

REPORT
OF THE
Study Team on Design Organisations
IN
SELECTED PUBLIC UNDERTAKINGS



INFORMATION & RESEARCH DIVISION
BUREAU OF PUBLIC ENTERPRISES
MINISTRY OF FINANCE
GOVERNMENT OF INDIA
NEW DELHI

REPORT
OF THE
Study Team on Design Organisations
IN
SELECTED PUBLIC UNDERTAKINGS



JUNE, 1972

INFORMATION & RESEARCH DIVISION
BUREAU OF PUBLIC ENTERPRISES
MINISTRY OF FINANCE
GOVERNMENT OF INDIA
NEW DELHI

FOREWORD

The importance of self-reliance in the design know-how in the basic and heavy industries in accelerating the rate of economic development hardly needs to be emphasized. This is particularly so in the field of product design, which has to constantly keep abreast of modern developments in technology, and to seek to improve cost efficiency. In the early stages of our industrial development, public enterprises had inevitably to depend upon foreign know-how. In the course of the last two decades, some public enterprises, i.e., Hindustan Machine Tools Ltd., and Bharat Heavy Electricals Ltd. have made some significant achievements in the field of absorption of foreign design know-how and carrying out further improvements thereon. But there are a number of areas in which gaps have yet to be filled. In view of the fact that the growth of these design organisations has to be geared to the long term requirements of the undertakings in particular, and the country in general, the Administrative Reforms Commission had recommended that the undertakings should be assisted and encouraged to build up adequate design and consultancy services. In pursuance of this recommendation, the Bureau of Public Enterprises set up a small Study Group comprising representatives from Ministry of Industrial Development, Ministry of Steel, Central Engineering Design Bureau, Council of Scientific & Industrial Research, National Industrial Development Corporation and the Bureau of Public Enterprises to undertake a study of the structure and the performance of the design organisations in selected undertakings.

2. The Report of the Group examines various aspects of the working of Design Organisation in the Heavy Engineering and Machine Building Sectors including, their structure, objectives, the problems relating to attracting and retaining personnel of requisite talent, the deficiencies in the Collaboration Agreements, the need for ploughing funds into R & D and for strengthening the institutional links of public enterprises with the other national institutes

(ii)

engaged in similar activities. The Report also identifies certain gaps in product-design capability developed in these sectors, which should enable the concerned authorities to make appropriate efforts to bridge them. The recommendations made by the Group, I hope, would help the administrative Ministries and the undertakings to plan the future growth of the design organisations, with a view to promoting self-reliance and reducing dependence on foreign know-how and technology to the maximum extent possible.

3. I would like to thank the members of the Group for having spared their time to study this important matter and produced this useful Report.

A. N. BANERJI

Additional Secretary &

Director-General, Bureau of Public Enterprises.

INTRODUCTION

The ARC in its "Report on Public Sector Undertakings" had recommended that these undertakings should be encouraged and assisted to set up adequate design and consultancy organisation. This recommendation was accepted by Government and as a result the Bureau of Public Enterprises constituted a Study Team in March 1970 to carry out field studies of design organisations in selected public enterprises with a view to identify areas in which they needed assistance. The broad objectives of the study are enumerated in para 7 of the report.

The report is based on the material collected from selected public enterprises in response to a questionnaire and on-the-spot study of design organisations and discussions carried out with senior officers of the undertakings.

The study has helped to bring together information/data on design capabilities developed in selected public enterprises belonging to the heavy engineering and machine building group which, after all, is the most important sector of industry in which there is urgent need for design development and innovation. The report has also identified areas in which these enterprises still depend upon foreign know-how in respect of design etc. Based on this study the report has also drawn some general conclusions which may be of interest to public enterprises as well as to Government and help them in initiating steps which may lead to strengthening the effort towards building up indigenous design capabilities and taking policy decisions with the object of reducing our dependence on foreign know-how.

(iv)

The team would like to place on record its deep appreciation of the diligence and efforts put in by Shri V. G. Kesary, Deputy Director and Shri S. Vaidyanathan, Asstt. Director of the Information & Research Division of the Bureau of Public Enterprises in the preparation of this report.

1. Ajit Singh
2. K. D. Mariwalla
3. A. B. Mullick
4. A. P. Paracer
5. B. M. Sen
6. B. R. Singh.

CONTENTS

Chapter	PAGE No.
I Introduction	1
II Role and Importance of Design Organisations . .	7
III Objectives of Design Organisations	10
IV Structure of Design Organisations	17
V Design Development—Capabilities	23
VI Product Design—Gaps	39
VII Personnel Problems	46
VIII Applied Research	52
IX Foreign Collaboration and R. & D.	64
X Financing R. & D.	73
XI Government and R. & D.	77
XII Summary of Conclusions and Recommendations .	79

Annexure

I List of Points on which Information regarding Design Organisations was collected.	103
II Organisational Chart, details of staff and their emoluments and plans for strengthening of Design Organisations.	106
III Activities of the Central and Unit Design Development Departments of H. M. T.	122
IV Salient achievements of Design Organisations . .	125
V Details of Project Planning Work done by HEIL . .	137
VI Gaps in Design Know-how	138
VII Specific cases of use of Computers for Typical Design Calculations	144

Chapter I

Introduction

Design Development & Innovation

1.1 In a world of fast moving technology, technological innovation based on well-organised research and development activity is essential to retain existing, and to win, new markets. In the case of a developing country like ours, is also necessary, as far as possible, to reduce dependence on foreign collaboration for product design, particularly in the basic and heavy industries, to the minimum in the shortest possible period, with a view to generate self-reliant growth and to accelerate the rate of economic development. Technological change is an important factor responsible for economic growth. It has been established that about 40 per cent of the total increase in the per capita national income of the U.S.A. has been contributed by advance of knowledge.

1.2 Before Independence, India almost totally relied on foreign countries for design consultancy and plant engineering services. In the case of almost all projects in the public sector, the services of foreign collaborators and consultants were found to be essential. The skills required for answering vital questions relating to product design and equipment were not available in the country. We had necessarily to rely heavily on imported technical know-how. However, over the past two decades, we have been able to build up these skills and a number of research and design organisations such as the Research and Development Organisation for Electrical Industry, FACT's Engineering and Design Organisation, the Planning and Development Division of the Fertilizer Corporation of India, the Central Engineering and Design Bureau of Hindustan Steel Ltd. etc. have been set up.

Recommendations of the Administrative Reforms Commission.

1.3 The process of economic development and growth is continuous. To enable the country to reach the level of self-reliance in the field of industrial development, the existing technological gap between India and other countries has to be narrowed. Modern technologies, modified to suit the local conditions, will have to be adopted to achieve economies in product-design and operational cost. With the existing scarcity of skilled personnel, the growth of design organisations has to be carefully nurtured in the context of the long-term requirements of the country. It was in view of these considerations that the Study Team of Public Sector Undertakings, set up by the Administrative Reforms Commission, observed that [“the development of designing and consultancy capacity in the public sector has been hampered because a large number of independent public undertakings have been set up even in the same field of technology”] and these undertakings have set up their own design/consultancy cells. The recommendations made by the Study Team in this regard were endorsed by the Commission and were incorporated in its report on Public Sector Undertakings. These are:—

- (1) Public Sector Undertakings should be encouraged and assisted to set up adequate designing and consultancy organisations.
- (2) The work of project planning and formulation should be handed over to the Sector Corporations.
- (3) Turnkey contracts with foreign collaborators should ordinarily be avoided.

Government decisions

1.4 Government of India considered these recommendations and decided that “Public Undertakings should be encouraged and assisted to set up adequate Designing Organisation.” etc.

Constitution of the team

1.5 With a view to assess the adequacy or otherwise of existing Design Organisations and identify areas where they needed strengthening etc., the Bureau of Public Enterprises (BPE) set up

a Study Team in March, 1970 consisting of the following members.

1. Shri Y. P. Passi,
Joint Director & Ex-Officio Dy. Secretary
Bureau of Public Enterprises,
Ministry of Finance,
New Delhi.
2. Dr. B. N. Bhargava,
Chief, Project Plan & Development
Ministry of Industrial Development,
Internal Trade & Company Affairs,
(Dept. of Industrial Development),
New Delhi.
3. Shri A. B. Malik,
Industrial Adviser,
Ministry of Steel & Heavy Engineering,
New Delhi.
4. Shri T. M. Varughese,
Dy. Adviser (Construction)
Bureau of Public Enterprises,
New Delhi.

Six major public undertakings were selected for the purpose of the field studies to be conducted by the Team. These were:—

1. Heavy Electricals (I) Ltd.
2. Bharat Heavy Electricals Ltd.
3. Heavy Engineering Corpn. Ltd.
4. Hindustan Shipyard Ltd.
5. Hindustan Machine Tools Ltd.
6. Mining & Allied Machinery Corpn.

1.6 Since the team consisted of part-time members, changes in its constitution had to be made from time to time. It was felt that it would be useful to associate experts from the concerned consultancy, design and scientific organisations outside the Government and from public enterprises. Shri Y. P. Passi, Dr. B. N. Bhargava, and Shri T. M. Varughese could not continue in the Team due to exigencies of work and these members were replaced by Shri Ajit Singh, Director, B.P.E., Shri Kan. D. Mariwalla, Chief Consultant, National Industrial Development Corporation (NIDC) and Er. A. P. Paracer, Dy. Adviser (Construction) B.P.E. Two outside experts *viz.*, Shri B. R. Singh from the Central Engineering and Design Bureau of HSL and Shri B. M. Sen, Council of Scientific and Industrial Research were also included in the Team. The final constitution of the Team was

1. Shri Ajit Singh,
Director, BPE,
Ministry of Finance,
New Delhi.
2. Er. A. P. Paracer,
Dy. Adviser (C), BPE.
Ministry of Finance,
New Delhi.
3. Shri A. B. Malik,
Industrial Adviser,
Ministry of Steel & Mines,
New Delhi.
4. Shri Kan D. Mariwalla,
Chief Consultant,
National Industrial Development Corporation,
New Delhi.

5. Shri B. R. Singh,
Project Officer,
Central Engineering & Design Bureau,
Hindustan Steel Ltd.,
Ranchi.
6. Shri B. M. Sen,
Scientist 'E'
Central Mechanical Engineering
Research Institute.
Durgapur.

Object of the study

1.7 No formal terms of reference were laid down for the team. Keeping in view the broad objective of the Study Team as mentioned in Para 5 above, the Team decided to cover the following specific areas :

- (i) To assess the adequacy or otherwise of organisations for product designing in the context of the requirements of the undertakings;
- (ii) to find out the extent to which these have helped to establish indigenous capability in the field of product designing;
- (iii) the extent to which collaboration agreements have been made use of in making further improvements on imported designs and developing new ones;
- (iv) to identify gaps in the field of product design capacity and suggest ways to bridge them;
- (v) to laydown guidelines for manning design organisations; and
- (vi) to assess the adequacy or otherwise of the policy relating to research and design development activities and training of design engineers.

Methodology

1.8 The Team framed a detailed questionnaire (Annexure I) and circulated it to selected undertakings. It was decided that the Team should adopt the following procedure for completing its tasks :

- (a) The members would study the replies received from the undertakings and furnish their comments in the form of (i) points on which further information might be called for from the undertakings and (ii) points for informal discussion with plant authorities while making an on-the-spot study on the undertaking.
- (b) Consolidated lists of supplementary points be circulated to all the members.
- (c) The Team should visit all the selected undertakings for on-the-spot study and for seeking clarifications/information on the supplementary points.

The Team visited the selected undertakings including their constituent units during the period November 1970 to September, 1971. During these visits, discussions were held with Chief Executives and senior management and design officers of these undertakings. These visits helped the Team to collect relevant additional information from undertakings and to clarify a number of issues.

Chapter II

Role and Importance of Design Organisations

2.1 A large majority of the manufacturing/industrial units of the public sector have been established in areas in which the country has had no earlier experience. The processes and technologies involved in the operations had, therefore, to be borrowed from industrially advanced countries. This fact together with the initial lack of organised expertise and skills within the country necessitated wholesale adoption of collaborator's designs, specifications and operational techniques subject to certain changes made therein, with the general agreement of the collaborators.

Technological gap

2.2 As things stand at present, it appears impossible to bridge the technological gap between India and the advanced countries in the near future. In fact, there is a great possibility of this gap widening further because of the country's inability to invest resources in research and design development on a scale comparable with those of the advanced countries. In view of the urgent need to increase production capability as quickly as possible, it is perhaps difficult to divert a sizable part of the available resources for research and development purposes. Apart from this, the Indian context differs significantly from the advanced countries which have comparatively abundant capital resources and shortage of manpower. Their approach to evolving plant product designs and technologies has been largely conditioned by these two factors. In our case, while capital resources are either absent or limited, the

abundance of cheap labour may not provide the comparable driving force to innovate with a view to reduce labour costs. Despite this there is a peculiar challenge in a situation like ours in which scarce capital resources have to be conserved with a view to reduce costs. This challenge has not been fully accepted.

The designs obtained from abroad have invariably to be adapted/modified to suit the Indian operational environments. In the initial stages of economic development, buying foreign technologies/designs could help in cutting down long lead-time and heavy developmental costs, but no country can expect to progress and build up industries based on advanced technologies through continued and total dependance on other people's ideas. The need to innovate varies from industry to industry. It is intense in rapidly changing fields where products become technically obsolescent within a few years. This is so in young industries like Petro-chemicals, Electricals/Electronics etc. Complete independence in the matter of designs/technology, however, is virtually impossible to achieve. Nor can it become even an object of pursuit. In fact, the advanced countries themselves depend quite substantially on import of technology etc. from other advanced countries. In this connection, the following extract from the U. K. Report of the Central Advisory Council for Science and Technology on "Technological Innovation in Britain" is revealing.

"In 1964, for example, we spent only some £ 50 million royalties and licences, well below one-tenth of what we spent on our own R & D, and less than we earned from royalties we sold. At about this same time, France and Germany, which have prospered greatly in recent years, each spent on foreign royalties nearly three times as much as they earned from receipts on their own. Japan has been particularly successful in pursuing the same policy. Even in the USA it is common practice to buy other people's knowledge. For example, 15 of the 25 major innovations made by Du Pont, and powerful science-based organisation, came from inventions made outside the firm."

Selective approach

2.3 Public enterprises have built up considerable capability and skills in product design/technology over the last two decades. The time has now been reached when we should take stock of the skills developed with a view to plan further development based on a selective approach. It would be desirable to concentrate on development in selected priority areas. A stage of technological take off in design capability could be considered to have been reached once a high level of technological capability is reached in these selected fields, even though there may be a number of other areas where dependence on foreign collaborators may remain inevitable for sometime to come. Adequate design organisations have, therefore, to be built to meet these requirements.

Chapter III

Objectives of Design Organisations

3.1 An essential part of the attempt to building indigenous design capabilities is to set up design organisations with specific short and long-term objectives and to organise activities of the undertakings in relation to these objectives. All the undertakings under study have set up design organisations of various sizes. The objectives etc., of these organisations are broadly as follows:—

Heavy Electricals (India) Ltd.

3.2 Immediate Objective :

- (i) To get conversant with the various designs provided by the collaborators.
- (ii) To undertake manufacture in accordance with these designs with maximum indigenous content.
- (iii) To achieve the highest possible productivity (based on such designs) in the shortest time and,
- (iv) to make these designs up-to-date in line with current changes in technology.

3.3 Long Term Objective :

- (i) To achieve total self-reliance in the designing, drafting and manufacturing of heavy electrical equipment.
- (ii) To keep in the forefront of new developments in this field.
- (iii) To establish research and development activity with a view to provide the necessary backing for new and sophisticated products in future.

Bharat Heavy Electricals Ltd.

3.4 The objectives laid down for the Design Organisations in the Units of Bharat Heavy Electricals Ltd. are to design, develop and prepare manufacturing drawings for all the equipment to be manu-

factured at these units keeping in view the maximum use of standardised components. The immediate objectives also include compilation of commissioning and testing instructions, operation manuals, evaluation of the performance of the equipment manufactured after installation at site, systematic study of the performance of the equipment with a view to improving the designs, to offer consultancy and operative solutions to engineering problems arising in the course of manufacture, installation and operation of the equipment. In this case, as may be seen, the undertaking has gone beyond product designing to project designing and consultancy work.

3.5 At the Hardwar Plant, more specific goals in terms of development of new series of motors from the basic documentation received from the Soviet Union, development of flame-proof control-gear to meet the Indian Mining Regulations, development of steam turbines of a capacity of 200 MW and above etc. have been laid down as the long-term objectives.

3.6 The long-term objective at the Hyderabad Plant is to develop a series of small and medium turbo-sets to meet the requirement of industry and pumping sets for power houses and industries based on basic documentation obtained from the Czech collaborators.

3.7 The long-term objective laid down for the design organisations of these two undertakings in the field of Heavy Electricals in general, is to keep abreast of modern designs developed in the allied fields by leading international manufacturers/design organisations and to evolve more efficient designs with the ultimate aim of reducing the cost of equipment and improving its reliability and performance characteristics. As conservation in the foreign exchange requirement for such equipment was one of the long-term objectives for the setting up of these plants, the design organisations have, by and large, concentrated on substitution of indigenous materials to the extent possible and have also associated with other manufacturing and research organisations in the country in the development of indigenous substitutes e.g. special alloy steels, insulating materials etc.

Hindustan Shipyard Ltd.

3.8 The immediate objectives set for the design organisation was the diversification of ship building activities, which till now by and large had been confined to building a single series of vessels and catering to a single owner. The Shipyard, therefore, started tendering for small and specialised craft such as 'Tugs, Launches and small Dredgers' for Visakhapatnam Port. Attempts are also being made to take up construction of fast and sophisticated cargo liners, oil tankers, bulk carriers and large dredgers in the range of 2000 cubic metres — 5000 cubic metres capacity.

Heavy Engineering Corporation.

3.9 The objectives of the Design Organisation, include, among others, the following :—

- (i) Conversion of documents and drawings received from collaborators to render them suitable for production as per plant standards. This includes checking and Indianisation of the drawings, import substitution etc.
- (ii) Alteration and improvement of designs to suit customers specific requirements.
- (iii) Modernisation of the existing designs to keep abreast of the latest technological development.
- (iv) To conduct research activity required for further development of the existing products.

3.10 *H.M.B.P. Design Unit* : This unit has the more specific goals of developing design capability for manufacture of Heavy Equipment required in construction of Steel Plant and other basic industries like, oil, Mining etc. and over a period to make it self-reliant in these fields.

3.11 *H.M.T.P. Design Unit* : This Unit has undertaken the development of new type of totally indigenous tools which are not yet manufactured in the country.

3.12 Project and Development Division : Like BHEL, this undertaking also has a specific objective, beyond product designing, to undertake project design work connected with crushing, grinding sintering and pelletising plants and also Continuous Castings installations to be taken up on turn-key basis.

It has been specifically stated by M.D. H.E.C. (Shri S. L. Vadera) the objective of HEC for the next 3 to 5 years shall be the build-up of production to attain DPR rates of output and as such the work in all its units would have to be devoted single-mindedly to this end bearing in mind the fact that the long-term objectives are not harmed. The management of the design office would, therefore, reflect this philosophy *i.e.* accent on the short-term with a watching brief on the long-term. A design organisation can contribute both to its short-term and long-term objects by concentrating on the following aspects of improvement and value engineering:—

- (a) reduction in the varieties of materials used;
- (b) reduction in the variety of fittings and hardware such as nuts, bolts, keys etc.;
- (c) reduction in the variety of systems, controls and instrumentation, e.g. hydraulic systems, electric controls, lubrication systems etc.
- (d) development of quality standards and establishing manufacturing deviations permissible including examination of the manufacturing technique to increase processes reliability;
- (e) minor improvements in existing designs to improve marketability and reduce costs, and possibly improve assessability of components for maintenance;
- (f) absorption of foreign know-how as well as productionising of design developed in indigenous institutes such as CMERI etc.;
- (g) participation in erection and commissioning of the equipment;
- (h) liaison with customers regarding performance of the equipment and difficulties which are faced by them in operation, performance and maintenance of the equipment;

- (i) participating in project formulation and discussions leading up to a sale;
- (j) heading project teams for manufacturing and development of new items which may be of critical importance to the Corporation's image and good will; and
- (k) participating in seminars, discussions and even leading them.

Hindustan Machine Tools

3.13 The objectives of the Design Organisation of HMT are:—

- (a) To attain self-sufficiency in the development of machine tools in the country within a reasonable period;
- (b) To be independent, to a great extent, from foreign design and consultancy services;
- (c) To project the technical image of the organisation in the fields of their activity in local and foreign markets;
- (d) To make the products competitive in the international market, in order to obtain a fair share of the market;
- (e) To produce machines which can give quality performance at competitive rates.

Mining and Allied Machinery Corpn.

3.14 *Primary objective*: To achieve self-sufficiency and complete independence from foreign collaboration in respect of design documentations for the items projected to be manufactured at the Plant.

3.15 *Ultimate Objective*: To cater to the preparation of design documentations with a view to undertake the manufacture of mining and allied machines required in India and abroad and to completely eliminate the import of foreign design documentations and know-how.

Summary of objectives

3.16 The above narration reveals that broadly the following are the short long-term objectives of Design Organisations in these undertakings:—

(i) *Short Term Objectives :*

- (1) To get familiar imported designs and know-how.
- (2) To develop capability to carry out modifications to foreign designs with a view to utilise indigenous materials.
- (3) To achieve standardisation of components.
- (4) To achieve maximum productivity of products based on these designs.
- (5) To keep the designs acquired from abroad, up to date.
- (6) To draw up commissioning and testing instructions.
- (7) To evaluate the performance of equipment manufactured in order to improving the designs, solving engineering problems etc.
- (8) To solve technical problems of diversification of production connected with projects.

(ii) *Long Term Objectives :*

- (1) To be independent from foreign design and consultancy services.
- (2) To keep abreast of developments made by leading manufacturers and evolve more efficient designs, reduce cost, improve reliability and performance.
- (3) To build sound research and development activity to provide backing for introduction of new and sophisticated products.
- (4) To project the technical image of the organisation.

Conclusions & Recommendations

3.17 One of the common features of these objectives is that these are not, by and large, time-bound. In some cases, where the period is mentioned, the undertakings do not appear to have attached the requisite importance to it in the pursuit of these objectives. As a result, the gap between present capabilities and the desired goals remains still large. These objectives also do not provide any quantified yardsticks with reference to which their performance in terms of achieving design development targets can be measured. In the absence of this specific framework of reference, there is also no concrete plan of action formulated to achieve the specified goals.

Future production pattern

3.18 We would, therefore, recommend that each enterprise should draw up concrete, quantified and time-bound objectives in terms of its projected production and a detailed pattern schedule of programme directed to meet those objectives. The programme should also provide a system for its periodic evaluation in terms of its objectives.

Chapter IV

Structure of Design Organisations

4.1 The undertakings selected for study are functioning in those areas where developing of indigenous skills for design was recognised even in the initial stages. These undertakings have now more or less well-established designs organisations/cells. The organisational set-up, strength of staff and expenditure on their salaries, estimated increase in staff and expenditure thereof are given in Annexure II.

4.2 The criteria adopted by the undertakings for fixing the staff strength of design organisations were generally based on the recommendations of the collaborators as modified by the plant authorities to suit conditions obtaining in the country. Some of these are detailed below.

- (a) Type and quantity of products/equipments,
- (b) Frequency of repetitive orders,
- (c) Experience of the foreign collaborator in his own country, modified to suit Indian conditions.
- (d) Requirements of development work.

4.3 The Bharat Heavy Electricals Ltd., have stated that it is not possible to fix any norm for the staff strength because of the complex nature of the work involving electrical, thermal, ventilation and mechanical calculations. The strength required is assessed on the general advice given by the collaborators/specialists and the plant's own experience and estimates of design house/design months required for completing any new designs.

4.4 For the Equipment Design Division of HMBP the basic norm of one working designer and draughtsman per year for 65 tonnes of equipment has been adopted. This is based on the Soviet norm of 80 tonnes per year which is scaled down to allow for lack

of experience of Indian designer and also the production profile of HEC. The manpower requirements of the Project Design Division are completely based on the Soviet recommendations.

4.5 Based on their own experience, HMT have fixed a minimum of 12 persons for the design and maintenance of a particular product. These 12 persons are distributed in two groups; one deals with maintenance of machine tools and the other with advanced design aiming at the development of a new product. The former group handles designs required for jobs such as alteration service for manufacture, customer engineering service and minor improvements to improve the marketability of machines. The staff strength of this group depends upon the complexity of the job. The second group projects the development programme into the future for a period of 3 to 5 years.

4.6 In the MAMC, the staff strength of the design cell is determined on the basis of the anticipated work load for the next 3 to 4 years.

Organisational structure

4.7 The lack of clarity about the criteria for fixing staff strength of Design Organisations is again due to lack of specify in the objectives of these organisations. The organisation pattern of Design Organisations in these enterprises does not follow any set pattern.

4.8 In the Heavy Electricals, the structure of the design organisation is built around products and not around functions like engineering and sales. Each production section e.g., steam turbine, switchgear and control-gear, water turbine, generators and large electrical machines, traction motors and transformers, is headed by a Divisional Chief Engineer who is responsible for all the design and development activities relating to his product and reports to the Divisional Manager. In turn, a group of two or three divisional managers report to the head of the department, who has overall responsibility for the work of the product sections under his charge.

4.9 The three units of the Bharat Heavy Electricals Ltd., at Hyderabad, Hardwar and Tiruchi have their own design organisations.

The Chief Engineer of the plants at Hyderabad and Hardwar, who is the head of the Design Organisation, reports to the General Manager. The Chief Design Engineer, who heads the design organisation at the Tiruchi plant, reports to the Senior Dy. General Manager.

4.10 At the Hindustan Shipyard, the Chief Manager Project Desings reports directly to the Director of Ship-Construction.

4.11 The head of the design department of the HMBP reports to the Chief Engineer (Technical) and that of the HMTP to the General Manager.

4.12 The function of the Chief of Design Organisation in some plants has become increasingly more administrative and managerial. In order to allow him to continue to contribute his best to a field which he has specialised in, it is necessary that he should be divested of the day to day administration and managerial work. The Chief Designer and designers down the line should be completely free of all non-design accountability. Both working conditions and organisational procedures should be such as to allow them time to think, to observe production and allied operations, to discuss with experts in the various levels of other functions (IE, OR, Production, materials management, accounting etc.) in their own plant and outside. Simultaneously there is a case for inducting specialists in these functions in the Design Teams as regular members.

Staff strength

4.13 The Team found that there was considerable gap between the sanctioned strength and the actuals in position in the middle and lower categories. While no reasons have been given for this gap, it is obvious that the personnel with the requisite educational qualifications and experience required by the undertakings in these categories are not easily available. The position in Hindustan Shipyard is particularly acute. During 1969-70 as against sanctioned strength of 17 design engineers, the actual strength was only 5. Similarly HMT and HEC could obtain only 50% of their sanctioned complement of design staff. The two Heavy Electrical Plants have been more fortunate in having been able to recruit the required personnel.

4.14 Information regarding budgeted and actual expenditure on the design organisations has been received only from the two Heavy Electricals units. It is seen that the budgeted amount has been actually spent by them. The total provision made by HEIL and two units of BHEL on R&D during years 1966-67 to 1968-69 was Rs. 374.16 lakhs against which the actual expenditure was Rs. 374.99 lakhs.

Functional distribution of design staff

4.15 The bulk of the staff of the design organisations is mainly engaged in product design. An important point to be borne in mind is that the role of design cells of large public sector undertakings should be limited to improving and evolving product designs only so that cost of production could be brought down and the products improved to keep pace with technological progress and improvement. The scope of work relating to plant engineering/design is best allotted to separate public sector consultancy agencies. A limited portion of power station and industrial projects engineering work in the case of heavy electricals plants has, however, to be undertaken necessarily by the equipment manufacturers themselves.

In the Heavy Electricals (India) the number of persons carrying out estimates and process development was under 5 per cent, while about 4 per cent was engaged in the design of tools and other means of production. The rest of the staff was engaged in the development of specific items of plant to meet limited needs of improved processes. Designing of plant and equipment of a capital nature is not undertaken by this undertaking. Practically, the same situation obtains in the High Pressure Boiler Plant of BHEL, Tiruchi. These details have not been furnished in respect of the Heavy Power Equipment Plant, Hyderabad and the Heavy Electrical Equipment Plant, Hardwar. In the Hindustan Shipyard, the project design office deals exclusively with the basic design of ships. While dealing with the basic design this office also deals with project evaluation, research activities in liaison with research laboratories and educational institutes and cost evaluation for the submission of tender for a ship. In the Heavy Engineering Corporation while 392 persons were engaged in the product design department, only 42

persons were employed in the Jigs, Fixtures and Tools Designs Section of the Heavy Machine Tools Plant and the H.M.B.P. In the case of H.M.T., organisation of the Design for plant, tools and other means of production, design of methods and process and estimates are in the process of being established. Out of a total of 321 persons employed in the Design Development Department of HMT, 163 were engaged in product design, 134 in the designs of special purpose machines and the rest in areas connected with standards, technical information etc. The Mining and Allied Machinery Corporation has not furnished this information.

Design function : Functional or product based.

4.17 The appropriate form of design organisation set-up and whether it should be functionally based or built productwise, would vary from undertaking to undertaking. In an organisation like the HEIL, producing a large variety of electrical equipment, the design organisation is organised product-wise. This facilitates manufacturing engineering coordination. The older organisation wherein the design function was vertically integrated could not meet the needs of the manufacturing operations covering a wide field. Under the restructured productwise organisation, the triple function of design, manufacture and sales have been concentrated under the control of a Divisional Manager for each product group. This has helped to improve coordination and responsive activity among the executives. This system of design organisation is particularly well suited to a multi-product environment. In the HMT also, where a large number of different types of machine tools are manufactured, design effort for each product is concentrated in a group responsible for design and engineering assistance. This type of structure may not be suitable for enterprises like the Hindustan Shipyard where the functional system of organisation would be more suited.

4.18 Whether a centralised design organisation working on a functional basis would suit the requirements of a particular undertaking or a decentralised design function distributed product-wise would be more appropriate would have to be decided by the undertakings themselves taking into account their individual requirements, the stage of their development and the experience of organisa-

tions referred to above. In a multi-unit organisation, with each unit specialising in a particular area of production, the design and development effort would have to be decentralised. In the areas of "advance design" and where specialised skills are scarce, the advantage would lie in building up centralised design development facilities.

Advance design

4.19 While the building up of self-reliance in design capability at the earliest remains the long term objective of these undertakings, the present disposition of design staff is biased towards adaptation of product-designs and design of tools and other means of production. In order to achieve the long term objective, there is need to reorient the staffing pattern towards applied industrial research. The setting up of a separate Advanced Design Unit as part of the Design Organisation as in the case of HMT (Annexure III) would go a long way in evolving designs which keep abreast of latest developments.

Chapter V

Design Development—Capabilities

5.1 The capabilities built by the enterprises in the field of design organisations generally fall into three distinct categories viz :

- (a) Absorption of imported design know-how;
- (b) Improvements effected on the imported designs resulting in cost reduction/import substitution; and
- (c) Development of new designs.

Absorption of imported design know-how

5.2 In the HEIL, products like switchgear, control gear, transformer and capacitor are, by and large, designed by their own engineers, the dependence on consultants being negligible. The company have obtained from their collaborators only basic design-data which are made use of for the preparation of individual designs to meet the requirements of specific custom-built equipment. Some of the salient achievements of the design organisation in these areas are given in Annexure IV.

5.3 For standard products like boilers in the range of 60-120 MW and turbo-sets of 60-100-110 MW ranges, the BHEL have fully assimilated the basic design documentation and dependence on foreign consultants in these cases is almost absent. The details of the designs/equipment development of the units of BHEL, on the basis of documentation/data obtained from their collaborators are given in Annexure IV.

5.4 The Hindustan Shipyard Ltd., are entirely dependent on foreign know-how for 'Basic Design' of highly sophisticated semi-container cargo vessels, modern dredgers of large capacity and design of Bulbous/Ram type bows for highspeed vessels. Some of the projects undertaken by the undertaking are given in Annexure IV.

5.5 HEC are also now able to design several equipments required for coke ovens, press forges, sintering and pelletising plants, continuous casting-machines, drilling rigs, production gears, crushing and grinding equipments. Designing of constituent and ancillary equipment for rolling mills has also been successfully undertaken. Details of design work done by the HEC are given in Annexure IV.

5.6 Absorption of imported design/technological know-how in the case of Hindustan Machine Tools Ltd. is more or less complete. This has been possible because once a particular machine is manufactured in collaboration with a foreign firm, subsequent developments are pursued independently.

5.7 Mining and Allied Machinery Corporation are now in a position to design independently all types of equipment for which reference designs were obtained by them earlier from the collaborators.

Improvements on imported designs.

5.8 Design organisations, while translating the imported know-how to the manufacturing process, have also to make adaptations/modifications etc. These become necessary for various reasons. The designs obtained from collaborators are generally based on foreign specifications for raw materials and components. Modifications become necessary when these raw materials are not available indigenously and imports are not practicable. The activities of the Design Organisations are also directed towards bringing about cost-reduction by carrying out modifications/improvements to the original designs. The information received from the undertakings reveals that the Design Organisations have been instrumental in effecting sizeable savings in foreign exchange through import substitution.

Cost Reduction

5.9 Heavy Electricals (India) Ltd. have stated that the company's products are not repetitive in nature and as cost reduction is a team effort between different wings of the organisation, it is difficult to identify the contribution of the design organisation in this regard.

5.10 The Design Department of BHEL participates actively in evolving standards and norms contributing to reduction in the variety of components and has brought out items such as fasteners, gaskets, packing materials etc. The evaluation of the exact reduction in cost achieved by these measures is stated to be not possible. In one case, where they were able to replace Admiralty brass tubes specified in the original designs received from Czechoslovakia with arsenical brass tubes, substantial saving in the cost of oil cooler tubes occurred. They have also stated as their products are custom-built to unique specifications, the design effort has a very large role in improving the profitability of the company.

5.11 For the 110 MV sets manufactured by BHEL, the material suggested for blades was 'drawn profiles'. Since there was no facility available in India for extruding these profiles, they were substituted, after a series of studies, with rectangular bar stocks and mill profiles to the exact shapes. Even though the machining cost involved in this process is slightly more, they have been able to replace the Muntz metal tube plates with mild steel plates, effecting considerable economy, as the former had to be imported.

5.12 Similarly, as against the use of 90:10 Cupronickel tubes envisaged in the original design for condenser tubes, aluminium-brass tubes, which are cheaper, have been successfully adopted by BHEL.

5.13 The Hindustan Shipyard Ltd. have stated that by rationalisation and standardisation of several items used in the construction of ships, there has been some decrease in the cost of raw material. No estimate of cost reduction has been made by them.

5.14 In Heavy Engineering Corporation, no study regarding the contribution of the Design Organisation towards cost reduction seems to have been made. However, attempts are being made by the Design Department to bring down the cost of production by relaxing unnecessarily fine tolerances and surface finishes of the imported designs and rationalising the raw materials, bought-out items and other manufacturing components.

5.15 In Hindustan Machine Tools, reduction in the cost of manufacture is sought to be effected through suggestions schemes and a number of other methods. Apart from this, the Production Technology Cell works in close liaison with the Advanced Design Centre to arrive at economic design. They have also stated that the direct contribution of the Design Organisation to cost reduction cannot be assessed.

5.16 In MAMC, the Design Department carries out necessary modifications of imported designs to incorporate indigenous items and material. The Technology Department, as a co-ordinator between Design and Production Departments, suggests modification to suit available manufacturing facilities with a view to reducing manufacturing costs wherever possible. However, no study to quantify these has been made by them in this regard.

5.17 Design efforts have an important bearing on the profitability of an organisation. We would, therefore, recommend that specific studies with a view to assess the cost-benefit relationship in these design efforts should be carried out by the undertakings as a regular part of their Management Control System.

Material substitution

5.18 Heavy Electricals (I) Ltd. are using resin-glass tapes in the design of transformer cores.

5.19 Bharat Heavy Electricals Ltd. The Engineering Department, have been actively considering the substitution of different materials used in the manufacture of power plant equipment such as, turbines and their auxiliaries. This has been done to such an extent that only creep resisting steels, steels for which hot-yield valves are not available and such of the non-ferrous compositions which are not indigenously manufactured, are now being imported.

5.20 In the Design documentation for turbo-alternators received from Czechoslovakia, all the materials used were as per Czech specifications. Detailed studies were undertaken to find out equivalent materials, applicable to Indian conditions. In respect of turbo-alternators, exciters and their auxiliaries, suitable equivalents between the CSM materials and IS Specifications were first established. Also,

alloy steels available in the country were made use of to the extent possible. As a result of these efforts, they have been able to establish economic substitutes for a number of originally specified Czech materials. By making the designs more broad-based, it has been possible to obtain alloy steels from cheap sources rather than procuring these from Czechoslovakia at a higher price. Similarly, in regard to Electric Sheet Steel, it has been possible to establish indigenous sources. These changes in the quality of materials also meant a change in basic design concepts of certain parts of turbo-alternator/exciters etc. design changes had to be effected and detailed manufacturing drawings prepared.

Import Substitution

5.21 Heavy Electricals (I) Ltd.: The design engineer ensures that indigenous material is incorporated in the designs to the maximum extent possible. He is assisted in this task by the Materials and Standards Section. The savings effected is estimated to be about Rs. 760 lacs till July, 1968.

5.22 Bharat Heavy Electricals Ltd.: One of the major activities of the design organisation is the adoption of indigenously available raw-materials, semi-finished items and components. The Tiruchi Boiler Plant has achieved an indigenous content of 60-65 per cent of the total value of the products. Import is mainly restricted to raw-materials, such as, boiler quality plates, seamless steel-tubes, specialised valves fittings etc. The total foreign exchange saved by this unit so far, on this account, amounts to Rs. 3.18 crores. The import substitution at the other two plants has been lower owing to the non-availability of special alloy steel forgings and castings. Substitution has been achieved mainly in respect of rolled-steel products, brass tubes, certain insulating materials, smaller range of ferrous and non-ferrous castings, alloy steel forgings and certain finished bought out items. No estimate of the value of import substitution has been worked out in these plants. The undertaking have pointed out that the contribution towards substitution comes from the collective efforts of many departments and it is not, therefore, possible to single out and quantify the contribution made by the design department.

5.23 Hindustan Shipyard Ltd. : The value of import substitution effected by the design organisation during the three years ended 1969-70 was estimated at Rs. 53.97 lakhs.

5.24 Heavy Engineering Corporation : Very little import substitution seems to have been achieved at the HEC as hitherto they have been relying on imported CKD packs for assembling major machines.

5.23 Hindustan Machine Tools : In the initial stages, the import content varied from 60% to 80% and this has now been brought down to 8%. The undertaking have stated that it is difficult to further reduce the import content, as specialised equipment like quality bearings, high quality steel, quality hydraulic equipment which are not at all manufactured indigenously, have necessarily to be imported.

5.26 Mining & Allied Machinery Corporation : The value of import substitution resulting from the activities of the Design Organisation of MAMC during the three years ended 1968-69 is estimated by them at Rs. 199.20 lakhs.

Incorporation of New Features into Existing Designs.

5.27 Heavy Electricals (India) Limited. : The HEIL are now using thyristors in industrial drive designs which dispenses with motor-generator sets. Crimped terminals and aluminium bus-bars are now in use for heavy currents. In the design of hydro-generators, use of spring mattress type of thrust bearings, hydro-static lubrication of thrust bearings, adoption of umbrella or semi-umbrella types of bearing arrangements, plug-in-type of oil coolers, continuously fast acting type of static Automatic Voltage regulators and adoption of negative excitation in the main generator field are some of the new features adopted.

5.28 Bharat Heavy Electricals Ltd. : The Heavy Pressure Boiler Plant have made the following adaptations with suitable improvements on original documents received from Czechoslovakia.

- (i) Pulverised fueled fired boiler rated at 380 t/hr. for Bhandina Thermal Power Station of Punjab State Electricity

Board. The boiler is to match the steam parameters of 110 MW turbo-alternator being supplied by BHEL, Hyderabad. The improvements incorporated are additional cooling tubes to protect the reheater as also the removal of one stage of injection control to get finer performance.

- (ii) Natural gas fired boiler rated at 150 t/hr. for Assam State Electricity Board: The boiler is to match the steam parameters of 30 MW turbo-alternator being supplied by HE (I) Ltd., Bhopal. The adaptation here is by way of incorporation of skin easing which considerably reduces the weight of the boiler besides improving its performance.

5.29 In the case of the Heavy Electrical Equipment Plant Hardwar, new designs were developed on the basis of the reference documentation received from Russia in the following cases:—

- (i) Design of the first 30 MW Hydro set for Giribata Project in Himachal Pradesh comprising hydro-turbine, hydro-generator and associated control gear has successfully been completed and manufacture is now in hand on the shop floor.
- (ii) Design of 16 MW hydro set for Bhatgar Project has also been completed and the manufacture of the same would be taken up on shop floor shortly.
- (iii) Design of 630 MW Asynchronous machine has been evolved and the machine has been manufactured successfully. Final tests are now in progress.

5.30 Hindustan Machine Tools: The Design and Development Department of the undertaking has successfully designed and developed the following products:—

- (1) Tool Grinding and Lapping Machine—GT,
- (2) Cylindrical & Universal Grinding Machine—HMT-G9.
- (3) Centre Lathe—HMT L 45,
- (4) Fine Boring Machine with Hydrostatic Boring Heads—HMT FB,
- (5) Electrically Centralised Milling Machine—HMT E2.

- (6) Heavy Duty Radial Drilling Machine with Hydraulic Pre-Selection—HMT R-78,
- (7) Ram Type Milling Machine—MITR,
- (8) Centre Lathe (Low priced)—LT20,
- (9) Progmato Electrical Programming Unit,
- (10) Autosizing Equipment for dimensional control on Grinding Machines,
- (11) Gear Tooth Rounding Machine,
- (12) Multi-Spindle Drilling Machine,
- (13) Automatic Chucking Machine—Minichucker.

Material and Component Standardisation

5.31 Heavy Electricals (India) Ltd. have a very extensive set-up for material and component standardisation which is reported to have done good work right from the inception of their factory. Standards are available for almost all the materials used by them. As regards components, both divisional and company standardisation have been introduced whereby the designer attempts to make use of components already standardised on a company basis failing which he tries to choose a component out of one of the divisional standards. Only when it is not possible to make use of this, they go for new designs.

New designs

5.32 Heavy Electricals (I) Ltd.: Some instances of plants and equipment designed indigenously by HEIL for improving the manufacturing processes are given below:

- (1) Hydraulic hot and cold armature coils press for traction motor.
- (2) Paper tensioning device for transformers winding machine.
- (3) Modification to turbo-bar impregnating vessel.
- (4) Conversion of capacitor winding machine from single operation to double operation.
- (5) Large handling lathe for traction generator work.

- (6) Hand pulling machine for stator and armature coils.
- (7) Edge-winding machine for resistor elements. The design manufacture of the above equipment have been done independently without any collaboration.

5.33 Bharat Heavy Electricals Ltd. : In the HPBP, original designs are made for multi fuel-fired boiler capable of burning pulverised fuel, oil, natural gas and rated at 395 t/hr. to match the performance parameters of 120 MW turbo-alternators.

34 Development works have also been undertaken and those completed/in progress are listed below :—

- (1) Design of fabricated drum will ends—an import substitution which has resulted in a great saving in foreign exchange.
- (2) Raw coal chain feeder size R 400.
- (3) Screw conveyer for pulverised coal size 320 mm × 9600 mm.
- (4) Needle type raw coal bunker closure of various sizes.
- (5) Hand-operated plate type raw coal bunker closure.
- (6) 2 sizes of hand-operated shut off damper in the pulverised coal—primary air line.
- (7) Screw operated shut off damper in the hot air line.
- (8) Forced draft fan, type radial, dia 1400 mm.
- (9) Induced draft fan, type axial, dia 1400 mm.
- (10) Induced draft fan, type axial, dia 1120 mm.
- (11) Induced draft fan, type axial, dia 2500 mm. (Biggest size designed and developed).
- (12) Primary Air fan DL 2 1600 mm.
- (13) Forced draft fan DLN/2 1000 mm.
- (14) Special fan for Fertilizer Corpn, Sindri DLN/2000.
- (15) Forced draft fan type DLN 2000 mm.
- (16) Forced draft fan type DLN 1000 mm.
- (17) Various sizes of de-aerators and feed water tanks.
- (18) Soot Blowers.

- (19) Power coupling for various applications.
- (20) Chain feeder variator drive for various applications.
- (21) Rectangular non-return type closure for raw coal piping.
- (22) Disc feeder for raw coal.
- (23) Floating seal for pulverised fuel rotary valves.
- (24) Anti-vibration mount for fans.
- (25) Switchgear for mining industry for use with medium voltage motors.

5.35 Apart from this, the plant has prepared original designs for 87 types of valves including the 600 mm. stop valve weighing about one ton, 407 castings drawings, 30 forging drawings for valve components.

5.36 The switchgear was completely developed by BHEL. Hardwar and no assistance was obtained from the USSR as the system used in the USSR mines is different. The development work covered the entire designing work with indigenously available components. The units also developed cover requirements that are normally necessary for Mining Industry for this particular type of starting gear.

5.37 The turbo-set supplied to Delhi 'C' Thermal Power Station needed certain special requirements in regard to the condensate design. The condensate had to be completely redesigned making major modifications in respect of the cooling area as well as structural design. Designs were developed for two cooling water heat exchangers for bearings in the equipment to be supplied for the Tuankur Jaafar Power Station, Malaysia, by the Tiruchi Plant. Designs were also developed for condensers, heaters, etc. for smaller turbo-sets required for projects such as, Ballarpur, Haldia etc; heaters for Bhilai Steel Plant and coolers, LP heaters, condensers ejectors etc. for 20 MW set against an export enquiry received from M/s Kuljian Corporation. In the Pumps Design Department, completely new design for circulating water pump for 110 MW sets was developed. The BHEL are receiving enquiries from time to time for various industrial turbines such as condensing turbines with

regulated extraction, back-pressure turbines with regulated extraction, condensing turbines without regulated extraction etc. Since, some experience has been gained in the methods of calculation in the design of condensing turbines and back pressure turbines, without regulated extraction, of comparatively smaller sizes upto 25mw., they are drawing up the specifications of these turbo-sets themselves. These specifications call for guarantees as regards specific heat consumption for which it is necessary to work out complete calculations in detail. They have undertaken such work for a few sets as an exercise wherein it has been possible to work out detailed blading plans, flow passage blade heights, casing design etc. In so far as auxiliaries required for industrial turbines are concerned, they have been developing these designs also independently.

5.38 Heavy Engineering Corporation : No technological innovation in the field of design development is reported to have been carried out. It is stated by them that in view of the accent placed by the undertaking on the short term objective, it is quite possible that the design incorporated in a particular equipment would be considerably out of date by the time mature designs are developed unless access is available to foreign or indigenous agencies which can help with the latest developments. It would be possible to break loose from the apron strings of the collaborators only when the second generation cycle starts.

5.39 Mining and Allied Machinery Corporation : The design organisation of MAMC has been able to design independently the following machines and equipment during the last three years. It is note-worthy that in a number of cases, though the tracings and drawing were purchased from outside, modifications were carried out by the Design Department independently to suit Indian conditions :

- (i) Salt Scraper
- (ii) Diesel Locomotive
- (iii) Belt feeder
- (iv) Cable Standing Machine
- (v) 20-HP Agricultural Tractor
- (vi) Gear Boxes—upto 220 KW
- (vii) Blade feeder
- (viii) Apron feeder

- (ix) Spreader
- (x) Plate conveyor
- (xi) Sampling plant
- (xii) Wagon Marshalling Equipment
- (xiii) Wagon Charging Equipment
- (xiv) Mine Fan*
- (xv) Underground and surface haulage*
- (xvi) Pontoon mounted sand pumps
- (xvii) Scraper Haulages both for sand and coal*
- (xviii) Conveyor system both surface and underground*
- (xix) Surface and underground water pumps of various capacities.*

5.40 Details of design work carried out by this undertaking during the last 4/5 years are given in Annexure IV.

5.41 From the above, the conclusion emerges that, in the earlier stages, because of the emphasis on production to meet current demands, the undertakings have paid comparatively less attention to applied Research & Development in the field of design development. In fact, in certain enterprises, the design organisations existed only in a rudimentary form. Where the Organisation was developed, their skills were directed to modifying the designs, specifications and drawings obtained from the collaborators into schedules which could be used by the Production Department. The Design Organisations were also engaged in solving technological problems arising during the course of production. Such problems related, in general, to minor modifications, evolving substitute materials and adaptations to suit Indian conditions. The Design Organisations, where they exist, have been useful in absorption and assimilation of borrowed designs of products/equipment. While this surely is a gain and is necessary to build up a base for strong design development activity in the country, it does not help in bridging the technological gap between us and the advanced countries. The technological advances made in some of these countries can be traced to the high pitch of development activity, a large content of which is directed towards programmes oriented to provide answers to problems of the future, evolving entirely new products and equipment etc. In contrast, our

*Referencee dawing were available only in these cases. The other items have been devloped without any reference drawing

development activity is of the 'absorptive' and not of 'innovative' type. It is to the fostering of the latter type that our skills should be directed. To reach such a stage, design organisations should lay greater emphasis on keeping their horizons and visions broader and avoid fixation of their vision only on segments of immediate interest. It would be appropriate to mention here that in a country where resources are severely limited, their allocations for design development activity has to be flexible and directed to meet priority requirements.

5.42 It was felt that as a number of products are custom-built to unique specifications the design effort has a very large part to play in improving the profitability of the company. We would recommend that this should be brought home to the undertakings in sufficient force.

5.43 It is necessary that the production of specialised equipments like quality bearings, high quality steel and quality hydraulic equipment should be undertaken indigenously after working out their economics and their impact on the promotion of indigenous technological advancement.

Project designing.

5.44 Apart from the design of equipment for customers' projects, HEIL undertake project planning work for all expansion schemes inside the factory. Details of such work completed during the last five years are given in Annexure V.

5.45 Mining & Allied Machinery Corporation have designed the ore and coal handling plant for Haldia Dock Project. They have prepared a preliminary project report for the Tuticorin Harbour Project. They are also engaged in the preparation of drawings for expansion of Paradeep Port and fertilizer unloader for the Kandla Port. Designing fabrication and erection of the structurals required at Haldia have also been taken up. They are also supplying bulk handling equipment for Marmugao, Madras and Paradeep ports and are negotiating with the Coal Board for the design, manufacture and installation of hydraulic transportation of sand through pipes.

5.46 In the Heavy Engineering Corporation, project design work and allied construction and installation jobs are undertaken by a separate division called the Project and Development Division. This Division has undertaken on a turn-key basis the following jobs :

- (1) Horton sphere.
- (2) Pig casting machine at Durgapur.
- (3) Revamping of 28" bar mill at Ichapur.

They have also prepared technological schemes and submitted quotations for Re-rolling Mill, Grinding and Crushing Plants and continuous casting plants. The setting up of the Design Organisation in the Heavy Machine Building Plant has helped in developing design capability in areas where design and manufacturing facilities were not available in the country.

5.47 Heavy Electricals (India) Limited claim that the activities of their Design Organisation have helped them to diversify into allied lines of production, such as power rectifiers, contractors, etc. They have also been able to undertake some repair jobs on generators supplied by foreign firms which otherwise would have had to be shipped abroad for repairs. Example of repair work done on generators supplied by foreign firms are : —

- (1) Machining of 2 Nos. L.P. Rotors.
- (2) Change of coil binding ring on Turbogenerator Rotor.
- (3) Repair of end bell on 30 MW. TG rotor of AEG make.
- (4) Repair of 62.4 MW, TG Rotor.
- (5) Repair of 15 MW Rotor.
- (6) Balancing of 33 MW TG Rotor.
- (7) Repair of Turbine Rotor Unit 1.
- (8) Repair of Turbine Rotor Unit No. 2.
- (9) Repair of Generator Rotor Unit 2.

- (10) Repair of 100 MW stator coils.
- (11) Re-insulation of stator bars of 35 MW hydro-generator (276-stator bars).

5.48 An important point to be borne in mind is that the role of design cells of large public sector undertakings, should be limited to improving and evolving product designs only so that cost of production could be brought down and the products improved to keep pace with technological progress and improvement. The scope of work relating to plant engineering/design is best allotted to separate public sector consultancy agencies. A limited portion of power station and industrial projects engineering work in the case of heavy electricals has, however, to be undertaken necessarily by the equipment manufacturers themselves.

Performance standards

5.49 In most of the undertakings studied, design organisations have been functioning, by and large, on the basis of the available job lead. The practice is to lay down the programme after taking into consideration the particular type of equipment and the delivery schedules. The undertakings have reported that generally the design organisations have been able to fulfil the stipulated targets which are based on various norms. The Heavy Electricals India Ltd. fix the targets for the issue of engineering and manufacturing information by the design engineers on the basis of their planned output for different types of equipment. The Bharat Heavy Electricals lay down production targets for the factory as a whole. In the case of Hindustan Shipyard, though it has not been possible to lay down any performance targets owing to the Project Design Office being in its early stages of formation, several new designs were taken on hand during the last three years and tenders submitted successfully. The Heavy Engineering Corporation have set a norm in regard to standard sheets per head of technical personnel per month. Performance targets are normally laid down in Hindustan Machine Tools for the development programme of a particular

schedule. The MAMC lay down annual programme for their design organisation wherein schedule periods are specified for each item. These targets were generally reported to be achieved.

5.50 From the foregoing, it is obvious that no specific performance standards in terms of design output are laid down by the enterprises. What is being done is only to indicate a 'standard' for output of making copies of drawings received from the collaborators but not in terms of any original design work. It was also felt that in the absence of these specific goals, the recruitment of design engineers also is not related to specific design 'task' but is oriented towards general strengthening of the organisation. We would therefore, suggest that the Design Organisation should as far as possible be product based with specific time-bound and quantified goals. The recruitment of engineers should also accordingly be with reference to specific individual design 'tasks'.

Chapter VI

Product Design-Gaps

6.1 It was discussed in the earlier chapter that undertakings have made considerable progress in mastering the design capability in respect of the products they are currently manufacturing. However, there are a number of areas where wide gaps still exist between the needs of their production programmes and the design capabilities developed by them. The extent of these gaps is detailed below:

Heavy Electricals (India) Ltd.

6.2 While basic know-how exists for the design of most products currently manufactured by HEIL, the undertaking continues to be dependent on foreign design know-how for steam turbines and turbo-generators. In respect of products like large meters, hydro-generating plants, etc. HEIL will still have to go in for further collaboration for designs of hydro-turbines for pump storage schemes, nuclear turbines and gas turbines. Such collaboration has to be resorted to mainly in order to cut short the delays and costs involved in developing these designs indigenously with the expertise available. In respect of steam turbines and turbo-generators, they are in the process of building up design expertise and have entered into a seven year collaboration agreement with the present consultants. External assistance for design know-how is now obtained only for specific items calling for know-how which they do not have and which could be developed by them only at great cost involving lot of delay. Examples of cases where design know-how gaps exist at present are given in Annexure VI.

Bharat Heavy Electricals Ltd.

6.3 For designing boilers of parameters higher than 120 MW, BHEL has to depend on foreign design consultants as it will take them some time before they can be backed by large scale research.

catch up with modern advances. The Boiler Plant is already negotiating with the leading boiler manufacturers for additional design know-how.

6.4 In the case of hydro-generating sets or for special types of motors for which designs would have to be developed locally at Hardwar to suit the customers' specifications, it is necessary to draw upon reference information available with their collaborators. In respect of specially complicated designs, BHEL have made arrangements for sending the designs developed at Hardwar for vetting by Soviet Designs Institutes. There is a provision under the existing contracts for obtaining documentation in respect of equipment manufactured by the collaborators on a 'per sheet' basis.

6.5 For developing new designs of small and medium turbo-sets for the industry, turbo-blowers and compressors for chemical and fertilizer industry, dependence on collaborators for basic documentation would continue for some more time.

6.6 Till such time as adequate research and development facilities are established within the country, dependence on foreign design and consultancy firms for manufacture of sophisticated equipment which is included in the profile of BHEL units will continue. Some of the areas where technological gaps, as identified by the Tiruchy Unit, exist, are given in Annexure VI.

Hindustan Shipyard Ltd.

6.7 In the case of Hindustan Shipyard, no collaboration arrangement as such exists for the purchase of design know-how. However, they buy designs and drawings whenever a customer wants them to build repeats of vessels already designed and built abroad, by payment of suitable fees. The Hindustan Shipyard have not so far built sophisticated semi-container cargo vessels and modern dredgers of large capacity. In these areas, they are dependent on foreign consultancy for basic designs. The same is the case in respect of design of Bullous/Ram type Bows for high-speed vessels. The undertaking has also felt acute shortage of trained personnel in design and drawing office work and has not been in a position to undertake

design work in respect of these activities, owing to the magnitude and complexity of their nature. The undertaking's dependence on foreign design and consultancy firms will, continue for quite some time, unless special steps are taken to develop such capability within the country.

Heavy Engineering Corporation

6.8 So far, the undertaking has been depending, to a large extent, on foreign design know-how for heavy steel plant equipment and heavy machine tools. The undertaking feels that collaboration with the foreign firms would help them in development of indigenous design in course of time. Examples of gaps in project and process design capacity are given in Annexure VI.

Hindustan Machine Tools

6.9 The undertaking does not have much dependence on foreign design and consultancy firms at present, except in respect of certain complicated and sophisticated machines. The undertaking has however, experienced considerable difficulty due to the non-availability of either agencies or experts in the field of design in Hydraulics and Numerical Controls necessary for developing sophisticated machine tools for Aircraft and Defence Equipment manufacture.

Mining & Allied Machinery Corporation

6.10 The undertaking is not dependent on foreign technology. With regard to design, they are dependent on foreign sources for coal washing and mineral dressing plants, hydraulic pit press, and bulk handling equipment including belt conveyers. Manufacturing activity in these lines has only been taken up recently.

Value analysis and maintainability

6.11 The importance of "value analysis" and "maintainability", in the designing process does not seem to have been realised by the undertakings. Practically no studies have been conducted to relate design activity with achieving optimum productivity and to assess its impact on the overall efficiency of the organisation. There is no "Value Analysis Cell" in the Heavy Electricals (India) Ltd. The

maintenability aspect is taken care of through action on feed back reports received from customers. The undertakings have suggested that a "Value Analysis Cell" and a "Product Development Committee" should be set up, the former consisting of people drawn from other disciplines such as production, sales and purchase besides design. It has been suggested that Sales and Site Erection Engineers should also be present at the meetings of the Product Development Committee. While there is no regular arrangements for undertaking the exercises of "value analysis" and "maintenability" in Bharat Heavy Electricals, the undertaking report that these techniques are employed at every stage of the design work, as this forms part of the training received by the design engineers. Since the R & D cell and the Central Design Organisation report to a Chief Engineer there is constant exchange of ideas and knowledge between the two wings. In the Heavy Engineering Corporation, these factors are stated to be taken into account by the designers in the design of all equipments. Discussions are held regularly with the steel plants to find out difficulties in erection, operation and maintenance and with a view to incorporate suitable changes in equipment. A joint study group consisting of designers from HMBP and CEDB examines the relevant problems in detail and the "value analysis" aspect is taken care of during these discussions. As far as ship design is concerned, Hindustan Shipyard expects that greater attention will be paid to "value analysis" and "maintenability" after attaining self-sufficiency in design know-how and indigenous manufacture of ships' equipment. However, they have reported that full performance tests lasting over a month are done on every ship delivered. At the design stage, every new design evolved by them is model tested in the model testing tanks either in India or abroad to compare the theoretical results and to modify the design, if necessary to achieve the desired results. Efforts are also being made to establish on a sound footing feed-back information from ship-owners. Hindustan Machine Tools wants that Value Engineering Departments, reporting directly to the Chief Executive and working in close liaison with the Design and Development Department, should be set up. In the Mining and Allied Machinery Corporation the question of maintenability of the equipment is kept in view while designing it. While the question of cost reduction is usually

considered at various stages, "value analysis" is not done. To integrate these functions with the other functions of the Design Organisation, the undertaking has suggested that Maintenance Engineers, Value Engineers and Production Technologists should be associated in the finalisation of design work.

6.12 By and large, the concepts of "Value analysis" and "maintenability" have not had full implementation and no adequate control systems have been built to assess the cost/benefit of design efforts. It is highly necessary that these concepts should be given practical shape and necessary machinery set-up in each undertaking for this purpose. In this connection, we would recommend setting up of Product Development Committees in the plants involving functions such as production, sales, purchase, as well as value engineers and maintenance engineers. A suitable control system for receipt of feedback information on maintenance problems with a view to identify improvements required, should also be built.

6.13 Practically no studies have been carried out to relate design activity to achieving optimum productivity and to assess the contribution of the design organisation to overall improvement in efficiency of the undertakings. Regular studies should be carried out by the undertakings to assess the cost-benefit relationship of design efforts as a part of their management control systems. These studies will also help in drawing up their future programmes more effectively and efficiently.

Computers and design calculations

6.14 The use of computers for purposes of design calculations is yet in the initial stages. The Heavy Electricals (India) Ltd. hire computer-time as and when required from IIT, Kanpur and Tata Institute for Fundamental Research, Bombay. The type of problems solved on computers can be broadly categorised as :—

- (i) those involving algebraic equations only, such as motor design, transformer design and generator design.
- (ii) those involving matrix equations such as power system analysis problems and mechanical stress calculations of hydro-generators.

- (iii) those involving differential equations which are solved by numerical analysis techniques such as steam flow calculations in turbine and Heat Exchangers.

Certain specific cases of use of computer by them for typical design calculations are given in Annexure VII. Bharat Heavy Electricals Ltd. utilise the computer facilities available at the Indian Institute of Science, Bangalore, College of Engineering, Guindy and the IIT, Kanpur. Some of the major problems tackled on computers are :—

- (i) flexibility calculations of pipelines.
- (ii) analysis of boiler supporting structure,
- (iii) dynamic modelling of super heaters, and
- (iv) Re-circulation calculations.

The undertakings have given specialised training to design personnel in Fortran and Autocoder languages. The HEC have not so far used computers for design work. The Hindustan Shipyard are equipped with an IBM-1401 computer which has been used by them to obtain Bonjean's curves, hydrostatic particulars, mid-ship sections and moment of inertia data of ships. They have reported a considerable saving in time as a result of the use of computers. The Hindustan Machine Tools also have used the computer for (i) the design of machine tool elements like gears and clutches and (ii) optimisation of machine tool drives. The Mining and Allied Machinery Corporation have not used computers for their design work so far.

6.15 The application of computers for design calculations etc. in the undertakings is yet only occasional. Computer has, obviously, important bearing on design development. Its application by undertakings will increase as their capabilities for independent design development increase. The team would recommend that the undertaking should be given full assistance to utilize computer facilities available outside them or to acquire their own computers, wherever necessary. Since they may not be able to utilise the computer fully for this purpose time-sharing facilities would be much cheaper.

Conclusions

6.16 In the heavy electrical sector, the enterprises continue to be dependent on foreign sources for design documentation in certain fields of manufacture e.g., steam turbines, turbo-generators, pump-storage, nuclear, and gas turbines; boilers of parameters higher than 120 MW, special types of motors and hydro-generating sets; Small and medium turbo-sets, turbo-blowers and compressors.

6.17 In the machine building sector also, undertakings continue to be dependent on foreign designs for heavy steel plant equipment dressing and heavy machine tools; coal washing and mineral plant; Coal mining machinery and bulk handling equipments. Dependence in the case of machine tools is limited to certain fields of complicated and sophisticated machines.

6.18 There is total dependence on foreign know-how sophisticated ship design viz. container ships, tankers, bulk carriers etc.

6.19 For developing design capabilities in the fields of hydraulics and numerical controls necessary for developing sophisticated machine tools for aircraft and defence equipment, HMT are in need of foreign collaboration. This is another important area in which government should give them necessary help to develop such capabilities at the earliest.

Chapter VII

Personnel Problems

7.1 As the areas of operation of the selected undertakings were new to the country at the time these undertakings were set up, experienced personnel to man the design department were not available. The procedure generally adopted by the undertakings in recruiting the required staff was (i) to draw upon experienced persons in allied industry and (ii) to recruit raw engineering graduates and train them in the collaborator's works or in the training schools attached to the undertakings. Apart from the difficulties in obtaining suitable persons, the undertakings were also experiencing considerable difficulty in retaining qualified technical personnel as job opportunities both within the country and abroad have increased. The major attraction of job security in Government undertakings no longer holds good, in the context of better emoluments and benefits offered by the private sector to the design personnel who have gained experience in the public undertakings. In fact, there appears to be a deliberate attempt by the private enterprises to 'steal' them away from these undertakings as it is cheaper to do so rather than train up fresh design engineers from the raw.

7.2 The development of a designer also requires careful attention. The career of one of the foremost designers of the nation gives a clue to the type of person who can be called a top designer. He started as a dynamo meter car supervisor and then moved over to the Drawing Office and thereafter was Production Engineer in one of the major Railway Workshops, from where he moved to the Central Standards Office of the Railways. After a career of approximately 15 years he developed the original designs for WP and WG Locomotives. In the process he developed the nucleus of a design team which today is recognised as one of the best of its type.

7.3 It is interesting to note that the nucleus which was built up by him at the Central Standards Office, later on became the Research

Design & Standards Office of the Railways. The persons staffing it even today have a wide and varied background, particularly in operation, maintenance and manufacture.

Flight of personnel

7.4 It has been revealed by a separate study made recently by the Bureau that the incidence of flight of technical personnel is highest among graduate engineers. The undertaking stricken most by this problem is the MAMC. The study has found that this Corporation lost 27 out of 57 engineers trained by them in the fields of design and technology development. The study has also found that the loss has been greater among design engineers as compared to other technical personnel. The Heavy Electricals (India) Ltd. lost 9 out of 23 engineers in the important Turbo Generator Group. The Heavy Machine Building Plant of Heavy Engineering Corporation who have a large number of design engineers have been losing these at the rate of one out of 5 engineers of the junior and middle executive levels over a period of three years which comes to an annual average of 6%. The study found the position to be similar in the plants of Bharat Heavy Electricals Ltd. The engineers, who resigned, were generally in the age group of 25 to 35. The reasons for resignation of these persons were (i) for going abroad either for study or for employment or for improving career prospects, (ii) more congenial work environments elsewhere (iii) to join another enterprise for bettering prospects, (iv) the tendency of management to concentrate more attention on manufacturing activities and less on the areas such as designs, research and development etc. which are slow in yielding results and which also keep the Design Bureaus consequently under-loaded resulting in the designers spending their time in looking for better prospects outside. A number of design engineers are also reported to have acquired jobs outside the country. The flight of highly qualified and experienced design engineers outside the organisations, particularly outside the country, represents a substantial loss to the undertakings who have invested so much money in their training. When design engineers are forced to seek jobs abroad, the loss is to the country; this, when we are trying to attract engineers back home, is a serious reflection on our present policies and a proof that our incentives to retain them in the undertakings/

country are not sufficiently attractive. In some cases, for want of promotion opportunities within the Design Organisations, experienced Chiefs of Designs have gone over to higher managerial or administrative posts, thereby, denying the Design Organisation, the benefits of their rich experience. One such case was brought to the notice of the Team during discussions with the General Manager of the Tiruchi plant of BHEL. He pointed out that, for want of adequate promotion opportunities within the Design Department, a Senior Design Engineer in one of the plants, one of the very few specialists in the country in his field, was offered the post of Materials Manager in the same plant in complete disregard of the loss of expertise and experience it would involve to the Design Department. Similar cases of loss of design personnel to the Design Organisation had occurred in other plants/enterprises also.

7.5 The difficulty caused as a result of stagnation and consequent frustration among design personnel has been emphasised particularly by the Heavy Electricals (India) Ltd. With the stabilisation of these Design Development cadres, they find that they are not able to create adequate opportunities for career advancement and thus provide for prospects to satisfy the legitimate aspirations of its young engineers. The factors responsible for this situation are :

- (a) Recruitment of a large number of engineers in the earlier stages of the project at almost the same period either for foreign training or for training in India.
- (b) As such officers are in the age group of 28 to 45 there is not likely to be any significant retirement during the next 6-10 years in the higher posts.
- (c) Limited scope for expansion of activities which could provide adequate openings in the future.

The undertaking has taken a number of steps to retain their trained manpower and meet their aspirations for career advancement. Some of these steps are :

- (1) Intermediary stages in the pay scales, providing for special pay have been introduced so as to provide incentive. Deserving officers in the scale of Rs. 775-1375 are provided

incentive through "promotion" to these stages carrying special pay of Rs. 100 and Rs. 200 p.m. A special pay of Rs. 90 has been introduced between the scale of Rs. 450-1075 and Rs. 775-1375. Similarly officers in the grade of Rs. 1375-1735 are also given incentives on the basis of their merit and accomplishment in the form of a special pay of Rs. 150/-.

- (2) Review of the sanctioned strength in the cadre from time to time in order to provide for the needs of the Organisation as well as career advancement for the engineers.
- (3) The intake from outside is being regulated.

In addition to taking the above mentioned steps, the undertaking feels that rethinking is necessary in the following areas in the interest of conserving the specialised skills accumulated by its design personnel.

- (i) Deployment of some personnel at the senior levels in other organisations either by deputation, transfer, or absorption so as to avoid their stagnation and to provide scope for chain promotions.
- (ii) In specialised organisations, the need for a longer grade especially at the lower levels appears inescapable. In the larger grade itself, there should be room for promotion by selection.

Head of design organisation : His position.

7.6 The solution to the problem of flight of personnel does not lie, according to the undertaking, in equating the head of the design organisation with the General Manager. Such a step would imply that heads of other functions, such as, manufacturing, commercial and finance, should also be given similar status as these functions are equally important for the success of the business organisation. Remunerating design staff adequately, for example, by means of a long time scale of pay, as is being done in the CSIR, would be the more appropriate step to prevent their flight.

7.7 While Bharat Heavy Electricals have not had any difficulty owing to flight of personnel, they agree that the head of the design organisation should enjoy a status equal to that of principal heads of departments. Hindustan Machine Tools are also of the same opinion. They are also of the view that design engineers should be considered for other top management posts alongwith others and that it would go a long way in removing frustration among them.

7.8 The Heavy Engineering Corporation also agree that it would help to prevent flight of design personnel if the head of the design organisation is given the status of general manager and if higher managerial posts in other areas are also thrown open to them. Hindustan Shipyard have also expressed similar opinion. The Mining and Allied Machinery Corporation are of the view that the head of the Design Organisation should be equated to the Works Manager.

7.9 To some extent, the flight of design engineers to other organisations or even outside the country is inevitable as it is impossible to ensure that conditions of service and prospects for promotion in a particular undertaking would always be better than those available elsewhere. Despite this, it is necessary that the undertaking should take all possible steps to retain experienced design engineers within the organisation. For this, a number of steps would be necessary. We would recommend the following :

Recommendations

- (i) Adequate opportunities for advancement should be provided within the Design Organisations by creating intermediary and special grades.
- (ii) After an engineer has put in five or six years of service in a particular grade, he should be provided in a higher grade, instead of allowing him to stagnate in that grade.
- (iii) The Chiefs of Design Organisations, at least in larger undertakings, should be equated with the post of General Manager or Deputy General Manager. The officers in the Design Organisation should enjoy a status equal, if not higher, to those holding managerial posts. This would

- minimise, if not altogether remove, the possibilities of their seeking jobs in other departments within the organisation.
- (iv) Design Engineers with aptitude for managerial functions should not, however, be debarred from moving to such positions.
 - (v) The present requirement that a trainee has to sign a bond that he will not leave the organisation for certain number of years after completion of his training, should be raised to 8 to 10 years.
 - (vi) One of the measures necessary to fill the gaps resulting from inevitable departures of design engineers from the organisation, would be to have regular minimum number of trainees in the 'pipeline' throughout. This would have to be determined by each enterprise individually.

Chapter VIII

Applied Research

8.1 The question of undertaking applied research work connected with development by the undertakings raises two questions viz. (a) whether such work, in view of the large resources required, should be left exclusively to separate research organisations/laboratories outside the undertakings and (b) whether in a multi-unit organisation (if part of such work has to be with the undertakings), this work should be centralised or left to the units concerned. The Heavy Electricals (India) Ltd. are of the view that so far as development of specific products or components is concerned, the connected research work should be done at the unit level. Matters of a generalised nature like mathematical techniques for analysis and computerisation, electrical analogy methods for solution of field problems, photo-elastic and brittle lacquer techniques for stress analysis, aerodynamic testing of models etc. can be tackled at the undertaking level with the help of national academic and research institutions. The Bharat Heavy Electricals also are of the view that in the case of multi-unit organisations where each unit manufactures different products, research and development work should be done at the unit level. However, they feel that it would be useful to have interchange of ideas among R & D departments of allied units in the same line of manufacture. The undertaking propose initially to spend about 2% of their turnover on R&D activities. The Heavy Engineering Corporation feel that while advanced research work for very limited objective may be done at the undertaking level, major activities should be handled on a centralised basis. According to them a design organisation is fit to take up the task of applied research only if it works on standardisation in the areas indicated in para 3.9 *infra* in addition to design work for current production. Such applied research would be directed towards improvement of a given piece of equipment or development of a superior model with better parameters. The Hindustan Shipyard hold that applied research work should

be undertaken at the proposed Central Marine Design and Research Organisation and the Government should bear all the expenses. Hindustan Machine Tools have urged that applied research work should be undertaken at the undertaking level and has estimated the cost of its activities in this regard at Rs. 60 lakhs per annum. The Mining and Allied Machinery Corporation is of the opinion that such work intended to cater to the needs of an industrial area or a group of organisations manufacturing similar types of equipment should be undertaken by a separate research organisation.

8.2 The cost of undertaking R & D work, arising from the requirements of design development, would be obviously quite large. The undertaking would naturally be reluctant at the present stage of their development to take up this work, even if it may legitimately be part of their product—development effort. Some of the undertakings are quite positive that R & D work connected with product development should be an integral part of their activities and it is only this close and continuous relationship between the two areas, within the manufacturing plant, that will be effective and yield satisfactory results. The same practice is followed in some of the large manufacturing companies abroad. The Team is of the view that it would be in the interests of product development, if some applied research facilities are set up at the plant level itself. This would also help to provide the necessary climate and motivation for carrying out further improvements/innovations in designing the products they are manufacturing. Since design innovation has a major bearing on profitability of an organisation, the motivation for carrying out problem oriented research can be provided by the organisation itself. In the area of product improvement, facilities for such work can be organised under their own umbrella, possibly under a separate functional wing.

8.3 Different views have been expressed by the undertakings on the question whether Design and Development effort in case of multi-unit organisation should be centralised or decentralised unit-wise. In view of the need to inter-link design and production effort closely, the balance of advantage would be in favour of locating the design development effort at the unit level in the case of units producing different products.

8.4 Research problems having a wider bearing and affecting a number of other products, will inevitably have to be entrusted to national or regional research organisation.

8.5 The team also feel that the present set-up of the Design Organisations seriously lacks research base in applied research. Research work to develop new designs is almost completely absent in the undertakings. Applied industrial research is fundamental for the healthy growth and survival of science and technology-based industries in which group most of these undertakings fall. Looking beyond the immediate future, the very competitiveness of Indian Industries in the international markets very largely depends on the industrial units in the public sector building up sound research and development wings oriented to provide the forward thrust in technological innovation. The difficulties experienced by the undertakings enumerated above, are equally applicable to creating this research-base. Nevertheless, the creation of such a base will have the long term objective for achieving which planned measures will have to be initiated even from now.

8.6 One of the points which was brought out during discussions with representatives of undertakings was the need to establish/strengthen applied research facilities in each unit. Since various units of multi-unit organisations are engaged in different areas of manufacture, separate research cells would be necessary in case of each unit. The areas for centralising research work in a multi-unit organisation may be very limited in view of the unit-wise decentralisation of manufacturing facilities to which, inevitably, any applied research work would have to be closely linked.

Liaison with research organisations.

8.7 One of the essential pre-requisites of successful Design and Development effort is that whatever capability is available in related research and production organisation is fully made use of. This requires close liaison between the production units and the National Laboratories.

8.8 The importance of intensifying communications between public undertakings and the national laboratories and research institutes has been stressed to the undertakings in a circular issued by

the Bureau in April, 1970. The Director General of the Council of Scientific and Industrial Research has also addressed the national laboratories/institutes pointing out that the public undertakings are keen on the closest possible contact with them in matters concerning research and development. Details of the type of liaison/contacts established by these undertakings with various research laboratories/organisations are given below :—

Heavy Electricals (India) Ltd.

8.9 The undertaking maintains close liaison with technological institutes like MACT, Bhopal, I.I.T., Kanpur, Electronic Research Institute, Pilani, Power Research Institute, Bangalore and the R & D Organisation of the Government of India at Bhopal. It also keeps in touch with Government research establishments, laboratories and academic institutions to ensure coordinated technological effort. Where composite jobs involving several undertakings and organisations are concerned, e.g., industrial projects such as steel rolling mills, etc. liaison is maintained with the concerned design cells. The undertaking has, however, stated that liaison effort in this area needs further improvement. According to them the national research institutions have not evinced adequate interest in accepting problems posed by industry.

Bharat Heavy Electricals Ltd.

8.10 Outside the BHEL, there are no other indigenous design cells engaged in developing designs for products included in their manufacturing range. However, there is a regular exchange of views between the units of Bharat Heavy Electricals Ltd. and Heavy Electricals (India) Ltd., Bhopal and also the Research and Development Organisation for Electrical Industry. Liaison is also maintained with the various national laboratories and universities for exchange of technical information and in regard to proposals for setting up joint research facilities etc.

8.11 Close coordination is also maintained with the Indian Consultancy firms engaged in providing consultancy facilities to the power station authorities for setting up of hydro and thermal power stations, in fields such as layout of power projects, erection schedules

and operation techniques for the equipment supplied by BHEL, performance of guarantee tests on equipment, exchange of information on modern developments in design, manufacture and operation of equipment etc.

Hindustan Shipyard Ltd.

8.12 In so far as cargo ship design is concerned, there is no organisation in the country other than the Hindustan Shipyard doing this work. Government research establishments and laboratories such as the Model Testing Tank at C.W. and P.R.S., Poona and facilities available at I.I.T., Madras and Kharagpur can, however, be used for the testing of ship models, especially the smaller craft designed in the Shipyard. The undertaking has suggested that the following steps may be taken to improve liaison between industry and national institutions :—

- (a) arranging regular flow of data between the two organisations and
- (b) mutual deputation of persons for short duration to study different problems.

8.13 However, due to limitations in the size and facilities available as well as the experience of the technical personnel in-charge of these laboratories, it may be necessary for the Shipyard to have some of its highly specialised work done in foreign countries till full capacity is developed indigenously. For vibration measurements, the help of Central Mechanical Engineering Laboratory, Durgapur and C.W. and P.R.S. Poona can be availed of. For material testing various Government material testing laboratories in the country are being utilised.

Heavy Engineering Corporation

8.14 HEC do not at present depend on other indigenous design organisations. However, they keep in touch with National Research Laboratories, Central Machine Tools Institute, Central Mechanical Engineering Research Institute etc. The undertaking feel that the existing gap in liaison between research/educational institutions and industry can be bridged through seminars, get-togethers, visits and

appointment of coordinating officers both in the industry and in the institutions. The experience of a public sector company like the HEC is limited to manufacture and commissioning and does not extend to maintenance and operation of the equipment manufactured by it. It would be in the best interest of design development if this work is carried out by an Institute subscribed to by both the manufacturers and their customers.

Hindustan Machine Tools

8.15 The undertaking have stated that they are keen to cooperate with indigenous design centres, Government research organisations and laboratories. They work in close cooperation with the Central Machine Tools Institute, Bangalore. They are exploring the possibility of utilising the technical services available in various CSIR laboratories. However, as machine tool development needs continuous backing of well-organised research, it is necessary that the research wing of HMT establish contacts with similar types of institutions in India and abroad. While HMT are maintaining close liaison with the Central Machine Tools Institute, Bangalore, they would like to establish contacts with research institutions in Europe and America and would welcome Government help for this purpose.

Mining and Allied Machinery Corporation

8.16 The undertaking does not normally depend on other design cells for its own products. The assistance of Government research and testing establishments is, however, required in respect of testing and approval of their products. To remedy the existing situation of inadequate liaison, the undertaking has made the following suggestions :—

- (a) The research institution should make the result of related research work available to the undertaking ;
- (b) The research institution should correlate its programme of work with the requirements of industry ; and
- (c) Development Engineers who are engaged in the utilisation of the results of research should be able to take the advice of concerned research workers as and when necessary.

8.17 It is likely that the national laboratories do not find industrially oriented projects sufficiently challenging to them in terms of technical achievements or for other reasons. In view of the fact that the gains to the country through such projects could be very great in terms of import savings, the Team feels that 25% of the programmes, in monetary terms, of these laboratories should be set apart for industrially oriented projects. Individuals actively participating in such projects may also be suitably rewarded monetarily.

8.18 It would be seen that while the undertakings have generally made efforts to set up R & D Organisations, their linkage and liaison with the national laboratories/institutions need to be strengthened. In the context of acute shortage of scientific personnel oriented for R & D work and also the limitation of resources that can be diverted for this purpose, it is necessary to bring about closer coordination between them with a view to concentrating the R & D efforts on major critical areas. To achieve these, the following need consideration :

- (a) It may be desirable that each public sector undertaking has direct understanding with one National R & D Institute specifically and a few others in general in keeping with the line of product and interest of the manufacturing unit. It would further be desirable that Senior board members of such industry are associated in the policy/project formulation level of the R & D Institute and vice-versa. This would facilitate direct dialogue and much more dynamic and committed efforts for indigenous development of industrial products and processes.
- (b) Industry-wise seminars should be organised periodically to consider design and technological problems of different industries. Representatives from the design organisations of establishments in the public and private sectors as also from the concerned national institutes/academic institutions should be invited to participate in the seminar to discuss various views. This would enable the transfer of know-how between industry and the research institutions.

- (c) A Coordination Committee should be set up in the DGTD to consolidate information regarding indigenous know-how. The Committee should consist of representatives from the CSIR, public sector and private sector enterprises, BPE and the DGTD.
- (d) To coordinate and pool the requirements of public sector undertakings in the field of developing design capability and procuring necessary facilities, a permanent cell may be created in the BPE.
- (e) One of the measures which has helped development of close liaison between the production units and the research organisation is having a common chairmanship for both as in the case of HMT and the Machine Tools Institute of India and HEIL, Bhopal and the Research and Development Organisation for Electrical Industry, Bhopal. This method should be taken advantage of in other fields, wherever possible. One of the major advantages of this arrangement is the comparative ease with which Design Data can flow from the production organisation to the Research body and vice-versa within the bounds of the contractual constraints imposed on the production units by their collaborators.
- (f) Another arrangement which can help flow of information from one organisation to the other under the present constraints of secrecy clause of collaboration agreements is deputation of personnel on an exchange basis. This has been tried out in a few cases with good results but should be adopted more extensively. This is one field where the Government's present policy in regard to deputationists in public undertakings needs a small change.

Advance design

8.19 Heavy Electricals (India) Ltd.: An advance design centre is functioning only in respect of steam turbines.

The efforts of this centres are directed towards:—

- (i) developing design know-how in respect of runner and guide blade design and manufacture.

- (ii) developing design know-how not only from the limited data obtained from the collaborator but also from published literature and indigenously sponsored work in the field. These efforts are expected to help in the development of designs for a 300 KW turbine.

Though no perspective plan in regard to design development has been drawn up, the undertaking is operating upon a forward plan based on customer demand which calls for new design developments. While preparing this plan, attention is given to new developments in the field of operation of the undertaking.

8.20 Bharat Heavy Electricals Ltd. : There is no advance design centre in this undertaking. However, the Tiruchirappali unit has drawn up a list of projects requiring concentrated attention. The unit has not drawn up a perspective plan for its design activities since, it is argued, the latest technology and results of the R & D activities of the collaborators are being made available to them. The immediate objective of the R & D Department of the unit is to tailor the available knowledge to the requirements under Indian conditions. Some of the specific projects taken up with this view are :—

- (i) Direct fired mills for utility boilers.
- (ii) Welded wall construction for all future boilers.
- (iii) Package boilers for process industries.

8.21 Heavy Engineering Corporation : The undertaking have suggested the setting up, in stages, of an institute for advanced research and development for the development of expertise for future steel plants. The preparation of a perspective plan with regard to design and development is tied up with the proposal for expansion of design department of HMBP which is already under their consideration. The plan of action in respect of HMTP would be evident from the information contained in Annexure IV.

8.22 Hindustan Shipyard : There is no advance design centre in this unit evidently because of the proposed setting up of a Central Marine Design and Research Organisation. Apart from the feasibility report on this organisation, the undertaking has not drawn up any perspective plan.

8.23 Hindustan Machine Tools : A Central Design Development & Research Department was set up in March, 1970. This Department is presently engaged with a number of development projects in respect of products which are expected to be released for commercial production in 1972. During the short period of its existence, the Department has undertaken the testing of :

- (1) Electrically controlled vertical milling machine E2V programmable in any two areas;
- (2) FN2—Horizontal and vertical milling machines, single axis, longitudinally programmable ; and
- (3) RM 63—Radial drilling machine.

A note on the activities of the Central Design Development & Research Department and the Unit Design Department is given in Annexure III.

8.24 Mining and Allied Machinery Corporation : The undertaking does not have an Advance Design Centre since the need for such a Department is reported to have not been felt. The Design Department looks after development also. The activity of this Department is carried out on the basis of a plan, which is prepared keeping in view the immediate commitments, expected orders as well as likely demand based on market research.

8.25 The design organisations have generally grown in an up-planned manner, based mostly on exigencies of the situation. There is, therefore, a greater need to organise them on sound footing not only in relation to the current operational requirements of the undertakings but also to meet the future needs not merely of the undertaking but also of the industry of which the undertaking forms part. This wider aspect of R & D activity has necessarily to be kept in mind by the public undertakings in the larger interest of the country as, in most cases they would be the biggest units in the respective industries. Consequently, the design organisation in each undertaking should be so organised as to be able to do forward planning based on market research to develop new products continuously. It should be the responsibility of a cell in the design organisation to "look ahead" and adopt a futuristic approach. Such an effort would

unavoidably be experimental in nature with no perceptible gains in the present. However, this is inescapable if undertakings are to be self-reliant in modern technologies. Only the HMT among the undertakings studied has such an organisation. They have attached a small group of design engineers to a cell called 'Advanced Design Centre' which projects the development programme for a period of 3 to 5 years. "Advanced Design Cells", on the lines of the one set-up in HMT, should be set up in all these undertakings to build up capabilities for designing proto-types of new advanced machines. It is considered necessary to lay much greater emphasis on this aspect of the developmental work in view of the avowed policy of the Government and objectives of undertakings to develop indigenous technology.

Research & Technical image

8.26 There is definitely a role for the Design Organisation in projecting the technical image of the organisation. This aspect generally appears to have received less attention than it deserves. Among the undertakings studied, Heavy Electricals (India) Ltd. appears to be conscious of this aspect. They mail to all important customers a monthly Technical Bulletin bringing out the achievements of the Company in design, manufacture, test and erection of equipment, their plans and programmes for the future in respect of research, development and production. The world-wide reputation of international industrial giants is built around their technical capability. They also make sure that this fact is given wide publicity.

8.27 The Team would also support the suggestion of HEC to set up an institute for research in problems of designing equipment etc. for Steel Industry.

Access to development abroad

8.28 The arrangement for making available up-to-date world-wide technical reference to the design organisation is generally through the establishment of technical libraries subscribing to the required technical journals and also by dissemination of information through digest/documentated literature. The undertakings also send their technical personnel abroad for training and obtaining information on the latest developments in their specialised fields.

8.29 The HMT have also established a technical translation centre for translating literature from French, German and Italian languages.

Perspective planning

8.30 A design and development organisation can be a successful innovator and leader only if its time horizon extends beyond the immediate problems of production. It is in this context that it is necessary that the design organisation in the undertakings should draw up a perspective production plan for a reasonable period, say 10 to 15 years. A perspective plan has necessarily to be flexible because of the inherent difficulties in forecasting future developments. Based on the manufacturing or production programme, the Design Department should draw up a perspective plan of action for developing product designs.

8.31 Undertakings should also consider the desirability of setting up value-analysis cells and product Development Committees involving the concerned disciplines in the organisation.

8.32 The Team would also support the proposal of the Hindustan Shipyard for setting up a Central Marine Design & Research Organisation with financial support from the Government. This is an important area where indigenous design capability is at present non-existent and should urgently be developed in view of the importance of ship building both to maintain trade and defence.

Chapter IX

Foreign Collaboration and R & D

9.1 From the narration in the earlier chapter relating to the achievement of the design organisations in the public undertakings, it would be seen that these achievements were made possible largely through purchase of technical know-how, design documentation, etc. of the products.

Heavy Electricals (India) Ltd.

9.2 This undertaking has stated that while design know-how is generally furnished by the collaborator, there are certain cases where the agreement provides only for the supply of manufacturing information in respect of specific designs and does not cover supply of design know-how. In case of steam turbines, the information supplied does not cover turbine blades, gears and items purchased outside. One of the major difficulties experienced by this undertaking in the operation of collaboration agreements is the failure on the part of the collaborators to supply components against committed deliveries. To overcome this difficulty, it has been suggested by the undertaking that future collaboration agreements and training programmes should ensure maximum indigenous participation in design and manufacture so as to ensure full self-reliance in minimum time. In the short run, a clause may be introduced in the agreement to avoid such difficulties. Adequate weightage must also be given to the acquisition of the latest technology of developed and proven market.

Bharat Heavy Electricals Ltd.

9.3 The Tiruchirrapali and the Hyderabad units have not experienced any major difficulty in the operation of collaboration agreements. The collaborators, in the former case, have helped the unit to grow in the field of boiler manufacture by imparting necessary competence in the engineers of the unit to attempt the

design and manufacture of various ranges of boilers some of which are not covered by the original scope of agreement. However, the unit feels the need that boilers manufactured by it should reflect modern advances in technology.

Heavy Engineering Corporation

9.4 One of the important gaps in the collaboration agreements entered into by this undertaking relates to lack of provision for updating the designs. Even the basic documents and calculations are not made available to help initiate applied design work.

Hindustan Shipyard

9.5 While no specific difficulties in the operation of collaboration agreements have been pointed out, the undertaking has stressed the need for having technical collaboration with a reputed Ship Design and Consultancy Organisation in training its personnel besides helping to solve different problems in the initial stages of the creating of the design organisation. The setting up of the proposed Central Marine Design and Research Organisation jointly by the three major public sector shipyards would help in drawing up a planned programme for training of personnel and development of indigenous design capacity for manufacture of ships' equipment. The Team has already in the earlier part of this report supported this proposal. The existing collaboration agreements are reported to have worked satisfactorily so far. However, future collaboration agreements should cover continuous training of design personnel in a planned manner including all the branches of shipbuilding.

Hindustan Machine Tools

9.6 The undertaking has stated developed countries seldom agree to part with technology as part and parcel of licensing agreements with developing countries. Where they agree, huge sums are demanded towards their costs.

Mining and Allied Machinery Corporation

9.7 The undertaking usually takes steps to ensure that there is no gap in the collaboration agreements. Conditions regarding training of personnel are incorporated even while finalizing the

agreements. However, some difficulty is reported to have been experienced in the case of collaboration for tailor-made items of equipment like Stackers, Reclaimers etc. To obviate these difficulties, it has been suggested that a liaison officer should be kept at the Collaborators' Works to guide them with regard to indigenous availability of materials, implementation of Indian standards, safety and other requirements etc. while the designs are under preparation. This suggestion is worth consideration.

9.8 The experience of the undertakings studied has shown that collaboration agreements in the past often placed the undertakings under a number of handicaps. Some of these are :

- (a) Sometimes, the agreements provided for supply of documentation only without the supporting basic design calculations ;
- (b) Most of the agreements relate to supply of information and documentation only in regard to current designs. Generally, there was no provision obligating the collaborator to transfer information relating to subsequent improvements/developments to the equipment/processes for which the undertaking had entered into the agreement. On the other hand, it was seen in some agreements that it was the supplier who had insisted on the undertakings making available to him any development or improvement, whether patented or not, or adaptations to the equipment that the undertaking has been able to effect.
- (c) The collaboration agreements largely provided for total project know-how on a turn-key basis. This is a very costly manner of acquiring design know-how as it precludes the use of indigenous designs and processes, raw materials, components etc. This also adds to our disadvantage as a package deal does not ensure that we are in fact obtaining the best available designs in each constituent segment of the plant.
- (d) Collaboration agreements also generally contain a clause prohibiting disclosure of the know-how to sister concerns and third parties. This often leads to repetitive import of

the same know-how by different agencies. Some instances of such prohibitory provisions are given below.

9.9 The agreement between the English Electric Co. Ltd. and the HEIL for the manufacture of Hydraulic turbines contains the following provisions :

8.1 "That all technical information (however acquired) which HEIL derive from AEI will be used solely in connection with the manufacture of the Generators by HEIL in the Bhopal Factory.

9.2 That all technical information described in detail in Annexure I, will always be safeguarded and treated as confidential by HEIL employees and HEIL will not disclose or permit to be disclosed to any third party or passed on or utilised by any other Company even in case of amalgamation or reconstruction of HEIL in the future."

It may be seen that the prohibition would remain even when the Company is 'reconstructed' or amalgamated with another public sector company.

9.10 In another agreement between HEIL and Associated Electric Industries concerning steam turbine generator plants, the clause runs as follows :

"HEIL shall treat as confidential all information of whatsoever nature and irrespective of the method of reproduction or communication all or relating to licensed material which may have been communicated or provided to HEIL, in no circumstances, shall any such information be communicated to any other foreign collaborator".

9.11 Agreement entered into by MAMC with Stamicarbon for coal treatment plants contains the following clause :

"MAMC shall take all reasonable precautions to safeguard Stamicarbon's interest in this respect and to keep said know-how secret to third parties".

9.12 Agreement for transfer of design know-how generally provide for training of personnel. It is, however, seen that this training relates only to acquainting the Indian engineers with the manufacturing processes, but not the design know-how as such. It is interesting to note that one foreign collaborator (English Electric Company Ltd.) had even stipulated that the Indian personnel will not normally have access to their research laboratories. Such visits to the laboratories could be permitted only for specific discussions. The clause in the Agreement reads as under :—

“The AEI will from time to time, at such time and for such periods as may be mutually agreed, permit a reasonable number of senior design manufacturing and inspection personnel of HEIL to visit the AEI Factory at Rugby (excluding the Research Laboratories) for the purpose of discussions relating to design, manufacture and inspection of the initial generator. Should it be found necessary in the course of their work on the generator for them to make a visit for a specific discussion to the research laboratories, the facility to do so will be provided”.

It will be seen from the above how jealously the collaborators guard their design and process capabilities.

9.13 The growth of design organisations has not been as rapid and diversified as the needs of the country demand. In certain areas, it is seen, considerable advances have been made by the undertakings in building up technical know-how in design capacity. However, dependence on imported technology will still have to continue in certain areas till requisite skills have been built up within the country. In certain other areas, it may not be practical to attempt to master the design know-how being developed abroad. This would involve commitment of enormous resources in men, money and material and also result in a costly process of trial and error. It is not uncommon even in advanced countries for firms to enter into collaboration agreements with others to keep themselves abreast of developments. Especially in India where technical talent is scarce, it would be profitable to concentrate the personnel in limited areas in the short run and buy the technical know-how and designs from abroad in sophisticated areas. As the base of R & D widens, it would be possible gradually to eliminate dependence on foreign sources.

Recommendations

9.14 It should, therefore, be ensured that the transfer and assimilation of technical knowledge, design know-how and other facilities are brought about in the most advantageous manner. For this purpose, greater care should be taken in drawing up collaboration agreements. In this context the Team would make the following suggestions :

- (a) Mere supply of documentation would not be enough : Supply of detailed design sheets, specifications and calculations should be insisted upon. Such details, as quality of raw materials, substitute material, alternative process to suit different working conditions should also be invariably incorporated.
- (b) It should be ensured that further developments, adoption, and improvements effected by the collaborator to the designs/ processes/equipment supplied by him under the agreement are made available to the contracting Indian party. In this context, it is learnt that the agreement between the Indian Telephone Industries and Standard Telephones provides specifically for transfer of such information.
- (c) It has been suggested that in some spheres know-how should be imported through National Institutes and then sub-licensed to the industry. It may also be desirable that when know-how is imported by a public sector undertaking, the related institute with which the particular industry is associated is taken into close confidence and a working arrangement set up for better assimilation of the know-how. It may not be out of place to mention that while importing know-how under foreign collaboration, comparative analysis is essential relating to all processes and products available in the world so that only the best available is selected. The lack of sufficient emphasis given to this aspect in the past led to acquisition of costly know-how, not always the best.
- (d) When importing know-how under foreign collaboration becomes unavoidable, public sector undertaking must have a

R & D cell working from the very beginning for better assimilation of basic concept, data and information so that utilisation, improvement and diversification could effectively follow within a reasonable period and fresh collaboration is avoided at the termination of the collaboration agreement period.

- (e) Care should be taken to break down the project into various sub-elements so as to ensure that designs and processes are obtained from the most capable manufacturers in the world. Therefore, turnkey or blanket approach to collaboration agreements should be avoided.
- (f) Training of personnel by the collaborators should also cover training of the engineers at their R & D Organisations. Apart from this, there should also be a provision for periodic refresher training courses for keeping the Indian design-personnel abreast of latest development in the collaborators' organisation. It is understood that adequate refresher opportunities are, at present, not being made available in the collaborators' plants with the result that the knowledge acquired by the original trainees gets obsolete.
- (g) To obviate the difficulties experienced in the case of the collaboration for tailor-made items of equipment, a liaison officer should be kept at the collaborators' works to guide them with regard to indigenous availability of raw materials, implementation of Indian standards, safety and other requirements etc. while the designs are under preparation.
- (h) The difficulty caused by restrictions placed on the enterprises by the "disclosure" clause can be overcome by adopting one of the following measures :
 - (i) The secrecy clause in collaboration agreement should be so worded as to permit the use of the information obtained from the collaborators in other government undertakings. For example, the agreement between

CAFL (a French firm) and the HEC for the manufacture of crankshafts contains the following provisions :

- “HEC undertake not to communicate either directly, or indirectly to any third party whosoever, the data, knowledge and results of the experience they may acquire, in accordance with the agreement, except to a party owned or controlled by the Government of India”.
- (ii) Government should directly acquire design know-how. In such a case, it would be possible for the Government to utilise the design know-how in any undertaking under its control.
 - (iii) A holding company which acquires the design know-how would be in a better position to transfer it to its subsidiaries. If this form of organisation would help in better transfer and assimilation of imported technical know-how, it may be desirable to consider setting up such Companies in different sectors, and
 - (iv) In certain spheres know-how could be imported through National Institutes and then sub-licensed. Public Sector undertakings could be closely associated with the National Institutes and working arrangements set up for better assimilation of know-how. Such an R & D Cell at the National Institute level would be able to make comparative analysis of all processes and products available in the world and select the best. However, it has to be kept in mind that National Laboratories' scope is limited only to analysing the performance of products, and as far as the R & D field is concerned, they go only upto development of prototypes. After that the development of mass production technology and plant engineering is taken care of by consulting and engineering organisation.
- (i) All imports of sophisticated equipment/components/spares should be accompanied simultaneously by acquisition of their designs know-how, specifications etc. This would

enable, in course of time to establish manufacturing facilities within the country for these items and obviate future imports.

- (j) In view of the scarcity of technical talent in the country, it would be profitable to concentrate the personnel on limited areas in the short run and buy the technical know-how and designs from abroad in sophisticated areas. As the base of R & D widens, it would be possible gradually to eliminate dependence on foreign sources.
- (k) If India is to keep pace with the rest of the world, some institutional arrangements for monitoring developments abroad should be made. In this context, the Japanese approach should be commended. Technical teams of centralized agency/agencies should be sent out to different countries at regular intervals to scout for improved designs and latest technology for translation into mass manufacturing method suitable to our country.

Chapter X

Financing R & D

10.1 The expenditure on research and development in India is known to be a very small percentage of the value of production. In the Central Sector, the percentage of R & D expenditure to total expenditure of the Central Government was estimated to be 3.12 during 1970-71. From the figures furnished by the enterprises the R & D expenditure is estimated at 1 to 3 per cent of the value of production. One of the major constraints with regard to undertaking R & D work by undertakings has been that of non-availability of finance. These undertakings are operating in the field of Heavy Industry where the period of gestation is long and return on investment low. In the initial period, efforts of the undertakings are directed to achieve rated capacity and render them economically viable. In the circumstances, the undertakings are naturally unable to set apart a sizeable amount from their own resources for research and design effort which would further depress their profitability. If undertakings have to be adequately motivated towards undertaking research and design effort, a satisfactory solution would have to be found for financing of R & D effort by them.

Some of the suggestions made by the undertakings are given below :

Heavy Electricals (India) Ltd.

10.2 The undertaking has suggested the creation of a development fund out of a certain percentage of the quoted price to the customer to cater to the financial needs of R & D work. In the case of undertakings which are in the 'red', such activities should be financed through Government grants. Development work in respect of large products like turbines and generators for hydro and thermal power projects can be undertaken only on the basis of specific contracts from the Ministry of Irrigation and Power and the Atomic Energy Commission.

10.3 *Bharat Heavy Electricals (Tiruchirappalli Unit)* on the other hand feel that finance for R & D activities will have to be raised by the unit itself. A matching contribution from the concerned Ministry can be utilised for the purchase of capital equipment. During discussion, the General Manager of the Tiruchi Plant mentioned that their unit was operating in an area where the product technology becomes obsolete in about 5 years. It is, therefore, necessary that adequate provision should be made in the annual budget of the company for the R & D effort. There was no defence for not doing so by a company which was making profits. As against the demand of Rs. 25 lakhs for R & D work for his plant, which amounted to 0.7% of the anticipated value of production, yielding a profit of about Rs. 6 crores, a budget provision of only Rs. 5 lakhs was agreed to by the Board. Allocation of money for R & D work in public enterprises in India was generally given a very low priority. Allocation for R & D represented about 5% of a company's turnover in advanced countries and he felt that we should spend at least 2% on these activities. The Hyderabad unit feels that centralisation of R & D activities would help in distributing the expenditure without placing the burden on individual units.

10.4 *Heavy Engineering Corporation* are of the view that large scale R & D activities should be undertaken on a centralised basis and hence there is no question of any burden on this account on any individual unit. The Hindustan Shipyard has also expressed a similar view.

10.5 *Hindustan Machine Tools* feel that it would be desirable to obtain Govt. grants in the form of cash assistance ranging from 50 to 100% on approved R & D projects.

10.6 *The Mining and Allied Machinery Corporation* have suggested that the activities of the Design and Development Department should be financed by charging the factory for services rendered by it. It would be better to keep a separate profit and loss account for this Department.

10.7 In the context of the replies received the following suggestions may be worth consideration :

- (a) All public sector undertakings should set aside specific funds for R & D and such budgetary provision may be made as a statutory obligation. The amount may vary with reference to the types and size of industry. Such provision would encourage (i) creation of a R & D cell within the industry and (ii) sponsoring projects and utilisation of assistance from the National Institutes and Universities.
- (b) The provision for abatement of tax on expenditure on R & D is not a sufficient motivation, since most of these undertakings do not earn profits and therefore do not pay taxes for a long time. In the circumstances, the Government may consider the following steps ;
- (i) to provide special equity capital for R & D activity or grant interest free loan for the same purpose. In case of undertakings who are suffering losses, their R & D programme will have to be financed through direct grants.
 - (ii) to allow the undertaking to add a certain percentage of manufacturing cost of products to the sale price on account of the development work involved. HE(I) is stated to be doing this. These receipts could go towards building up a Development Fund. Obviously this is possible only in the case of those enterprises whose products are susceptible to cost plus formula.
 - (iii) The suggestion at (ii) above may not be practicable in the case of undertakings manufacturing products for competitive market. In its long term interests, every industry should devote a certain percentage of its income to R & D with a view to stay competitive. Government could think of giving out-right subsidy for such purpose to certain undertakings whose gestation period, comparatively, is much longer and whose profitability rate is expected to be low.
 - (iv) We would also commend the suggestion of HEIL that development work in respect of large products like generators and turbines should be financed by the

Ministry of Irrigation & Power and Atomic Energy Commission on contract basis. This is also being done in some of the advanced countries.

- (v) Though research and development efforts in the field of advance design should be more appropriately centralized with the undertaking headquarters in case of a multi-unit organisation, such effort as is connected with the production carried on by the individual plant will have to be located in that plant. The tendency to centralize even that effort is ill-advised as it will take it away from the critical production process with which it should remain closely inter-linked in order to be productive.
- (vi) We would also support the suggestion by MAMC that in order to provide a framework for evaluation of the R & D effort, the activities of the Design & Development Department should, as far as possible, be financed by charging the factory for the services rendered by it and that a separate profit and loss account should be maintained for it.
- (vii) In consultation with enterprises, Government should also lay down specific Design Development goals for each undertaking indicating the ways and means of financing it as part of its exercise to fix their economic, financial and social objectives and obligations. This would be necessary in case of enterprises who are not forced to undertake such development work under the impact of normal competitive forces. Due allowance would, however, have to be given for the cost of such work in fixing their financial goals.
- (viii) In important and strategic areas, where the enterprise may be reluctant to undertake research and development work in view of the high cost involved, Government should consider 'sponsoring' such work entirely at its own cost as is being done in some of the advanced countries.

Chapter XI

Government and R & D

11.1 During the course of discussions with the officers of the Design Organisations, it was learnt that there are several procedural difficulties faced by them in regard to obtaining Government clearance/approval. Negotiations with foreign collaborators for technical know-how and designs have necessarily to be conducted in great detail and extend over several months before the parties come to an agreement. Even after this, considerable delay occurs in the Government according their approval to the undertaking for concluding the agreement. It was pointed out by one undertaking that in two cases the Ministry took almost a year to accord approval to the collaboration agreement. Prolonged pre-agreement negotiations itself is enough to discourage the foreign parties. If on the top of this, there is delay in signing the agreement, it works as a positive disincentive. The Study Team has not been able to go into the question of how and where delays occur in the grant of approval. There is need to identify the bottlenecks in this regard with a view to eliminate such delays.

11.2 The Design Organisations also face difficulties in the matter of obtaining DGTD clearance and import licences for equipment, components and raw materials needed for analytical tests. Restrictions on the import of such critical supplies impede progress in research and development. The requirements of scientific research and development should receive greater importance than in the case of equipment and raw materials needed generally by the industries. A more liberal release of foreign exchange for these purposes would, in fact, help build up the potential for conserving/earning the much-needed foreign exchange. In the scheme of priorities, we would, therefore, suggest that release of foreign exchange, clearance by DGTD and issue of import licences by CCIE to R & D institutions should receive better consideration. We would recommend allocation

of special foreign exchange for this purpose as also issue of suitable blanket licences for import of equipment/parts for research & development purposes.

11.3 Research and development activity is spread out over a wide area both in the public and the private sector, the Council of Scientific and Industrial Research with its chain of national laboratories being the premier institution. Besides these, considerable technological and design achievements have been consolidated in the public undertakings in very vital sectors of the industry. At present there appears to be a big gap in communication between the various agencies. Elsewhere in this report, the need for closer association of the public undertakings with national research institutions has been stressed. Such integration and coordination of activities could be supplemented by the establishment of a national Design Archives, which will store all available designs in the country both in the private and public sectors. This suggestion was supported by the HEIL during discussion. A lot of design data and information have now come into the hands of both private and public sector industries. The industries are, at present unable to check at any central point whether design know-how in a particular field is available with an indigenous firm before they can decide to go abroad for collaboration and whether such data can be obtained from it and, if so, on what terms. The absence of this facility is also responsible for repetitive import of know-how. It is, of course, understood that only such parties would supply information to such an archive who are not prohibited from doing so by the terms of collaboration agreements. The archives can also serve as a Technical Information service on the pattern organised in USSR. Though a Central national archives would be the desirable objective to work for, a beginning could be made by setting up archives on a regional/sectoral basis or, if even this is not at present feasible, an attempt could at least be made to pool the information available with the various R & D organisations, in the public undertakings. To start with, the information/design available in the archive may not be large but in course of time, it can grow up into an important storehouse of information. Possibly such information could be made part of the Data Bank, being set up in the Bureau of Public Enterprises, and supplied to the various interested undertakings.

Chapter XII

Summary of Conclusions and Recommendations

Role & importance of design organisations

Technological

There is possibility of the technological gap between India and the advanced countries widening because of our inability to invest resources in research and design on a scale comparable with those of the advanced countries. The Indian context differs significantly from the advanced countries which have comparatively abundant capital resources and shortage of manpower. Their approach to evolving plant/product designs and technologies has largely been conditioned by these two factors. In our case, while capital resources are either absent or limited, the abundance of cheap labour may not provide the comparable driving force to innovate with a view to reduce labour costs. Despite this, there is a peculiar challenge in a situation like ours in which scarce capital resources have to be conserved with a view to reduce costs. This challenge has not been fully met.

(Para 2.2)

2. The need to innovate varies from industry to industry. It is intense in rapidly changing fields where products become technically obsolescent within a few years. This is so in young industries like Petrochemicals, Electricals/Electronics etc. Complete independence in the matter of designs/technology, however, is virtually impossible to achieve. Nor can it become even an object of pursuit.

(Para 2.2)

Selective approach

3. The time has now been reached when we should take stock of the skills developed with a view to plan further development

based on a selective approach. A state of technological take-off in design capability could be considered to have been reached once a high level of technological capability is achieved in selected key-fields even though there may be a number of areas where dependence on foreign collaboration may remain inevitable for some time to come. Adequate design organisations have, therefore, to be built to meet these requirements.

(Para 2.3)

Objectives

4. Broadly, the short and long term objectives of the Design Organisations studied are as follows :—

(i) Short Term Objectives

- (1) To get familiar with imported designs and know-how.
- (2) To develop capability to carry out modifications to foreign designs with a view to utilize indigenous materials.
- (3) To achieve standardisation of components.
- (4) To achieve maximum productivity.
- (5) To keep up-to-date the designs acquired.
- (6) To draw up commissioning and testing instructions.
- (7) To evaluate the performance of equipment manufactured in order to improving the designs, solving engineering problems etc.
- (8) To solve technical problems of diversification of production connected with projects.

(ii) Long Term Objectives

- (1) To be independent from foreign design and consultancy services.

- (2) To keep abreast of developments made by leading manufacturers and evolve more efficient designs, reduce cost, improve reliability and performance.
- (3) To build sound research and development activity to provide backing for introduction of new and sophisticated products.
- (4) To project the technical image of the organisation.

(Para 3.16)

5. These objectives are not, by and large, time-bound. Also, they do not provide any quantified yardsticks with reference to which performance of the Design Organisations in terms of achieving design development targets can be measured. There is also no concrete plan of action formulated to achieve the specified goals.

(Para 3.17)

6. Each enterprise should draw up concrete, quantified and time-bound objectives in terms of its projected production and a detailed schedule of programme directed to meet those objectives. The programme should also provide a system for its periodic evaluation in terms of its objectives.

(Para 3.18)

Staff strength of design unit

7. The criteria adopted by the undertakings for fixing the staff strength of the design organisations were generally based on the recommendations of the collaborators as modified by the plant authorities to suit conditions obtaining in the country. Some of these are :—

- (a) Type and quantity of products/equipments
- (b) Frequency of repetitive orders

The Chairman HEG, has pointed out that it might be useful to consider the scope and feasibility of developing inter-disciplinary teams for complicated projects.

(c) Experience of the foreign collaborator in his own country, modified to suit Indian conditions.

(d) Requirements of development work.

(Para 4.2)

8. The lack of clarity about the criteria for fixing staff strength of design organisations is partly due to lack of specificity in the objectives of these organisations.

Position of design unit in the organisational Hierarchy

9. There is diversity in the pattern of organisation of design units. Some are product-centred while others are unit-based, in the case of multi-unit enterprises. Similarly, the level of reporting also shows variations. The function of the Chief of Design Organisation in some plants has become increasingly administrative and managerial. In order to allow him to contribute his best to a field which he has specialised in, it is necessary that he should be divested of the day-to-day administrative and managerial work. Both working conditions and organisational procedures should be such as to allow him time to think, to observe production and allied operations, to discuss with experts in the various levels of other functions (IE, OR production, materials management, accounting etc.) in his own plant and outside. Simultaneously, there is a case for inducting specialists in these functions in the Design Teams as regular members.

(Paras 4.8 to 4.12)

10. There is considerable gap between the sanctioned strength of staff and the actuals in position in the middle and lower categories. While no reasons have been given for this gap, it is obvious that the personnel with the requisite educational qualifications and experience required by the undertakings in these categories are not easily available.

(Para 4.13)

The MAMC and the HMT have stated that it is not desirable to delink the administrative and technical responsibilities of the Chief of Design Organisation.

Functions of design unit

11. Bulk of staff in design organisation is mainly engaged in product design.† (An important point to be borne in mind here is that the role of design cells of large public sector undertakings should be limited to improving and evolving Product-Designs only, so that the cost of production could be brought down and the product improved to keep pace with technological progress and development.) The scope of work relating to plant engineering/design is best allotted to separate public sector consultancy agencies. A limited portion of power station and industrial projects engineering work in the case of heavy electricals plants has, however, to be undertaken necessarily by the equipment-manufacturers themselves.

(Para 4.15)

Design organisation : product or functional basis

12. Whether a centralised design organisation working on a functional basis would suit the requirements of a particular undertaking or a decentralised design function distributed product-wise would be more appropriate would have to be decided by the undertakings themselves taking into account their individual requirements, the stage of their development and the experience of organisations referred to above. In a multi-unit organisation, with each unit specialising in a particular area of production, the design and development effort would have to be decentralised. In the areas of "advance design" and where specialised skills are scarce, the advantage would lie in building up centralised design development facilities.

(Para 4.18)

Applied research orientation of staff

13. While the building up of self-reliance in design capability at the earliest remains the long term objective of these undertakings, the present disposition of design staff is biased towards adaptation

†The MAMC have stated that some amount of project work is inevitable in a competitive market, as most of the customers place orders on turn-key basis; engaging outside project design organisation will push up cost and affect competitiveness.

of product-designs and design of tools and other means of production. In order to achieve the long term objective, [there is need to reorient the staffing pattern towards applied industrial research. The setting up of a separate Advanced Design Unit as part of the Design Organisation as in the case of HMT would go a long way in development of requisite technical skills.]

(Para 4.19)

Design development capabilities

14. Design capabilities built up by the enterprises fall into three distinct categories.

Absorption of Imported know-how

- (a) Absorption of imported design know-how. The HEIL and the BHEL are, by and large, no longer dependent on Collaborators for Switchgear, Controlgear, Transformers, 60-120 MW boilers, 60-100 MW turbosets.

(Paras 5.2 & 5.3)

Cost Reduction

- (b) *Improvements on imported designs and Cost reductions/import substitution.* The enterprises have been able to modify/adapt foreign specifications of components/raw materials to suit indigenous availabilities. These efforts have resulted in considerable Savings in Cost, though in many cases it is difficult to assess the total quantum of savings. In BHEL substitution of arsenical brass tubes for Admiralty brass tubes, aluminium brass tubes for Cupronickel tubes and mild steel for Muntz metal has resulted in considerable economies.

(Paras 5.8—5.16)

Material substitution

15. The undertakings have been successful in economic substitution of easily available material e.g., resin-glass tapes in transformer cores (HEIL).

(Paras 5.18—5.20)

Foreign exchange savings

16. Considerable progress has been made in indigenisation of raw materials/components in certain undertakings resulting in sizeable savings in foreign exchange. HEIL have saved Rs. 760 lakhs till July 1968, Tiruchi Boiler Plant of BHEL has achieved an indigenous content of 60-65%, depending on imports only for boiler quality plates, seamless steel tubes, specialised value fittings etc. This unit has saved Rs. 3.18 crores so far. Import content of HMT products is as low as 8%, needed for specialised equipment like quality bearings etc.

(Paras 5.21 — 5.26)

Incorporation of New Features

17. The two Electrical Units and the HMT have distinguished themselves by introducing several new features into existing designs e.g., Thyristors which dispense with motor generator sets in industrial drive designs, crimped terminals and aluminium busbars for heavy currents, hydro-static lubrication of thrust bearings (HEIL); HMT have developed new products like, Lapping machines, Prog-mato Electrical Programming unit etc.

(Paras 5.27 — 5.30)

Material & Component Standardisation

18. The HEIL are the only undertaking who have attempted standardisation for almost all the materials used by them. As regards components, divisional and company standardisations have been introduced.

(Para 5.31)

New designs

19. The HEIL, BHEL and MAMC claim to have designed independently a large number of equipments to suit the specifications of customers. No technological innovation in design development has been reported by HEC as the accent has been on build up of production based on current designs. It would be possible to

break loose from the apron strings of the collaborators only when the second generation cycle starts.

(Paras 5.32 — 5.39)

20. Since design efforts have an important bearing on the profitability of the organisations, specific studies should be carried out by the undertakings to assess the cost-benefit relationship in the design efforts, as a regular part of the Management Control Systems.

(Para 5.17)

21. In the earlier stages, because of the emphasis on production to meet current demands, the undertakings have paid less attention to applied Research and Development. The design organisations were engaged generally in absorption and assimilation of borrowed designs of products/equipment and carrying out minor modifications, and evolving substitute materials to suit Indian conditions. This does not help in bridging the technological gap between India and the advanced countries, whose success can be traced to the high pitch of development activity. Their programmes are oriented to provide answers to the problems of the future; to evolving entirely new products and equipment etc. In contrast ours is of the 'absorptive' and not of the 'innovative' type. Design Organisations should keep their horizons and visions broader.

(Para 5.41)

22. As a number of products are custom-built to unique specifications, it has to be brought home to the undertakings in sufficient force that the design effort has a very large part to play in improving the profitability of the company.

(Para 5.42)

23. Production of specialised equipments like quality bearings, high quality steel and quality hydraulic equipment should be undertaken indigenously after working out their economics and their impact on the promotion of indigenous technological advancement.

(Para 5.43)

Project planning

24. Some undertakings, besides the direct work concerning Design of equipment/Products, have ventured into the field of project design and allied activities. MAMC have designed the ore and coal handling plant for the Haldia Dock Project. HEC's Project and Development Division undertake turn-key jobs, e.g., pig casting machine at Durgapur.

(Para 5.44 to 5.47)

25. [An important point to be borne in mind is that the role of design cells of large public sector undertakings, should be limited to improving and evolving product designs only so that cost of production could be brought down and the products improved to keep pace with technological progress and improvement. The scope of work relating to plant engineering/design is best allotted to separate public sector consultancy agencies. A limited portion of power station and industrial projects engineering work in the case of heavy electricals has, however, to be undertaken by the equipment manufacturers themselves.

(Para 5.48)

Performance standards & Goals

26. No specific performance standards in terms of design output are laid down by the enterprises. In the absence of these specific goals, the recruitment of design engineers is not related to specific design 'task' but is oriented towards general strengthening of the organisation. [Design Organisation should be, as far as possible, product-based with time-bound and quantified goals. The recruitment of engineers should also be with reference to specific individual design 'tasks'.

(Para 5.50)

Design gaps

27. In the Heavy Electricals Sector, there are a number of areas where wide gaps still exist between the needs of their production programmes and the design capabilities. The HEIL continues to depend on foreign design know-how for steam turbines for pump storage schemes, nuclear and gas turbines. BHEL depend on foreign

consultants for designing boilers of parameters higher than 120 MW, turbo-blowers and Compressors for the chemical and fertiliser industry.

(Paras 6.2 — 6.6)

28. For ship building dependence on foreign design is almost total. For sophisticated semi-container Cargo Vessels and modern dredgers, bulbous/Ram type Bows Hindustan Shipyard needs foreign consultancy.

(Para 6.7)

29. In the Heavy Engineering area also, dependence upon foreign designs is substantial. HEC depends heavily on foreign knowhow for heavy steel plant equipment and heavy machine tools. For coal washing and bulk handling equipment MAMC relies on foreign assistance.

(Paras 6.8 & 6.10)

30. In the machine building area, some achievements have been made but these are areas where foreign collaboration is necessary. HMT is self-reliant except in respect of certain complicated and sophisticated machines, e.g., hydraulics and numerical controls.

Value analysis and maintainability

31. By and large, the concepts of "Value Analysis" and 'Maintenability' have not had full implementation and no adequate control systems have been built to assess the cost-benefit of design efforts. It is highly necessary that these concepts should be given practical shape and necessary machinery set up in each undertaking for this purpose. In this connection, we would recommend setting up of Product Development Committee in the plants involving functions such as production, sales, purchase, as well as value engineers and maintenance engineers. [A suitable control system for receipt of feed-back information] on maintenance problems with a view to identify improvements required should also be built. Regular studies should be carried out by the undertakings to assess the cost-benefit relationship of design efforts as part of their management control systems.

(Paras 6.12 & 6.13)

Use of computers

32. The use of computers for purposes of design calculations is yet in the initial stages. HEIL and BHEL use the computer for algebraic, matrix and differential equations, flexibility calculations, dynamic modelling etc. Hindustan Shipyard have made use of the computer for obtaining Bonjean's curves, hydro-static particulars and moment of inertia data and have reported considerable saving in time. HMT have utilised the computer for optimisation of machine tool drives etc. MAMC have not made use of computers for design work. Computer application has important bearing on design development and will increase as undertakings' capabilities for independent design development increase. The team recommend that the undertakings should be given full assistance to utilise computer facilities.

(Paras 6.14 — 6.15)

Dearth of design personnel

33. As the areas of operation of the selected undertakings were new to the country at the time these undertakings were set up, experienced personnel to man the design department were not available. The procedure generally adopted by the undertakings in recruiting the required staff was (i) to draw upon experienced persons in allied industry and (ii) to recruit raw engineering graduates and train them in the collaborator's works or in the training schools attached to the undertakings.

(Para 7.1)

Flight of personnel

34. [Apart from the difficulties in obtaining suitable persons, the undertakings were also experiencing considerable difficulty in retaining qualified technical personnel as job opportunities both within the country and abroad have increased. The major attraction of job security in Government undertakings no longer holds good, in the context of better emoluments and benefits offered by the private sector to the design personnel who have gained experience in the public undertakings. In fact, there appears to be a deliberate

attempt by the private enterprises to 'steal' them away from these undertakings as it is cheaper to do so rather than train up fresh design engineers from the raw.]

(Para 7.1)

35. It has been revealed by a separate study made recently by the Bureau that the incidence of flight of technical personnel is highest among graduate engineers. The undertaking stricken most by this problem is the MAMC. The study has found that this Corporation lost 27 out of 57 engineers trained by them in the fields of design and technology development. The study has also found that the loss has been greater among design engineers as compared to other technical personnel.

(Para 7.4)

36. The reasons for resignation of these persons were (i) for going abroad either for study or for employment or for improving career prospects, (ii) more congenial work environments elsewhere, (iii) to join another enterprise for bettering prospects, (iv) the tendency of management to concentrate more attention on manufacturing activities and less on the areas such as designs, research and development etc. which are slow in yielding results and which also keep the Design Bureaus consequently under-loaded resulting in the designers spending their time in looking for better prospects outside.

(Para 7.4)

37. In some cases, for want of promotion opportunities within the Design Organisations, experienced Chiefs of Designs have gone over to higher managerial or administrative posts, thereby, denying the Design Organisation, the benefits of their rich experience.

(Para 7.4)

38. The flight of highly qualified and experienced design engineers not only represents a substantial loss to the undertakings who have invested large sums in their training but is a serious reflection on our present policies and proof that the incentives to retain them are not sufficiently attractive.

(Para 7.3)

Measures to retain & motivate design personnel

39. The problem of flight of design engineers to other organisations or even outside the country is inevitable as it is impossible to ensure that conditions of service and prospects for promotion in a particular undertaking would always be better than those available elsewhere. Despite this, it is necessary that undertakings should take all possible steps to retain experienced design engineers within the organisation. For this, a number of steps would be necessary. We would recommend the following:

- (i) Adequate opportunities for advancement should be provided within the Design Organisations by creating intermediary and special grades.
- (ii) After an engineer has put in five to six years of service in a particular grade he should be provided a higher grade instead of allowing him to stagnate in that grade for a long time.
- (iii) The chiefs of Design Organisations, at least in large undertakings, should be equated with the post of General Manager or Deputy General Manager. The officer in design organisation should enjoy a status equal, if not higher, to those holding managerial posts. This would minimise, if not altogether remove, the possibilities of their seeking jobs in other departments within the organisation.
- (iv) Design engineers with aptitude for managerial functions should not, however, be debarred from moving to such positions.
- (v) The present requirement that a trainee has to sign a bond that he will not leave the organisation for certain number of years after completion of his training should be raised to 8 or 10 years.

The MAMC have stated the raising of bond after training from 8 to 10 years is not a practicable one. The NIDC have stated that while higher grades may be allowed for the same work, it should be related to professional development and not merely to the length of service.

- (vi) One of the measures necessary to fill the gaps resulting from inevitable departures from the organisation would be to have a regular minimum number of trainees in the 'pipe line' throughout.

(Para 7.9)

40. Sometimes there is a lack of opportunities for career development owing to the following factors:

- (a) Recruitment of a large number of engineers in the earlier stages of the project at almost the same period either for foreign training or for training in India.
- (b) As such officers are in the age group of 28 to 45 there is not likely to be any significant retirement during the next 6-10 years in the higher posts.
- (c) Limited scope for expansion of activities which could provide adequate openings in the future.

(Para 7.5)

41. Some of the steps suggested to meet this situation are:

- (a) Intermediary stages in the pay scales, providing for special pay be introduced so as to provide incentive. Deserving offices in the scale of Rs. 775-1375 be provided incentive through "promotion" to those stages carrying special pay of Rs. 100 and Rs. 200 p.m. A special pay of Rs. 90 be introduced between the scale of Rs. 450-1075 and Rs. 775-1375. Similarly officers in the grade of Rs. 1375-1735 be given incentives on the basis of their merit and accomplishment in the form of a special pay of Rs. 150/-.
- (b) Review of the sanctioned strength in the cadre from time to time in order to provide for the needs of the Organisation as well as career advancement for the engineers.
- (c) The intake from outside be regulated.
- (d) Deployment of some personnel at the senior levels in other organisations either by deputation, transfer or absorption so as to avoid their stagnation and to provide scope for chain promotions.

- (e) In specialised organisations, the need for a longer grade especially at the lower levels appears inescapable. In the larger grade itself, there should be room for promotion by selection.

(Para 7.5)

42. The question of undertaking applied research work connected with development by the undertakings raises two questions viz (a) whether such work, in view of the large resources required, should be left exclusively to separate research organisations/laboratories outside the undertakings and (b) whether in a multi-unit organisation (if part of such work has to be with the undertakings), this work should be centralised or left to the units concerned. Different views have been expressed on this; some hold that in view of their immediate objective to achieve rated production levels, this work should be entrusted to outside organisations. Others are of the view that this is an integral part of their work and facilities should be created for carrying it out effectively within their own plants.

(Para 8.1)

✓ 43. Some of the enterprises have suggested that a percentage of their turnover should be spent on R & D activity.

(Para 8.1)

44. The cost of undertaking R & D work, arising from the requirements of design development, would be obviously quite large. The undertaking would naturally be reluctant at the present stage of their development to take up this work, even if it may legitimately be part of their product-development effort. [Some of the undertakings are quite positive than R & D work connected with product development should be an integral part of their activities and it is only this close and continuous relationship between the two areas, within the manufacturing plant, that will be effective and yield satisfactory results.] The same practice is followed in some of the large manufacturing companies abroad.

(Para 8.2)

Facilities for applied research

45. It would be in the interests of product development, if some applied research facilities are set up at the plant level itself. This would also help to provide the necessary climate and motivation for carrying out improvements/innovations in designing the products they are manufacturing. Since design innovation has a major bearing on profitability of the organisation, the motivation for carrying out problem-oriented research can be provided by the organisation itself. In the area of product improvement, facilities for such work can be organised under their own umbrella, possibly under a separate functional wing.

(Para 8.2)

46. In view of the need to interlink design and production effort closely, it would be advantageous to locate the design development effort at the unit level in the case of units of a multi-unit organisation producing different products. Research problems having a wider bearing and affecting a number of other products, will inevitably have to be entrusted to national or regional research organisation.

(Paras 8.3 & 8.4)

47. [The present set up of the design organisations seriously lacks research base. The creation of such a base should be the long term objective of undertakings for which planned measures will have to be initiated even from now.]

(Para 8.5)

Liaison with Research Organisations

48. One of the essential requisites of successful design and development effort is that whatever capability is available in related research and production organisation is fully made use of. This requires close liaison between the production units and the national laboratories.

HEIL and BHEL maintain close liaison with each other and technological institutions like MACT, Bhopal, IIT, Kanpur, Electronic Research Institute, Pilani and Power Research Institute,

Bangalore. Even so they feel the liaison needs further strengthening.]

HEC keep in close touch with CMTI, CMERI, etc.

HMT cooperate with the CMTI and other Government research organisations and laboratories. As machine tool development requires continuous research backing, they would like Government help to establish contact with research institutions in Europe and America.

(Paras 8.7—8.16)

49. *It is likely that the national laboratories do not find industrially oriented projects sufficiently challenging in terms of technical achievements. The Team are, therefore, of the view that as the benefits from industry-oriented projects could be very great in terms of import savings, [25% of the programmes (in monetary terms) of the national laboratories should be set apart for such projects.] Individuals actively participating in such projects may also be rewarded suitably.

Measures for better liaison with research bodies

50. To facilitate direct dialogue and more dynamic and committed efforts for indigenous development of industrial products and processes, each undertaking should have direct understanding with one national R & D institute specifically and a few others in general. Senior board members of such industry should be associated in the policy/project formulation level of the institute.

(Para 8.18)

51. Periodic industry-wise seminars should be organised to consider design and technological problems of different industries to enable transfer of knowhow between industry and research institutions.

(Para 8.18)

*The Dept. of Science & Technology have stated that the problems relating to the R. & D. programmes in the national laboratories would be solved to a great extent with the implementation of the S. & T. plan.

✓ 52. A coordination Committee should be set up in the D.G.T.D. to consolidate information relating to available indigenous knowhow in various fields.

(Para 8.18)

✓ 53. A permanent cell may be created in the BPE to coordinate and pool the requirements of the undertakings in the fields of developing design capability and procuring necessary facilities

(Para 8.18)

✓ 54. Common chairmanship of the undertaking and the associated research body will help the flow of design data between them within the contractual obligations imposed on the production units by their collaborators.

(Para 8.18)

✓ 55. Deputation of personnel on an exchange basis will help flow of information from one organisation to another under the present constraints of secrecy of collaboration agreements. This is a field where Government's present policy in regard to deputationists needs a small change.

(Para 8.18)

56. By and large, very little resources are devoted to problems of advance design. HEIL have an advance design centre for steam turbines only. Their forward plan pays attention to new developments. The Tiruchi Plant of the BHEL has drawn up a list of projects calling for concentrated attention. HEC have stressed the need for an advance design institute for steel industry. The Hindustan Shipyard will rely on the work of the Central Marine Design & Research Organisation, when it is established. The undertaking has prepared a feasibility report of this organisation. The HMT have a well organised R & D Department engaged in a number of developments whose products are to be released for commercial production. MAMC has not felt the need for a separate Advance Design Centre.

(Paras 8.19—8.24)

57. The design organisations have generally grown in an un-planned manner. There is need to organise them on sound footing to meet the current operational requirements and also to meet the

future needs of the undertaking and the concerned industry group. This wider aspect of R & D activity has to be kept in mind by public undertakings in the larger interests of the country as, in most cases they would be the biggest units in the respective industries. Consequently, the Design Organisation in each undertaking should be so organised as to be able to do forward planning based on market research to develop new products continuously. It should be the responsibility of a cell in the design organisation to "look ahead" and adopt a futuristic approach. ["Advanced Design Cells" should be set up in all undertakings to build up capabilities for designing proto-types of new advanced machines. It is necessary to lay much greater emphasis on this aspect of development work in view of the avowed policy of the Government and objectives of the undertakings to develop indigenous technology.]

(Para 8.25)

Technical image

58. The role of the design organisation in projecting the technical image of the undertaking to which it belongs needs more attention.

(Para 8.26)

59. *The Team support the suggestion of HEC to set up an institute for research problems of designing equipment etc. for Steel Industry.

(Para 8.27)

Perspective plan

60. It is necessary that the design organisation should have a perspective plan for a reasonable period, say 10 to 15 years. Based on the manufacturing or production programme, the Design Department should draw up a perspective plan of action for developing product designs.

(Para 8.30)

*The CEDB has since been converted into a separate company, namely Metallurgical Engineering Consultants (India) Ltd. and is being expanded to meet the needs of the steel industry

61. The Team supports the proposal of Hindustan Shipyard for setting up a Central Marine Design and Research Organisation with financial support from the Government.

(Para 8.32)

Foreign collaborations

62. Achievements of the design organisations have been possible largely through purchase of technical know-how, design documentation, etc. A number of difficulties/problems have been experienced by the undertakings in respect of the collaboration agreements. Certain HEIL agreements provided only for supply of manufacturing information and not design knowhow. HEC have felt the lack of provision for updating the designs. Basic documents and calculations are not also made available to help initiate applied design-work. Hindustan Shipyard felt the need for providing for training of design personnel on a continuous basis. In the case of tailor-made equipment, MAMC have experienced difficulties relating to Indian Standards, use of indigenous materials, etc.

Some of the deficiencies noticed in the collaboration agreements are given below :—

- (a) Some of the collaboration agreements entered into in the past provide for only supply of documentation without the supporting basic calculations.
- (b) There has generally been no provision making it obligatory on the collaborator to transfer information regarding improvements/developments to equipments/processes.
- (c) Entering into collaboration agreements for total project know-how on a total turn-key basis is a very costly manner of acquiring design know-how.
- (d) The provision prohibiting the disclosure of knowhow to third parties often leads to repetitive import of the same knowhow by different agencies.
- (e) In some cases, provision relating to training of Indian personnel in the collaborator's works did not include the requirement for acquainting the engineers with design know-how but only with the manufacturing processes.

63. While considerable advances have been made in building up technical knowhow in certain areas, dependence on imported technology will have to continue in certain areas till requisite skills are built up within the country. Since it would not be profitable to attempt to master all the design and technological practices being developed abroad, it would be more profitable to concentrate the scarce technical talents in limited areas and to buy the technical knowhow and designs from abroad in sophisticated areas in the short run.

(Para 9.13)

Collaboration agreements : Need for Care

64. *Greater care should be taken in drawing collaboration agreements to ensure that :

- (a) the transfer and assimilation of technical knowledge, design knowhow and other facilities are brought about in the most advantageous manner;
- (b) collaboration agreements provide for supply of not only documentation but also of detailed design sheets, specifications and calculations. Such details as quality of raw materials, substitute material and alternative processes to suit different working conditions should also be invariably incorporated;
- (c) collaboration agreements also ensure that knowhow/further developments, adaptations and improvements effected by the collaborator to the design/processes/equipment supplied by him are made available to the contracting Indian parties;
- (d) In some spheres knowhow could be imported through National Institute and sub-licensed to the industry. Close association of public undertakings with the National Institutes and setting up of working arrangements between them for better assimilation of knowhow would enable comparative analysis of knowledge/processes available in the world and selection of the best available;
- (e) for better assimilation of basic concepts, data and information and to ensure fuller utilisation, improvement and

*The Dept. of Science & Technology have stated that the recommendations on foreign collaboration are being taken care of by the NCST Group which is working out new guidelines on foreign collaboration.

diversification within a reasonable period, each undertaking should have a R & D cell working from the very beginning;

- (f) care should be taken to break down the project into various sub-elements to ensure that designs and processes are obtained from the most capable manufacturers in the world for each of these elements instead of entering into blanket agreements;
- (g) training of personnel by the collaborators should also cover training of the engineers at their R & D organisation. Refresher courses to enable the teams to absorb knowledge about latest improvements should also be provided for;
- (h) in the case of collaboration for tailor-made items of equipment, a liaison officer should be kept at the collaborators' works, while the designs are prepared to guide them with regard to indigenous availability of raw materials, implementation of Indian Standards, safety and other requirements;
- (i) Restrictions placed by the 'disclosure' clause can be overcome by adopting one of the following measures :—
 - (i) The clause should be so worded as to permit the use of information obtained by one undertaking in other Government undertakings.
 - (ii) Government should directly acquire design knowhow.
 - (iii) If holding company type of organisation would make the transfer of the imported knowhow to its subsidiaries easier and enable its better utilisation and assimilation, it may be desirable to set up such companies in different sectors.
 - (iv) In certain spheres, knowhow could be imported through national Institutes and then sub-licensed.
- (j) Imports of sophisticated equipments/components/spares should be accompanied by acquisition of their design know-how specifications etc.
- (k) In view of the scarcity of technical talent in the country, it would be profitable to concentrate the personnel in limited

areas in the short-run and buy the technical knowhow and designs from abroad in sophisticated areas. As the base of R & D widens, it would be possible gradually to eliminate dependence on foreign sources; and

- (1) Technical teams should be sent out to different countries at regular intervals to scout for information relating to designs and latest technologies. (Para 9.14)

Financing R & D

65. One of the major constraints with regard to undertaking R & D work by the undertakings is finance.

66. Finance for R & D effort could be found by the following methods :

- (a) Setting apart a fixed budget provision varying with the type and size of industry. This may be made as a statutory obligation.
- (b) Provision of separate equity capital or interest-free loans by Government.
- (c) Allowing the enterprises to add a certain percentage to the manufacturing cost on a cost-plus basis. Enterprises in the competitive sector devote a certain percentage of income for R & D.
- (d) Government should give outright subsidies to enterprises with long gestation period and low profitability rate for carrying out R & D work.
- (e) Development work in respect of large products should be financed by Government e.g. development work in respect of generators should be financed by the Ministry of Irrigation and Power.
- (f) While R & D efforts in the field of advance design should be centralised, such effort as is connected with the production carried on by the individual plant should be located in that plant.

- (g) The activities of the Design & Development work could be financed by charging the factory for the services rendered by it and by maintaining a separate profit and loss account.
- (h) As part of its exercise to fix economic, financial and social objectives for the undertakings, Government should lay down in consultation with enterprises specific design development goals for each undertaking, indicating the ways and means of financing them.
- (i) In view of the high cost involved, R & D work in some important and strategic areas should be sponsored by the Government at its own cost as is being done in some of the advanced countries. (Para 10.7)

Procedural bottle-necks

67. The undertakings stated that they face several procedural difficulties in obtaining Government clearance/approval for technical collaborations, import licences for equipment, critical components and raw-materials needed for research and analytical tests. The Team, therefore, suggest that release of foreign exchange, clearance by DGTD, and issue of import licences by CCI&E to R&D institutions should receive better consideration. There is need to identify bottle-necks in this regard with a view to eliminate such delays. The Team, therefore, recommend allocation of special foreign exchange and issue of blanket import licences for R&D purposes.

(Paras 11.1—11.4)

Design archives

68. *Closer association of the undertakings with research institutions should be supplemented by the establishment of a national Design Archives which will store all design information available in the country both in the private and public sectors. A beginning could be made by setting up archives on a regional/sectoral basis or by pooling the available information in R&D organisations of the public sector. This could possibly be made part of the Data Bank being set up in the BPE. (Para 11.2)

*According to the Dept. of Science & Technology, this suggestion may be taken care of either in the information system to be built up in the Dept. of Science & Technology or in the Data Bank to be built up in the DGTD.

ANNEXURE I

(Chap. I para 1.8 refers)

List of Points on which information regarding Design Organisations was collected

Objectives :

1. It is felt that every undertaking must clearly outline the immediate and long-term objectives (as distinct from 'activities' or functions) of their Designing Organisations, after duly considering their short-term and long-term corporate objectives and the resources which they can spare.

- (a) Do you agree with the above statement ?
- (b) What objectives have been laid down for your Designing Organisation.
- (c) What is the present extent of dependence on foreign design & consultancy firms? Please give reasons.
- (d) What are your long-term plans to sustain the level of progress obtained with a view to progressively achieving complete independence in the matter of foreign collaboration for the projects under your organisation.
- (e) To what extent do you plan depending upon other indigenous design cells, Government research establishments and laboratories, academic institutions and Indian consultancy firms?
- (f) What are your long-term plans in regard to the strengthening of the design organisation? Please furnish details in terms of the following :—
 - (i) Estimated increase in staff and office.
 - (ii) Estimated increase in expenditure.

Staff Strength & Organisation Structure

2. (a) What criteria have been adopted for fixing strength of staff and the qualifications and experience required of them?

- (b) Please furnish an organisation chart of the Design Organisation.
- (c) To whom does the head of this organisation report?
- (d) How do you ensure coordination between Sales, Design and Production Functions?
- (e) What has been the sanctioned and actual strength of Design Organisation of your undertaking during each of the last three years?
- (f) What is the present sanctioned and actual strength of this organisation?
- (g) What is the distribution of the present strength as between (i) Product Designs, (ii) Design of Plant, Tools and other Means of Production and (iii) Designs of Methods and Processes etc. (iv) Estimates.
- (h) Do you have a 'Value Analysis' section in the Organisation & is 'Design' associated with this aspect?

Recruitment & Retention of Technical Personnel

3. Have you experienced any difficulties in recruiting and retaining the qualified technical personnel for Design Organisation? If so, what measures have you taken or propose to take to overcome these difficulties.

Budget

- 4. (a) What have been the budget estimates and actual expenditure for the design organisation during each of the last three years under the following heads :—
 - (i) Emoluments of staff
 - (ii) Cost of equipment
 - (iii) Other charges.
- (b) What has been the ratio of the recurring expenditure on Design Organisation to the cost of production/sales during each of the last three years?
- (c) What income has accrued during each of the last three years directly due to the activities of the Design Organisation?

Targets & Reporting of Performance

5. Where any performance targets laid down during each of the last three years? If so, what were these and to what extent were they achieved?

Achievements

6. (a) How far has the present Design Organisation succeeded in designing various processes, equipment and products independently (as distinct from detailed manufacturing drawings)? What are its salient achievements in this respect during each of the last three years?
- (b) Are any new projects also designed by this organisation? If so, please furnish details for each of the last three years.
- (c) Is construction and installation work of projects also undertaken or proposed to be undertaken? If so, please furnish details for each of the last three years.
- (d) How far has the design cell helped in stepping up production by suggesting technological innovations and thus introducing modern production techniques and designs in the plants?
- (e) What is the value of import substitution which has been made possible by Design Organisation during each of the last three years?
- (f) How far has this organisation helped to bring down the cost of production?
- (g) What are the other advantages derived as a result of the functioning of the Design Organisation in financial terms with regard to the impact achieved on the profitability of the Corporation?
- (h) Has any specific study been made in this respect?

Technical References

7. What is the present arrangement for making available up-to-date world wide technical reference to the design organisation? Do you consider it adequate?

Miscellaneous

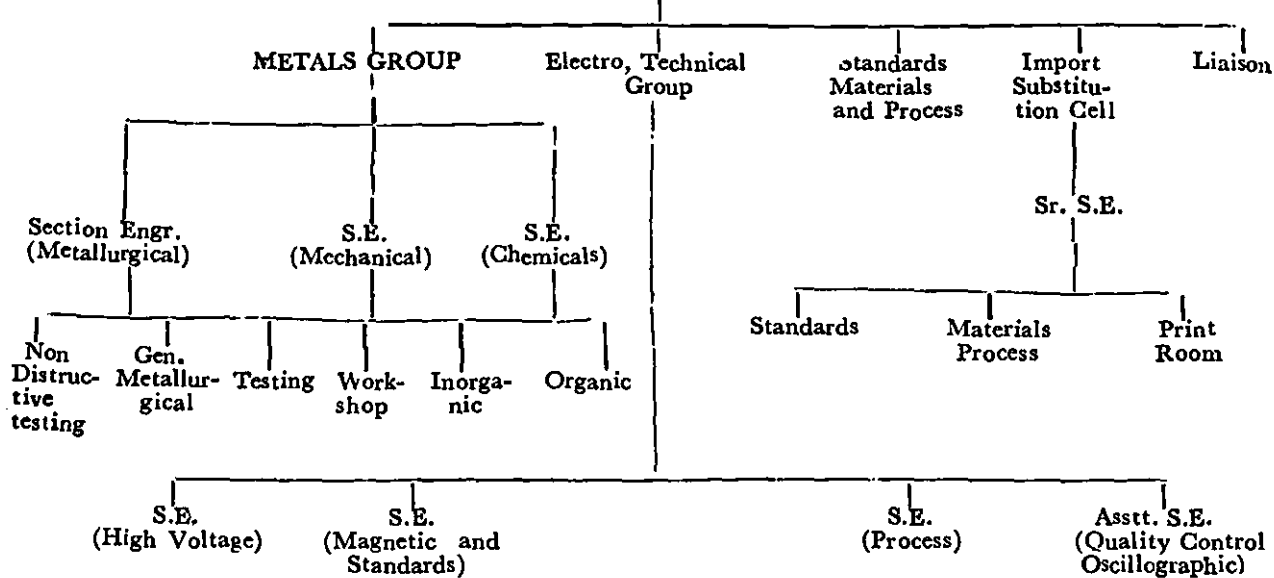
8. Any other information which you consider will be relevant for making a proper study of the design organisation of your undertaking.

ANNEXURE II
 (Chapter IV, Para 4.1 refers)

Heavy Electricals (India) Limited

Organisation Chart of Research and Development

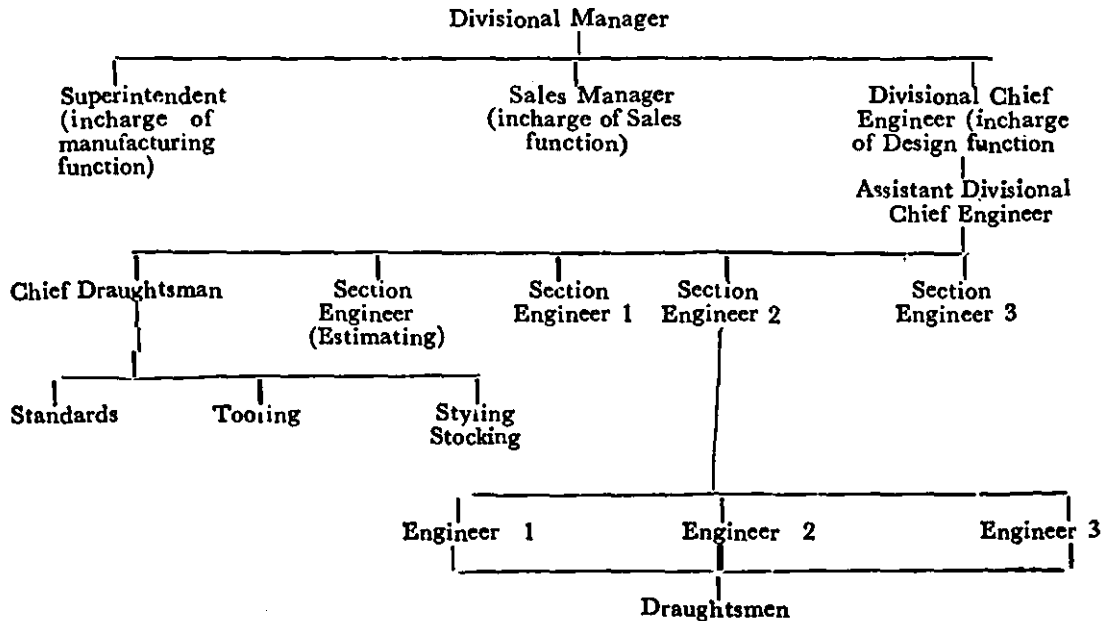
Chief Research Engineer



Heavy Electricals (India) Ltd.

Organisation Chart of the Design Organisation

The product design organisation is under the control of the Company Chief Engineer.



Heavy Electricals (I) Limited

I. Details of staff of Design Organisation during the last three years.

	Sanc- tioned	Actual
31-3-1968	1372	1228
31-3-1969	1388	1102
31-3-1970	1392	1208
31-3-1971	1392	1208

II. Emoluments of Staff of Design Organisation

	Budget (Rs. in lakhs)	Actual (Rs. in lakhs)
1966-67	69.94	66.98
1967-68	78.29	72.26
1968-69	74.22	75.96

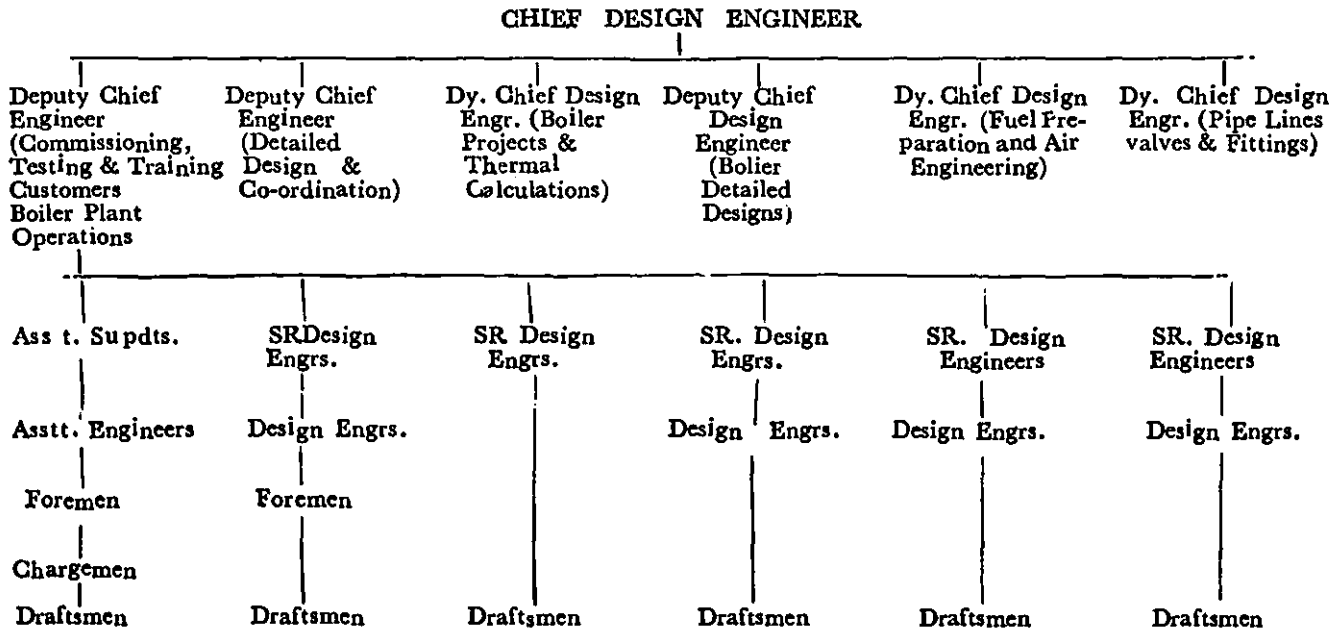
III. Plans for strengthening Design Organisation

Net addition

	Staff	Expendi- ture (Rs. in lakhs)
1970-71	50	11.2
1971-72	100	15.4
1972-73	150	19.6
1973-74	200	23.8

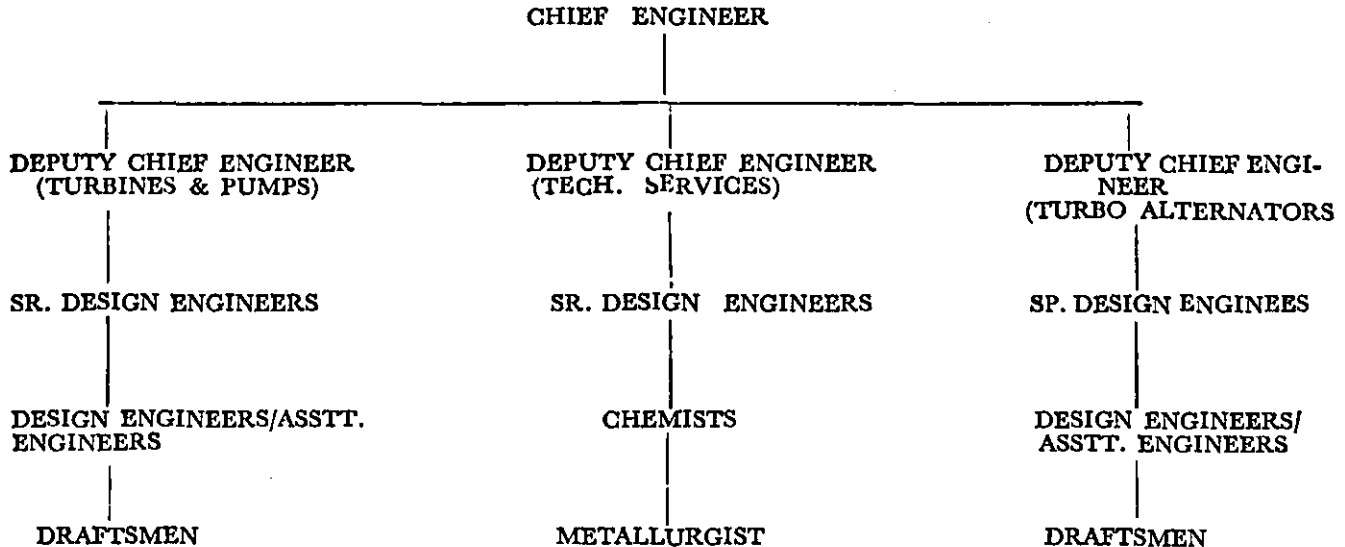
Bharat Heavy Electricals Ltd. (Tiruchirapalli)

Organisation Chart of Design Department



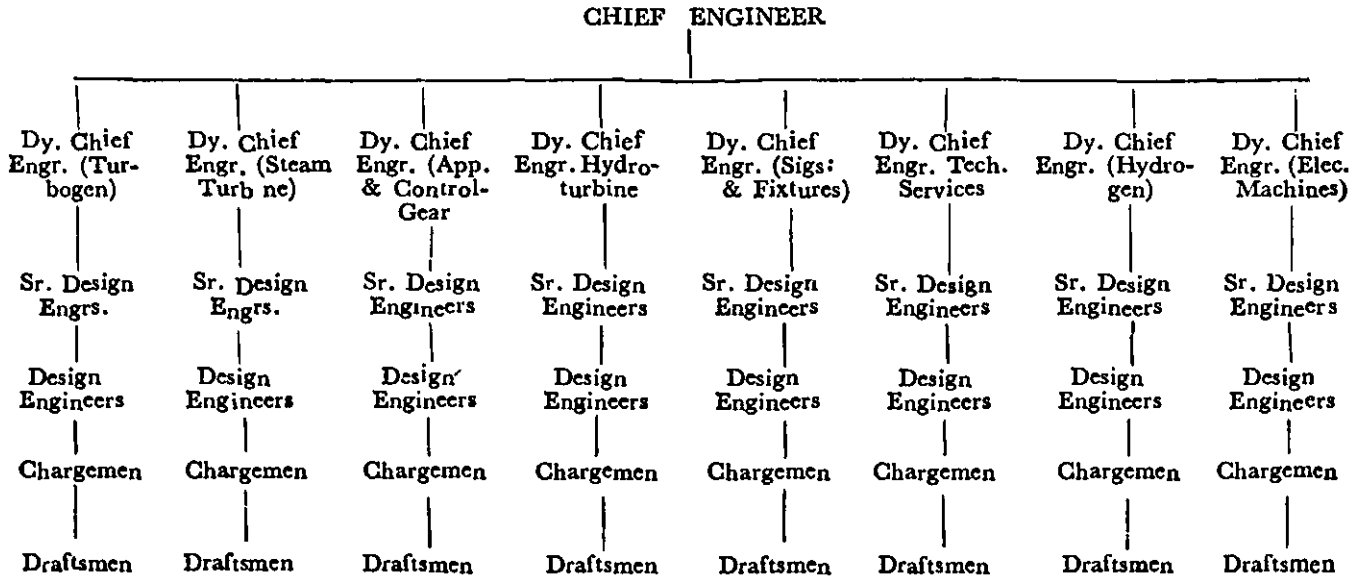
Bharat Heavy Electricals Ltd. (Hyderabad)

Organisation Chart of Design Department Heavy Power Equipment Plant—Hyderabad



Bharat Heavy Electricals Ltd. (Hardwar)

Organisation Chart of Design Department Heavy Electrical Equipment Plant—Hardwar



Bharat Heavy Electricals Limited

I. Details of staff of Design Organisation during the last three years.

Details of staff of Design Organisation during the last three years.

	Hardwar	Hydera- bad	Tiruchi
Present sanctioned strength	580	260	270
Present actual strength	514	209	278

II. Emoluments of staff of Design Organisation during the last three years.

	Hardwar (Rs. in lakhs)			
	Hyderabad		Tiruchi	
	Budget	Actual	Budget	Actual
1967-68 (actual)				13.69
1968-69 (actual)				20.97
1969-70 (actual)				26.05
1966-67	10.58	8.64	10.00	8.94
1967-68	9.18	9.94	12.00	13.29
1968-69	12.18	13.00	16.96	16.31

III. Plans for strengthening Design Organisation

The exact requirement of individual units would be different in view of the different levels of organisational set up.

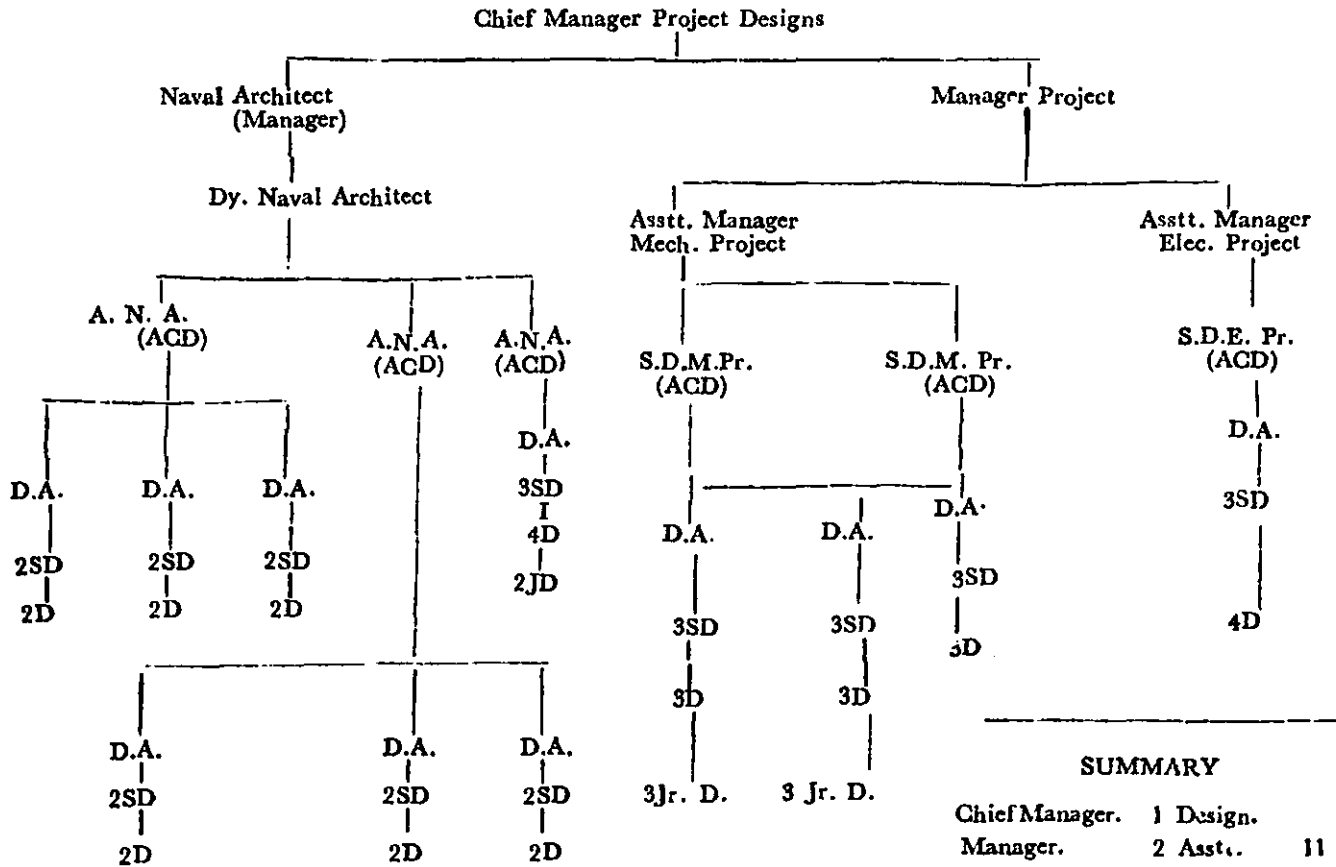
Design Office to be increased by 20 to 40%.

Expenditure expected to go up by 20 to 40%.

Hindustan Shipyard Ltd.

Design Office

Director of Ship Construction



SUMMARY

Chief Manager.	1	Design.	
Manager.	2	Asstt.	11
Asstt. Manager	3	Sr. D/man	27
Asstt. Chief		D/man.	29
Draughtsmen.	6	Jr. D/man	8

Hindustan Shipyard

I. Details of staff of Design Organisation during the last three years.

Year	Sanc- tioned strength	Actual Strength
1967 68	15	3
1968-69	15	3
1969-70	17	5

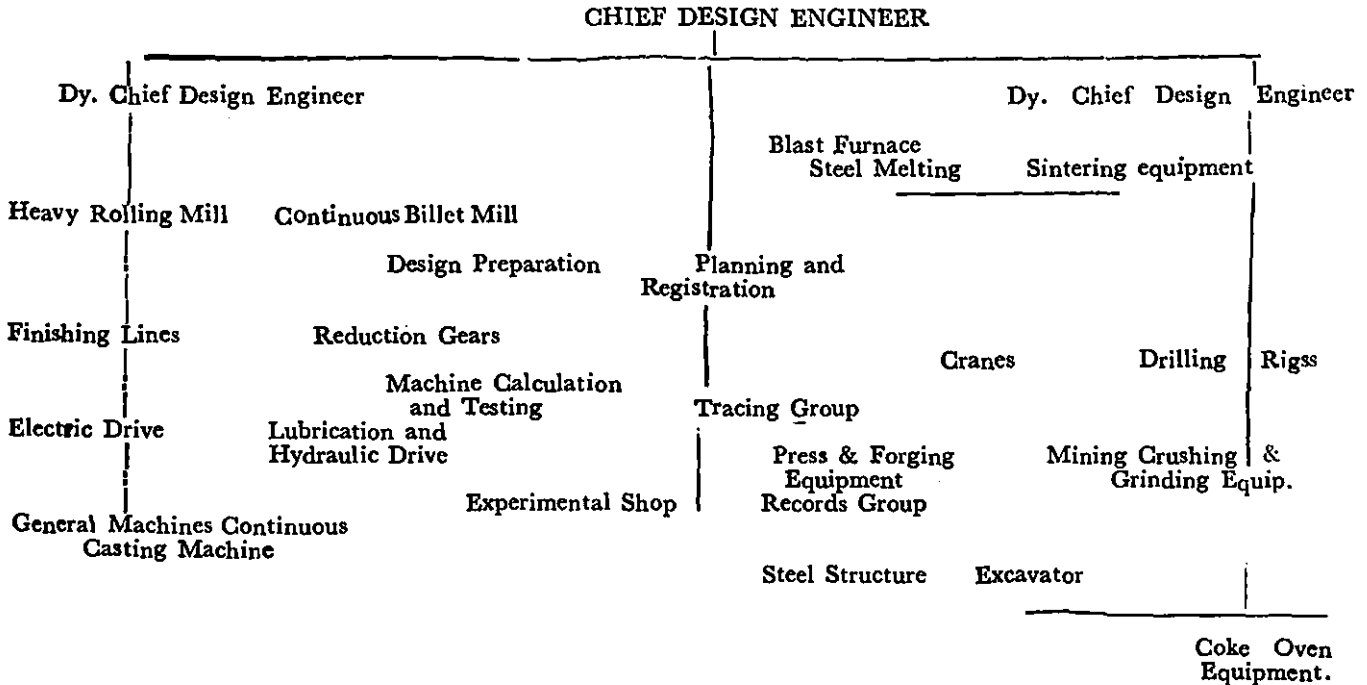
II. Emoluments of staff of Design Organisation during the last three years.

No information given as the Design Office is still in the process of being organised.

III. Plans for strengthening Design Organisation

Officers to be increased to 18 during the next five years and staff to 55. Estimated increased in expenditure would be Rs. 25,000/- per month.

Present Organisation of Heavy Machine Building plant Design Office : Heavy Engineering Corporation

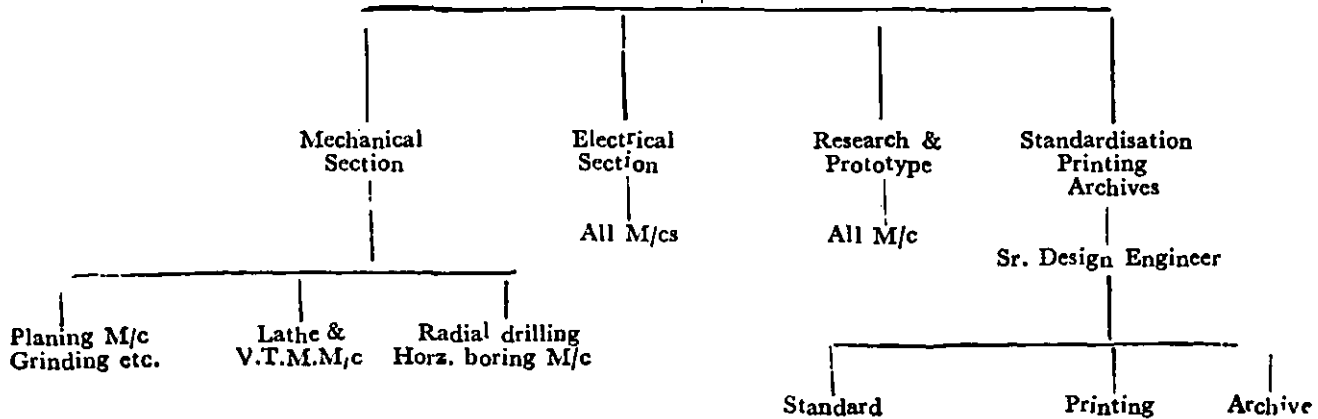


Existing organisation chart of Design department Heavy Machine Tools plant.

Heavy Engineering Corporation Ltd. Ranchi

CHIEF DESIGN ENGINEER

DY. CHIEF DESIGN ENGINEER



Heavy Engineering Corporation

I. Details of staff of Design Organisation during the last three years.

1. Heavy Machine Building Plant :

	San- ctioned Strength	Actual
1967-68	607	369
1968-69	607	337
1969-70	607	333

Besides, there is a Structural Design Office which has at present 160 technical persons. Expenditure figures not given.

2. Heavy Machine Tools Plant :

Sanctioned strength is 79 and the actual is 59.

3. Project and Development Division : (Central Construction Design Unit)

The Present strength is 173.

II. Emoluments of staff of Design Organisation during the last three years.

Heavy Machine Tools Plant.

	Rs. in lakhs
1967-68	3.15
1968-69	4.02
1969-70	4.43

III. Plans for strengthening Designing Organisation.

Estimated increase in staff and expenditure not given.

Hindustan Machine Tools Ltd. Design Office

CHAIRMAN & MANAGING DIRECTOR

Chief of Design
& Development

ADVANCED PRODUCT DESIGN	PRODUCTION TECHNOLOGY	PROTOTYPE TESTING	RESEARCH & DEVELOPMENT	CENTRAL STANDARDS	TECHNICAL INFORMATION
Numerical Control Structures and Control Systems	Product Engineer- ing	Geometrical Accuracies	New Materials New Processes	Basic Machine Elements. Tools	Technical Information Documentation
Machine Elements Unit Machines Lathes Milling Machines Drilling Machines	Process Engineer- ing. Methods & Estimation	Static Rigidity Dynamic Stability	New Cutting Tools. Machine Eleme- nts (Bearings, Con- trol Slideways etc.) Advanced Numer- ical Control.	Equipment Inventory Control	Technical Translation ADMINISTRATIVE CON- TROL OF THE RESPEC- TIVE GENERAL MANAGER
Grinding Machines Gear Cutting Machines Automats Broaching Machines Boring Machines SPMs (Custom Built) Die Casting Machines Printing Machines Tractors Watch Making.	Production Tech- niques Assembly Techni- ques SPMs (Automatic) Transfer Lines Tools design Series and Mass Production.	Performance Tests. Testing of Control Systems. Testing of Machine Elements.	Adaptive Controls Fluidics	Import Subs- titution ISO & ISI activities	UNIT DESIGNS HMT I & II, III, IV, V Maintenance Design Service Design Following up of Alternations. Service Orientat ion of Designs. Import Substitution Unit Standards Unit Documentation Technical Information.

Hindustan Machine Tools Ltd.

I. Details of staff of Design Organisation during the last three years.

Designation	As on January 1, 1969		*As on June 1, 1970	
	San- ctioned	Actual	San- ctioned	Actual
Chief of Design Development	..	..	1	..
Chief Engineer . . .	1	1	5	1
Senior Engineer . . .	6	4	32	2
Engineers . . .	20	3	68	7
Junior Engineers . . .	69	41	109	70
Draughtsmen . . .	60	68	188	107
	156	117	403	187

II. Emoluments of staff of Design Organisation during the last three years.

(i) Emoluments of staff	} Year 1970-71 (Rs. in lakhs)
(ii) Cost of equipment	
(iii) Other charges . . . . .		37

III. Plans for strengthening Designing Organisation

Design Organisation is being continuously strengthened.

Estimated increase in staff and officers	About 200
Estimated increase in expenditure	Rs. 25 lakh per annum.

*This does not include the design and development personnel working on Special purpose Machine Design. As on June, 1970 there are 134 persons in position.

Mining & Allied Machinery Corporation Ltd.

I. Details of staff of Design Organisation during the last three years.

Since the Design Organisation had been in the process of re-organisation, no information has been given.

II. Emoluments of staff of Design organisation during the last three years :

	Rs. in lakhs
1967-68	11.40
1968-69	10.68
1969-70	10.44

III. Plans for strengthening Design Organisation.

Proposal under consideration. Hence no information given.

ANNEXURE III

(Chapter IV, para 4.19 and
Chapter VIII, para 8.23 refer)

(a) Activities of Central Design Development and Research Department of HMT

1. To prepare and consolidate development schedules of new products, accessories and improvements on existing products in collaboration with HMT Units.

2. To evolve short and long range product policy of the company in collaboration with Commercial Department and other HMT Units.

3. To associate with HMT Units and Commercial Department for the implementation of new products as detailed in the drill for introduction of new products in HMT.

4. To co-ordinate and assist HMT Units in the implementation of design and development programme.

5. To recommend the commercial production of products after its prototype testing and redesigns is completed.

6. To design and develop new project at the request of :

- (a) Board of Management.
- (b) HMT Units.
- (c) On its own.

However, in all the above cases, the Unit Design Chiefs will be closely associated.

7. To provide advanced testing facilities to the Units for new products developed and any other attachment.

8. To provide assistance to the units in the following fields :

- (a) Value Engineering of Products.
- (b) Training of Design & Testing Staff.
- (c) Evaluation of Designs.

9. To develop expertise and establish a full-fledged Research and Development Centre to back-up the activities of the HMT complex.

10. To conduct Central Standards activities.

11. To co-ordinate the participation of HMT Organisation in Conventions, Seminars and Exhibitions, both of national and international importance.

12. To maintain Central Technical Information Service for disseminating information regarding the latest advances in technology and product trends through organised effort.

13. To establish Central Industrial Design Cell.

14. To evolve systems for product evaluation.

ANNEXURE III—Contd.

(b) *Activities of the Unit Design Department of HMT*

1. Development of new products to replace the existing range of products to remain effectively in the Indian and International markets.
2. Continuous development of the existing products at regular intervals to improve its performance and marketability.
3. Value engineer each product for economical production to be competitive in the domestic and international markets.
4. Continuous adaptation of the product to the changing demands of technology and the development of new materials and standard parts.
5. Build prototypes of new designs and conduct preliminary tests.
6. Evaluate quality of manufacture of established products.
7. Development of Design Staff.
8. To prepare and maintain unit standards which are not covered by Central Standards.
9. To maintain and organise effective technical information service.
10. To organise and maintain, storage and distribution of drawings, standard sheets etc. required for production in the unit.

(Chapter V, para 5.2 refers)

Some of the salient achievements of the Design Organisation of Heavy Electricals (India) Ltd.

(i) Design of water turbines and water wheel generators for UBPC, Ramganga, Koyna, Ukari, Sumbal Sindhi, Gumti and Khodri-hydel Project.

(ii) Design of a 30 MW air cooled turbo-generator.

(iii) Design of heat exchangers for a 30 MW steam generating set for Namrup Power Station.

(iv) Design of industrial motors upto 2000 HP rating.

(v) Design industrial control gears and composite industrial drives.

(vi) Design of over 400 transformers upto 250 MVA rating of the 220 kV class.

(vii) Special purpose transformers like furnace transformers, Bokaro Steel Plant, a 12.5 MVA transformer for railway electrification and rectifier transformer, transformers and motors with aluminium windings:

(viii) Sine wave generators.

(ix) Design of a metre gauge Diesel electric loco traction generator.

(x) Development of the design of an inductor alternator to replace exciters on metre gauge diesel locos.

(xi) Development of the design of a 1500 V DC Loco traction motor of 690 HP rating.

(xii) Electric voltage regulators and speed control devices.

Bharat Heavy Electricals Ltd.

Designs Development at the Units High Pressure Boiler Plant, Tiruchi.

(1) 420 t/hr. pulverised fuel fired, dry bottom type, boiler to match the parameters of 100 MW non-reheat steam turbo generator of Russian design.

(2) 60 t/hr. bi-drum, oil fired, process steam boiler for MFL.

(3) 11.5 t/hr. oil fired packaged boiler for HOC Ltd., Rasayani, Maharashtra.

(4) 125 t/hr. Asphalt fired boiler for Haldia Refineries.

(5) 30 t/hr. Bi-drum type oil and gas fired boiler for Gujarat Aromatics Ltd.

(6) 6 t/hr. oil fired boiler for FCI, Sindri.

(7) 105 t/hr. Waste Heat Boiler for FEDO, Alwaye, Travancore.

(8) 540,000 lbs/hr. oil fired Membrane walled Boiler for Tunku Jaffar Power Station, Malaysia (EXPORT ORDER).

Besides the above, original designs are being made for multi-fuel fired boiler capable of burning pulverised fuel, oil or natural gas and rated at 395 t/hr. to match the performance parameters of 120 MW turbo-alternator being supplied by HE(I)Ltd., Bhopal. This original design is against the order placed by Gujarat Electricity Board.

The original designs indicated above also necessitated evolving of designs for connected auxiliaries to match.

The following are the adaptations with suitable improvements on original documents received from USSR :

- (i) Pulverised fired boiler rated at 380 t/hr. for Bhatinda Thermal Power Station of Punjab State Electricity Board. The Boiler is to match the steam parameters of 110 MW turbo.

Heavy Power Equipment Plant, Hyderabad.

- (i) Design of small turbine of capacities of 5, 9.5, 12.5, and 19 MW based on the enquiries received from various customers.
- (ii) New designs for turbo-alternators of sizes 7.5, 9.5 & 12 MW for different industries in India.
- (iii) Modified designs for air coolers for turbo-alternators.
- (iv) Circulating water pumps and other pumps.

Heavy Electrical Equipment Plant, Hardwar.

- (i) Design of the first 30 MW Hydro set for Giribata Project in Himachal Pradesh comprising hydro-turbine, hydro-generator and associated controlgear has successfully been completed and manufacture is on hand.
- (ii) Design of 16 MW hydro set for Bhatgar Project has also been completed and the manufacture of the same would be taken up on shop floor shortly.
- (iii) Design of 630 MW Asynchronous machine has been evolved and the machine has been manufactured successfully. Final tests are now in progress.
- (iv) Design of the flame proof switchgear was evolved and the prototype was manufactured. Prototype has been approved by the Inspector of Mines, Dhanbad, and now the series production to this design is in hand. Two more of such gear are in various stages of development.

(Chapter V, para 5.4 refers)

Hindustan Shipyard

List of major projects of Ship construction undertaken

(i) Tender for proposed I. N. Survey Vessel. The Indian Navy has kept this proposal in abeyance since they are modifying their basic requirements and design for this vessel.

(ii) Design for 12000 Ton cargo Liner for Shipping Corporation of India for their Indian/Australia Run. This Project is also kept in abeyance since Messrs. Shipping Corporation of India Ltd., has indicated priority to their India/America Run vessels mentioned below.

(iii) Design for 14,500 Ton D.W.T. fast semi-container cargo vessel for M/s. Shipping Corporation of India Ltd., for their India/America Service, in collaboration with Messrs Burness, Corlett and Partners Ltd., U.K., is on hand.

(iv) Design of a Training Ship for D. G. Shipping. Order procured and construction of ship is on hand.

(v) Tender submitted for a 6000/8000 Ton D.W.T. cargo liners for Iraq Maritime Transport Company, Iraq. Our Ministry is not too keen on our entering the export market now.

(vi) Preliminary Designs have been worked out and the cost of construction quoted for a 16,500 Tons Oil Tanker for Messrs Shipping Corporation of India.

(vii) Among the minor projects mention may be made of the following :—

- (1) Passenger motor launch for Visakhapatnam Port.
- (2) 500 M Grab Hopper Dredger for Visakhapatnam Port.
- (3) 2000 BHP. Kort-Nozzle Tugs for Visakhapatnam Port.
- (4) 1500 BHP Kort Nozzle Tugs for Paradeep and Mangalore Ports.
- (5) 500 Persons landing craft—Ferry for Shipyard personnel.
- (6) 1200 BHP Kort Nozzle Tugs for Tuticorin Port.

ANNEXURE IV

(Chapter V, paras 5.5 and
Chapter VIII para 8.21 refer)

4 Heavy Engineering Corporation Ltd.

A. HEAVY MACHINE BUILDING PLANT

Designs Completely Originally Made

Coke oven equipment

1. Mechanisation of coal handling plan in FFP on a turn-key basis.
2. Electronic weighing device for wagon tippler.
3. Rotaside wagon tippler.

Steel Structures.

4. Transfer Trolley.
5. Transfer Trolley.

Press Forging Equipment.

6. Lead Extrusion Press 2500 T.
7. 5T Take-up stand for Lead Extrusion Press.
8. 800 T Straightening Press.
9. 1250 T Hydraulic Forging Press.

Sintering & Pelletising Equipment.

10. Sintering Machine 75 M2
11. Drum type Mixer \varnothing 2.8 M \times 8 M (Primary)
12. Shuttle charge Distributor 800 \times 3000
13. Technical Project for Pelletising Plant 100,000T/Year.

Continuous Casting Machines.

14. Double strand Radial type continuous steel casting machine for casting billets of 100×100 MM and 80×80 mm.
15. Single strand Radial type continuous steel casting machine for casting billets of 100×100m and 80×80 mm.

General Machines

16. Cable Armouring Machine.
17. Plate Bending Machine.

Blast Furnace Equipment

18. Lime and dolomite kiln for FFP.
Chimney for Lime kiln
Body of kiln
Burner Assembly
Tray Type Feeder
Discharging Chute
Charging arrangement
Gear for Concrete Burner
Skip, V-O 75 M3
Burner Assembly.
Skip Bridge.
Dust collection and air supply system of lime kiln
Installation details of line shaft kiln 40T/day.
19. Automatic welding machine.

Drilling Rigs Equipment

20. Light Duty Percussion Rig HMB-PR-1.
21. Medium Duty Director Rotary Rig HMB DR-15
22. Medium Duty Percussion Rig HMB DR-15
23. Medium Duty Combination Rig HMB CR-15

24. Light Duty Rotary Rig HMB-DR-10*Reduction Gears.*

- 25. Reduction Gear Box for 2000 HP. cement Mill $i=42$.
- 26. 2500 H.P. Drive for 28" Finishing Lines.
- 27. Reduction Gear Box A-1120, $i=6$
18 for 2000 H.P. cement Mill.
- 28. Standard 3-Stage Vertical Gear Boxes.
A=500
- 29. B=750
- 30. A=950
- 31. Standard 2-Stage Horizontal Gear Boxes.
A=400
- 32. A=500
- 33. A=650

Crushing & Grinding Equipment.

- 34. Secondary Cone Crusher KCD 2200B
- 35. Single Roll Sinter Crusher 1200×2100
- 36. Heavy Duty Apron Feeder
1800×6500 mm.
- 37. Single Roll Sinter Crusher
1300×2700
- 38. Heavy Duty Stationary
Grizzly 2000×4700

Cranes

- 39. 20/5T heavy duty EOT Crane (Suitable for magnet and grab operation).
- 40. Medium and heavy duty EOT cranes 5T to 50/10T capacities.

41. 10T and 15T Travelling cantilever crane for steel melting shop.
42. 15T Goliath crane 32m span.
43. 30/ST Gantry crane, 32m span with 5m overhang on both sides.
44. 30T Gantry crane 32m span.
45. 15T, 15/15T, 15+15T, 10/10T and 10T, 40/15T Magnet duty EOT crane for steel mill, maximum span 37m, with double trolleys, moving cabin and twin hook hoist.
46. 5/5T Magnet and two rope grabbing duty EOT crane.
47. 75/20T 100/20T and 124/20T medium and heavy duty EOT cranes, suitable for steel mill.
48. 150/30T crane, 75+15T and 180+50T Ladle cranes.
49. 30/(200)T Stripper crane.

Rolling Mills.

50. Pig casting machine.
51. Plate coiling machine.
52. Furnace roller table.
53. Furnace bumpers.
54. Turn Table.
55. High pressure hand pump.
56. Cooling Bed.
57. Hot Bloom transfer.
58. Stationary stop.
59. Disappearing stop. (Pneumatic)
60. Throwing device.
61. Disappearing stop (Electrical).

62. Skid dog lifting mechanism.
63. Drive for 28" finishing mill.
64. Transfer Trolley.
65. Plate straightening machine.
66. Hot saw \varnothing 1200 mm.
67. Crop disposal device.
68. Travelling stop.
69. Manipulator.
70. Housing Rollers.
71. Working roller table.
72. Hot bloom shear.
73. Strip coiler \varnothing 450.
74. 3-High 450×1500 mill stand
(Tech. project)
75. 3-High 300×800 mill stand
(Tech. project)
76. 250-Double due mill stand (Tech. Project)
77. Lighter construction of 450×1200 mill
stand (Tech. project)
78. Tilting table for 450 mm
3-High mill stand (Tech. project)
79. 170/500×500 cold strip mill
stand (Tech. project)
80. Belt wrapper drum dia 450
(Tech. project)
81. Feeding press for cold rolling mill
500 (Tech. project.)
82. Section straightener stand
9×200×100 (Tech. project).

B. HEAVY MACHINE TOOLS PLANT

1. Sophisticated machine tools developed completely indigenously.
 1. Roll turning lathe, LRT 60
 2. Roll turning lathe, LRT 120
 3. Deep-hole boring machine, BDH 120
 4. Travelling type of radial drilling machine, DR 6
 5. Travelling type of radial drilling machine, DR 10
 6. Hydraulic copying attachment, model AC 1
 7. Grinding Attachment, Model AG 1
 8. Heavy special-duty too post, TP 1
 9. Commutator turning lathe
 10. Traction gears for Indian Railways.

2. Design work in progress.
 1. Vertical boring and turning mill, model BV 16
 2. Centre lathe (9-shear) model LC 100 B
 3. Horizontal boring machine (improvement of existing design), model BH 100 A.
 4. Oil hole drilling machine for the crankshaft.
 5. Crankpin turning attachment.

3. Improvement in design of existing products made in progress.
 1. Edge planing machine, model PL 12-Carriage redesigned completely.
 2. Modification of the rail heads for the planing machines to increase the rigidity of the machines.
 3. Designing of new boring head for BH 100.
 4. Design of new steadies for LC 100/105.

5 Mining & Allied Machinery Corporation

Design work completed during the last 4-5 years

Port Mechanization and Mechanical Handling Equipment.

- | | |
|--|---|
| 1. Disc Feeder—80 M ³ /hr | Based on Russian Documentation. |
| 2. Sampler (for Bokaro) | Do. |
| 3. Apron Feeder | New Design. |
| 4. Belt Feeder for Ore | Do. |
| 5. Belt Feeder for Coal | Do. |
| 6. Spreader | Do. |
| 7. Wagon Marshalling Device. | Do. |
| 8. Wagon Changing Device | Do. |
| 9. Sampler (for Haldia) | Do. |
| 10. Plate conveyor | Do. |
| 11. Gearboxes | } These are our standard products and new sizes are being developed as and when required. |
| 12. Gear couplings | |
| 13. Layout of the coal and ore handling plant for Haldia Dock Project (about 2% work left) | |

Work in progress.

1. Blade feeder
2. Apron feeder for Madras Port Trust
3. Gearboxes for Madras and Marmugoa Port orders (4 sizes).
4. Mold back device

Mining Machinery :

1. UG Belt conveyor
2. Scraper chain conveyor
3. Stage Loader

4. Sand Pump ¹	.	.	.	.	.	.	.
5. Sand Pump ²	.	.	.	.	.	.	.
6. Slurry Pump ¹	.	.	.	.	.	.	.
7. Slurry Pump ²	.	.	.	.	.	.	.
8. Cantilever Pump	.	.	.	.	.	.	.
9. Water Pump	.	.	.	.	.	.	.
10. Booster Fan	.	.	.	.	.	.	.
11. Main Axial Fan ¹	.	.	.	.	.	.	.
12. Main Axial Fan ²	.	.	.	.	.	.	.
13. Diesel Locomotive	.	.	.	.	.	.	.
14. Battery Locomotive ¹	.	.	.	.	.	.	.
15. Battery Locomotive ²	.	.	.	.	.	.	.
16. Granby Car	.	.	.	.	.	.	.
17. Shuttle Car	.	.	.	.	.	.	.
18. Scraper Haulage	.	.	.	.	.	.	.
19. Sand Scraper Haulage	.	.	.	.	.	.	.
20. Pontoon Mounted Sand dredger	.	.	.	.	.	.	.
21. Direct Haulage	.	.	.	.	.	.	.
22. Endless Haulage	.	.	.	.	.	.	.
23. Double Drum Winder	.	.	.	.	.	.	.
24. Friction winder	.	.	.	.	.	.	.
25. Winder	.	.	.	.	.	.	.
26. Jib Assembly ¹	.	.	.	.	.	.	.
27. Jib Ass embly ²	.	.	.	.	.	.	.
28. Shovel Loader	.	.	.	.	.	.	.
29. Gathering Arm	.	.	.	.	.	.	.
30. Hydraulic Prop (Dowty)	.	.	.	.	.	.	.
31. Rectangular Prop	.	.	.	.	.	.	.
32. Tubular Prop	.	.	.	.	.	.	.
33. Cross Bar ¹	.	.	.	.	.	.	.
34. Cross Bar ²	.	.	.	.	.	.	.
35. Coal Cutter Picks	.	.	.	.	.	.	.
36. Wheel & Axle	.	.	.	.	.	.	.
37. Landing Chairs & Gates	.	.	.	.	.	.	.

ANNEXURE V
(Chap V, para 5.44 refers)

Heavy Electricals (I) Ltd.

Details of Project Planning work completed during the last five years

	Estimated capital invest- ment
	Rs. lakhs
1. Manufacture of Transformers for 25 KV freight Locomotives	41
2. Manufacture of power factor capacitor using Aroclor dielectric	8
3. Power Transformer expansion from 3000 to 6000 MVA.	280
4. Additional manufacturing facilities for Railway Traction Equip- ment.	100
5. Establishment of permanent Tool & Gauge department (Not taken up for implementation).	140
6. Establishment of capt.ve steel foundry	27
7. Power Transformer expansion—memorandum for phased expansion from 3000 MVA to 6000 MVA output.	166
8. Pilot plant for paints and varnishes	2.40
9. Permanent factory main store and ware-house	71
10. Revision of steam turbine and generator project to take up larger machines.	1465
11. Introduction of liquid petroleum gas system and expansion of oxygen and other facilities.	20

ANNEXURE VI

(Chap. VI, para 6.2 refers)

(1) Examples where design know-how gaps exist at present in the Heavy Electricals (I) Limited.

1. Special transformers such as Furnace Transformers and Power Transformers of 400 KV class and above.
2. Circuit breakers and associated switchgear apparatus for 400 KV system, rated at about 25,000 MVA rupturing capacity.
3. (a) Design and development of thyristor and chooper control for Electric Rolling Stock.
(b) Application of induction motors and alternators to Traction.
4. High grade thermally stabilised insulating materials and superior grades of dynamo grade electrical steel for industrial machines.
5. In respect of steam Turbines :
 - (a) Runner and guide blade design and manufacture
 - (b) Gears, bearings, supervisory equipment etc.
 - (c) High temperature properties of special alloy materials.
6. Condenser and Heat Exchangers for sets of rating of 500 MW and above.
7. Watercooling techniques for turbo-generators of 200 MW and above.

8. In the field of Industrial Electronics :
 - (a) Static speed control of induction motors.
 - (b) Reversible drives for higher rating DC motors.
 - (c) Static conversion.
9. Evaluation of different types of cooling and knowhow in respect of Thyristor equipment for rectifiers.
10. Electronic controls for :
 - (a) Cold tandem mills.
 - (b) Continuous and semi-continuous hot strip mills.
 - (c) Very large and sophisticated industrial drives involving thyristor application in some cases.

ANNEXURE VI

(Chap. VI, para 6.6 refers)

- (2) Some specific areas where technological gaps have been identified by the Tiruchi unit of Bharat Heavy Electricals Ltd.**
1. Mill to suit direct firing of boilers.
 2. Welded wall panels.
 3. Pressurized combustion chambers.
 4. Fabrication of economical shop-assembled boilers to suit the needs of process industries like fertilizers and refineries.
 5. Modernised designs in Boiler House auxiliaries such as electrostatic precipitator, fans and regenerative air heaters.
 6. Modernised Furnace arrangement. This was a handicap especially in penetrating the export market.

ANNEXURE VI

(Chap. VI, para 6.8 refers)

- (3) **Examples of gaps in certain areas of project and process design capability in the Heavy Engineering Corporation.**
1. *Coke Ovens* : Design of ovens and batteries, structurals, development of basic designs of new equipment or batteries for new processes based on raw materials, transport & handling facilities, including crushing, screening and gas handling, co-ordination of coke ovens and by-product plant, and preparation of civil engineering task.
 2. *By-product Plant* : Basic designs of all units, pipe-line layouts, services, preparation of civil engineering task.
 3. *Blast Furnaces* : Design of furnace proper, refractories, pipe-lines, instrumentation, electrical project, power house, blower house, material handling etc.
 4. *Sintering & Pelletisation Plant* : Design of plant structurals, services, etc.
 5. *Steel Melting Shop* : Design of open-hearth furnace, converters, oxygen plant, dolomite plant, preparation of civil engineering task etc.
 6. *Rolling Mills* : Design of soaking pits, rolling mill furnaces, pickling plant, degreasing line, tinning line, galvanising line, service, preparation of civil engineering task.

*ANNEXURE VI (Contd.)***Gaps in Equipment Design in the Heavy Machine Building Plant of Heavy Engineering Corporation.****1. Rolling Mills.**

Ingot buggies.

Universal slabbing mill.

Plate mill stand.

strip mill stand & coilers.

Slabbing & blooming mill

Cold rolling mill stands and coilers.

Plate and strip shearing and slitting lines.

Pickling lines.

Degreasing lines.

250 mm. merchant mill.

250 mm. wire & rod mills.

Tube and pipe rolling mills.

Skelp mills.

Non-ferrous rolling mills, for brass, bronze and aluminium, etc.

Rolling mills for high alloy steels like spring steels, tools steel, stainless steel, transformer and dynamo steel etc.

Special rolling mills like foil rolling mills, sendzimir mill, ball rolling mills.

2. Blast Furnace, Steel Melting, Sintering & Pelletising Plant Equipment.

Smaller blast furnaces of capacities 130 to 250 T, 40 T, 100 T, 250 T, converters.

Open-hearth furnaces.

Kaldo furnaces.

Sintering plant of 100 s.q.m., 150 s.q.m., 250 s.q.m. and 300 s.q.m.

Pelletising plant of any capacity.

Torpedo cars

Slurry cars.

Weighing mechanisms.

Floor chargers other than 15 T floor charging machines.

Sintering machines 100-300 M².

Pig casting machines of capacities other than 160T per hour.

3. Coke Ovens and By-product Plant Equipment.

Coke oven machinery other than machines like coke pushers, door extractors, coal charging cars, coke quenching cars for 21.6 cu.m. and 27.3 cu.m. coke ovens.

By-product plant equipment like distillation plant, ammonia plant, benzol recovery plant, sulphuric acid plant etc. based on fully developed assembly drawings supplied by specialised organisations engaged in chemical engineering.

Development of project layout for a coke oven battery based on thermo-chemical analysis from specialised institutes.

Working out purchase specifications for items not within HMBP's manufacturing scope, like conveyors, crushing towers, structurals, etc.

4. Cranes :

Stripper and soker cranes of different capacities.

Coal and ore bridge cranes.

5. Continuous casting Machines.

Complete know-how.

Steel Structures for new machines and equipment.

Fabrication and Hydraulics for new machines and equipment.

Instrumentation, illumination, power and control systems for new machines.

(Chap. VI, para 6.14 refers)

**SPECIFIC CASES OF USE OF COMPUTERS
FOR TYPICAL DESIGN CALCULATIONS
BY HEAVY ELECTRICALS (INDIA) Ltd.**

1. Steam Turbine

- (a) Feed Heating Heat Balance Calculations for performance guarantees.
- (b) Critical Speed calculations for turbine rotor.
- (c) Rotor and Disc Stress calculations.
- (d) Flexibility calculations for steam pipes.

2. Water Turbine

- (a) Spiral casing plate development.
- (b) Draft Tube level plate development.
- (c) Top cover constraints and stress analysis.

3. Generators & Large Motors

- (a) Centrifugal stresses in Turbo Generator Rotors.
- (b) Natural frequency calculations of stator yokes
- (c) Turbogenerator reactances.

4. Transformer

- (a) Tender design for off-circuit transformer.
- (b) Tender design for load transformer.
- (c) Optimum cone design.

5. Transaction & Industrial Machines

- (a) Induction Motor Performance.
- (b) Deep Bar effect for squirrel cage rotor bars.
- (c) Shaft deflection.
- (d) Calculation for rotor weight and inertia.