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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)  
MINISTRY OF COMMERCE AND INDUSTRY  
THE SULTANATE OF OMAN

**STUDY  
ON  
ESTABLISHMENT OF INDUSTRIAL RESEARCH CENTER  
IN  
THE SULTANATE OF OMAN**

**(SUMMARY)**

JULY 1996

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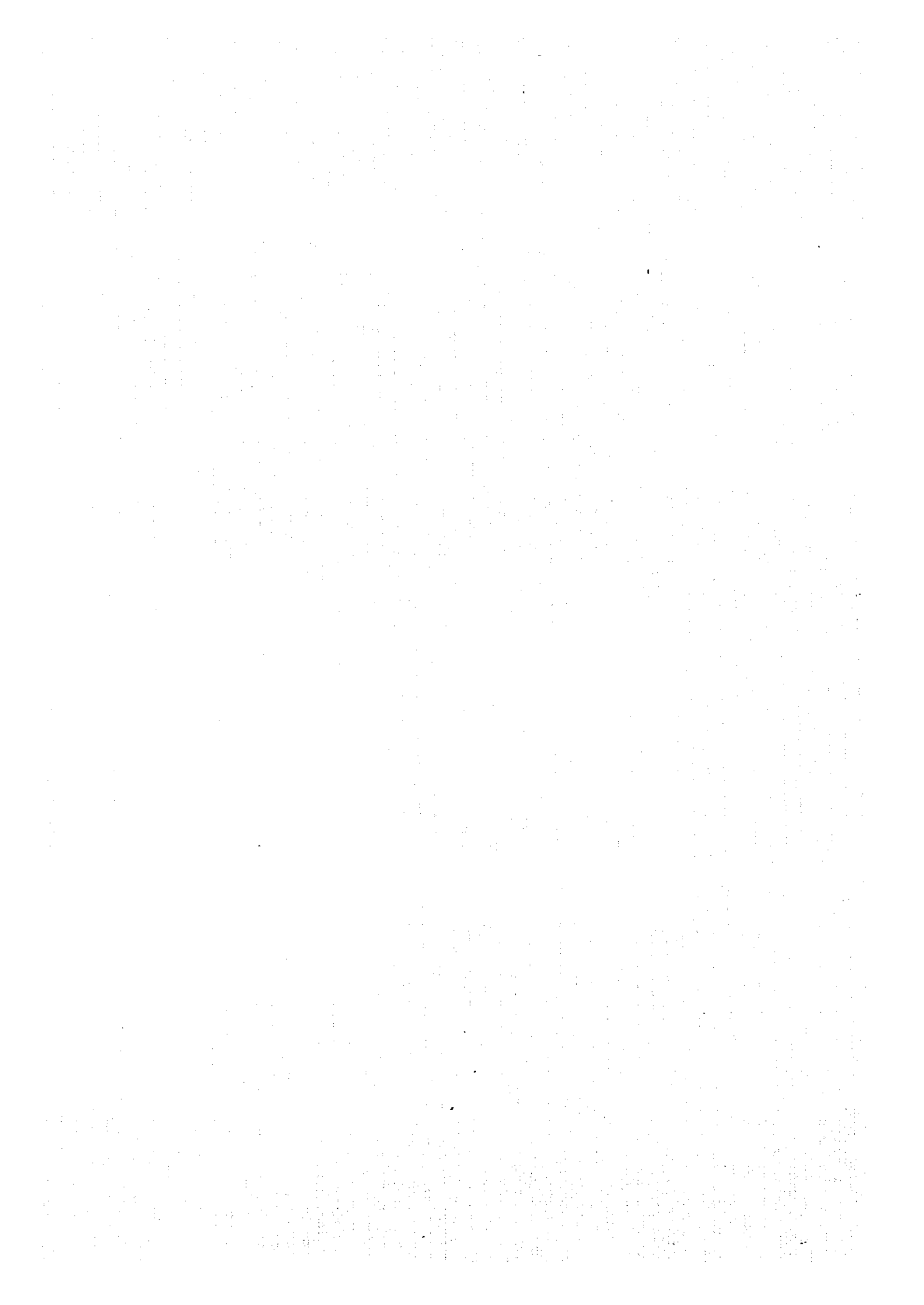
**UNICO INTERNATIONAL CORPORATION**

**TOKYO, JAPAN**

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## Abbreviations

ASEAN	Association of Southeast Asian Nations
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CSF	Common Service Facility
DGSM	Directorate General of Specifications and Measurement, MCI
F/S	Feasibility Study
GCC	Gulf Cooperation Council
GCF	Gross Capital Formation
GDP	Gross Domestic Product
GOIC	Gulf Organization for Industrial Consulting
HS	Harmonized Commodity Description and Coding System
IDD	Industrial Development Department
IRC	Industrial Research Center
IRR	Internal Rate of Return
ISIC	International Standard Industrial Classification
ITMF	International Textile Manufacture Federation
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
MCI	Ministry of Commerce and Industry
MFA	Multi-Fiber Arrangement
MPM	Ministry of Petroleum and Minerals
NAFTA	North American Free Trade Agreement
OCCI	Oman Chamber of Commerce and Industry
OJT	On the Job Training
PEIE	The Public Establishment for Industrial Estate
R&D	Research and Development
RO	Rial Omani
S/W	Scope of Work
SGRF	State General Reserve Fund
SITC	Standard International Trade Classification
SMI	Small and Medium Industry
SQU	Sultan Qaboos University
UAE	United Arab Emirates
US, USA	United States of America
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
PAMAP	The Public Authority for Marketing Agricultural Produce
OEM	Original Equipment Manufacture



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## Executive Summary

### 1 Industrial Research Center

The Industrial Research Center is a technical institute planned to be established under Ministry of Commerce and Industry (MCI) to provide technical support for promotion of industrial development in Oman in line with the industrial development strategy which will be adopted in the forthcoming Fifth Five Year Plan. The center is also planned to foster capacities to assimilate transferred technologies and accumulate technologies for further advancement.

#### **Need for technical support for industrial development in the Sultanate**

Oman has a relatively small market consisting of 2 million population and its natural resources are not large enough, in terms of variety and availability, to support sustainable growth of the economy. Thus, industrial development in Oman needs to go beyond the sectors relying on natural resources to resource-independent ones, while emphasizing industrial development on the basis of foreign demand in addition to domestic demand. In particular, industrial development using foreign demand as an impetus is a viable option in view of the country's locational advantages, including: (1) Oman being located midway between Africa and Southwest Asia and one of the few countries facing the ocean in the Middle East; and (2) inflow of container cargoes to the Middle East is much larger than outflow, so that container-based exports show a relative advantage over geographical distance.

To promote industrial development based on the above strategy, technical support for the industrial sector is essential for the following purposes:

- 1) **Effective use of domestic resources:** To fully utilize domestic resources in the industrial development process, technical and economic information on the available possibilities of resource utilization is indispensable in addition to quantitative information on endowment of resources. Without such information, development projects cannot progress beyond the initial planning stage.
- 2) **Selection of adequate products and technologies:** The industrial sector of the Sultanate totally depends on technology transferred from overseas. Successful selection of technology, therefore, hinges on availability of adequate information on viable technology and the ability to select the optimum technology from among various options. Also, technical and economic information related to products and their markets enables selection of appropriate projects. As a variety of projects is expected to emerge,

including smaller ones and non-resource types, business enterprises and investors who do not have access to the above information will participate in such projects, and technical support will play an increasingly important role. This also applies to the improvement of existing enterprises including the removal of constraints on growth.

3) **Improvement in competitiveness:** Traditionally, industrial production in Oman has focussed on import substitution that is, principally served the domestic market. Price and non-price competitiveness - prerequisite to penetration of products to foreign markets - has not been given of high priority. On the other hand, garment products - one of the country's major export items - are losing international competitiveness. Introduction of advanced production systems through mechanization as well as productivity and quality improvement efforts are called for to transform the existing industrial base into the one having export potential.

4) **Technology improvement and development:** Although the seeds of technology improvement have germinated in the process of assimilating imported technology, they have not been materialized, so that the first-generation technology remains without much improvement and alone forms the foundation of manufacturing industries in the Sultanate. As existing technologies easily become obsolete and enterprises using them lose competitiveness, new technology must be imported and assimilated. The time has come for Oman to build up technical capabilities that will enable the sultanate to effectively absorb foreign technologies and use them as the basis of developing indigenous technologies.

#### **Major activities of the Center**

The Center should be started as a nucleus to be experimented 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 activities 1) and 2) above.

The functions and activities of the Center were defined in consideration of the functions and activities to be carried out by other relevant institutions as well as IDD so that the Center can fulfill its tasks without duplication while providing complementary functions.

### **Target technology fields of the Center and technical support services**

While a wide range of industrial subsectors has emerged in response to import substitution policy, they have failed to reach critical mass as an integrated industrial base. This implies that the Center must meet a variety of needs in many subsectors, each of which is fairly small in terms of user base. This prohibits the Center from dealing with every technical field with equal weight. Instead, the Center should select target technology fields that enable the effective use of its resources.

The target technology fields must be selected in consideration of their importance in the country's industrial development strategy and the need for technical support. From the viewpoint of industrial development strategy, the immediate focus should be placed on 1) technology fields where new projects can be developed by using domestic resources, and 2) technology fields which are related to the development of industries that primarily serve foreign markets. Based on these principles, the following four areas have been selected as target technology fields.

#### **(1) Garment technology**

**Status of industry:** The export garment industry accounts for approximately 18% of non-petroleum commodity exports (value basis) of the Sultanate. However, the industry would have been unable to attract the interest of foreign buyers to the US market, unless the sultanate has been allocated quota by the US. Also, the industry is facing difficulty as creation of NAFTA has resulted in inflow of products not subject to the quota system into the US.

#### **Direction of technical support:**

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

#### **Technical supports provided**

##### **Phase 1**

- 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 services to the garment industry:

- a) Experimental services for development of new mechanized operations to replace the presently practiced manual operations.
- 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-based operation among the industry.

(The costs of the Center will be paid partly by service charges collected from the beneficiaries and partly subsidized with the government budget during the initial phase, but it is to be privatized eventually for independent operation with the participation of the industry.)

- 2) 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 test services for consumption performance of apparel products manufactured in Oman.

### (2) Packaging technology

**Status of industry:** The food industry, which is the major industry using packaging, 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 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 focus the technical assistance on the packaging related to food industry, in order to provide the food industry (existing as well as new establishments) with a technical data base on advanced packaging technology, thereby 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 those for exports, in order to satisfy buyer's 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 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 as requested, 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 become the Consumer Packaging Unit.

**(3) Non-metal mineral resources development and research**

**Status of Industry:** Among the non-metal mineral resources, gypsum and lime are one of most promising resources. 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 decision prevents development projects from proceeding beyond the inception stage.

Another prospective area of development based on non-metal minerals is ceramic production. 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.

**Direction of technical support:**

- 1) To carry out developmental research for economic utilization of prospective non-metal mineral resources available in Oman, thereby preparing the technical information and data base needed to promote investment for the development of industry based on those resources as well as commercial exploitation of the resources. As the basis for carrying out such research work, the Center will have close coordination with the Ministry of Petroleum and Minerals (MPM) for basic exploration surveys which should be one of the MPM's function.
- 2) At the initial stage, to focus on such research activities as required for the development of ceramic raw materials.

**Technical support provided:**

Phase 1

- 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.
- 2) Compilation of such research results for dissemination to potential investors.

Phase 2 & 3

- 1) As for raw materials for ceramic industry, if Phase 1 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) Expand such research work on 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 Outline of the Center

### Technical services to be provided

A. Technology Transfer (Technical Guidance)	1) Collection of technical and market information
(1) Collection and provision of technical and market information	2) Provision of opportunity for exchange of information
(2) Testing service	1) Technical consultancy service
(3) Technical consultancy and guidance service	2) Technical guidance service
(4) Provision of facilities and equipment	3) Assistance for product sample development
B. Research and Development	- As common service facilities
C. Human Resource Development	- Own research for use of natural resource
	- Training for garment designing, etc.

### Organizational structure and manpower assignment

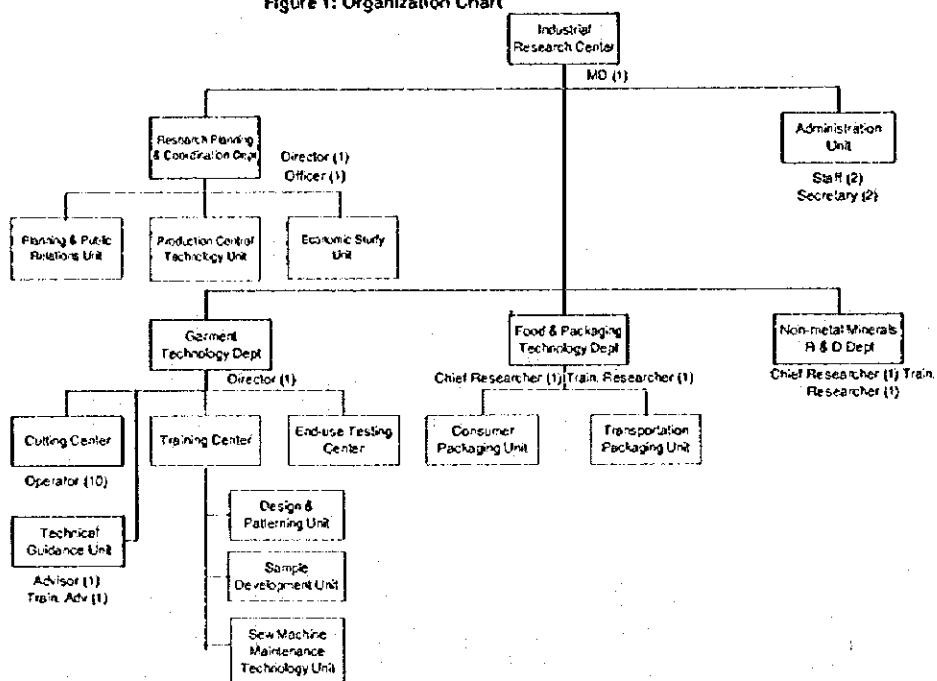
The Center will have the following departments at the initial stage of its operation: Garment Technology Department, Packaging Technology Department, and Non-metal Minerals R&D Department. In addition, the Center will have the Research Planning and Coordination Department to provide service for technology fields other than those served by the three departments. The addition of technology fields in the future will be decided in consideration to the actual progress of industrial development and its direction.

Table 1: Manpower Plan

(Unit : person)

	Phase 1	Phase 2	Phase 3
Managing Director/Director/Chief Researcher	4	4	4
Key Technical Staff	3	5	8
Trainee Researcher	3	4	9
Secretary/Administration Staff	4	7	7
Operation Staff	10	21	21
Total	24	41	49

Figure 1: Organization Chart



Notes: Block with thick line means the organizations in Phase 1.  
Manpower assignment shown is for Phase 1 only

Table 2: Technical Services to be Provided by Department  
(Phase 1)

(1) Garment Technology Dept.

- Cutting Center
  - 1) Contract service for pattern making process and sewing preparation process
  - 2) Technical guidance
- Technical guidance
  - 1) Technical guidance of production control technology
  - 2) Collection and provision of technical information
  - 3) Technical consultation

(2) Packaging Technology Dept.

- 1) Collection and provision of information
- 2) Technical consultation and guidance
- 3) Contract testing (to be entrusted to DGSM laboratory)

(3) Non-metallic Mineral R&D Dept.

- 1) Development research of ceramic raw materials
- 2) Technical consultation and guidance on ceramics production
- 3) Contract testing (to be entrusted to MPM laboratory)



### Required capital for establishment and expansion

It is assumed that the Center will use facilities and equipment of other institutes, as far as practicable, to avoid duplication in investment. In particular, the Center may entrust a part of its testing activities to the following institutes:

- 1) MPM Lab for analysis of non-metal minerals
- 2) Central Lab of DGSM for analysis of food materials

**Table 3: Required Capital for Establishment and Expansion**

	in Rial Omani			in US dollars		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
(1) Building construction costs	176,000	163,500	221,500	453,200	430,300	582,900
(2) Labo facilities & equipment						
1) Garment Technology Dept.						
a) Cutting Center						
- Automated cutting spreading M/C	301,000	296,000	0	792,100	778,900	0
- CAD system	65,000	0	0	171,100	0	0
b) Technical Guidance Unit						
- PC production management system	14,000	0	0	36,800	0	0
- PC filing system	10,500	0	0	27,600	0	0
c) Training Center						
- Fashion design system	0	32,500	0	0	85,500	0
- M/C for sample development	0	31,000	0	0	81,600	0
- M/C for mechanization	0	58,500	0	0	153,900	0
d) Garment end-use testing center	0	0	337,000	0	0	886,800
2) Packaging Technology Dept.						
a) Packaging materials test labo	0	187,000	0	0	492,100	0
b) Transportation packaging labo	0	0	626,500	0	0	1,648,700
3) Non-metal Mineral Research Dept.						
a) Gypsum development research labo	0	0	15,000	0	0	39,500
b) Ceramic raw material research labo	82,000	0	0	215,800	0	0
Total	472,500	605,000	978,500	1,243,400	1,592,000	2,575,000
(3) Office equipment, etc.	44,000	69,000	14,000	115,800	181,600	36,800
Total	692,500	837,500	1,214,000	1,822,400	2,203,900	3,194,700

### **3 Institutional setup and management**

#### **Institutional setup**

While the Center's activities should basically follow MCI's industrial development policy, they should be independent from all government agencies to ensure flexibility in action and the ease of securing and maintaining manpower. In particular, it should be given of autonomy in the areas of employment, and salary and wage determination.

Nevertheless, the Center should preferably be managed in line with the government industrial development policy. For this purpose, a steering committee should be formed, chaired by an executive of MCI and consisting of representatives of the interested parties<sup>1</sup>. The committee will set forth the basic direction of the Center's operation and at the same time assist the Center to obtain extensive support from related organizations so as to ensure the maximum use of the Center's service in the industrial development process.

#### **Technical staff**

Unfortunately, it is still difficult to recruit key technical staff for the Center in the country. They should therefore be invited or recruited from abroad at the initial stage of the Center's operation, and Omani staff should be increased step by step. For this purpose, trainee staff will be employed.

#### **Financial outlook**

Except for the Cutting Center of the Garment Department, expected revenues in other departments will not be able to cover required operation costs and expenses. In fact, the Center's expenditures are expected to exceed its revenues by RO.168,300 in the initial year, and by RO.108,500 in the third year.

The plan assumes that the Center will charge and collect fees for their services from the beneficiaries (users). Collection of service fees, however, will face difficulty since the government has been providing its service for free of charge. Thus, it is recommended to start service-for-pay in the areas where service produces direct and tangible benefits, such as the Cutting Center's service and contract testing service, followed by gradual expansion into other areas.

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<sup>1</sup> To expect the maximum results from R&D activities, autonomy of R&D departments must be ensured as far as practicable. As industrial development progresses, government control over management of the Center should be reduced gradually. For the time being, however, management policy should be aligned with government policy to ensure the effective use of limited resources (manpower and fund) and to accomplish the immediate objective, and the steering committee will serve as a powerful instrument for the purpose.

Table 4: Financial Projection for the IRC

(Unit: RO.)

	Phase 1					Phase 2	Phase 3
	1	2	3	4	5		
Garment Tech. Dept.							
- Cutting Center	121,600	144,100	159,100	159,100	159,100	302,300	302,300
- Other services	6,800	11,300	12,500	5,800	8,200	0	1,800
(Total)	128,400	155,400	171,600	164,900	167,300	302,300	304,100
Packaging Tech. Dept.	3,400	9,400	9,600	12,200	12,400	24,700	37,100
Non-metal Mineral R&D Dept.	0	2,800	3,200	5,600	5,600	5,600	6,000
Research Plan/Coordination	2,400	4,800	9,600	11,200	11,200	11,200	11,200
<b>Revenue Total</b>	<b>134,200</b>	<b>172,400</b>	<b>194,000</b>	<b>193,900</b>	<b>196,500</b>	<b>343,800</b>	<b>358,400</b>
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
Other operational costs	38,500	38,500	38,500	38,500	38,500	74,900	104,600
<b>Operation Costs/Expenses Tot</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>526,700</b>	<b>668,900</b>
<b>Balance</b>	<b>-168,300</b>	<b>-130,100</b>	<b>-108,500</b>	<b>-108,600</b>	<b>-106,000</b>	<b>-182,900</b>	<b>-310,500</b>
(Depreciation)	131,400	105,900	85,500	69,000	55,800	104,700	152,100
<b>Balance after depreciation</b>	<b>-299,700</b>	<b>-236,000</b>	<b>-194,000</b>	<b>-177,600</b>	<b>-161,800</b>	<b>-287,600</b>	<b>-462,600</b>

#### Government assistance

No research institute is managed solely on its own revenue sources. Most of them are established by governments and the operational costs and expenses are funded under the government budget. Even in the case of institutes established jointly by the public and private sectors, which are increasingly seen in Japan, the government sector not only provides assistance in the establishment process, but supports their operation by commissioning a number of research projects.

In the case of the proposed Center, the establishment of the Center as a public institute, and operation of it under 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 is expected to be far exceed the amount of funds to be provided by the government.

#### 4 Possible technical cooperation from abroad

The major issue related to smooth operation of the Center is to obtain technical staff. In particular, senior staff, which may be recruited from overseas through employment, should preferably be obtained in the form of technical assistance.

At the initial stage of operation, the Center should make efforts to obtain foreign

assistance in the following areas:

- 1) Chief researchers and researchers with expertise and experience in relevant fields, along with management capabilities in responsible departments.
- 2) Technology transfer related to the establishment of the Cutting Center, initial training, operation and management techniques and know-how.

## **5 Future vision of the Center**

The plan primarily emphasizes viability and selects the service areas and levels where the needs of industries are directly expected. The plan prescribes stepwise development plans for industrial technology fields that are selected as priority areas, and future expansion to other fields needs to be considered in light of the actual progress of industries in the country.

In other countries, technical support as contemplated in the plan covers machinery, plastics processing, food, and textile in many cases. The Center may be able to meet future requirements by expanding its planned resource base, except for the machinery sector.

Further functional expansion of the Center may be considered in the following areas after establishing its operational basis:

- 1) Expansion of service area to Dubai and other GCC countries, particularly for testing and training services.
- 2) Strengthening of testing functions, to addition the internationally recognizable level.
- 3) Reinforcement of the ability to assist prototype development and sample production in order to supplement supporting industries which are supposedly fulfilling such role but are not capable at present.
- 4) Upgrading of facilities, equipment, and human resources in the field of applied research, while it may take some time to develop basic research capabilities.

## **1 Background, Objectives, and Scope of the Study**

### **1.1 Background**

The Ministry of Commerce and Industry (MCI) of the Government of the Sultanate of Oman plans to establish an institution for technical support to industry, named the Industrial Research Center (the Center), as one of the programs which are to be implemented in the Fifth Five-Year Plan, and requested the Government of Japan to provide assistance by Japan International Cooperation Agency (JICA) for the Study on the Establishment of the Center, including investigations on the role and functions of the Center and the designing of its development plan, including the plans for activities, facilities, organization and management, which serves to provide MCI with the basis for preparing the implementation program for the establishment of the Center.

In response to this request, JICA sent a preliminary study mission to Oman in June, 1995 to make a preliminary Study and discuss with MCI the scope of work for the Study. The Scope of Work for the Study was subsequently agreed upon and signed between the JICA mission and MCI, the Government of Oman. Based on the Scope of Work thus agreed, the Study was carried out by a team organized by UNICO International Corporation under the assignment by JICA.

### **1.2 Objective and Scope of the Study**

The objective of the Study is to formulate and recommend the plan for the establishment of the Center, which consists of the following two phases:

#### **Phase 1:**

- 1) Identification of the needs for the Center, based on review of the industrial development and analysis of current situation of the industry and future direction of industrial development.
- 2) Defining the role and functions of the Center to meet the thus identified needs, the designing of the preliminary development plan for the Center, and investigation on its viability.

#### **Phase 2:**

Formulation of the detailed plan for the Center based on the preliminary development plan prepared in Phase 1 above.

## **2 Needs for Establishment of Industrial Research Center**

*The industrial research center will be established to provide technical support for the industrial sector. This section examines and identifies the needs for technical support from the viewpoint of industrial development promotion policy and strategy (2.1) and assisting the existing industries and enterprises to solve the problems they are facing (2.2). In 2.3, the main technology fields to be assisted by the center are selected as the conclusion obtained from the discussions in the above two sections. The section 2.4 defines the contents of technical support which will meet such needs.*

### **2.1 Need for Technical Support from the Viewpoint of Industrial Development Promotion**

From the viewpoint of promoting and fostering industrial development, the needs for technical support are found in the following areas.

- (1) Need for strengthening sustainable growth potential of existing industries  
To strengthen sustainable growth potential of existing industries, the following approaches will be pursued:
  - 1) Further promotion of import substitution;
  - 2) Development of new applications for already utilized domestic resources;
  - 3) Development of already utilized domestic resources for export purposes; and
  - 4) Improvement and maintenance of competitiveness in export markets by manpower saving, mechanization, and increased value added for existing industries, or competitiveness against imported products.

The existing industries in Oman are founded upon imported technological resources including production equipment and expatriate engineers. Further, their size of operation is small. As a result, they do not have function to develop and build up their own technology. This means, they have to obtain information from overseas whenever they start a new business, develop a new application, or learn specifications required overseas. Furthermore, technology once introduced is continuously used without internal improvement and soon becomes obsolete to adversely affect competitiveness. Local industries lack resourcefulness to overcome such situation.

Such problem is widely seen particularly in processing type light industries. To ensure their growth potential, therefore, comprehensive support from various fields including technological field is essential.

In the case of process industries such as cement and flour milling, they are operated by relatively large enterprises, each of which has the ability to overcome technical problems through consultation with overseas sources. Nevertheless, they also need technical support in developing new applications and markets since they do not own R&D resources.

(2) Need for promotion of oil and natural gas related industrial subsectors

So far Oman has produced petroleum products mainly for export purposes. The fostering of natural gas derivative industries is the one of major challenges in future. Nevertheless, since the oil and natural gas industries have strategic importance for the country and maintain their own sources of technical assistance in various countries, they do not require technical support other than that at present.

(3) Need for promotion of investment in export industries using non-oil-and-gas resources

Other than oil and natural gas, there are no resources in the country which show a high prospect from international standards for various reasons, such as relatively small reserves, the lack of infrastructure to support development projects, or relatively low levels of quality. However, there are several resources which can be commercially exploited if certain conditions are fulfilled. To attract investment in these areas, technical support is required.

[Fields of Particular Emphasis]

- 1) Development of large-scale gypsum mining for export.
- 2) Industries based on gypsum, kaolin and other non-metal minerals produced in Oman (such as gypsum board and plaster, ceramics and other building materials for domestic market and exports).

(4) Need for development or attraction of industries which can take advantage of the country's locational advantages and base on overseas demand

The strategy for development or attraction of such industries include following:

- 1) Development of industries taking advantage in container transportation charges based on a smaller flow of goods from the Middle East compared to the inflow to the region, which would more than compensate for a longer distance to various markets;
- 2) Attraction and promotion of transitional production and trade bases for foreign companies on the country's locational advantages; and
- 3) Fostering of industries which will be effective for attracting the above production and trade bases; which include such industries as packaging and other supporting

industries.

Among them, the expected size of industries and enterprises in 1) and 2) is not large as seen from market size and available container volume, and these industries seem to be suitable for development with involvement of a wide range of small light industries. In this case, because of labor supply and demand condition in the country, the development requires those of modern light industries armed with manpower saving and automation technologies and target production of high value added products, rather than labor-intensive industries. Since a large number of small industries are expected to be involved in this type of project, comprehensive support from various fields including technological field is essential.

[Fields of Particular Emphasis]

- 1) Food industries for exports
- 2) Repackaging/re-export industries
- 3) Packaging industry related to the above industries

(5) Need for employment promotion of Omani people by the industrial sector

Employment of local people by the industrial sector is very limited, and most of managers, engineers and workers are expatriates. Although various programs are in place to provide education and training for local people to work in the industrial sector, existing training does not allow trainees to obtain high levels of technical skills to find employment. Given the anticipated increase in younger population, imminent slowdown in employment growth in traditional employers of indigenous people, e.g., the government, military, and financial industry, and the need for local labor force having expertise and skills in industrial technology as the basis of economic diversification in the future, there is a strong need for effective support to create employment opportunities in the industrial sector.

The above policy direction is in line with industrial development policies and strategies which are summarized as follows.

- (1) In Oman, the oil sector has been playing a critical role in the country's economic development. In future, the country will continue to depend much on the oil and natural gas sector. At the same time, recent economic downturns due to limited petroleum production and sluggish oil prices suggest that future economic development must come from non-oil sectors. In this recognition, the government has announced its new economic development policy "to encourage diversification of the economic structure,



while maintaining sustainable growth, and thereby to reduce dependency on oil and establish a stable foundation of future economic growth." Diversification of the economic structure seems to represent a large hope for significant growth of the industrial sector.

(2) In fact, the industrial sector has been rapidly expanding over the past two decades and has become the largest non-oil productive sector. It is difficult, however, to expect sustainable growth of the industrial sector at the past pace for various reasons:

- 1) the past industrialization process was driven by import substitution, and now a room for further substitution is limited;
- 2) the current level of industrial accumulation is far less than satisfaction, and the existing industries rely on imported materials and have not formed much inter-industrial linkage, so that the industry sector does not have the ability to create much domestic demand;
- 3) fairly small population limits consumer demand.

(3) Under these circumstances, the current strategic focus of industrial development is being placed on building the industrial foundation, thus the level of industrial accumulation, by leveraging all the opportunities for industrial development. After that, industrial deepening through development of inter-industrial linkage will be pursued. Following is the development area to be pursued with this strategy:

- 1) Continuation of industrial promotion strategy as seen in the past:
  - a) To sustain and rev up the existing industries which mostly serve the domestic market through:
    1. through accelerated export promotion,
    2. strengthening of competitiveness against imported products, and
    3. strengthening of competitiveness of existing export industries, and
  - b) To further promote import substitution-based industrialization.
- 2) Promotion of the oil and natural gas based industry
- 3) Industrial development exploiting non-oil natural resources which are available in certain quantities
- 4) Industrial promotion oriented to foreign markets to supplement the small domestic market:
  - a) Attraction and promotion of industries which form part of or support transitional production and trade bases by relying on Oman's locational advantages;
  - b) Promotion of export industries which can capitalize on locational advantages and other favorable business environment in Oman.

(4) In addition, the government has high expectation for growth of the industrial sector as the means to expand and diversify employment opportunities for local citizens. Increased employment in the industrial sector is expected in view that it will create labor force having expertise and skills, which will form the foundation of new development for the national economy.

## **2.2 Need for Technical Support Required by Existing Industries and Enterprises**

The need for technical support by existing industries and enterprises is relatively small, excepting some specific industrial areas. Industries which urgently need technical support are those exporting or intending to export their products.

Details are as follows.

Almost all of technologies used in the existing industries in Oman have been transferred from abroad.

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. Also, industries who urgently need the improvement or modification of existing technology introduced from overseas are limited to those exporting or planning to export their products, for the following reasons. 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. As a result, they can effectively compete in the domestic market. 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, they faced few problems in selection and application of technology for their operation.

The major export-oriented industry is the garment industry. The industry require full-scale support including technical support.

The export garment industry in Oman primarily exports to the United States, where competition with exports from other countries is becoming more and more serious. At present, as Oman still has some unfulfilled portion in its quota, orders are placed to the Omani garment manufacturers. However, as the export garment industry in Oman is essentially weak in cost competitiveness, the industry may become unable to sustain export competitiveness. The survival of the industry must be pursued through enhancement of cost competitiveness and diversification of products, improvement of quality, improvement of productivity by mechanization, upgrading and rationalization of production systems, as well as diversification of export markets.

In the food processing industry which is about enter into the export market, the need for technical support is becoming apparent in some areas. The industry has been traditionally serving the domestic market with some exports to neighboring countries. In the case of the food processing and beverages industry, enterprises trying to export their products to the markets other than the neighboring countries, they face the need to improve products, quality and productivity. Particularly the improvement of packaging is the most important task for them. Many enterprises engaged in production only for domestic market, however, have no awareness of the value of packaging. As enterprises launching on an export campaign or manufacturing of new types of processed food increase, the need for improvement of packaging as well as improvement of products and quality will rise.

The need for technical support in other industries is fairly small.

Most industries have been using technology and equipment imported from foreign countries and are mainly serving the domestic market, facing the situation mentioned earlier. Such industries include the textile industry, the garment industry serving the domestic market, the woodcraft and furniture industry, the paper and paper product industry, the printing industry, the chemical and chemical product industry, the non-metallic mineral product industry, and the metal and machinery industry.

### **2.3 Priority Industries for Technical Supports**

In overall consideration to the need from the standpoint of promoting industrial development and the need from assisting the existing industries and enterprises to solve problems they are facing, three technology fields, garment technology, packaging technology, and non-metallic mineral resource-related R&D (at the initial stage, ceramics and gypsum will be principal target areas) have been selected as priority industries (technologies) to which focused technical support efforts will be directed.

The selection process is described below.

The selection criteria are as follows.

The objective of the Center is to provide industries with technical assistance for promoting industrial development in line with the industrial development strategy and to foster the capacity of assimilating transferred technologies and accumulating technologies for further advancement. To meet this objective, the priority industries for technical support is selected by taking the strategic importance for industrial development and the needs for technical supports by industries as the criteria. As a result, priority is given to the following:

- 1) Industries requiring urgent improvement and having many beneficiaries.
- 2) Prospective industries to which priority is given for the promotion of development and for which the provision of technical support is needed.

The promising industrial fields, for which technical support is strategically required, are as enumerated below.

- 1) Resource-based industries for which new investment is encouraged for export
  - a) Development of large-scale gypsum mining for export.
  - b) Industries based on gypsum, kaolin and other non-metal minerals produced in Oman (such as gypsum board and plaster, ceramics and other building materials for domestic market and exports).
- 2) Industrial fields which are useful for promoting establishment of production or distribution base for their transit trade based on geographic advantages of Oman.
  - a) Food industries for exports
  - b) Repackaging/re-export industries
  - c) Packaging industry related to the above industries

Many of them are also in the category of the existing industries requiring support for improvement of competitiveness in export markets.

Then, one of the existing industries which has particular large need for technical support is the export garment industry (see 2.2). This is an important industrial subsector to help maintain and promote sustainable growth of the existing industries. Also, it creates relatively large employment opportunities to meet demand.

The food processing and beverage industries, particularly those making an attempt to export their products, are increasingly realizing the need for improved product design and quality, increased productivity, and better packaging. In particular, the improvement of packaging technology is an important area from the viewpoint of industrial development

based on the country's locational advantages.

Other strategies to ensure sustainable growth of existing industries, such as the development of new applications for already developed local resources, support for export development, support for import substitution, are concerned with many industrial fields, making it difficult to select a limited number of priority areas. For this reason, special consideration will be required to devise measures to address the needs in other fields which have not been selected but have a certain level of prospect.

## **2.4 Contents of Technical Support to be Required and Needs for Establishing the Center in view of the Priority Sub-sectors Selected**

### **2.4.1 Garment Manufacturing Technology**

**Major Issues :** The export garment industry accounts for approximately 18% of non-petroleum commodity exports (value basis) of the Sultanate. However, the industry would have been unable to attract the interest of foreign buyers to the US market, unless the sultanate has been allocated quota by the US. Also, the industry is facing difficulty as creation of NAFTA has resulted in inflow of products not subject to the quota system into the US.

To overcome the situation, the following strategic focuses are imperative:

- 1) To ensure the survival of the industry by developing it into an attractive supply source for buyers exporting products to the U.S.

Required actions:

- a) To decrease production costs through productivity improvement and mechanization; and
  - b) To develop the ability to meet detailed requirements from buyers by reducing time for pattern making and improving design skills.
- 2) In the future, to explore new markets with reducing high dependency on buyers for a single market, and shifting from low-end and mid-end products.

Required actions:

- a) Development of products lines appealing to new markets including Europe by means of original product development, modification of existing products, and quality improvement; and
- b) Sales promotion targeting buyers for the new markets.

Among them, sales promotion for export markets can be taken care of by the proposed export promotion center. Furthermore, support from trading companies established by

OCCI can be expected to establish contact with buyers. Prior to sales promotion, however, cost reduction and the improvement of technological level are required on the industry's side. Since individual enterprises are unable to do them by themselves, technical support is essential and is expected to produce significant results.

In addition, the export garment industry is labor intensive in nature and is promising to create employment opportunities for local people. In reality, however, most of local workers working in the industry are engaged in odd jobs and are by no means indispensable labor force to support the industry. Concurrently with creation of employment opportunities, therefore, efforts should be made to train local people to have technical expertise and skills in design, equipment maintenance and other areas to replace foreign workers.

**Direction of Technical Support :**

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

The contents of technical support, which require to achieve the purpose, are as follows.

- 1) Support for cost reduction by streamlining the existing production system
  - a) Technical support for introduction of production systems with advanced functions
  - b) Technical support for improvement of production control skills
- 2) Support for introducing and accumulating product development technologies
- 3) Support for introducing and accumulating skills for repairing sewing machines
- 4) Support for the quality certification necessary to undertake independent sales

**Required Technical Support:**

Among them, the highest priority should be given to 1) that directly contributes to the survival of existing industries, followed by 2) and 3) that form the basis of future expansion and development. On the other hand, support in 4) focuses on the technology base which will be required when sales activity of original products emerges.

The following sections discuss the needs on the industry side for each type of support.

**Possible contents of technical support and assessment of needs:**

**(1) Technical support for introduction of production systems with advanced functions**

Mechanizing the operations - from development of samples to production of cut parts - that are now conducted manually, will enable costs to be reduced, quality to be improved, lead time to be shortened, etc. However, Oman's garment manufacturers are generally small in scale, and it would be difficult for them to individually carry out such mechanization. By installing the mechanized system as a pilot plant and allowing the companies in the industry to use it, the Center will contribute to reducing their costs; contribute to acquire the technology to utilize such system; improve their awareness of usefulness of the system and encourage them to acquire such system by themselves either individually or jointly, in the future.

**Needs of Industry for the Center's Support:** The needs for this kind of technical support are extremely high, and the anticipation that it would lead to autonomous product development, and market development, is also high.

They are obliged to introduce production systems having advanced functions, but the companies are too small to take such action. According to the manufacturers survey conducted in the Study, all seven manufacturers responded by pointing out that they have been facing the challenge of improvement of their efficiency, and without exception expect prompt introduction of such system to a common service facility.

**(2) Technical support for improvement of production control skills**

The productivity of Oman's garment industry is quite low compared to that of the ASEAN countries. This is because production control is excessively concentrated on individual workers' goals and incentives, and because control policy is not built on management engineering techniques. With improvement of production control skills, besides the mechanization of production systems, cost would be reduced.

**Needs of Industry for the Center's Support:** Some manufacturers have already noticed this situation, but none of them have taken action for improvement because of lack of knowledge, experience and support.

According to the manufacturers survey conducted in this study, two companies out of seven pointed out the need for improvement of production control methods, while five mentioned quality management and six are anticipating technical guidance for improvement.

**(3) Support for Introducing and Accumulating Product Development Technologies**

To transfer product development technologies - for designing, pattern making etc. - to manufacturers and train their in-house personnel in these technologies.

**Needs of Industry for the Center's Support:** In the present business system, manufacturers are dependent on buyers, and their desire to improve their technology is not very strong. According to the manufacturers survey, only two manufacturers are aware that they have a problem of new product development and product diversification. Only one manufacturer is expecting the Center to do something for their human resources development, and another for design development.

If they can acquire a prospect for improving cost competitiveness, they can then be expected to turn their attention to the next step: employee training. However, it is indispensable that personnel training be approached not from the standpoint of individual companies but rather from that of elevating the entire industry. Moreover, at present vocational training schools teach sewing, but manufacturers have not set up OJT (on-the-job training) systems, so when students graduate they are still unable to put their knowledge to practical use. Product development skills, more than sewing skills, are believed to be easily accepted among the younger generation in Oman.

(4) Support for Introducing and Accumulating Skills for Repairing Sewing Machines

At present Omani companies rely on foreign workers for the skills needed to repair sewing machines; they are unable to cope on their own with the progress in equipment design. Training in repair skills that are suitable for the next generation of equipment to be introduced thereafter is necessary.

**Needs of Industry for the Center's Support:** Existing equipment consists of relatively old general-purpose machines that foreign workers are hired to repair. These foreign workers are replaced after short periods. It is desirable that systems in which the repairs are done by Omanis be established. However, such systems would most likely increase costs, so that manufacturers are not necessarily enthusiastic about them. Rather, this kind of service should be provided in view of creating job opportunities for Omani laborers.

(5) Support for the Quality Certification Necessary to Undertake Independent Sales

In the present business system, all production processes are conducted based on buyer approval: for example, buyers must approve the supply of raw materials, the supply of designs, and patterns. The checking of the final product is also done essentially by buyers. If, in the future, it should come about that manufacturers procure raw materials independently and sell products manufactured with non-approved designs, buyers will demand that the manufacturers provide a reliable certification of product quality obtained from an impartial agency. The Center is to facilitate establishment of this function.



**Needs of Industry for the Center's Support:** At present there is only one manufacturer that procures its materials independently as advanced case. For the time being, test demand that could justify establishing such an agency cannot be expected. The action for this theme should be taken according to the future change of the business system.

## **2.4.2 Packaging Technology Focusing on Food and Beverage Industries**

### **Major Issues:**

The food industry, which is the major industry using packaging, 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.

To establish packing technology, the emergence of the packaging material industry is essential. However, domestic demand for packaging materials is fairly small and is satisfied by imports and in-house production by user industries for the time being. Accordingly, supportive efforts will be limited to the general objective of raising awareness of importance of packaging and the need for its improvement by providing technical guidance for packaging material users, while building up packaging know-how through efforts to solve packaging-related problems arising in the country. Although the scope is limited, this is the first step for establishing future packaging technology and will be able to meet demand from new entrants in addition to existing industries.

The improvement of packaging technology should include the improvement in design that is closely related to sales promotion, which will be addressed in the future when the need for improvement of industrial and commercial designs, e.g., the establishment of a design center. At present, such needs are dispersed throughout broad fields and must be fulfilled by overseas sources from the efficiency point of view.

### **Direction of technical support:**

Given the above limitations, technical support for packaging technology should be directed toward the following areas.

- 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 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 focus the technical assistance on the packaging related to food industry, in order to provide the food industry (existing as well as new establishments) with a technical data base on advanced packaging technology, thereby 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 those for exports, in order to satisfy buyer's 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.

The strategic focuses for the technical support in view of the above, are as follows:

- 1) Quality improvement of packaging materials made in Oman
- 2) Diversification of packaging materials
- 3) Improvement of techniques of food packaging work
- 4) Improvement of packaging design for food
- 5) Environmental preservation

(In addition, production and use of adequate packaging materials in the context of modern packaging technology, the improvement of packaging design and printing technologies, support for automation of packaging processes and maintenance, and package design for import products are other candidates, but all of them are too early to consider in Oman where the packaging material industry does not exist, together with the absence of major users of transport packages, the electrical/electronics industry and the precision equipment industry.)

**Required technical support:**

Based on the above discussion, major elements of technical support to be provided by the center are summarized as follows.

Although existing enterprises do not necessarily recognize the importance of strategic focuses selected here, they are all indispensable from the viewpoint of development strategy. Considering that the packaging material industry is in its infant stage and industries using packages do not realize the need for improvement of package quality, it is

recommended in the first step to implement strategic focuses in a flexible manner to meet the situation of individual enterprises. Thus, a basic activity plan should be designed to provide such flexibility and responsiveness to varying needs of individual enterprises.

It should be noted that the industry-wide activity alone is not likely to produce result so far as no company has packaging specialist.

**Possible contents of technical support and assessment of needs:**

The following section discusses the needs of the industries for each of strategic focuses which have been identified.

**(1) Quality improvement of packaging materials made in Oman**

The objective in this area is to improve production technology and quality control techniques related to packaging materials in order to prevent production of packaging materials having poor quality due to poor production practice and/or insufficient quality control. With focusing on the packaging materials produced locally, the first target will be the improvement of corrugated cardboard to eliminate irregularities corrugations or on the surface.

**Needs of Industry for the Center's support:** Packaging materials produced in the country are mainly those of simple design and construction, including corrugated cardboard, cartons, PET bottles manufactured by mineral water and soft drink bottlers, and shopping bags. At present, deterioration of packaged products is not a consumer problem, and user industries are not active in improving product quality.

**(2) Diversification of Packaging Materials**

To provide support for new ventures or existing companies to enable them to use new packaging materials. This will become a major issue in immediate future for the food industry, with entry to the retort packed food and frozen food business, and use of heat resistant films for food heated at home.

**Needs of Industry for the Center's support:** The present forms of packaging used by various manufacturers has been introduced only recently, and it takes some time until the need for new packaging materials will arise. Nevertheless, such information is important for companies who enter the food market. According to the manufacturers survey conducted in the Study, three out of four respondents are expecting the provision of technical and market information from the Center.

**(3) Improvement of Techniques of Food Packaging Work**

Typical examples of inadequate packaging due to inappropriate packaging work are

seen particularly in sealing, fusing, and pinholes due to poor temperature control in the food sealing process.

**Needs of Industry for the Center's support:** In the absence of complaints from the market and consumers, the industry has not well recognized the need for improvement of packages. According to the manufacturers survey, only two companies responded positively regarding the necessity of improvement of their packaging, out of the total of four companies.

Nevertheless, so far as the industry intends to enter the export market, inadequate packages need to be improved unless it is intended to target consumers satisfied with low-cost products. The Center should take action aggressively for promoting improvement of packaging methods and technic.

#### (4) Improvement of packaging design for food

The primary purpose of a package is to maintain the quality of its content. In this sense, packaging involves in every process of the food industry, including food processing, distribution, and storage. In particular, efforts should be made to help the industry achieve its purpose by providing technical guidance for existing manufacturers and supplying technical information for new projects.

**Needs of industry for the Center's support:** Selecting an appropriate type of package is an important issue for new products. On the other hand, existing manufacturers who already use certain types of packages do not feel the need for improvement of package design unless there is a strong demand from consumers.

Thus, the collection and provision of technical information will be given the first priority as the activity of the Center for the manufacturers who plan or adopt new products, or entities who start new businesses.

#### (5) Environmental Preservation

The major themes include:

- a) Reduction of packaging materials that cause air pollution (e.g., chlorine-based packaging materials);
- b) Overall reduction of packaging materials consumed;
- c) Use of photolytic/biodegradable plastics; and
- d) Promotion of recycling and reuse of packaging materials.

**Needs of Industry for the Center's support:** Environmental preservation efforts in Oman have still to be taken in a systematic manner and individual companies generally lack environmental concern. The need will arise as the exporters face environmental control or regulation on specific packaging materials which they use, in destination

countries, in the process of export promotion.

### **2.4.3 Non-metallic Mineral Research**

#### **Major Issue:**

#### **1) Ceramic-related 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. At present, availability of raw materials has only been confirmed, and no research and study is made on their commercial applicability. This is the main reason why commercialization does not progress in this field only.

To effectively drive commercialization efforts, the following information must be obtained:

- a) Technical and economic information on production equipment available from overseas resources; and
- b) Technical information on standards and specifications of products widely distributed in international markets as well as new products.

In addition to technical support, financial assistance will be required in some areas such as small-scale pottery production. Various organizations such as IDD under MCI are already providing various types of support in the investment stage.

At a later stage of commercialization, raw materials and products will be tested and evaluated upon request of manufacturers. In this connection, the scope of technical support needs to be extended with growth of the ceramics industry into: a) standardization, and b) technical consultation and advice on product and production.

#### **2) Gypsum and lime research**

Among the non-metal mineral resources, gypsum and lime are one of most promising resources. 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 decision prevents development projects from proceeding beyond the inception stage.

Exports of gypsum resources are not economically feasible with the current production volume and the existing loading facility, and large-scale development is inevitable. To attract investors for development projects involving investment in equipment import and mining, sufficient technical and economic information must be

provided to allow them to make necessary decisions.

For promotion of the industries using gypsum and lime, a variety of information needs to be furnished to potential investors, including products and markets, manufacturing plants, and production technology required for production of new products, in addition to information on raw gypsum.

In this connection, it is recommended to conduct research and study on economic and technical feasibility of use as construction materials - major applications of gypsum and lime products - including social and economic impacts of new products (e.g., energy saving and fire protection effect). Following the preliminary evaluation of economic feasibility, commercial applicability for various products will be verified by manufacturers through experimental use.

Then, it is important to launch promotional activity for products which are considered to be economically feasible, which would help expand the market for the industry.

Finally, consultation service seems to be required for the existing manufacturers of gypsum and lime products to improve production technology, since many small enterprises operating in the secondary product area often supply mediocre quality products.

**Direction of technical support/required technical support:**

1) Ceramics research

Commercial exploitation of ceramic materials can only become feasible after research and study is conducted for their characteristics and commercial applicability, thus availability of resources alone never justify investment for their development. Other prerequisites are the provision of sufficient market information, proper guidance on production technology, and human resources development, which will surface at the start of a commercial project. In any case, the first hurdle to be cleared is commercial feasibility of raw materials which must be found in preliminary research, and technical support will emphasize the research area.

2) Gypsum and lime research

An organization responsible for economic and technical feasibility study related to development of natural resources is MCI's Study & Planning Department. Based on the result of the department's study, center will evaluate and confirm technical feasibility in use of resources in question. In particular, the center will be responsible for the following activities:

- a) To conduct research on commercial use of resources which are prospective in

terms of volume and provide the result. Also to provide information on products and markets, manufacturing plants, and production technology required for production of new products.

- b) To conduct research on economic and technical feasibility of use as construction materials - major applications of gypsum and lime products - including social and economic impacts of new products (e.g., energy saving and fire protection effect), followed by verification of commercial applicability for various products by manufacturers through experimental use.

In addition, instruction on production technology will be given to manufacturers of secondary gypsum and lime products. For this purpose, sources and distribution of substandard products will be studied, followed by research on possible quality improvement measures that will form the basis of actual service. Data on substandard products will be furnished by DGSM, and research will be conducted under cooperation of SQU. Technical consultation and guidance will be provided for individual enterprises.

**Possible contents of technical support and assessment of needs:**

The following section discusses the needs of the industries for each of strategic focuses which have been identified.

**(1) Research on Ceramic Raw Materials**

The existing ceramic industry produces chinaware by using clay available in and around local communities. However, no study has been conducted to analyze properties of clay or to find alternative clay materials. The following activities are identified as strategic points of emphasis in the area of research on ceramic raw materials:

- 1) Analysis and evaluation of clay available locally as ceramic raw material;
- 2) Research on improvement of the current earthenware products (particularly on reinforcement of the products)
- 3) Exploration of clay resources in other areas;
- 4) Analysis and evaluation of local kaolin resources and research on utilization techniques; and
- 5) Exploration of other ceramic materials such as feldspar and pottery stone.

**Needs of Industry for the Center's support:** At present, there are only a few earthenware manufacturers and some individuals who put colors on the earthenware produced by the factory of Ministry of Heritage, as the existing industry of this kind. However, given potential demand and relatively strong interest in new investment

opportunities for manufacturing pottery and porcelain, found in the country, new projects aiming at fostering the ceramics industry can easily be promoted so far as commercially exploitable resources are found and detailed information is effectively communicated.

## (2) Market Study

Anticipated themes under the market study include:

- a) To contribute product development ideas about chinaware products supplied by existing enterprises; and
- b) To conduct market research on ceramic products in Oman and neighboring countries, assuming the projects utilize a new kaolin resource.

**Needs of Industry for the Center's support:** Like the ongoing ceramic tile project, a large enterprise may be able to conduct its own research when importing a new plant from a foreign country. In future, however, as more and more companies enter the market, not all of them will have the ability to conduct their own market research, particularly small project or enterprises. Accordingly, there will be an increasing need for market research to be conducted by an independent organization.

## (3) Technical guidance on ceramics production

Study of properties of available ceramic raw materials and identification of products suitable for such materials are the presumed requirements for the establishment of the technical guidance services function. Further development of the industry which bases on the currently available raw materials is not prospective. The reinforcement of products supplied by the traditional earthenware industry, would contribute to the extension of its market, to some extent, but this kind of research and developmental work should be carried out as part of activity related to research on ceramic materials, since the inferior strength of the earthenware is mainly because of nature of raw materials instead of production technology.

**Needs of Industry for the Center's support:** At present, the need for upgrading the products of traditional earthenware industry is recognized, but potential demand for the technical guidance service will be insignificant.

## (4) Human Resources Development

While modernized ceramic factories will be operated by expatriate engineers and managers at the initial stage of operation, it is desirable to replace them by Omani people step by step in future.

**Needs of Industry for the Center's support:** It is not likely that the need for human



resources development will arise on the industry side for a while, since the manpower requirement for the factory production of ceramic tiles will be fulfilled by expatriate labor. Further, the development of the existing earthenware industry will be limited so long as the product is in line with the current earthenware production. Such demand emerges only after promising products are successfully identified through raw materials research and market study mentioned above.

(5) Testing services

The following are the themes under testing services:

- a) Tests related to ceramic materials, including composition analysis and firing tests; and
- b) Product tests related to product strength, dimensional accuracy, and contents of lead and other harmful matter

**Needs of Industry for the Center's support:** The ceramic tile manufacturing project currently under planning will have its own capability to conduct necessary tests on materials. Any product test, if required, should be intended for providing certification to a third party.

There is no need for testing in the family-operated sector.

#### 2.4.4 Needs of Gypsum and Limestone-Based Industries for Establishing of the Center

- (1) Analysis and evaluation on availability of gypsum resources and their properties in view of its use

To provide technical information related to availability of gypsum resources and their properties for potential investors who are interested in development of gypsum resources, export or utilization.

**Needs of Industry for the Center's support:** Even for large enterprises, exploration and verification of many potential deposits on the basis of limited information involves a very high risk. The lack of basic information partly explains why various mineral resources in Oman have not been commercially exploited despite the fact that many investors have strong interest. Thus, the needs for such activity is extremely high.

- (2) Provision of technical information on gypsum/ limestone-based construction materials

The following technological information presumed.

- 1) To collect and supply technical and economic information on gypsum- or limestone-

based construction materials: investment promotion by providing information for potential investors, and

- 2) Research and study on construction materials from the standpoint of energy saving and fire resistance, and promotional activity for commercial use of useful materials: with dissemination of economic impacts of gypsum-related construction materials that are not widely used in the Middle East including Oman, promote their commercial use and support market development.

**Needs of Industry for the Center's support:** Though there is no business establishment in this industrial field, but according to the survey on manufacturers which produce similar products, or utilize such resource, there is strong interest among potential investors.

- (3) Technical guidance on production of gypsum and limestone-based projects (mainly for production of construction materials)

Construction materials currently supplied by small- and medium-sized manufacturers include those accompanying safety problems. In particular, aggregates produced by crushing stones available in wadi often present a problem. This is because rocks and stones in wadi, while looking alike, often vary in physical property, but are generally used by the manufacturers without consideration to such difference.

The technical guidance is the major activity, while the research works on relationship between raw material rocks used and strength of construction materials, and forms the basis for the technical guidance.

**Needs of industry for the Center's support:** There are many manufacturers and suppliers of construction materials in Oman. On the other hand, the government enforces strict control on safety of construction materials, so that suppliers, particularly small- and medium-sized enterprises, would have strong interest in technical guidance.

### **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 take 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 to 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.

### **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's activities have no duplication but complemented with those in other relevant public institutions each other. Following is recommended in defining the role and function of the Center in relation with other relevant public institutions.

#### **(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
- 2) Information specific to a certain product area
- 3) Information specific to a certain product/buyer

The focus of provision of information by the Center should be placed on the second item on the above.

There is a plan to establish an investment and export promotion center. 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 joint 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. The item three on the above require this kind of activity, and should be undertaken by such 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.

The testing for research and development has been undertaken by SQU (Sultan Qaboos 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 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.

### (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. No organization provides these services at present. 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

The provision of common service facilities to support the development of strategic industrial fields, should be regarded as one of the functions of the Center under the current industrial situation.

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 under 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. There is no organization which is undertaking any kind of research work.

The Center should undertake the research, particularly a part of applied researches as one of its activities.

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 it 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.

## **3.2 Planning of Functions and Services by Technological Field**

### **3.2.1 Garment technology**

#### **(1) 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

#### **(2) Technical support provided**

##### **Phase I**

- 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 services 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.)

2) 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.

(3) Inputs for implementation

#### 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 (2 units are required in ordinary cases as the minimum). 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 20,000 pcs/day (or equivalent to the work load of six factories) with the 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.

### 3.2.2 Packaging Technology

#### (1) 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 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.

#### (2) Technical support 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.

### (3) Inputs for implementation

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
- 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 limits 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 industry, 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.

### **3.2.3 Non-metal Mineral Research**

#### **(1) 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.

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. Thus, technical guidance on production is also considered to be one of the important strategic activities of the Center.

(2) Technical support provided

Phases 1 and 2

- 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 the current earthenware (particularly, on its reinforcement)
- 2) Compilation of such research results for dissemination to potential investors.

Phase 3

- 1) As for raw materials for ceramic industry, if Phases 1 and 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.

(3) Inputs for implementation

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.

### **3.2.4 Other Technological Fields**

#### (1) Direction of technical support

The above three 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.

#### (2) Technical support provided

##### 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.

##### Phases 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.

#### (3) Input for implementation

##### 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.

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.

### **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 is for common service operation, but, so is the software and hardware 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. At the same time, these efforts will create job opportunities for Omani engineers and/or technicians who have basic education in computer systems even with no experience in garment technology.
- 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

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, with the view of the following criteria, the order of priority among the four fields should be as described below.

- 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.

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 repackaging/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 Activities of the Center, Expected Effects and Possible Risks of Implementation**

#### **3.4.1 Major Services to be Provided (Final Plan)**

##### **(1) First stage**

The services in the Garment Technology Department will be focused on rationalizing and modernizing the existing industry. The existing industry's expectations regarding these services are extremely high. To achieve these goals, a Cutting Center that provides support for the preparatory processes in sewing work will be established, as will a Technical Guidance Unit that provides guidance for improving production efficiency.

In the packaging industries, awareness of the need to improve quality is still less than complete, so it will be necessary for the Packaging Technology Department to work on this. A technical guidance system that can grasp the situation in the existing industry and the situation with regard to potential investors, and that can identify problems, will be established, building up the guidance capability within the department (the department will not have its own testing and research machinery and equipment).

In the Non-metallic Minerals Research Department, effort will be focused on developing gypsum resources and ceramic materials. For gypsum resource development, organization of the necessary study is essential at this stage of development, and thus the Unit will have a coordination function alone. For development of ceramic raw materials, the main function is to evaluate the potential raw materials available locally in view of their use, and disseminate the information thus obtained, among the potential investors.

A Planning Coordination Department will be established to deal with requests from industrial sectors that do not fall under the purview of the departments mentioned above. The department will provide the service of transferring the customer requests by introducing the appropriate outside organizations to handle the matter.

(2) Second stage

In the second phase, each department will expand their level of its services assuming that the services provided in the first phase have brought about certain effects for their development. Therefore, the transition timing to the second phase will vary among the departments depending on the progress of development.

In the garment industry, companies are continuing to improve their production efficiency, and are expected to strengthen their ability to move in the future from the existing production system, in which manufacturers are dependent on buyers for raw materials and designs, to a system in which production is based on a manufacturer's own designs. In line with this progress, the department is to establish a training center. The Production Control Technical Guidance Unit, which was established in the first stage, was able, it is believed, to achieve certain results in the garment industry; and in the future, as a unit geared not just to the garment industry but to all other industries as well, it will be transferred to the Planning & Coordination Department.

In the Packaging Technology Department, the strategic focus will be shifted from improvement of quality consciousness in the industry to trouble shooting through guidance.

In the Non-metallic Mineral R&D Department, the activities for development of gypsum resources will be strengthened, though the major activity still remains the organization of development study. The activity of ceramic raw materials development will also be strengthened.

The Planning and Coordination Department will strengthen their activity in public relations and library services, assuming the development of activities of the Center, accumulation of experiences by the Center, and increase in needs of customers. Also, assuming that the target of the guidance provided for production control and quality control will be expanded to include all industries, the Production Control Technical Guidance Unit, which was established in the first stage as part of the Garment Technology Department, will be transferred to the Planning Coordination Department. A unit in charge of market surveys and economic surveys will also be established in this department.

(3) Third stage

The development plan for the third phase should be reviewed after confirming the effects of implementation of the second phase and industrial development at that time.

In the garment industry, as companies increasingly use their own designs and arrange by themselves for their raw materials, customers will increasingly demand

certification of product quality based on product testing. To deal with this, a Testing Center will be established in the Garment Industry Technology Department. In the Packaging Technology Department, it will be necessary to deal with the increasing transport of precision equipment, etc. That is, in addition to guidance and testing for consumer packaging technology, which has been the focal point until now, guidance and testing for transport packaging will be demanded in the future. A Transport Packaging Unit that can deal with this will be established.

With the progress in development of gypsum resources, it will be necessary to add, in the Non-metallic Minerals Resources Department, a research system oriented to the industrial use of gypsum.

### **3.4.2 Expected Effects of Implementation<sup>1</sup>**

The short-term effects of implementation may be expected most significantly from the Garment Technology Department.

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 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.

Following the above mentioned effects, the effects from the Packaging Technology Department may also be expected.

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

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<sup>1</sup> See Table 1.



**Table 1 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**

	Contribution to GDP	Contribution to Exports	Contribution to Employment of Omani
- Gypsum export			
- 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

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. 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.

In mid-term, the effects from Non-metal Mineral Research Department may be expected.

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.

Further, in the fields of garment technology and packaging technology, following technological effects may be expected.

In terms of technological contribution in the garment technology field, 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.

The 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.

In the long-term, the establishment of the Center will contribute indirectly to development of human resource to engage in research and development and technical guidance within the industry, besides those in the Center. This is nothing but a kind of technological accumulation, and the manufacturers may take advantage of it for improvement of their process or products, and use it as a base for research to be initiated by themselves. The technological experiences obtained through the researches on ceramic raw materials and gypsum, may provide a clue for development of other mineral resources in Oman.

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.

### **3.4.3 Financial Risk<sup>2</sup>**

In terms of financial situation, the Cutting Center of Garment Technology Department is significantly different from others.

Basically, 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

<sup>2</sup> Table 2 shows the estimated balance between revenue and costs and expenses of the Center as a whole.

**Table 2 Financial Projection for the IRC**

(Unit: RO.)

	Phase 1					Phase 2	Phase 3
	1	2	3	4	5		
Garment Tech. Dept.							
- Cutting Center	121,600	144,100	159,100	159,100	159,100	302,300	302,300
- Other services	6,800	11,300	12,500	5,800	8,200	0	1,800
(Total)	128,400	155,400	171,600	164,900	167,300	302,300	304,100
Packaging Tech. Dept.	3,400	9,400	9,600	12,200	12,400	24,700	37,100
Non-metal Mineral R&D Dept	0	2,800	3,200	5,600	5,600	5,600	6,000
Research Plan/Coordination	2,400	4,800	9,600	11,200	11,200	11,200	11,200
<b>Revenue Total</b>	<b>134,200</b>	<b>172,400</b>	<b>194,000</b>	<b>193,900</b>	<b>196,500</b>	<b>343,800</b>	<b>358,400</b>
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
Other operational costs	38,500	38,500	38,500	38,500	38,500	74,900	104,600
<b>Operation Costs/Expenses Total</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>526,700</b>	<b>668,900</b>
<b>Balance</b>	<b>-168,300</b>	<b>-130,100</b>	<b>-108,500</b>	<b>-108,600</b>	<b>-106,000</b>	<b>-182,900</b>	<b>-310,500</b>
(Depreciation)	131,400	105,900	85,500	69,000	55,800	104,700	152,100
<b>Balance after depreciation</b>	<b>-299,700</b>	<b>-236,000</b>	<b>-194,000</b>	<b>-177,600</b>	<b>-161,800</b>	<b>-287,600</b>	<b>-462,600</b>

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%).

For the departments other than the Cutting Center, the amount of income expected from the provided technical services will cover only a part of total expenses of the departments. The major expense is the direct labor cost which is categorized as a fixed cost. Therefore, there will be low risk of significant divergence from the estimated original financial balance.

#### **3.4.4 Risk from change in business conditions**

Since the IRC is planned to be established using the existing buildings, the risk caused by procurement and preparation of land and buildings is expected to be minimized from change in business environment.

The establishment of the Garment Technology Department, particularly establishment of the Cutting Center 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.

However, once the Cutting Center is established, the financial risk involved in the establishment of the Training Center is estimated to be insignificant, due to the fact that the Training Center assumes use of facilities installed in the Cutting Center without adding major equipment and facilities, and the financial requirement for the additional equipment and facilities is minimal. In addition, the major costs and expenses required for the operation are the salaries and wages for instructors and operators who will be expatriates.

However, 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.

For the establishment of Packaging Technology Department, 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.

In the case of establishment of Non-metal Mineral Research Department, the risk 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 of the equipment may be used for research work of other minerals.

There might be a risk that the manpower assigned to the department will not be utilized, for establishment of Research Planning and Coordination Department, 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.

### **3.5 Organizational Set-up and Management of the Center**

#### **3.5.1 Institutional Structure**

The Center's (IRC's) services are expected to have a significant economic effect, while it could generate only a limited amount of revenue.

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.

It should be enabled to offer its services for pay in cases where its beneficiaries can obtain a profit directly from those services.

In conclusion, the Center is recommended to be established, like PEIE, as a public organization under the auspices of MCI, and the costs for the set-up and operation of IRC will have to be financed/supplemented with the government budget.



### 3.5.2 Organizational Structure

The activities of IRC should be expanded in future in terms of services to be provided, research level, and covering industrial fields. The initial organization, however, should be formulated according to the minimum requirement. Figure 1 shows the organizational structure of IRC in Phase 3 with indicating that in Phase 1.

#### (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. 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, food and 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 (Figure 1).

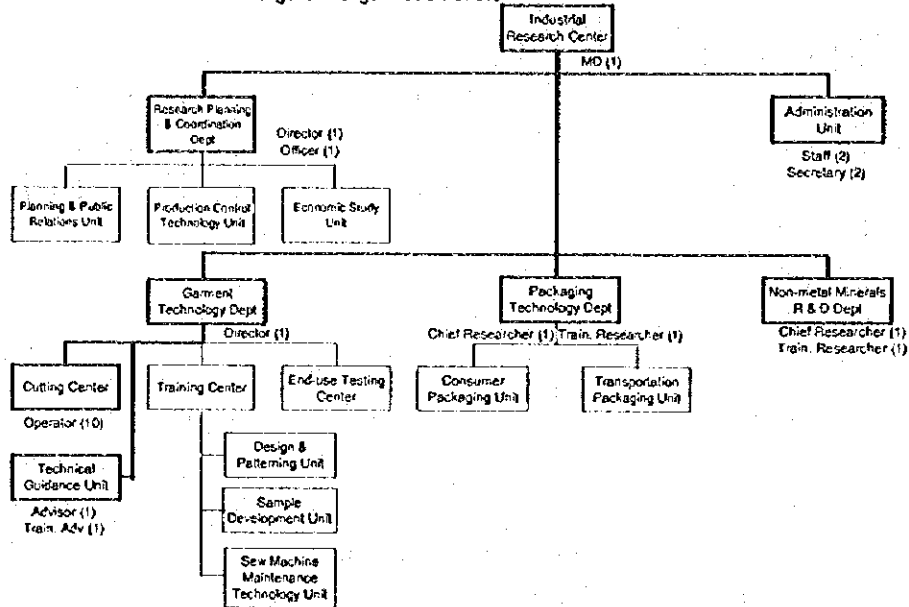
The development plan for other industrial technology areas should be defined by studying the future development of relevant industrial sub-sectors.

#### (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.

Figure 1 Organization Chart



Notes: Block with thick line means the organizations in Phase 1.  
Manpower assignment shown is for Phase 1 only

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.

### 3.6 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 (Table 3), 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.

### 3.7 Government Assistance

It is recommended that the Center should be established and operated with funds from the government.

No research institute is managed solely on its own revenue sources. Most of them are established by governments and the operational costs and expenses are funded under the government budget. Even in the case of institutes established jointly by the public and private sectors, which are increasingly seen in Japan, the government sector not only provides assistance in the establishment process, but supports their operation by commissioning a number of research projects.

In the case of the proposed Center, the establishment of the Center as a public institute, and operation of it under the funding of the government, may be also justifiable in that the

**Table 3 Financial Projection for the IRC**

(Unit: RO.)

	Phase 1					Phase 2	Phase 3
	1	2	3	4	5		
Garment Tech. Dept.							
- Cutting Center	121,600	144,100	159,100	159,100	159,100	302,300	302,300
- Other services	6,800	11,300	12,500	5,800	8,200	0	1,800
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Packaging Tech. Dept.	3,400	9,400	9,600	12,200	12,400	24,700	37,100
Non-metal Mineral R&D Dept.	0	2,800	3,200	5,600	5,600	5,600	6,000
Research Plan/Coordination	2,400	4,800	9,600	11,200	11,200	11,200	11,200
<b>Revenue Total</b>	<b>134,200</b>	<b>172,400</b>	<b>194,000</b>	<b>193,900</b>	<b>196,500</b>	<b>343,800</b>	<b>358,400</b>
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
Other operational costs	38,500	38,500	38,500	38,500	38,500	74,900	104,600
<b>Operation Costs/Expenses Total</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>526,700</b>	<b>668,900</b>
<b>Balance</b>	<b>-168,300</b>	<b>-130,100</b>	<b>-108,500</b>	<b>-108,600</b>	<b>-106,000</b>	<b>-182,900</b>	<b>-310,500</b>
(Depreciation)	131,400	105,900	85,500	69,000	55,800	104,700	152,100
<b>Balance after depreclation</b>	<b>-299,700</b>	<b>-236,000</b>	<b>-194,000</b>	<b>-177,600</b>	<b>-161,800</b>	<b>-287,600</b>	<b>-462,600</b>

Center is expected to generate economic effects, besides the expected contribution to technological upgrading. The tangible economic effects alone is expected to be far exceed the amount of funds to be provided by the government.

### **3.8 Management Capablity**

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.

### **3.9 Technical Assistance from Abroad**

The most difficult point for the operation of the Center is assuring it the needed technical staff. 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

### **3.10 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**

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.

**(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 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

## **4 Detailed Plan for Establishment of the Center**

### **4.1 Set-up Plan**

#### **4.1.1 Major Services to be Provided**

The outline of services to be provided by the Center is given in Table 2. The level of services varies among the departments depending on the situation of the industry covered by each department, rather than there being uniform provision of services.

#### **4.1.2 Organization and Staffing**

The organization charts with manpower assignment, by department and by phase of establishment, are shown in Table 5, and Figures 2 through 5. In charge of the entire center will be a Managing Director. The Garment Technology Department and the Planning Coordination Department will be headed by Directors: persons with planning and administrative abilities. The technical departments will each be led by a Chief Researcher: an administrator with technical knowledge and experience.

Researchers and Advisors, while not responsible for managing departments, will be positions that require technical knowledge and experience. Trainee Researchers will be employed to train, from among the Omani, the personnel who will be necessary to operate the center in the future.

#### **4.1.3 Spaces**

Table 6 and Figure 6 summarize the space that will be necessary in each development phase. The required space in the first phase will be 1,300 m<sup>2</sup>, of which 1,000 m<sup>2</sup> are used with the Cutting Center of the Garment Technology Department.

In the third phase, the Center requires 3,285 m<sup>2</sup> of space, while it will be 1,625 m<sup>2</sup> excluding the Cutting Center.

#### **4.1.4 Facility and Required Capital for Set-up**

Table 7 shows the funds necessary for establishment and expansion of the Center, including costs for facility and equipment. The required funds for establishment in Phase 1 amount to RO. 700,000 (or equivalent to US\$ 1,820,000), and it will be around RO. 520,000 (or US\$ 1,360,000) excluding building costs.

## **4.2 Management Plan**

### **4.2.1 Revenue**

The expected revenue from the services provided includes: 1) fees from contract processing at the Cutting Center of Garment Technology Department, 2) fees from contract testing at Garment Technology Department and Packaging Technology Department, 3) fees from technical guidance, and 4) membership fee and revenue from sales of publications.

The revenue is estimated in Table 8 by type of services provided, and assumed fee rates.

The estimated revenue in the third year of operation is around RO. 190,000, of which the revenue from the services provided by the Cutting Center amounts to around RO. 160,000.

The Cutting Center provides services which directly benefit customers, and thus, the fee rates are set at the level where the Cutting Center are able to be operated on a commercial basis.

### **4.2.2 Costs/Expenses and Balance**

Table 9 estimates the costs and expenses. Table 10 shows the estimated balance between revenue and costs/expenses. The balance shows the deficit of RO. 168,000 in the first year of operation (excluding depreciation), and the deficit will be decreased to RO. 108,000 in the third year. The amount of deficit is equivalent to 65% and 40% of direct labor costs respectively. The deficit will increase to RO. 203,000 and RO. 187,000, if the revenue and costs/expenses of the Cutting Center are excluded.

### **4.2.3 System to Improve the Services**

It is necessary to continually work, from the following viewpoint, to improve services. This will involve the following.

- 1) Contribution to industrial development
- 2) Establishment of own R&D plan
- 3) Updating the operation style (change of addition of data sources, addition or renewal of equipment, invitation of human resources, etc.)
- 4) Adjustments in keeping with change of the needs of industry
- 5) Decision making on the appropriateness of transferring to the next stage planned, and review of plan in the next stage



6) Planning of future expansion besides those in the current plan

The following organizations are recommended to be utilized for the aim of operation improvement:

- 1) Steering Committee
- 2) Director/chief Researcher Meeting
- 3) Membership System

### 4.3 Implementation Process

Figure 7 shows the set-up and preparation process up to commencement of Phase 1 operation.

It is estimated to take 12 months from official approval of the plan to commencement of operation.

In this implementation plan, the Center is assumed to use buildings already available. The most critical time is the time required for recruitment of adequate staff, but the above plan does not take it into account. If the implementation assumes the technical cooperation from abroad, the time required for procedure is also necessary to be included in advance. The training period for the staff of the Cutting Center is another time factor to be considered in formulating the implementing plan.



**Table 4 Outline of Technical Services Provided by the Center**

<b>A. Technology Transfer (Technical Guidance)</b>	
(1) Collection and provision of technical and market information	1) Collection of technical and market information 2) Provision of opportunity for exchange of information
(2) Testing service	
(3) Technical consultancy and guidance service	1) Technical consultancy service 2) Technical guidance service 3) Assistance for product sample development
(4) Provision of facilities and equipment	- As common service facilities
<b>B. Research and Development</b>	- Own research for use of natural resource
<b>C. Human Resource Development</b>	- Training for garment designing, etc.

**Table 5 Manpower Plan**

(Unit : person)

	Phase 1	Phase 2	Phase 3
Managing Director/Director/Chief Researcher	4	4	4
Key Technical Staff	3	5	8
Trainee Researcher	3	4	9
Secretary/Administration Staff	4	7	7
Operation Staff	10	21	21
<b>Total</b>	<b>24</b>	<b>41</b>	<b>49</b>

**Table 6 Summary of Space Plan for Industrial Research Center**

				(Unit: m <sup>2</sup> )
Department	Phase 1	Phase 2	Phase 3	Remarks
<b>(1) Operation space</b>				
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	
<b>(2) Laboratories</b>				
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	
<b>(3) Offices and other spaces</b>				
Offices	80	150	175	3.35m <sup>2</sup> /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	
<b>Total</b>	<b>1,300</b>	<b>2,440</b>	<b>3,285</b>	

**Table 7 Required Capital for Establishment and Expansion**

	In Rial Omani			in US dollars		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
(1) Building construction costs						
1) Operation spaces (*1)	121,000	88,000	0	318,400	231,600	0
2) Laboratories (*2)	15,000	22,500	157,500	39,500	59,200	414,500
3) Offices & other spaces (*3)	40,000	53,000	64,000	105,300	139,500	168,400
Total	176,000	163,500	221,500	463,200	430,300	582,900
(2) Labo facilities & equipment						
1) Garment Technology Dept..						
a) Cutting Center						
- Automated cutting spreading M/C	301,000	296,000	0	792,100	778,900	0
- CAD system	65,000	0	0	171,100	0	0
b) Technical Guidance Unit						
- PC production management system	14,000	0	0	36,800	0	0
- PC filing system	10,500	0	0	27,600	0	0
c) Training Center						
- Fashion design system	0	32,500	0	0	85,500	0
- M/C for sample development	0	31,000	0	0	81,600	0
- M/C for mechanization	0	58,500	0	0	153,900	0
d) Garment end-use testing center	0	0	337,000	0	0	886,800
2) Packaging Technology Dept.						
a) Packaging materials test labo	0	187,000	0	0	492,100	0
b) Transportation packaging labo	0	0	626,500	0	0	1,648,700
3) Non-metal Mineral Research Dept.						
a) Gypsum development research labo	0	0	15,000	0	0	39,500
b) Ceramic raw material research labo	82,000	0	0	215,800	0	0
Total	472,500	605,000	978,500	1,243,400	1,592,000	2,575,000
(3) Office equipment, etc. (*4)	44,000	69,000	14,000	115,800	181,600	36,800
Total	692,500	837,500	1,214,000	1,822,400	2,203,900	3,194,700

Notes:      1) RO.110/m<sup>2</sup>  
             2) RO.300/m<sup>2</sup>  
             3) RO.200/m<sup>2</sup>  
             4) RO.550/m<sup>2</sup> for offices & library

**Table 8 Projected Revenue from IRC's Services**

		Phase 1					Phase 2	Phase 3
		1	2	3	4	5		
<b>Garment Tech Dept.</b>								
Contract service for sewing preparation								
Cut parts	'000 Pcs.	2,808.0	3,369.6	3,744.0	3,744.0	3,744.0	7,488	7,488
	Revenue	112,300	134,800	149,800	149,800	149,800	299,500	299,500
Graded pattern	No. of item	374	374	374	374	374	374	374
	Revenue	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Marker sheet	No. of marker	3,432	3,432	3,432	3,432	3,432	0	0
	Revenue	6,500	6,500	6,500	6,500	6,500	0	0
sub-total		121,600	144,100	159,100	159,100	159,100	302,300	302,300
Technical guidance	Man-hour utilization	0.50	0.75	0.75	0.25	0.25	0	0
	Revenue	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	0	1,200	2,400	2,400	4,800	0	0
Contract testing	No. of tests	0	0	0	0	0	0	18
	Revenue	0	0	0	0	0	0	1,800
<b>Total Revenue</b>		<b>128,400</b>	<b>155,400</b>	<b>171,600</b>	<b>164,900</b>	<b>167,300</b>	<b>302,300</b>	<b>301,100</b>
<b>Packaging Tech Dept.</b>								
Technical guidance	Man-hour utilization	0.25	0.5	0.5	0.5	0.5	1	1.5
	Revenue	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	0	2,400	2,400	4,800	4,800	9,600	14,400
Contract testing	No. of contract	0	2	4	6	8	16	24
	Revenue	0	200	400	600	800	1,600	2,400
<b>Total Revenue</b>		<b>3,400</b>	<b>9,400</b>	<b>9,600</b>	<b>12,200</b>	<b>12,400</b>	<b>24,700</b>	<b>37,100</b>
<b>Non-metal mineral R&amp;D Dept.</b>								
Contract research	No. of contract	0	2	2	4	4	4	4
	Revenue	0	2,400	2,400	4,800	4,800	4,800	4,800
Contract testing	No. of tests	0	4	8	8	8	8	12
	Revenue	0	400	800	800	800	800	1,200
<b>Total Revenue</b>		<b>0</b>	<b>2,800</b>	<b>3,200</b>	<b>5,600</b>	<b>5,600</b>	<b>5,600</b>	<b>6,000</b>
<b>Research Planning &amp; Coordination Dept.</b>								
Technical guidance	Man-hour utilization							
	Revenue	0	0	0	0	0	0	0
Supporting membership fee	No. of member	40	80	160	186	186	186	186
	Revenue	2,400	4,800	9,600	11,200	11,200	11,200	11,200
<b>Total Revenue</b>		<b>2,400</b>	<b>4,800</b>	<b>9,600</b>	<b>11,200</b>	<b>11,200</b>	<b>11,200</b>	<b>11,200</b>
<b>Total Revenue</b>		<b>134,200</b>	<b>172,400</b>	<b>194,000</b>	<b>193,900</b>	<b>196,500</b>	<b>343,800</b>	<b>358,400</b>

**Table 9 Financial Projection for the IRC (Costs & Expenses)**

Year of operation:	Phase 1					Phase 2	Phase 3
	1	2	3	4	5		
<b>Direct labor cost</b>							
Managing Director	37,500	37,500	37,500	37,500	37,500	37,500	37,500
Director	60,000	60,000	60,000	60,000	60,000	60,000	60,000
Chief Researcher	30,000	30,000	30,000	30,000	30,000	30,000	30,000
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
<b>Total</b>	<b>261,000</b>	<b>261,000</b>	<b>261,000</b>	<b>261,000</b>	<b>261,000</b>	<b>444,800</b>	<b>551,300</b>
<b>Maintenance costs</b>	<b>3,000</b>	<b>3,000</b>	<b>3,000</b>	<b>3,000</b>	<b>3,000</b>	<b>7,000</b>	<b>13,000</b>
<b>Utility costs</b>							
- Electricity	22,800	22,800	22,800	22,800	22,800	42,700	57,500
- 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
<b>Other operational costs</b>	<b>38,500</b>	<b>38,500</b>	<b>38,500</b>	<b>38,500</b>	<b>38,500</b>	<b>74,900</b>	<b>104,600</b>
<b>Operation Costs Total</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>526,700</b>	<b>668,900</b>
<b>Building</b>	<b>25,000</b>	<b>21,400</b>	<b>18,400</b>	<b>15,800</b>	<b>13,500</b>	<b>17,100</b>	<b>23,200</b>
<b>Labo facilities &amp; equipment</b>	<b>97,300</b>	<b>77,300</b>	<b>61,400</b>	<b>48,700</b>	<b>38,700</b>	<b>78,600</b>	<b>127,100</b>
<b>Office equipment, etc.</b>	<b>9,100</b>	<b>7,200</b>	<b>5,700</b>	<b>4,500</b>	<b>3,600</b>	<b>9,000</b>	<b>1,800</b>
<b>Depreciation</b>	<b>131,400</b>	<b>105,900</b>	<b>85,500</b>	<b>69,000</b>	<b>55,800</b>	<b>104,700</b>	<b>152,100</b>
<b>Total</b>	<b>433,900</b>	<b>408,400</b>	<b>388,000</b>	<b>371,500</b>	<b>358,300</b>	<b>631,400</b>	<b>821,000</b>

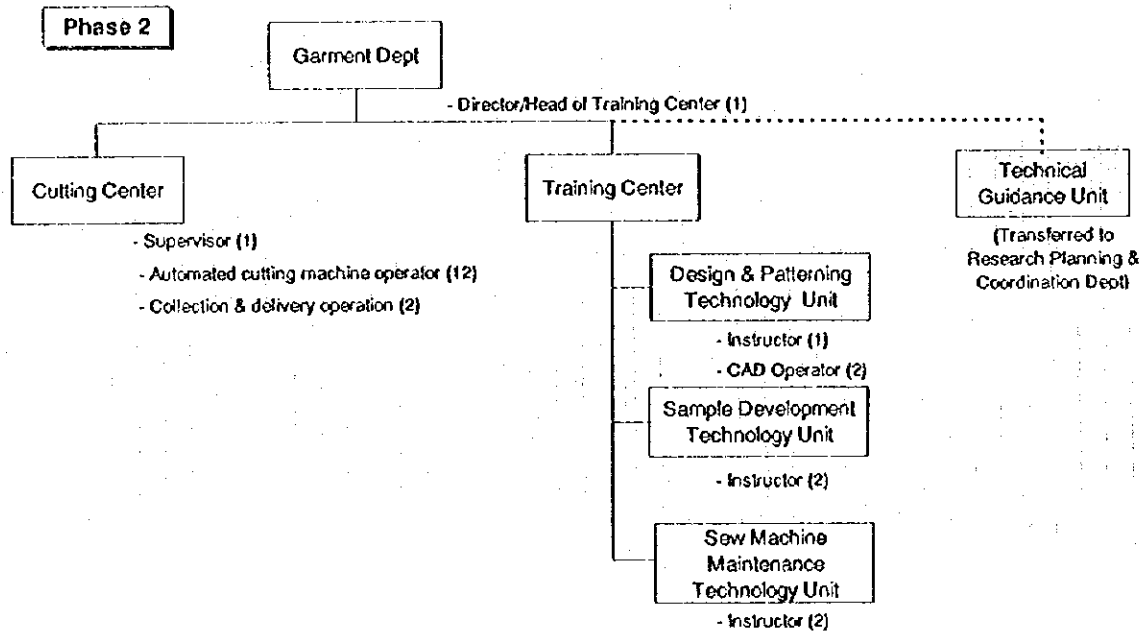
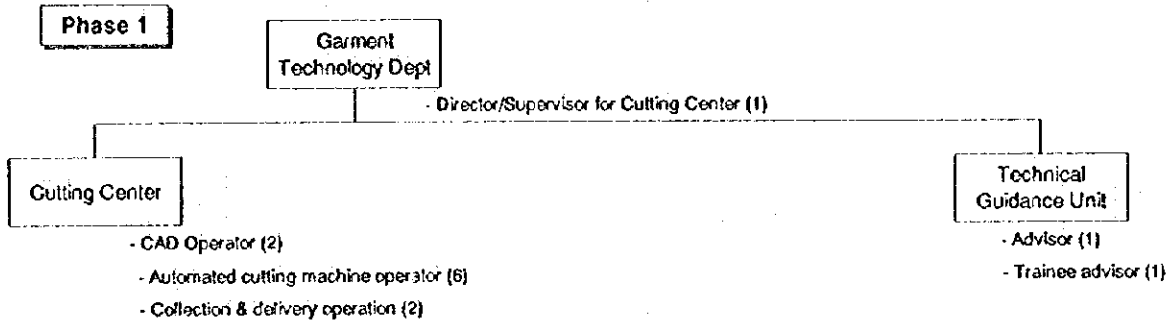
**Table 10 Financial Projection for the IRC**

(Unit: RO.)

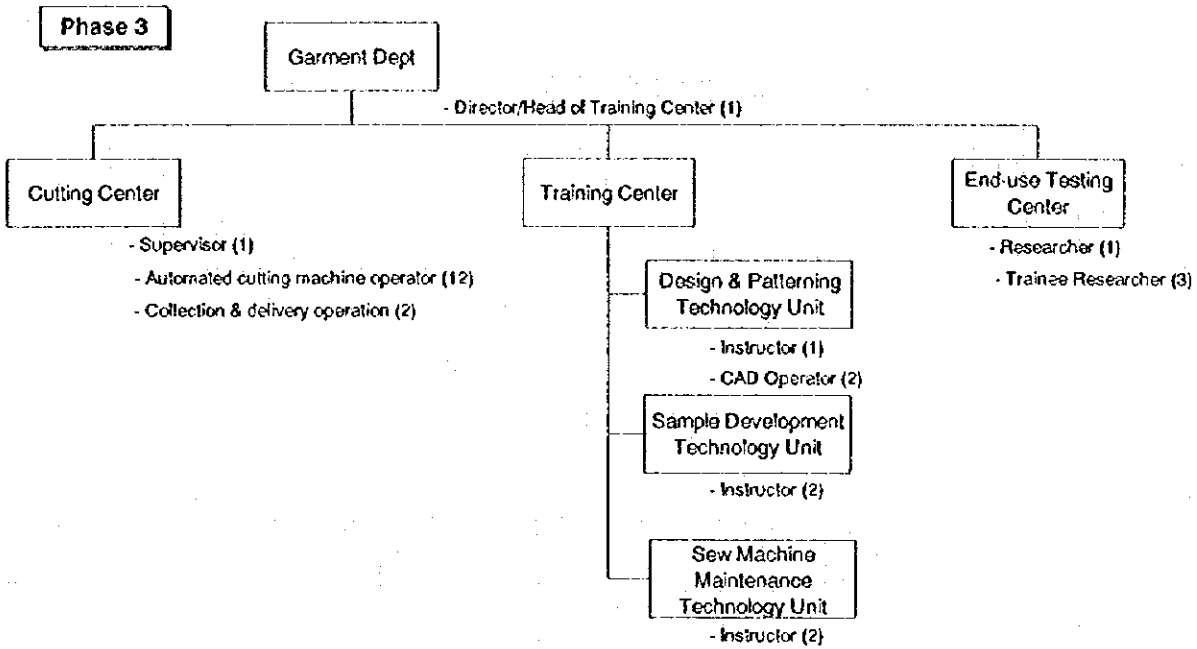
	Phase 1					Phase 2	Phase 3
	1	2	3	4	5		
Garment Tech. Dept.							
- Cutting Center	121,600	144,100	159,100	159,100	159,100	302,300	302,300
- Other services	6,800	11,300	12,500	5,800	8,200	0	1,800
(Total)	128,400	155,400	171,600	164,900	167,300	302,300	304,100
Packaging Tech. Dept.	3,400	9,400	9,600	12,200	12,400	24,700	37,100
Non-metal Mineral R&D Dept	0	2,800	3,200	5,600	5,600	5,600	6,000
Research Plan/Coordination	2,400	4,800	9,600	11,200	11,200	11,200	11,200
<b>Revenue Total</b>	<b>134,200</b>	<b>172,400</b>	<b>194,000</b>	<b>193,900</b>	<b>196,500</b>	<b>343,600</b>	<b>358,400</b>
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
Other operational costs	38,500	38,500	38,500	38,500	38,500	74,900	104,600
<b>Operation Costs/Expenses Total</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>302,500</b>	<b>526,700</b>	<b>668,900</b>
<b>Balance</b>	<b>-168,300</b>	<b>-130,100</b>	<b>-108,500</b>	<b>-108,600</b>	<b>-106,000</b>	<b>-182,900</b>	<b>-310,500</b>
(Depreciation)	131,400	105,900	85,500	69,000	55,800	104,700	152,100
<b>Balance after depreciation</b>	<b>-299,700</b>	<b>-236,000</b>	<b>-194,000</b>	<b>-177,600</b>	<b>-161,800</b>	<b>-287,600</b>	<b>-462,600</b>



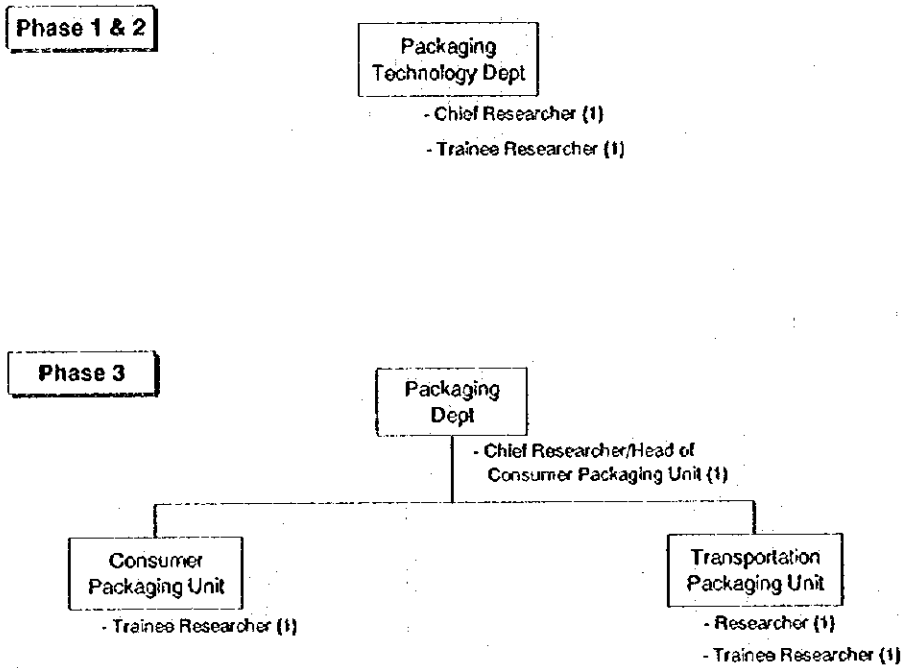
**Figure 2 (1) Organization and Manpower Plan for Garment Department**



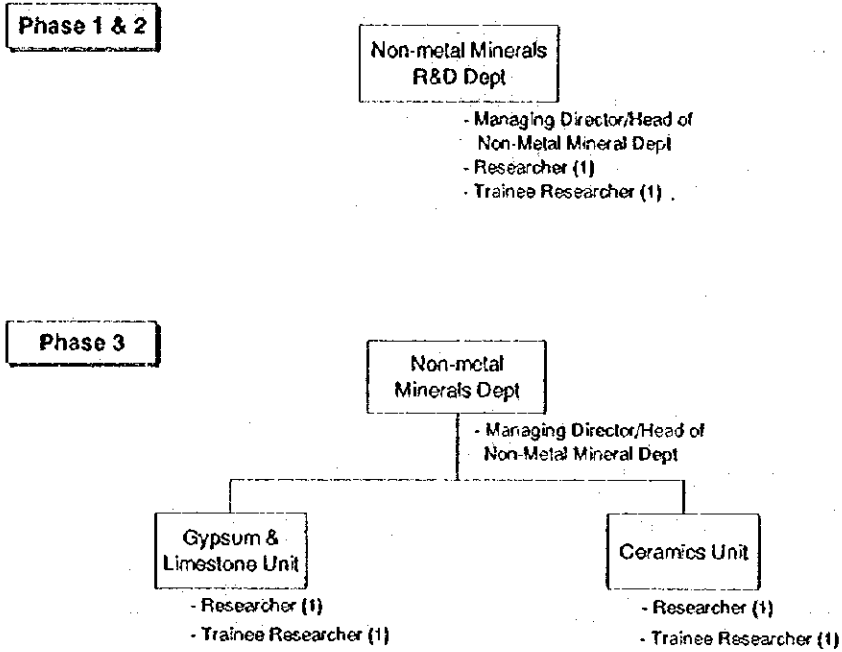
**Figure 2 (2) Organization and Manpower Plan for Garment Department**



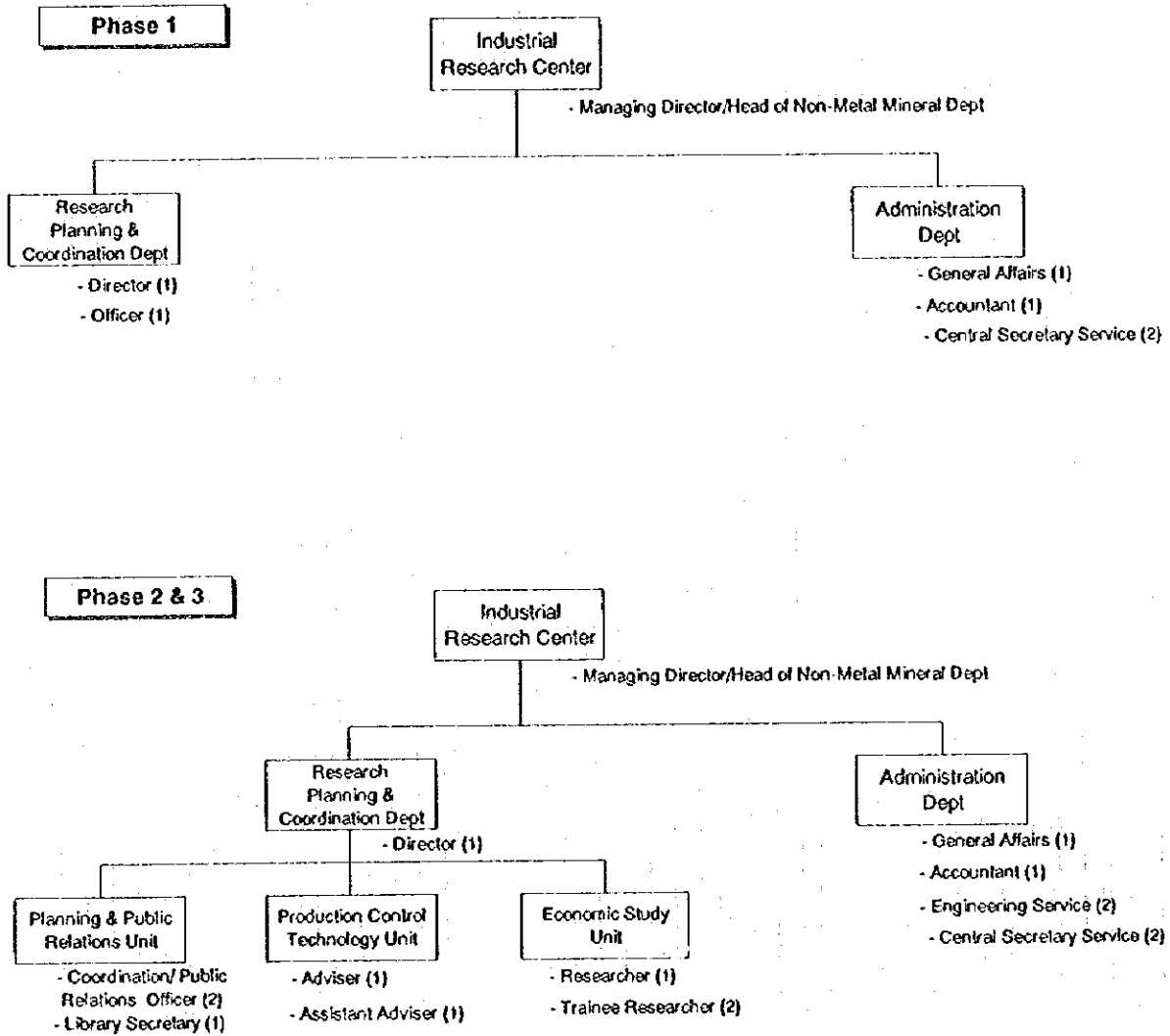
**Figure 3 Organization & Manpower Plan for Packaging Technology Department**



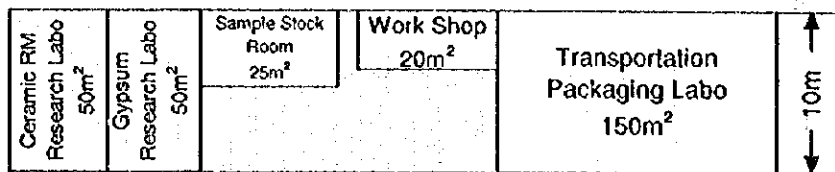
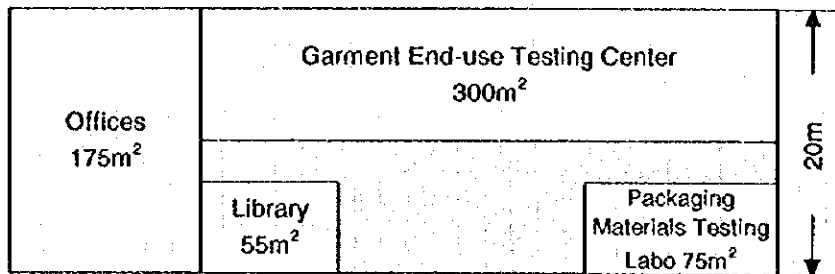
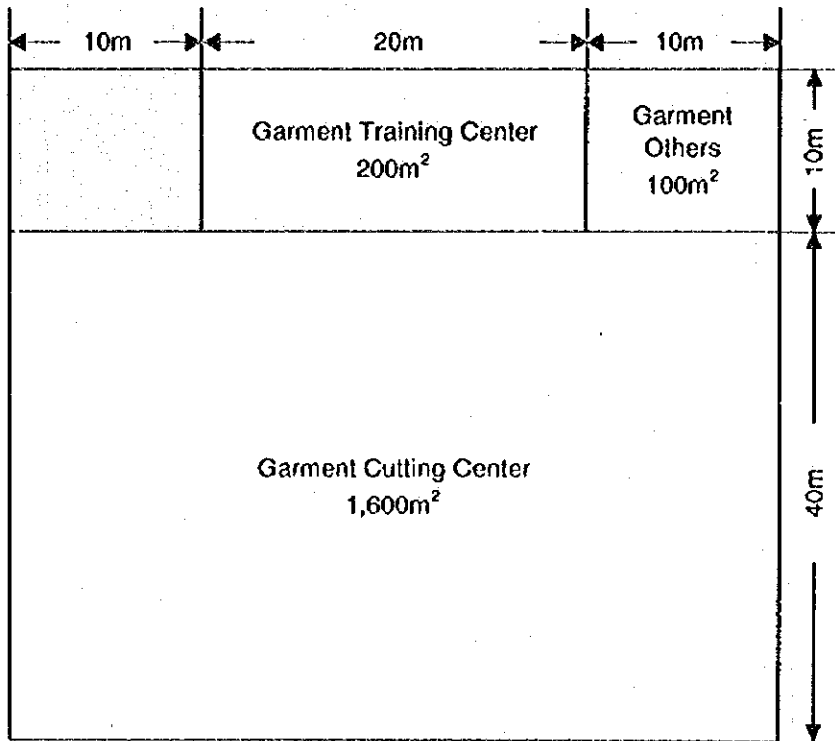
**Figure 4 Organization and Manpower Plan for Non-metal Mineral Department**



**Figure 5 Organization and Manpower Plan for Management and Administration**

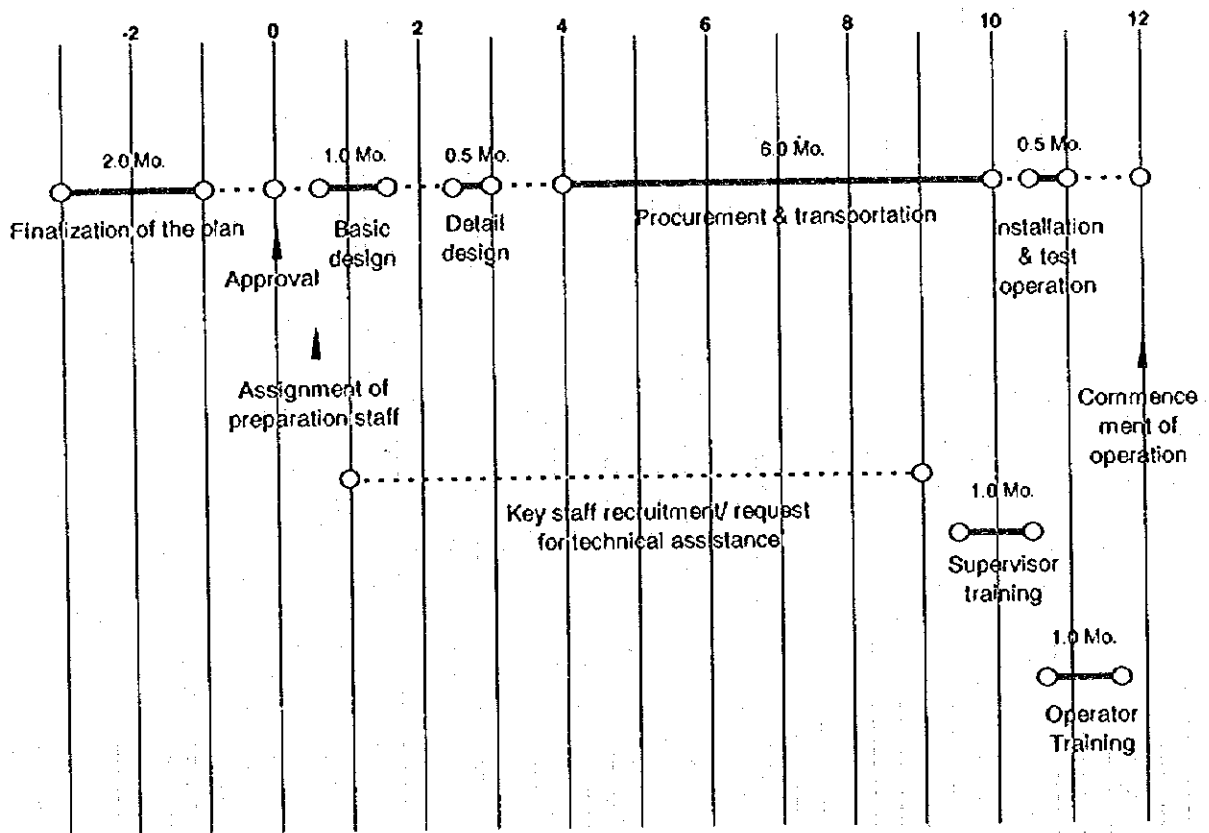


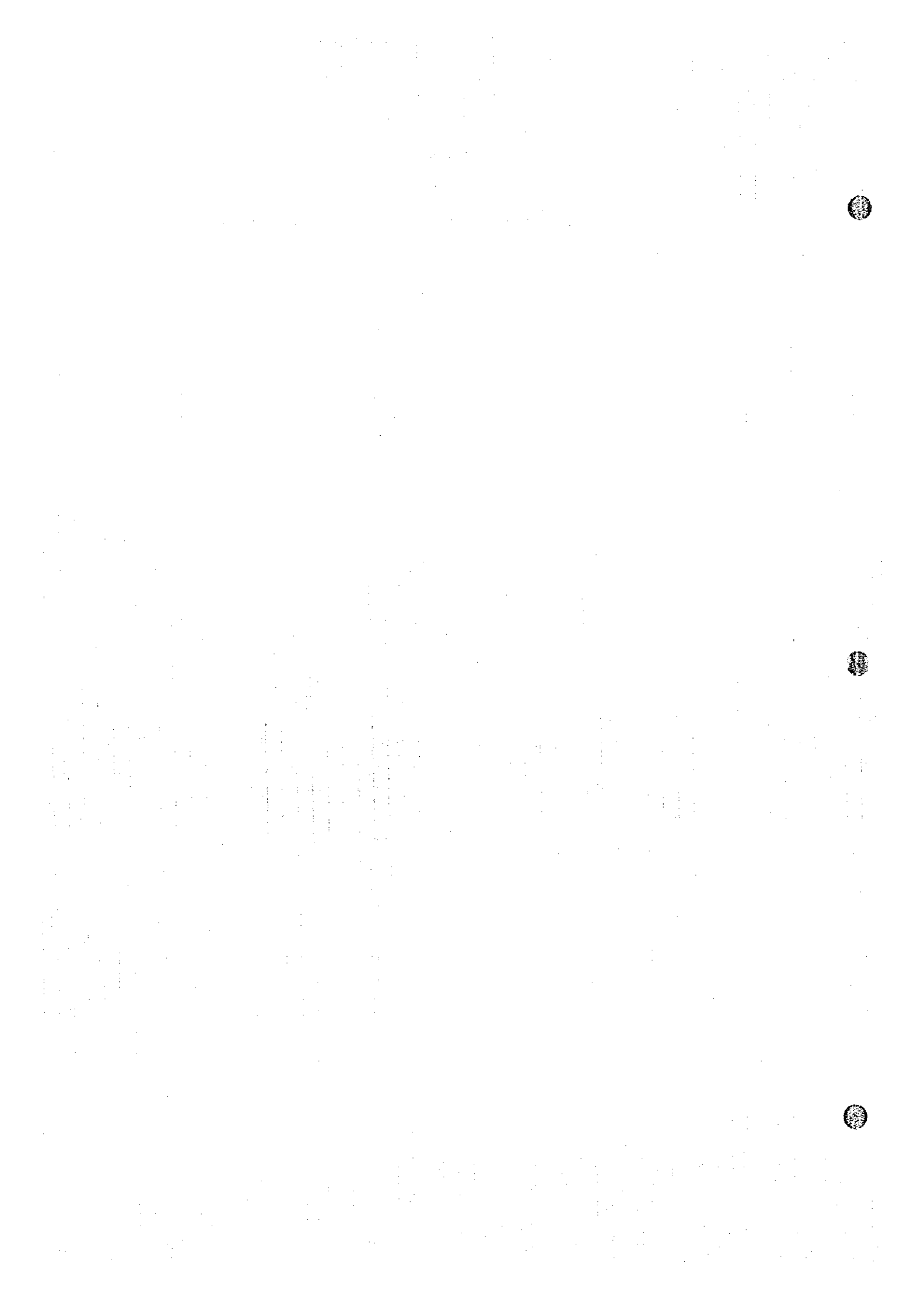
**Figure 6 Space Plan for Industrial Research Center**



Note :  Other Spaces 485m<sup>2</sup>

**Figure 7 Implementation Process for Establishment of the Center**









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