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1 OF 2

1.0 2.8 2.5 3.2 2.2 3.6 2.0 4 1.1 1.8 1.25 1.4 1.6

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

24×
F

2. UNIDO to obtain a list of each of the plants of the types shown in the sample matrix completed since 1960 in each of the countries selected.

3. From these lists UNIDO to select randomly the individual plants to be surveyed. The numbers and locations of the plants to be as shown in Exhibit 1.

4. UNIDO to send a questionnaire to the UN office in each country so that this office can ensure that the questionnaire is completed by the person most qualified to do so and returned to UNIDO.

Exhibit 1

MATRIX FOR SAMPLE SURVEY

Type of Plant	Classifications of Countries from which sample is to be drawn (Number in matrix indicates number of plants to be surveyed) I	II	III	IV	TOTAL
Electric Power Plant	4	4	4	4	16
Cement Plant	4	4	4	4	16
Petroleum Refinery	4	4	4	4	16
Cotton Textile Mill	4	4	4		12
Ammonia-Based Fertilizer Plant	4	4			8
Iron and Steel Mill	4	4			8
Motor Vehicle Assembly Plant	4	4			8
Tire Plant	4	4			8
Caustic-Chlorine Plant	4				4
Petrochemicals Plant	4				4
Machine Tool Plant	4	—	—	—	4
TOTALS	44	32	16	12	104

Each sample of four plants should be drawn from geographical areas as follows:

	Latin America & West Indies	Africa	West Asia	Southern & Southeastern Asia
Class I	2	-	-	2
II	2	1	-	1
III	1	1	1	1
IV	1	1	1	1

Exhibit 2

DESCRIPTION OF PLANTS TO BE SURVEYED

1. Electric power plant

Thermal electric power plants fueled by coal, fuel oil, or natural gas. Does not include electric transmission and distribution systems.

2. Cement plant

A cement-making plant using either wet or dry process.

3. Petroleum refinery

A refinery starting with crude oil and producing three or more grades of products, typically motor gasoline, kerosene, and several grades of fuel oil. Always includes crude distillation unit, and might include reforming and cracking.

4. Cotton textile mill

A mill starting with raw cotton and producing at least grey cloth as a product. Typically includes blender-feeders, pickers, cards, draw frames, combs, spindles, and looms. Might include finishing operations.

5. Ammonia-based fertilizer plant

A plant producing ammonia from naphtha, natural gas, refinery gas, or coal. Might include an adjacent plant manufacturing another fertilizer, such as ammonium nitrate or urea.

6. Iron and steel mill

A mill producing pig iron and ingot steel starting with iron ore. Might include further processing equipment, such as a rolling mill.

7. Motor vehicle assembly plant

A plant in which motor vehicles are completely assembled, either from "Complete Knocked Down" kits or a combination of imported and domestic-made parts.

8. Tire plant

A plant in which rubber is made into tires. Often includes tube manufacture.

9. Caustic-chlorine plant

A plant in which caustic soda and chlorine are made from salt.

10. Petrochemicals plant

A plant in which a petrochemical such as vinyl chloride monomer, ethylene, styrene, polyvinyl chloride, polyethylene, or polystyrene is made.

11. Machine tool plant

A plant in which basic machine tools are made, such as lathes, milling machines, and drill presses.

Exhibit 3

CLASSIFICATION OF DEVELOPING COUNTRIES

Note: This basic classification of countries rests upon economy of scale in the production process relative to effective domestic demand, which in turn is determined by a combination of population and per capita income.

TYPE I. Developing countries with the greatest variety of types of industrial plants. These countries typically have either very large populations or populations in excess of 20 million and per capita incomes in excess of $200. Examples are India and Mexico.

Type II. Developing countries with a great variety of industries including such items as a motor vehicle assembly plant, but lacking in effective demand to support such industries as petrochemicals and machine tools. These countries typically have populations in excess of 10 or 20 million with per capita incomes in excess of $100 or $200. Examples are Peru and United Arab Republic.

Type III. Developing countries with a few major industries, such as cotton textiles, but lacking major plants for making iron and steel, tires, and for assembling motor vehicles. These countries typically have populations in excess of 10 or 20 million but have a per capita income less than $100 or $150, or have smaller populations but per capita incomes greater than $100 or $150. Examples are Nigeria and Uruguay.

Type IV. Developing countries that have very few major industries. Typical examples of the few large-scale industrial facilities

Exhibit 3 (continued)

in these countries are power plants, cement plants, and petroleum refineries. These countries typically have populations less than 10-20 million and in some cases less than 1 million. Per capita incomes often are less than $100 but sometimes exceed this amount severalfold. Examples are Afghanistan, Costa Rica, and Jordan.

Exhibit 4

DESCRIPTION OF GEOGRAPHIC AREAS

The geographic areas are defined in accordance with the principles used in the United Nations, World Economic Survey, 1966 (pp. iii, 163, 166, and 168), and are as follows:

Latin America and West Indies =	The Western Hemisphere countries except United States and Canada.
Africa =	Continental Africa, excluding South Africa.
West Asia =	Asian Countries normally considered to be part of the "Middle East," including Aden, Bahrain, Iran, Iraq, Jordan, Kuwait, Lebanon, Qatar, Saudi Arabia, and Syria.
Southern & Southeastern Asia =	All of Asia excluding the West Asian countries.

III. THE QUESTIONNAIRE

The purpose of this study is to obtain information about, and insight into, the problems encountered in implementing industrial projects in developing countries, with primary emphasis on those problems that cause delays.

The Implementation Phase

The implementation phase is taken to be the work starting with detailed project planning and design, through construction and start up, to the time when the project is functioning in a satisfactory manner at, or near, its rated capacity. Thus, the decision to invest is assumed to have been made; the product, general process, scale, market, financing method, and general location have been decided upon. Government approval is assumed, at least in principle, and the investment funds, including foreign exchange, are assumed to be allocated and available. At this point implementation begins. It includes site selection, detailed design of the project to accomodate it to the site and to final engineering changes, bidding, contracting and procurement, construction, production start-up, and build-up to capacity.

Analysis of Delays

Project delay is defined to mean falling behind schedule 25% or more of the planned time of achievement for any major activity of the project. The measure of 25% is intuitive. It contains a 10% allowance for inaccuracy in scheduling (on the general observation that it is frequently difficult to schedule construction activities more accurately than ± 10% in developing countries) and a 15% time-loss for assignable causes of delay. It is important, however, that this distinction of causes within the 25% not be known to the users of this questionnaire, lest they attempt to distinguish assignable causes from scheduling variance in the appraisal of their activity delays. The design of the study already comprehends this distinction and accounts for it in the sampling procedures.

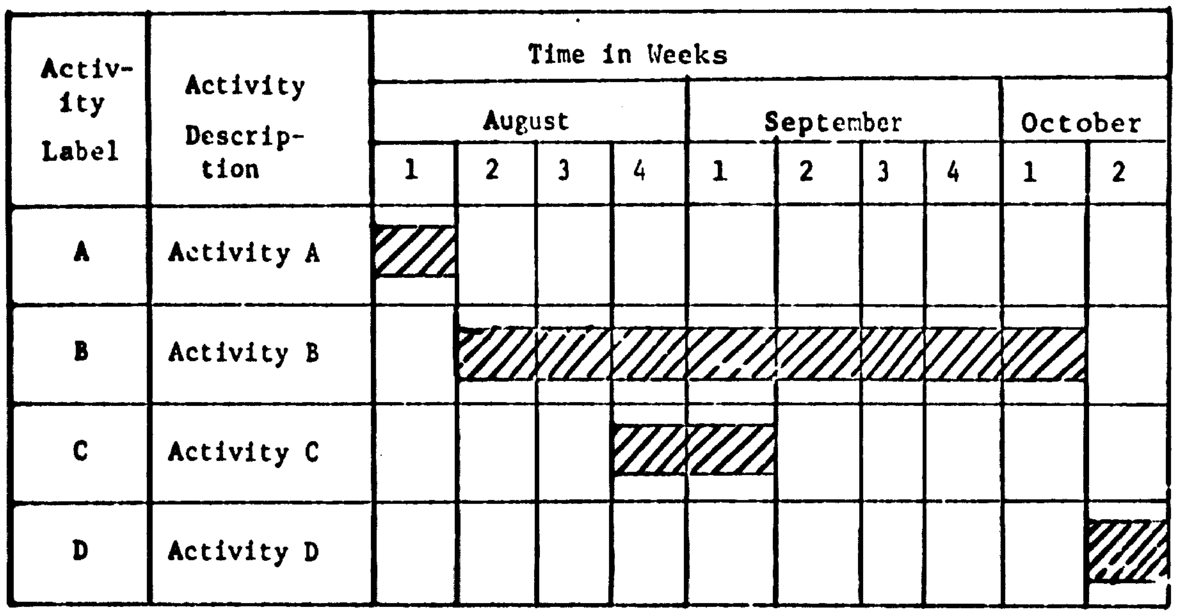
Activity is used in the precise meaning it has in bar chart scheduling or network scheduling. It is assumed that most large scale industrial projects will have been scheduled with one of these methods. Figure 1 shows the meaning of activity as used in these scheduling methods. The illustrations are drawn from the UNIDO publication Procedures for Programming and Control of Implementation of Industrial Projects in Developing Countries. An activity is a logical subdivision of the project work that can be scheduled as an entity because it is distinctly different from that which precedes or follows it. Thus, the simple bar chart of Figure 1 shows Activity A of one week duration, Activity B of 8 weeks duration, and so forth. The simple network illustration shows activity 1, Purchase Pumps, of 5 months duration, activity 2, Install Pumps, of 7 months duration, and activity 3, Dewater Site, of 8 months duration.

A "major activity" is one that is scheduled in months, rather than days; that is, an activity whose planned duration is at least one month. Since this study covers only large industrial projects of over $1 million value, and construction periods ranging from about six months to about five years, it is neither necessary nor desirable to investigate delays in activities shorter than this.

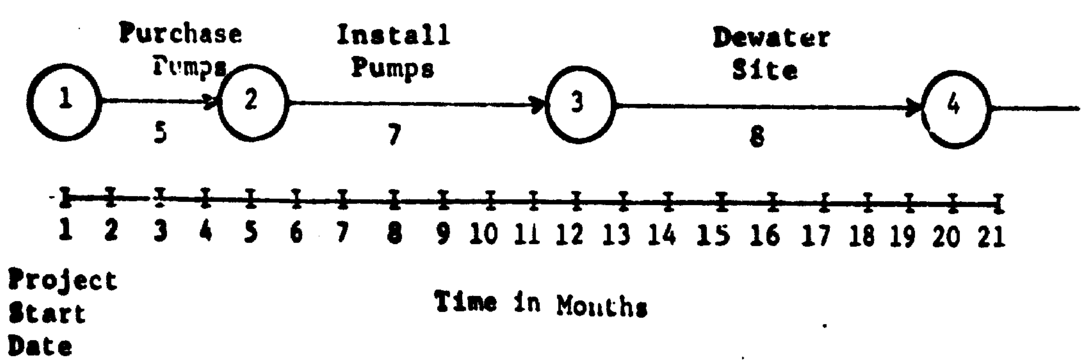
The "planned time of achievement" is not necessarily measured

Figure 1 - Meaning of Activity

Simple Bar Chart



Simple Network



by calendar dates; that is, day of the week or month, but by time duration, or number of days. Thus it is possible for a major activity to be completed later than the scheduled calendar date and still not, in itself, be a "delayed activity," in the meaning of the definition of this study. This could happen if a previous activity were delayed, thereby moving back the starting date of the referenced activity. Another way of putting this point is that delays are not cumulative. Each major activity is judged with respect to its planned elapsed time, as shown on the original schedule (or any revisions thereto made prior to the start of the referenced major activity) and not with respect to the calendar as such.

With this meaning, then, it is possible that an industrial project may suffer delay in one or more major activities and yet be completed by the scheduled date. The study is designed intentionally to include this possibility, for otherwise some important instances of delay may escape the survey. On the other hand, it is not possible for a total project to fall 25% or more behind schedule unless one or more of its major activities does so.

Cost of Delays

Although we are interested in knowing about each major delay and its course, when we come to calculate the cost of delays we shall consider only those that contributed to the cumulative delay of the project. In the language of network scheduling, we are interested in delays of activities that are on the "critical path." Activities that are more or less independent in time from other activities, or whose delay does not hold up the accomplishment of other activities critical

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DESIGN OF AN EMPIRICAL STUDY OF PROBLEMS IN IMPLEMENTING INDUSTRIAL PROJECTS IN DEVELOPING COUNTRIES to the completion of the project, are not considered in cost calculations. The effective delay, in terms of cost, is the period of time over which funds were invested or immobilized and the project was not in operation, although it could have been if these delays were not experienced.

Questionnaire Objectives and Method

The written questionnaire is designed to answer five questions:

1. Did delays occur?
2. In what activity or stage of the project work did they occur?
3. How long, in months and as % of planned time, were the delays?
4. What caused the delays?
5. What was the cost of the delays?

The questionnaire will appear to ask some of these questions twice, once directly and again indirectly. This is planned redundancy for verification purposes.

The questionnaire asks each respondent to attach to it, if available, a copy of the bar chart schedule or network schedule that was in effect at the date of project approval, and any major revisions thereto. The respondents are also asked to list out, as part of the questionnaire, each major activity of the project with its scheduled time duration and actual time duration.

The in-depth interviews (discussed in Part IV, "Analysis of Completed Questionnaires") will be selected as a small cross section of the respondents. Their primary purpose will be to seek explanation of, and insight into, the reasons for large difference between planned and actual activity duration times.

Questions on project costs are structured so as to fit the method of cost analysis set forth in the previous UNIDO study on _Problems Encountered in Implementing Industrial Projects in Developing Countries_, Chapter 2, "The Cost of Delays." If the questions are properly answered, they should provide sufficient information and data for such an analysis.

A sample of the suggested questionnaire follows and case studies using the questionnaire are included in Part V of this report.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Questionnaire

DELAYS IN IMPLEMENTING INDUSTRIAL PROJECTS

This questionnaire is part of a study being conducted by the United Nations Industrial Development Organization for the purpose of learning more about the causes and costs of delays in implementing industrial projects in developing countries.

The questionnaire has been sent to you for the project named below on the basis of a random selection and not because of any knowledge of delays in this project.

Project name ______________________________

Country ______________________________

Once filled in this questionnaire will be kept confidential. Specific project information will not be divulged. Only totals, averages and general observations will be published.

You are asked to complete this questionnaire as promptly as possible and return it to the United Nations Industrial Development Organization, Felderhause, Rathausplatz 2, 1010-A Vienna, Austria.

Thank you for your assistance.

Definition of Terms Used

"Implementation Phase"

The implementation phase is taken to be the work starting with detailed project planning and design, through construction and start up, to the time when the project is functioning in a satisfactory manner at, or near, its rated capacity. Thus, the decision to invest is assumed to have been made; the product, general process, scale, market, financing method, and general location have been decided upon. Government approval is assumed, at least in principle, and the investment funds, including foreign exchange, are assumed to be allocated and available. At this point implementation begins. It includes site selection, detailed design of the project to accommodate it to the site and to final engineering changes, bidding, contracting and procurement, construction, production start-up, and build-up to capacity.

"Delay"

Project delay is defined to mean falling behind schedule 25% or more of the planned time of achievement for any major activity of the project.

"Activity"

Activity is used in the precise meaning it has in bar chart scheduling or network scheduling. It is assumed that every large scale industrial project will have been scheduled with one of these methods. Figure 1 shows the meaning of activity as used in these scheduling methods. An activity is a logical subdivision of the project work that can be scheduled as an entity because it is distinctly different from that which precedes or follows it. Thus, the simple bar chart of Figure 1 shows Activity A of one week duration, Activity B of 8 weeks duration, and so forth. The simple network illustration shows activity 1, Purchase Pumps, of 5 months duration, activity 2, Install Pumps, of 7 months duration, and activity 3, Dewater Site, of 8 months duration.

"Major Activity"

A major activity is one that is scheduled in months, rather than days or weeks; that is, an activity whose planned duration is at least one month. Since this study covers only large industrial projects of over $1 million value, and implementation periods ranging from about one to eight years, it is neither necessary nor desirable to investigate delays in activities shorter than this.

Definition of Terms, Continued

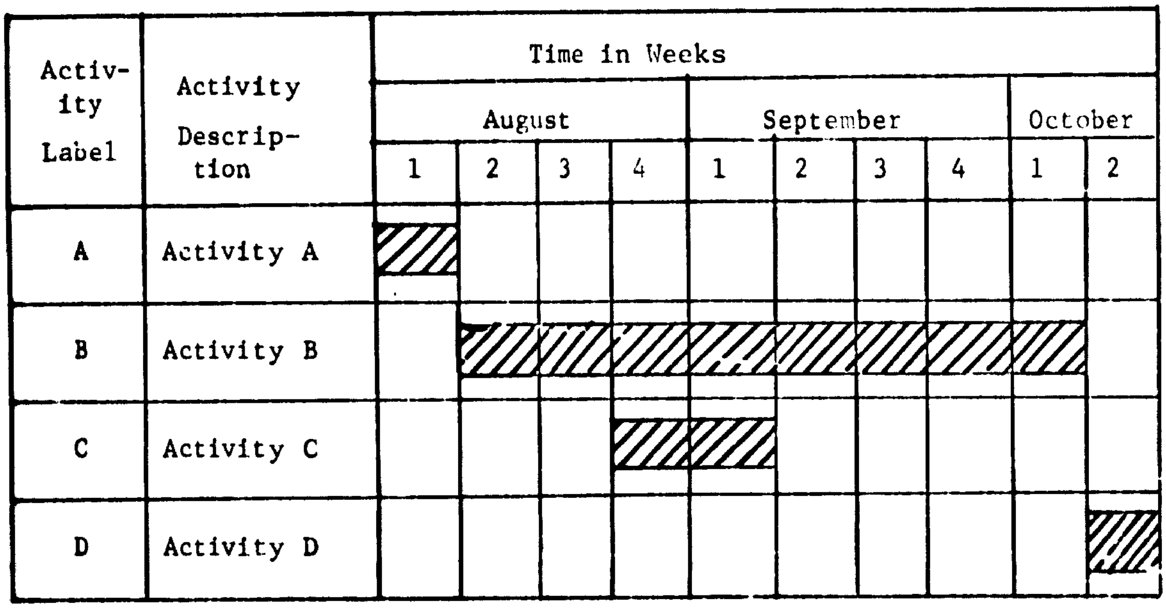
"Planned Time of Achievement"

The planned time of achievement is not necessarily measured by calendar dates; that is, day of the week or month, but by time duration, or number of days. Thus it is possible for a major activity to be completed later than the scheduled calendar date and still not, in itself, be a "delayed activity," in the meaning of the definition of this study. This could happen if a previous activity were delayed, thereby moving back the starting date of the referenced activity. Another way of putting this point is that delays are not necessarily cumulative. Each major activity is judged with respect to its planned elapsed time, as shown on the original schedule (or any revisions thereto made prior to the start of the referenced major activity) and not with respect to the calendar as such.

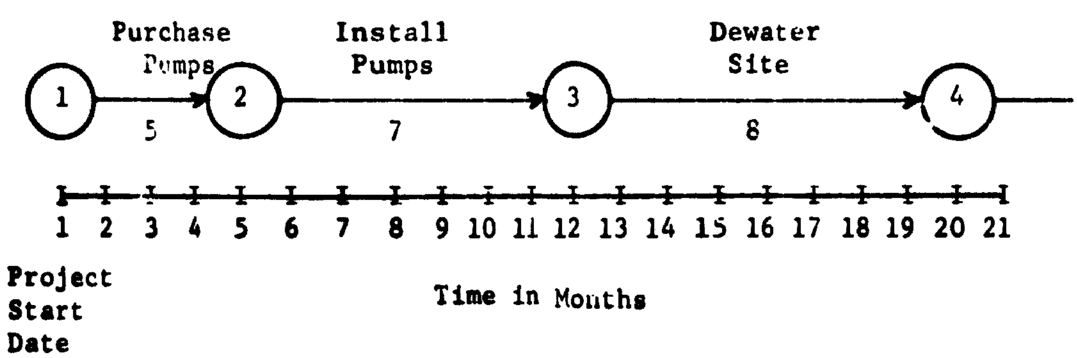
With this meaning, then, it is possible that an industrial project may suffer delay in one or more major activities and yet be completed by the scheduled date. The study is designed intentionally to include this possibility, for otherwise some important instances of delay may escape the survey. On the other hand, it is not possible for a total project to fall 25% or more behind schedule unless one or more of its major activities does so.

Figure 1 - Meaning of Activity

Simple Bar Chart



Simple Network



Questionnaire

Part I. General Project Information

1) Country ______________________. 2) Project name ______________________

State or province ____________.

3) Project ownership

Public (Agency or Department) ______________________________.

Private (Corporation name) ______________________________.

Joint public-private ______________________________.

4) Implementing agency (ies) ______________________________

______________________________.

5) Prime contractor(s) ______________________________

______________________________.

6) Type of contract (describe) ______________________________

______________________________.

7) Project description ______________________________

____

____

______________________________.

8) Products to be produced ______________________________.

9) Planned annual capacity ______________________________.

10) Planned total employment at full capacity ______________________.

11) Comments or explanations for any of the items of Part I (if necessary)

____

____

____

____

____

____

In the next two parts (Parts II and III) of the questionnaire we divide the project implementation phase into four stages:

Stage 1. Detailed project planning (including site selection, detailed engineering design, and cost estimating).

Stage 2. Bidding, contracting and procurement.

Stage 3. Construction and start-up.

Stage 4. Build-up to capacity production.

We realize it is not always possible to divide project work into these four stages. If you find you cannot do so for this project, please change the stage definitions above and on the following pages to ones that you can use systematically for the rest of the questionnaire.

Note: If neither a bar chart nor a network schedule was made for the implementation phase of this project, do not attempt to fill out the activity listings on the following pages. Turn directly to page 21 at the end of Part III and provide what general information you can. Also, please complete page 8.

Part II. Project Scheduling and Identification of Delays

1) Was a bar-chart (or Gantt chart) schedule prepared for the implementation phase of this project?____________________.

2) Was a network (or PERT or CPM) schedule prepared for the implementation phase of this project?____________________.

3) If neither a bar-chart nor a network schedule was prepared for the implementation phase of this project, describe the scheduling procedure that was used.____________________

____

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____

____.

> If it is available, we would appreciate receiving with this questionnaire a copy of the project schedule for the implementation phase as it stood at the beginning of that phase. It may be abbreviated, if desired, to include only "major activities" as defined in this questionnaire.

4) Who (what agency or group) prepared the schedule for the implementation phase of this project?____________________

____.

Part II. Project Scheduling and Identification of Delays, Continued

5) On what dates did the following events actually occur?

a) Implementation phase of project actually started*______________.

b) Foreign exchange portion of funds committed by government______

____.

c) Final approval of project by government______________________.

d) Ground breaking____.

e) Start of production (plant "on-line")_________________________.

f) Capacity production achieved (implementation phase ended)______

____.

*See definition of "implementation phase."

6) On what date was the project originally scheduled to start production (go on-line)?____.

7) On what date was the project originally scheduled to reach full capacity production?____.

United Nations Industrial Development Organization

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DESIGN OF AN EMPIRICAL STUDY OF PROBLEMS IN IMPLEMENTING INDUSTRIAL PROJECTS IN DEVELOPING COUNTRIES

Maurice D. Kilbridge
Robert B. Stobaugh, Jr.

Harvard Business School
Boston, Massachusetts
November 1968

Part II. Project Scheduling and Identification of Delays, Continued

8) Referring to the project schedule for the implementation phase, list below the "major activities" (refer to definition) of Stage 1 -- detailed project planning. Also list the planned or scheduled time duration for each major activity, in months, and the actual time duration experienced.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Part II, Continued

8) Stage 1 -- detailed project planning, continued

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Part II. Project Scheduling and Identification of Delays, Continued

9) List below the major activities of Stage 2 -- bidding, contracting and procurement.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Part II, Continued

9) Stage 2 -- bidding, contracting and procurement, continued.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Part II. Project Scheduling and Identification of Delays, Continued

10) List below the major activities of Stage 3 -- construction and start up.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Part II, Continued

10) Stage 3 -- construction and start-up, continued.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Part II. Project Scheduling and Identification of Delays, Continued

11) List below the major activities of stage 4 -- build-up to capacity production.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

"Delay" has been defined earlier to mean "falling behind schedule 25% or more of the planned time of achievement."

Wherever a number of 25% or larger appears in column (6) of the above listings for any of the four stages, circle the corresponding activity number. These are the activities we will consider to have been delayed. In the following part of this questionnaire we seek the reasons for these delays.

Part II. Project Scheduling and Identification of Delays, Continued

12) List below the 5 delays that in your judgment made the greatest contribution to the total delay of the project. Put them in what you estimate to be the order of their magnitude of contribution to total delay and estimate their contribution in months.

Number	Delay	Contribution to Total Delay (Months)
1.		
2.		
3.		
4.		
5.		

Questionnaire

Part III. Reasons for Delays

(If no delays were identified in Part II, skip this part.)

Complete the following sections only for those major activities that were delayed, that is where 25% or a greater number appeared in column (6) of Part II of this questionnaire.

1) Stage 1 -- detailed project planning.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)

Part III. Reasons for Delays, Continued

2) Stage 2 -- bidding, contracting and procurement.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)

CONTENTS

Questionnaire

Part III. Reasons for Delays, Continued

3) Stage 3 -- construction and start-up.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)

Questionnaire

Part III. Reasons for Delays, Continued

4) Stage 4 -- build up to capacity production.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)

Part III. Reasons for Delays, Continued

5) If no formal scheduling procedure was used for this project, please give below as much information as you have about delays, their time and causes.

Questionnaire

Part IV. Project Cost Information

1) Total project investment (actual, if different from planned)*

____

Major cost elements:

Land____________________

Land preparation____________________

Non-residential buildings and plant__________

Capital equipment____________________

Housing____________________

Roads, railroads & access_______________

Water____________________

Power____________________

Fees and services____________________

Other____________________

____

2) Foreign currency component of project (actual)_______________

3) Local currency component of project (actual)_______________

4) Source(s) of foreign currency (or lending agency)_______________

5) Source(s) of local currency (or lending agency)_______________

____

6) Terms of foreign currency loan (if any)____________________

____

7) Terms of local currency loan (if any)____________________

____

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*Includes all cost elements such as housing colony, land, road improvements, owned power supply, and so forth, that are required for the successful completion and operation of the project.

8) On what date was the foreign capital component of the investment for this project allocated?______________. Was it unavailable for other projects thereafter?________________________________.

9) Was all or part of the foreign exchange component of the investment committed on the above date? Please explain____________________

____.

10) Additional comments or information that respondent feels may be helpful to UNIDO in this study.

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11) Name of person(s) filling out this questionnaire______________

____

12) Title and affiliation_____________________________________

____

13) Mailing address____

____

14) Date__________________________.

IV. ANALYSIS OF COMPLETED QUESTIONNAIRES

The primary use of the completed questionnaires will be to determine the lengths and causes of delays and whether the delays are correlated with variables, such as type of plants, class of countries, or type of geographical areas. Also, the completed questionnaires will enable certain plants to be selected for in-depth interviews, as discussed below. Finally, the completed questionnaires will provide data for approximating the cost of delays. However, it should be noted that these cost estimates are not of crucial importance, but are intended only to provide an order-of-magnitude estimate of the over-all cost of delays in order to confirm that the use of a substantial amount of resources can be justified in order to reduce delays.

To determine the lengths and causes of delays and whether the delays are correlated with variables, certain tabulations should be made. First, the information on the delays should be tabulated as follows:

1. <u>The stage of the project during which delay occurred</u>; that is, detailed project planning; bidding, contracting, and procurement; construction and start-up; and build-up to plant capacity.
2. <u>Individual cause of each delay</u>. An example is: "Vendor late in submitting equipment drawings for approval."
3. <u>Categories of causes of delays</u>. Examples are:
    a. Change of scope of project (e.g., plant owner decides to increase plant capacity).

b. Result of other acts by plant owner (e.g., plant owner slow in approving purchase order).

c. Apparent inefficiency on the part of the contractor (e.g., contractor has inadequate number of men on job).

d. Delays by local governments (e.g., government delays issue of import licenses).

Next, each of the above three sets of data should be tabulated against type of plant, class of country, and type of geographical area. The result will be nine tabulations. As an example, Exhibit 5 presents a format that might be used for the tabulation, "Type of Plant" versus "Stage During Which Delay Occurred."

After these nine tabulations have been made and analyzed, further tabulations should be made in order to explore such issues as type of contract (e.g., turn-key versus cost-plus-fixed-fee) and type of ownership (government versus local-private versus local-foreign joint venture versus foreign).

These analyses will uncover the most important types of delays that might be encountered in various situations and will assist in pinpointing where remedial action should be taken.

Cost of Delay Calculations*

Exhibits 6, 7, and 8 are three cost calculation tables based on different capital intensities that show the reduction in net worth of a project as a percentage of the total project investment for different periods of delay under various assumptions.

*For further discussion see "The Cost of Delays" and the "Appendix: Calculations Leading to Table 2" in M. Kilbridge, Problems Encountered in Implementing Industrial Projects in Developing Countries, UNIDO, December 1967.

Exhibit 6 is to be used in interpreting questionnaires for:

**Cotton Textile Mill

**Motor Vehicle Assembly Plant

Exhibit 7 is to be used in interpreting questionnaires for:

**Cement Plant

**Iron and Steel Mill

**Caustic Soda Plant

**Machine Tool Plant

**Tire Plant

Exhibit 8 is to be used in interpreting questionnaires for:

**Electric Power Plant

**Petroleum Refinery

**Ammonia-Based Fertilizer Plant

**Petrochemical Plant

The tables contain two kinds of cost, one due to delays in project completion, and the other due to the time required to reach full capacity production. Delay in project completion is the time between the originally scheduled start of production and the actual start of production. Time to reach full capacity is the time between the start of production and when capacity production was achieved. Both times are calculable from the information provided in Part II, item 5, of the questionnaire.

Two forms of financing are shown (Columns (1) and (2)). Column (1) covers the situation in which about one-half the capital (usually the foreign exchange component) is tied, or committed at the start of the project and is not available for other uses thereafter, while the other half of the capital (usually the local currency component) is made available as necessary from a general account. Column (2) covers the situations in which all investment costs coincide with investment outlays. This is pay-as-you-go all the way.

Two rates of time discount are used, 7% and 15%. These are naturally higher than the financial terms on which project loans are typically made and reflect more accurately the marginal efficiency of capital in developing countries. The low rate of savings, the abundance of labor, and the political determination to accelerate economic growth by rapid increases in the level of investment also indicate high rates of time discount. Availability of credit is limited, and demand is virtually unlimited. These considerations make a 7% discount rate the lowest that reasonably can be assumed.

To illustrate the use of these tables, consider Case 1, Sati Thermal Power Station (presented in Part V of this report). Exhibit 8 is to be used. The total investment was $9.0 million. Delay in completion of the project was 20-1/2 months. There was no subsequent delay in reaching full capacity production. The foreign exchange component, representing roughly one-half the capital investment, was committed at the beginning of the project and was unavailable for other use thereafter. The local component of investment was made available as needed. Thus

I. INTRODUCTION

Previous reports* prepared for the United Nations Industrial Development Organization on the implementation of industrial projects in developing countries indicate that extensive delays are commonly encountered and that the effect of these delays is to lower the present worth of the industrial projects by as much as 10 to 30%. This cost is seldom calculated and frequently not even understood. No systematic analysis of the causes of implementation delays has been made until now, and yet their cost is at least as great as those associated with location choices, labor productivity differences, economies of scale and the choice of technology.

This report presents the design of an empirical study to be undertaken by the United Nations Industrial Development Organization to determine the nature of delays in implementing industrial projects, their causes and their costs.

The essential tool of the study is a questionnaire to be administered to a stratified random sample of 104 industrial plants completed in developing countries since 1960. Part II lays out the sampling procedure stratified by geographical area and by stage of economic development and shows how to select the sample of 104 plants. Part III contains the questionnaire and the reasoning employed in its development. Methods for analyzing the completed questionnaires, including calculations of the cost of delays, and a subsample of in-depth interviews are given in Part IV.

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*See Bibliography.

one-half the capital was tied and Column (1) of the table applies. Assume first a 7% discount rate. Looking under "Delay in Project Completion" and interpolation between 1.5 and 2.0 years we get approximately 10%. This tells us that, under the assumption of a 7% discount rate, delay in completing this project reduced its net worth by about 10%, or $900,000. If we assume a 15% discount rate, and use the table in the same fashion, we get approximately an 18% reduction in net worth, or $1,620,000.

A second illustration of the use of these tables is Case 2, a cement plant. Exhibit 7 is to be used. The total project investment was $4 million. Delay in completion of the project was 12 months, and there was a subsequent delay of 12 months in reaching full capacity. Neither the foreign exchange component nor the local currency component was committed at the beginning of the project, but they were made available as needed. If we assume a 15% discount rate for this industrial project, we look under "delay in project completion" and get 3%. This tells us that at a 15% discount rate this delay reduced the net worth of the project by $120,000. Next we look under "time to reach full capacity production" and get 10%. This tells us that this lag in reaching capacity production reduced the net worth of the project by $400,000. These two factors combined reduce the net worth of the project by 13% or $520,000.

Selected In-Depth Interviews

Approximately 15 to 20 in-depth interviews should be conducted at plants from which completed questionnaires were returned in order to obtain additional insight into the causes of delays and their possible prevention.

Most of the interviews should be conducted at plants which experienced the delays which the interview analyses indicate to be most prevalent and costly. The interviews should explore in depth such factors as project organization, project control, project scheduling, experience of contractor, and similar items. Persons interviewed should include the engineers and management of the owning firm, the engineering contractor, the construction contractor, and in a few cases, the major equipment vendor. Recommendations should be obtained from the persons interviewed as to how delays can be prevented in the future.

Some few interviews should be conducted at plants in which the most serious delays did not occur. The actions taken by the owners and contractors which prevented delays from occurring should be determined.

The plants at which in-depth interviews are to be conducted should be selected so that each type of plant is represented, each class of country is represented, and each geographical area is represented.

At least some of these interviews should be made by a representative of the central UNIDO office. This will insure against the possible bias which might be enoountered if all interviews were conducted by a local representative of UNIDO.

Exhibit 5

EXAMPLE OF TABULATION OF INFORMATION ON DELAYS

Type of Plant	Stage during Which Delays Occurred: I Detailed Project Planning		II Bidding, Contracting and Procurement		III Construction and Start-up		IV Build-up to Capacity	
	No. of Delays	Sum of Delays in Months	No. of Delays	Sum of Delays in Months	No. of Delays	Sum of Delays in Months	No. of Delays	Sum of Delays in Months
Electric Power Plant								
Cement Plant								
Petroleum Refinery								
Cotton Textile Mill								
Ammonia-Based Fertiliser Plant								
Iron and Steel Mill								
Motor Vehicle Assembly Plant								
Tire Plant								
Caustic-Chlorine Plant								
Petrochemicals Plant								
Machine Tool Plant								

Exhibit 6

[Use for: Cotton Textile Mill, Motor Vehicle Assembly Plant]

REDUCTION IN NET WORTH AS % OF TOTAL PROJECT INVESTMENT

	7% Discount Rate				15% Discount Rate			
	Delay in Project Completion		Time to Reach Full Capacity Production		Delay in Project Completion		Time to Reach Full Capacity Production	
	% Reduction		% Reduction		% Reduction		% Reduction	
Years	(1) 1/2 Cap. Tied	(2) Pay as Go	(1) 1/2 Cap. Tied	(2) Pay as Go	(1) 1/2 Cap. Tied	(2) Pay as Go	(1) 1/2 Cap. Tied	(2) Pay as Go
0.5	1.0	0.5	3.0	2.0	2.0	1.0	4.0	3.0
1.0	2.0	1.0	6.0	4.0	4.0	1.5	8.0	6.0
1.5	3.0	1.5	7.5	5.5	5.0	2.5	9.5	7.5
2.0	3.5	1.5	9.0	7.0	6.5	3.0	11	9.0
2.5	4.5	2.0	11	8.5	7.5	4.0	13	11
3.0	5.0	2.5	12	10	9.0	5.0	14	13
3.5	6.0	3.0	14	12	11	6.5	16	14
4.0	7.0	4.0	15	13	12	8.0	17	15

Exhibit 7

[<u>Use for</u>: Cement Plant, Iron and Steel Mill, Caustic Soda Plant, Machine Tool Plant, Tire Plant]

REDUCTION IN NET WORTH AS % OF TOTAL PROJECT INVESTMENT

	7% Discount Rate				15% Discount Rate			
	Delay in Project Completion		Time to Reach Full Capacity Production		Delay in Project Completion		Time to Reach Full Capacity Production	
	% Reduction		% Reduction		% Reduction		% Reduction	
Years	(1) 1/2 Cap. Tied	(2) Pay as Go	(1) 1/2 Cap. Tied	(2) Pay as Go	(1) 1/2 Cap. Tied	(2) Pay as Go	(1) 1/2 Cap. Tied	(2) Pay as Go
0.5	2.0	1.0	5.0	3.5	4.0	1.5	6.0	5.0
1.0	4.0	1.5	10	7.0	8.0	3.0	12	10
1.5	5.5	2.5	13	8.5	11	4.5	15	14
2.0	7.0	3.0	16	12	13	6.0	19	17
2.5	8.5	4.0	19	14	16	7.5	22	19
3.0	10	4.5	22	16	18	9.0	24	20
3.5	12	5.5	25	19	21	11	27	22
4.0	13	6.0	28	21	23	12	29	24

Exhibit 8

[Use for: Electric Power Plant, Petroleum Refinery, Ammonia-Based Fertilizer Plant, Petrochemical Plant]

REDUCTION IN NET WORTH AS % OF TOTAL PROJECT INVESTMENT

	7% Discount Rate				15% Discount Rate			
	Delay in Project Completion		Time to Reach Full Capacity Production		Delay in Project Completion		Time to Reach Full Capacity Production	
	% Reduction		% Reduction		% Reduction		% Reduction	
Years	(1) 1/2 Cap. Tied	(2) Pay as Go	(1) 1/2 Cap. Tied	(2) Pay as Go	(1) 1/2 Cap. Tied	(2) Pay as Go	(1) 1/2 Cap. Tied	(2) Pay as Go
0.5	3.5	1.0	7.5	5.0	6.0	2.5	9.0	7.0
1.0	7.0	2.0	15	10	12	4.5	18	14
1.5	9.0	3.5	20	13	16	7.0	24	18
2.0	11	4.5	24	16	20	9.0	29	22
2.5	13	6.0	29	19	24	12	33	25
3.0	15	7.0	33	21	27	14	36	28
3.5	17	8.5	37	24	31	17	40	31
4.0	19	10	41	26	34	19	[illegible]	34

Case 1: Sati* Thermal Power Station (India)

The Project

The Sati thermal power station is in the northern part of the State of Bihar in India. It consists of two 15 mw generating units, each fed by a separate coal-fired boiler, and the related coal handling equipment, switch gear, and housing colony.

The project was financed by the U. S. Development Loan Fund (now incorporated in the U. S. Agency for International Development) under an agreement signed on June 30, 1960. The DLF provided $3.8 million to the Government of India to meet the foreign exchange requirements, and Rs. 13.1 million was obtained by the State of Bihar from a PL 480 Title I (the use of local counterpart funds) loan to cover the local currency costs. Although the original foreign exchange loan was adequate to cover the costs of imported equipment and services, actual local currency costs ran Rs. 11.8 million above the loan estimate, a 90% deviation from the budget attributed to inflation, delays and unforeseen costs.

The power plant and switch gear were designed and manufactured by Invest Import of Yugoslavia and erected by them under a turn-key contract. This firm subcontracted to M/s. Steinpudler, of West Germany, the design and manufacture of the boiler and some ancillary equipment. The Kuljian Corporation of Philadelphia, USA, served as general consultant to the Bihar State Electricity Board, the owner and operator of the plant, for all work related to the design and erection of the power station. Kuljian also constructed

*Name disguised.

the plant buildings and all non-residential civil works. The residential buildings (essentially the housing colony) were built by the Bihar State Electricity Board itself.

Delays in Implementation

Project work began in January, 1959, with the intention of bringing the first 15 mw unit on line in November, 1961, and the second in March, 1962. The units actually were put into service in October, 1963, and November, 1963, respectively, approximately two years behind schedule. This falling behind by 70% of the planned time of implementation is attributable to a variety of delays in the procurement and construction phases, some of which are the consequences of risks inherent in multinational financial and engineering efforts and others of which appear to result from careless planning.

A major source of delay was rooted in the triangular relationships between the prime contractor, Invest Import of Yugoslavia, the subcontractor, M/s. Steinpudler of West Germany, and the U. S. Development Loan Fund. The DLF wished to use Yogoslavian dinars instead of U. S. dollars to the fullest extent possible in payments to Invest Import. This involved frequent payment delays while the U. S. Treasury searched its accounts for dinars. During these delays Invest Import tended to slow down its design, machining or shipment of the plant components. When Steinpudler was asked to provide the boilers and ancillary equipment they requested payment in dollars, either from Invest Import or the DLF directly. Invest Import refused to provide dollars and the boiler equipment, although ready for shipment, was held up in West Germany for seven months until the DLF finally opened a line of credit for Steinpudler in the U. S.

Another principle source of delay was in the relationship between the Yugoslavian company, which had prime responsibility for designing the entire plant, and the Kuljian Corporation, which prepared the site and built the civil works. The submission of the site plan with the equipment and yard arrangement, detailed foundation drawings, and building drawings was, for some unexplained reason, held up for almost a year. This delayed completion of the civil construction work, but not by an equivalent amount.

A further source of delay, and one that should be avoidable, was in the inadequate investigation of the soil mechanics of the site. Although drilling and soil testing went on for 14 months before the start of construction, the high subsoil water and poor bearing capacity of the soil had not been adequately compensated for in the design of pilings and foundations.

A continuing source of irritation and delay was the repeated shortage, or oversight in ordering, critical imported components and materials. Refractories for lining the fire boxes of the boilers were imported from Yugoslavia after much debate over the quality of locally available Indian-made refractories. When they arrived, just in time for installation, a large number were broken. It was decided to replace them with the Indian product so as not to hold up the entire project, but the Yugoslavian contractor was unable to provide the exact specifications and dimensions of the brick required, and they had finally to be imported from Yugoslavia after all, involving a delay of three months.

Similar delays of minor importance were encountered in the site preparation and construction of residential housing. Tube well parts were damaged in shipment. An order of hardware and plumbing fixtures was lost; another was held up by customs in Bombay for seven months.

In the procurement phase six major activities were delayed, or fell 25% or more behind the planned time of achievement. These were activities 1 (boiler framework), 5 (super heater), 11 (forced draught fans), 12 (cold and warm air lines), 21 (boiler sheeting), and 34 (turbine). Their average delay was 6.2 months, or about 40% of the average planned time of achievement. In the construction and start-up phase 19 activities were delayed, and of these 18 were in preparation of the site and construction of the civil works. The civil works delays averaged 8.6 months each, or about 60% of the planned time. The only delay in the erection of the power station itself was experienced in activity 16 (bricking) for a period of three months, or 50%.

An analysis of these delays makes it quite clear that their largest root cause was in the confusion due to distance and national barriers, or in other words, the dependence of the Bihar State Electricity Board on imported design, equipment and technical skills. Once the plant was delivered to the site, erection went ahead on schedule, with exception of one activity. Under normal conditions the prime contractor, Invest Import of Yugoslavia, would have been bound by penalty agreement for failure to commission the units on time, but the difficulty of assigning blame for the currency shortage and payments

In Part V we apply the questionnaire in the detailed study of five actual cases of industrial project implementation: a thermal power plant in India, a cement plant in Latin America, two petrochemical plants in Asia, and a textile mill in Latin America. We have disguised the names of these projects at the request of those who provided the case information, but the facts remain unaltered.

delay provided them with an escape from the contract.

The Cost of Delays

Not all of the delays encountered contributed to the cumulative delay of the project. Some, in the parlance of network scheduling, were not on the critical path. That is, they were more or less independent in time from other activities, or they did not hold up the accomplishment of other activities critical to the completion of the project.

The effective delay, in terms of cost, is the period of time over which funds were invested or immobilized and the project was not in operation, although it could have been if these delays were not experienced. For the Sati Thermal Power Station this cumulative delay in project completion was from November 1961 to October 1963, or 23 months, for unit 1 and from March 1962 to November 1963, or 20 months, for unit 2. For cost calculations we can consider these separate delays equivalent to a single unit delayed by 20½ months.

Referring to Exhibit 8 under Part IV, Analysis of Completed Questionnaires, we can estimate the real cost of this delay under various assumptions. Since the foreign exchange component of the investment was committed at the start of the project and was unavailable for other use thereafter, and the rupee investment was made on a pay-as-you-go basis, and since the foreign exchange component is roughly half the total investment, this is a column (1) case (½ Capital Tied). Thus, if we use a 7% discount rate, the reduction in net worth of the Sati Thermal Power Station due to 20½ months of delay in completion is about 10%, or $900,000. At a 15% discount rate the reduction in net worth is about

18%, or $1,620,000. As was mentioned earlier under the discussion of cost of delay analysis, the actual interest rate (in this case 3½% on foreign exchange and 7% on local exchange) has little or nothing to do with the true loss to the economy of India caused by this delay. The country's borrowing capacity is limited, especially for foreign capital, and the opportunities for investment are many. The capital tied up during the delay in completing this power station represents a large loss to the nation in potential income from the sale of electricity and in potential savings for reinvestment.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Questionnaire

DELAYS IN IMPLEMENTING INDUSTRIAL PROJECTS

This questionnaire is part of a study being conducted by the United Nations Industrial Development Organization for the purpose of learning more about the causes and costs of delays in implementing industrial projects in developing countries.

The questionnaire has been sent to you for the project named below on the basis of a random selection and not because of any knowledge of delays in this project.

Project name Sati Thermal Power Station

Country India

Once filled in this questionnaire will be kept confidential. Specific project information will not be divulged. Only totals, averages and general observations will be published.

You are asked to complete this questionnaire as promptly as possible and return it to the United Nations Industrial Development Organization, Felderhause, Rathausplatz 2, 1010-A Vienna, Austria.

Thank you for your assistance.

Definition of Terms Used

"Implementation Phase"

The implementation phase is taken to be the work starting with detailed project planning and design, through construction and start up, to the time when the project is functioning in a satisfactory manner at, or near, its rated capacity. Thus, the decision to invest is assumed to have been made; the product, general process, scale, market, financing method, and general location have been decided upon. Government approval is assumed, at least in principle, and the investment funds, including foreign exchange, are assumed to be allocated and available. At this point implementation begins. It includes site selection, detailed design of the project to accommodate it to the site and to final engineering changes, bidding, contracting and procurement, construction, production start-up, and build-up to capacity.

"Delay"

Project delay is defined to mean falling behind schedule 25% or more of the planned time of achievement for any major activity of the project.

"Activity"

Activity is used in the precise meaning it has in bar chart scheduling or network scheduling. It is assumed that every large scale industrial project will have been scheduled with one of these methods. Figure 1 shows the meaning of activity as used in these scheduling methods. An activity is a logical subdivision of the project work that can be scheduled as an entity because it is distinctly different from that which precedes or follows it. Thus, the simple bar chart of Figure 1 shows Activity A of one week duration, Activity B of 8 weeks duration, and so forth. The simple network illustration shows activity 1, Purchase Pumps, of 5 months duration, activity 2, Install Pumps, of 7 months duration, and activity 3, Dewater Site, of 8 months duration.

"Major Activity"

A major activity is one that is scheduled in months, rather than days or weeks; that is, an activity whose planned duration is at least one month. Since this study covers only large industrial projects of over $1 million value, and implementation periods ranging from about one to eight years, it is neither necessary nor desirable to investigate delays in activities shorter than this.

Definition of Terms, Continued

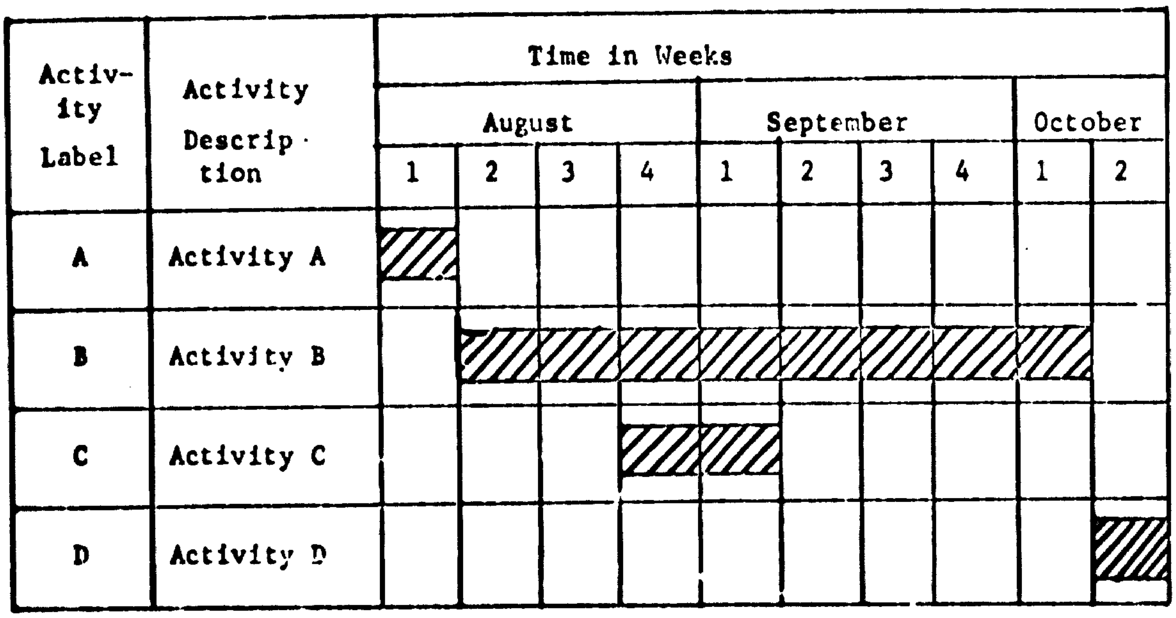
"Planned Time of Achievement"

The planned time of achievement is not necessarily measured by calendar dates; that is, day of the week or month, but by time duration, or number of days. Thus it is possible for a major activity to be completed later than the scheduled calendar date and still not, in itself, be a "delayed activity," in the meaning of the definition of this study. This could happen if a previous activity were delayed, thereby moving back the starting date of the referenced activity. Another way of putting this point is that delays are not necessarily cumulative. Each major activity is judged with respect to its planned elapsed time, as shown on the original schedule (or any revisions thereto made prior to the start of the referenced major activity) and not with respect to the calendar as such.

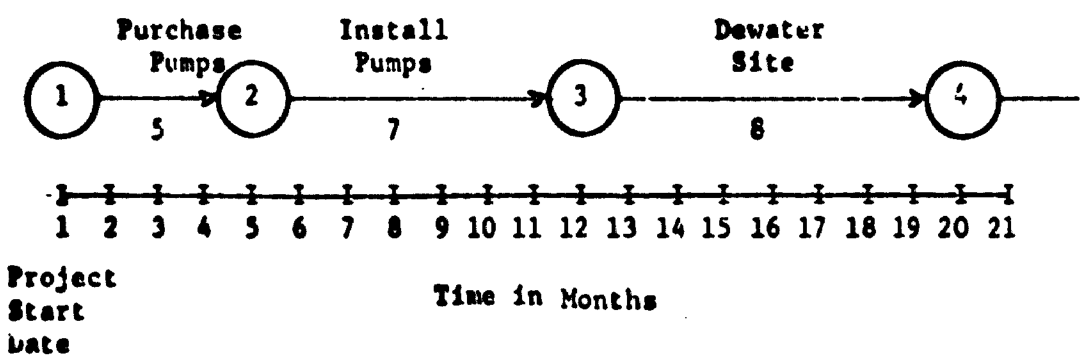
With this meaning, then, it is possible that an industrial project may suffer delay in one or more major activities and yet be completed by the scheduled date. The study is designed intentionally to include this possibility, for otherwise some important instances of delay may escape the survey. On the other hand, it is not possible for a total project to fall 25% or more behind schedule unless one or more of its major activities does so.

Figure 1 - Meaning of Activity

Simple Bar Chart



Simple Network



Questionnaire

Part I. General Project Information

1) Country India. 2) Project name Sati* Thermal Power

State or province Bihar.

3) Project ownership

Public (Agency or Department) Bihar State Electricity Board (Patna).

Private (Corporation name) ________.

Joint public-private ________.

4) Implementing agency (ies) Bihar State Electricity Board

________.

5) Prime contractor(s) (Plant) Invest Import of Yugoslavia, (Consulting Services and Civil Works) Kuljian Corp., Philadelphia, USA.

6) Type of contract (describe) Turn Key

________.

7) Project description Steam power plant of 30 mw capacity consisting of two 15 mw units; boilers fueled with pulverised coal. Plant and equipment is Yugoslavian and is installed by Invest Import. Civil works for the power station are by Kuljian Corporation. Residential buildings are by Bihar State Electricity Board.

8) Products to be produced Electric power.

9) Planned annual capacity 30,000 KW or 2.62 million KW hr.

10) Planned total employment at full capacity 281 (16 executives, 265 workers).

11) Comments or explanations for any of the items of Part I (if necessary)

Original target dates for 1st and 2nd units on line were November 1961 and March 1962, respectively. Electrical generation thus started about 2 years later than planned.

*Name disguised.

In the next two parts (Parts II and III) of the questionnaire we divide the project implementation phase into four stages:

Stage 1. Detailed project planning (including site selection, detailed engineering design, and cost estimating).

Stage 2. Bidding, contracting and procurement.

Stage 3. Construction and start-up.

Stage 4. Build-up to capacity production.

We realize it is not always possible to divide project work into these four stages. If you find you cannot do so for this project, please change the stage definitions above and on the following pages to ones that you can use systematically for the rest of the questionnaire.

Note: If neither a bar chart nor a network schedule was made for the implementation phase of this project, do not attempt to fill out the activity listings on the following pages. Turn directly to page 21 at the end of Part III and provide what general information you can. **Also please complete page 8.**

Part II. Project Scheduling and Identification of Delays

1) Was a bar-chart (or Gantt chart) schedule prepared for the implementation phase of this project? Yes.

2) Was a network (or PERT or CPM) schedule prepared for the implementation phase of this project? No.

3) If neither a bar-chart nor a network schedule was prepared for the implementation phase of this project, describe the scheduling procedure that was used. ______________________________

____

____

____

____

____

______________________________.

> If it is available, we would appreciate receiving with this questionnaire a copy of the project schedule for the implementation phase as it stood at the beginning of that phase. It may be abbreviated, if desired, to include only "major activities" as defined in this questionnaire.

4) Who (what agency or group) prepared the schedule for the implementation phase of this project? Bihar State Electricity Board (Civil Works) - Invest Import of Yugoslavia (Power Station).

Part II. Project Scheduling and Identification of Delays, Continued

5) On what dates did the following events actually occur?

a) Implementation phase of project actually started* January, 1959.

b) Foreign exchange portion of funds committed by government June 30, 1960.

c) Final approval of project by government June 1958.

d) Ground breaking February 1959.

e) Start of production (plant "on-line") September 1963, October 1963.

f) Capacity production achieved (implementation phase ended) October 1, 1963 (Unit 1) November 1963 (Unit 2).

*See definition of "implementation phase."

6) On what date was the project originally scheduled to start production (go on-line)? November 1961 (Unit 1) March 1962 (Unit 2).

7) On what date was the project originally scheduled to reach full capacity production? Same as 6).

II. SAMPLING PROCEDURE FOR QUESTIONNAIRES

The object of the sample design is to ensure that a representative cross section of kinds of industrial plants important to the development process are surveyed in a variety of developing countries and geographical areas. The sampling procedure is laid out in Exhibits 1 through 4 which follow. Exhibit 1 presents a matrix indicating the numbers of each type of plant to be sampled in each class of country in each geographical area. Exhibit 2 presents a description of the various types of plants to be surveyed. Exhibits 3 and 4 present the classifications of developing countries and the description of geographic areas, respectively.

Selection of Individual Plants

Questionnaires are to be completed for 104 individual plants, all of which are to have been finished after January 1, 1960, in a variety of industries and countries. Following are two examples of how to interpret Exhibit 1 for the selection of plants to be sampled.

Example 1: Sixteen electric power plants are to be surveyed as follows:

2 in Latin America and West Indies Class I countries

2 in Southern and Southeastern Asia Class I countries

2 in Latin America and West Indies Class II countries

1 in Africa Class II country

1 in Southern and Southeastern Asia Class II country

1 in Latin America and West Indies Class III country

1 in Africa Class III country

1 in West Asia Class III country

Part II. Project Scheduling and Identification of Delays, Continued

8) Referring to the project schedule for the implementation phase, list below the "major activities" (refer to definition) of Stage 1 -- detailed project planning. Also list the planned or scheduled time duration for each major activity, in months, and the actual time duration experienced.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Detailed scheduling information is not available on this project prior to contract signing. The bar charts start at that point. General scheduling information, however, was found in the project file and is incorporated in the description of the project under Case 1.

Part II, Continued

Stage 1 -- detailed project planning, continued

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Questionnaire

Part II. Project Scheduling and Identification of Delays, Continued

9) List below the major activities of Stage 2 -- Procurement only (including design, manufacture, shipping).

Procurement of Power Station and Switch Gear

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
1	Boiler framework	13	20	7	55
2	Galleries & stair cases	14	14	0	0
5	Super heater	16	23	7	43
8	Economizer	16	16	0	0
11	Forced draught fans	19	25	6	32
12	Cole & warm air lines	10	26	5	30
16	Bricking	11	10	0	0
17	Induced draught fans	18	17	0	0
18	Flue gas dust separator	20	20	0	0
19	Chimney	16½	16	0	0
20	Flue gas duct	21	20	0	0
21	Boiler shuting	18½	26	7½	40
22		11	12	1	9
23		7	8	1	13
24		10	10	0	0
25		8½	8	0	0
26		20	19	0	0
27		18½	18	0	0
28		12½	12	0	0
29		16½	17	½	6
30	Pump station	14½	15	½	5
31	Crane	16	17	1	7
32		17½	17	0	- 0
33		16½	17	½	
34	Turbine	15	20	5	30
35		19½	18	0	- 0
36		19½	17	0	--
37		20	21	1	5
39	Alternator 1	23	23	0	- 0
40		24	22	0	- 0
41		5	6	1	20
42		17	17½	½	3
43		21	20	0	- 0
44		19	19	0	- 0
45		20	18½	0	- 0
46		20	18½	0	- 0
47		20	18½	0	- 0
48		23	22	0	- 0
49		18	18½	½	2
50		17	17	0	- 0
51	Cables	19	18½	0	- 0

Part II, Continued

Stage 2 -- bidding, contracting and procurement, continued.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Part II. Project Scheduling and Identification of Delays, Continued

10) List below the major activities of Stage 3 -- construction and start up.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
I. Civil Construction					
Preliminaries					
1(a)	Drilling for soil samples	14	14	0	0
Land					
2	Purchase	24	24	0	0
Railway Siding					
3(a)	Layout of track	24	42	18	75
3(b)	Earth work	22	33	11	50
Roads & Culverts					
4(a)	Roads in station area	15	24	9	60
4(b)	Colony roads	21	33	12	57
4(c)	Temporary approach roads	36	42	6	18
Permanent Non-Residential Buildings					
5(a)	Inspection bungalow	12	13	1	9
5(b)	Administrative building	8	26	18	225
5(c)	Permanent store (3)	15	15	0	0
Permanent Residential Buildings					
6(a)	Six-roomed house	8	8	0	0
6(b)	Five-roomed house (2)	8	8	0	0
6(c)	Four-roomed house (2)	11	11	0	0
6(d)	Two-roomed house (90)	32	32	0	0
6(e)	Foreign tech. house	9	16	7	77
Fencing					
7(a)	Power station area	10	20	10	100
7(b)	Colony quarters	24	36	12	50
Water Supply					
8(a)	Tube well	2	3	1	50
8(b)	Overhead tank	24	36	12	50
8(c)	Distribution mains	9	9	0	0
8(d)	Temporary supply	35	48	13	37

Part II, Continued

Stage 3 -- construction and start-up, continued.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
Civil Construction, Continued					
Rain Water Drainage					
9(a)	Pucca open drain	12	na	--	--
9(b)	Pucca covered drain	12	na	--	--
9(c)	Earthen drain	12	na	--	--
9(d)	Pump house & system	12	6	--	--
9(e)	Fall out arrangement	12	na	--	--
9(f)	Temporary drainage	24	36	12	50
Central Plant Works					
10(a)	Pile foundation	2	3	1	50
10(b)	Foundations	9	12	3	33
10(c)	Crusher house	10	13	3	30
10(d)	Cooling towers	6	8	2	33
10(e)	Pump house	8	14	6	75
10(f)	Main power station building	12	19	7	58
II. Erection of Power Station					
1	Boiler framework	2	2	0	0
2		2	2	0	0
3		1	1	0	0
4		3½	4	½	12
5		3½	4	½	12
6		3½	4	½	12
7		1½	1½	0	0
8		3½	3½	0	0
9		3½	3	0	0
10		2	2	0	0
11		1	1	0	0
12		3	3	0	0
13		4	3½	0	0
14		4	4	0	0
15		1½	1½	0	0
16	Bricking	6	9	3	50
17		1	1	0	0
18		2	2	0	0
19		2	2	0	0
20		2	2	0	0

List below the major activities of Stage 3 -- <u>construction and start-up, continued</u>

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Weeks)	(4) Actual Duration (Weeks)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
II. Erection of Power Station, Continued					
21		1½	1½	0	0
22		2	2	0	0
23	Regulation	3	3	0	0
24	Feed pumps	3	3	0	0
25		3½	4	½	12
26		3	3	0	0
27		3	3	0	0
28		4½	4	0	0
29		3½	3	0	0
30		4	4	0	0
31		3	3	0	0
32		3½	3½	0	0
33		3½	3½	0	0
34		3½	3	0	0
35		3½	4	½	12
36		3½	3½	0	0
37		3	3	0	0
38	Measuring equipment	2	2	0	0
III. Erection of Switch Gear					
39	Alternator 1	3	3	0	0
40		2	2	0	0
41		--	--	--	--
42		4	4	0	0
43		3	3	0	0
44		8	9	1	12
45		3	3	0	0
46		3	3	0	0
47		3	3½	½	12
48		2	2	0	0
49	Compressed air installation	4	4	0	0
50	Accu-Battery	2	2	0	0
51	Cables	9	9	0	0

Part II. Project Scheduling and Identification of Delays, Continued

11) List below the major activities of stage 4 -- build-up to capacity production.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
	Not applicable to conventional thermal power station.				

"Delay" has been defined earlier to mean "falling behind schedule 25% or more of the planned time of achievement."

Wherever a number of 25% or larger appears in column (6) of the above listings for any of the four stages, circle the corresponding activity number. These are the activities we will consider to have been delayed. In the following part of this questionnaire we seek the reasons for these delays.

Part II. Project Scheduling and Identification of Delays, Continued

12) List below the 5 delays that in your judgment made the greatest contribution to the total delay of the project. Put them in what you estimate to be the order of their magnitude of contribution to total delay and estimate their contribution in months.

Number	Delay	Contribution to Total Delay (Months)
1.	Invest Import hold up shipment waiting for dinar payment.	7
2.	Waiting for site plan.	6
3.	Steinpudler holds up shipment of boiler waiting for letter of credit.	2
4.	Piling and foundations held up by high subsoil water.	2
5.	Waiting for replacement of imported refractories.	3

Questionnaire

Part III. Reasons for Delays

(If no delays were identified in Part II, skip this part.)

Complete the following sections only for those major activities that were delayed, that is where 25% or a greater number appeared in column (6) of Part II of this questionnaire.

1) Stage 1 -- detailed project planning.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)

Detailed scheduling information is not available on this project prior to contract signing. The bar charts start at that point. General scheduling information, however, was found in the project file and is incorporated in the description of the project under Case 1.

1 in Southern and Southeastern Asia Class III country

1 in Latin America and West Indies Class IV country

1 in Africa Class IV country

1 in West Asia Class IV country

1 in Southern and Southeastern Asia Class IV country

Example 2: Four machine tool plants are to be surveyed as follows.

2 in Latin America and West Indies Class I countries

2 in Southern and Southeastern Asia Class I countries

Basis of Selection of Types of Plants to be Surveyed

The types of plants to be surveyed were selected to meet the following criteria:

a. A single plant is an important project, with the investment per plant always exceeding $1 million and sometimes exceeding $50 million (in fact, plants less than $1 million should not be surveyed).

b. The plants represent the main industrial sectors included in UNIDO's International Symposium on Industrial Development (Athens, 1967) and most of the "selected industries" for which data are published in the "World Summary" section of the United Nations Statistical Yearbook.

c. Many of the plants represent the strategic industries that because of linkages to other activities are important in the economic development process.

d. Plants represent various types of production processes, such as continuous liquid processing, continuous solids processing, and assembly lines.

e. The plants are representative of a variety of industries so that some of the plants are likely to be locally owned, some are likely to be joint ventures between local and foreign owners, and some are likely to be wholly foreign owned.

Part III. Reasons for Delays, Continued

2) Stage 2 -- Procurement only (including design, manufacture & shipping)

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)
1	Boiler frame work	55	Confusion in procurement from M/s. Steinpudler, West Germany. Although boiler and ancillary equipment was manufactured on schedule, its shipment was delayed about 7 months until a letter of credit was opened in the U. S.
5	Super heater	43	" " "
21	Boiler sheeting	40	" " "
11	Forced draught fans	32	Slow down by Import Invest of Yugoslavia
12	Cold and warm air lines	30	" " "
34	Turbine	30	" " "

Questionnaire

Part III. Reasons for Delays, Continued

3) Stage 3 -- construction and start-up.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II	(4) Cause of Delay. (Please be specif[illegible] and detailed. Use extra sheets if necessary.)
I. Civil Construction			
3(a)	Layout of track	75	Waiting for site plan drawings.
3(b)	Earth work	50	" " " " "
4(a)	Roads in station area	60	" " " " "
4(b)	Colony roads	57	" " " " "
5(b)	Administration building	225	Waiting for imported hardware and plumbing fixtures
6(e)	Foreign technician house	77	" " " " "
7(a)	Fencing station area	100	Waiting for site plan drawings
7(b)	Fencing colony area	50	" " " " "
Water supply			
8(a)	Tube well	50	Waiting for imported parts
8(b)	Overhead tank	50	Delayed by tube well
8(d)	Temporary supply	37	Delayed by tube well
9(f)	Temporary drainage	50	Waiting for site plan drawings
Central works			
10(a)	Pile foundation	50 33	Inadequate exploration of soil data and piling well foundations
10(b)	Foundations	33	" " "
10(c)	Crusher house	30	" " "
10(d)	Cooling towers	33	" " "
10(e)	Pump house	75	" " "
10(f)	Main power station building	58	" " "
II. Erection of Power Station			
16	Bricking	50	Imported refractories arrived broken and had to be replaced from Yugoslavia

Part III. Reasons for Delays, Continued

4) Stage 4 -- build up to capacity production.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specifi and detailed. Use extra sheets if necessary.)
	Not applicable to conventional thermal power station		

Part III. Reasons for Delays, Continued

5) If no formal scheduling procedure was used for this project, please give below as much information as you have about delays, their time and causes.

Part IV. Project Cost Information

1) Total project investment (actual, if different from planned)*

($6,560,000)** Actual Cost = $9,002,000.

Major cost elements: (Actual)

Land $650,000

Land preparation $365,000

Non-residential buildings and plant $2,118,521

Capital equipment $3,200,000

(Residential Bldgs.)Housing $447,000

Roads, railroads & access $1,501,479

Water $228,000

Power Nil

Fees and services $110,000

Other ---

2) Foreign currency component of project (actual) $3,800,000

3) Local currency component of project (actual) ($2,760,000)** Actual=$5,202,000

4) Source(s) of foreign currency (or lending agency) Development Loan Fund of USA (later AID).

5) Source(s) of local currency (or lending agency) PL 480 Title I loan of counterpart rupee funds.

6) Terms of foreign currency loan (if any) 3½% repayable in Indian Rs. in 39 semi-annual installments from August 1963 to August 1982.

7) Terms of local currency loan (if any) 7% for 15 years.

*Includes all cost elements such as housing colony, land, road improvements, owned power supply, and so forth, that are required for the successful completion and operation of the project.

**Planned cost.

8) On what date was the foreign capital component of the investment for this project allocated? June 30, 1960. Was it unavailable for other projects thereafter? Yes.

9) Was all or part of the foreign exchange component of the investment committed on the above date? Please explain All committed on June 30, 1960.

10) Additional comments or information that respondent feels may be helpful to UNIDO in this study.

11) Name of person(s) filling out this questionnaire

Maurice Kilbridge

12) Title and affiliation Professor, Harvard Business School

13) Mailing address Boston, Mass. 02163

14) Date October 17, 1968 .

Case 2: Mesa Verde* Cement Plant (Latin America)

The Project

The Mesa Verde Cement Plant is in a Latin American country. It manufactures cement by the dry process and consists of a dry-process kiln with varied equipment including a raw material conveyor, mill, cement conveying equipment, packing plant, and electrical generating plant. This plant was built at the site of an existing cement plant owned by Mesa Verde, S.A. Residential facilities were not built as part of this plant.

The project was financed partially by Mesa Verde, partially by an international lending organization and partially by foreign suppliers' credits. The international lending organization provided lending commitment against which the Mesa Verde Company could withdraw funds as needed. The total cost of the project was $4 million and approximately $2.4 million on this was for imported material and equipment. The foreign exchange for this material and equipment was provided by a $1,600,000 loan from the international lending organization and by a $800,000 credit from equipment suppliers.

Overall responsibility for the work for the project rested with the engineering department of the Mesa Verde. This engineering department obtained and analyzed the equipment bids and decided with which company to place the orders. The major equipment items were purchased in Europe and the design of the equipment was carried out by the equipment suppliers. Some of the civil engineering design work was subcontracted to engineering consulting firms within the Latin American country. The construction of the project was handled by the Mesa Verde

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*Name disguised.

but the major equipment suppliers provided an erection supervisor to supervise the installation and startup of the equipment.

Delays in Implementation

Project work began in May 1964 with the intention of completing the project in December 1965 and reaching full capacity in March 1966. The plant actually started production in December 1966 and it was December 1967 before the plant reached capacity output.

This falling behind by one year in the planned time in completing the plant is attributable primarily to major delays during the planning and procurement phases of the project. The nine-month delay in the plant's reaching capacity output is attributable to equipment problems experienced with a major peice of equipment, and in the time needed to make arrangements to sell the output of the plant once the equipment problem had been solved.

The major source of delay in the planning and procurement stage was the decision to change the scope of the project by buying one 2500 kilowatt steam turbine rather than two 1,200 kilowatt diesel generators, as had originally been planned. This extra cost had to be met by extra supplier's credit and approval had to be obtained from the international lending organization. During the negotiations to buy the one steam turbine rather than the two diesel turbines a decision was made to increase the size of the steam turbine to 3500 kilowatts, which again increased the price. Negotiating this purchase and obtaining the necessary approval from the international lending organization delayed the project by 8 months. During this delay some of the equipment

The Cost of Delays

For this plant the cumulative delay in project completion was from March 1, 1965, to September 3, 1965, or a delay of 6 months. For an estimate of the cost of this delay in completing the project, refer to Exhibit 8 under Part IV, Analysis of Completed Questionnaires. Since neither the foreign exchange component nor the local exchange component of the investment was committed at the start of the project, the investment was made on a pay-as-you-go basis. If a 15% discount rate is used, the reduction in net worth due to delay in completion of the project is about 2.5% or $80,000. (This is listed in column [2] under "Delay in Project Completion" under the 15% Discount Rate).

Using the same table we determine that the 5-month lag (September 1965 to February 1966) in reaching full capacity production after the plant was onstream reduced the net worth of the project by approximately 6% or approximately $200,000. (See column [2] under sub-heading, "Time to Reach Full Capacity Production"; 7% is shown for a 6-month lag so a 5-month lag would be approximately 6%.)

These two factors combined to reduce the net worth of the project by 8.5% or $280,000.

Although two plants are seldom identical, to have comparable data it is desirable to survey plants that have approximately the same facilities as other plants of that type. The main variables affecting comparability of plants are capacity, extent of facilities in terms of vertical and horizontal integration, and whether it is an extension of an existing facility, or built alone. The questionnaire is designed to reveal these key variables for each plant.

Basis of Selection of Groups of Countries and Size of Sample

The numbers of plants were selected to reflect both the incidence of such plants in the developing world and the incidence of developing countries containing the plants. The sample size, however, is not necessarily directly proportional to the number of plants in the developing world nor to the number of developing countries containing the plants.

Several types of countries and geographical areas were selected in order to enable comparisons to be made among plants built under varying conditions. The proportion of the sample tc be surveyed in each type of country and in each geographical area was selected to ensure adequate representation of the various types of countries and geographical areas.

Procedural Suggestions

The following procedure is suggested for having the questionnaires completed:

1. UNIDO to select a number of countries of each of the four types shown in Exhibit 1 "Matrix for Sample Survey."

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Questionnaire

DELAYS IN IMPLEMENTING INDUSTRIAL PROJECTS

This questionnaire is part of a study being conducted by the United Nations Industrial Development Organization for the purpose of learning more about the causes and costs of delays in implementing industrial projects in developing countries.

The questionnaire has been sent to you for the project named below on the basis of a random selection and not because of any knowledge of delays in this project.

Project name Mesa Verde Cement Plant*

Country Latin America

Once filled in this questionnaire will be kept confidential. Specific project information will not be divulged. Only totals, averages and general observations will be published.

You are asked to complete this questionnaire as promptly as possible and return it to the United Nations Industrial Development Organization, Felderhause, Rathausplatz 2, 1010-A Vienna, Austria.

Thank you for your assistance.

*Name disguised.

Definition of Terms Used

"Implementation Phase"

The implementation phase is taken to be the work starting with detailed project planning and design, through construction and start up, to the time when the project is functioning in a satisfactory manner at, or near, its rated capacity. Thus, the decision to invest is assumed to have been made; the product, general process, scale, market, financing method, and general location have been decided upon. Government approval is assumed, at least in principle, and the investment funds, including foreign exchange, are assumed to be allocated and available. At this point implementation begins. It includes site selection, detailed design of the project to accommodate it to the site and to final engineering changes, bidding, contracting and procurement, construction, production start-up, and build-up to capacity.

"Delay"

Project delay is defined to mean falling behind schedule 25% or more of the planned time of achievement for any major activity of the project.

"Activity"

Activity is used in the precise meaning it has in bar chart scheduling or network scheduling. It is assumed that every large scale industrial project will have been scheduled with one of these methods. Figure 1 shows the meaning of activity as used in these scheduling methods. An activity is a logical subdivision of the project work that can be scheduled as an entity because it is distinctly different from that which precedes or follows it. Thus, the simple bar chart of Figure 1 shows Activity A of one week duration, Activity 3 of 8 weeks duration, and so forth. The simple network illustration shows activity 1, Purchase Pumps, of 5 months duration, activity 2, Install Pumps, of 7 months duration, and activity 3, Dewater Site, of 8 months duration.

"Major Activity"

A major activity is one that is scheduled in months, rather than days or weeks; that is, an activity whose planned duration is at least one month. Since this study covers only large industrial projects of over $1 million value, and implementation periods ranging from about one to eight years, it is neither necessary nor desirable to investigate delays in activities shorter than this.

Definition of Terms, Continued

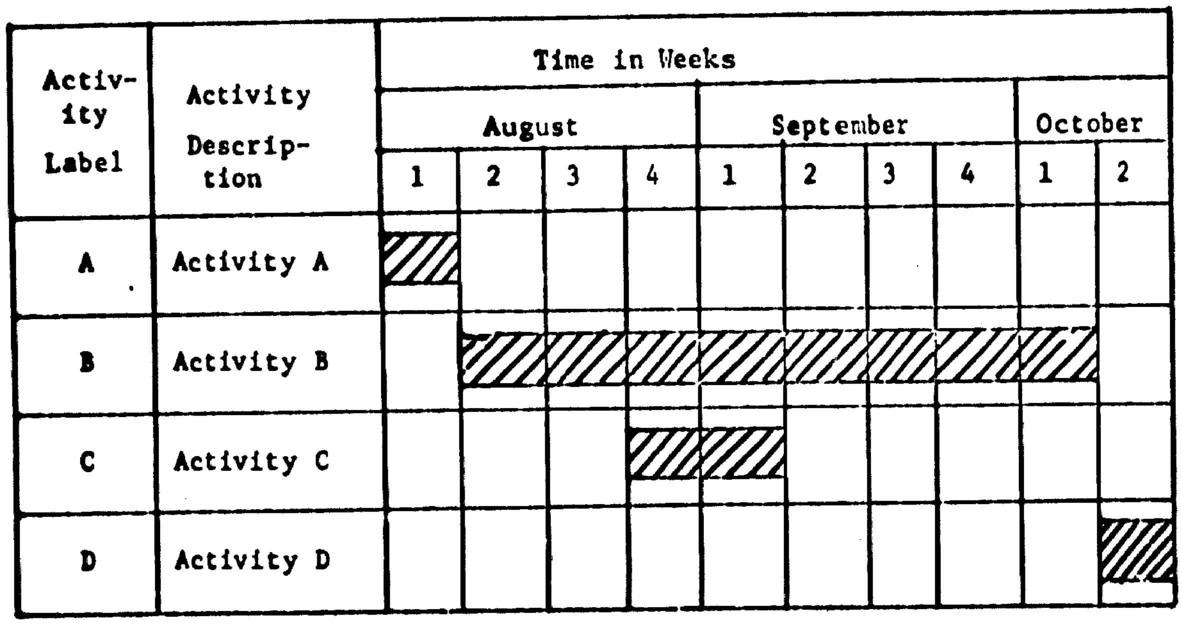
"Planned Time of Achievement"

The planned time of achievement is not necessarily measured by calendar dates; that is, day of the week or month, but by time duration, or number of days. Thus it is possible for a major activity to be completed later than the scheduled calendar date and still not, in itself, be a "delayed activity," in the meaning of the definition of this study. This could happen if a previous activity were delayed, thereby moving back the starting date of the referenced activity. Another way of putting this point is that delays are not necessarily cumulative. Each major activity is judged with respect to its planned elapsed time, as shown on the original schedule (or any revisions thereto made prior to the start of the referenced major activity) and not with respect to the calendar as such.

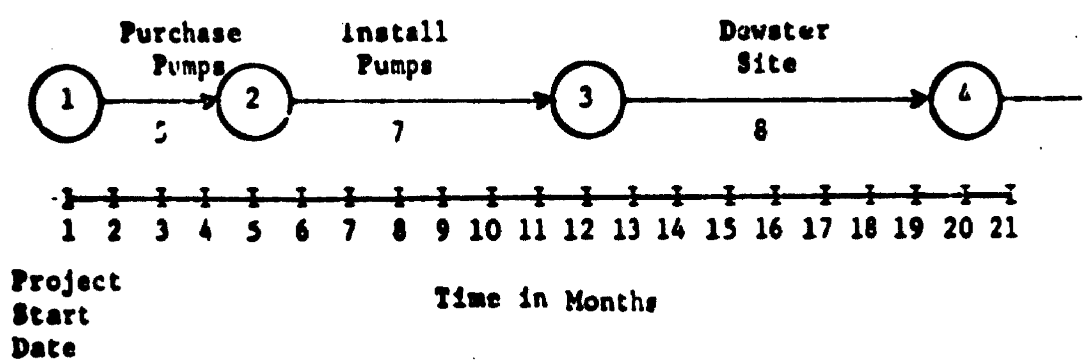
With this meaning, then, it is possible that an industrial project may suffer delay in one or more major activities and yet be completed by the scheduled date. The study is designed intentionally to include this possibility, for otherwise some important instances of delay may escape the survey. On the other hand, it is not possible for a total project to fall 25% or more behind schedule unless one or more of its major activities does so.

Figure 1 - Meaning of Activity

Simple Bar Chart



Simple Network



Questionnaire

Part I. General Project Information

1) Country Latin America. 2) Project name Mesa Verde Cement Plant

State or province -.

3) Project ownership

Public (Agency or Department) -.

Private (Corporation name) Mesa Verde, S.A..

Joint public-private -.

4) Implementing agency (ies) -.

5) Prime contractor(s) Owner; major equipment vendors provided erection supervisors for the equipment.

6) Type of contract (describe) Owner signed fixed price purchase orders for equipment.

7) Project description Cement plant using dry process to make Portland cement. Includes kiln, milling facilities, and electrical generating capacity.

8) Products to be produced Portland cement.

9) Planned annual capacity 130,000 tons.

10) Planned total employment at full capacity 100 (pro rata share of total at factory site).

11) Comments or explanations for any of the items of Part I (if necessary)

This plant was built at same site as an existing cement plant owned by same company.

In the next two parts (Parts II and III) of the questionnaire we divide the project implementation phase into four stages:

Stage 1. Detailed project planning (including site selection, detailed engineering design, and cost estimating).

Stage 2. Bidding, contracting and procurement.

Stage 3. Construction and start-up.

Stage 4. Build-up to capacity production.

We realize it is not always possible to divide project work into these four stages. If you find you cannot do so for this project, please change the stage definitions above and on the following pages to ones that you can use systematically for the rest of the questionnaire.

Note: If neither a bar chart nor a network schedule was made for the implementation phase of this project, do not attempt to fill out the activity listings on the following pages. Turn directly to page 21 at the end of Part III and provide what general information you can. Also please complete page 8.

Part II. Project Scheduling and Identification of Delays

1) Was a bar-chart (or Gantt chart) schedule prepared for the implementation phase of this project? Yes.

2) Was a network (or PERT or CPM) schedule prepared for the implementation phase of this project? No.

3) If neither a bar-chart nor a network schedule was prepared for the implementation phase of this project, describe the scheduling procedure that was used. ______

If it is available, we would appreciate receiving with this questionnaire a copy of the project schedule for the implementation phase as it stood at the beginning of that phase. It may be abbreviated, if desired, to include only "major activities" as defined in this questionnaire.

4) Who (what agency or group) prepared the schedule for the implementation phase of this project? Mesa Verde's engineering department.

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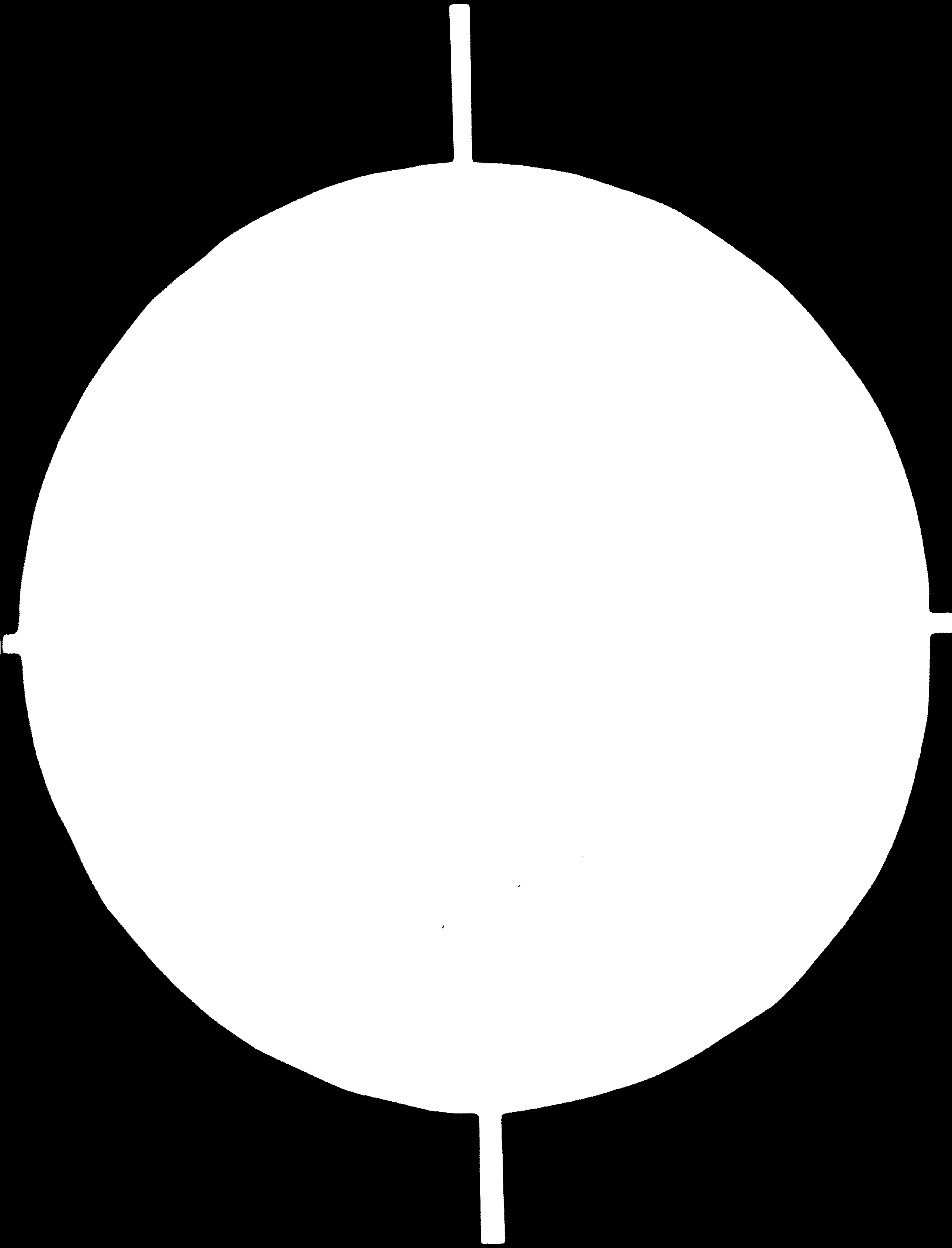

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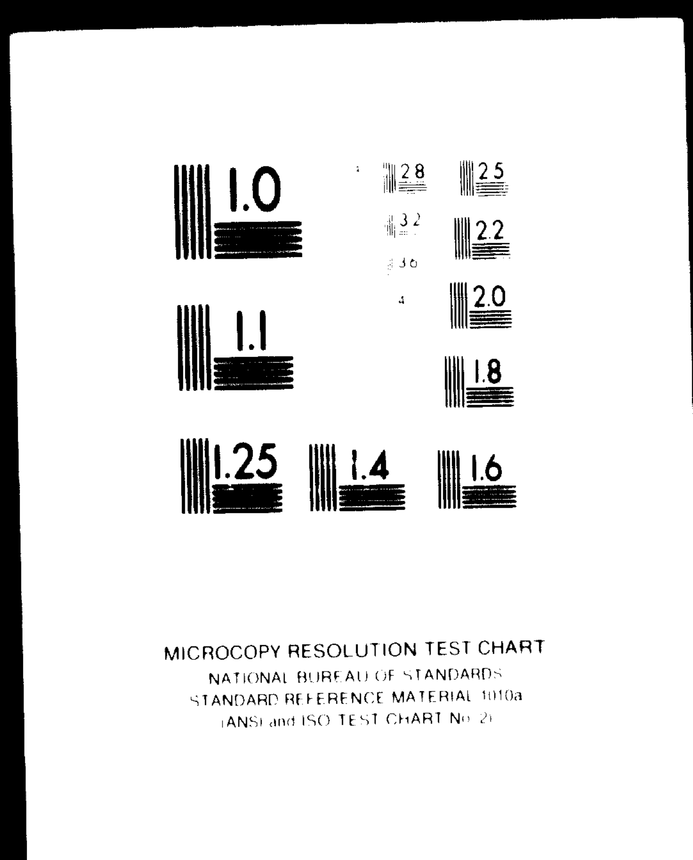
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Part II. Project Scheduling and Identification of Delays, Continued

12) List below the 5 delays that in your judgment made the greatest contribution to the total delay of the project. Put them in what you estimate to be the order of their magnitude of contribution to total delay and estimate their contribution in months.

Number	Delay	Contribution to Total Delay (Months)
1.	Build up to capacity operations	9
2.	Obtain and analyze bids; place equipment orders, have equipment delivered: Power plant	8
3.	Pour foundations	2
4.	Test drill for limestone reserves	1
5.	Write specifications for equipment	1

Part III. Reasons for Delays

(If no delays were identified in Part II, skip this part.)

Complete the following sections only for those major activities that were delayed, that is where 25% or a greater number appeared in column (6) of Part II of this questionnaire.

1) Stage 1 -- detailed project planning.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)
1	Write specifications for equipment	50	Approval of general manager was slow in being obtained.
6	Test drill for limestone reserves	100	Consulting engineer took longer than promised.

Questionnaire

Part III. Reasons for Delays, Continued

2) Stage 2 -- bidding, contracting and procurement.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)
	Obtain and analyze bids; place equipment orders & have equipment delivered		
7	Kiln	50	Change made in kiln design. Also, there was a delay in financing because of higher costs of kiln than originally estimated. This delayed placement of final order for kiln.
8	Mill	50	There was a delay in financing becaus of higher costs of mill than originally estimated. This delayed placement of final order for mill.
9	Power plant	80	Scope of project changed first to use an steam generator rather than 2 diesel generators, and second, to increase the electrical generation capacity.

Part III. Reasons for Delays, Continued

3) Stage 3 -- construction and start-up.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)
16	Pour foundations	67	A change in the design of the kiln delayed the kiln foundation drawings; this in turn delayed the construction of the foundations.

Questionnaire

Part III. Reasons for Delays, Continued

4) Stage 4 -- build up to capacity production.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specifi and detailed. Use extra sheets if necessary.)
30	Build-up to plant capacity	300	Trouble was experienced with the mill. Finally, a new part had to be obtained from Europe. This delay in turn affected the sales commitment which could be made for plant output. Thus, even after the plant was capable of producing at design capacity, it took some months to obtain the necessary sales to operate the plant at the nominal capacity.

Part III. Reasons for Delays, Continued

5) If no formal scheduling procedure was used for this project, please give below as much information as you have about delays, their time and causes.

Questionnaire

Part IV. Project Cost Information

1) Total project investment (actual, if different from planned)*

$4.0 million

Major cost elements:

Land already available

Land preparation $10,000

Non-residential buildings and plant $50,000

Capital equipment $3,330,000

Housing -

Roads, railroads & access $10,000

Water already available

Power $600,000

Fees and services -

Other -

2) Foreign currency component of project (actual) $2,400,000

3) Local currency component of project (actual) 1,600,000

4) Source(s) of foreign currency (or lending agency) suppliers credit plus an international lending organization

5) Source(s) of local currency (or lending agency) Owner

6) Terms of foreign currency loan (if any) Suppliers credits for $800,000 payable in equal quarterly installments over a 3 1/2 year period; international lending organization $1,600,000 for 10 years at 7 1/2%.

7) Terms of local currency loan (if any) None

---

*Includes all cost elements such as housing colony, land, road improvements, owned power supply, and so forth, that are required for the successful completion and operation of the project.

8) On what date was the foreign capital component of the investment for this project allocated? May 1964 . Was it unavailable for other projects thereafter? No .

9) Was all or part of the foreign exchange component of the investment committed on the above date? Please explain No .

10) Additional comments or information that respondent feels may be helpful to UNIDO in this study.

Because the equipment arrived later than had been scheduled, a considerable amount of overtime was worked in order to ensure that the installation of the equipment was done promptly.

11) Name of person(s) filling out this questionnaire

Ing. Pablo Blanco

12) Title and affiliation Chief Engineer, Mesa Verde, S.A.

13) Mailing address Apatado 123, La Ciudad Grande Latin America

14) Date October 15, 1968.

Case #3 - Eastern Plastics Petrochemical Plant*

The Project

The Eastern Plastics petrochemical plant is located in an Asian Country. This plant manufactures polyvinyl chloride from vinyl chloride monomer. Housing was not included as part of this project. Its capacity is 20,000 tons per year.

The plant is owned by the Eastern Plastics Company, which was formed as a joint venture between foreign and local capital. The funds for the project were not set aside but were provided by the parent companies to the Eastern Plastics Company as they were needed during the course of the project.

The engineering design work for the project was carried out by Transnational Engineering Corporation.* This company was selected for this job on the basis of its international reputation. The contract was on the basis of cost plus a fixed fee. Transnational was responsible for the selection of the process design to be purchased, completion of the process design not included in the process design package, procurement of all equipment, detailed engineering work, and construction. Equipment was purchased in both the U.S. and Europe; some items of material were purchased locally.

Delays in Implementation

The government approved the project in April 1962. Prior to this time the company had been negotiating with several engineering companies. The contract for the engineering and construction work

---

*Name disguised.

Part II. Project Scheduling and Identification of Delays, Continued

5) On what dates did the following events actually occur?

a) Implementation phase of project actually started* May 1964.

b) Foreign exchange portion of funds committed by government -.

c) Final approval of project by government January 1964.

d) Ground breaking March 1965.

e) Start of production (plant "on-line") December 1966.

f) Capacity production achieved (implementation phase ended) December 1967.

*See definition of "implementation phase."

6) On what date was the project originally scheduled to start production (go on-line)? December 1965.

7) On what date was the project originally scheduled to reach full capacity production? March 1966.

was placed with Transnational on August 1, 1962. This is the date considered to be the start of the implementation phase. The project was scheduled for completion on March 1, 1965, and was scheduled to reach design output on April 1, 1965. The plant started production in September 1965 or a delay in completion of 6 months. It reached design output on February 2, 1966, some 10 months after the schedule time and some 5 months after the completion of construction. The most important delay occurred during the procurement of the equipment. First, the decision was made to purchase all of the equipment of one type from one vendor in order to save money on the purchase of the equipment. This meant that the delivery of the equipment was spread over a long period of time rather than concentrated in a short period of time as had originally been scheduled. Second, there was a delay in approving the vendors' drawings for the reactor because this was a complex pressure vessel and negotiation with the vendor took longer than expected.

There was an initial delay in the project of about 2 months in purchasing a process design package because of the negotiations that took place with the firm providing this design.

The manager of Eastern Plastics made arrangements to import product when he saw that the plant completion was running late. He mis-estimated the amount of product to be imported, and, therefore, when the plant started operation, he had an excessive amount of material on hand or on order. This resulted in the delay in bringing the plant up to full design capacity.

was already on order and was being manufactured. Thus, some equipment was delivered a number of months before the generating plant was delivered. A part was held up pending financing approval.

A second major source of delay in the planning and procurement stage was the time taken to analyze the kiln and mill bids and renegotiate the loan with the international lending organization. This equipment cost more than originally estimated; hence, this necessitated an increase in the suppliers' credit and further negotiation with the international lending organization.

Another source of delay was in the test drilling of the limestone reserves. This test drilling was required before the international lending organization would extend the financing.

Only minor delays were experienced during the construction phase of the project because the construction crews worked overtime in an attempt to make up the time lost during the early phases of the project.

<u>The Cost of Delays</u>

Not all of the delays encountered contributed to the cumulative delay of the project because some of these delays were not on the "critical path." In other words, some delays were more or less independent in time from other activities, or they did not hold up the accomplishment of other activities critical to the completion of the project. For the Mesa Verde Cement Plant this cumulative delay in project completion was from December 1965 to December 1966, or 12 months. For the cost calculations, refer to Exhibit 7 under Part IV, Analysis of Completed Questionnaires. Since neither the foreign exchange component nor the local exchange component of the investment was committed at the start of the project, the investment was made on a pay-as-you-go basis. If we use a 15% discount rate, which is a reasonable one for an industrial project such as this, the reduction in net worth due to delayed completion of the project is about 3% or $120,000. Next, to determine what the cost of the one-year period in reaching full capacity production was, we look under "time to reach full capacity production" and this shows a reduction in net worth of the project by 10%; hence, this tells us that this lag reduced the net worth of the project by $400,000. These two factors combined reduced the net worth of the project by 13% or $520,000.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Questionnaire

DELAYS IN IMPLEMENTING INDUSTRIAL PROJECTS

This questionnaire is part of a study being conducted by the United Nations Industrial Development Organization for the purpose of learning more about the causes and costs of delays in implementing industrial projects in developing countries.

The questionnaire has been sent to you for the project named below on the basis of a random selection and not because of any knowledge of delays in this project.

Project name Eastern Plastics Petrochemical Plant*

Country Asian

Once filled in this questionnaire will be kept confidential. Specific project information will not be divulged. Only totals, averages and general observations will be published.

You are asked to complete this questionnaire as promptly as possible and return it to the United Nations Industrial Development Organization, Felderhause, Rathausplatz 2, 1010-A Vienna, Austria.

Thank you for your assistance.

*Name disguised.

Definition of Terms Used

"Implementation Phase"

The implementation phase is taken to be the work starting with detailed project planning and design, through construction and start up, to the time when the project is functioning in a satisfactory manner at, or near, its rated capacity. Thus, the decision to invest is assumed to have been made; the product, general process, scale, market, financing method, and general location have been decided upon. Government approval is assumed, at least in principle, and the investment funds, including foreign exchange, are assumed to be allocated and available. At this point implementation begins. It includes site selection, detailed design of the project to accommodate it to the site and to final engineering changes, bidding, contracting and procurement, construction, production start-up, and build-up to capacity.

"Delay"

Project delay is defined to mean falling behind schedule 25% or more of the planned time of achievement for any major activity of the project.

"Activity"

Activity is used in the precise meaning it has in bar chart scheduling or network scheduling. It is assumed that every large scale industrial project will have been scheduled with one of these methods. Figure 1 shows the meaning of activity as used in these scheduling methods. An activity is a logical subdivision of the project work that can be scheduled as an entity because it is distinctly different from that which precedes or follows it. Thus, the simple bar chart of Figure 1 shows Activity A of one week duration, Activity B of 8 weeks duration, and so forth. The simple network illustration shows activity 1, Purchase Pumps, of 5 months duration, activity 2, Install Pumps, of 7 months duration, and activity 3, Dewater Site, of 8 months duration.

"Major Activity"

A major activity is one that is scheduled in months, rather than days or weeks; that is, an activity whose planned duration is at least one month. Since this study covers only large industrial projects of over $1 million value, and implementation periods ranging from about one to eight years, it is neither necessary nor desirable to investigate delays in activities shorter than this.

Definition of Terms, Continued

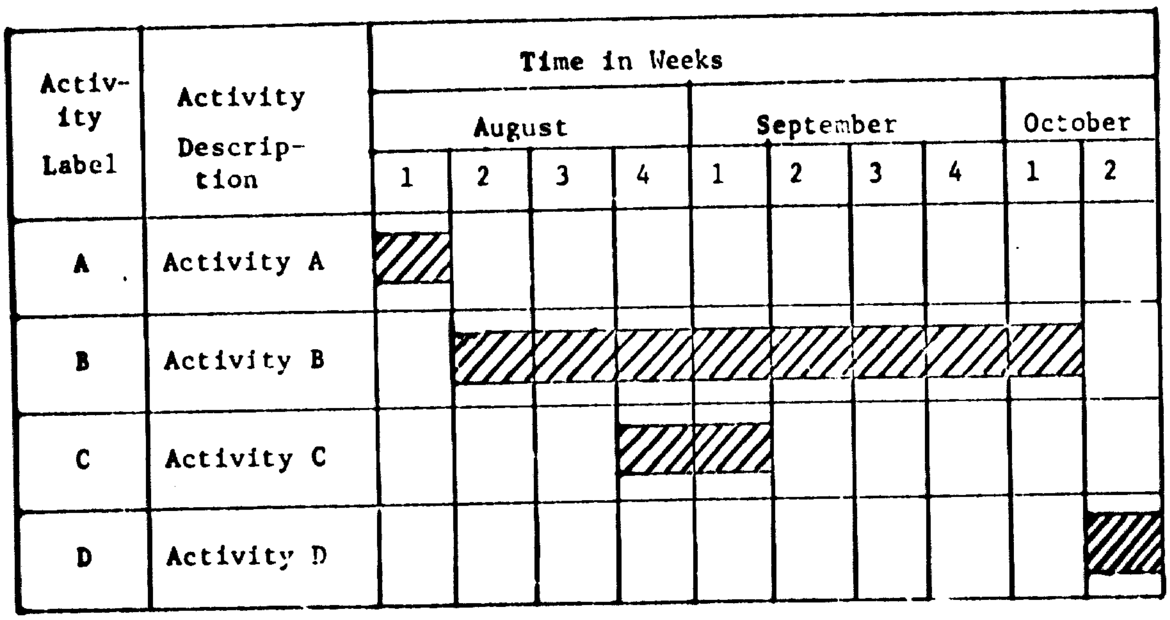
"Planned Time of Achievement"

The planned time of achievement is not necessarily measured by calendar dates; that is, day of the week or month, but by time duration, or number of days. Thus it is possible for a major activity to be completed later than the scheduled calendar date and still not, in itself, be a "delayed activity," in the meaning of the definition of this study. This could happen if a previous activity were delayed, thereby moving back the starting date of the referenced activity. Another way of putting this point is that delays are not necessarily cumulative. Each major activity is judged with respect to its planned elapsed time, as shown on the original schedule (or any revisions thereto made prior to the start of the referenced major activity) and not with respect to the calendar as such.

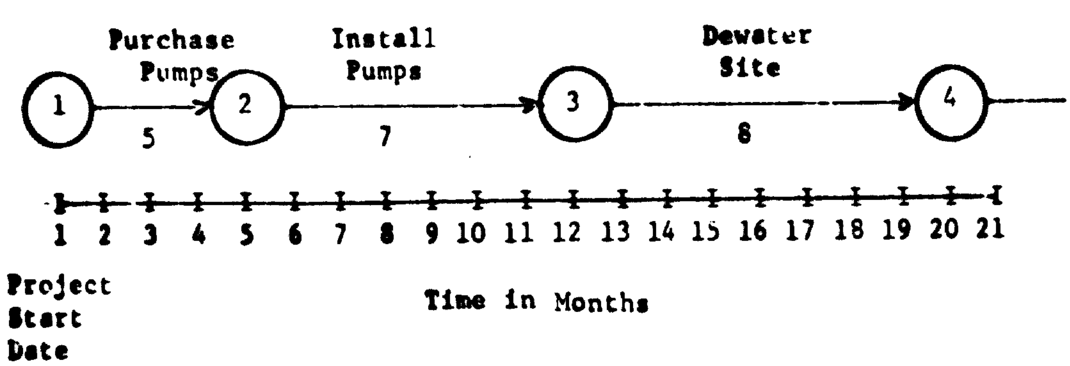
With this meaning, then, it is possible that an industrial project may suffer delay in one or more major activities and yet be completed by the scheduled date. The study is designed intentionally to include this possibility, for otherwise some important instances of delay may escape the survey. On the other hand, it is not possible for a total project to fall 25% or more behind schedule unless one or more of its major activities does so.

Figure 1 - Meaning of Activity

Simple Bar Chart



Simple Network



Questionnaire

Part 1. General Project Information

1) Country Asian. 2) Project name Eastern Plastics Petrochemical Plant

State or province - .

3) Project ownership

Public (Agency or Department) - .

Private (Corporation name) Eastern Plastics Company.

Joint public-private - .

4) Implementing agency (ies) - .

5) Prime contractor(s) Transnational Engineering Company.

6) Type of contract (describe) Cost plus fixed fee.

7) Project description Petrochemical plant to produce polyvinyl chloride from vinyl chloride monomer.

8) Products to be produced Polyvinyl chloride.

9) Planned annual capacity 20,000 tons.

10) Planned total employment at full capacity 130 men.

11) Comments or explanations for any of the items of Part I (if necessary)

Site had already been selected and land already owned by firm.

In the next two parts (Parts II and III) of the questionnaire we divide the project implementation phase into four stages:

Stage 1. Detailed project planning (including site selection, detailed engineering design, and cost estimating).

Stage 2. Bidding, contracting and procurement.

Stage 3. Construction and start-up.

Stage 4. Build-up to capacity production.

We realize it is not always possible to divide project work into these four stages. If you find you cannot do so for this project, please change the stage definitions above and on the following pages to ones that you can use systematically for the rest of the questionnaire.

Note: If neither a bar chart nor a network schedule was made for the implementation phase of this project, do not attempt to fill out the activity listings on the following pages. Turn directly to page 21 at the end of Part III and provide what general information you can. Also, please complete page 8.

Part II. Project Scheduling and Identification of Delays

1) Was a bar-chart (or Gantt chart) schedule prepared for the implementation phase of this project? ___Yes___.

2) Was a network (or PERT or CPM) schedule prepared for the implementation phase of this project? ___No___.

3) If neither a bar-chart nor a network schedule was prepared for the implementation phase of this project, describe the scheduling procedure that was used. ______________________________

____

____

____

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______________________________.

If it is available, we would appreciate receiving with this questionnaire a copy of the project schedule for the implementation phase as it stood at the beginning of that phase. It may be abbreviated, if desired, to include only "major activities" as defined in this questionnaire.

4) Who (what agency or group) prepared the schedule for the implementation phase of this project? ___Transnational Engineering Company___

______________________________.

Part II. Project Scheduling and Identification of Delays, Continued

8) Referring to the project schedule for the implementation phase, list below the "major activities" (refer to definition) of Stage 1 -- detailed project planning. Also list the planned or scheduled time duration for each major activity, in months, and the actual time duration experienced.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
(1)	Write specifications for equipment	2	3	1	50
2	Design buildings	5	6	1	20
3	Prepared engineering drawings for equipment foundations	5	6	1	20
4	Prepare electrical drawings	5	4	-	-
5	Prepare site drawings	5	5	-	-
(6)	Test drill for limestone reserves	1	2	1	100

Part II. Project Scheduling and Identification of Delays, Continued

5) On what dates did the following events actually occur?

a) Implementation phase of project actually started* August 2, 1962.

b) Foreign exchange portion of funds committed by government -

c) Final approval of project by government April 26, 1962.

d) Ground breaking March 15, 1964.

e) Start of production (plant "on-line") September 3, 1965.

f) Capacity production achieved (implementation phase ended) February 2, 1966.

*See definition of "implementation phase."

6) On what date was the project originally scheduled to start production (go on-line)? March 1, 1965.

7) On what date was the project originally shceduled to reach full capacity production? April 1, 1965.

Part II. Project Scheduling and Identification of Delays, Continued

8) Referring to the project schedule for the implementation phase, list below the "major activities" (refer to definition) of Stage 1 -- detailed project planning. Also list the planned or scheduled time duration for each major activity, in months, and the actual time duration experienced.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
(1)	Purchase Process Design Package	4	6	2	50
2	Complete Process Design	2	2	-	-
	Engineering Design:				
3	Towers	3	3	-	-
4	Reactors	2	2	-	-
5	Drums	2	2	-	-
6	Tanks	2	2	-	-
7	Exchangers	2	2	-	-
8	Compressors	2	2	-	-
(9)	Pumps & Drivers	1	2	1	100
(10)	Other Equipment	1	2	1	100
(11)	Foundations	2	3	1	50
(12)	Buildings	2	3	1	50
13	Yard Structures	3	3	-	-
14	Underground Piping	7	8	1	14
15	Above Ground Piping	7	8	1	14
16	Instruments	9	10	1	11
(17)	Electrical	6	8	2	33
18	Insulating & Fireproofing	1	1	-	-

Part II, Continued

8) Stage 1 -- detailed project planning, continued

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Part II. Project Scheduling and Identification of Delays, Continued

9) List below the major activities of Stage 2 -- bidding, contracting and procurement.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
	Obtain and analyze bids and place equipment orders for:				
19	Towers	4	4	-	-
(20)	Reactors	3	4	1	33
21	Drums	4	4	-	-
22	Tanks	4	4	-	-
23	Exchangers	4	4	-	-
24	Compressors	4	4	-	-
25	Pumps & Drivers	4	4	-	-
26	Other Equipment	4	4	-	-
	Purchase materials:				
27	Piping	9	8	-	-
28	Instruments	10	11	1	10
29	Electrical	9	10	1	11
30	Other	10	10	-	-
	Approve vendors' drawings and fabricate equipment and deliver to job site;				
(31)	Towers	11	18	7	64
(32)	Reactors	11	19	8	73
(33)	Drums	11	15	4	36
(34)	Tanks	11	14	3	27
(35)	Exchangers	10	18	8	80

Questionnaire

Part II, Continued

9) Stage 2 -- bidding, contracting and procurement, continued.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
36	Compressors	12	14	2	17
37	Pumps & Drivers	11	14	3	27
38	Other Equipment	12	14	2	17

Part II. Project Scheduling and Identification of Delays, Continued

10) List below the major activities of Stage 3 -- construction and start up.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
39	Yard Work	9	10	1	11
40	Foundations	6	7	1	17
41	Buildings	5	5	-	-
42	Yard Structures	6	7	1	17
43	Underground Piping	3	3	-	-
44	Above Ground Piping	6	9	3	50
45	Instruments	4	6	2	50
46	Electrical	4	6	2	50
47	Insulation	4	3	-	-
48	Fireproofing	1	1	-	-
49	Painting	4	4	-	-
50	Exchangers	4	7	3	75
51	Reactors	2	2	-	-
52	Other Pressure Vessels	4	8	4	100
53	Pumps & Drivers	4	7	3	75
54	Compressors	2	2	-	-
55	Other Equipment	4	4	-	-
56	Startup Plant	1	2	1	100

Part II, Continued

10) Stage 3 -- construction and start-up, continued.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Part II. Project Scheduling and Identification of Delays, Continued

11) List below the major activities of stage 4 -- build-up to capacity production.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
(58)	Bring plant to design capacity	1	5	4	400

"Delay" has been defined earlier to mean "falling behind schedule 25% or more of the planned time of achievement."

Wherever a number of 25% or larger appears in column (6) of the above listings for any of the four stages, circle the corresponding activity number. These are the activities we will consider to have been delayed. In the following part of this questionnaire we seek the reasons for these delays.

Part II. Project Scheduling and Identification of Delays, Continued

12) List below the 5 delays that in your judgment made the greatest contribution to the total delay of the project. Put them in what you estimate to be the order of their magnitude of contribution to total delay and estimate their contribution in months.

Number	Delay	Contribution to Total Delay (Months)
1.	Bring plant up to design capacity	4
2.	Approve vendors' drawings and fabricate reactors and deliver to job site	3
3.	Process design	1
4.	Obtain and analyze bids and place equipment order for reactors	1
5.	Startup plant	1

Part III. Reasons for Delays

(If no delays were identified in Part II, skip this part.)

Complete the following sections only for those major activities that were delayed, that is where 25% or a greater number appeared in column (6) of Part II of this questionnaire.

1) Stage 1 -- detailed project planning.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)
1	Purchase Process Design Package	50	The agreement to purchase a package process from a manufacturer took more time to negotiate than expected, primarily because of the negotiations over exactly how the plant was supposed to perform in order to meet the guarantee.
	Engineering Design:		
9	Pumps & Drivers	100	There seemed to be no special causes for the delays in this engineering design work other than the fact that probably an inadequate amount of time was allowed for the engineering design work connected with the pumps and drivers.
10	Other Equipment	100	
11	Foundations	50	The engineering contractor underestimated the amount of man-hours required to design the foundations and to do the civil engineering structural design. As a result, he did not allocate sufficient manpower to the job; thus the duration was longer than expected.
12	Buildings	50	
17	Electrical	33	This work was delayed because of the delay in designing the foundations and the building.

Part II, Continued

8) Stage 1 -- detailed project planning, continued

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Questionnaire

Part III. Reasons for Delays, Continued

2) Stage 2 -- bidding, contracting and procurement.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)
	Obtain and analyze bids and place equipment orders for:		
20	Reactors	33	This is a complex vessel and negotiations with the vendor took longer than expected.
	Approve vendors' drawings and fabricate equipment and deliver to job site:		
31	Towers	64	This equipment was purchased from one vendor for each type of equipment. This overloaded the vendors' shops and caused the deliveries of individual equipment to be spread out over longer periods of time than had been planned.
32	Reactors	73	
33	Drums	36	
34	Tanks	27	
35	Exchangers	80	
37	Pumps & Drivers	27	

Questionnaire

Part III. Reasons for Delays, Continued

3) Stage 3 -- construction and start-up.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)
44	Above Ground Piping	50	The delay in delivery of the major equipment delayed these activities.
45	Instruments	50	
46	Electrical	50	
50	Exchangers	75	
52	Other Pressure Vessels	100	
53	Pumps & Drivers	75	
56	Startup Plant	100	Inadequate time had been scheduled for the start-up of the plant because the time allowed was that normally taken in a developed country. In a developing country the operators required more training.

Part III. Reasons for Delays, Continued

4) Stage 4 -- build up to capacity production.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specifi[c] and detailed. Use extra sheets if necessary.)
58	Bring plant up to design capacity	400	There was an inordinately long delay in bringing the plant up to design capacity because the owner of the plant had made previous arrangements to import material when he saw that the plant construction was running behind. Therefore, he delayed in bringing the plant up to design capacity.

Part III. Reasons for Delays, Continued

5) If no formal scheduling procedure was used for this project, please give below as much information as you have about delays, their time and causes.

Questionnaire

Part IV. Project Cost Information

1) Total project investment (actual, if different from planned)*

$3,317,000

Major cost elements:

Land -

Land preparation $17,000

Non-residential buildings and plant $216,000

Capital equipment $2,670,000 (including installation)

Housing -

Roads, railroads & access $14,000

Water Already Available

Power Already Available

Fees and services $400,000

Other -

2) Foreign currency component of project (actual) $2,316,000

3) Local currency component of project (actual) $1,001,000

4) Source(s) of foreign currency (or lending agency) Foreign Parent

5) Source(s) of local currency (or lending agency) Local Parent

6) Terms of foreign currency loan (if any) -

7) Terms of local currency loan (if any) -

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*Includes all cost elements such as housing colony, land, road improvements, owned power supply, and so forth, that are required for the successful completion and operation of the project.

8) On what date was the foreign capital component of the investment for this project allocated? ___-___. Was it unavailable for other projects thereafter? ___No___.

9) Was all or part of the foreign exchange component of the investment committed on the above date? Please explain ___No___

____.

10) Additional comments or information that respondent feels may be helpful to UNIDO in this study.

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Questionnaire

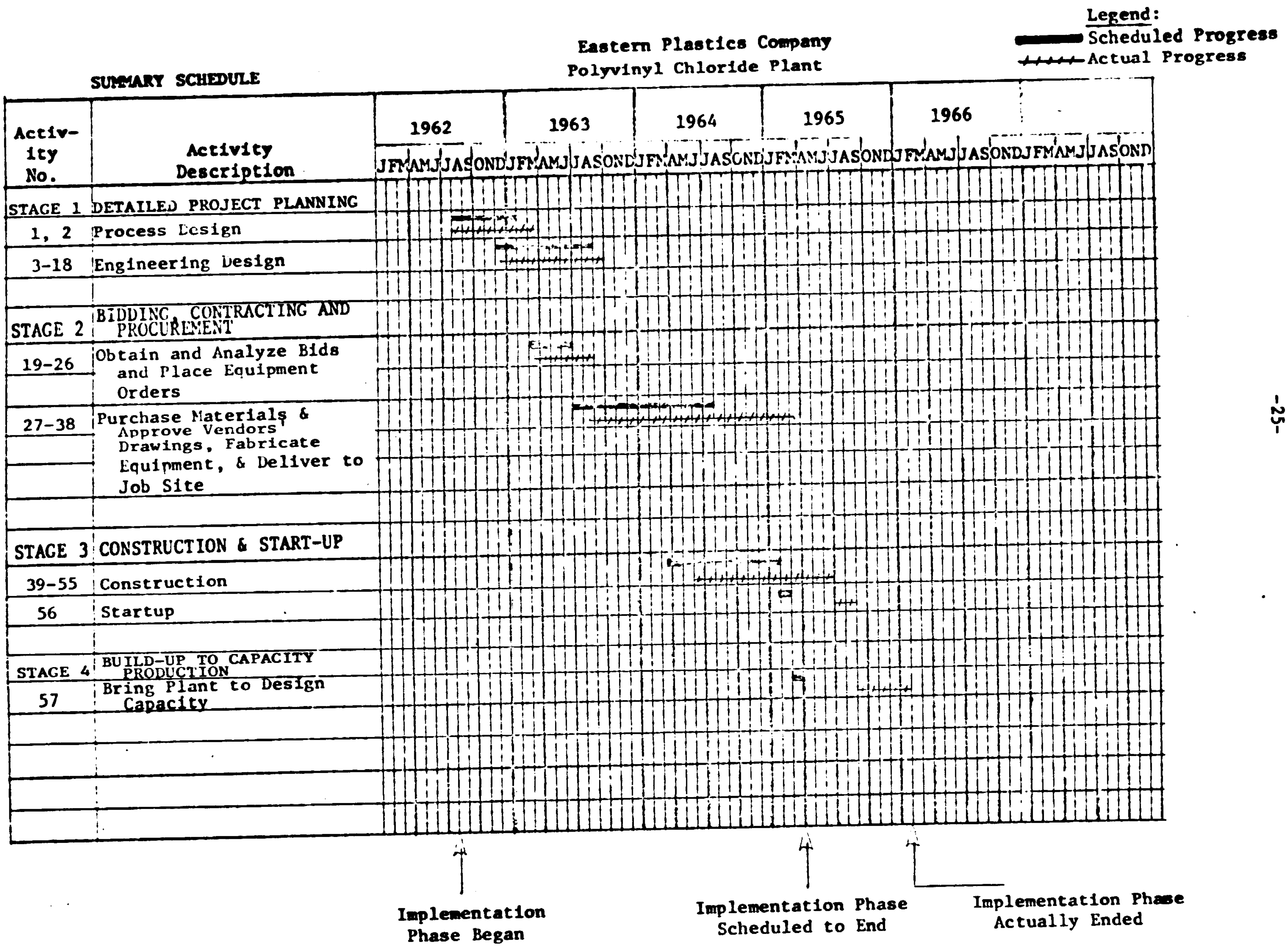
11) Name of person(s) filling out this questionnaire ____________

James West

12) Title and affiliation Project Manager, Transnational Engineering Company

13) Mailing address 11 Stella Road, Belmont, Massachusetts

14) Date October 12, 1968.


Eastern Plastics Company
Polyvinyl Chloride Plant
SUMMARY SCHEDULE
Legend:
Scheduled Progress
Actual Progress
Activity No.
Activity Description
1962
1963
1964
1965
1966
JFMAMJJASOND
STAGE 1 DETAILED PROJECT PLANNING
1, 2 Process Design
3-18 Engineering Design
STAGE 2 BIDDING, CONTRACTING AND PROCUREMENT
19-26 Obtain and Analyze Bids and Place Equipment Orders
27-38 Purchase Materials & Approve Vendors' Drawings, Fabricate Equipment, & Deliver to Job Site
STAGE 3 CONSTRUCTION & START-UP
39-55 Construction
56 Startup
STAGE 4 BUILD-UP TO CAPACITY PRODUCTION
57 Bring Plant to Design Capacity
Implementation Phase Began
Implementation Phase Scheduled to End
Implementation Phase Actually Ended

Case 4: Fali Olefins Petrochemicals Plant*

The Project

The Fali Olefins Plant is located in an Asian country. It consists of a 50,000 ton per year ethylene plant and includes facilities for recovering the co-product propylene. Naphtha is used as a raw material. A housing colony was not included as part of this project.

The Fali Olefins Company is the sole owner of the ethylene plant. This company is a subsidiary of a major oil company; the Olefins plant is located adjacent to an oil refinery owned by the major oil company. The total project investment was $9,000,000, and it was financed by the parent company of Fali Olefins.

Fali Olefins contracted with Transnational Engineering Corporations for the process design, engineering design, equipment procurement, and construction of the plant. The contract was a cost plus fixed fee. The process design was done in the United States and the detailed engineering design was done in the London office of Transnational Engineering. The bulk of the major equipment was purchased in Europe.

Delays in Implementation

The implementation phase of the project started in July 1963; it originally was planned to bring the plant on-line on June 1, 1966, or a scheduled construction period of 35 months. It originally was planned that the plant would take 6 months, or until December 1, 1966, to reach full production capacity. In actual fact, the start of on-line

*Disguised name.

production was April 1967, some ten months behind the original schedule. Full capacity production was reached on October 1967, some ten months after the original scheduled date and some six months after the project came on stream; this six months lag was as originally scheduled.

This falling behind by 10 months in the time of completing the project is attributable to a variety of delays in the procurement and construction phases. The major delay was caused by the decision to purchase all similar types of equipment from a single equipment vendor. This decision was made because a lower price could be obtained in the purchase of the equipment. However, this decision meant that one equipment vendor had to supply many items of equipment. Since the vendors' shops were not able to make all of the equipment at one time, the delivery was spread out over a number of months. This did not delay the start of the installation of the equipment because the equipment delivered early could be installed. However, the completion of the installation of 100% of the equipment was delayed until the final pieces of equipment were delivered. By being ready to install the last pieces of the equipment at the moment they arrived, the potential 12-month delay (this was the delay in completion of the final piece of equipment delivered) was kept to a delay of only 5 months on the over-all project.

Another source of delay was in the relationship between the engineering contractor and the plant owner. The original schedule was made on the basis that the owner'a engineering department would not become involved with either the process or the mechanical design. However, the owner's engineers became involved and changed some basis process conditions after the process design had started. This resulted in a

Part II. Project Scheduling and Identification of Delays, Continued

9) List below the major activities of Stage 2 -- bidding, contracting and procurement.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
	Obtain and analyze bids; place equipment orders and have equipment delivered:				
7	Kiln	10	15	5	50
8	Mill	10	15	5	50
9	Power plant	10	18	8	80
10	Electrical equipment	10	11	1	10
11	Heat exchange	10	10	-	-
12	Homogenizer and cooler	10	12	2	20
13	Other equipment	10	11	1	10

delay in completing the process design which then delayed the completion of the rest of the project work.

A minor delay occurred during the placing of the orders for the equipment, because of the discussions that had to take place between the plant owner and the engineering contractor before a decision could be made to place all of the orders with one vendor. Finally, there was a minor delay in the construction at the job site because this was the first plant that this engineering contractor had built in this country. Therefore, the contractor did not have accurate data on the productivity of local workers; hence, it was difficult to have the right amount of manpower on hand for each job. This resulted in some delays during the construction period.

The Cost of Delays

Not all of the delays encountered contributed to the cumulative delay of the project because some were not on the "critical path." That is, either they were independent in time from other activities or they did not hold up the accomplishment of other activities critical to the completion of the project.

The effective delay in terms of cost for the Fali Olefins Plant was from June 1966 to April 1967, or a period of 10 months. Referring to Exhibit 8 under Part IV, Analysis of Completed Questionnaires, we can estimate the cost of this delay. Since the project monies were spent as the project was constructed, the investment can be considered to have been made on a pay-as-you-go basis. If we use a 15% discount rate, which is reasonable for an industrial project such as a petrochemicals plant, we can look under "Delay in Project Completion" under

under the 15% discount rate heading, and using column 2 can interpolate between the 0.5 and the 1.0 year case. For a delay of 10 months, we can estimate that the reduction in net worth of the project is approximately 4%. This 4% reduction represents a loss in present value of the plant of $360,000.

Using this same table, we can determine that the 6 months' lag in reaching capacity production after the plant was on-line reduced the net present value of the plant by 7%. (Note that this is a reduction in net present value of the plant because of the lag in reaching full capacity after the plant was capable of producing at full capacity. This lag is independent of the time originally scheduled to reach full capacity production after the plant was completed, because in this case the original schedule did allow for this 6-months' period.) This reduction of 7% in present value represents a loss of $630,000.

Thus, the combination of the delay in project completion and the lag in the plant's reaching full capacity production represents a total reduction in present value of the project of 11% or $990,000.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Questionnaire

DELAYS IN IMPLEMENTING INDUSTRIAL PROJECTS

This questionnaire is part of a study being conducted by the United Nations Industrial Development Organization for the purpose of learning more about the causes and costs of delays in implementing industrial projects in developing countries.

The questionnaire has been sent to you for the project named below on the basis of a random selection and not because of any knowledge of delays in this project.

Project name Fali Olefins Company*

Country Asian

Once filled in this questionnaire will be kept confidential. Specific project information will not be divulged. Only totals, averages and general observations will be published.

You are asked to complete this questionnaire as promptly as possible and return it to the United Nations Industrial Development Organization, Felderhause, Rathausplatz 2, 1010-A Vienna, Austria.

Thank you for your assistance.

---

*Disguised name.

Definition of Terms Used

"Implementation Phase"

The implementation phase is taken to be the work starting with detailed project planning and design, through construction and start up, to the time when the project is functioning in a satisfactory manner at, or near, its rated capacity. Thus, the decision to invest is assumed to have been made; the product, general process, scale, market, financing method, and general location have been decided upon. Government approval is assumed, at least in principle, and the investment funds, including foreign exchange, are assumed to be allocated and available. At this point implementation begins. It includes site selection, detailed design of the project to accommodate it to the site and to final engineering changes, bidding, contracting and procurement, construction, production start-up, and build-up to capacity.

"Delay"

Project delay is defined to mean falling behind schedule 25% or more of the planned time of achievement for any major activity of the project.

"Activity"

Activity is used in the precise meaning it has in bar chart scheduling or network scheduling. It is assumed that every large scale industrial project will have been scheduled with one of these methods. Figure 1 shows the meaning of activity as used in these scheduling methods. An activity is a logical subdivision of the project work that can be scheduled as an entity because it is distinctly different from that which precedes or follows it. Thus, the simple bar chart of Figure 1 shows Activity A of one week duration, Activity B of 8 weeks duration, and so forth. The simple network illustration shows activity 1, Purchase Pumps, of 5 months duration, activity 2, Install Pumps, of 7 months duration, and activity 3, Dewater Site, of 8 months duration.

"Major Activity"

A major activity is one that is scheduled in months, rather than days or weeks; that is, an activity whose planned duration is at least one month. Since this study covers only large industrial projects of over $1 million value, and implementation periods ranging from about one to eight years, it is neither necessary nor desirable to investigate delays in activities shorter than this.

Definition of Terms, Continued

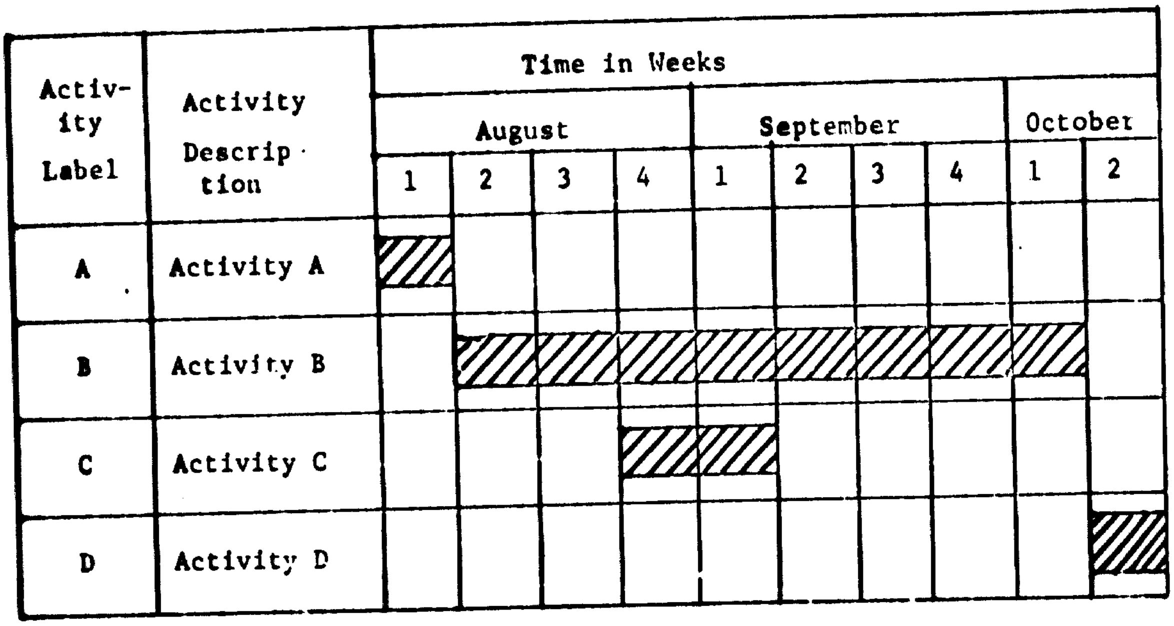
"Planned Time of Achievement"

The planned time of achievement is not necessarily measured by calendar dates; that is, day of the week or month, but by time duration, or number of days. Thus it is possible for a major activity to be completed later than the scheduled calendar date and still not, in itself, be a "delayed activity," in the meaning of the definition of this study. This could happen if a previous activity were delayed, thereby moving back the starting date of the referenced activity. Another way of putting this point is that delays are not necessarily cumulative. Each major activity is judged with respect to its planned elapsed time, as shown on the original schedule (or any revisions thereto made prior to the start of the referenced major activity) and not with respect to the calendar as such.

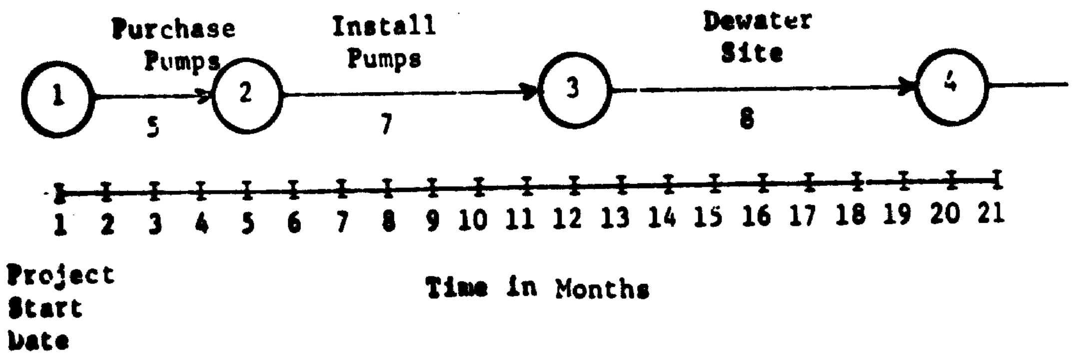
With this meaning, then, it is possible that an industrial project may suffer delay in one or more major activities and yet be completed by the scheduled date. The study is designed intentionally to include this possibility, for otherwise some important instances of delay may escape the survey. On the other hand, it is not possible for a total project to fall 25% or more behind schedule unless one or more of its major activities does so.

Figure 1 - Meaning of Activity

Simple Bar Chart



Simple Network



Questionnaire

Part I. General Project Information

1) Country __Asian______. 2) Project name Fali Olefins Company

State or province ___-___.

3) Project ownership

Public (Agency or Department) ___-___.

Private (Corporation name) Fali Olefins Company___.

Joint public-private ___-___.

4) Implementing agency (ies) ___-___

______.

5) Prime contractor(s) Transnational Engineering Company

(disguised name)___.

6) Type of contract (describe) cost plus fixed fee___

______.

7) Project description Petrochemical plant to produce ethylene and

propylene from naphtha.___

______

______.

8) Products to be produced Ethylene and propylene___.

9) Planned annual capacity 50,000 tons___.

10) Planned total employment at full capacity 600___.

11) Comments or explanations for any of the items of Part I (if necessary)

______

______

______

______

______

______

In the next two parts (Parts II and III) of the questionnaire we divide the project implementation phase into four stages:

Stage 1. Detailed project planning (including site selection, detailed engineering design, and cost estimating).

Stage 2. Bidding, contracting and procurement.

Stage 3. Construction and start-up.

Stage 4. Build-up to capacity production.

We realize it is not always possible to divide project work into these four stages. If you find you cannot do so for this project, please change the stage definitions above and on the following pages to ones that you can use systematically for the rest of the questionnaire.

Note: If neither a bar chart nor a network schedule was made for the implementation phase of this project, do not attempt to fill out the activity listings on the following pages. Turn directly to page 21 at the end of Part III and provide what general information you can. Also, please complete page 8.

Part II. Project Scheduling and Identification of Delays

1) Was a bar-chart (or Gantt chart) schedule prepared for the implementation phase of this project? yes.

2) Was a network (or PERT or CPM) schedule prepared for the implementation phase of this project? no.

3) If neither a bar-chart nor a network schedule was prepared for the implementation phase of this project, describe the scheduling procedure that was used. -

> If it is available, we would appreciate receiving with this questionnaire a copy of the project schedule for the implementation phase as it stood at the beginning of that phase. It may be abbreviated, if desired, to include only "major activities" as defined in this questionnaire.

4) Who (what agency or group) prepared the schedule for the implementation phase of this project? Transnational Engineering Company.

Questionnaire

Part II. Project Scheduling and Identification of Delays, Continued

5) On what dates did the following events actually occur?

a) Implementation phase of project actually started* July 1, 1963.

b) Foreign exchange portion of funds committed by government -

.

c) Final approval of project by government May 3, 1963.

d) Ground breaking May 1,1964.

e) Start of production (plant "on-line") April 3, 1967.

f) Capacity production achieved (implementation phase ended)

October 5, 1967.

*See definition of "implementation phase."

6) On what date was the project originally scheduled to start production (go on-line)? June 1, 1966.

7) On what date was the project originally scheduled to reach full capacity production? December 1, 1966.

Part II, Continued

9) Stage 2 -- bidding, contracting and procurement, continued.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Part II. Project Scheduling and Identification of Delays, Continued

8) Referring to the project schedule for the implementation phase, list below the "major activities" (refer to definition) of Stage 1 -- detailed project planning. Also list the planned or scheduled time duration for each major activity, in months, and the actual time duration experienced.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
1	Select Site	1	1	-	-
2	Acquire Land	7	6	-	-
(3)	Process Design	7	9	2	29
	Engineering Design:				
4	Towers	6	6	-	-
5	Reactors	5	5	-	-
(6)	Exchangers	3	5	2	67
(7)	Drums	5	7	2	40
(8)	Tanks	1	3	2	200
9	Compressors	5	5	-	-
(10)	Pumps & Drivers	1	5	4	400
(11)	Furnaces	2	4	2	100
12	Piping	8	9	1	13
13	Instruments	11	11	-	-
14	Structures	5	5	-	-
15	Foundations	5	6	1	20
16	Control House	2	2	-	-
17	Other Buildings	2	2	-	-
18	Elec. Distribution & Transformers	7	6	1	14

Part II, Continued

8) Stage 1 -- detailed project planning, continued

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
19	Elec. Switchgear & Controls	3	3	-	-
20	Elec. Misc.	3	3	-	-

Part II. Project Scheduling and Identification of Delays, Continued

9) List below the major activities of Stage 2 -- bidding, contracting and procurement.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
	Obtain and analyze bids and place equipment orders for:				
(21)	Exchangers	3	4	1	33
22	Reactors	4	4	-	-
(23)	Towers	3	4	1	33
24	Furnaces	5	5	-	-
25	Drums	3	3	-	-
26	Tanks	4	4	-	-
27	Pumps & Drivers	3	3	-	-
28	Compressors	4	4	-	-
29	Other Equipment	3	3	-	-
	Approve Shop Drawings & Fabricate, Test, and Deliver Equipment:				
(30)	Exchangers	11	22	11	100
(31)	Reactors	12	24	12	100
(32)	Towers	12	23	11	92
33	Furnaces	14	16	2	14
(34)	Drums	12	23	12	92
35	Tanks	12	14	2	17
(36)	Pumps & Drivers	11	23	12	109
(37)	Compressors	12	18	6	50
38	Other Equipment	12	14	2	17

Questionnaire

Part II, Continued

9) Stage 2 -- bidding, contracting and procurement, continued.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
	Purchase Materials:				
39	Underground Piping	2	2	-	-
40	Above Ground Piping	8	9	1	13
41	Instruments	11	10	-	-
42	Electrical	11	12	1	9
43	Other Material	8	9	1	13

Part II. Project Scheduling and Identification of Delays, Continued

10) List below the major activities of Stage 3 -- construction and start up.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
44	Yard Work Including Sewers and Access Roads	7	15	8	114
45	Install Foundations	8	13	5	63
46	Construct Buildings	3	13	10	334
47	Install Yard Structures	7	10	3	43
	Install Equipment:				
48	Towers	3	6	3	100
49	Furnaces	3	6	3	100
50	Drums & Reactors	3	3	-	-
51	Tanks	4	15	11	275
52	Pumps & Drivers	8	9	1	13
53	Compressors & Drivers	4	4	-	-
54	Exchangers	7	6	-	-
55	Misc. Equipment	7	7	-	-
56	Install Underground Piping	3	3	-	-
57	Install Above Ground Piping	9	17	8	89
58	Install Instruments	6	12	6	100
59	Install Electrical Items	6	13	7	117
60	Install Insulation & Fireproofing	8	12	4	50
61	Paint	6	10	4	67
62	Startup Plant	1	3	2	200

Part II, Continued

10) Stage 3 -- construction and start-up, continued.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Questionnaire

Part II. Project Scheduling and Identification of Delays, Continued

11) List below the major activities of stage 4 -- build-up to capacity production.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
63	Bring plant up to design capacity and make guarantee run	6	6	-	-

"Delay" has been defined earlier to mean "falling behind schedule 25% or more of the planned time of achievement."

Wherever a number of 25% or larger appears in column (6) of the above listings for any of the four stages, circle the corresponding activity number. These are the activities we will consider to have been delayed. In the following part of this questionnaire we seek the reasons for these delays.

Part II. Project Scheduling and Identification of Delays, Continued

12) List below the 5 delays that in your judgment made the greatest contribution to the total delay of the project. Put them in what you estimate to be the order of their magnitude of contribution to total delay and estimate their contribution in months.

Number	Delay	Contribution to Total Delay (Months)
1.	Approve shop drawings, and fabricate test, and deliver reactor*	5
2.	Startup plant	2
3.	Process design	1
4.	Obtain and analyze bids and place equipment orders for towers	1
5.	Install above ground piping	1

*This also applies for the other major equipment, see major activity numbers 30, 31, 32, 34, 36, and 37.

Questionnaire

Part III. Reasons for Delays

(If no delays were identified in Part II, skip this part.)

Complete the following sections only for those major activities that were delayed, that is where 25% or a greater number appeared in column (6) of Part II of this questionnaire.

1) Stage 1 - detailed project planning.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)
3	Process Design	29	Owner changed some basic process conditions after process design had started. This delayed process design work plus caused some completed work to be redone.
	Engineering Design:		
6	Exchangers	67	Delay in process design caused delay in engineering design after engineering design work had commenced. Also, original schedule for engineering design work on tanks and pumps and drivers was probably unrealistically short.
7	Drums	40	
8	Tanks	200	
10	Pumps & Drivers	400	
11	Furnaces	100	

Part III. Reasons for Delays, Continued

2) Stage 2 -- bidding, contracting and procurement.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)
	Obtain and analyze bids and place equipment orders for:		The client of the engineering and construction company became very involved with the analysis of the bids and took longer than scheduled to approve the placing of orders. Also, negotiations with the vendors took longer than scheduled because it was decided to place most of the equipment orders of similar types with a single vendor in order to save money and this caused renegotiation of the bids.
21	Exchangers	33	
23	Towers	33	
	Approve shop drawings & fabricate, test, and deliver equipment:		The major cause of the delay which resulted in delays of as long as 12 months was that the equipment vendors were not able to provide equipment in the time period originally envisaged when the engineering contractor made out the schedule. Furthermore, in order to save money on the purchase price of the equipment, it was decided to purchase major equipment items of a similar type with one vendor. While this resulted in a lower cost for the equipment, a single vendor was not able to produce the equipment for delivery at one time. Rather, he completed the equipment piece by piece for a long period of time and this delayed substantially the delivery of the final piece of equipment. The second delay was that there was misunderstanding between the engineering contractor and the equipment vendor concerning the details to be shown on the vendors' drawings. Since th engineering design was done in one country and most of the equipment was purchased in other countries,
30	Exchangers	100	
31	Reactors	100	
32	Towers	92	
34	Drums	92	

Part II. Project Scheduling and Identification of Delays, Continued

10) List below the major activities of Stage 3 -- construction and start up.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
15	Clear site and build roads	3	3	-	
(16)	Pour foundations	3	5	2	67
	Install major equipment as follows:				
17	Crusher	3	3	-	
18	Plant unloading equipment	3	2	-	
19	Kiln	6	5	-	
20	Mill	6	6	-	
21	Mill conveyor	3	2	-	
22	Power plant	6	6	-	
23	Electrical	6	6	-	
24	Heat exchange	3	3	-	
25	Homogenizer and cooler	6	5	-	
26	Blending and storage	3	3	-	
27	Packing machine	2	2	-	
28	Other equipment	6	7	1	17
29	Construct buildings	6	6	-	
30	Start up plant	1	1	-	

Questionnaire

Part III. Reasons for Delays, Continued

2) Stage 2 -- bidding, contracting and procurement.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)
			excessive delays occurred in transmittal of drawings and correspondence concerning this subject. At least two months of the delays could be attributed to this.
36	Pumps & Drivers	109	Primary cause of this delay was the underestimation by the engineering contractor of the time required for delivery of the equipment. Secondly, the decision to place all the orders with one vendor caused the delivery to be spread out over a long time period.
37	Compressors	50	

Questionnaire

Part III. Reasons for Delays, Continued

3) Stage 3 -- construction and start-up.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II	(4) Cause of Delay. (Please be specific and detailed. Use extra sheets if necessary.)
44	Yard work including sewers and access roads	114	The delay in the design engineering work caused a delay in sending the final drawings to the field. This delayed the completion of these activities.
45	Install Foundations	63	
46	Construct Buildings	334	The completion of other parts of the project were not affected by the completion of the buildings. Therefore, the buildings were not given priority in the allocation of labor and the job lingered on for a long time.
47	Install Yard Structures	43	This was delayed by the lateness of arrival of the final engineering drawings to the field.
	Install Equipment		The completion of this work was delayed because of the long period of time over which equipment deliveries were made. The original schedule contemplated that the equipment would be delivered in a short period of time and be installed in a short period of time. In actual fact, since the equipment was delivered over a long period of time, the installation took place over a long period of time.
48	Towers	100	
49	Furnaces	100	
51	Tanks	275	
57	Install Above Ground Piping	89	
58	Install Instruments	100	
59	Install Electrical Items	117	
60	Install Insulation and Fireproofing	50	
61	Paint	67	
62	Startup Plant	200	The engineering contractor had not had any experience in starting up plants in this country and underestimated the problems involved in checking out the plant and getting it operating. No major problems were encountered, but a host of minor problems were.

Part III. Reasons for Delays, Continued

4) Stage 4 -- build up to capacity production.

(1) Major Activity Number	(2) Description of Major Activity	(3) % Delay (Column (6) of Part II)	(4) Cause of Delay. (Please be specifi and detailed. Use extra sheets if necessary.)

Part III. Reasons for Delays, Continued

5) If no formal scheduling procedure was used for this project, please give below as much information as you have about delays, their time and causes.

Part IV. Project Cost Information

1) Total project investment (actual, if different from planned)*

$9.0 million

Major cost elements:

Land $103,000

Land preparation $37,000

Non-residential buildings and plant $99,000

Capital equipment $7,930,000 (includes installation)

Housing None

Roads, railroads & access $31,000

Water Already available

Power Already available

Fees and services $800,000

Other -

2) Foreign currency component of project (actual) $6.0 million

3) Local currency component of project (actual) $3.0 million

4) Source(s) of foreign currency (or lending agency) Parent company of Fali Olefins

5) Source(s) of local currency (or lending agency) Parent Company of Fali Olefins

6) Terms of foreign currency loan (if any) -

7) Terms of local currency loan (if any) -

*Includes all cost elements such as housing colony, land, road improvements, owned power supply, and so forth, that are required for the successful completion and operation of the project.

8) On what date was the foreign capital component of the investment for this project allocated? - . Was it unavailable for other projects thereafter? No .

9) Was all or part of the foreign exchange component of the investment committed on the above date? Please explain No .

10) Additional comments or information that respondent feels may be helpful to UNIDO in this study.

The implementation phase of this project lasted for 51 months instead of 41 months as originally planned. These delays can be attributed primarily to a combination of a) deliberate action taken on the part of the owner, b) inexperience on the part of the engineering contractor in constructing plants in the country, and c) an unrealistically short schedule in the beginning.

The owner delayed the project in three different ways: a) the owner decided to have all the equipment orders for a given type of equipment placed with one vendor in order to save on the cost of the equipment. However, this caused the equipment deliveries to be spread out over a long period of time and this was the largest single cause of delay in the project; b) the owner's engineers got very involved with the process design; this resulted in delays, which delayed various other parts of the project; c) the owner's engineers became very involved with the approval of bids, which delayed material delivery and thereby delayed construction. The original schedule had been made on the basis that the owner's engineers would not delay the work of the engineering contractor.

The engineering contractor had never built a plant in this country before and his unfamiliarity with the country caused the project to go slower than he had scheduled. (However, he did not have trouble procuring equipment licenses or getting the material through Customs, although he had thought that he might.) Part of the inexperience in job scheduling came about because of a lack of accurate data for the engineering contractor to use in scheduling the construction work. The engineering contractor estimated the construction man-hour requirements for the job on the basis of U.S. practice and then translated this into local personnel on the basis of four local man-hours needed in place of every one U.S. man-hour. While on the average this was slightly conservative in that slightly less local man-hours were used than estimated, it still caused delays because of the differences in productivity between various crafts. In other words, in some cases a local man-hour produced essentially the same amount of work as a U.S. man-hour. These were in cases such as welding, where the technology was such that the local worker had to be equipped with modern tools. However, in other areas where the technology of the construction was such that the local worker did not have to be equipped with modern tools, the output per man-hour was sometimes only one-eighth of that of a U.S. man-hour, because the U.S. man would be equipped with modern tools for such tasks.

Finally, the schedule was too optimistic in that it did not allow ample time for the amount of time required to do the purchasing in a number of countries and deal with vendors who were not used to preparing drawings according to the standards required by the engineering contractor.

Some of the items were delayed deliberately because the work did not affect the completion of other phases of the project and therefore was given lower priority.

Questionnaire

11) Name of person(s) filling out this questionnaire ______________

James West

12) Title and affiliation Project Manager, Transnational Engineering Company

13) Mailing address 11 Stella Road, Belmont, Massachusetts

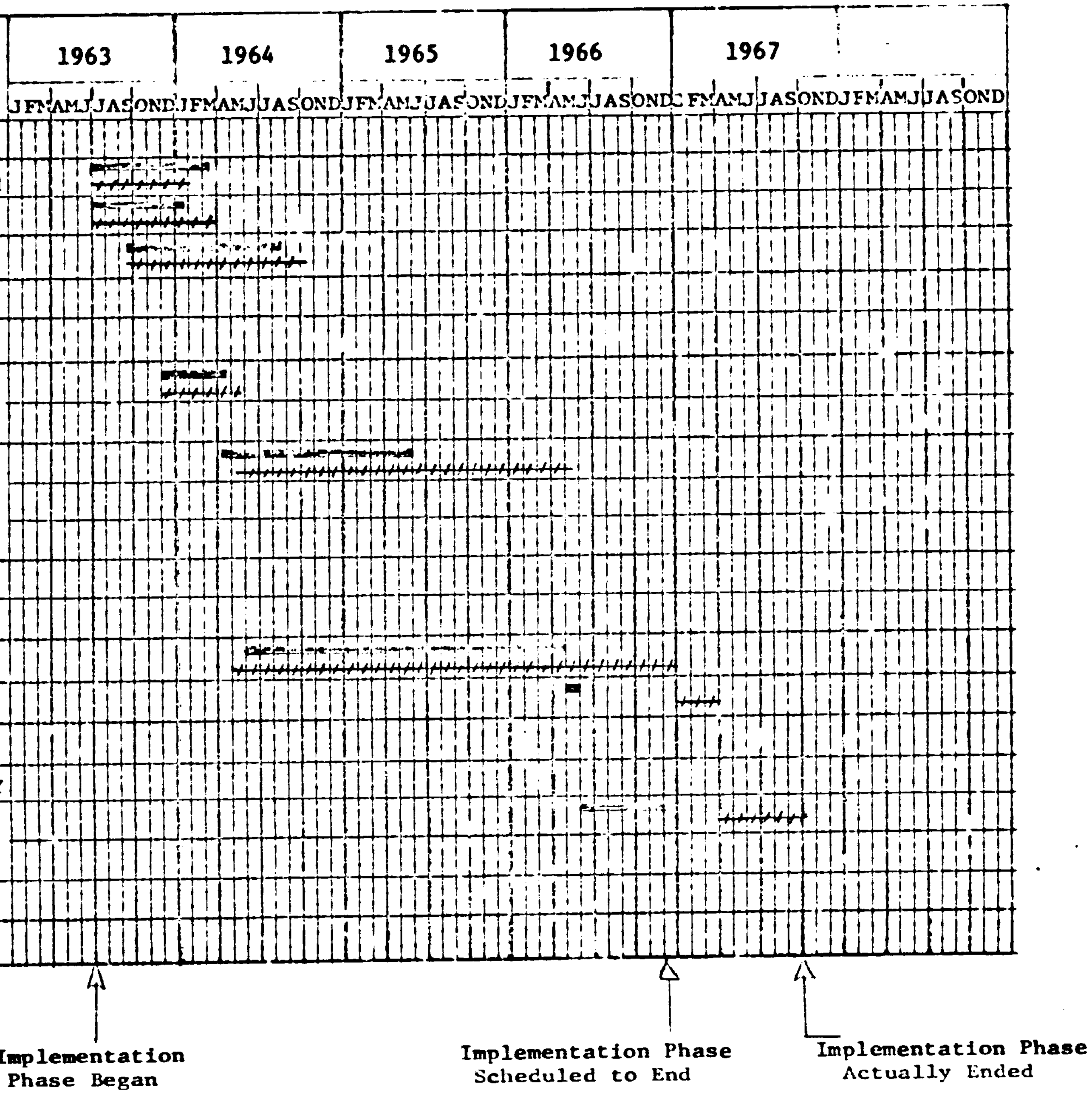
14) Date October 12, 1968.

Fall Olefins Corporation
Ethylene Plant

SUMMARY SCHEDULE

Legend:
Scheduled Progress
Actual Progress

Activity No.	Activity Description
STAGE 1	DETAILED PROJECT PLANNING
1, 2	Select Site & Acquire Land
3	Process Design
4-20	Engineering Design
STAGE 2	BIDDING, CONTRACTING AND PROCUREMENT
21-29	Obtain and Analyze Bids and Place Equipment Orders
30-43	Approve Shop Drawings & Fabricate, Test, & Deliver Equipment & Purchase Materials
STAGE 3	CONSTRUCTION & START-UP
44-61	Construction
62	Startup Plant
STAGE 4	BUILD UP TO PLANT CAPACITY
	Bring Plant up to Design Capacity and Make Guarantee Run



Part II, Continued

10) Stage 3 -- construction and start-up, continued.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)

Case 5: Las Salinas Textile Mill*

The Project

The Las Salinas Textile Mill, owned by Las Salinas, S.A., is located in a Latin American country. It is an integrated textile mill capable of producing 10 million meters of cloth. The mill includes preparation, spinning, weaving and finishing operations, and the necessary services such as electric power substations and laboratory equipment.

The textile mill was financed partially with funds from Las Salinas, partially from a loan by an international lending organization, and partially from a local mortgage bond issue. The cost of the project was $5 million, of which $1.8 million was from the international lending organization and $2 million from the local mortgage bond.

Las Salinas already owned one textile mill before this new mill was built. The Las Salinas engineering department was responsible for specifying and purchasing the equipment, doing the engineering design on items such as the building and other civil works, and supervising the construction work. The major items of equipment were imported from Europe and the United States, and the equipment vendors designed the equipment.

Delays in Implementation

The plant was scheduled to be completed in September 1966, but it was not completed until June 1967. Because of some problems with equipment operation and because of the time required to train the workers, the plant did not reach design output until November 1967.

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*Name disguised.

Delays in Implementation

The order for the major items of equipment was placed in February 1965. This occurred before the company had secured the necessary financing for the plant. Some four months after the equipment orders had been placed, the commitment for extra financing was obtained, but this commitment was contingent on Las Salinas' obtaining the needed local financing and having its accounting records audited. It took an additional seven months for Las Salinas to meet these conditions. This delay in financing started a chain reaction which ultimately resulted in a delay of approximately seven months in completing the project. First, the construction of the building was not started until the conditions on the financial commitment were met. This resulted in a delay in completing the building, so that equipment began to arrive at the job site before the building was complete. When it became obvious that the equipment was being delivered before it could be installed, Las Salinas asked the suppliers to delay shipment of some of the equipment. The suppliers delayed the subsequent shipments for too long a period of time so that when the building was complete and ready for the installation of the equipment, all of the equipment was not available.

Another factor which delayed the installation of the equipment was that the building design was modified part of the way through the project when it was discovered that the floor area was not adequate and that additional space had to be provided. Also, the building design was changed to provide better light.

The firm's engineering department used neither a bar chart nor a network scheduling technique. As a result, detailed scheduling information is not available for the project.

The Cost of Delays

The cumulative delay in completion of this project was nine months, the period from September 1966 to June 1967. We will use Exhibit 8 under Part IV, Analysis of Completed Questionnaires. Neither the foreign exchange component nor the local exchange component of the investment was committed at the start of the project; hence, the investment was made on a pay-as-you-go basis. If a 15% discount rate is used, the reduction in net worth of the project is approximately 3.5%, or $175,000. (This value of 3.5% is obtained by interpolating between the 2.5% for 0.5 year and the 4.5% for 1.0 year in column (2) under "Pay-As-You-Go" heading under "Delay in Project Completion" for the 15% discount rate.)

Using the same exhibit, we can determine under the heading "Time to Reach Full Capacity Production," that the reduction in net worth of the project because of the five months required to reach full capacity production is 4%, or $200,000 (the 4% was obtained for the five-month delay by interpolating between 0% for 0 years and 5% for 0.5 years).

These two factors combined to reduce the net worth of the pboject by 7.5%, or $375,000.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Questionnaire

DELAYS IN IMPLEMENTING INDUSTRIAL PROJECTS

This questionnaire is part of a study being conducted by the United Nations Industrial Development Organization for the purpose of learning more about the causes and costs of delays in implementing industrial projects in developing countries.

The questionnaire has been sent to you for the project named below on the basis of a random selection and not because of any knowledge of delays in this project.

Project name Las Salinas Textile Mill*

Country Latin America

Once filled in this questionnaire will be kept confidential. Specific project information will not be divulged. Only totals, averages and general observations will be published.

You are asked to complete this questionnaire as promptly as possible and return it to the United Nations Industrial Development Organization, Felderhause, Rathausplatz 2, 1010-A Vienna, Austria.

Thank you for your assistance.

*Name disguised.

Definition of Terms Used

"Implementation Phase"

The implementation phase is taken to be the work starting with detailed project planning and design, through construction and start up, to the time when the project is functioning in a satisfactory manner at, or near, its rated capacity. Thus, the decision to invest is assumed to have been made; the product, general process, scale, market, financing method, and general location have been decided upon. Government approval is assumed, at least in principle, and the investment funds, including foreign exchange, are assumed to be allocated and available. At this point implementation begins. It includes site selection, detailed design of the project to accommodate it to the site and to final engineering changes, bidding, contracting and procurement, construction, production start-up, and build-up to capacity.

"Delay"

Project delay is defined to mean falling behind schedule 25% or more of the planned time of achievement for any major activity of the project.

"Activity"

Activity is used in the precise meaning it has in bar chart scheduling or network scheduling. It is assumed that every large scale industrial project will have been scheduled with one of these methods. Figure 1 shows the meaning of activity as used in these scheduling methods. An activity is a logical subdivision of the project work that can be scheduled as an entity because it is distinctly different from that which precedes or follows it. Thus, the simple bar chart of Figure 1 shows Activity A of one week duration, Activity B of 8 weeks duration, and so forth. The simple network illustration shows activity 1, Purchase Pumps, of 5 months duration, activity 2, Install Pumps, of 7 months duration, and activity 3, Dewater Site, of 8 months duration.

"Major Activity"

A major activity is one that is scheduled in months, rather than days or weeks; that is, an activity whose planned duration is at least one month. Since this study covers only large industrial projects of over $1 million value, and implementation periods ranging from about one to eight years, it is neither necessary nor desirable to investigate delays in activities shorter than this.

Definition of Terms, Continued

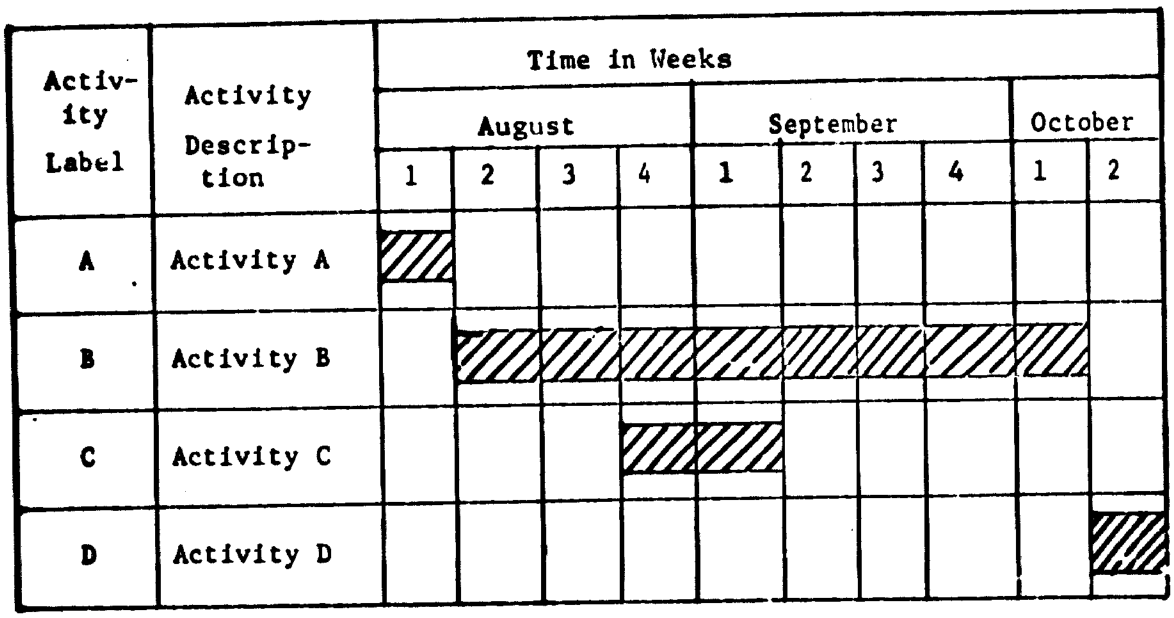
"Planned Time of Achievement"

The planned time of achievement is not necessarily measured by calendar dates; that is, day of the week or month, but by time duration, or number of days. Thus it is possible for a major activity to be completed later than the scheduled calendar date and still not, in itself, be a "delayed activity," in the meaning of the definition of this study. This could happen if a previous activity were delayed, thereby moving back the starting date of the referenced activity. Another way of putting this point is that delays are not necessarily cumulative. Each major activity is judged with respect to its planned elapsed time, as shown on the original schedule (or any revisions thereto made prior to the start of the referenced major activity) and not with respect to the calendar as such.

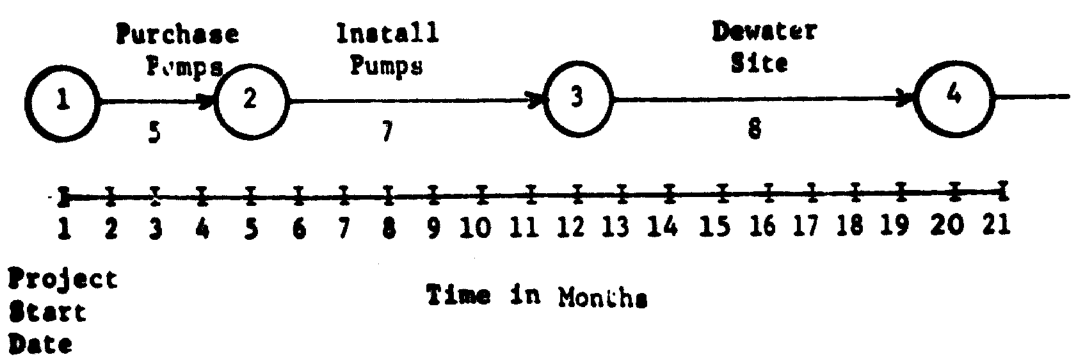
With this meaning, then, it is possible that an industrial project may suffer delay in one or more major activities and yet be completed by the scheduled date. The study is designed intentionally to include this possibility, for otherwise some important instances of delay may escape the survey. On the other hand, it is not possible for a total project to fall 25% or more behind schedule unless one or more of its major activities does so.

Figure 1 - Meaning of Activity

Simple Bar Chart



Simple Network



Questionnaire

Part I. General Project Information

1) Country Latin American. 2) Project name Las Salinas Textile Mill

State or province -.

3) Project ownership

Public (Agency or Department) -.

Private (Corporation name) Las Salinas, S.A.

Joint public-private -.

4) Implementing agency (ies) -.

5) Prime contractor(s) Owner.

6) Type of contract (describe) Owner signed fixed price purchase orders for equipment.

7) Project description An integrated textile mill to produce cloth from raw cotton. Includes preparation, spinning, weaving, and finishing operations plus required service facilities.

8) Products to be produced cloth.

9) Planned annual capacity 10 million meters.

10) Planned total employment at full capacity 800.

11) Comments or explanations for any of the items of Part I (if necessary)

Las Salinas already owned a textile mill. This new mill was built adjacent to their old mill.

In the next two parts (Parts II and III) of the questionnaire we divide the project implementation phase into four stages:

Stage 1. Detailed project planning (including site selection, detailed engineering design, and cost estimating).

Stage 2. Bidding, contracting and procurement.

Stage 3. Construction and start-up.

Stage 4. Build-up to capacity production.

We realize it is not always possible to divide project work into these four stages. If you find you cannot do so for this project, please change the stage definitions above and on the following pages to ones that you can use systematically for the rest of the questionnaire.

Note: If neither a bar chart nor a network schedule was made for the implementation phase of this project, do not attempt to fill out the activity listings on the following pages. Turn directly to page 21 at the end of Part III and provide what general information you can. Also, please complete page 8.

Note: Neither a bar chart nor a network schedule was made for the implementation phase of this project; therefore, pages 7 and 9 through 20 are omitted from this completed copy of the Las Salinas Textile Mill questionnaire.

Part II. Project Scheduling and Identification of Delays, Continued

5) On what dates did the following events actually occur?

a) Implementation phase of project actually started* October 1964 .

b) Foreign exchange portion of funds committed by government ______

______ - ______.

c) Final approval of project by government October 1964 ______.

d) Ground breaking ______ October 1965 ______.

e) Start of production (plant "on-line") June 1967 ______.

f) Capacity production achieved (implementation phase ended) ______

______ November 1967 ______.

*See definition of "implementation phase."

6) On what date was the project originally scheduled to start production (go on-line)? ______ September 1966 ______.

7) On what date was the project originally scheduled to reach full capacity production? ______ December 1966 ______.

Part II. Project Scheduling and Identification of Delays, Continued

11) List below the major activities of stage 4 -- build-up to capacity production.

(1) Major Activity Number	(2) Description of Major Activity	(3) Planned Duration (Months)	(4) Actual Duration (Months)	(5) Difference (4)-(3)	(6) % Difference (5)/(3)
(30)	Build up to capacity output	3	12	9	300

"Delay" has been defined earlier to mean "falling behind schedule 25% or more of the planned time of achievement."

Wherever a number of 25% or larger appears in column (6) of the above listings for any of the four stages, circle the corresponding activity number. These are the activities we will consider to have been delayed. In the following part of this questionnaire we seek the reasons for these delays.

Part III. Reasons for Delays, Continued

5) If no formal scheduling procedure was used for this project, please give below as much information as you have about delays, their time and causes.

A. The major delay of the project resulted from a delay in obtaining the necessary financing from the international lending organization. The following chain of events occurred and it is estimated that the resulting delay of project completion was 7 months.

1. An order was placed for the major equipment in February 1965.

2. There was a delay in applying for the loan from the international lending organization, and this loan finally was approved in June 1965; but approval was contingent on the company's obtaining local financing and on obtaining an audited statement of its financial records.

3. The contingent terms of the loan were not met until January 1966, and no disbursements could be made against this loan until that time.

4. The delay in obtaining this financing delayed the start of construction of the main buildings. As a result, the equipment started arriving at the job site before it could be installed, because the building was not complete.

5. Because of this pile-up of equipment at the job site, the loom manufacturer was requested to hold up on additional loom shipments.

6. When the building was complete and ready for the equipment installation, the equipment at the job site was installed. However, the looms for which delivery intentionally had been delayed were not available for installation. These looms did not arrive until 4 months after the building was complete.

B. The only other important source of delay was a change in the design and size of the building. The building design was modified to provide better light and the building size was increased over that originally planned.

C. Some difficulties were experienced with the equipment and with the training of the operators. Thus, it took 5 months after the plant was operating before it produced at capacity output.

Part IV. Project Cost Information

1) Total project investment (actual, if different from planned)*

$5.0 million

Major cost elements:

Land: Already available

Land preparation: $20,000

Non-residential buildings and plant: $450,000

Capital equipment: $4,520,000

Housing: -

Roads, railroads & access: $10,000

Water: Already available

Power: Already available

Fees and services: -

Other: -

2) Foreign currency component of project (actual) $3.5 million

3) Local currency component of project (actual) $1.5 million

4) Source(s) of foreign currency (or lending agency) International lending organization (part)

5) Source(s) of local currency (or lending agency) Company and local mortgage loan

6) Terms of foreign currency loan (if any) $1,800,000 for 9 years at 7-1/2%

7) Terms of local currency loan (if any) $2,000,000 for 8 years at 10%

*Includes all cost elements such as housing colony, land, road improvements, owned power supply, and so forth, that are required for the successful completion and operation of the project.

8) On what date was the foreign capital component of the investment for this project allocated? - . Was it unavailable for other projects thereafter? No .

9) Was all or part of the foreign exchange component of the investment committed on the above date? Please explain No .

10) Additional comments or information that respondent feels may be helpful to UNIDO in this study.

An attempt was made to keep track of the progress of this project by marking up a layout drawing of the mill. A different color was assigned for each possible status of each item of equipment. For example, green meant the equipment was on order, red meant the equipment had been shipped, and so on. A copy of the layout drawing was then colored every 3 months to indicate the current status of the project.

While this method gave some indication of the status of the equipment, it did not aid in scheduling the project.

Questionnaire

11) Name of person(s) filling out this questionnaire ______

Ing. Jose Duro

12) Title and affiliation Head of Engineering Department,

Las Salinas, S.A.

13) Mailing address Aptado 456, La Ciudad Viejo, Latin America

14) Date October 15, 1968.

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