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# PREPARING FEASIBILITY STUDIES FOR METALLURGICAL PROJECTS 1/

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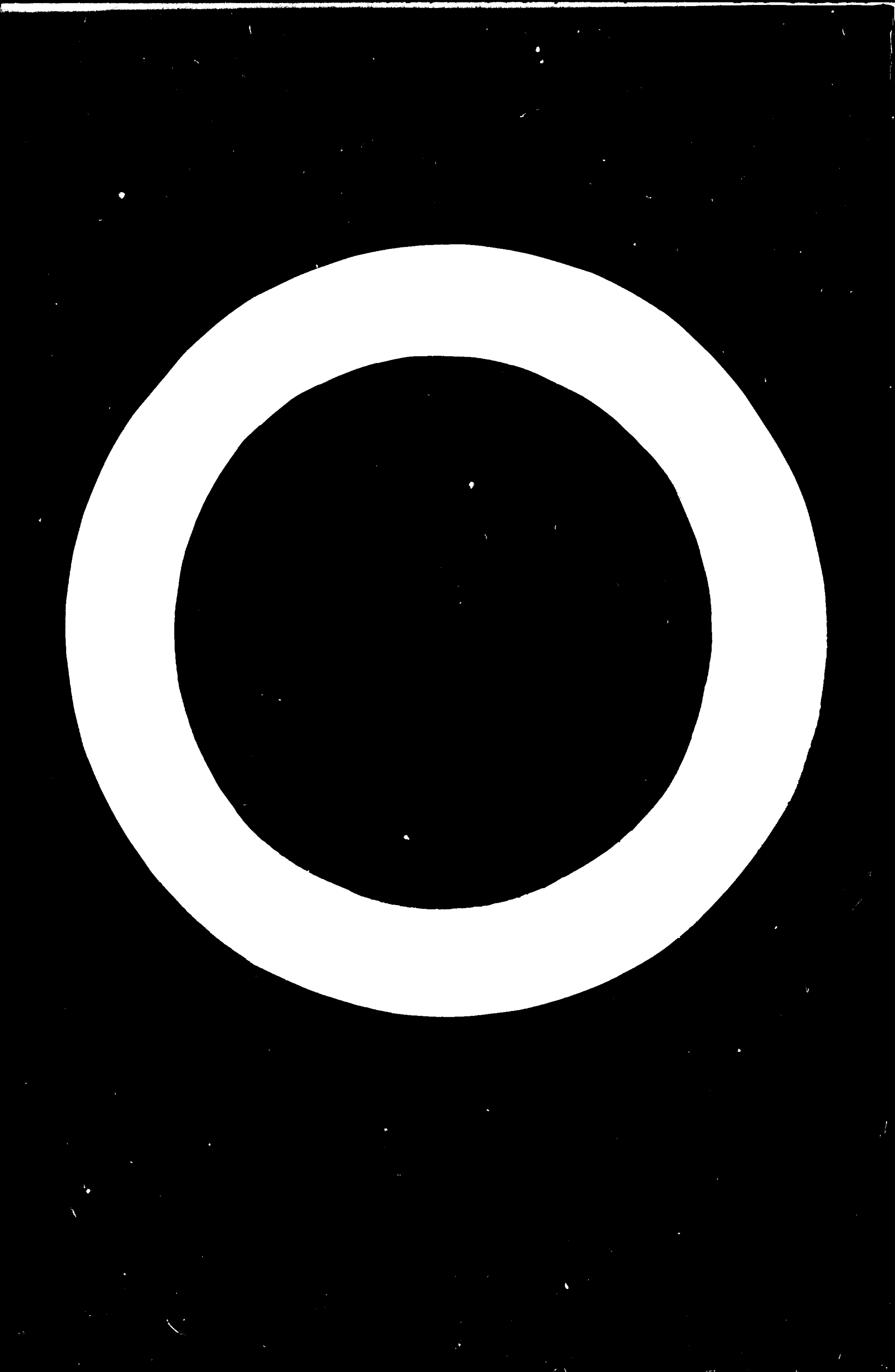


## I. INTRODUCTION

1. Pre-feasibility, feasibility and project report studies are vital links in the chain of investigations leading to a green-signal to proceed with the detailed engineering and commitment of funds on a new metallurgical project or plant expansion. The expenses being incurred at this preparatory stage are small, but the investigations have a major effect on the future success of the undertaking. Numerous examples can be cited of metallurgical projects - both in developing and in developed countries - which have floundered because the feasibility step was jumped or performed cursorily or undertaken by an inappropriate agency. In a developing country, these investigations have even greater significance due to the added handicaps of poorly-developed infra-structure, paucity of funds and lack of skills.

2. The consequences of inadequate pre-planning include subsequent difficulties with the quality and quantity of raw materials, selection of unsuitable equipment and processes resulting in uncompetitive production costs, investment greatly exceeding original estimates and inordinate delay in plant construction, inadequate attention to external water, power, transportation and other infra-structure items, neglect of manpower development with consequent necessity of using teams of foreign operators and so on.

3. Quite apart from the serious financial consequences on a developing nation's slender resources of a major project's failure to produce anticipated cash receipts on time, such 'white elephant' projects raise doubts on the whole rationale of developing basic industries to spearhead economic growth.

## II. WORK TO BE COVERED

4. In the pre-investment study, followed by the feasibility study and the project report, the main technical and economic questions to be answered are broadly the same, with the accent on financial viability and choice of location and processes in the feasibility study, while greater consideration is given to the engineering, specification and construction aspects in the project report and the pre-engineering stage. In the case of a small project where there are few uncertainties, a combined feasibility and detailed project study could be telescoped to cover the whole ground and lead direct to preparation of equipment specifications for issuing tenders. However, on large complex projects, such haste in the planning stage could cause delays and difficulties later.

5. The main topics covered in the feasibility study include the following:

Establishment of demand for the product

6. This requires first a review of the present production, exports and imports to arrive at net apparent consumption and a study of the existing pattern of demand by product categories and consuming sectors. This investigation has to be done in the field by a team of market analysts and should cover the requirements, problems and expansion plans of the bulk of present consumers, through well-prepared questionnaires and interviews. The field survey data must be supplemented and cross-checked by discussions with concerned government and industrial organizations.

7. A long time series is needed of imports of the product being studied. In the case of steel products, confusion is encountered in nomenclature as customs statistics are generally trade oriented. Further, data is needed not only on rolled steel products but also on indirect imports of steel in the form of machinery, components, etc.

8. Then projections have to be made of the probable rise in demand, by suitable statistical techniques. For steel, the end-use approach has been found useful wherein future output targets are determined for all steel consuming products/sectors and multiplied by the steel input 'norm' for each product. The

total demand estimates must then be checked by alternative techniques and by comparison with other countries, specially those in similar situations.

9. The effect on demand of price elasticity as well as that of material substitution may be significant. The possibilities of exporting the product, directly or indirectly, needs consideration, to arrive at the total demand (broken down by categories and sizes) and the corresponding shortfalls. New capacity can only meet a certain estimated share of the categorywise shortfalls.

Investigations of raw materials

10. Based on the available data, the feasibility study must make broad estimates of the reserves of various raw materials required. The reliability of data on reserves needs to be seriously questioned and independently evaluated. Problems of raw material quality for alternative production processes have to be studied together with possibility of blending some better quality imported ore if required specially in the initial years of operation. Suitable schemes are required to be prepared for mining the ore and delivering it to the plant site. Beneficiation and agglomeration processes need to be evaluated where required.

11. An incisive investigation of raw materials is perhaps the most important study at the feasibility stage. It requires a team consisting of geologist, mining engineer, and mineral beneficiation technologist to evaluate the work already done, propose new lines of investigations, and make preliminary estimates of the investment required in mines, quarries, transportation systems, beneficiation plants as well as of the cost of materials at the mine-head and delivered at plant site.

12. As raw material development has long gestation periods, the feasibility study must outline the further geological investigations required, mining development and other studies connected with delivering ore of appropriate quality to the proposed plant.

Selecting the location

13. Locational factors include the cost of assembling raw materials to alternative sites and delivering finished products

to consumption centres, the costs involved in developing the infra-structure, the cost and availability of power, water and transport the site conditions such as topography, sub-soil characteristics and climate, the social conditions and availability of suitable labour and the problems of environmental pollution.

14. The effect of these on the capital and operating costs at three or four likely plant locations have to be estimated. There are other locational factors which cannot be readily quantified such as national policy to develop backward areas or strategic considerations. Then there are personal or political preferences for one or the other location. The consultant's job is to present the advantages and disadvantages objectively and perhaps list the sites in order of overall preference, leaving it to the authorities concerned to take the final decision.

Determination of plant capacity/product-mix

15. Plant size and product-mix have to be fixed based upon the market study, the optimum size of equipment and the share of the total demand that the proposed plant can be expected to take. The iron and steel industry, when based on conventional blast furnaces and heavy primary mills, is markedly sensitive to the economies of scale. However, recent developments such as direct reduction processes, electric smelting furnace, arc furnace steelmaking and continuous casting have made integrated steelworks of even small capacity (say, 200,000 tons/year and over) viable. Even so, costs will come down as the plant expands. A view must be taken as to when the new products can be expected to enter the market and the rate at which the demand will grow so that expansion can be planned rationally from the beginning in a continuing manner.

Selecting production processes and equipment

16. Various process alternatives have to be evaluated within the framework of raw materials, power, natural gas and other inputs available.

The choice of technology available is wide, with new processes challenging the old conventional systems. But how fast are some of these new techniques going to reach commercial exploitation to warrant their adoption in a developing country? Would it be wiser to stick initially to proven methods, at the same time making full provision for the new processes in future? What is the appropriate balance that must be struck between sophisticated high-speed automated processing lines and more manageable manually controlled equipment? Skilled, trained labour is scarce in developing countries and no longer 'cheap'. These are some of the problems in process selection to which the planners must direct themselves.

17. Auxiliary facilities and utility systems (power, water, gas, compressed air, etc) have to be studied.

18. Planning the layout requires specific provision in space and design for rapid expansion. Depending upon the material base and market potential, plant capacity could increase six or eight-fold in future. Here again, steel plant layout is becoming more compact as the restraints imposed by railway systems are giving place to the flexibility of conveyors, road-bound vehicles, and pneumatic transport.

19. Equally important is the planning of facilities outside the plant perimeter, such as township for personnel, areas for ancillary industries, railway marshalling yards, slag dumps etc.

Estimating capital costs:

20. These are generally preliminary cost figures based on budgeting prices from equipment suppliers and preliminary designs for civil, structural and utility systems. Provision has to be made for spares, ocean and inland freight, training, commissioning, clients administration during construction, design and engineering and contingencies. The foreign exchange component of the plant cost and the phasing of construction expenditures have to be estimated.

21. At the same time, the report must arrive at the total project cost, including promotional expenses, interest during construction, technical assistance and training, start-up and infra-structure developments.

Assessing manpower requirements:

22. Managerial, technical, supervisory, skilled and unskilled manpower needed for plant operation and maintenance has to be determined and thought given at this stage itself to augmenting the available skills by intensive training programmes.

Estimating production cost:

23. The inputs of raw material, utilities, labour and supplies and the corresponding unit costs of these have to be estimated to arrive at the works production cost per ton and the total annual manufacturing expenses.

24. If iron production in electric smelting furnaces or steel production in arc furnaces is being considered, the cost and availability of electric power becomes important and controversial. At the feasibility stage, it is difficult to get a definite power tariff, as so many factors including national policy become involved. A way out is to show graphically the effect on production costs and overall profitability of a whole range of unit power costs.

Analysing financial viability:

25. The final step is the financial analysis to determine the overall viability by the use of up-to-date project evaluation techniques. A major problem is the estimating of probable selling prices. Suitable rates have to be adopted for short and long-term credit, depreciation, amortization, taxation etc.

26. A rigorous financial analysis would include the profit and loss and cash flow statements over the life of the project, estimation of break-even points and internal rate of return,

excess present value analysis, pay back period, savings in foreign exchange and rate of return on foreign exchange.

27. Depending on the structure of the economy and the nature of the project, social profitability calculations may be desirable.

28. Quo vadis? Where does the project go from here?

The feasibility study should spell out the action required on a concerted front so that the various sub-studies and investigations could be initiated expeditiously, and pursued energetically.

## III. SPECIAL ASPECTS OF METALLURGICAL PROJECTS

29. Metallurgical projects particularly in the iron and steel field have characteristics which make the feasibility exercise more crucial and complex.

30. First, the plant is costly and will absorb a sizeable chunk of available resources. Moreover, as much as two-thirds of project cost may be in scarce foreign exchange.

31. Second, the economies of scale are dominant here and the question always arises: should the plant size (and investment) be restricted to short-term needs, often at high production costs, or should a bolder view be taken of future demand (including possibility of some exports to neighbouring countries) and optimum-sized plant installed even if some investment remains under-utilised for a defined period?

32. Third, the selection of production process is heavily raw material-oriented and this requires comprehensive geological investigations to establish quality and reserves as well as laboratory and pilot plant tests on representative samples to fix the process parameters. It also calls for mining scheme and development on large scale. While there should preferably be evidence of probable reserves for 25 to 30 years of plant life before a worthwhile feasibility study can be made, the actual

proving of reserves and pilot plant tests could be initiated at this stage and continued more vigorously when the detailed project studies are underway.

33. Finally, a metallurgical plant needs a high order of operating and managerial skills. Where these cannot be drawn from a developed industrial base, the problems of manpower planning, recruitment and training need to be tackled energetically from the feasibility stage itself.

## IV. ORGANIZATION NEEDED FOR STUDIES

34. Total implementation of an industrial project involves two distinct phases:

i) Project planning and evaluation
ii) Engineering, specifications and construction

### Independence and objectivity

35. If the project seeks financial aid, there is a desire on the part of the aid giving country to tie project planning, engineering and equipment supply into one package. This is hardly in the interest of the recipient. Apart from the increase in project cost (8 to 12% or more) through tied aid, there is the disadvantage that the project planning and choice of equipment are more suited to what the supplier can offer rather than to the specific needs of the developing country.

36. It would be best for the country to have its own independent consulting organisation to carry out the planning study. If in a special sector the requisite experience is not available, then the feasibility report task could be contracted to an outside consultant who has specific and recent experience of work in developing countries

37. One cannot over-emphasise that the selected agency should have independence and objectivity, divorced from vested interests, particularly in the feasibility report stage. There are many metallurgical projects where over-designed, expensive equipment (for example a massive slabbing mill which may not be fully utilized for a decade) or obsolete techniques (scrap-based open-

hearths in foundries), or relatively untried processes (pre-reduction in kilns and hot transfer to smelting furnaces) have been foisted on unknowing clients by equipment suppliers.

Specialised indigenous institutes

38. In some developing countries the two phases - feasibility studies and engineering - are undertaken by separate organisations, one attached perhaps to the Ministry of Planning and the other, say, to the Ministry of Industry. Whether separate agencies are used or a single agency for the complete range of consultancy services, depends on the circumstances, available personnel and personalities. Most of the technical and economic disciplines required are common to both phases and therefore there is advantage in combining these functions in one integrated organisation.

39. Later, depending upon the raw material endowment and industrial maturity of the economy, additional institutes may be created progressively in different fields - for metallurgical plants, petroleum, water and power resource development, chemical and petro-chemicals. There are obvious merits in such specialisation, if a truly professional job is to be done.

40. More importa[illegible] is the kind of technical leadership that the newly-established design organisation has. A dynamic technologist with confidence in himself and in his colleagues can do more in a short period with less funds than, say, a person who has no technology-orientation and who also lack vision and courage. A design institute can have all the facilities and appearance of efficiency, but will still remain a 'shell' if the leadership is diffident.

Selected outside assistance

41. In the early stages the newly-founded design institute may advantageously cooperate with a similar foreign design organization in order to speed-up the absorption of consultancy skills. Transfer of technology from the donor to the recipient institute can be effected by deputing selected experienced personnel to assist on specific projects-in-hand, sending local personnel for actual work with the technical collaborator, receiving specially-prepared documentation which can then be expanded to form a reservoir of basic technical standards for future work.

42. However, in such arrangements there is also the danger that the expertise and personnel available with the donor are not wholly in tune with the requirements of the recipient, and that indeed for political or other reasons a marriage is forced which has little chance of developing into a healthy relationship.

43. There is again the possibility that the recipient, through such an arrangement, is rendered helpless and not allowed to take on meaningful on-the-job responsibilities. Consequently, when the next major project comes along, the recipient continues to have to depend upon the donor. This need not be the case. Given the proper encouragement from the top, even this kind of specialised experience can be transferred within a period of three to five years. This is not to say that the recipient would then be wholly self-reliant - he would, however, have the confidence in future to take the prime responsibility, supplemented by outside assistance in a selective and limited manner only.

44. To acquire capability, whether it is in design work or in playing tennis, reading manuals and attending 'workshops' helps, but there are not substitutes for doing the job oneself - the first time with external assistance and the next few occasions with limited guidance, until the Institute has developed the competence and confidence to go it alone.

## V. INPUTS NEEDED

45. Depending upon the type of project, the duration of the feasibility study may be four months for a relatively straightforward unit to 12 months and more if a variety of locations, raw materials, processes and other problems are to be covered. The corresponding inputs of professional effort may vary from 10 man-months to over 100 man-months. Of this, as much as half may be spent in the field studies and the rest in home offices.

46. It is obviously difficult to quantify the cost of such studies but it would certainly be under 0.25% of the cost for a large project. This is indeed a very small commitment but one which would have far-reaching effects on the future success of the project.

47. The first step is to appoint a Project Manager for coordinating and expediting the various investigations, some of which should proceed concurrently while others must wait for the input from the preceding study. An inter-disciplinary approach is involved with the team covering the complete range of engineering disciplines - geological and mining, process engineering, civil/structural, electrical, instrumentation, materials handling, transportation, water, power and utility systems, construction, manpower planning ane economics.

48. It may not be possible to keep some specialists (eg the market research team) fully loaded the year round; therefore such personnel can be 'borrowed' for specific assignments, or should be capable of undertaking other types of studies when needed.

49. On a typical study of a small new iron and steel complex in a developing country (500,000 t/yr, investment about $ 200 million), the following minimum inputs in various disciplines may be required.

| | Major disciplines - man-months | | | | | |
|---|---|---|---|---|---|---|
| | Geol/ Mining | Techno-logist | Civil/ Struc/ Const | Elec/ Mech/ Util | Economist/ Financial Analysts | Total |
| 1. Demand, capacity product-mix .. | - | 4 | 1 | 1 | 8 | 14 |
| 2. Raw materials | 5 | 3 | 1 | - | 1 | 10 |
| 3. Location .. | - | 2 | 2 | 2 | 3 | 9 |
| 4. Production and auxiliary facilities, layout .. | 1 | 7 | 2 | 2 | 1 | 13 |
| 5. Capital cost | - | 2 | 2 | 2 | 1 | 7 |
| 6. Manpower, production costs | - | 5 | 1 | 1 | 1 | 8 |
| 7. Financial analysis .. | - | 3 | 1 | - | 5 | 9 |
| Total .. | 6 | 26 | 10 | 8 | 20 | 70 |

50. A team of about 12 professional personnel would be needed over a study period of say 9 months, supported by secretarial, drafting and other specialist staff. It will be noted that the bulk of the work-load falls on the technologist - the specialist in iron, steel rolling mills and other processes. This is followed by the industrial economist who may well be an engineer or technologist familiar with project evaluation, market research and other techniques.

51. For market research, raw material investigation and site selection (items 1,2, 5 above) the bulk of the work (say three-fourths) would be done in the field. For the other aspects of the study, the main effort would be in the home offices based upon data collected in a short field trip.

52. The organisation of the task force for the study would be typically as in Figure 1. The Project Manager is like the conductor of a symphony orchestra, who must set the pace and keep the different musicians in harmony. His personality and experience, and the confidence in which he is held by his colleagues would have an important effect on the success of the project.

Work programme

53. The sequence of work in a typical feasibility study is shown in the network (Figure 2). A preparatory period of one month may be spent in home offices preparing questionnaries, collecting and studying available data and orienting the team on the task ahead. For the next three months or so the action would move to the field, during which the raw material sources and utilities available would be studied, the market for steel investigated through interviews with main consumers/importers of steel etc, the alternative sites visited and intensive discussions held with various agencies dealing with all aspects of the plant's requirement etc.

54. A problem encountered during the field studies is that of language. The consultants team should preferably have personnel who know the local language - or have such personnel seconded to them by the client.

55. The lack of basic economic data is another major difficulty. Definitions of macro indicators are widely different or the time series may be interrupted by a revised method of calculation after a new political regime has taken over. The necessity of checking and cross-checking data cannot be over-emphasised.

56. The next phase of work would be in the home offices. A brief return to the field may be made, if necessary, for data that may have been missed or for checking main conclusions. In this period of intensive study, the main alternatives on plant size, product-mix, production process, construction phasing are vigorously analysed and their cost implications estimated. On this basis, the optimum plant parameters are evolved. The selected alternatives are then elaborated, preliminary designs and drawings prepared for estimating quantities and costs.

57. It is obviously essential to keep all assumptions, process calculations and cost estimates in the form of complete working papers, from which the text and appendices of the feasibility report would emerge. Good engineers are not necessarily good at preparing concise and readable reports and the job of report-writing, editing and reproduction can be very time-consuming.

58. Generally it is a good idea to discuss the feasibility study in draft form with the authorities concerned to get their comments on the conceptual aspects and to check out the assumptions made. While these comments should be given full consideration, the final responsibility for objective, technical recommendations on the project is that of the consultant.

59. As mentioned earlier, the feasibility report is only the beginning of a series of investigations on which further action required has been outlined. The critical path in the subsequent implementation programme and the agencies to be involved must be clearly impressed upon the client, in order that the volume of the feasibility report, resplendent in its leather binding, do not find an honoured and final resting place on the clients' book-shelf.

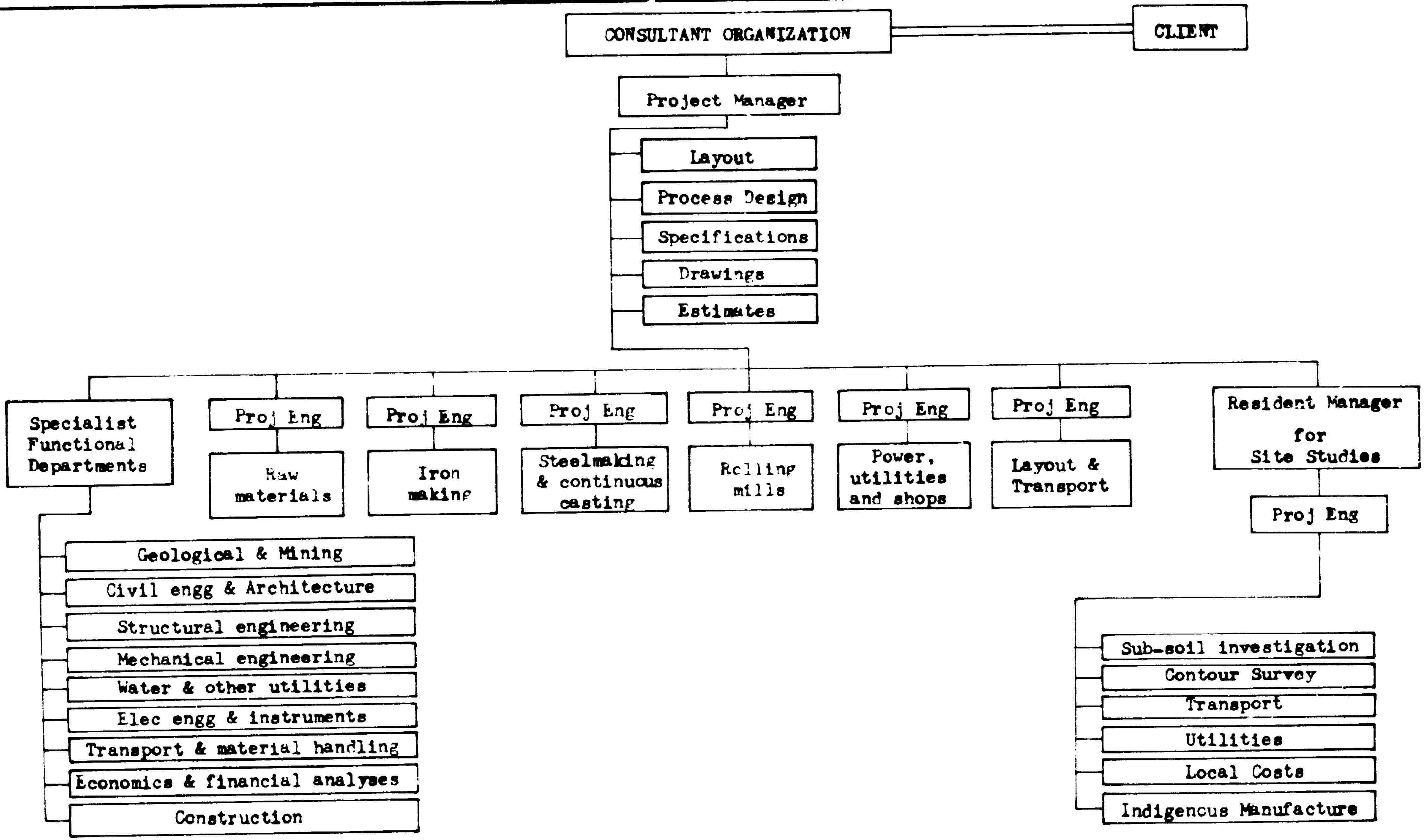
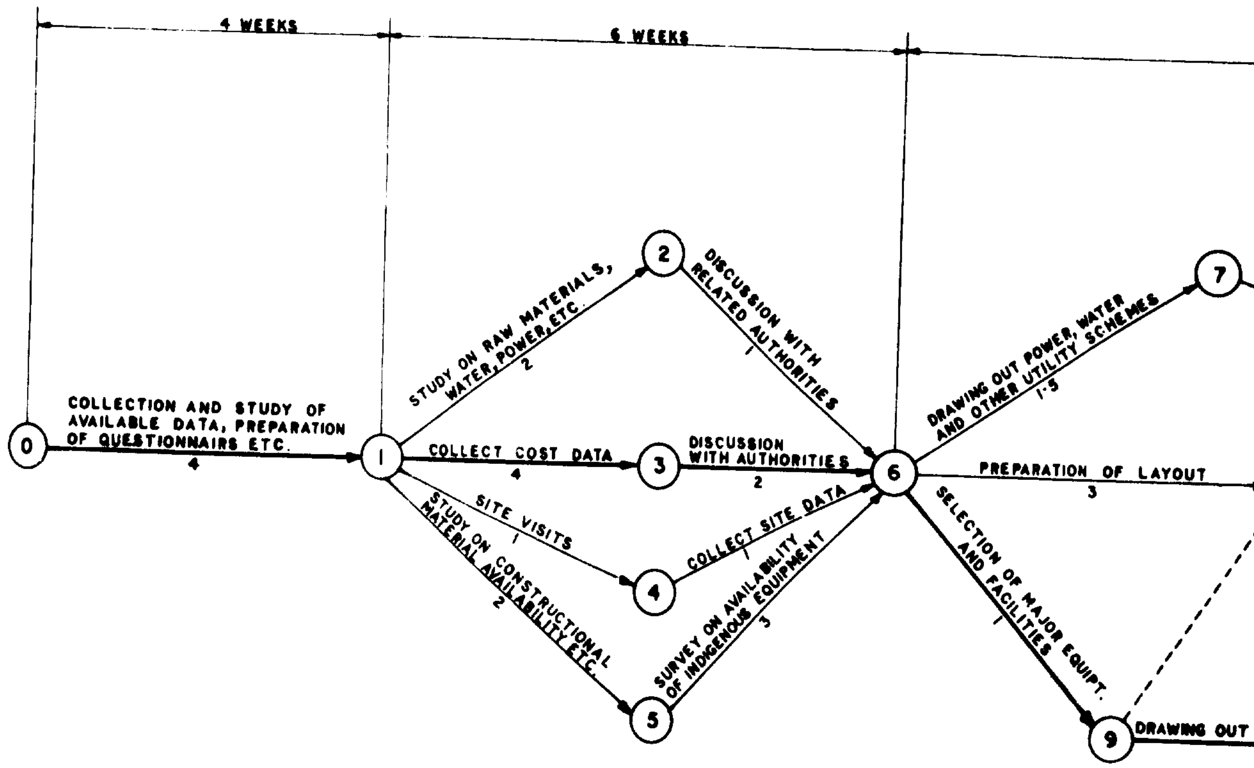



FIG.1 - ORGANIZATION FOR TYPICAL PROJECT WORK

## CRITICAL

## PHASING ACTIVITIE




**NOTE**:-

ACTIVITY

CRITICAL

DASTUR ENGINEERING INTERNATIONAL GmbH, CONSULTING ENGINEERS

FIG. 2

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SHOWING
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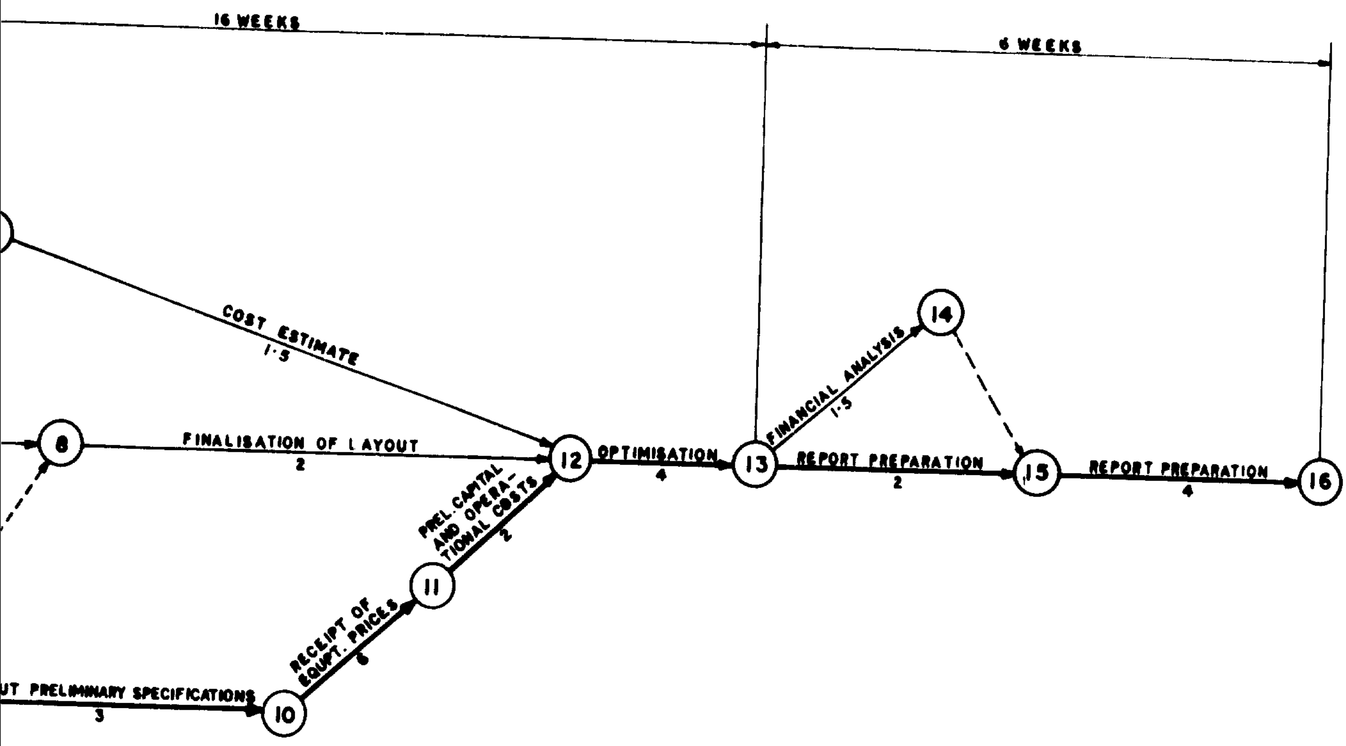


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