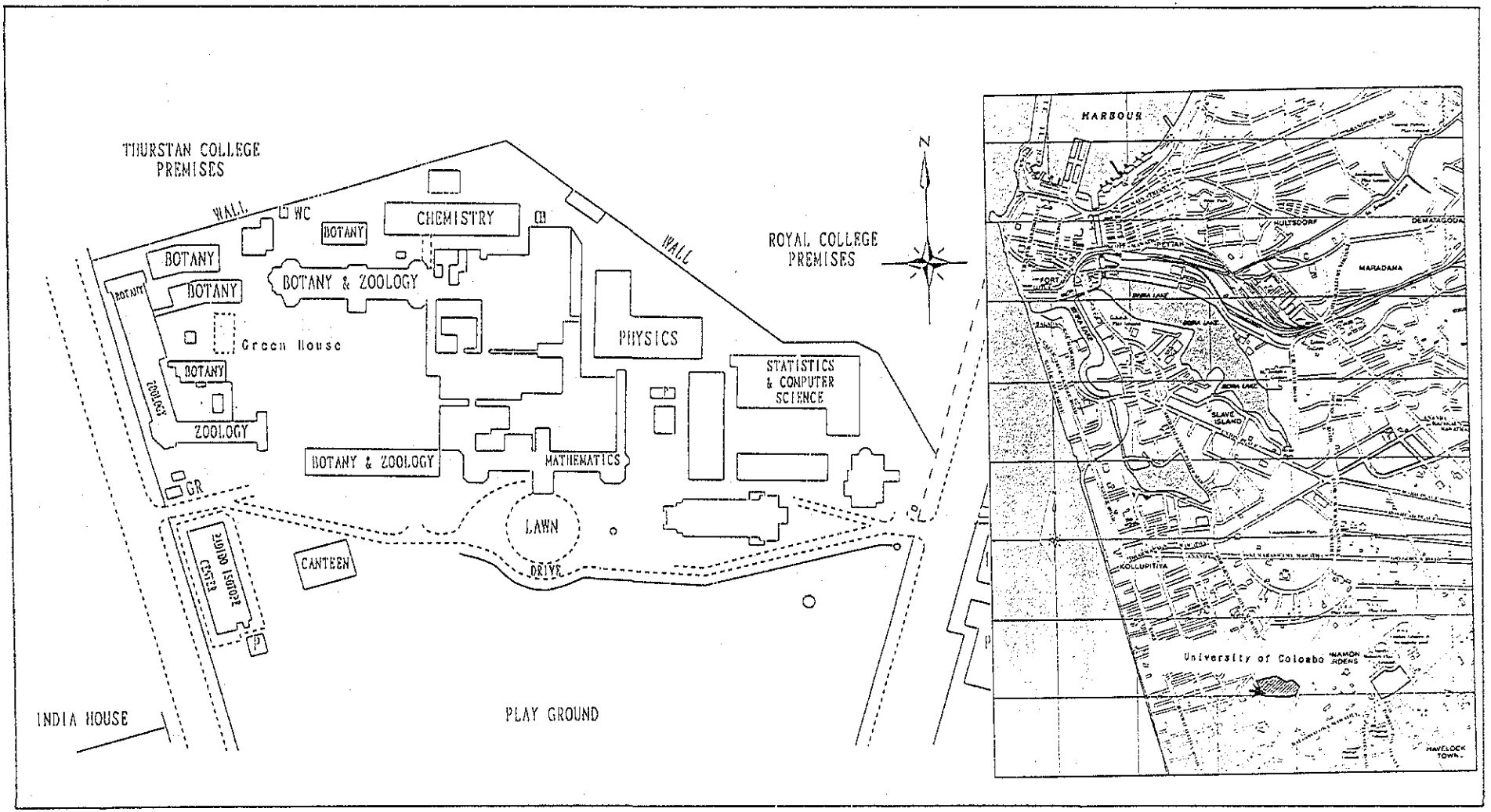


Figure 3-2 Site Plan of the Faculty of Science, the University of Colombo

3-3-4 Outline of Equipment

Table 3-3 shows the outline of major equipment, which are studied in Section 3-2.

Table 3-3 Outline of Major Equipment

EQUIPMENT	CURRICULUM	USE OF EQUIPMENT
90 MHz NMR spectrometer with a data station	Common for Chemical Department	Structural analysis of organic compounds
Polarimeter (digital)	Organic Chemistry(Research)	Determination of optical rotation of natural products
HPLC (gradient elution)	Organic Chemistry(Research)	Component separation from chemical mixtures
UV visible-spectrophotometer	Organic Chemistry(Research)	Evaluation of molecular configuration of chemicals
FT IR spectrophotometer	Organic Chemistry(Research)	Analysis of molecular structure of organic chemicals
Gas chromatograph	Organic Chemistry(Research)	Component analysis by separation of samples
High speed refrigerated centrifuge	Biochemistry	Component separation applied in biochemistry, etc.
Freeze drier	Biochemistry	Drying of samples under high vacuum applied in biochemistry
GC-MS	Common for Chemical Department	Separation and structural analysis of mixtures
Ultracentrifuge	Biochemistry	Separation of ultra small components from samples
Spectrofluorometer	Organic Chemistry (Research)	Evaluation of metal ions
X-ray diffractometer	Solid State Phy.	For analysis of crystalline structure
Camera & interface for making slides	Waves & Optics	Experimental equipment for application of optical instruments
High vacuum pump system (Rotary plus diffusion)	Solid State Phy.	Testing emission, etc. in vacuum
Semiconductor detectors (Ge Li)	Nuclear Physics	Detecting radiation
Multichannel analyser	Electronics	Carry out analysis by radiation
Oscilloscope, dual trace, 20 MHz	Electronics	Monitoring high speed wave phenomena
Oscillator 2 Hz to 20 MHz	Electro Magnetics	Generate high-frequency currents
Cathetometers	General Physics, Heat	Measurement of a distant vertical motion
Electronic training equipment system	Electronics	Teach basic electronic circuits
Microcomputers	Phys. Computer Room	For data processing and logic calculation
Centre lathes for metal	Mech. Work Shop	Shaving cylindrical, columnar shapes and screws
Shaping machine	Mech. Work Shop	Shaving square & flat plates
Universal milling machine	Mech. Work Shop	Machine tool for shaving level surfaces
Vacuum coating apparatus	Solid State Phy.	Device for vacuum etching experiments
Microcomputer	Solid State Phy.	Processing experimental results
Weather station	Atmospherics	Observe wind velocity, direction & rain fall

(Continued)

Table 3-3 Outline of Major Equipment (Continued)

(Continued)

EQUIPMENT	CURRICULUM	USE OF EQUIPMENT
Autoanalyzer (macro & micro nutrient analyzer)	Microbiology	Analyse nutritive elements of plant such as NH4
Scanning electron microscope	Plant physics	Observe plant tissue with high magnification
Laminar flow inoculating-chambers	Microbiology	For aseptic work, inoculation, etc of microbal
Leaf area meter	Plant physics	Measure leaf area in relation to photosynthesis
Photosynthetic system	Plant physics	Observe metabolism associated with photosynthesis
Phase contrast microscope	Microbiology	Observe live organizms without staining
Student microscope	Plant biology	General microscope for beginners
Freeze drying microtone	Plant physiology	Device to obtain thin sections for microscopic observation
Greenhouse	Plant biology	Grow plants under artificial environment
Quantum-radiometer-photometer	Plant physiology	For quantitative measurement of incident rays
UV visible-spectrophotometer	Ecology	Water analysis, analysis of materials in body
Coulter counter (electron particle sizer)	Physiology	Count micro organism, cells, etc.
Ovens	Histology	Heating for sterilizing treatment
Phase contrast microscope	Histology	Observe live organisms by means of phase contrast
Kymographs pen recording type	Physiology	Investigate muscular contraction
Student microscope	Histology	General microscope suitable for beginners
Cryostat	Histology	To cut thin section at low temperature
Freezer (upto -80℃)	Histology	Storage of animal specimens, etc by freezing
Isometric force transducer	Physiology	Investigate musle contraction with stimulation
Event recorders	Ecology	Monitor animal behaviour
Lick - counter	Physiology	Monitor amount of water intake by animals
Non-invasive (tail cuff) method	Physiology	Measure blood pressure of animals
Microcomputer system	Programing & System Analysis	Generalize programing, networking by using PCs.
X-ray fluorescence system	Applied Nuclear	Investigate material components by means of X-ray diffraction

3-3-5 Operation and Maintenance Plan

The budget for operation and maintenance of the equipment will be granted by the U.G.C. based on the request of the Faculty which will be prepared by the Dean and Head of each Department. Attachments and parts necessary for operation of the equipment will be manufactured by the two workshops belonging to the Department of Physics. The workshops also will repair the equipment in most cases. Supply of Machines and tools necessary for these activity of the workshops are included in the Project.

In the case of an equipment failure beyond the workshops' capability, the instructor who uses such equipment shall consult with the workshops and find out the cause and location of the failure, then he will communicate to an outside repair shop and repair the equipment failure. When the repair cost is expected to be a considerable amount, it shall be expensed after a decision by the commitee of Heads of Departments in the Faculty.

As there are very few repair workshops in Sri Lanka, each of the workshops in the Faculty will be one of the best educational equipment repair shops in the country after renovations planned by the Project. The abilities of these workshops are shown in Table 3-4.

The equipment will be stored in the existing store rooms attached to the laboratories.

Table 3-4 Ability of the Workshops

Electric Workshop

Inspection of Transistors and ICs

Inspection and replacement of circuit boards.

Repair by soldering

Replacement of electric or electronic parts.

(continued)

Table 3-4 Ability of the Workshops (continued)

Machinery Workshop

- Metal plate work
- Welding (including stainless steel)
- Metal cutting and turning
- Drilling
- Rivetting
- Welding of plastics
- Tool grinding

Machinery Workshop

- Wood machining
- Coil winding for transformers
- Glass blowing

The estimation of annual operation and maintenance expense of the equipment is shown in Table 3-5.

In the estimation, the cost of parts is estimated for the parts which have to be replaced for repairs or preventive maintenance in one year. The cost of the parts is calculated based on the amount of spare parts provided by the maker for one year's spare parts and the consumption rate from experience. The cost of consumables is calculated as the total amount of one year's consumables as estimated by the manufacturers.

The cost for outside repairs is for repairs which must be done by overseas companies, when the workshops in the Faculty and the Institute of Computer Technology can not do them. It is estimated based on the assumption that one engineer is despatched from Japan for the repairs and the following three items of equipment are assumed to fail once in two years.

	Frequency of repair per year
NMR	0.5
GC-MS	0.5
SEM	0.5
Total	1.5

Concerning these three items, it is recommended that the University should have a preventive maintenance contract with the manufacturers or competent technical firms, in order to keep the equipment operating continuously.

No increase of workshop staff is considered, because the workshops have enough staff to do the repairs. Operation and maintenance costs of the workshops are also included in the estimation as a part of the equipment.

Table 3-5 Operation & Maintenance Costs

	(Unit 1,000 Rps)
Parts	2022
Consumables	1101
Repair by outside companies	
Engineer's fee 1.5 × 10 days	468
Travelling expenses 1.5 times	164
Electricity, Gas (for media)	1095
Total	4850

3-4 Technical Cooperation

For technical training it is recommend that one technician should be sent to provide instruction in the operation and maintenance of each of the following: NMR, GC-mass spectrograph and scanning election microscope and another technician for other important equipment i.e. four technicians in total.

Each technician would provide training for about 3 months.

Chapter 4 Basic Design

Chapter 4 Basic Design

4-1 Design Policy

The policy for the basic design of the equipment granted through this project is based on the following:

(1) The equipment must contribute to the improvement of scientific education in Sri Lanka and to the upgrading of its standard.

(2) The equipment must contribute to the advancement of the Sri Lankan industries through its effective use by the University of Colombo in producing competent graduates to achieve this end.

(3) The students must be able to use the equipment with the assistance and instruction of faculty members.

(4) Spare parts and consumable for the equipment must be available, and the university must be able to maintain it.

(5) The equipment shall be able to withstand the tropical climate of Sri Lanka.

4-2 Study and Examination on Design Criteria

4-2-1 Design Conditions

The equipment must comply with the following conditions:

(1) Ambient temperature

Upper limit	33°C
Lower limit	25°C
Average	30°C

(2) Ambient humidity 82%

(3) Altitude +30 meters

(4) Power supply

Alternating current (AC)	230 V	50 Hz
Alternating current (AC)	400 V	50 Hz

(5) Water supply

Water quality: Hardness 18.5 mg/l $CaCO_3$ equiv.

Electric conductivity 53.1 μS/cm

(6) City gas

Calorific value: 5,340 kcal/m³

(7) Compressed air

None

Notes:

1. According to the Ceylon Electric Board, the voltage fluctuation is kept within 2.5% in the Colombo City area.
2. The values for the water quality have been measured by the University of Colombo, however they may be subject to fluctuation.
3. The city gas is a mixture of 20% LPG (more than 70% butane) and air.

4-2-2 Ambient Temperature and Humidity

The following table gives the temperature and humidity in the City of Colombo. As indicated, the maximum temperature is in the range of 30 to 33°C, the minimum temperature in the range of 22 to 26°C, and the average temperature in the range of 25 to 30°C. The fluctuations of the maximum, minimum, and average temperatures are minimal with steady temperatures throughout the year. The same is true for humidity.

Equipment that requires an ambient temperature of less than 30°C will be installed in rooms with air conditioning. Further, water will be provided from the head tank on the top of each building. Thus, the temperature of the water will be equivalent to the ambient temperature. For equipment that require cooling-water below 25°C, a refrigerating cooler will be installed.

The humidity in the City of Colombo is about 80% throughout the year, which is very high. For this reason, instruments that may deteriorate by mold, such as the lenses of microscopes, must be stored in containers containing desiccant.

Temperature • Humidity	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Mean monthly Temp. of Max. Temp. °C	31.1	32.3	32.4	32.0	31.5	30.9	30.1	30.4	31.3	31.0	30.3	30.6
Mean monthly Temp. of Min. Temp. °C	22.0	24.1	24.7	25.1	25.5	26.0	24.6	25.5	25.6	24.1	23.1	22.1
Mean Temp. °C	25.0	27.3	28.1	28.8	28.7	28.3	27.1	27.6	28.4	27.6	26.9	25.9
Relative Humidity %	78	80	79	80	82	82	84	80	77	80	85	84

(Source: Port Statistics Sri Lanka, Series 11, 1989-1990)

4-3 Equipment Plan

After deliberating on the educational equipment requested for each department, the equipment selected finally totaled 405 items. The project will be carried out in two stages, the first term and the second term. Considering the priority and the delivery time of each item of equipment, the equipment to be supplied for each department during the two terms is as follows:

Table 4-1 The Number of Selected Items of Equipment

Department	1st Term	2nd Term	Total
Department of Chemistry	54	36	90
Department of Physics	96	86	182
Department of Botany	39	11	50
Department of Zoology	52	16	68
Department of Statistics and Computers	2	1	3
Department of Mathematics	3	1	4
Library	2	2	4
Radio Isotope Centre	2	1	3
Total	250	154	404

A list of the equipment is shown in Table 4-2 and gives, by department, a description of each item, the quantity, the basis for deciding the quantity (the number of students in the study groups which use the equipment), the basic specifications and the main curricula for which the equipment will be used.