3 Development Planning of Industrial Research Center

3.1 Role and Fundamental Functions of the Center

3.1.1 Objective and Functions of the Center

The Center aims at:

(1) providing the industries with technical support for promoting the industrial development in line with the industrial development strategy, and

(2) building up the capabilities of industries to assimilate transferred technologies and accumulate technologies for further advance.

The role to be played by the Center for the existing industries will be provision of technical support, which contributes to enhancement of capability of manufacturers to sustain their growth, or technical supports which contribute to improvement of their competitive power, through improvement and diversification of products, improvement of quality and productivity and cost reduction, if one putting together the both roles which are vital needs not only for solving the problems that the existing industries are facing, but also for pursuing the industrial development strategy. On the other hand, the role of the Center for the development of new industrial fields will be provision of the technical supports which will be useful for the enterprises showing interest in the establishment of new industrial undertakings by assisting their pre-investment study and investment decisions on such projects as a part of the Government's role to take necessary steps for the promotion of domestic private investment and foreign investment in such new industries in Oman.

The required functions of the Center to fill such role may be systematized as follows:

(1) Function of technology transfer
   1) Provision of technical and market information, and provision of opportunities for information exchange
   2) Testing service with trouble shooting based on the testing result
   3) Technical consultancy service and technical guidance
   4) Technical transfer through provision of new facility and equipment for trial use
   5) Training

(2) Function of research and development
   1) Basic research
   2) Applied research

(3) Function of development of human resource and technological base, as a side effect of

the above activities

The center's functions will be determined in consideration to the current state of technology fields to be supported, strategic consideration as to how the technology fields should be deployed, and functional division with other related functions, which are discussed below.

3.1.2 Role and Fundamental Functions to be Fulfilled by Public Institution in Providing Technical Supports

In this section, the roles of the public organization in technical support are examined for each of two functional areas, R&D and technology transfer.

First of all, few large companies in Oman have their own R&D function, except for the oil industry. There is no applied research capability, in addition to basic research, not to mention smaller enterprises. Thus, so far as the need for industrial development strategy exists, the R&D function must be provided by the public organization.

On the other hand, technology transfer can takes place at different stages of the project, prior to the start of the project, upon commencement of the project, or after the start of the project where further improvement and growth are intended. Previously, there is no public organization responsible for technology transfer, and individual enterprises have been doing on their own. It should be noted, however, that large projects requiring large amounts of technical information have been carried out by large enterprises or state enterprises. While technology transfer concurrent with the start of the project will continue to be done on a commercial basis, that before and after the start of the project cannot be carried out properly by individual enterprises except for large enterprises and state enterprises, constituting one obstacle for industrial development in the country. In future, technology transfer will become more and more difficult for individual enterprises to handle since the focal point of industrial development will move to creation of light processing industries which involve many small enterprises. For this reason, technology transfer must be handed to the function of the public organization.

Detailed discussion is as follows.

There are two important functions to be fulfilled by a public institution in providing technical support for promoting industrial development. One is the technical transfer for the existing industries and potential investors, while another is research and development.

These activities will not only directly promote the improvement of both production efficiency and distribution efficiency, but also contribute to the building-up of Oman's

technological base by developing technical research capabilities and human resource development. This is the third major function of such a public institution for industrial development, though the effect is indirect.

The degree of responsibility of the public institution in such technical support functions varies with a level of industrial development in a particular country. As these functions can be performed by individual enterprises with maturing of the industries, they will be possessed by enterprises conducting or planning to conduct businesses requiring R&D or technology transfer. Or organizations with such functions emerge in the private sector and provide contract service for users. However, the situation is different for large enterprises and smaller ones, and in most countries, large enterprises tend have their own functions. On the other hand, small enterprises depend upon public organizations providing such services.

Among R&D functions, basic research capabilities involve sophisticated technological base with financial resources and high risks, so that they are generally possessed by enterprises in the highly matured industries, Thus they tend to rely on the public sector at the latest stage. On the other hand, applied research development capabilities are divided into many levels, and those closed to commercialization are owned by individual enterprises.

However, even in the countries in West Europe, the USA and Japan, the R&D investment of the following types are mainly covered by the public sector; 1) research with risk, 2) special areas requiring huge amount of costs, 3) time consuming R&D, 4) basic research which has objective to obtain output as public goods, 5) research work in such fields of public welfare as those related to energy, the environment, and medical welfare, etc., and 6) research which can not be developed with the market mechanism alone.

The technology transfer function is roughly divided into three types according to the timing and purpose: The first type required to select appropriate technology before the start of the project; the second type carried out when the project is actually started; and the third type required for improvement and growth. Technology transfer is conducted in a variety of forms, provision of technical information, technical guidance and consultation, provision of equipment, and human resource development. Technology transfer in any stage is conducted by large enterprises which can collect technical information and afford to purchase technology. On the other hand, smaller enterprises do not have financial or technical capabilities to do so and often rely on public organizations except for technology transfer when the project is started. In most industrialized countries, there are many public

institutions to provide technical guidance for the private sector, particularly SMEs.

Thus, the above conclusion was drawn from the general trend, the current capabilities of the industries in Oman, and the need for reinforcement of these functions in the country as a whole.

Almost all of technologies used in the existing industries in Oman have been transferred from abroad. In Oman, as there are few indigenous technologies inherited as traditional technology and advanced to the status of up-date industrial technologies, industrial development has been pursued on the basis of technologies transferred from abroad. This development pattern will continue henceforward as well.

Oman has virtually no restriction nor obstacle in the transfer of foreign technology, since the legislation is liberal regarding foreign investment, technology transfer, and imports of machinery and equipment.

Apparently, the selection of appropriate technologies, which is one of the key factors for the successful technology inducement, has also been undertaken without causing significant problems. Technologies transferred to Oman have been selected in consideration of the limitations prevalent, and the industrial development peculiar to the country, namely 1) a small domestic market, 2) necessity to import most raw materials and component parts due to lack of supporting industries, and 3) availability of skilled labor from abroad at relatively low costs. The existing process-plants adopt relatively modern technologies, although most of those plants are smaller in production scale than the internationally standard. On the other hand, the small- and medium-scale light processing industries mostly adopt conventional labor-intensive production systems. Such production is essentially weak in sustaining competitiveness in international markets. In Oman, however, as industrialization is still at an early stage and the majority of the existing industries undertake the import substitution in a limited field of industries, except the export-oriented industries represented by the export garment industry, they faced few problems in selection and application of technology for their operation.

The issue of technology transfer for further development of industry in future are discussed below, particularly regarding the process-plant based industries and small- and medium-scale light processing industries.

In the process-plant based industries, the set-up of plants will be based on established

foreign manufacturing processes and plant equipment imported from abroad. The feasibilities studies of projects as well as the design and engineering of plants to be constructed will also be entrusted to experienced foreign consultants or engineering contractors. The selection of appropriate technologies will be carried out by the thus entrusted consultants or engineering contractors, and therefore no problem will occur in the transfer of technologies for the process plants henceforward as well.

In the small- and medium-scale light processing industries, most enterprises leave the selection of technologies and machinery to expatriate engineers whom they employ for managing their factories. These engineers tend to select conventional technologies and machinery because they have little information and experience regarding cutting-edge technologies. Success in the selection of technology depends on whether adequate information on appropriate technologies is available and also whether enterprises have adequate capability to select optimum technology. In Oman, as the development of small- and medium-scale industries progresses, entrepreneurs and potential investors who have no access to such information will increase. Hence assistance to them in providing adequate information on appropriate technologies will be more important. Such needs are not only for the establishment of new factories but also improvement and debottlenecking of existing factories.

Further, Omani industry lacks the basic capabilities to assimilate transferred technologies and accumulate technologies for further advancement. Expatriate engineers and technicians employed in the Omani companies generally fulfill only assigned duties since they work under a short term contract. There are no native engineers and technicians who have vast experience in application of those transferred technologies, nor those who will be able to absorb technologies and skills held by expatriate engineers and technicians in the near future. Under this situation, it will be difficult for Oman to establish the technological base for carrying out the improvement of technologies and the development of applied technologies based on technologies transferred from abroad. Hence transferred technologies have been used without any improvement or modification after the adoption at the initial stage. As those technologies become obsolete and lose competitiveness after several years, while innovation and advancement of technologies proceeds in industrialized countries, the industries in Oman will be compelled to renovate their plants with new technologies.

For the establishment of the technological base, what is most important is to nurture the ability to identify and commercialize seeds of technological improvement and

innovation from daily operation in the industries. The effective measures include: 1) nurturing Omani engineers who are engaged in carrying out technological research and development, and 2) encouraging longer stay of qualified expatriate engineers with incentives (including grant of citizenship) to undertake such technological accumulation, research and development. The former should be regarded as one of important functions of the Center.

As such, the technology transfer function and research and development function are important for establishing the technological base.

The technical transfer function is multifaceted. It includes providing entrepreneurs launching on the establishment of industrial undertakings with technical information, and technical assistance for pre-investment studies and technical investigation during project preparation. It also includes providing existing industrial undertakings with technical consulting and guidance for solving or improving problems which they face through the daily operation or those claimed by customers. Another facet of technology transfer function is fulfilled by providing testing or prototype development facility and equipment. All facets of this function will be required in Oman, although its depth and nature varies depending on the industry.

The research and development function can be divided into two types: basic research and development of technologies, and applied research of technologies. The basic research and development requires capable human resources and financial resources and it is time-consuming efforts. As the industrialized countries have long been devoting efforts to basic research and development of technologies, it will not be realistically effective for Oman to undertake the basic research and development in view of the lack of experience.

The applied research on technologies has two levels of research; one is the development of new technologies based on applied technologies, and the other is the optimum application and improvement of existing technologies. In Oman, what is important for the industrial development is research for optimum application and improvement of existing technologies to meet local conditions, particularly characteristics of available resources and the level of technologies adopted in the existing industries.

In Oman, most of the industrial standards are adopted from foreign or international standards directly or with some modification. This adoption procedure is one of the efficient ways to promote standard development. However, there are some areas where the

development of industrial standards specifically applicable to the local conditions is required. This will help improve the manufacturing and distribution efficiencies. Such development and updating industrial standards should be regarded as one of the important themes of applied research focusing on optimum application and improvement of the existing technologies.

Another important function is to develop capable human resources through technical guidance and applied research.

3.1.3 Defining of Role and Functions of the Center in Relation with Other Relevant Public Institutions

In Oman, there are several public institutions which presently undertake or plan to undertake part of the foregoing technical supports or similar services. Therefore, the activities to be carried out by the Center should be defined in due consideration of the activities which are being carried out or are to be carried out by other institutions so that the Center' activities have no duplication with those in other relevant public institutions.

However, the function of the Center is basically to provide technical support for the realization of the industrial development strategy, by means of providing the existing industries with technical supports for improvement of their technical problems or providing appropriate technical information to the industries to be newly established as well as the existing industries in Oman. Thus these activities are not limited to the preparation of such basic information as compiled at the MPM's laboratory, and aim at providing technical guidance to the industries more actively than that provided by DGSM. These also include human resource development required for pursuing the industrial development strategy.

As the need for technical support varies depending on the industrial subsectors, however, the level of technical support to be provided by the Center should be different for each priority industrial fields selected for receipt of technical support.

Enumerated below are the main activities which should be provided for the industries in Oman by institutions undertaking applied research of technologies or undertaking technical guidance to the industries.

1) Gathering and provision of technical and market information, or provision of

opportunity for industry to exchange their information among them

2) Testing service
3) Technical guidance
4) Sample product test production service
5) Provision of common service facility to support upgrading
6) Provision of testing facilities for industry to undertake their research work using these facilities
7) Joint research work with industry, or provision and coordination of such work among the industry and research institutes
8) Undertaking of in-house research work to establish the basis for technical guidance
9) Human resources development

Table 3-1 shows the functions and activities of the Center defined in consideration of a) the functions and activities to be carried out by other relevant institutions as well as IDD and other departments in MCI and b) the relationship and linkage with those institutions as well as IDD and other departments of MCI, so that IRC can fulfill its tasks without duplication and while providing complement functions.

OCCI has a plan to establish an organization, which is to have an integrated function of promoting industrial development, export, and investment. Figure 3-1 shows the plan conceived by OCCI, but it is uncertain yet when such an organization will actually be established. Further, the plan does not focus on the technological fields in terms of research. Therefore, the activities to be carried out by this organization are not taken into consideration in the present examination of the Center's activities.

(1) Providing technical and market information

As for the technical and market information, there are following three categories of information.

1) General information on export market conditions

The information required for any export undertaking. For example, regulation on import restrictions, tariffs, and trade relationship with Oman, etc.

2) General product and technical information

For certain types of products, such as ceramic products, building materials, etc. For example, information related to the scale of demand, product characteristics, purchasers' trends, transportation and price conditions, etc.

3) Information specific to a certain product/buyer

Information related to specific products and buyers - for example, in the ceramics

area, high-grade ceramic tableware and its buyers; in building materials, gypsum board and its buyers, etc.

In Oman, there is no organization which provides sufficient information on the export market in general, although limited information is available form IDD, MCI on specific product groups.

The function of IDD is to encourage, advise and guide potential entrepreneurs to invest in manufacturing projects as well as assist the existing units in overcoming some of the problems they face, and improving productivity and business performance. For this aim IDD distributes to investors various project profiles provided by consultants and GOIC, and gives them necessary advice and guidance. The IDD's function includes guidance services for these potential investors to help them obtain an industrial license and/or government incentives, including in those services quotations from different sources for machinery and construction, and undertaking of detailed feasibility studies which are required by the Government for their approval. At the same time the IDD has provided potential investors with advice and information for project ideas of their own.

However, this information is confined to product for which IDD has carried out its feasibility study in the past. Further, the information available is only about the market size and prices. Currently, the IDD is the sole source of information regarding specific products and specific buyers, but its capacity to supply information is limited. The potential investors and exporters have tried to obtain such required information from trading houses overseas, but it has been hard to attract the interest of trading houses in Omani products, as the latter have been unable to obtain sufficient information.

There is a plan to establish an investment and export promotion center, but the plan has not taken shape yet. The general information on export markets such as conditions the exporters have to fulfill, and requirement for potential foreign investment, etc. should be provided by this organization.

OCCI has established a trading company with investment from the private sector under the leadership of OCCI. The trading company has made a great effort to expand the export of Omani products. This kind of activity is essential for obtaining information on specific products or buyers, and should be undertaken by trading companies.

(2) Testing services

The testing function includes the following in terms of its objective:

1) Testing for trouble shooting
2) Testing for research and development
3) Testing for certification

The Center should function to meet the above testing services as required, in which the testing for trouble shooting is the most important function to be undertaken by the Center.

Testing for trouble shooting is for identifying the causes of problems faced in production fields and/or distribution fields. Generally, manufacturers or distributors bring their products or materials, which have problems, to a technical guidance organization, and the technical guidance organization offers technical guidance to them on the basis of testing results. This is one of the typical approaches for technical guidance. There is no organization in Oman which can provide this function, and this function should be regarded as one of the major functions of the Center.

The testing for research and development is carried out for their own research purpose or upon request from industry. This kind of testing has been undertaken by SQU (Sultan Quaboos University) in such limited areas as safety tests of construction materials. However, the expansion of the scope of work by SQU seems to be hard to accomplish because of limitation in facilities and staff. Most of testing undertaken by SQU will for educational purpose.

The laboratory of MPM has carried out analysis of minerals collected by themselves for the study of mineral resource reserves. These tests, however, exclude tests for evaluation of minerals for industrial use, or improvement of its characteristics, and are limited to the tests for analyzing chemical components and physical properties. The information available from these tests are still insufficient for the interested potential investors to make their decision on their investment. Therefore, the testing for research and development should be regarded as one of the major functions of the Center.

The function of testing for certification is basically a function of DGSM. The testing by DGSM covers many fields which industries require. These tests are done to confirm compliance with the standards, compliance with which is mandatory in Oman. The testing fields will be further expanded in future if exports of Omani products are to be expanded and buyers request the Omani manufacturers for the third-party certificate for their

products. In such case the Center also has to undertake some part of the testing depending on the availability of testing equipment.

(3) Technical guidance

Technical guidance is one of the most important functions to be provided by the Center in view of its objective. Although there are some institutions partly carrying out technical guidance to individual enterprises in respect of productivity and quality improvement, such technical guidance should be better included in the Center's activities in order to provide systematic guidance.

The technical guidance activity includes the technical consultation on the existing processes and new technology. There is no organization providing technical guidance service in either area. Guidance regarding quality management, which is a part of technical guidance, is currently being provided by MCI's IDD and DGSM. Both guidance services provide either enlightening activity for industry in general, or technical guidance to individual manufacturers, supported by Japanese experts.

IDD's activities are part of the Management Training Program, and consist mainly of lectures. They are not directly linked to grasping and solving problems at the production site. The activities of DGSM have been made in seminars. The objective of DGSM's activity is quality assurance for the industry through regulation, rather than promotion of quality improvement at individual manufacturers.

(4) Prototype development

Sample product test production is one of the technical guidance functions, and includes the three categories, namely, a) development of products, b) support for manufacturing samples of products whose manufacturing methods have already been designed, and c) assistance for test marketing of the products. The function c) may be provided by the trading company mentioned before, and the functions a) and b) should be provided by the Center.

(5) Common service facilities

Common service facilities are facilities which play a vital role in improvement of production efficiency, but are too costly to be owned by individual manufacturers, and therefore owned and operated jointly by more than one manufacturers. They may be categorized as follows: 1) the facilities for resident manufacturers in a specific areas like industrial estates, and 2) the facilities for manufacturers in a specific industrial fields. The

examples of former type in Oman are those for utilities seen in the industrial estates operated by PEIE.

There is no facility of the former type in Oman, where the number of manufacturers in specific industrial fields are generally too small to own or operate such facilities. Common service facilities are basically owned and operated by the private sector or area joint undertaking of beneficiary companies. In Oman, however, there is little experience in joint operation; moreover, further development can be expected from operating the equipment in a "pilot project"; accordingly, operation should be undertaken by the Center.

(6) Research work

The major category of research work includes basic research work and applied research work, though further detailed categorization may be applicable. There is no organization which is undertaking any kind of research work.

Research work is indispensable in view of industrial development and investment promotion, and the Center should also undertake applied research work focusing on product development and study on use of resources. This kind of research work should start with those directly effective in industry. As for the basic research work, it should be assigned to SQU where is will develop research capacity.

(7) Human resource development

There are three levels of category for human resource development; namely, a) educational, b) vocational training, and c) upgrading of skill/expertise in strategic industrial development areas. The category a) is basically undertaken by schools, and colleges/universities, whereas the category b) is carried out by vocational schools in public and private sectors. The category c) is to improve technological level in a specific technology areas, and should be undertaken by the vocational schools. The vocational schools, however, cover a wide range of trainees and handle technology areas already matured and disseminated. Therefore, special measures are required instead of vocational schools to disseminate the technologies in a specific technological areas. The Center should engage in technological training particularly of in strategic technological areas.

3.1.4 Framework of Functions to be Provided by the Center

Based on the role and fundamental functions of the Center and relationship with other relevant public institutions in Oman, the framework of functions to be provided by the

Center can be contemplated as follows:

(1) Providing technical and market information: Information specific to a certain product area (For example, as for ceramic and building materials, information regarding demand size, product characteristics, consumers' preference or characteristics in different levels of consumers, transportation and pricing conditions)
(2) Testing services: Mainly the testing for trouble shooting, but carrying out some tests for research and development and also tests for certification as necessary.
(3) Technical guidance: covering all areas of technical guidance, including the guidance for productivity and quality improvement.
(4) Sample product pilot production: Assistance for pilot production of sample products required for product development and for production of marketing samples.
(5) Common service facilities: undertaking a pilot operation of common service facilities for some strategic industries, aiming to promote joint operation by enterprises in those industries.
(6) Research work: Mainly for applied research.
(7) Human resource development: Development of human resources who are engaged in the development of strategic industries.

The Center is the first try at establishment of an institution aiming at providing technical support to industrial undertakings in Oman. Hence the Center should be started as a nucleus for experimentation for future expansion, and thus the scope of initial activities should be confined to technical services and information services that directly meet the immediate needs of the existing industries as well as prospective industries with high growth potential. Major activities to be carried out in the initial stage will focus on the following three areas:

(1) Technical support for the selected existing industries to meet their needs, particularly for their modernization and improvement, diversification and expansion;
(2) Technical support for initiation of new projects in the selected prospective sectors; and
(3) In-house research required for undertaking (1) and (2) above.

The functions and activities of the Center shall be defined in consideration of the functions and activities to be carried out by other relevant institutions so that the Center can fulfill its tasks without duplication while utilizing their facilities and services as much as practical.

3.2 Planning of Functions and Services by Technological Field

3.2.1 Garment technology

(1) Functions, and services to be provided

Major tasks: The export garment industry accounts for approximately 18% of non-petroleum commodity exports (value basis) of the Sultanate. However, the industry would not have been able to attract the interest of foreign buyers to the US market, except that the Sultanate was allocated a quota by the US. The industry is now facing difficulty in staying in existence, however, as the creation of NAFTA has resulted in inflow of products not subject to American quots.

In order to cope with this, it is necessary to encourage productivity improvement and mechanization to improve cost competitiveness, reduce the time required for pattern preparation, and improve design capabilities so as to meet the diverse needs of buyers. This will be essential to enable the industry to survive the present competition, and in future, to reduce heavy dependency on buyers and explore new markets by offering products of original design and high quality.

Direction of technical support:

1) To provide the garment industry with technical assistance which can stimulate upgrading and diversification of product lines, to thereby make it possible to generate higher value added as well as strengthen the cost-competitiveness of exports.
2) To create job opportunities for Omani engineers and/or technicians to undertake a part of the production lines in the garment industry.

To this end, the following will be tackled by the Center:

1) Support for cost reduction through improvement of efficiency of the current production system
   a) Introduction of production systems with advanced functions
   b) Improvement of production control technology
2) Support for introducing and accumulating product development technologies
3) Support for introducing and accumulating skills for repairing sewing machines
4) Support for quality certification necessary to undertake independent sales

Technical support provided

<u>Phase 1</u>

1) To establish a Cutting Center as a common service facility to introduce and experiment with new systems for pattern making, pattern grading and marker making,

and automatic cloth cutting based on the CAD/CAM system. The Center would provide the following se To establish a Cutting Center as a common service facility to introduce and experiment with new systems for pattern making, pattern grading and marker making, and automatic cloth cutting based on the CAD/CAM system. rvices to the garment industry:

a) Experimental services for development of such new mechanized operations to replace the presently practiced manual operation.

b) Train Omani engineers and/or technicians who undertake such new operation.

c) Transfer of technical know-how about CAD/CAM operation, thereby promoting commercial-base operation among the industry.

(The costs of the Center will be paid partly by service charges collected from the beneficiaries and partly subsidized by government funds during the initial phase, but it is to be privatized eventually, for independent operation with the participation of the industry. The fee rates for the experimental services of the cutting center should be fixed appropriately so that the beneficiaries are not limited to specific manufacturers.)

1) To establish a Technical Guidance Unit which provides the following technical services to the industry:

a) Technical guidance and transfer of technology for production control and quality control.

b) Collection and provision of technical information.

c) Technical consultation for diversification, upgrading, expansion and/or new establishment.

Phase 2

To establish a Training Center for Omani engineers, technicians and/or operators who are engaged in modern apparel industry. It will primarily consist of:

a) Design patterning technology unit

b) Product development technology unit

c) Apparel manufacturing apparatus repairing technology unit.

Phase 3

To establish a Test Center which provides performance test service for apparel products manufactured in Oman.

(2) Inputs for implementation

1) Organization and manpower assignment[1,2]

Phase 1

Establish Cutting Center and Technical Guidance Unit.

The Cutting Center is to install two sets of CAD system and one plotter/cutter set at the initial stage of operation. The Center will install three spreading machines to prevent lowering the utilization rate of the plotter/cutter due to time required for clearing the spreading machine after cutting denim (the ordinary system is equipped with 2 spreading machines). With these facilities, the Center can handle up to 10,000 pcs/day of sewing preparation, which is equivalent to the work load of three factories of average scale. It can also extend the grading and marker making service. The designed operation capacity of the Center is the minimum scale required for extending technical assistance service to manufacturers who are conscious about improvement of their operation, and disseminate among the industry of the effectiveness of such advanced system.

The above system requires 10 operators and one supervisor.

For the Technical Guidance Unit, an advisor and an assistant advisor, who assists the advisor and is given on-the-job training to become an advisor, will be assigned. The advisor can assist eight manufacturers by scheduled visits for guidance every half year, assuming that the advisor is engaged in the service for two days a week and visits two companies every day for visit. With this, the advisor can supply guidance to 32 manufacturers in two years, if one cycle of guidance is completed in 6 months.

Phase 2

The department is to establish a Training Center. The Training Center will consist of three units, one each in charge of the training of design and patterning technology, product development technology, and sewing machine maintenance technology. Each unit has instructor(s). The minimum number of the instructors required to be assigned in each unit is two, but in the case of the Design and Patterning Unit, it may be reduced to one assuming that the CAD operator, who were assigned at Phase 1, assists the instructor.

The Cutting Center will install one additional set of the same facilities as installed in Phase 1, to further promote mechanization. The capacity of the Center is to be increased to 2,000 pcs/day (or equivalent to the work load of six factories) with the

---

[1] The organization charts and manpower assignment are shown in Figures 3-2 through 3-6 by department and by development phase. The manpower assignment by department is summarized in Table 3-2.

[2] See Figure 3-3.

expansion, which is sufficient to undertake the function as a pilot plant. The operators of automated cutting machines will be increased by six accordingly.

In this phase, the Technical Guidance Unit is to be transferred to Research Planning and Coordination Department to extend its service to the industries other than the garment industry, for which the dissemination of production control technology is assumed to have been completed in Phase 1.

Phase 3

The Department is to establish a Testing Center within itself. The Center is assumed to be operated at minimum level of scale, since the demand for testing will be minimum at the initial stage of its operation, and therefore, one researcher will be assigned. Nevertheless, three trainee researchers will be also assigned to train for future expansion.

2) Facilities and spaces[3,4]

Phase 1

The Garment Technology Department will be composed of office space, which will be equipped with the computers necessary to provide technical guidance for production control, and a Cutting Center. The cutting system installed in the Center will be one unit of minimum scale.

Phase 2

A Training Center will be established in the Department. The cutting system will be expanded to two units.

Phase 3

The Department will have testing equipment required for end-use testing garments.

(3) Expected effects of implementation[5]

Without the technical assistance to the industry through establishment of the Center, the survival of the export garment manufacturing industry is doubtful. The Center is expected to contribute to prevention of decline of the industry and beyond that, to further its penetration of new markets. The contribution of the Center is estimated to amount to

---

[3] Table 4-7 and Figure 4-6 summarize the space that will be necessary in each development stage. The details for each department are shown in Figures 4-7 through 4-13. The equipment plan is given in Tables 4-8 through 4-19.

[4] See Figures 3-8, 3-9, and Tables 3-4 through 3-15.

[5] See Table 3-16.

about RO. 7,500,000 a year of GDP increase (or of reduced decline) and RO. 24,500,000 a year of increase in exports (or of reduced decline).

Around 500 Omani people are employed in this industry, and therefore, if the technical service of the Center could contribute to prevent the industry from declining, and further to its expansion, then it will mean also the contribution to maintaining and increasing job opportunities for Omani labor. In addition, the computer aided design work and patterning work, etc. will create more attractive job opportunities to the Omani people than the lower-level work now typical of the industry.

The improvement of production efficiency through dissemination of production control technology is expected to reduce the waste of raw materials.

In terms of technological contribution, the accumulation of garment technology is expected as a direct effect, but at the same time, acquisition and accumulation of computer technology, and its dissemination to other industries, are also anticipated as a side effects.

(4) Financial risk[6,7]

The overwhelming majority of income of the Department is projected to come from the Cutting Center, while the wages and salaries, particularly that of the director and researcher, are the major costs and expenses of the Department, which accrue regardless of establishment of the Cutting Center. However, the initial capital requirement for the Department is mostly for the establishment of the Cutting Center.

The Cutting Center may be run on a commercial basis. If the Center can provide the industry with their services at 70% of the current costs prevailing among the industry, the IRR (Internal Rate of Return) of the Center is expected to be 0.9%. The size of demand for such services is estimated to far exceed the designed capacity of the Center. Nevertheless, the manufacturers can rely on the services of the Center for their cost reduction, only if they can reduce their manpower by replacing their process with services of the Center. Therefore, the Center must handle the entire demand from manufacturers once they decide to rely on the services of the Center. This fact might affect the capacity utilization rate of the Center. The IRR will decrease to -0.3% if the capacity utilization rate declines to 50% in the first year of operation (the base case assumes the rate at 75%).

The Training Center assumes use of facilities installed in the Cutting Center without adding major equipment and facilities. Thus, the financial requirement for the additional equipment and facilities is minimal. In addition, the major costs and expenses required for

---

[6] Table 3-17 shows the estimated balance between revenue and costs and expenses of the Center as a whole. The estimated balance by department is given in Tables 3-18 through 3-22.

[7] Table 3-18.

the operation are the salaries and wages for instructors and operators who will be expatriates. Therefore, the financial risk involved in the establishment of the Training Center is estimated to be insignificant.

The establishment of the Testing Center for the end-use testing of garments, requires a significant amount of initial investment. The demand for tests will increase only when the garment industry has the capability to design by itself and sell its products through channels it develops. There is almost no demand for the tests at present. The establishment of the Testing Center, therefore, involves a high financial risk, and is necessary to study carefully about the development of the garment industry in terms of the above.

(5) Business environmental risk

The establishment of the Department presumes the existence of a garment industry. If the industry loses the very basis of existence before implementing the program, as may be caused by conspicuous changes in the US market, it is necessary to review the appropriateness and size of department since it involves a major investment.

3.2.2 Packaging Technology

(1) Functions, and services to be provided

Major tasks: Establishment of packaging technology required for export industries. The food industry is primarily serving the domestic market and is expected to enter the export market in future. However, present food packaging used by the industry may not be effective enough to promote food products in the export market.

Direction of technical support:

1) To provide technical assistance for improvement of packaging in existing industry as well as new industrial establishments, particularly for those that are export-oriented, as the improvement of packaging technology is one of the prerequisites for the development of export industries and the leveraging of the country's locational advantage as stated in Vision 2020.
2) At the initial stage, to concentrate on the technical assistance for the packaging related to food industry, in order to provide the food industry (existing as well as new establishments) with a technical data and technical guidance to promote improvement of packaging, and also to provide technical assistance for improvement of packaging or application of suitable and economical packaging to meet quality requirements and characteristics of food to be packaged, particularly for the export market, in order to satisfy buyers' requirements as well as meet import inspection and standards in the

export markets (countries).

3) In future to expand the fields of application of technical assistance to wider fields of consumers' packaging and also to industrial (transport) packaging.

Technical support to be provided

Phase 1

1) Collection and provision of technical information concerning packaging technology particularly focusing on food
2) Technical consultation and guidance on improvement of packaging quality through seminars, consultation on request, and scheduled visits for technical guidance at the individual factories.
3) Tests on packaging materials required for the consultation (to be entrusted to DGSM).

Phase 2

1) To carry out self-initiated research or contract research on packing materials and packaging processes
2) Collection and provision of technical information
3) Technical consultation and guidance

Phase 3

To establish an Industrial (Transport) Packaging Technology Unit to carry out the foregoing activities for industrial (transport) packages, while the existing research staff becomes the Consumer Packaging Unit.

(2) Inputs for implementation

1) Organizational set-up and manpower[8]

The center is expected to establish a support system to provide technical guidance for individual companies, together with capabilities to conduct supportive tests, analyses and measurement.

To be able to provide all the functions, the Department requires the following equipment to fulfill all of its functions expected:

1) Testing and measuring instruments for quality control of packaging materials:
   a) Strength testers for hardboard and corrugated cardboard;
   b) Strength testers for paper and films; and
   c) Performance testers for plastic films.
2) Testing equipment for food packaging
3) Support equipment for preparation of sample products, mainly food packaging

[8] See Table 3-4.

4) Equipment required for development of packaging material standards
5) Testing equipment related to transportation packaging

The improvement packaging requires that of food technology and that of packaging materials and packaging work methods.

However, the approach from the area of food processing technology might make the scope of work of the Department too wide a limited number of staff and limites facilities for handle. Further, the number of manufacturers in each of the specific food sub-sectors is small, resulting in inefficiency of investment in such facilities. Therefore, the Department will limit its activities to the area of packaging technology that may be applicable also to other industries in future, and will not install the facility and equipment required for tests of packaged food, and food sample development.

Phase 1

In the food industry, which is the major user industry of packaging, awareness of the need to improve quality is still less than complete, so it will be necessary for the Center to work positively on this at the initial stage. A technical guidance system that can grasp the situation in the existing industry, and the situation of potential investors, and that can point out problems, will be established at this stage, building up the guidance capability within the Center (the department will not have its own testing and research machinery and equipment).

The Department assigns a researcher and a trainee researcher who assists the researcher and, at the same time, is given training in consumer packaging technology. Assuming that a researcher carries out technical guidance for two days a week, visiting two manufacturers a day for a scheduled visit, and visiting one manufacturer twice a month, the researcher can extend the guidance to eight manufacturers in every half-an-year. Assuming that one cycle of technical guidance requires 6 months, the researcher can extend technical guidance to 32 manufacturers in 2 years.

Phase 2

In the packaging technology field, the strategic focus will be shifted from improvement of quality consciousness of the industry to trouble shooting through guidance. Since the capacity of Center is too limited to cover all the technologies in the food processing industry, it will concentrate its service areas in packaging technology.

The number of staff remains the same as Phase 1, though the Department introduces the testing equipment for packaging materials. This is because the tests related to food

will be mostly entrusted to DGSM, and the tests on quality of packaging materials will be undertaken by the trainee researcher.

Phase 3

In the packaging technology field, guidance and testing for transportation packaging will be started in response to the increasing transport of precision equipment, in addition to guidance and testing for consumer packaging technology, which has been the focus until this phase. A Transportation Packaging Unit that can deal with this will be established, while the current staff will be organized into the Consumer Packaging Unit. The number of staff will be increased by one researcher and are trainee researcher. This assignment will be sufficient for the unit to fulfill its duties for the time being, since the major activities of the Transportation Packaging Unit is to carry out the self-initiated tests and contract tests. However, in future, the number of staff, or number of trainee researchers in this case, should be increased in accordance with increase in the demand for tests.

2) Facilities and spaces[9]

Phase 1

The Department will not have testing machines or equipment; it will only have office space.

Phase 2

The Department will have testing equipment for testing the performance of packaging materials.

Phase 3

It will have the testing equipment for transportation packaging.

(3) Expected effects of implementation[10]

The main effects expected from the implementation will be to strengthen the marketing capability of industries using packaging, through improvement of packaging. The effects may be categorized into two types; one is to prolong the quality expectancy period of product which is visible directly, and another is improvement of appeal of packaging to consumers, which is hard to be measured directly. The former will contribute to expansion of markets by making the suppliers able to sell to markets located farther than the current markets. If these effects are assumed to amount to 3% each of production and export value, their contribution to GDP is expected to be around RO.

[9] See Figures 3-10 through 3-12, and Tables 3-12 through 3-13.
[10] Table 3-16.

900,000 a year, while it will be RO. 2,800,000 a year for export.

The improvement of methods of packaging work will reduce the waste of packaging materials. The packaging costs account for 15% of total manufacturing costs on the average which is much higher than the ratio of packaging costs in other countries, due to the fact that most of the packaging materials are imported to Oman. If it is reduced by 3% (assuming that there will be no change in the sales price of products), it contributes to RO. 130,000 a year. Further, assuming that 80% of the packaging materials are imported, it contributes to RO. 100,000 of import reduction a year.

Other indirect effects expected from the establishment of Packaging Technology Department include increase in demand for packaging materials from the neighboring countries, in accordance with accumulation of packaging technology to the Center.

Further, the accumulation of packaging technology by the Center and industry, and development of packaging materials industry in Oman, will contribute indirectly to promotion of industries using packaging, providing technical infrastructure to them.

(4) Financial risk[11]

The amount of income expected from the technical guidance service will be equivalent to 24% of total expenses (in the third year of operation) of the Department. The major expense is the direct labor cost accounting for 95% of total expenses in Phase 1. Therefore, there will be low risk of significant divergence from the estimated original financial balance even if it includes the depreciation, since no facility or equipment are assumed in Phase 1.

The procurement of a large amount of testing equipment is assumed in Phase 2 and after, particularly in Phase 3. However, the possibility of discrepancy from the projected financial balance is small, since the expected revenue is estimated to be small.

(5) Risk from change in business environment

Risks from change in the business environment are most likely to happen when the installed equipment is not utilized. This kind of risk is minimal in Phase 1, since the Department will not be equipped with any equipment.

The risk in Phase 2, that the testing equipment for quality of packaging materials is not utilized, may be prevented by measuring the response from the industry on technical guidance undertaken in Phase 1. The increased demand for testing equipment assumes the increasing use of transportation packaging. The risk in Phase 3 may be also prevented by studying the demand in detail.

---

[11] Table 3-19.

3.2.3 Non-metal Mineral Research

(1) Functions, and services to be provided

Major thrusts:

1) Ceramics research

There are promising markets for ceramic products in Oman and neighboring countries, and the country has mineral resources required for ceramic production including clay and kaolin. These resources, if economically exploitable, would likely lead to viable projects.

2) Gypsum and lime research

There are huge deposits of gypsum and lime in Oman. Their commercial use would create direct or indirect export opportunities. There are many potential investors who are interested in development of these resources, but the lack of data and information required for making of investment decisions prevents development projects from proceeding beyond the inception stage.

Direction of technical support:

1) Ceramics research

Commercial exploitation of ceramic materials becomes a possibility only after research and study has identified their characteristics and potential applications. The Center will conduct research on exploration and use of ceramic materials available in the country in view of identifying possibilities of commercial use, and will disseminate the results for use by the industry and other sectors.

2) Gypsum and lime research

Research work is to be undertaken in view of its value for use of resources, after it is found prospective quantitatively, and the industry and potential investors are to be provided with its results.

Exports of gypsum resources are not feasible under the conditions of the present level of exploration, and loading facilities, and a large-scale development project is called for. As the first step of such project, technical and market information must be provided to potential importers as well as potential investors for their decision making regarding quarry development .

To promote the industries using gypsum and lime, information on major products and their markets, manufacturing plants, and production technology, must be provided in addition to information on gypsum and lime resources.

Furthermore, other market exploration efforts are required, including research on economic and social impacts of new construction materials using gypsum and lime, e.g., energy saving and fire resistance. The possibility to use the resource for a specific products may be confirmed through trial tests made by manufacturers for whom the Center requests trial use after economic evaluation at the initial study stage.

The promotional activities for products which are considered feasible in the above research activity, will be effective for the market development.

In the existing subsector engaged in production of gypsum and limestone-related products, many small- and medium-sized enterprises are in operation, particularly making secondary products. Some of these manufacturers lack the ability to produce high quality products. The adequate technical guidance requires the data on substandard products prevailed and research work for their improvement. The data on the substandard goods may be obtained from DGSM, while the research work may be carried out in collaboration with SQU. The most effective way for technical guidance will be those for individual manufacturers. The guidance will be provided to the interested companies with technical diagnosis and visits for guidance for a certain period.

The evaluation results thus obtained will be made available to the public by the periodical publication of the Center, and at the same time, it will be accumulated in a data base.

Technical support provided:

<u>Phases 1 & 2</u>

1) Development research on raw materials for ceramic production, including:
   a) Collection and evaluation of available data on kaolin, clay and other materials such as feldspar and pottery stone.
   b) Supplemental composition and quality tests; to be entrusted to the MPM laboratory, and evaluation of the test results.
   c) In-house evaluation tests of collected samples.
   d) Research on improvement of currently available earthenware products (particularly for reinforcement of the products).
2) Compilation of such research results for dissemination to potential investors.

<u>Phase 3</u>

1) As for raw materials for ceramic industry, if Phases 1 & 2 work results indicate promise for development,
   a) Continuation of such development research in a wider scope and at a deeper level

b) Collection and provision of technical information on ceramic technology

c) Consultation and technical guidance to potential investors

2) Expansion of such research work to other non-metal minerals such as gypsum and other minerals to meet the needs of potential investors identified as the result of the investment promotion activities carried out by other departments of MCI and other relevant institutions.

(2) Inputs for implementation

1) Organization and manpower assignment[12]

In Phases 1 and 2, the Department will include the function for ceramic research alone, and add the research function on gypsum use in Phase 3.

Phases 1 & 2

The Department will assign a researcher who has expertise in ceramic raw material development, and a trainee researcher to assist the researcher and train for this technological area. The assignment is the minimum for fulfilling the function, since there is almost no existing manufacturers in this industry, and further, the project under planning will not require any technical assistance from the Center, as all the necessary research will be undertaken within the project. No additional manpower assignment will be necessary in Phase 2, during which guidance for production technology is started. The market information may be provided temporarily by inviting experts from abroad if necessary.

Phase 3

A researcher, who has expertise in use of minerals in general, will be assigned in accordance with the needs for technical information on use of gypsum following the progress of techno-economic study on gypsum resource development. A trainee researcher will also be assigned for the future development of the research work in this technological field. These staff will be organized to form Gypsum Research Unit, while the staff assigned in Phase 1 will be organized as the Ceramic Research Unit.

2) Required equipment and space[13]

The Center will conduct its own testing, research and exploration activities. For this purpose, the following equipment is required:

1. Chemical analyzer
2. Mineral microscope
3. Electric furnace with maximum firing temperature at 1,400℃

---

[12] Figure 3-5.

[13] See Figures 3-13 through 3-14, and Tables 3-14 through 3-15.

4. Devices for sample preparation
5. Devices and tools for blending tests

If the Center is able to use the facilities and equipment available in other institutes, the Center should rely on these facilities and equipment for a part of its activities. The plan for establishment of the Center is formulated taking into account this factor, so that the duplication of investment can be avoided.

However, the facilities and equipment of outside laboratories which can be used for the purpose of technical guidance and research work of the Center will be limited to those that can accept outside requests. The results are reported to the Center for evaluation. If the facilities and equipment will be used by researchers frequently, or be used commonly with other organizations, it will cause a lot of inconvenience.

The analyses using the chemical analyzer and the mineral microscope are not necessarily done by the center, and can be commissioned to a reliable laboratory. The MPM's laboratory is the laboratory having such equipment[14].

On the other hand, testing equipment in 3) and 4) must be owned by the center in order to conduct various analyses on a continuous basis.

Phase 1

Install the testing equipment required for research work on ceramic raw materials.

Phase 2

No additional equipment is installed.

Phase 3

Testing equipment required for research on use of gypsum will be installed additionally.

---

[14] The MPM's laboratory may be used for chemical analysis and mineral component analysis of ceramic raw materials and gypsum. However, in the case of the chemical laboratory of Science Department of SQU, most of the testing equipment required for the Center are not available, although they equip with various primary equipment for chemical analyses such as balance and pH meter. Again, most of the facilities and equipment available in the civil engineering laboratory of the SQU are those for physical tests of cement and concrete. For the research work of ceramic raw materials, only a standard sieve set, a drying oven, and a table balance may be used among the equipment available in the laboratory. These equipment, however, is used from time to time during the research work, and further, the cost of this equipment accounts for a minor part of the total costs of equipment required for this kind of research work. In the case of research work on gypsum, the laboratory has some similar equipment, including a tensile strength tester, which can be used but with an attachment specifically designed for gypsum testing. Some of the equipment available at the laboratory, such as Vicat needle apparatus and a measurement tool for specific surface area, etc. may be used but again with in-advance adjustment. An electric kiln to calcine gypsum, which is the major equipment for the gypsum research is not available. Thus, all the required facilities and equipment for this purpose will be necessary to be furnished in the Center.

(3) Expected effects from implementation[15]

The significant effects of implementation of raw material development research may be expected only from the area of factory operation even if the ceramic industry is created as a result of the development of raw materials. The effects from small scale individual operation will be minimal. Assuming that there is a new tile manufacturing project on the basis of locally available raw materials besides the project under planning, and that the production capacity of the new project is 5,000 tons a year of tile, it will contribute to increase in GDP of around RO. 550,000. Further, since the production will substitute for imports which will be continued to be brought in unless the project is materialized, it reduces imports by around RO. 1,100,000.

In addition, the increase in small scale individual pottery production will create job opportunities for Omani people.

In the area of gypsum resource development, the largest effect is expected from gypsum export. If one million tons of gypsum is exported, it will contribute to the increase in RO. 1,600,000 a year of GDP, and RO. 3,800,000 a year of exports. The creation of job opportunities, however, will not be significant, since the number of people engaged in the mineral resource industry is negligibly small. The development of industry that uses gypsum for industrial purposes, will add the effects further.

In addition to such tangible effects, the research work at the Center will contribute to accumulation of technology in the field of non-metal mineral resource development, resulting in further development of similar resources in future.

(4) Financial risk[16]

The estimated income from the technical guidance service will be negligibly small compared to costs and expenses of the Department (9% of costs and expenses in the third year of operation, for example). The major portion of costs and expenses are the direct labor costs (90% of total in Phase 1). Therefore, it will be very unusual of the balance between revenue-costs and expenses diverges from the estimated value.

(5) Risks from change in business environment

The risk that can be anticipated in the case when the installed equipment and facilities are not utilized because of whatever reason. The most worst case is failure of identifying the prospective raw materials for ceramic production. However, if such is the case, most

[15] Table 3-16.
[16] Table 3-20.

of the equipment may be used for research work of other minerals.

3.2.4 Other Technological Fields

(1) Functions, and services to be provided

The above four technological fields are regarded as the strategic areas for technical support by the Center. Nevertheless, the Center will establish a department (Research Planning and Coordination) to deal with other technological fields other than the above, since the industry might request the technological assistance in various fields.

Activities

Phase 1

1) Planning of annual work plans and budget.
2) Establishment of network for external information supply sources and external tie-up network for test and research work.
3) General access window for receiving inquiries for technical information and other technical services for fields other than those of the three departments.
4) Public relations and coordination with other agencies or institutions in Oman.

Phase 2 & 3

1) Establishment and management of a library and data bank.
2) Establishment of Production Control Technology Unit and Economic Study Unit depending on the needs that arise.

(2) Input for implementation

1) Organization and manpower assignment[17]

Phase 1

An officer and a director will be assigned as a minimum requirement for fulfilling the function.

Phases 2 and 3

In Phase 2, the Technical Guidance Unit of the Garment Technology Department will be transferred to this department, and carry out the technical guidance for production management and quality management. The Department is to establish three units including the above; a Research Coordination Unit to handle the technological fields to which no other department was assigned, and an Economic Study Unit to provide all the technological areas with relevant economic studies.

[17] Figure 3-6.

The staff for guidance of production management and quality management are an advisor and an assistant advisor who were promoted after having been a trainee researcher in Phase 1. Assuming that the advisor engages in guidance for two days a week, providing guidance to two companies a day, and that one manufacturer receives technical guidance twice a month, then, the advisor can extend the guidance to eight manufacturers in half a year. With one cycle of guidance being six months, the advisor can provide support services to 32 manufacturers in two years, and therefore, the number of assigned staff will be sufficient to fulfill their function.

The staff assigned to the Economic Study Unit is one researcher as the minimum requirement. However, two trainee researchers will be assigned to prepare for future expansion.

The activities of the Planning and Coordination Unit will increase with expansion of the organization of the Center as a whole, progress in the accumulation of technologies, and further, increase in the public relations service. Thus, the staff will be increased by one, besides the two assigned in Phase 1.

2) Facility and equipment and spaces

Phase 1

The required space include the office space and the space for library.

Phases 2 and 3

No additional facility and equipment.

(3) Expected effects of implementation

Since the technological fields to be handled can not be specified at this stage, it is difficult to estimate qualitative effects. Nevertheless, provision of services in a variety of technological fields to meet the needs of industry is essential for promotion of small and medium business development in future. Expectations regarding the activities undertaken by this department will not be negligible.

The information services to the public about what information was collected and accumulated, will be indispensable to make results in other department more fruitful.

(4) Financial risk[18]

The estimated income from the technical guidance will account for only a part of the required costs and expenses of the department (21% in the third year of operation). Most of the costs and expenses are direct labor costs (98% in Phase 1). Therefore, since the

[18] Table 3-21.

assumed revenue is minimal, the divergence from the estimated balance between the income and costs and expenses will be small.

(5) Risks from change in business conditions

There might be a risk that the manpower assigned to the department will not be utilized, since the technological fields for the department to handle can not be specified at this stage. However, the proposed assignment of two will be the minimum requirement to fulfill its function in public relations. The assignment in Phase 2 and after should be reviewed step by step, so that the risk of-over assignment may be avoided.

3.3 Discussion of Plan Alternatives

(1) Plan alternatives for individual technology fields

1) Setting-up of Cutting Center of Garment Technology Department as an independent organization from IRC

Alternative: To set up the cutting center as an independent unit on a self-accounting and commercial operation basis, for the reason that it will be a common service operation for the garment factories, to enable them to rationalize and reduce operation costs, but it will require no technical research nor technical guidance to be carried out by the IRC.

Merits and demerits are as follows:

a) If the cutting center is set up as an independent unit, it will mitigate the financial burden of the IRC, so that budget funds can be allocated to other activities.
b) However, as the pattern making, pattern grading, marker making and automatic cloth cutting based on the CAD/CAM system which will be adopted for the proposed cutting center will be a system new to Oman, experimental operation as well as on-the-job training of technicians and operators are essential to ensure adoption of this system by the garment industry.
c) Not only this system provides common service facility, but, so does the software for introducing modern production planning and control system as well as training in design technology which are important for the garment industry to diversify product mixes and raise cost competitiveness.
d) For this end the IRC's important role in the area of garment technology will be to carry out technical guidance and human resource development for transfer of appropriate production control and design technology by using the facilities installed at the cutting center.

Therefore, it is recommended that the cutting center be set up as one component of the Garment Technology Department. However, it should be planned to be privatized as a self-supporting entity with the participation of the industry after the initial phase of operation, in that it is can be operated on a financially self-sustaining basis and the service capacity proposed is still insufficient to cover the whole industry.

2) Discussion on scope to be covered by the Packaging Technology Department

Discussion:

a) Should research or technical services on food packaging include processing technology to some extent?

b) What kind of research and technical services can be practically carried out on food processing with the limited number of staff and also without the department's own testing or pilot equipment?

c) In view of the objective of this department, that is to provide technical assistance for improvement of packaging in order to promote the development of export industries and repackaging industry based on the country's locational advantage, in what directions the activities should be expanded in future?

The conclusions are as follows:

a) The initial phase activities should be concentrated on providing technical assistance, particularly the collection and provision of technical information on advanced packaging technology and technical guidance and consultation to the existing food and beverage factories for improvement of packaging and also those services to investors setting up new factories.

b) In order to provide such services, tests on quality and shelf life of packaged products would be required. These tests may be entrusted to DGSM, and the IRC will carry out evaluation of the test results.

c) Improvement of packaging in some products would require the improvement of food processing technologies. However, as R&D for the improvement of food processing technologies needs a large number of staff and also various equipment, it would not be feasible for IRC to undertake such activities. Thus, such activities will be entrusted to established institutions abroad. For this end IRC will establish an external network.

d) In future there may be emergence of factories undertaking more variety of processed foods such as canning, frozen, retort pouch, etc. In order to provide technical assistance for selecting appropriate packaging materials and packaging

technology, the production of samples and tests of the sample products would be required. However, as these activities also require sample manufacturing equipment as well as a number of staff, such activities will be entrusted to the established institutions abroad.

e) Thus, IRC will carry out the collection and provision of technical information and technical guidance through seminars and visits to the existing factories, as well as general consultation to new investors, and any tests and pilot production activities will be entrusted to DGSM and external institutions during Phase 1. Particularly in the initial phase, the activities will be concentrated on the existing factories, since there are more than 20 factories and most do not yet realize the value of making improvements, hence positive action would bring about tangible results.

f) As the future direction based on findings in the first phase, IRC's activities will be upgraded to handle more specific technical matters of consumer packaging in the second phase and expanded further to industrial (transport) packaging in the third phase in keeping with the industrial development in future. In this expansion of fields, IRC will have to acquire some test equipment to carry out tests which can not be done at other institutes.

g) Job load for carrying out the above scope of work may be handled by the allocated staff.

3) Relationship with MPM laboratory in undertaking ceramic research work

Discussion:

Demarcation of functions among MPM laboratory and IRC regarding the research on mineral resources

IRC will closely collaborate with the laboratory of MPM for their basic function in exploration of minerals. However, only general geological and basic exploration surveys have been carried out by MPM, and evaluation tests have not been carried out. Further, the exploration surveys are still insufficient particularly on clay. In view of this situation, the following should be the activities undertaken by IRC:

a) To compile data available from MPM, and evaluate these data to identify possible investment opportunities for mineral processing industries.

b) To collect samples and carry out evaluation tests on collected samples to ensure adequacy and suitability of raw materials available, while entrusting chemical and composition analysis to MPM's laboratory.

c) To provide interested potential investors with technical guidance for their project studies on the basis of the raw material data prepared by IRC.

4) Function of IRC in development of gypsum resources

Discussion:

Necessity of involvement of IRC in organizing a technological and economic study (feasibility study) on large scale gypsum deposit development.

a) At present gypsum mining is carried out by a conventional method and on a small scale, for the supply to cement plants. A huge deposit of gypsum has been found by exploration surveys carried out by MPM, and there are some potential investors interested in commercial exploitation of this newly found deposit for exports as well as industrial uses. However, commercial production requires a huge amount of investment and development of infrastructure. Under this situation, for the development of gypsum industry, it is essential to organize ministry level action for promotion, including the preparation of a pre-feasibility study, some financial assistance for a detailed feasibility study including additional boring tests, study on mining and shipping methods, etc. which are to be carried out by interested investors. It was agreed that these activities will be undertaken by the Directorate of Industrial Planning, MCI, rather than IRC. If the development prospects emerge from such project studies, there may be need for evaluation tests on gypsum to ensure adequacy and suitability of gypsum to be exploited. In such event, IRC will implement its functions as proposed.

b) In view of these steps, the initial phase will concentrate on the developmental research work on raw materials for ceramics as mentioned in 1) above, and in the second or third phases such work on gypsum or other non-metal minerals will be done depending upon the needs arising along with investment promotion carried out by other agencies.

(2) Implementation priority among the technology fields selected

The foregoing three fields have been selected on the basis of existing needs of the industries and also strategic needs for the industrial development in future. Thus these fields are equally important.

However, in view of implementation the order of priority among three fields should be discussed by using the following criteria:

a) Urgency and degree of existing needs by the industries.
b) Degree of potential need for further development of the industries.
c) Speed and certainty of effect which could be brought out by those activities.

The order of priority thus given for implementation is as follows:

1) The top priority is to be given to the Garment Technology Department, in view of the following:
   a) The export garment industry in Oman will face severe competition, and might be unable to stay in existence without a quota in the USA, unless diversification of product mix and improvement of cost competitiveness are realized very soon.
   b) In view of the contribution of the existing garment industry to export earnings and employment, there is urgent need to provide technical support for diversification and improvement of production. Thus the proposed programs should be implemented urgently.

2) The next priority is given to the Packaging Technology Department for the following reasons:
   a) There are a number of existing factories in which active technical assistance for improvement of packaging could bring about tangible results.
   b) Most of the existing factories are not fully aware of the value of improvement of packaging for promoting exports.
   c) Establishment of advanced packaging industry is important for the development of export industries and repacking/distribution industries based on the locational advantage of Oman.

3) The Non-metal Mineral Research Department is put in the third priority from the following reasons:
   a) Although these activities are important for promoting the development of new fields of industry in Oman, the development of these fields of industry requires not only IRC's support but also active investment promotion activities by other agencies.
   b) There are uncertainties for ensuring availability of adequate and suitable raw materials.
   c) In this situation, the possibility of bringing about tangible results depends also on the actions taken by other agencies.

3.4 Organizational Set-up and Management of the Center

3.4.1 Organizational Set-up of the Center

3.4.1.1 Institutional Structure

The following is a hypothetical institutional structure based on that of similar agencies.

1) A department of a government agency (the same as the case of MPM Laboratory and Central Laboratory of DGSM)
2) An organization funded from by the Government budget but partly independent from the government in a certain area of operation and management (the same as the case of PEIE)
3) A non-government organization supported by the Government with the government investment and/or subsidies, etc. (This type of organization is seen in manufacturing sector and for large scale projects in Oman, but there is no organization of this type for a technical institute. There are many examples with joint investment by government and private sector abroad.)

IRC should be operated in accordance with MCI's industrial development policy. On the other hand, as an agency independent from the government, it should have its own hiring and pay systems, freedom of activity, and freedom in obtaining and training personnel. Moreover, it should be enabled to after its services for pay in cases where its beneficiaries can obtain a profit directly from those services. Therefore, IRC should be set up as a government-supported institutions. The costs for the set-up and operation of IRC will have to be financed/supplemented with the government budget, since IRC's services are expected to have a significant economic effect, while it could generate only a limited amount of revenue.

In conclusion, the Center is recommended to be established, like PEIE, as a public organization under the auspices of MCI.

3.4.1.2 Organizational Structure

At the initial stage of establishment, the center will be organized at minimum required level.

(1) Organization for management

The direction of activities must be in line with government policy on industrial development. A steering committee should be formed headed by an executive of MCI to

ensure the linkage[19]. The committee is to give instructions on the basic direction of operation of the Center, and at the same time assist the Center to obtain support from the relevant organizations.

(2) Operational organization

At the initial stage of operation, the proposed Center will have three departments which are assigned respectively to the specific areas of technology; namely, garment, packaging, and non-metal minerals. In addition to these three departments, the Center will have a planning and coordination department, which handles not only the matter of public relations, economic research and project coordination, but also the industrial branches which are not handled by the above three departments.

These three departments are not necessarily permanent organizations. However, since the facilities and equipment will be installed and manpower will be recruited for operation of these departments, the departments are necessary to be designed so that the facilities and equipment as well as the assigned manpower can be utilized even if there is a change in organization. The above departments are identified as appropriate in view of necessity for industrial development and also in view of the following:

1) There is a certain extent of need for establishment of them at present, and the need seem certain to increase further in the foreseeable future even if it is small at present.
2) There is a strategic theme to be tackled by the department, and the facilities and equipment and manpower may be utilized for other themes also, even if the strategic theme is converted to others.
3) The current theme is large enough to justify the establishment of the department, even if the theme is abandoned in the future.

The strategic themes for technical assistance and training to be provided by the Garment Technology Department are those to be tackled by the private sector companies by themselves, if this sub-sector is well established in the future. If such is the case, the strategic focus of the Center in this technological field will be shifted to applied research. However, the effects expected from operation of this department are large enough to justify the department to be established with short-term objectives alone.

---

[19] To ensure the fruitful output from the research and development work, autonomous decision on activities of R&D institute is essential. The increasing extent of independence of the said institute should be pursued in accordance with progress of industrial development in the future avoiding too much influence from the policy side. Nevertheless, in the case of Oman, the Center must materialize the intended objectives in a possible short period, making the most of the limited resources (human and capital resources) available. In this connection, it would be more effective if the direction of operation be determined by the Steering Committee for the time being.

The needs of industry for establishing the food and packaging technology department are not significant at present. The establishment of packaging technology, however, is indispensable for the Sultanate to develop its industry on the basis of locational advantage in the Middle East. The establishment of this department may be justified from this point of view.

Gypsum resource development and ceramic raw materials research are the two main strategic focal points for the Non-metal Mineral R&D Department. Both themes might be abandoned in the future if the target resources are found not attractive. However, in such case, since in Oman there are various non-metal mineral resources which are not utilized or are utilized insufficiently, the planned facilities and equipment and research staff may be utilized for the research of other resources.

The direction of phased development of the above three departments is discussed elsewhere above. The development plan for other industrial technology areas should be defined by studying the future development of relevant industrial sub-sectors.

(3) Management and technical staff

The Center is to be managed internally by Directors and Chief Researchers led by Managing Director. Basic policy for operation is to be decided by a group consisting of Directors and Chief Researchers.

The key technical staff should be invited or recruited from abroad at the initial stage of establishment. However, the number of Omani staff should be increased step by step. Toward this end, trainee staff will be assigned under the supervision of the above key technical staff.

For the actual operation of the common service facilities, the Center will recruit some expatriates who have a certain level of knowledge and experiences in the said field as the operators and the instructors. At the same time, trainee instructors of Omani will also be assigned to CAD and CAM units for training.

(4) Membership system

In order for the Center to maintain a close relationship with industry and disseminate useful information among industry, and at the same time, for the industry to recognize the function of the Center time to time, and convey their needs to the Center, the Center will have a membership system. The membership is to consist of companies and individuals who accept the objective of this system, and pay a membership fee to the Center. Members will receive bulletins to be issued by the Center free of charge. Further, the

Center will keep inform the members regarding events to be held by the Center including seminars. The members may participate such events at the lower cost fee than non-members.

3.4.2 Financial Viability

The major income sources of the Center include the fees from the contract testing, fees for use of CSF for the garment industry, income from sale of publications, and membership fees.

The expected income of the Center will not cover the required operation costs and expenses, and the financial assistance from the Government is recommended.

It is assumed that the Center will collect fees for services, from the beneficiaries. The collection of fees for the services, however, will be difficult to justify in that the government services have been provided free of charge so far in the case of Oman. The collection of fees is necessary start from the services which produce direct benefit to the client. Further, a system should be introduced wherein the whole or a part of fees paid by the small scale enterprises be covered by the Government by dispensation of a bounty or a subsidy.

The Center shall provide the following (and some other) 1) those that contribute directly to the benefit of beneficiaries (for example, use of CSF and contract testing), 2) those intended to contribute to the benefit of users, but the benefit is not assured (for example, provision of technical information, technical guidance, technical consultancy service, contract research, etc.), and 3) those for which beneficiaries are not defined (for example, own research and development study).

Generally speaking, many public institutes charge fees for the services under category 1) above, while undertake the services under category 2) free of charge. Private sector consultants charge for services under category 2), but the public institutes make it free of charge in most cases. This is because the users of public institutes are mainly small and medium enterprises, and the service is undertaken with the objective of assisting them. The services are provided to identify the users' problems and assist their improvement, rather than to gain income. However, even if the users are small businesses, if they have the capacity to pay for the services and they contract with the Center for the services because it is inconvenient to seek the same service from the private sector, then the Center may charge fees. The fee for the services under category 3) may be collected indirectly as a part of fee for the services under 2).

There is no established method of setting the fee rates. Generally the fees are set not on the basis of required costs for the services, but on the basis of fees that prevail at similar institutes. Most of these institutes are not operated on the basis of revenue from their services alone. The costs and expenses of these institutes are paid under the budget of government, and the revenues are transferred to the government.

3.4.3 Government Assistance

In the case of the proposed Center, the establishment of the Center as a public institute, and operation of it with the funding of the government, may be also justifiable in that the Center is expected to generate economic effects, besides the expected contribution to technological upgrading. The tangible economic effects alone are expected to far exceed the amount of fund to be provided by the government.

Among the research institutes, besides the institutes which are established to make a contribution to industry, there are some institutes which are established to make profit from research and testing services. These institutes usually concentrate their research on areas that generate profit, by selling the research results.

However, except for such institutes, most institutes which are established to contribute to industry are not operated by their revenue alone.

In the case of private testing agencies, many are established for the purpose of undertaking testing work from the general market in order to effectively use the testing equipment that manufacturing companies and others often have. In such cases, however, the tests requested by these manufacturing companies almost always constitute the bulk of operations. In the case, too, of the "third sector" research institutes that are established jointly by the public and private sectors and that have recently appeared in Japan, the public sector does not merely provide support for establishing these institutes, but supports their operation, by ordering much research work from them.

As a general tendency, the governmental support for industrial technology development, particularly in those areas where the technology is not developed sufficiently enough to be exposed to free competition, is increasing.

In the case of Japan, 20% of investment in R&D comes from the public sector, including Government established institutes, universities, and corporations established for special purposes, while the remaining 80% comes from the private sector. The ratio of investment by the public sector accounts for as much as 40% in the case of the US.

The R&D investment by the public sector mainly covers; 1) research with risk, 2) special areas requiring huge amount of costs, 3) time consuming R&D, 4) basic research which has objective to obtain output as public goods, 5) research work in such fields of public welfare as those related to energy, the environment, and medical welfare, etc., and 6) research which can not be developed with the market mechanism alone.

Most of public institutes in Japan are operated by the funds from the budget, and insignificant amount of their income is collected as the fees.

It is believed that this kind of public research institute's operation, which is based on government funds, can theoretically be justified if the economic benefits of the services provided by the agency are large compared to the budget money that the government invests in the institutes. In the case of the Center, the economic benefits from the current plan will be, it is estimated, as shown in Table 3-2.

3.4.4 Management Capability

The Center may be managed by Omani management such as the managing director and directors, as in the case of other organizations in Oman. However, regarding the operation of the Center in terms of technological area, Omani management resources with sufficient experience and knowledge are hard to find. Therefore, at the initial stage of operation, the Center should recruit experienced chief researchers and operate the Center under the leadership of these researchers.

3.4.5 Technical Assistance from Abroad

The most difficult point for the operation of the Center is assuring it the needed technical staff. Because of the low appreciation of the technical jobs that has prevailed in Oman, persons of excellent ability have tended to get jobs in government agencies, with the military forces, or at financial institutions, etc. However, in recent years the people has increasingly become respectful of the technical jobs particularly of military forces, hospitals, and universities. Nevertheless, the recruitment of Omani senior technical staff is still difficult, and they have to be recruited from abroad. Although the recruitment of senior technical staff from abroad may be possible, assuring these staff through technical cooperation of foreign governments will be more advised in view of obtaining more appropriate expertise.

The technical and market information also needs to be obtained from abroad.

Particularly, the following assistance is recommended to be pursued:

1) Dispatch of a chief researcher(s)/ a researcher(s) who has (have) both technical knowledge and experience and competent capability to manage the department in charge
2) Transfer of technical and management know-how about establishment, initial training, and operation

3.5 Plan for Future Expansion

The current plan emphasizes the practical operation of the Center, and assumes the minimum organization and services to be provided. The phased development plan is formulated also within this framework. In other words, the current establishment plan assumes the phased development within the scope of three technological fields identified as strategically important, and does not include further long-term expansion prospects. The following gives the long-term prospects of the expansion of the Center beyond such scope, though the actual expansion should be studied in detail again taking into account the needs according to the development at that time.

(1) Expansion of industrial technology areas covered

The current establishment plan put focuses of the target technology areas on garment technology, packaging technology, and non-metal mineral research. According to the experience in Japan[20], the demand for technical guidance mostly comes from textile and garment, metal and machinery, food, and ceramics industries. All of these industries involve a significant portion of small business within the industries. Actually, the small business with less than 50 employees have accounted for 75% of total establishments received the technical guidance services from such institutes.

Also in the case of Oman, if the emphasis of the Center is placed on small business development, machinery industries and plastic processing industries should be targeted for technical guidance in the future, and food, machinery and garment industries be focal points for research and development.

However, these future-potential industries may be covered by the departments proposed in the current plan by functional expansion, except for the machinery industries.

In the case of machinery industries, since it involves wide range of industries, a specific target area should be defined taking into account the machinery industrial areas developing at that time. The existing machinery industry is still too immature to be taken as the target industry of the Center, and is not included in the current plan. However, in the future, the department which handles metal engineering, plastic processing machinery

[20] Number of technical advisory services extended in 1987 through 1989 in Japan.

and molds, and improvement and maintenance of other industrial machinery will be one of the major departments of the Center.

(2) Level of services provided by the Center

The main objective of the Center under the current establishment plan is to meet the direct needs of industry. Thus, the emphasis of the Center's function is placed on technical guidance (or technical transfer). Even the research and development function for ceramic raw materials is planned to formulate the basis of technical guidance in this technological field.

In the future, however, testing and research work for solving problems which the industry faces, will be found necessary in accordance with identification of their problems through technical guidance. Thus, the emphasis should be increasingly placed on the research and development function in the future to assist solving the problems which the industry actually faces.

According to the current plan, one-sided technology transfer (or technical guidance) is provided from the Center. In the future, however, once the industry could accumulate technological experiences through their operation, and the Center can identify the problem areas, the function of technology transfer may be further developed to communication to and from industry and the Center, and exchange of experience among industry with joint research with industry and organization of research societies of manufacturers among industry, etc.

(3) Implication for future development direction of the Center

The current establishment plan of the Center emphasizes the importance of the practical nature of its operation, selecting the technological areas of direct needs of industry and level of services which meet the needs. The development of functions of the Center in the future will not be easy because of the current industrial development situation, with its wide range of industrial development for import substitution but existence of small number of companies in each sub-sector. To overcome this issue, the following is recommended in the future as its operation direction:

1) Expansion of the coverage area of the Center to Dubai, and further to GCC countries, particularly for testing services and training services
2) Strengthening of testing functions to the level applicable by international standards
3) Development of functions to assist prototype development and sample development, to complement the supporting industries which are weak in the Sultanate
4) Upgrading of facilities and equipment and human resources in the field of applied

research, though the basic research may be difficult to undertake in the near future

Table 3-1 Functions of IRC in Relationship with Other Relevant Institutions

	IRC (Industrial Research Center)	PEIE (Public Est. of Industrial Estates)	Investment Export Promotion Center	Central Laboratory, DG of Specifications	Trading Company under OCCI	MPM Laboratory	Sultan Qaboos Univ.
(1) Technical/ Market Information							
1) General information on export market condition			x				
2) Information specific to a certain product area	x						
3) Information specific to a certain product/ buyer					x		
(2) Testing							
1) Testing for trouble shooting	x						
2) Testing for research and development	x					x	x
3) Testing for certification				x			
(3) Technical guidance							
1) Technical advisory/ trouble shooting	x						
2) Provision of facility for information exchange	x						
3) Technology development on behalf of manufacturers	x						
(4) Prototype Development							
1) Assistance for product development	x						
2) Assistance for prototype making	x						
3) Test marketing					x		
(5) Common Service Facilities							
1) For the resident manufacturers in the industrial estates		x					
2) For manufacturers in specific industry areas	x						
(6) Research Work							
1) Basic research work							
2) Applied research work	x						
(7) Human Resource Development							
1) Educational							x
2) Vocational training							
3) Upgrading of skill/expertise in strategic industrial development areas	x						

Table 3-2 Summary of Manpower Plan

	Phase 1						Phase 2						Phase 3					
	Management & Administration	Planning & Coordination Dept.	Garment Technology Dept.	Packaging Tech Dept.	Non-metal Minerals R&D Dept.	Total	Management & Administration	Planning & Coordination Dept.	Garment Technology Dept.	Packaging Tech Dept.	Non-metal Minerals R&D Dept.	Total	Management & Administration	Planning & Coordination Dept.	Garment Technology Dept.	Packaging Tech Dept.	Non-metal Minerals R&D Dept.	Total
Managing Director	1					1	1					1	1					1
Director		1	1			2		1	1			2		1	1			2
Chief Researcher				1		1				1		1				1		1
Researcher/ Advisor/ Supervisor			1		1	2		2	1	0	1	4		2	2	1	2	7
Assistant Researcher/ Officer		1				1		1				1		1				1
Trainee Researcher			1	1	1	3		2	0	1	1	4		2	3	2	2	9
Secretary	2					2	2	1				3	2	1				3
Administration Staff	2					2	2					2	2					2
Engineering Service						0	2					2	2					2
Instructor						0			5			5			5			5
Operator			10			10			16			16			16			16
Total	5	2	13	2	2	24	7	7	23	2	2	41	7	7	27	4	4	49

Table 3-3 Summary of Space Plan for Industrial Research Center

(Unit: m^2)

Department	Phase 1	Phase 2	Phase 3	Remarks
(1) Operation space				
Garment Tech. Dept.				
Cutting Center	1,000	1,600	1,600	Case 2
Training Center		200	200	
Others	100	100	100	
Total operation space	1,100	1,900	1,900	
(2) Laboratories				
Garment Tech. Dept.				
End-use Testing Center			300	
Packaging Tech. Dept.				
Packaging materials test labo		75	75	
Transportation packaging labo			150	
Non-metal Minerals R&D Dept.				
Ceramic raw material research	50	50	50	
Gypsum research			75	
Total labo space	50	125	650	
(3) Offices and other spaces				
Offices	80	150	175	3.35m^2/staff
Library		55	55	8% of (2) in Phase 3
Workshop		20	20	3% of (2) in Phase 3
Others	70	190	485	35% of (2) & (3)
Total office and other spaces	150	415	735	
Total	1,300	2,440	3,285	

Table 3-4 List of Facilities and Equipment for Garment Department, IRC

Phase: 1st Stage (Design Pattern)

Garment CAD System

Item	Article	Quantity	Unit Cost	Cost
1	Garment CAD System (Server/Client 1) AM- 800 Series PDS Software Grading Software Marking Software Other Fundamental Software	2 Sets		
2	Plotter & Cutter M/C	1 Set		
Total Amount			R.O. (US$	61,000 160,000)

Table 3-5 List of Facilities and Equipment for Garment Department, IRC

Phase: 1st Stage (Central Cutting Center)

CAM System (Automated Cutting Machine & Spreading Machine)

Item	Article	Quantity	Unit Cost	Cost
1	Cutter Machine S- 7200- 24- L	1 Set		
2	Spreading Machine	3 Sets		
3	Loading Machine	3 Sets		
4	Spreading Table 25 M Air Flotation	3 Line		
5	Band Knife Cutter M/C	2 Sets		
	Total Amount		R.O. (US$	281,500 740,500)

Table 3-6 List of Facilities and Equipment for Garment Department, IRC

Phase: 1st Stage (Production Management)

PC- based Production Management System

Item	Article	Quantity	Unit Cost	Cost
1	PDM System	1 Set		
	Processor Include Disk			
	Color Monitor			
	Printer			
	Scanner			
	PDM Software			
	Total Amount		R.O.	13,000
			(US$	34,000)

Table 3-7(1) List of Facilities and Equipment for Garment Technology Department

Phase: 1st Stage (Technical Information)

PC- based Filing System

Item	Article	Quantity	Unit Cost	Cost
1	PC- based Filing System Processor Include Disk Display A3 Scanner A3 Printer Optical Magnetic Disk Filing Software	1 Set		
	Total Amount		R.O. (US$	10,000 26,000)

Table 3-7(2) List of Facilities and Equipment for Garment Department, IRC

Phase: 2nd Stage (Central Cutting Center, Expansion)

CAM System (Automated Cutting Machine & Spreading Machine)

Item	Article	Quantity	Unit Cost	Cost
1	Cutter Machine S- 7200- 24- L	1 Set		
2	Spreading Machine	3 Sets		
3	Loading Machine	3 Sets		
4	Spreading Table 25 M Air Flotation	3 Line		
	Total Amount		R.O. (US$	277,000 728,000)

Table 3-8 List of Facilities and Equipment for Garment Department, IRC

Phase: 2nd Stage (Design Pattern)

Garment Fashion Design System

Item	Article	Quantity	Unit Cost	Cost
1	Artworks System	1 Set		
	Processor Include Disk			
	High- resolution Color Monitor			
	Printer			
	Scanner			
	Artworks Software			
	Total Amount		R.O. (US$	30,000 80,000)

Table 3-9 List of Facilities and Equipment for Garment Department, IRC

Phase: 2nd Stage (Sewing Processing)

Machineries for Sample Development

Item	Article	Quantity	Unit Cost	Cost
1	1- Needle Lockstitch DDL- 550N- 3- WB/EC10A	2 F		
2	1- Needle Overlock M/C MO- 3904- OD4- 300/TO39	1 F		
3	1- Needle Overlock M/C (Hemming) MO- 39105E- OD4- 210/L121	1 F		
4	2- Needle Overlock M/C MO- 3914E- BD6- 300/TO39	1 F		
5	2- Needle Safety Stitch M/C MO- 3916E- DD4- 300/TO39	1 F		
6	Lockstitch Buttonhole M/C LBH- 791NS- 1	1 F		
7	Eyelet Buttonhole M/C 558- 31391	1 F		
8	Lockstitch Buttonsewing M/C LK- A851- 555/Z156	1 F		
9	Lockstitch Bar Tacking M/C LK- 1852- 1U	1 F		
10	Vacuum Board & Steam Iron (Finishi JVB- 957/JES- 356	1 Set		
11	Vacuum Board & Steam Iron JVB- 939/JMB- 153/JES- 356	1 Set		
12	Fusing Press M/C HP- 330JS	1 F		
13	Water Softener	1 Set		
Total Amount			R.O. (US$	29,000 77,000)

Table 3-10 List of Facilities and Equipment for Garment Department, IRC

Phase: 2nd Stage (Sewing Processing)

Machineries for Improvement of Mechanization

Item	Article	Quantity	Unit Cost	Cost
1	1- Needle Lockstitch DDL- 550N- 3- WB/EC10A	2 F		
2	1- Needle Overlock M/C MO- 3904- OD4- 300/TO39	2 F		
3	Lockstitch Automatic Welting M/C APW- 239N	1 F		
4	Serving M/C ASN- 395L	1 F		
5	Compressor G22K (3HP) with Air Dryer	1 Set		
6	Boiler NR- 200EK	1 Set		
7	Eyelet Buttonhole M/C 558- 31391	1 F		
8	Boring M/C	1 F		
9	Glinder	1 Set		
10	Belt Sander	1 Set		
11	Vice	3 Set		
12	Sets of Tool	5 Set		
	Total Amount			R.O. 55,000 (US$ 144,000)

Table 3-11 List of Facilities and Equipment for Garment Department, IRC

Phase: 3rd Stage (Testing Center)

Item	Article	Quantity	Unit Cost	Cost
1	Mechanical Equipment's	1 Set		
2	Laboratory Furniture & Facilities	1 Set		
3	Testing Instruments for Fiber & Products	1 Set		
4	Laboratory Apparatuses Chemical Testing	1 Set		
5	Laboratory Equipment's & Glass War	1 Set		
6	Chemicals	1 Set		
7	Testing Instruments for Fiber & Products	1 Set		
8	Laboratory Apparatuses for Chemical Testing	1 Set		
	Total Amount		R.O. (US$	337,000 886,800)

Table 3-12 List of Equipment for Packaging Technology Department

Phase: 2nd Stage

(Testers and Measuring Instruments for Packaging Material Quality Control)

No.	Description	Quantity	Estimated Cost
1	Ring Crash Tester	1 Set	
2	Mullen type Bursting Tester	1 Set	
3	Elmendorf type Tearing Tester	1 Set	
4	Strograph	1 Set	
5	Direct Reading Digital Haze Meter	1 Set	
6	Heat Gradient Tester Test for heat gradient	1 Set	
7	Folding Endurance Tester	1 Set	
8	Punclure Tester	1 Set	
9	Adhesion Tester	1 Set	
10	Precision Sample Cutter	1 Set	
11	Abrasion Resistance Tester	1 Set	
12	Friction Tester	1 Set	
13	Water Vapor Transmission Tester	1 Set	
14	Gas- chromatograph (TCD. FID) with Facility of Head Space Sampling	1 Set	
15	Ultrasonic Thickness Meter	1 Set	
16	Side wall Distribution Analyzer	1 Set	
17	Ramp Pressure Tester	1 Set	
18	Hot End Coating Meter	1 Set	
Total Amount			R.O. 175,000 (US$ 460,000)

Table 3-13 List of Equipment for Packaging Technology Department

Phase: 3rd Stage

(Testing Equipment for Transportation Packaging)

No.	Description	Quantity	Estimated Cost
1	Compression Tester	1 Set	
2	Vibration Test System	1 Set	
3	Shock Test System	1 Set	
4	Drop Tester	1 Set	
5	Electric Hook	1 Set	
6	Incline Impact Tester	1 Set	
7	Bump Tester	1 Set	
8	Acceleration Measuring System	1 Set	
9	Constant Temp.- humidity Chamber	1 Set	
10	Constant Low Temperature Chamber	1 Set	
11	Water Spray Test Chamber	1 Set	
12	Dynamic Compression Tester	1 Set	
13	Distribution Environmental Recording System	1 Set	
14	Scale	1 Set	
	Total Amount		R.O. 585,000 (US$ 1,540,000

Table 3-14 List of Equipment for Ceramic Raw Materials Research Unit

Phase : 1st Stage

No.	Description	Quantity	FOB Price
1	Pot Mill Set	2 Sets	
2	Standard Sieve Set	1 Set	
3	Filter Press	1 Set	
4	Moisture Tester	1 Set	
5	Hardness Tester	1 Set	
6	Drying Over	1 Set	
7	PH Meter	1 Set	
8	Viscosity Meter	1 Set	
9	Extruder with Vacuum System	1 Set	
10	Potter Wheel	2 Sets	
11	Electric Kiln with Automatic Controller	1 Set	
12	Table Balance	3 Sets	
13	Mortar Grinder	1 Set	
14	Stainless Steel Mortar with Pestle	3 Sets	
15	Portable Agitator	2 Sets	
16	Specimen Forming Press	1 Set	
17	Colorimeter	1 Set	
18	Magnetic Separator	1 Set	
19	Measuring Tools	1 Lot	
20	Miscellaneous Tools	1 Lot	
	Total Amount		R.O. 77,000 (US$ 202,000)

Table 3-15 List of Equipment for Gypsum Development Unit

Phase : 3rd Stage

No.	Description	Quantity	Estimated Cost
Sample Preparation			
1	Coarse Crusher	1	
2	Fine Crusher	1	
Preparation of Calcined Gypsum			
1	Electric Kiln	1	
2	Thermometer	1	
3	Calcined Gypsum Crusher	1	
Testing Equipment for Calcined Gypsum			
1	Electronic Balance	1	
2	Vicat Needle Apparatus	1	
3	Tensile Strength Tester	1	
4	Metal Mold for Strength Tester	2	
5	Measurement Tool for Specific Surface Area	1	
6	Miscellaneous Tools, Equipment and Chemicals		
	Total Amount		R.O. 14,000 (US$ 36,000)

Table 3-16 Estimated Economic Contribution of IRC

Garment Tech. Dept.

Cutting Center

- without IRC, the export garment industry will not be able to survive with formulation of NAFTA
- with IRC;
  1) the existing industry may improve their competitiveness and maintain the current operation level with maintaining the current share in the US market
  2) further expansion of their operation with acquiring the higher technology and penetrate into the mildly-high end market

	Contribution to GDP	Contribution to Exports	Contribution to Employment of Omani
- Current:	RO. 7.5 mil./yr.(*1)	RO. 24.5 mil./yr. (*2)	500 persons
- w/o IRC	RO. 1.5 mil./yr.	RO. 4.9 mil./yr.	100 persons
- w/ IRC	RO. 9.0 mil./yr.	RO. 29.4 mil./yr.	600 persons
- Contribution	RO. 7.5 mil./yr.	RO. 24.5 mil./yr.	500 persons

(Assuming 80% decrease w/o IRC, while 20% increase w/ IRC.)

Technical Guidance Unit

- Improvement of productivity by 15%

Contribution to GDP	Contribution to Exports	Contribution to Employment of Omani
- Reduction of input (or increase in value added) RO. 0.85 mil./yr. (or RO. 1.70 mil. in two years)		

(Assuming 7 companies to participate to the productivity improvement scheme every year for 2 years (i.e. 14 companies in total)

Training Center

1) increase in Omani employment with training as those related to CAD, maintenance, etc. besides keeping the present level

	Contribution to GDP	Contribution to Exports	Contribution to Employment of Omani
- Increase by			84 persons

(Assuming creation of employment of Omani as 2 CAD related operators and 2 maintenance engineers for each of 40% of the existing manufactures)

2) Accumulation of technical know-how at IRC which may be transferred to the industry

End-use testing Center

- Decrease in rejection rate through improvement of quality control

	Contribution to GDP	Contribution to Exports	Contribution to Employment of Omani
- Increase by:	RO. 0.19 mil./yr.		

(Assuming 2.5% of productivity improvement or 2.5% increase in value added.)

Food & Packaging Tech. Dept.

- Improvement of productivity through improvement of packaging method and decrease in rejection rate

	Contribution to GDP	Contribution to Exports	Contribution to Employment of Omani
- Increase by:	RO. 0.13 mil./yr.		

- Increase in export, or expansion of market through improvement of shelf-life with improvement of packaging

	Contribution to GDP	Contribution to Exports	Contribution to Employment of Omani
- Increase by:	RO. 0.88 mil./yr.	RO. 2.86 mil./yr.	

(Assuming 3% increase in production and export sales)

Non-metal Mineral R&D Dept.

Gypsum development

- Gypsum export

	Contribution to GDP	Contribution to Exports	Contribution to Employment of Omani
- Increase by:	RO. 1.60 mil./yr.	RO. 3.80 mil./yr.	2 persons (10.5% of increase in employment)

(Assuming 1 million tons of gypsum export at RO. 3.8/ton with total costs at RO. 2.2/ton every year.)

Ceramic raw material research

- Import substitution by local production using the local ceramic raw materials

	Contribution to GDP	Contribution to Exports	Contribution to Employment of Omani
- Increase by:	RO. 0.55 mil./yr.		
- Decrease in import by:		RO. 1.1 mil./yr.	

(Assuming 5,000 tons/year of increase in ceramic tile production besides the project under planning. The price of tile is assumed to be RO. 220/ton with value added ratio to value of finished goods at 0.5)

Notes:
(*1) 1993, Yearly Industrial Statistical Book
(*2) 1993, Foreign Trade Statistics

Table 3-17 Financial Projection for IRC (Total)

	Phase 1					Phase 2	Phase 3
Year of operation:	1	2	3	4	5		
Technical guidance							
- Man-hour utilization (% of available m/h)							
- Revenue (RO.)	10,200	16,900	16,900	10,200	10,200	13,500	20,300
Contract research							
- No. of contract							
- Revenue (RO.)	0	6,000	7,200	12,000	14,400	14,400	19,200
Contract testing							
- No. of tests							
- Revenue (RO.)	0	600	1,200	1,400	1,600	2,400	5,400
Others							
- Revenue (RO.)	124,000	148,900	168,700	170,300	170,300	313,500	313,500
Revenue	134,200	172,400	194,000	193,900	196,500	343,800	358,400
Managing Director	37,500	37,500	37,500	37,500	37,500	37,500	37,500
Director/ Chief Researcher	90,000	90,000	90,000	90,000	90,000	90,000	90,000
Researcher/ Advisor	45,000	45,000	45,000	45,000	45,000	112,500	180,000
Asst. Researcher	15,000	15,000	15,000	15,000	15,000	60,000	45,000
Trainee Researcher	27,000	27,000	27,000	27,000	27,000	45,000	99,000
Secretary	7,500	7,500	7,500	7,500	7,500	11,300	11,300
Admini. Staff	9,000	9,000	9,000	9,000	9,000	9,000	9,000
Engineering Service	0	0	0	0	0	9,000	9,000
Instructor	0	0	0	0	0	22,500	22,500
Operator	30,000	30,000	30,000	30,000	30,000	48,000	48,000
Direct labor costs	261,000	261,000	261,000	261,000	261,000	444,800	551,300
Maintenance costs	3,000	3,000	3,000	3,000	3,000	7,000	13,000
Utility costs							
- Electricity	22,800	22,800	22,800	22,800	22,800	42,700	57,600
- Water	1,100	1,100	1,100	1,100	1,100	2,100	2,500
- Communication	2,600	2,600	2,600	2,600	2,600	5,100	5,900
Spare parts & chemicals	4,700	4,700	4,700	4,700	4,700	10,800	20,600
Office supplies	800	800	800	800	800	1,600	1,900
Travel expenses	2,300	2,300	2,300	2,300	2,300	4,400	5,100
Transportation expenses	700	700	700	700	700	1,400	1,600
Other costs	3,500	3,500	3,500	3,500	3,500	6,800	9,500
Other operation costs	38,500	38,500	38,500	38,500	38,500	74,900	104,600
Total Costs & Expenses	302,500	302,500	302,500	302,500	302,500	526,700	668,900
Balance	-168,300	-130,100	-108,500	-108,600	-106,000	-182,900	-310,500
Building	25,000	21,400	18,400	15,800	13,500	17,100	23,200
Labo facilities & equipment	97,300	77,300	61,400	48,700	38,700	78,600	127,100
Office equipment, etc.	9,100	7,200	5,700	4,500	3,600	9,000	1,800
Depreciation total	131,400	105,900	85,500	69,000	55,800	104,700	152,100
Balance after depreciation	-299,700	-236,000	-194,000	-177,600	-161,800	-287,600	-462,600

Table 3-18(1) Financial Projection for Garment Tech Dept. (Total)

Year of operation:	Phase 1					Phase 2	Phase 3
	1	2	3	4	5		
Technical guidance							
- Man-hour utilization (% of available m/h)							
- Revenue (RO.)	6,800	10,100	10,100	3,400	3,400	0	0
Contract research							
- No. of contract							
- Revenue (RO.)	0	1,200	2,400	2,400	4,800	0	0
Contract testing							
- No. of tests							
- Revenue (RO.)	0	0	0	0	0	0	1,800
Others							
- Revenue (RO.)	121,600	144,100	159,100	159,100	159,100	302,300	302,300
Revenue	128,400	155,400	171,600	164,900	167,300	302,300	304,100
Managing Director	0	0	0	0	0	0	0
Director/ Chief Researcher	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Researcher/ Advisor	22,500	22,500	22,500	22,500	22,500	22,500	45,000
Asst. Researcher	0	0	0	0	0	0	0
Trainee Researcher	9,000	9,000	9,000	9,000	9,000	0	27,000
Secretary	0	0	0	0	0	0	0
Admini. Staff	0	0	0	0	0	0	0
Engineering Service	0	0	0	0	0	0	0
Instructor	0	0	0	0	0	22,500	22,500
Operator	30,000	30,000	30,000	30,000	30,000	48,000	48,000
Direct labor costs	91,500	91,500	91,500	91,500	91,500	123,000	172,500
Maintenance costs	2,700	2,700	2,700	2,700	2,700	5,900	12,600
Utility costs							
- Electricity	20,300	20,300	20,300	20,300	20,300	35,000	42,400
- Water	600	600	600	600	600	1,100	1,200
- Communication	1,400	1,400	1,400	1,400	1,400	2,600	3,000
Spareparts & chemicals	3,900	3,900	3,900	3,900	3,900	8,100	11,400
Office supplies	500	500	500	500	500	800	900
Travel expenses	1,200	1,200	1,200	1,200	1,200	2,200	2,500
Transportation expenses	400	400	400	400	400	700	900
Other costs	2,800	2,800	2,800	2,800	2,800	5,000	6,200
Other operation costs	31,100	31,100	31,100	31,100	31,100	55,500	68,500
Total Costs & Expenses	125,300	125,300	125,300	125,300	125,300	184,400	253,600
Balance	3,100	30,100	48,300	39,600	42,000	117,900	50,500
Building	18,900	16,200	13,900	11,900	10,200	7,300	100
Labo facilities & equipment	80,400	63,900	50,700	40,200	32,000	54,200	43,800
Office equipment, etc.	1,000	800	600	500	400	16,900	47,100
Depreciation total	100,300	80,900	65,200	52,600	42,600	78,400	91,000
Balance after depreciation	-97,200	-50,800	-18,900	-13,000	-600	39,500	-40,500

Table 3-18(2) Financial Projection for Cutting Center, Garment Tech Dept.

	Phase 1					Phase 2	Phase 3
Year of operation:	1	2	3	4	5		
Technical guidance							
- Man-hour utilization (% of available m/h)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- Revenue (RO.)	0	0	0	0	0	0	0
Contract research							
- No. of contract	0	0	0	0	0	0	0
- Revenue (RO.)	0	0	0	0	0	0	0
Contract testing							
- No. of tests	0	0	0	0	0	0	0
- Revenue (RO.)	0	0	0	0	0	0	0
Others							
- Revenue (RO.)	121,600	144,100	159,100	159,100	159,100	302,300	302,300
Revenue	121,600	144,100	159,100	159,100	159,100	302,300	302,300
Managing Director	0	0	0	0	0	0	0
Director/ Chief Researcher	30,000	30,000	30,000	30,000	30,000	0	0
Researcher/ Advisor	0	0	0	0	0	22,500	22,500
Asst. Researcher	0	0	0	0	0	0	0
Trainee Researcher	0	0	0	0	0	0	0
Secretary	0	0	0	0	0	0	0
Admini. Staff	0	0	0	0	0	0	0
Engineering Service	0	0	0	0	0	0	0
Instructor	0	0	0	0	0	0	0
Operator	30,000	30,000	30,000	30,000	30,000	42,000	42,000
Direct labor costs	60,000	60,000	60,000	60,000	60,000	64,500	64,500
Maintenance costs	2,500	2,500	2,500	2,500	2,500	4,300	6,800
Utility costs							
- Electricity	20,100	20,100	20,100	20,100	20,100	30,900	30,900
- Water	500	500	500	500	500	700	700
- Communication	1,200	1,200	1,200	1,200	1,200	1,700	1,700
Spare parts & chemicals	3,700	3,700	3,700	3,700	3,700	6,600	6,600
Office supplies	400	400	400	400	400	500	500
Travel expenses	1,000	1,000	1,000	1,000	1,000	1,400	1,400
Transportation expenses	300	300	300	300	300	500	500
Other costs	2,700	2,700	2,700	2,700	2,700	4,200	4,200
Other operation costs	29,900	29,900	29,900	29,900	29,900	46,500	46,500
Total Costs & Expenses	92,400	92,400	92,400	92,400	92,400	115,300	117,800
Balance	29,200	51,700	66,700	66,700	66,700	187,000	184,500
Building	18,600	16,000	13,700	11,700	10,100	7,300	0
Labo facilities & equipment	75,400	59,900	47,500	37,700	30,000	38,400	0
Office equipment, etc.	0	0	0	0	0	0	0
Depreciation total	94,000	75,900	61,200	49,400	40,100	45,700	0
Balance after depreciation	-64,800	-24,200	5,500	17,300	26,600	141,300	184,500

Table 3-18(3) Financial Projection for Garment Tech Dept. Excl. Cutting Center

	Phase 1					Phase 2	Phase 3
Year of operation:	1	2	3	4	5		
Technical guidance							
- Man-hour utilization (% of available m/h)	0.50	0.75	0.75	0.25	0.25	0.00	0.00
- Revenue (RO.)	6,800	10,100	10,100	3,400	3,400	0	0
Contract research							
- No. of contract	0	1	2	2	4	0	0
- Revenue (RO.)	0	1,200	2,400	2,400	4,800	0	0
Contract testing							
- No. of tests	0	0	0	0	0	0	18
- Revenue (RO.)	0	0	0	0	0	0	1,800
Others							
- Revenue (RO.)	0	0	0	0	0	0	0
Revenue	6,800	11,300	12,500	5,800	8,200	0	1,800
Managing Director	0	0	0	0	0	0	0
Director/ Chief Researcher	0	0	0	0	0	30,000	30,000
Researcher/ Advisor	22,500	22,500	22,500	22,500	22,500	0	22,500
Asst. Researcher	0	0	0	0	0	0	0
Trainee Researcher	9,000	9,000	9,000	9,000	9,000	0	27,000
Secretary	0	0	0	0	0	0	0
Admini. Staff	0	0	0	0	0	0	0
Engineering Service	0	0	0	0	0	0	0
Instructor	0	0	0	0	0	22,500	22,500
Operator	0	0	0	0	0	6,000	6,000
Direct labor costs	31,500	31,500	31,500	31,500	31,500	58,500	108,000
Maintenance costs	200	200	200	200	200	1,600	5,800
Utility costs							
- Electricity	200	200	200	200	200	4,100	11,500
- Water	100	100	100	100	100	400	500
- Communication	200	200	200	200	200	900	1,300
Spareparts & chemicals	200	200	200	200	200	1,500	4,800
Office supplies	100	100	100	100	100	300	400
Travel expenses	200	200	200	200	200	800	1,100
Transportation expenses	100	100	100	100	100	200	400
Other costs	100	100	100	100	100	800	2,000
Other operation costs	1,200	1,200	1,200	1,200	1,200	9,000	22,000
Total Costs & Expenses	32,900	32,900	32,900	32,900	32,900	69,100	135,800
Balance	-26,100	-21,600	-20,400	-27,100	-24,700	-69,100	-134,000
Building	300	200	200	200	100	0	100
Labo facilities & equipment	5,000	4,000	3,200	2,500	2,000	15,800	43,800
Office equipment, etc.	1,000	800	600	500	400	16,900	47,100
Depreciation total	6,300	5,000	4,000	3,200	2,500	32,700	91,000
Balance after depreciation	-32,400	-26,600	-24,400	-30,300	-27,200	-101,800	-225,000

Table 3-19 Financial Projection for Packaging Tech. Dept.

	Phase 1					Phase 2	Phase 3
Year of operation:	1	2	3	4	5		
Technical guidance							
- Man-hour utilization (% of available m/h)	0.25	0.50	0.50	0.50	0.50	1.00	1.50
- Revenue (RO.)	3,400	6,800	6,800	6,800	6,800	13,500	20,300
Contract research							
- No. of contract	0	2	2	4	4	8	12
- Revenue (RO.)	0	2,400	2,400	4,800	4,800	9,600	14,400
Contract testing							
- No. of tests	0	2	4	6	8	16	24
- Revenue (RO.)	0	200	400	600	800	1,600	2,400
Others							
- Revenue (RO.)	0	0	0	0	0	0	0
Revenue	3,400	9,400	9,600	12,200	12,400	24,700	37,100
Managing Director	0	0	0	0	0	0	0
Director/ Chief Researcher	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Researcher/ Advisor	0	0	0	0	0	22,500	45,000
Asst. Researcher	0	0	0	0	0	0	0
Trainee Researcher	9,000	9,000	9,000	9,000	9,000	18,000	36,000
Secretary	0	0	0	0	0	0	0
Admini. Staff	0	0	0	0	0	0	0
Engineering Service	0	0	0	0	0	0	0
Instructor	0	0	0	0	0	0	0
Operator	0	0	0	0	0	0	0
Direct labor costs	39,000	39,000	39,000	39,000	39,000	70,500	111,000
Maintenance costs	0	0	0	0	0	1,400	5,500
Utility costs							
- Electricity	200	200	200	200	200	2,100	5,900
- Water	100	100	100	100	100	200	300
- Communication	200	200	200	200	200	400	800
Spareparts & chemicals	0	0	0	0	0	1,900	8,100
Office supplies	100	100	100	100	100	100	200
Travel expenses	200	200	200	200	200	400	700
Transportation expenses	100	100	100	100	100	100	200
Other costs	100	100	100	100	100	500	1,600
Other operation costs	1,000	1,000	1,000	1,000	1,000	5,700	17,800
Total Costs & Expenses	40,000	40,000	40,000	40,000	40,000	77,600	134,300
Balance	-36,600	-30,600	-30,400	-27,800	-27,600	-52,900	-97,200
Building	300	200	200	200	100	3,100	6,100
Labo facilities & equipment	0	0	0	0	0	24,300	81,300
Office equipment, etc.	800	600	500	400	300	6,300	17,700
Depreciation total	1,100	800	700	600	400	33,700	105,100
Balance after depreciation	-37,700	-31,400	-31,100	-28,400	-28,000	-86,600	-202,300

Table 3-20(1) Financial Projection for Non-metal Minerals R&D Dept.

Year of operation:	Phase 1					Phase 2	Phase 3
	1	2	3	4	5		
Technical guidance							
- Man-hour utilization (% of available m/h)							
- Revenue (RO.)	0	0	0	0	0	0	0
Contract research							
- No. of contract							
- Revenue (RO.)	0	2,400	2,400	4,800	4,800	4,800	4,800
Contract testing							
- No. of tests							
- Revenue (RO.)	0	400	800	800	800	800	1,200
Others							
- Revenue (RO.)	0	0	0	0	0	0	0
Revenue	0	2,800	3,200	5,600	5,600	5,600	6,000
Managing Director	0	0	0	0	0	0	0
Director/ Chief Researcher	0	0	0	0	0	0	0
Researcher/ Advisor	22,500	22,500	22,500	22,500	22,500	22,500	45,000
Asst. Researcher	0	0	0	0	0	15,000	0
Trainee Researcher	9,000	9,000	9,000	9,000	9,000	9,000	18,000
Secretary	0	0	0	0	0	0	0
Admini. Staff	0	0	0	0	0	0	0
Engineering Service	0	0	0	0	0	0	0
Instructor	0	0	0	0	0	0	0
Operator	0	0	0	0	0	0	0
Direct labor costs	31,500	31,500	31,500	31,500	31,500	46,500	63,000
Maintenance costs	500	500	500	500	500	500	500
Utility costs							
- Electricity	1,300	1,300	1,300	1,300	1,300	1,400	3,200
- Water	100	100	100	100	100	100	200
- Communication	200	200	200	200	200	300	400
Spare parts & chemicals	800	800	800	800	800	800	1,000
Office supplies	100	100	100	100	100	100	200
Travel expenses	200	200	200	200	200	300	400
Transportation expenses	100	100	100	100	100	100	200
Other costs	300	300	300	300	300	300	600
Other operation costs	3,100	3,100	3,100	3,100	3,100	3,400	6,200
Total Costs & Expenses	35,100	35,100	35,100	35,100	35,100	50,400	69,700
Balance	-35,100	-32,300	-31,900	-29,500	-29,500	-44,800	-63,700
Building	2,900	2,500	2,100	1,800	1,600	100	3,000
Labo facilities & equipment	16,900	13,400	10,600	8,500	6,700	0	1,900
Office equipment, etc.	800	600	500	400	300	700	1,000
Depreciation total	20,600	16,500	13,200	10,700	8,600	800	5,900
Balance after depreciation	-55,700	-48,800	-45,100	-40,200	-38,100	-45,600	-69,600

Table 3-20(2) Financial Projection for Gypsum Unit, NMM Dept.

	Phase 1					Phase 2	Phase 3
Year of operation:	1	2	3	4	5		
Technical guidance							
- Man-hour utilization (% of available m/h)							
- Revenue (RO.)	0	0	0	0	0	0	0
Contract research							
- No. of contract						0	2
- Revenue (RO.)	0	0	0	0	0	0	2,400
Contract testing							
- No. of tests						0	4
- Revenue (RO.)	0	0	0	0	0	0	400
Others							
- Revenue (RO.)	0	0	0	0	0	0	0
Revenue	0	0	0	0	0	0	2,800
Managing Director	0	0	0	0	0	0	0
Director/ Chief Researcher	0	0	0	0	0	0	0
Researcher/ Advisor	0	0	0	0	0	0	22,500
Asst. Researcher	0	0	0	0	0	15,000	0
Trainee Researcher	0	0	0	0	0	0	9,000
Secretary	0	0	0	0	0	0	0
Admin. Staff	0	0	0	0	0	0	0
Engineering Service	0	0	0	0	0	0	0
Instructor	0	0	0	0	0	0	0
Operator	0	0	0	0	0	0	0
Direct labor costs	0	0	0	0	0	15,000	31,500
Maintenance costs	0	0	0	0	0	0	300
Utility costs							
- Electricity	0	0	0	0	0	100	1,900
- Water	0	0	0	0	0	0	100
- Communication	0	0	0	0	0	100	200
Spare parts & chemicals	0	0	0	0	0	0	200
Office supplies	0	0	0	0	0	0	100
Travel expenses	0	0	0	0	0	100	200
Transportation expenses	0	0	0	0	0	0	100
Other costs	0	0	0	0	0	0	300
Other operation costs	0	0	0	0	0	300	3,100
Total Costs & Expenses	0	0	0	0	0	15,300	34,900
Balance	0	0	0	0	0	-15,300	-32,100
Building	0	0	0	0	0	100	3,000
Labo facilities & equipment	0	0	0	0	0	0	1,900
Office equipment, etc.	0	0	0	0	0	200	500
Depreciation total	0	0	0	0	0	300	5,400
Balance after depreciation	0	0	0	0	0	-15,600	-37,500

Table 3-20(3) Financial Projection for Ceramic Unit, NMM Dept.

Year of operation:	Phase 1					Phase 2	Phase 3
	1	2	3	4	5		
Technical guidance							
- Man-hour utilization (% of available m/h)							
- Revenue (RO.)	0	0	0	0	0	0	0
Contract research							
- No. of contract	0	2	2	4	4	4	2
- Revenue (RO.)	0	2,400	2,400	4,800	4,800	4,800	2,400
Contract testing							
- No. of tests	0	4	8	8	8	8	8
- Revenue (RO.)	0	400	800	800	800	800	800
Others							
- Revenue (RO.)	0	0	0	0	0	0	0
Revenue	0	2,800	3,200	5,600	5,600	5,600	3,200
Managing Director	0	0	0	0	0	0	0
Director/ Chief Researcher	0	0	0	0	0	0	0
Researcher/ Advisor	22,500	22,500	22,500	22,500	22,500	22,500	22,500
Asst. Researcher	0	0	0	0	0	0	0
Trainee Researcher	9,000	9,000	9,000	9,000	9,000	9,000	9,000
Secretary	0	0	0	0	0	0	0
Admini. Staff	0	0	0	0	0	0	0
Engineering Service	0	0	0	0	0	0	0
Instructor	0	0	0	0	0	0	0
Operator	0	0	0	0	0	0	0
Direct labor costs	31,500	31,500	31,500	31,500	31,500	31,500	31,500
Maintenance costs	500	500	500	500	500	500	1,100
Utility costs							
- Electricity	1,300	1,300	1,300	1,300	1,300	1,300	1,300
- Water	100	100	100	100	100	100	100
- Communication	200	200	200	200	200	200	200
Spare parts & chemicals	800	800	800	800	800	800	800
Office supplies	100	100	100	100	100	100	100
Travel expenses	200	200	200	200	200	200	200
Transportation expenses	100	100	100	100	100	100	100
Other costs	300	300	300	300	300	300	300
Other operation costs	3,100	3,100	3,100	3,100	3,100	3,100	3,100
Total Costs & Expenses	35,100	35,100	35,100	35,100	35,100	35,100	35,700
Balance	-35,100	-32,300	-31,900	-29,500	-29,500	-29,500	-32,500
Building	2,900	2,500	2,100	1,800	1,600	0	0
Lebo facilities & equipment	16,900	13,400	10,600	8,500	6,700	0	0
Office equipment, etc.	800	600	500	400	300	500	500
Depreciation total	20,600	16,500	13,200	10,700	8,600	500	500
Balance after depreciation	-55,700	-48,800	-45,100	-40,200	-38,100	-30,000	-33,000

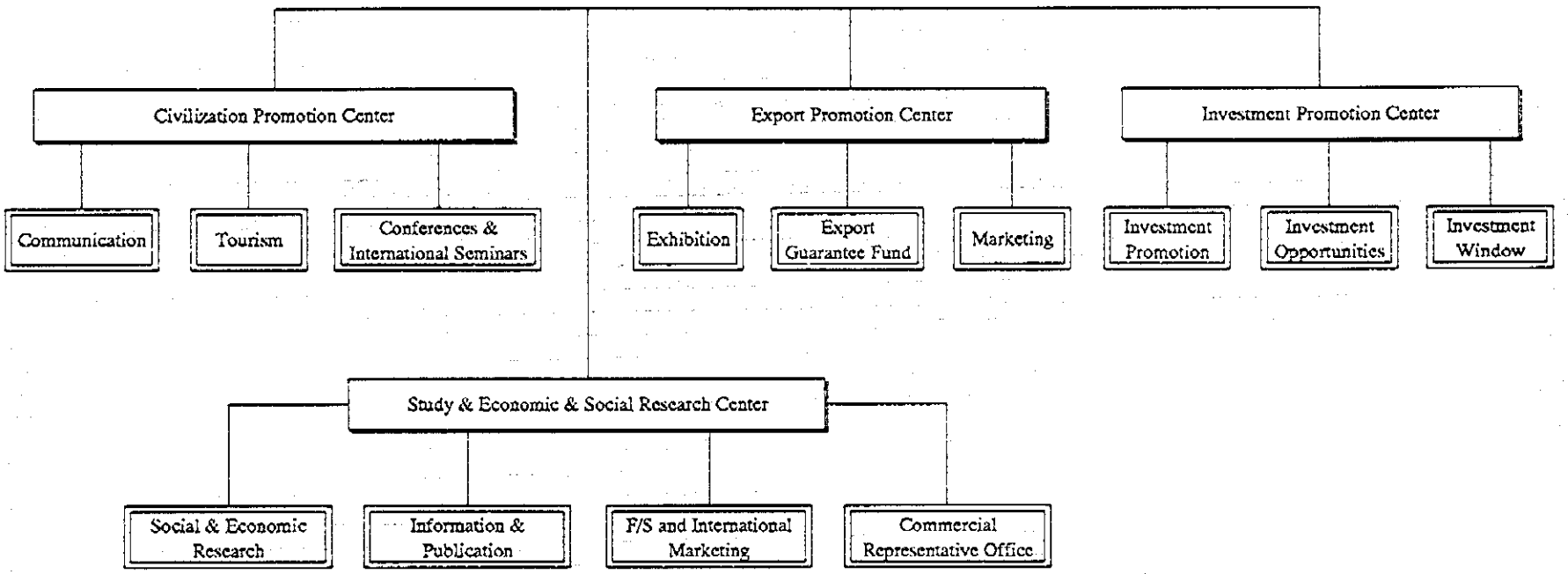
Table 3-21 Financial Projection for Research Planning & Coordination Dept.

	Phase 1					Phase 2	Phase 3
Year of operation	1	2	3	4	5		
Technical guidance							
- Man-hour utilization (% of available m/h)							
- Revenue (RO.)	0	0	0	0	0	0	0
Contract research							
- No. of contract							
- Revenue (RO.)	0	0	0	0	0	0	0
Contract testing							
- No. of tests							
- Revenue (RO.)	0	0	0	0	0	0	0
Others							
- Revenue (RO.)	2,400	4,800	9,600	11,200	11,200	11,200	11,200
Revenue	2,400	4,800	9,600	11,200	11,200	11,200	11,200
Managing Director	0	0	0	0	0	0	0
Director/ Chief Researcher	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Researcher/ Advisor	0	0	0	0	0	45,000	45,000
Asst. Researcher	15,000	15,000	15,000	15,000	15,000	45,000	45,000
Trainee Researcher	0	0	0	0	0	18,000	18,000
Secretary	0	0	0	0	0	3,750	3,750
Admini. Staff	0	0	0	0	0	0	0
Engineering Service	0	0	0	0	0	0	0
Instructor	0	0	0	0	0	0	0
Operator	0	0	0	0	0	0	0
Direct labor costs	45,000	45,000	45,000	45,000	45,000	141,750	141,750
Maintenance costs	0	0	0	0	0	100	300
Utility costs							
- Electricity	200	200	200	200	200	700	700
- Water	100	100	100	100	100	400	400
- Communication	200	200	200	200	200	1,000	1,000
Spareparts & chemicals	0	0	0	0	0	0	0
Office supplies	100	100	100	100	100	300	300
Travel expenses	200	200	200	200	200	900	900
Transportation expenses	100	100	100	100	100	300	300
Other costs	100	100	100	100	100	400	400
Other operation costs	1,000	1,000	1,000	1,000	1,000	4,000	4,000
Total Costs & Expenses	46,000	46,000	46,000	46,000	46,000	145,850	146,050
Balance	-43,600	-41,200	-36,400	-34,800	-34,800	-134,650	-134,850
Building	300	200	200	200	100	700	0
Labo facilities & equipment	0	0	0	0	0	0	0
Office equipment, etc.	800	600	500	400	300	2,200	2,200
Depreciation total	1,100	800	700	600	400	2,900	2,200
Balance after depreciation	-44,700	-42,000	-37,100	-35,400	-35,200	-137,550	-137,050

Table 3-22 Financial Projection for Common for all the Dept.

Year of operation:	Phase 1					Phase 2	Phase 3
	1	2	3	4	5		
Technical guidance							
- Man-hour utilization (% of available m/h)							
- Revenue (RO.)	0	0	0	0	0	0	0
Contract research							
- No. of contract							
- Revenue (RO.)	0	0	0	0	0	0	0
Contract testing							
- No. of tests							
- Revenue (RO.)	0	0	0	0	0	0	0
Others							
- Revenue (RO.)	0	0	0	0	0	0	0
Revenue	0	0	0	0	0	0	0
Managing Director	37,500	37,500	37,500	37,500	37,500	37,500	37,500
Director/ Chief Researcher	0	0	0	0	0	0	0
Researcher/ Advisor	0	0	0	0	0	0	0
Asst. Researcher	0	0	0	0	0	0	0
Trainee Researcher	0	0	0	0	0	0	0
Secretary	7,500	7,500	7,500	7,500	7,500	7,500	7,500
Admini. Staff	9,000	9,000	9,000	9,000	9,000	9,000	9,000
Engineering Service	0	0	0	0	0	9,000	9,000
Instructor	0	0	0	0	0	0	0
Operator	0	0	0	0	0	0	0
Direct labor costs	54,000	54,000	54,000	54,000	54,000	63,000	63,000
Maintenance costs	100	100	100	100	100	800	1,500
Utility costs							
- Electricity	400	400	400	400	400	1,900	1,900
- Water	200	200	200	200	200	300	300
- Communication	600	600	600	600	600	800	800
Spareparts & chemicals	100	100	100	100	100	1,200	2,400
Office supplies	200	200	200	200	200	200	200
Travel expenses	500	500	500	500	500	700	700
Transportation expenses	200	200	200	200	200	200	200
Other costs	200	200	200	200	200	500	700
Other operation costs	2,400	2,400	2,400	2,400	2,400	5,800	7,200
Total Costs & Expenses	56,500	56,500	56,500	56,500	56,500	69,600	71,700
Balance	-56,500	-56,500	-56,500	-56,500	-56,500	-69,600	-71,700
Building	600	600	500	400	300	1,800	0
Labo facilities & equipment	1,900	1,500	1,200	900	800	14,800	14,800
Office equipment, etc.	2,600	2,000	1,600	1,300	1,000	0	0
Depreciation total	5,100	4,100	3,300	2,600	2,100	16,600	14,800
Balance after depreciation	-61,600	-60,600	-59,800	-59,100	-58,600	-86,200	-86,500

Figure 3-1 Oman Promotion Board Planned by OCCI



Source : OCCI

Figure 3-2 Organization and Manpower Plan (Summary)

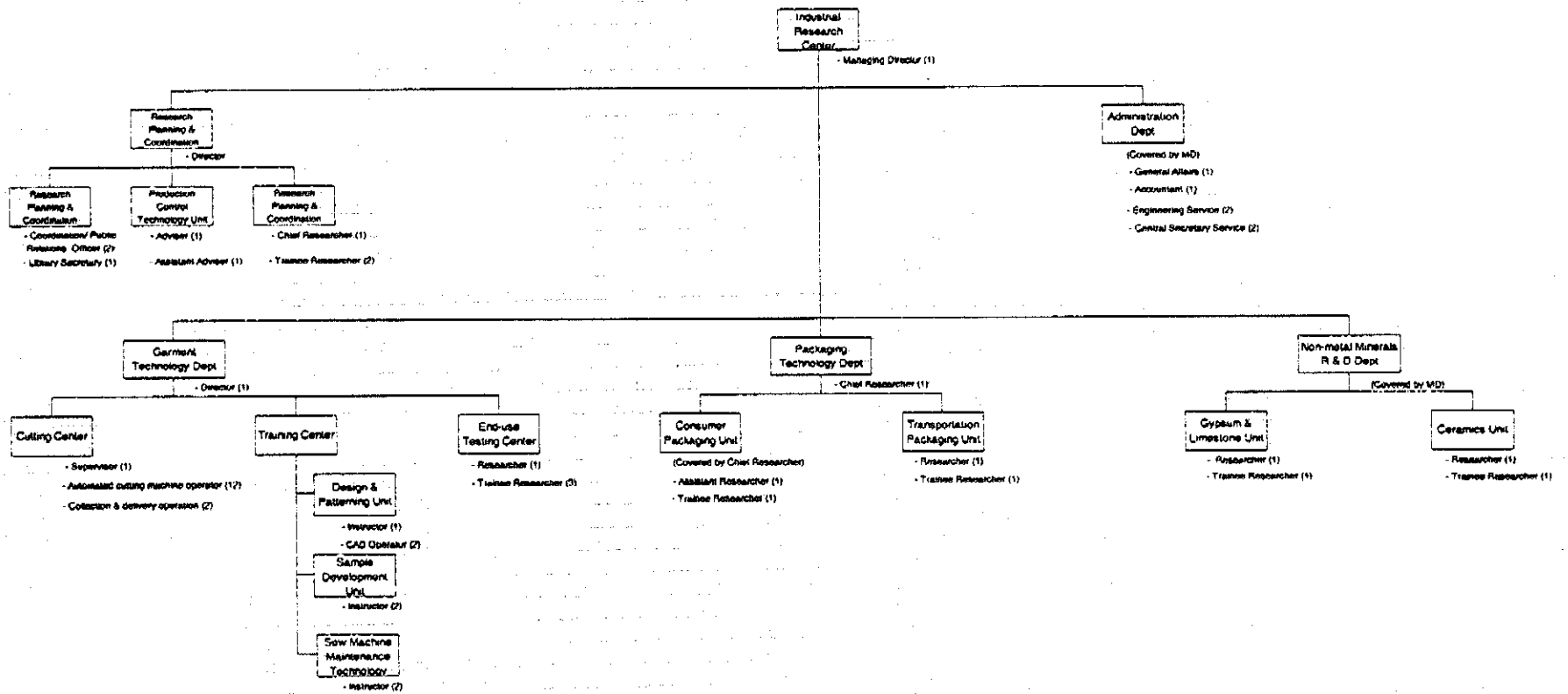


Figure 3-3(1)Organization and Manpower Plan for Garment Development

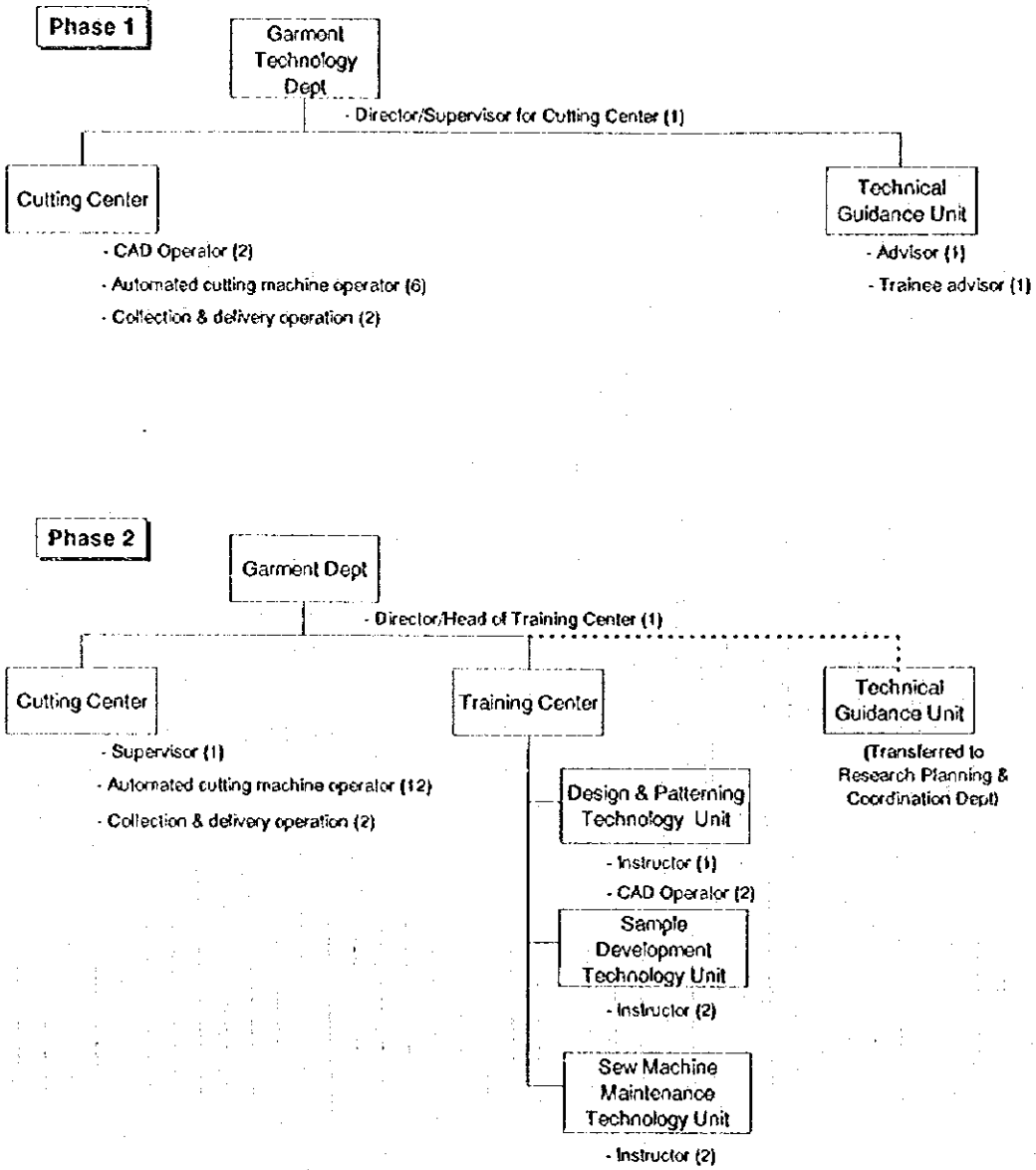


Figure 3-3(2)Organization and Manpower Plan for Garment Development

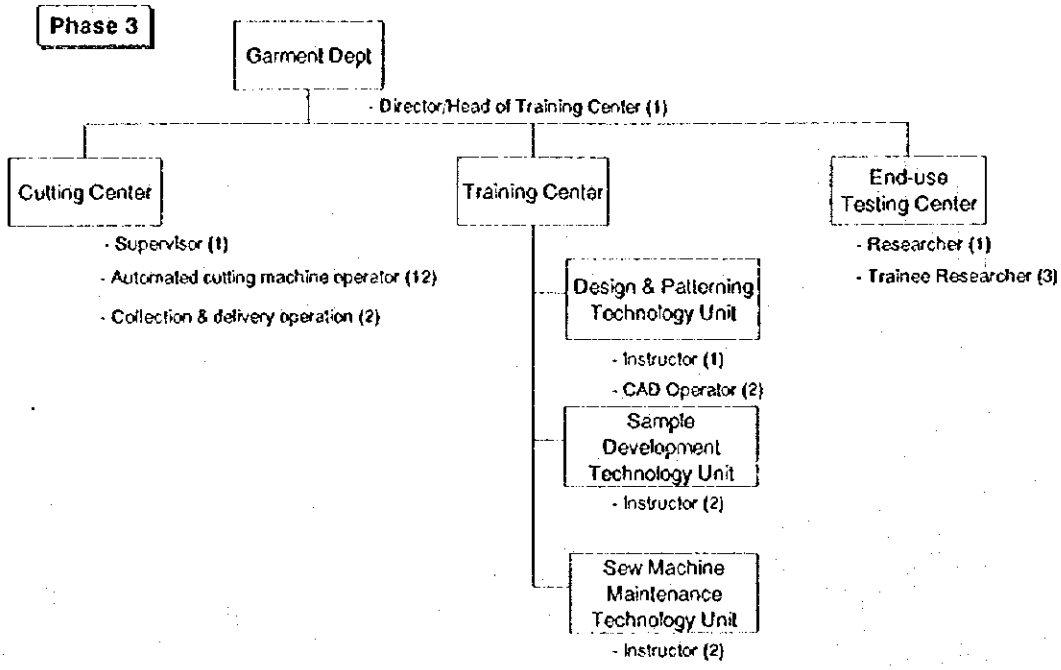


Figure 3-4 Organization & Manpower Plan for Packaging Technology Department

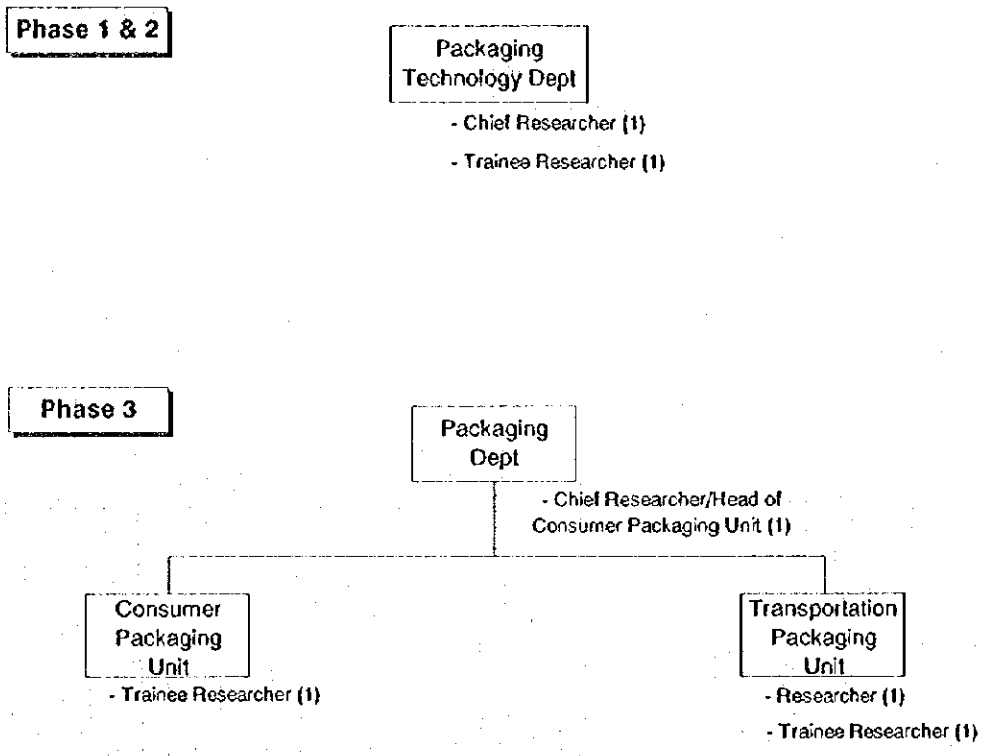


Figure 3-5 Organization and Manpower Plan for Non-metal Mineral Department

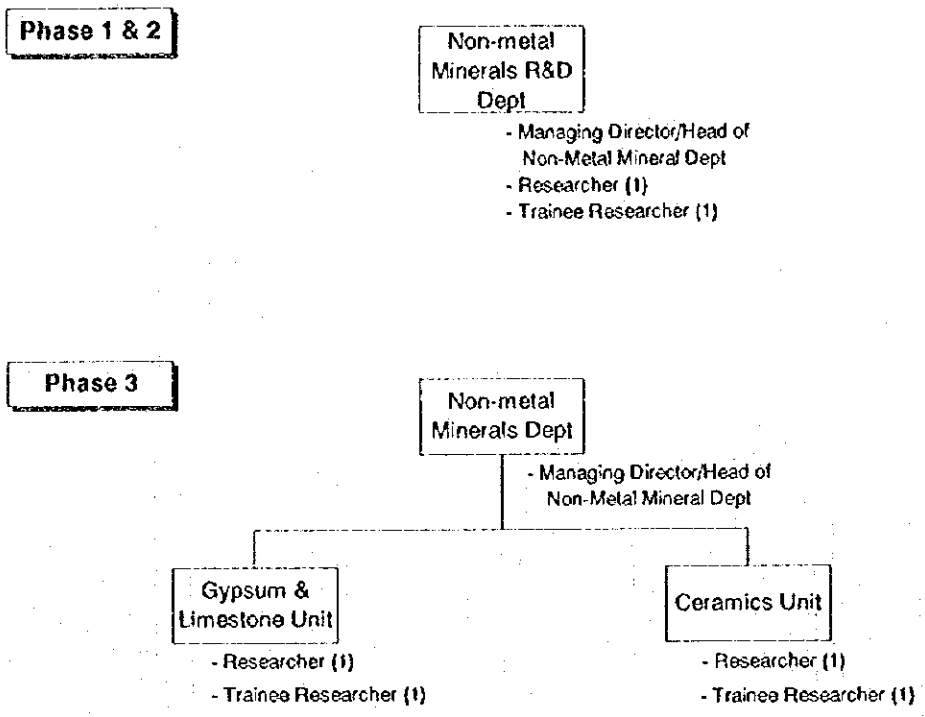
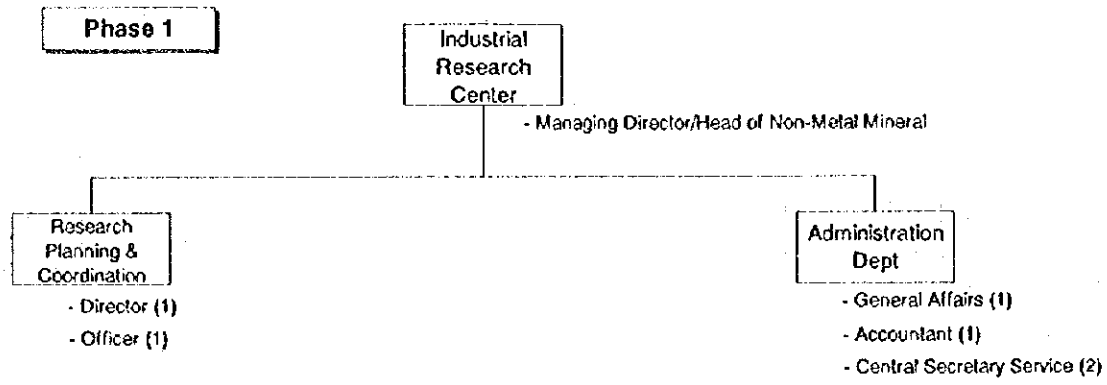


Figure 3-6 Organization and Manpower Plan for Management and Administration



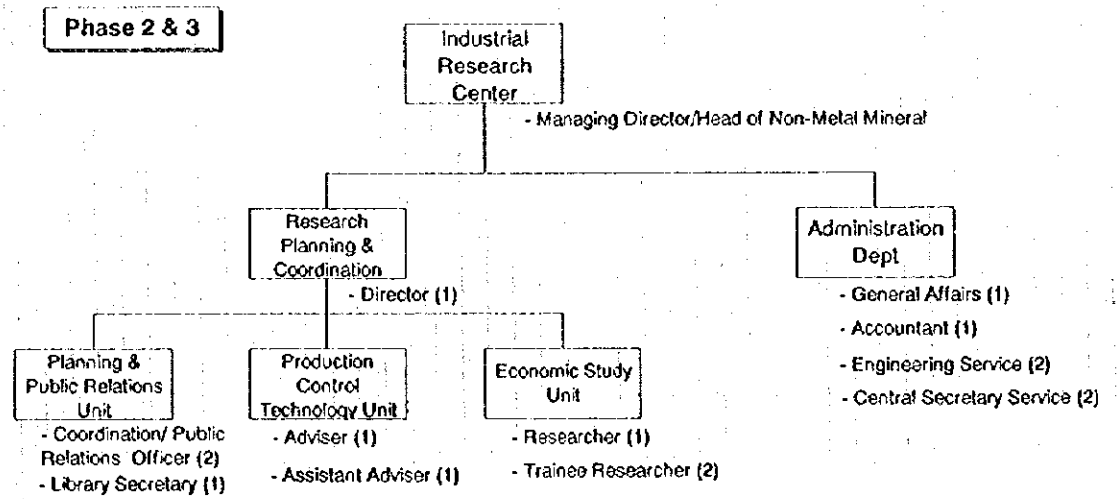
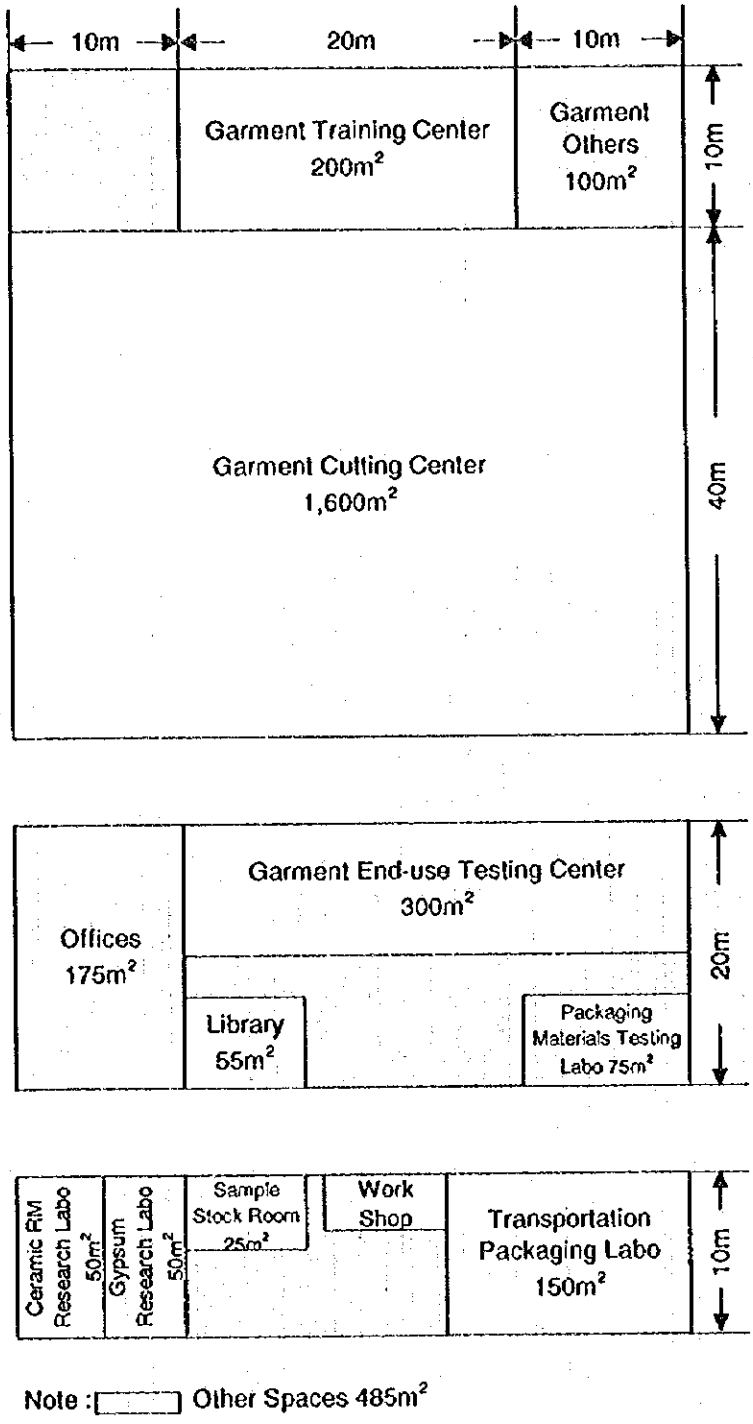


Figure 3-7 Space Plan for Industrial Research Center



Note : [ ] Other Spaces 485m²

Figure 3-8 SPACE PLAN FOR GARMENT TECHNOLOGY DEPARTMENT(Cutting Center and Training Center)

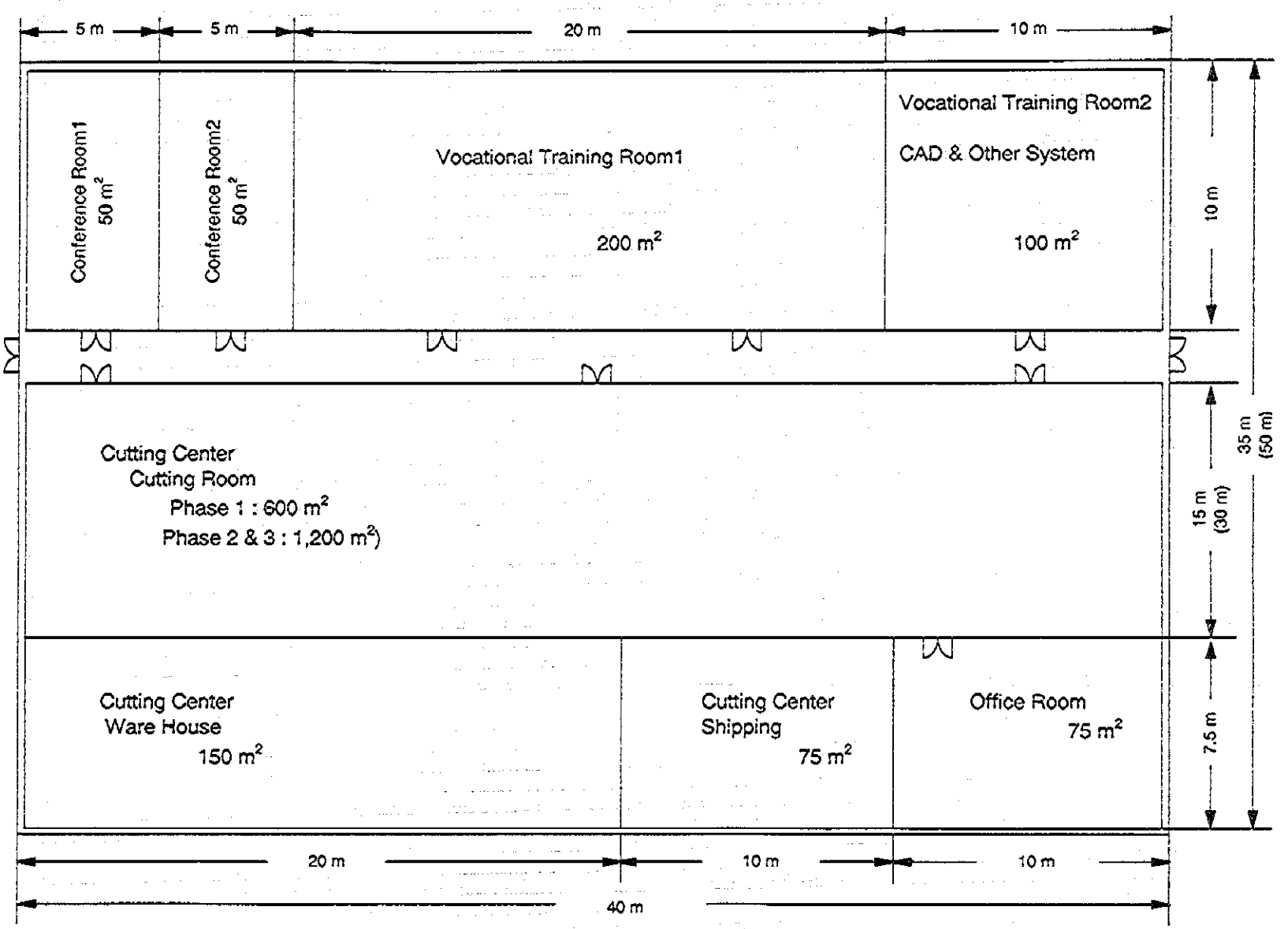


Figure 3-9 Space Plan for Garment Technology Department (Testing Center)

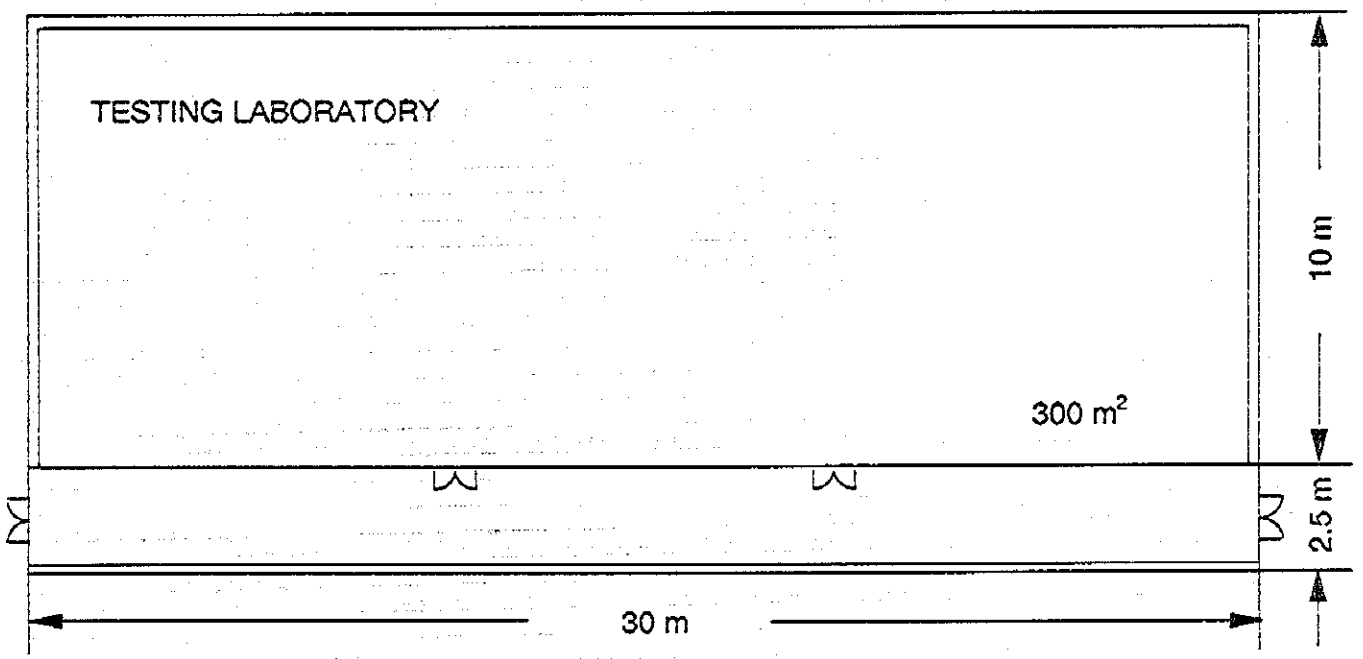
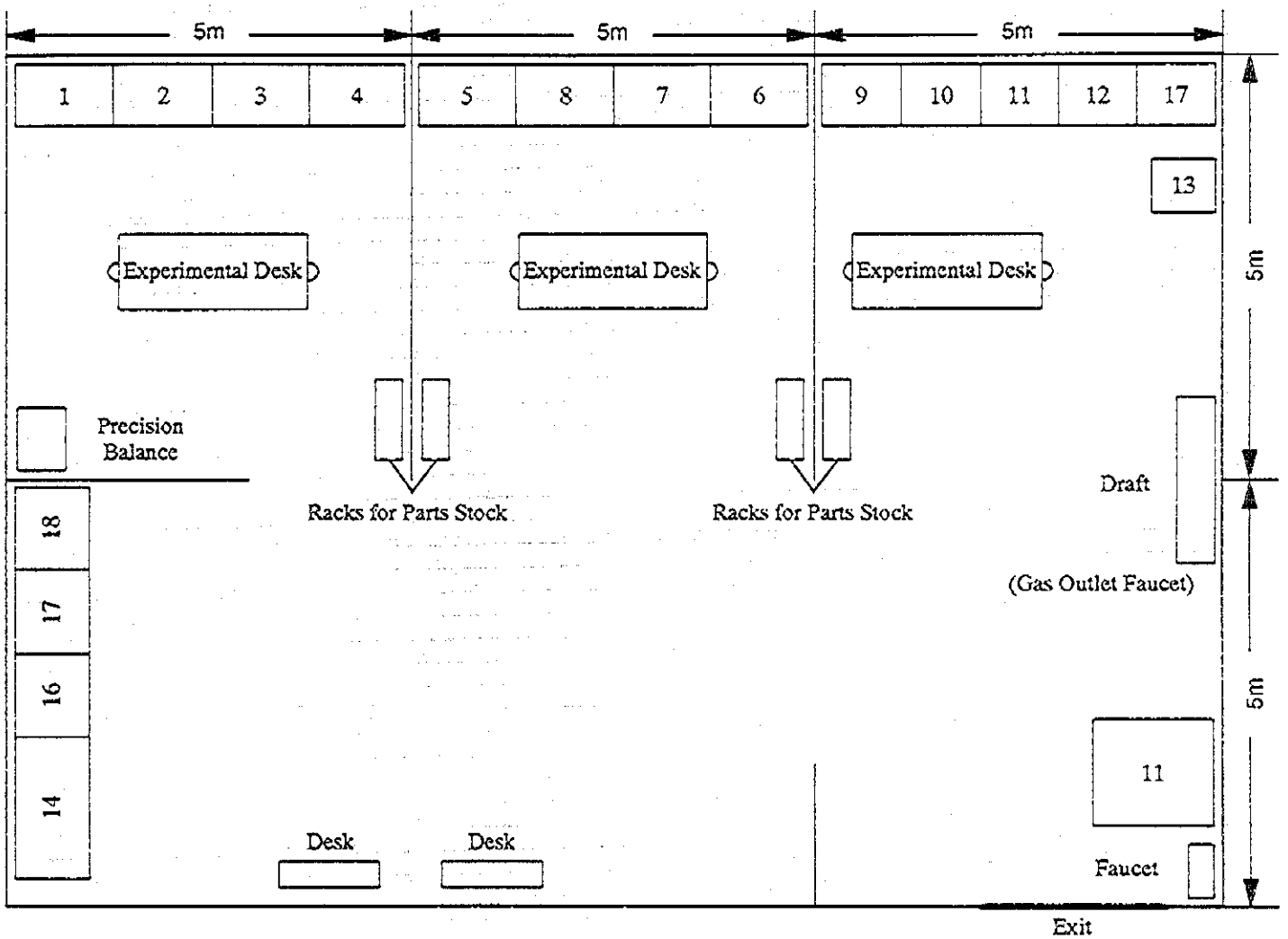


Figure 3-10 Space Plan for Packaging Department
(Laboratory for testers and measuring instruments for packaging material quality control)



Note: Figures mean the reference number of equipment in the list (Table 3-12).

Figure 3-11 Space Plan for Packaging Department
(Packaging facilities for sample development)

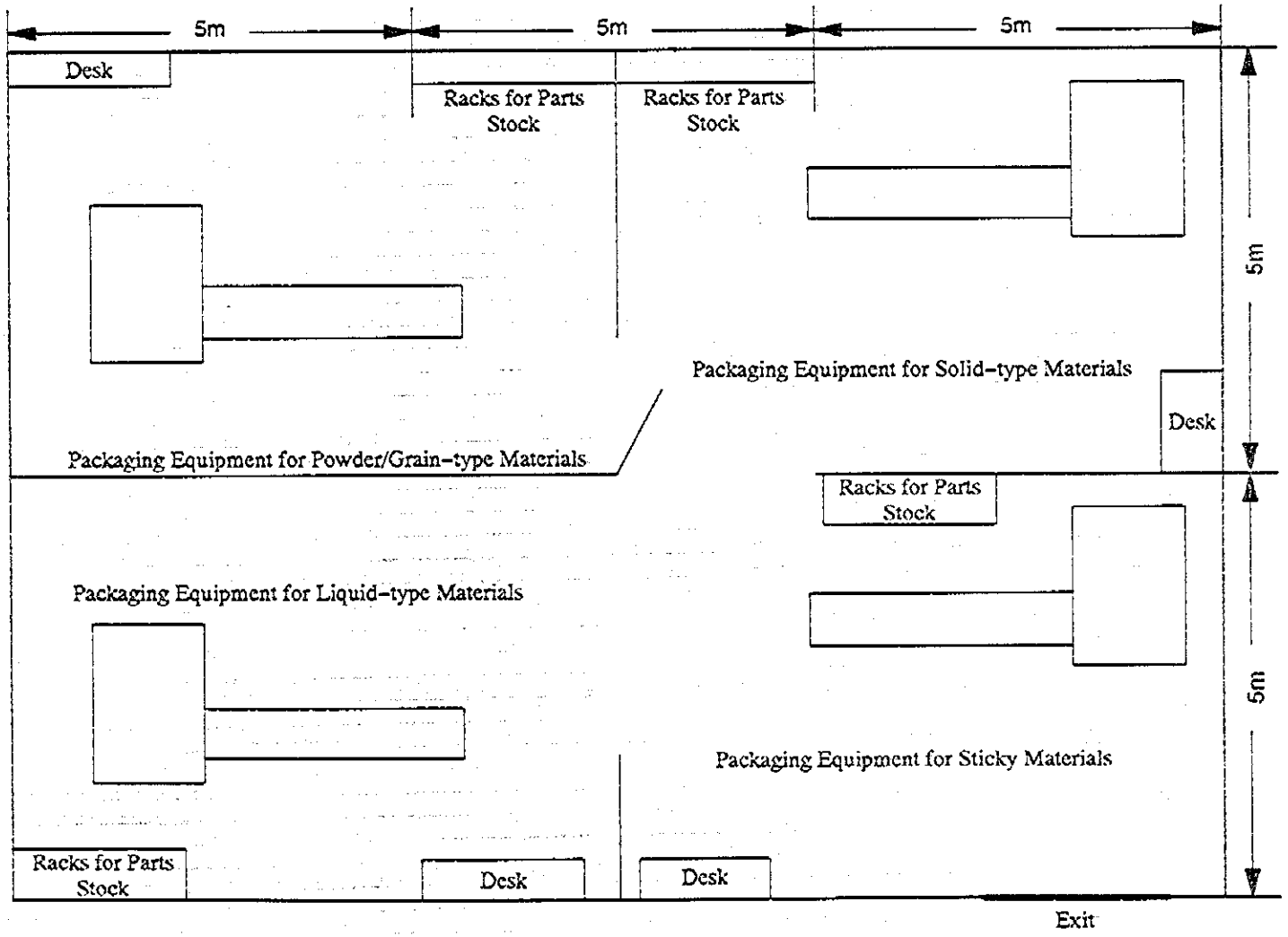
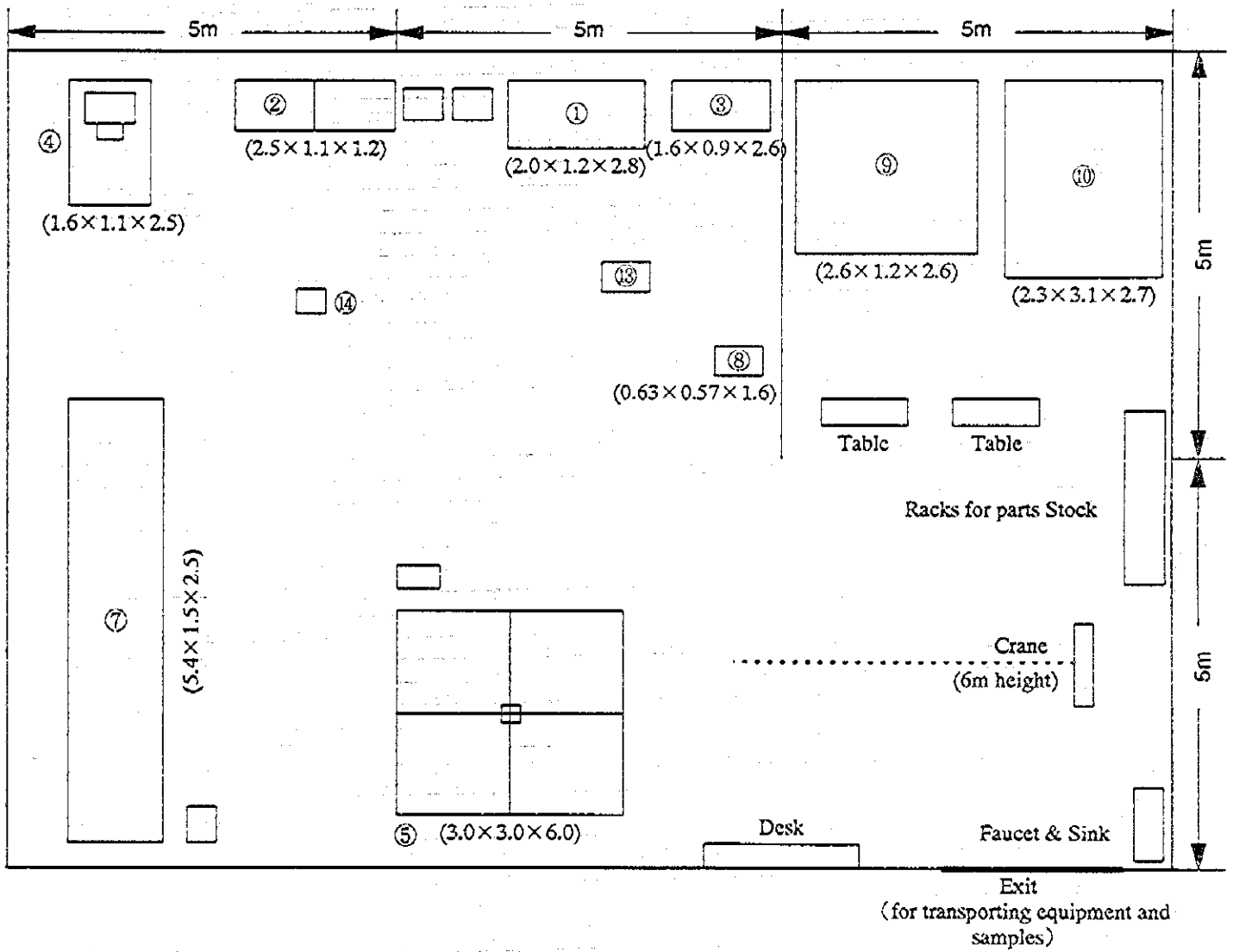
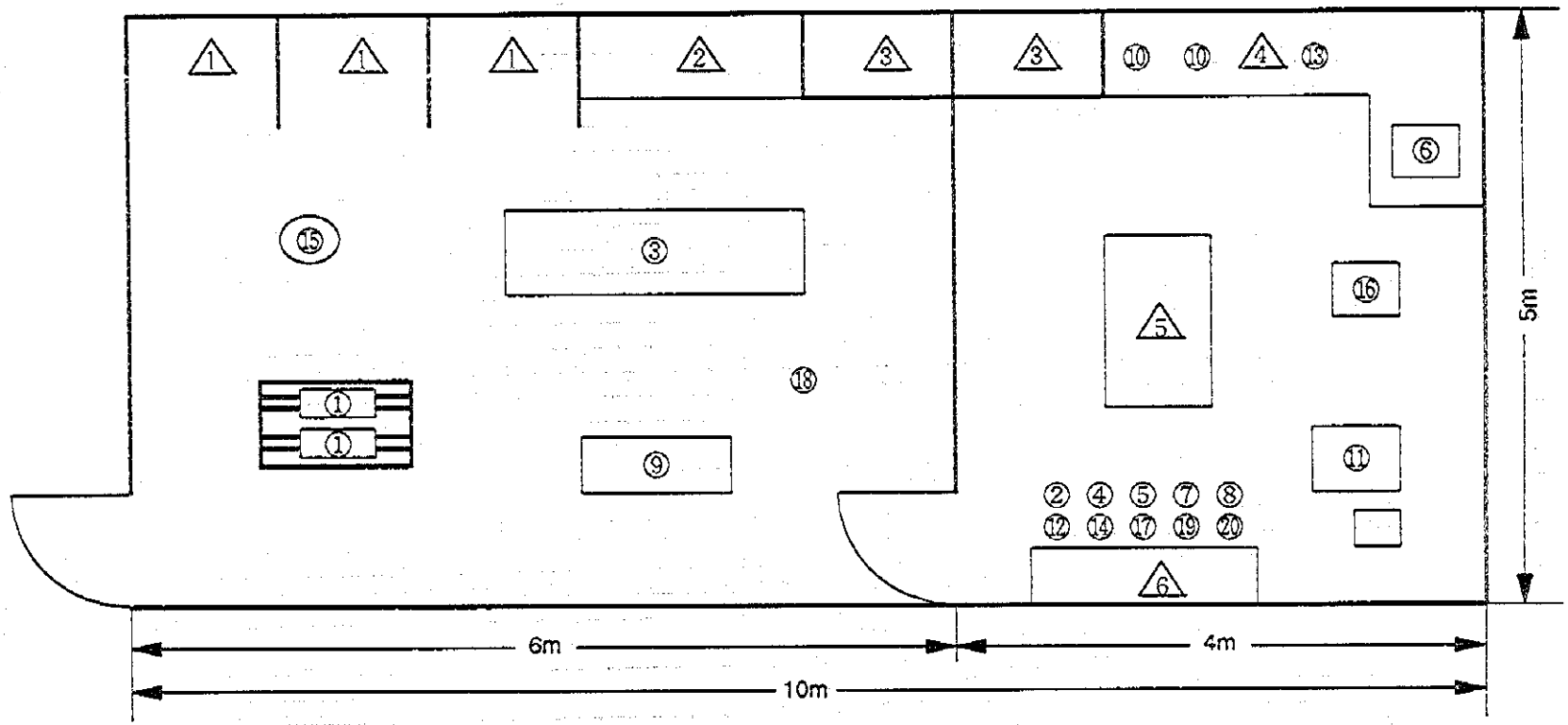


Figure 3-12 Space Plan for Packaging Department
(Testing laboratory for transportation packaging)



Note: Encircled numbers mean the reference number of testing equipment listed in Table 3-13.

Figure 3-13 SPACE PLAN FOR CERAMIC RAW MATERIALS RESEARCH UNIT



Facilities not Included in the List

- ① Stock place for raw materials
- ② Wooden shelf
- ③ Water tank
- ④ Concrete table
- ⑤ Working table
- ⑥ Wooden shelf

Equipment Included in the List

- ① Pot mill set
- ② Standard sieve set
- ③ Filter press
- ④ Moisture tester
- ⑤ Hardness tester
- ⑥ Drying over
- ⑦ PH meter
- ⑧ Viscosity meter
- ⑨ Extruder with vacuum system
- ⑩ Potter wheel
- ⑪ Electric kiln with automatic controller
- ⑫ Table balance
- ⑬ Mortar grinder
- ⑭ Stainless steel mortar with pestle
- ⑮ Portable agitator
- ⑯ Specimen forming press
- ⑰ Colorimeter
- ⑱ Magnetic separator
- ⑲ Measuring tools
- ⑳ Miscellaneous tools

Figure 3-14 SPACE PLAN FOR GYPSUM RESARCH UNIT