

CODIFICACION DEL CATALOGO GENERAL
DE CONCEPTOS QUE INTERVIENEN
EN EL COSTO TOTAL DE UN -
CONJUNTO HABITACIONAL

- - -

CODIFICACION DE CONTRATOS

1

2

3

4

- 1 Año en el que se firma el contrato (2 núm)

- 2 Tipo de contrato (letra)
 - a) Precio alzado
 - b) Precio unitario
 - c) Administración
 - d) Fideicomiso
 - e) Arrendamiento
 - f) Trabajo individual

- 3 Giro (letra)
 - a) Urbanización
 - b) Edificación
 - c) Servicios técnicos
 - d) Mobiliario Urbano
 - e) Instalaciones de captación y desecho
 - f) Terrenos
 - g) Indirectos

- 4 Numeración progresiva (4 números)

004/73.

'ml.m.

A .- URBANIZACION

- A Red de agua
- B Red de drenaje y alcantarillado
- C Terracerias, pavimentos, banquetas y andadores
- D Red de distribución eléctrica y alumbrado
- E Red de teléfono
- F Red de gas
- G Jardinería
- H Equipo e instalaciones especiales
- I Varios obras exteriores
- J Protección contra precipitación pluvial

CONCEPTOS GENERALES

- A URBANIZACION
- B EDIFICACION
- C SERVICIOS TECNICOS
- D EQUIPAMIENTO URBANO
- E INSTALACIONES DE CAPTACION Y DESECHO
- F TERRENOS
- G INDIRECTOS.

AA .- RED DE AGUA

- A Terracerías
- B Tubería
- C Piezas especiales
- D Tomas domiciliarias
- E Bocas de riego
- F Trabajos de albañilería
- G Conexión del sistema municipal

AAA .- TERRACERIAS

- A Limpieza de terreno
- B Trazo y nivelación
- C Demoliciones
- D Carga y acarreos
- E Excavaciones
- F Afines
- G Rellenos
- H Protección colindancias
- I Consolidación
- J Control de agua

2

AAB - TUBERIAS

- A De asbesto cemento
 - B De cobre
 - C De galvanizado
 - D De polietileno o PVC
 - E De otros materiales
 - F Cama de arena
- - -
- 20

AAC - PIEZAS ESPECIALES

- A Cruces
- B Tees
- C Extremidades
- D Tapas ciegas
- E Carretes
- F Codos
- G Reducciones
- H Tornillos y tuercas
- I Plato quiebra chorro
- J Césped, bola y codo
- K Válvulas
- L Juntas gibault
- M Mangueras

AAD = TOMAS DOMICILIARIAS

A Tomas de Agua

B Insertor

C Tubo de polietileno

D Llave de banqueta

E Caja para llave de banqueta

AAF .- TRABAJOS DE ALBAÑILERIA

- A Atraques
- B Cajas
- C Registros
- D Ductos o trincheras
- E Soportería

AB - RED DE DRENAJE Y ALCANTARILLADO

- A Terracerías
- B Tubería
- C Piezas especiales
- D Descargas domiciliarias y conexión a atarjeas
- E Trabajos de albañilería
- F Fosas sépticas y pozos de absorción
- G Conexión del sistema municipal

ABA .- TERRACERIAS

- A Limpieza de terreno
- B Trazo y nivelación
- C Demoliciones
- D Carga y acarreos
- E Excavaciones
- F Afines
- G Rellenos
- H Protección colindancias
- I Consolidación
- J Control de agua

ABB - TUBERIAS
INSTRUMENTACIÓN DE TUBERIAS

A Camas ablas ob y ablas ab losos 1

B Tubería ablas ablas 2

ablas 3

ablas 4

ABE .- TRABAJOS DE ALBAÑILERIA

A Pozos de visita y de caída

B Alcantarillas

C Areneros

D Drenes

AC .- TERRACERIAS, PAVIMENTOS,
BANQUETAS Y ANDADORES

- A Obras preliminares
excavaciones y rellenos
- B Movimiento de tierra
movimiento y compactación
- C Sub-base
capas de arena y grava
- D Base
capas de arena y grava
- E Carpeta
capa de asfalto
- F Guarniciones
capas de arena y grava
- G Banquetas
capas de arena y grava
- H Andadores
capas de arena y grava
- I Otros trabajos de albañilería

ACA .- OBRAS PRELIMINARES

A Limpieza del terreno

Trazo y nivelación

Demoliciones

Carga y acarreos

Excavaciones

Protección de colindancias

DEPARTAMENTO DE OBRAS PUBLICAS

ACB .- MOVIMIENTO DE TIERRA

- A Excavaciones
- B Rellenos
- C Carga y acarreos
- D Consolidaciones
- E Conformación y afine

AI .- VARIOS OBRAS EXTERIORES

A Ornamentación

B Nomenclatura y señalamiento

C Bardas

D Casetas vigilancia

AD .- RED DE DISTRIBUCION ELECTRICA
Y ALUMBRADO

- A Terracerías
- B Tubería
- C Acometida compañía de luz
- D Postería
- E Cableado
- F Lámparas y accesorios
- G Trabajos de albañilería
- H Sub-estación
- I Transformadores

AE .- RED DE TELEFONOS

A Terracerías

B Ductos

C Cableado

D Piezas especiales

E Trabajos de albañilería

F Teléfonos de México, S.A.

AF .- RED DE GAS

- A Terracerías
- B Tuberías y pruebas
- C Piezas especiales
- D Tomas domiciliarias
- E Trabajos de albañilería

AG .- JARDINERIA

- A Preparación del terreno
- B Suministro de tierra vegetal
- C Plantas
- D Cultivo
- E Mantenimiento

AH.- EQUIPO E INSTALACIONES
ESPECIALES

A Bombas.

B. Tanque elevado

C Oficinas administrativas y vigilancia

B -- EDIFICACION

- A Obras preliminares
- B Cimentación
- C Cisterna
- D Estructura
- E Albañilería gruesa
- F Albañilería acabados
- G Impermeabilización
- H Acabados especiales
- I Instalación hidráulica y sanitaria
- J Instalación de gas
- K Instalación eléctrica
- L Instalaciones especiales
- M Herrería
- N Yesería
- O Pintura
- P Carpintería y ebanistería
- Q Cerrajería
- R Vidriería
- S Muebles de baño, cocina y conexos
- T Jardinería (solo en casas, dentro de las bardas).
- U Mobiliario
- V Equipo
- W Limpieza
- X Varios

BA .- OBRAS PRELIMINARES

- A Limpieza del terreno
- B Trazo y nivelación
- C Demoliciones (del nivel de piso de banqueta para abajo)
- D Carga y acarreos
- E Excavaciones
- F Rellenos
- G Protección de colindancia
- H Consolidación
- I Control de agua

* Se considera que el terreno está despejado (inclusive de árboles), ya que la limpieza a nivel de banqueta debe considerarse en urbanización.

BAB .- TRAZO Y NIVELACION

A Testigos

B Bancos de nivel

C Trabajos topográficos

BAD .- CARGA Y ACARREOS

A En camión

B En carretilla

80

80

BAE .- EXCAVACIONES

A Con máquina

B A MANO

C Afines

BAD .-- CARGA Y ACARREOS

A En camión

B En carretilla

DAF -- RELLENOS

A Con material producto de la excavación

B Con material de fuera de la obra

G

BAG .- PROTECCION COLINDANCIAS

A Ademes

B Troqueles

C Apuntalamiento

- - -

BAL .- CONTROL DE AGUA

A Pozos de bombeo

B Bombeo

C Piezómetros

D Drenas

E Cárcamos

F Tabaestacas

G Otros sistemas

BB .- CIMENTACION

- A Plantilla
- B Mamposterías
- C Concretos
- D Hierro
- E Cimbra
- F Dalas, cadenas y castillos
- G Impermeabilización
- H Precolados
- I Muretes
- J Lastres
- K Registros de cimentación, juntas, anclas
- L Pilotes, pilas
- M Acabados en cimentación
- N Preparaciones especiales

EBA .- PLANTILLAS

A De concreto

B De pedaceria de tabique

BEC .- CONCRETOS

A Resistencia rápida

B Normal

C Ciclópeo

D Curado

EBD .- FIERRO

A $F_y = 4.000 \text{ Kg/m}^2.$

B $F_y = 2.530 \text{ K/cm}^2.$

C Malla

BBE .- CIMBRA

A Aparente

B No aparente

C Ahogada

D Chaflanes y goteros

BBG .- IMPERMEABILIZACION

A Aditivos

B Sobrecargas de desplante

C Impermeabilización especial

BC .- CISTERNA

- A Obras preliminares
- B Estructura
- C Impermeabilización
- D Preparaciones especiales

ECA .- OBRAS PRELIMINARES

A Preparación del terreno

B Movimiento de tierra

C Protección de colindancias

D Consolidación

E Control de agua

BCB .- ESTRUCTURA

- A Fierro
- B Concreto
- C Cimbra
- D Aditivos
- E Aplanados
- F Curado
- G Impermeabilización especial

BD .- ESTRUCTURA

- A Columnas
- B Trabes
- C Losas
- D Otras cubiertas
- E Rampas
- F Estructura metálica
- G Prefabricados de concreto
- H Otros elementos estructurales de concreto

A

BDA .- COLUMNAS

A Fierro

B Concreto

C Cimbra

D Aditivos

E Curado

DDB

- A Fierro
- B Concreto
- C Cimbra
- D Aditivos
- E Curado

BDC .-- LOSAS

- A Fierro
- B Concreto
- C Cimbra
- D Aditivos
- E Curado
- F Blocks o ductos aligerantes
- G Bóveda catalana
- H Aislantes

BDE .- RAMPAS

A Escaleras

B Estacionamiento

BDF. - ESTRUCTURA METALICA

A Fabricación y montaje

B Control de calidad

C Piezas especiales

DE .- ALBAÑILERIA GRUESA

- A Pisos
- B Muros
- C Cadenas, castillos y cerramientos
- D Azoteas
- E Colocaciones y amacizados
- F Registros ductos y albañales
- G Escaleras
- H Chimeneas
- I Varios

BEA .- PISOS

A Firmes

B Finos y zoclos de cemento

C Aditivos

D Losetas en patios

E Sardineles

BEB .- MUROS

- A De tabique recocido
- B De barro prensado extruído
- C De block vidriado
- D De block de cemento
- E De tabicón
- F De mampostería
- G Celosías
- H Bardas
- I Remates

BEC - CADENAS, CASTILLOS Y
CERRAMIENTOS

- A Ahogados en el muro
- B Con cimbra en una cara
- C Con cimbra en dos caras
- D Con cimbr_a en tres caras
- E Repisones y cejas de concreto

80

D

BED .- AZOTEAS

A Rellenos

B Entortados

C Enladrillados

D Tejas

E Chaflanes

BEE .- COLOCACIONES Y AMACRADOS

8

- A Herrería
- B Accesorios para baño
- C Instalaciones en general
- D Tinacos y calentadores
- E Domos y tragaluces
- F Muebles
- G Piezas de aluminio

BMF .- REGISTROS, DUCTOS Y ALBAÑALES

- A Registros, ductos, trincheras, etc., de instalación eléctrica.
- B Registros y ductos teléfono
- C Registros y albañales de instalación eléctrica.

BEG - ESCALERAS

- A Forjado o colocado de escalones

- B Mesetas.

- C Colocación de escaleras, barandales,
etc., metálica.

- D Escaleras precoladas.

BEM - CHIMENEAS

A Tiros

B Construcción chimeneas

C Hornos de mampostería

BEI .- VARIOS

- A Gárgolas
- B Lavaderos
- C Juntas
- D Resames
- E Jardinería
- F Muebles de mampostería en baños y cocina
- G Rellenos y entortados en baños
- H Preparaciones pasos, tubos, ductos, etc.
- I Cajillos

BF .- ALBAÑILERIA ACABADOS

A Pisos

B Muros

C Prefabricados ornamentales

D Escaleras

BFA .- PISOS

- A mosaicos, terrazos, etc.
- B De barro
- C De cerámica
- D De piedra
- E De madera
- F Soclos
- G Recubrimiento sardineles

BFB .- MUROS

- A Acabados aparentes
- B Aplanados de mezcla
- C Lambrines
- D Recubrimientos de fachada
- E Pastas
- F Martelizados
- G Recubrimientos especiales

RELACIONAL DE PROGRAMAS DE OBRAS
DE IMPERMEABILIZACION

A Baños

2011

2011

B Azoteas

2011

2011

C Jardinerías

BH .- ACABADOS ESPECIALES

A Muros

B Pisos

C Plafones

D Escaleras

BHB .- PISOS

A Alfombras

B Mármoles

C Losetas vinílicas y lineoleums

D De madera

BI .-- INSTALACION HIDRAULICA Y
SANITARIA

- A Alimentación de muebles con agua fría y caliente
- B Desagüe de agua negras, jabonosas y pluviales
- C Líneas contra incendio
- D Otras instalaciones
- E Fosa séptica y pozo de absorción

Definir cuándo este concepto forma parte de un saneamiento y cuando de edificación, creyendo - que siempre en conjuntos habitacionales, deberá estar en la primera.

BJ .- INSTALACION DE GAS

A Líneas de alimentación y distribución

B Tanques, medidores y accesorios

BK .- INSTALACION ELECTRICA

A Electricidad en alta

B Electricidad en baja

C Para-rayós

PROYECTO BKA. -- ELECTRICIDAD EN ALTA

A Acometida Compañía de luz

B Ductos y cableado

aproximadamente

- - -

aproximadamente

aproximadamente

BKE - ELECTRICIDAD EN BAJA

- A Acometida compañía de luz
- B Tableros e interruptores
- C Ductos, cableado y placas
- D Alimentación a distintos equipos
- E Alarmas

• Cuando sin instalaciones no especializadas o patentadas.

B.L. -- INSTALACIONES ESPECIALES

A Aire acondicionado

B Elevadores

C Alarmas

D Teléfonos

E Intercomunicación y sonido

BM .- HERRERIA

A Estructural

B Tubular

C Aluminio

BN .- YESERIA

- A Aplanados de yeso
- B Varios de yeso
- C Tirol y masacústico
- D Falsos plafones

ENA .- APLANADOS DE YESO

- A Picado de concreto

- B Aplanados

- C Boquillas y esquineros

BNE .- VARIOS DE YESO

A /Cajillos

B Molduras y estucados

C Curvas de romate

SOCIEDAD

BND - FALSOS PLAFONES

- A De yeso

- B Cajas para lámparas

- C De materiales varios

BP .- CARPINTERIA Y EBANISTERIA

A Puertas

B Closets.

C Muebles

D Canceles

E Lambrines

F Plafones;

G Escaleras

H Celosías

EO .- PINTURA

A A la cal

B Temple

C Vinílica

D Esmaltes

E Aceites

F Barnices

G Lacas

H Pinturas especiales

I Silicones y repelentes

BQ - CERRAJERIA

- A Chapas
- B Herrajes.
- C Cortineros
- D Varios

acililtes p... 7

... 8

... 9

... 10

DR.- VIDRERIA

- A Vidrio
- B Block
- C Espejos
- D Domos
- E Plásticos, acrílicos
- F Placas vidriadas (porcewall,..)
- G Láminas de asbesto (cuando está en lugar
da vidrio)
- H Enmasticado y sellado

ES .- MUEBLES DE BAÑO COCINA Y
CONEXOS.

A Muebles de baño

B Muebles de cocina

C Accesorios de baño

D Calentadoras

E Tinacos

BRA -- VIDRIO

A Del país

B Polarizado

C Especial

D Carretones

E Flotado

F Persiana, con canto pulido

G Solar gray

BVC - INCENDIO

A Extinguidores

B Hidrantes

C Mangueras

IVB. - INSTALACION ELECTRICA.

A Planta de emergencia

B Generadores

C Motores

D Sub-estación

E Transformadores

BT - JARDINERIA

- A Preparación del terreno
- B Suministro de tierra vegetal
- C Plantas
- D Cultivo
- E Mantenimiento

EU - MOBILIARIO -

BY - EQUIPO

A Instalación hidráulica y sanitaria

B Instalación eléctrica

C Incendio

D Aire acondicionado

BVA - INSTALACION HIDRAULICA
Y SANITARIA

A Bombas

B Equipo hidroneumático

C Electroniveles

OW - LIMPIEZA

A General

B Acabados, muebles, equipos y accesorios

* C Jardinería y exteriores

D Para entrega de la obra

* Sólo lo que corresponde a edificación.

BWA .- GENERAL

- A Sacar cascajo

- B Mantenimiento limpieza durante la obra

- C Mantenimiento de limpieza después de -
terminada la obra.

EX -- VARIOS

A Licencias y permisos

B Conexión albañal (cuotas)

C Toma de agua (cuotas).

C .- SERVICIOS TECNICOS

A Asesorías

B Diseño urbanístico

C Diseño arquitectónico

D Diseño estructural

E Mecánica de suelos

F Topografía

G Laboratorios de Control de Calidad

[Handwritten signature]
D. Co. S. S. S. S. S.

D .- EQUIPAMIENTO URBANO

A Escuelas

B Mercados

C Instalaciones deportivas

INFRAESTRUCTURA

E --INSTALACIONES DE CAPTACION Y DESECHO--

- estacion de*
A Captación de agua potable
- B Planta de ~~Cloración~~ *potabilizadora*
- ~~C~~ Desperdicios
- D Planta de tratamiento de aguas negras
- E Sistema de descarga
- F Otros servicios
- G Acceso al fraccionamiento

F .- TERRENOS

- A Adquisición
- B Servicios técnicos preliminares a la adquisición
- C Gastos legales de adquisición
- D Cooperaciones y licencias de fraccionamiento

G - INDIRECTOS

- A Supervisión y administración
- B Cargos de plan piloto
- C Intereses
- D Gastos legales
- E Gastos de fiduciario
- F Mantenimiento para su entrega

Journal of the
CONSTRUCTION DIVISION

Proceedings of the American Society of Civil Engineers

ANALYSIS OF TIME-LAPSE CONSTRUCTION FILMS

By Howard B. Sprinkle,¹ M. ASCE

INTRODUCTION

Construction labor costs have been steadily rising along with a marked decrease in productivity. It is necessary that management search for new ways to reduce costs. One approach has been generally ignored. It is the cost savings technique known as methods improvement, or as it is more commonly known, time and motion studies. Methods improvement is a systematic effort to accomplish routine operations in the most economical manner. This method has long been in use in the manufacturing industry.

Time and motion studies are easier to perform and cost saving adjustments are easier to make in a factory set-up than in construction work. In the factory, equipment and men are performing the same work at the same position day after day. In construction, each new contract or job is more or less unique. However, there are certain construction operations which are essentially identical and repetitious from job to job. This is where management should concentrate its efforts to apply methods improvement techniques. If the construction manager recognizes that certain construction operations are repetitions, then the question becomes how to improve these operations in terms of costs. First, he must collect data about a particular operation. Secondly, he must analyze that data and reach conclusions about improvements. Last, he must make changes in the operation to reflect his conclusions. The following review covers some of the ways that data collected by the use of time-lapse photography may be converted into various forms of useful management statistics and charts.

Note.—Discussion open until February 1, 1973. To extend the closing date one month, a written request must be filed with the Executive Director, ASCE. This paper is part of the copyrighted Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, Vol. 96, No. CO2, September, 1972. Manuscript was submitted for review for possible publication on April 6, 1971.

¹Chief Engr., Lee Turzillo Contracting Co., Atlanta, Ga.

This information may then be used in reaching conclusions about improvements in job operations.

DATA COLLECTION AND EQUIPMENT

For the average construction company, data collection is a major problem. The conventional method of collecting job data consists of using an observer equipped with a stop watch and a clip board. This consumes the time of one or several men depending on the number of workers and the complexity of the operation under observation. A way around this problem is the use of photography. A camera can take the place of several observers. The camera set-up takes only a few minutes each day. The film provides an irrefutable record which can be reviewed as often as desired. Photography relieves management of the tedium of data collection while producing an accurate record which can be used for various purposes in addition to methods improvement. For example, the film can be used for training purposes, job progress records, cost verification, and even as evidence in contract disputes and liability suits.

If photography is selected as the means of collecting data, the camera and the projector should be carefully considered. Any compromise with regard to equipment operational features can result in increased analysis time. An example is the use of conventional motion picture equipment. The analysis of conventional motion picture film is much more tedious and time consuming than the analysis of time-lapse film. When filming with a time-lapse camera, photographs are taken every 3 sec to 4 sec. The shutter is tripped automatically by a device known as an intervalometer (manual tripping is possible but requires manpower). With a special projector the time-lapse film can be viewed at one of several speeds. An operation which was filmed at an exposure rate of one frame every 4 sec and projected at the speed of two frames per sec can be viewed in one-eighth of the actual event time. Thus, an 8-hr work day can be viewed in 1 hr. The same 8-hr day photographed with conventional equipment would require 8 hr to review. Inherently, there is some loss of detail with time-lapse filming. If the exposure rate is maintained in the range of one frame every 4 sec or less, then the loss of detail is not serious enough to affect analysis of the film. A 4-sec interval provided adequate detail for the analysis of the case studies presented herein.

The equipment used in this study consists of the Time-lapse Analyst II System manufactured by Timelapse Inc., Palo Alto, Calif. The 8mm camera is portable, automatic, cartridge loaded with zoom lens, automatic tripping device, and tripod. The projector is flickerless, with automatic loading and forward and reverse control. Several projection rates are possible. For more detail with regard to both selection and use of time-lapse equipment, refer to Ref. 4.

DATA ANALYSIS

The objective of the film analysis is to find ways to improve operations. When viewing the film, a complete cycle of work must be identified. The cycle may then be broken into a number of work elements. It is recommended that the analyst first review the whole operation at a fast projection rate (the motion will resemble an old silent movie) for general familiarization. The

projection rate can then be reduced as the scope of attention narrows to a particular operation.

As aids in the analysis of construction operations, one of several approaches may be used to reduce observations into useful charts and tables. The following sections describe some of these aids. Case field studies have been included to demonstrate their application where possible.

Operator	Time (min)	Truck	Time (min)	Shovel	Time (min)
Run Shovel	1.5	Idle	1.5	Load Truck	1.5
Idle	2.5	Truck out and in.	2.5	Idle	2.5
Run Shovel	3.0	Idle	3.0	Load Truck	3.0
Run Shovel	3.5	Truck in and out	3.5	Save Ahead In	3.5
Run Shovel	1.5	Idle	1.5	Load Truck	1.5
Check Grade	5.0	Truck out and in	2.0	Idle	5.0
Run Shovel	2.0	Idle	5.0	Load Truck	2.0
Idle	7.0	No Trucks (idle)	1.0		
Tighten Clutch	5.0	Truck in	2.0	Idle	12.0
Run Shovel	2.0	Idle	6.0	Load Truck	2.0
TOTAL	33		33		33
		5 LOADS			

	Operator	Truck	Shovel
Idle Time	9.5	22.0	19.5
Working Time	23.5	11.0	13.5
Total Cycle Tr.	33.0	33.0	33.0
Utilization(%)	23.5/33 = 71%	11/33 = 33%	13.5/33 = 41%

FIG. 1.—CREW BALANCE CHART, ORIGINAL OBSERVATIONS (from *Construction Estimating and Job Preplanning*, by George E. Deatherage, McGraw Hill Book Company, New York, 1965. Used with permission of McGraw-Hill Book Company)

Crew Balance Chart.—The crew balance chart is also known as the man and machine chart. The chart is a tool which demonstrates the relationship between the work of the members of a crew and the equipment they are using. When equipment is not involved, the chart may be used to show man-to-man relationships. Figs. 1 and 2 are examples of man and machine operations. Figs. 3 and 4 are examples of man-to-man charts.

Operator	Time (min)	Truck	Time (min)	Shovel	Time (min)
Run Shovel	1.5	Idle	1.5	Load Truck	1.5
Idle	1.5	Truck out and in.	1.5	Idle	1.5
		Idle	1.5	Load Truck	1.5
Run Shovel	6.5	Truck out and in.	1.5	Move Ahead In	3.5
		Idle	2.0	Cut.	1.5
Idle	1.5	Truck out and in.	1.5	Load Truck	1.5
Run Shovel	1.5	Idle	1.5	Load Truck	1.5
Idle	1.5	Truck out and in.	1.5	Idle	1.5
Run Shovel	1.5	Idle	1.5	Load Truck	1.5
Idle	1.5	Truck out and in.	1.5		
Tighten Clutch	5.0	Idle	5.0	Idle	6.5
Run Shovel	1.5	Idle	1.5	Load Truck	1.5
Idle	1.5	Truck out and in.	1.5	Idle	1.5
		Idle	1.5	Load	1.5
Run Shovel	6.5	Truck out and in.	1.5	Move Ahead In	3.5
		Idle	2.0	Cut	1.5
		Idle	1.5	Load Truck	
TOTAL	31.5		31.5		31.5

8 LOADS

	Operator	Truck	Shovel
Idle Time	7.5	21.0	12.5
Working Time	24.0	10.5	19.0
Total Cycle Tm.	31.5	31.5	31.5
Utilization(%)	24/31.5 = 76%	10.5/31.5 = 33%	19/31.5 = 60%

FIG. 2.—CREW BALANCE CHART, IMPROVED OPERATION (from Construction Estimating and Job Preplanning, by George E. Deatherage, McGraw Hill Book Company, New York, 1965. Used with permission of McGraw-Hill Book Company)

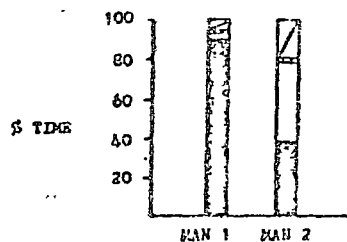


FIG. 3.—CREW BALANCE CHART (CREW 1)

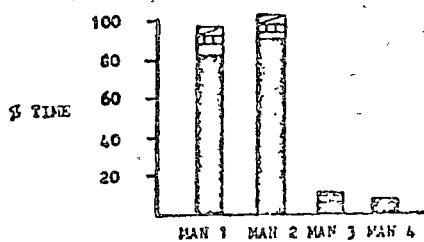


FIG. 4.—CREW BALANCE CHART (CREW 2)

Fig. 1 is a chart of an original observation. Fig. 2 is a chart of a later observation after out and in times for the trucks had been shortened and the

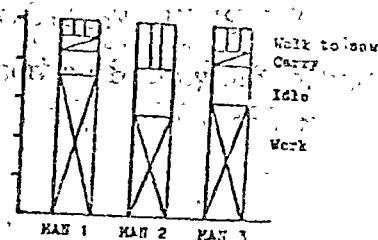


FIG. 5.—MAN-TO-MAN CREW BALANCE CHART

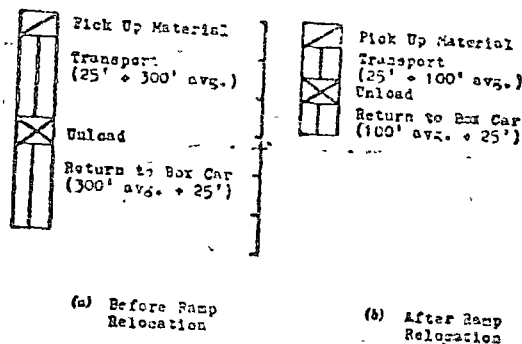
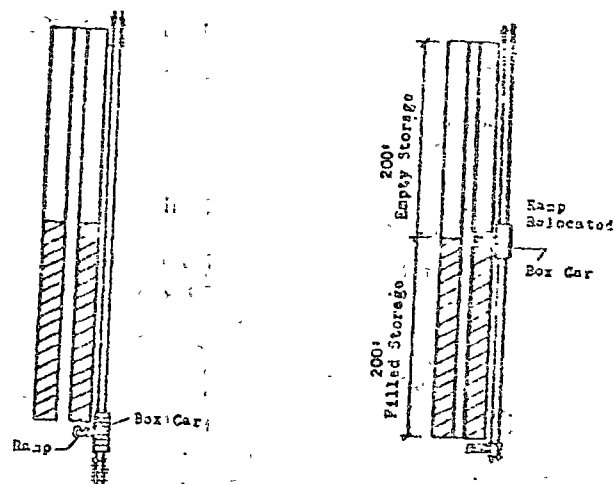


FIG. 6.—PROCESS CHART

shovel operator had been relieved of the responsibility for checking grade. The result is an increase in the excavation yardage (eight loads versus five loads) over about the same time period. Though these data are hypothetical,

It demonstrates the usefulness of such charts. Fig. 1 shows that improved shovel utilization is needed. The 41% utilization is too low for this expensive and key piece of equipment. Fig. 2 shows that by speeding up the positioning of empty trucks, the shovel was better utilized and production was improved.

A hypothetical example of a man-to-man crew balance chart is shown in Fig. 5. This type of chart is a graphical representation of the work element breakdown. It may be thought of as a summation of the activities of each crew member.

Under the section titled Case Studies herein, man-to-man crew balance charts (Figs. 3 and 4) were used in the analysis of Case 1. These show the relative percentages of time each man spent performing each work element. These were used to compare the performance of individuals and crews. Fig. 3 shows that Man 1 spent much more time working on the forms than did Man 2. This indicates that the two men were not working well as a team. This is especially obvious when checking the performance of the second crew as shown in Fig. 4. Within this second crew, Man 1 and Man 2 performed the same work elements at nearly equal percentages. The result was the performance of the same amount of work in about 70% of the time.

The man-to-man chart is useful where the manager wishes to check performance in search for ways to improve crew productivity. He may wish to observe the crew before and after a training or instruction session. Case 1 is a good example of how one crew can learn from another. The manager could point out the advantages of having materials close at hand and the need for more team work. An added use for this type of information is the verification of costs. An exact number of man-hours can be equated to a known quantity of column form work.

Process Chart.—The process chart is a graphical or tabular analysis method. This is a sequence chart which traditionally shows the operations, transportation, inspection, delays, and storage which occur during an operation. Symbols or hatched graphs may be used to represent various actions and the relative times of each. Fig. 6 is an example of a process chart. Fig. 6(a) shows the original position of an unloading ramp at one end of a rail side stockyard. In order to fill the far half of the yard, travel by a forklift equals an average distance of about 325 ft both ways. By moving the ramp to the center of the yard, travel distance is reduced by approximately two-thirds [Fig. 6(b)]. Travel time could be further improved by locating the ramp at the center of the unfilled area. Though a process chart might not be used for problems this simple, more complicated situations require this type of analysis chart.

Figs. 1 and 2 were called crew balance charts. When the work is shown in sequence these charts are in a sense process charts also. The major distinction between the two types of charts is that crew balance charts tend to emphasize crew and equipment or man-to-man work relationships where process charts tend to emphasize work flow.

Figs. 7 and 8 are extracts of process charts used in the analysis of Case 1. These charts depict graphically the work motions recorded on film. Such charts may be used to illustrate the work of crews when it is not possible to show the film. They may also be used to develop the crew balance chart and supporting data. A process chart is not always a necessity in evaluating a work cycle. It may be eliminated depending on the requirements and experience of the analyst. However, some form of time sequence record is necessary in order to calculate the times each man spends performing each work element.

In the case of Figs. 7 and 8, the number of frames was multiplied by the frame interval (4 sec) to arrive at the time for each work element.

Activity Study.—An activity study is conducted to determine the productive work time of a crew or individuals during a specific time interval. The ratio of productive work time to possible work time is a measure of manpower utilization. For example, if a man has been productively active for 6 hr out of

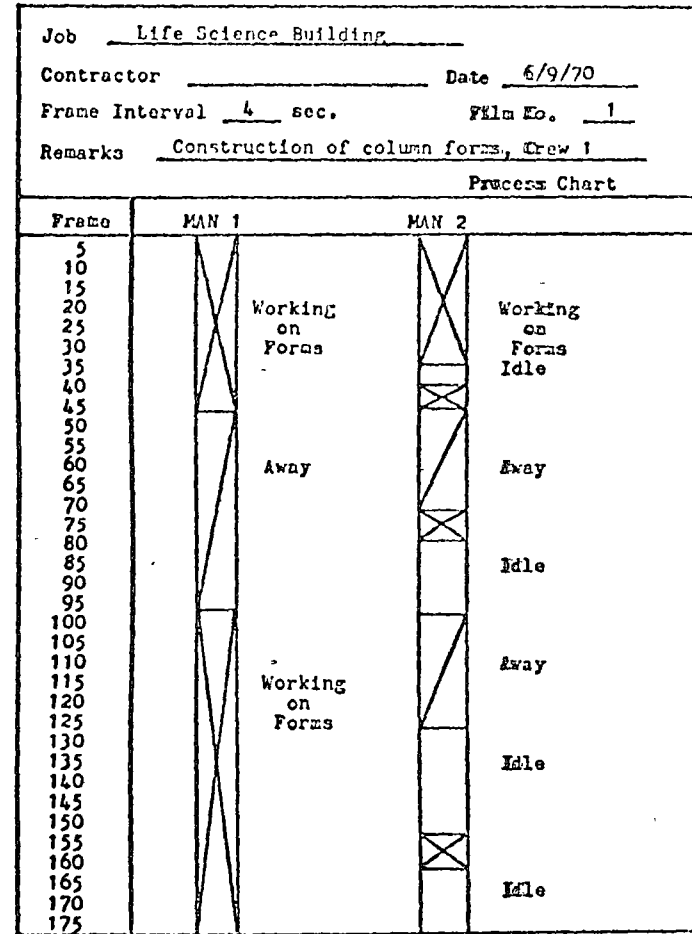


FIG. 7.—PROCESS CHART (CREW 1)

an 8-hr work day, then his utilization percentage or efficiency as a worker has been 75% for that day. Such studies should be of interest to construction management, for they provide basic information with regard to productivity. One experienced superintendent told the writer that he felt fortunate if his men were productive 50% of the time. Every manager should have in mind a utilization percentage which he wants to achieve at various working operations and under various working conditions. Obviously 100% utilization is not possible.

Extremes of weather, and height above and below ground will reduce man power efficiency and must be considered. The question of a reasonable utilization percentage is not within the scope of this paper. Only the methods of tabulating such information will be reviewed herein.

Activity studies may cover only a few minutes or an extended period, say an entire work day. The manager may be interested in a study which covers

Job <u>Life Science Building</u>				
Contractor _____		Date <u>6/9/70</u>		
Frame Interval <u>4</u> sec.		Film No. <u>1 & 2</u>		
Remarks <u>Construction of column forms, Crew 2</u>				
Process Chart				
Frame	MAN 1	MAN 2	MAN 3	MAN 4
545				
550				
555		Working		
560		on		
565		Forms		
570				
575		Climb	Climb	
580				
585		Away	Away	
590				
595				
600				
605				
610			Away	
615				
620				
625				
630				
635		Working	Working	
640		on	on	
645		Forms	Forms	
650				
655				
660				
665				
670				
675				
680		Climb	Idle	
685				
690				
700				
705				
710		Idle	Away	
715				
720				

FIG. 8.—PROCESS CHART (CREW 2)

a large group of workers or only a small group. The larger the group, the more difficult it is to collect data. This is where photography has an advantage over conventional stop watch studies. A camera can cover large areas and replaces several observers. Case 2 is an example of an extended activity study. It covers a full work day. The work activities were divided into categories

seen as working, idle, and rest (break). These categories were defined at the beginning of the analysis.

Case 3 contains examples of the short duration activity sampling technique known as the 5-min rating. This method consists of observing and classifying a small percentage of the total project activity. Where Case 2 covered the total activity of a crew for a full work day, activity sampling covers short periods of activity at random. If enough samples are taken, then the level of productivity of the entire project may be estimated. Activity sampling is fast; it directs attention to areas of poor productivity; and it enables management to locate those areas.

The 5-min rating technique receives its name from the rule that no crew should be observed for less than 5 min. A minimum observation time (in minutes) for any crew should be equal to the number of men in the crew. Thus, a 10-man crew should be observed for 10 min or longer. A three-man crew should be observed for at least 5 min.

The rating takes into account delays of two types, as follows:

1. Delay that impedes progress. The work is not progressing at an acceptable rate (poor method, material shortage, faulty engineering details).
2. Delays that affect the cost of the job even though work continues at an acceptable rate (too many men or too much equipment, or both).

The rating procedure is relatively simple. Each man in a crew is observed at the same time. The total observation period is divided into arbitrary equal time units of from 30 sec to several minutes (a unit of 1 min was chosen for Case 3). Within the time unit chosen, the ratio of delay to total possible work time is noted. If the delay is less than 50%, 0 on the time block is marked as effective. The ratio of the total number of effective blocks to the total blocks yields an effectiveness rating for the crew under observation.

The 5-min rating is considered herein only because it is another handy analysis tool that can be used to locate job delays and to indicate the need for better planning. The fact that the data have been collected by time-lapse photography is not intended to imply that 5-min ratings are best accomplished through photography. These short studies can be performed with reasonable convenience using the stop watch collection method. The 5-min rating should not be overlooked as another analysis tool regardless of the means of collecting data.

COST VERIFICATION

The ultimate objective in any of these studies is the reduction of costs through methods improvement and improved crew efficiency. Each time a particular operation is analyzed, the information which is accumulated can be converted into cost information, with the possible exception of short duration study data. For example, in Case 1, 5.10 man-hr and 3.41 man-hr were expended by two crews constructing a known amount of column forms. In Case 2, the number of man-hours (or crew-hours) expended can be equated to the quantity of work completed to determine floor forming costs. This type of information is inherently available and it is easily taken from the time-lapse film. The information can be used to check job estimates, to spot check costs, and for general estimating purposes.

Case 4 is an example of a collection of data used specifically to check the cost of an operation. The contractor had anticipated that it would take about 30 min for a crew and crane to pick up and reset a portable floor form. The average crew time for the several operations observed equalled 17. Time-lapse photographic equipment was used to collect the data. The operations observed took place within a period of about 6 weeks. The data were taken from the film as information in addition to the main subject under study. The information was easily accumulated as the job progressed. This same information could have been collected using conventional stop watch methods; however, scheduling was a problem. While the forms were scheduled to be moved at specific points in the overall job sequence, the timing of the moves was sometimes off as much as 48 hr. By taking the information from the film, the analyst did not have to be concerned about being too late or too early to observe the operation and thus waste his time. Instead, the camera was on the job all of the time gathering data.

CASE STUDIES

The following are case studies of actual construction operations. At the time of these studies only building construction work was available for observation. All data was collected using the time-lapse photographic method.

Case 1.—The work observed in this study consisted of constructing a plywood column form complete with steel form clamps. The column is about 15 ft in height. The work was concluded when the workmen had finished the form work and centered the reinforcing steel in preparation for pouring the concrete. Two different crews were observed working at different columns on the same day. To facilitate analysis, the operation was divided into the following activities or work elements:

1. Working on forms: This included movement of materials within about 15 ft of the column, placing plywood sheets, nailing, adjusting steel reinforcing cage, placing form clamps, placing metal keyways, and adjusting scaffolding.
2. Idle, doing nothing.
3. Climbing up or down scaffolding.
4. Away, out of picture area. In most cases the workmen were searching for materials.

The work element breakdown of Crew 2 shows an even distribution of activities between members of the crew. Crew 1 performed with an obvious difference. Their work was not evenly distributed. These differences can be seen in Figs. 3 and 4. The work element breakdown is tabulated in Tables 1 and 2. These in turn were used to plot the crew balance charts in Figs. 3 and 4. Process charts were plotted for both crews. Figs. 7 and 8 are extracts of those charts. Though the process chart was not a necessity in this analysis, it was helpful when tabulating each man's work element times. The process charts do show that the work flow of Crew 2 was smoother and better coordinated when compared with Crew 1.

By studying the crew balance charts and the process charts, it can be concluded that Crew 2 was more efficient than Crew 1. In terms of man-hours to perform the same amount of work, this is definitely the case, as shown in the following paragraphs.

Crew 1.—2 men \times 153 min = 306 min = 5.10 man-hr.

Crew 2.—1 man \times 93 min + 1 man \times 99 min + 1 man \times 9 min + 1 man \times 4 min = 205 min = 3.42 man-hr. (Man 3 and Man 4 on Crew 2 spent most of their time extending the metal scaffolding.) Note that Crew 1 expended almost 50% more man-hours than Crew 2 when performing an identical work operation.

The ratio of productive time to possible work time is a measure of crew effectiveness. Work elements No. 1 (working on forms) and No. 3 (climbing) are considered productive activities. The summation of the productive time:

TABLE 1.—WORK ELEMENT BREAKDOWN, CREW 1, CASE 1

Crew 1	Time, in seconds	
	Man 1 (1)	Man 2 (3)
1. Working on forms	8,268	3,456
2. Idle	292	3,372
3. Climbing	218	96
4. Away	364	2,248
Total	9,172	9,172

9,172 sec = 153 min

TABLE 2.—WORK ELEMENT BREAKDOWN, CREW 2, CASE 1

Crew 2	Time, in seconds			
	Man 1 (2)	Man 2 (3)	Man 3 (4)	Man 4 (5)
1. Working on forms	4,708	5,241	280	224
2. Idle	321	40	164	—
3. Climbing	248	236	68	28
4. Away	264	408	—	—
Total	5,541	5,928	512	252

5,928 sec = 99 min.

of Crew 1 is 201 min. The summation of the productive time of Crew 2 is 184 min. Thus, in terms of crew effectiveness, the crews performed as follows:

Crew 1 Effectiveness: 201 (Productive time)/ 306 (Total possible time) = 65.7%.

Crew 2 Effectiveness: 184 (Productive time)/ 205 (Total possible time) = 89.8%.

This case is a good example of the contrast between two different crews performing identical jobs. Crew 2 worked as a team apparently with some preplanning since most of their materials were close at hand. The team work of Crew 1 was erratic and too much time was spent searching for materials.

The obvious advantages of planned and coordinated work cycles are reflected in the man-hours expended by both crews and the crew effectiveness ratings.

Case 2.—The work observed for this case study consisted of the general preparation of a floor area for pouring. This included the cleaning and the oiling of portable (flying) forms, layout and placement of side and end bulkheads, placement of steel, and construction of a built-in-place floor form over a small area.

TABLE 3.—MORNING WORK ELEMENT BREAKDOWN, CASE 2

Work element (1)	Breakdown, as a Percentage		
	Man 1 (2)	Man 2 (3)	Man 3 (4)
1. Work	80.0	79.5	62.0
2. Idle	8.2	13.5	35.7
3. Instructional	10.3	1.7	1.1
4. Break	1.4	5.3	1.2
Total time, in minutes	155	165	161
Number of category changes ^a	54	67	59

^a Number of times worker changed from one of the five work elements to another.

TABLE 4.—AFTERNOON WORK ELEMENT BREAKDOWN, CASE 2

Work element (1)	Breakdown, as a Percentage		
	Man 1 (2)	Man 2 (3)	Man 3 (4)
1. Work	50.4	61.5	49.0
2. Idle	38.8	30.0	45.4
3. Instructional	8.9	1.2	0.0
4. Break	1.9	7.2	5.5
Total time, in minutes	101	121	81
Number of category changes ^a	53	93	54

^a Number of times worker changed from one of the five work elements to another.

This study was conducted to observe and analyze the activity of a crew for a full day. The workday was divided into two 4-hr periods, morning and afternoon. The same three men were observed for the entire day. At times the men worked as a team. At other times, they worked independently. The crew consisted of a working carpenter foreman (Man 1), carpenter (Man 2), and helper (Man 3). The work activities were subdivided into the following five work elements:

1. Working—actual physical production such as carrying materials; measuring, nailing, placing forms, etc.

2. Idle, doing nothing.
3. Instructional—either giving or receiving instructions.
4. Work Break—an obvious brief rest; e.g., a stop for water.
5. Away, out of the picture area.

During the time the men were out of the work area (away) their activities could not be analyzed. For this reason, the first four work elements have been considered in Tables 3 and 4. Thus, the total time represents only that portion of the workday that the men were within the work area covered by the camera.

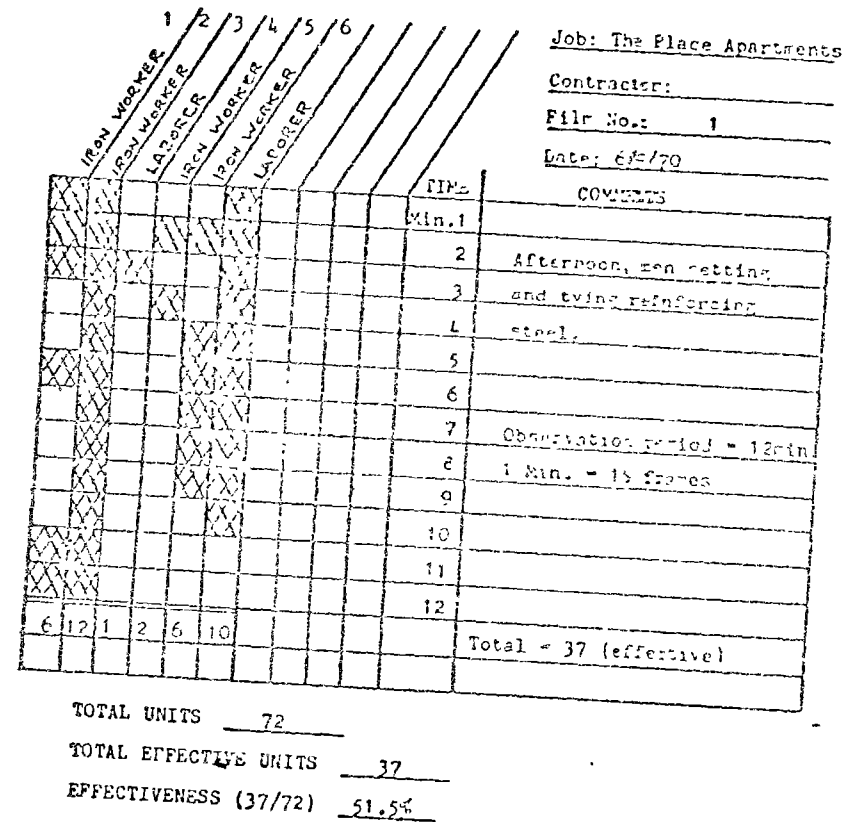


FIG. 9.—FIVE-MIN RATING (REINFORCING BAR CREW)

Tables 3 and 4 are the work element breakdown percentages for the morning and afternoon periods.

The data in Tables 3 and 4 do not reflect the following two observations made during the film analysis:

1. In many cases the worker performed for the longest uninterrupted period after taking a break (work element 4) or after receiving instructions (work element 3).

2. Much of the time spent walking and carrying materials could have been eliminated if the materials had been more centrally located.

The following are observations with regard to the preceding work element breakdown:

1. The workers were more productive in the morning. In the morning, element 1 (work) represented 73.4 % of the total combined time of the three men. For the afternoon, the same calculation yields 54.0 %.

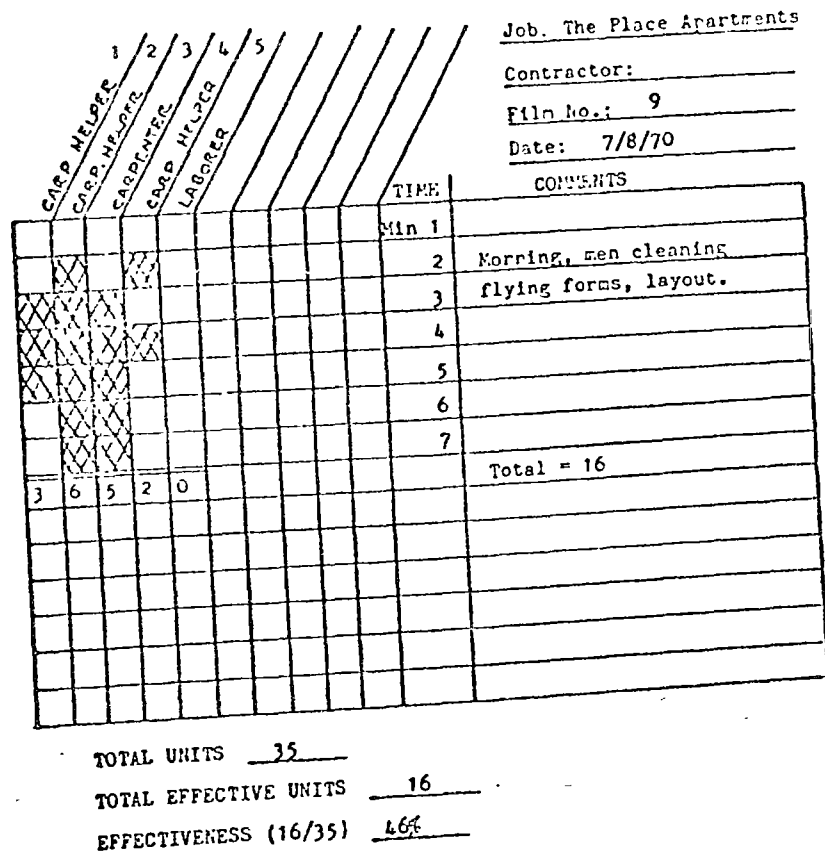


FIG. 10.—FIVE-MIN RATING (FIRST FORMING CREW)

2. Man 2 received more instructions than Man 3 and was also more active in elements 4 and 1.

3. The number of the element changes appears to have no influence on the percentages.

It was interesting to observe that Man 1 and Man 2 worked for the longest uninterrupted periods after receiving instructions and after taking a break. Further, Man 2 took more break time and received more instructions during

Man 3 while outperforming Man 3 by a considerable percentage in the work element. With these limited statistics, it may not be accurate to conclude that Man 2 outperformed Man 3 on the basis of instructions and break time. The possibility of such a conclusion may encourage further study in this area. It certainly seems reasonable to assume that improved work percentages are the result, at least in part, of proper instruction and rest periods.

Case 3.—Several groups of men were observed and rated using the 5-min rating activity sampling technique. Fig. 9 is the tabulation of a 5-min rating for a six-man reinforcing bar crew. The crew was placing steel for a concrete

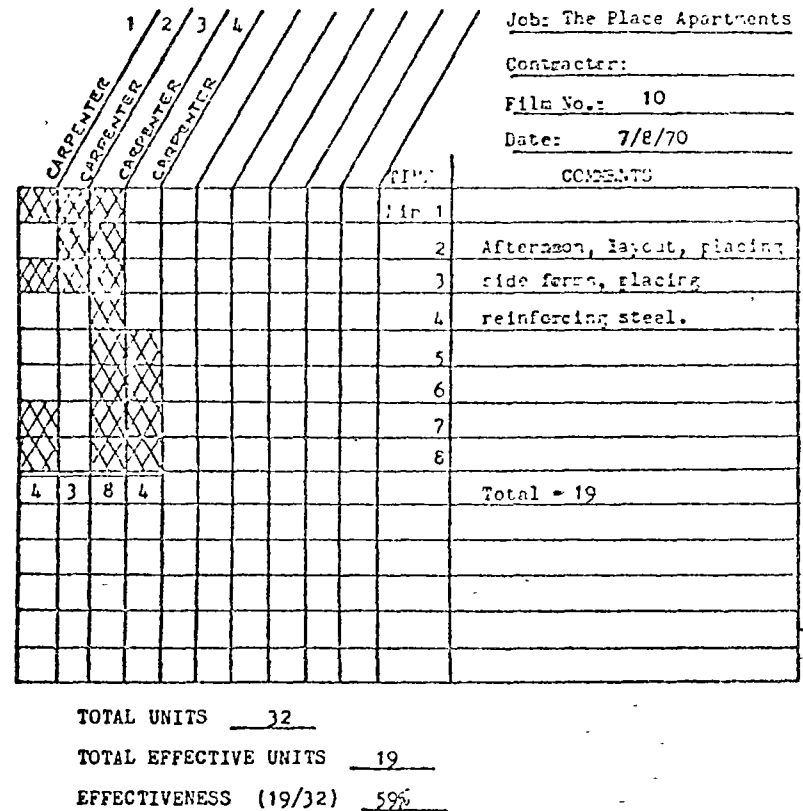


FIG. 11.—FIVE-MIN RATING (SECOND FORMING CREW)

floor. The effectiveness of this crew was 51.5 %. It was noted that most of the delays were of the second type described under the heading Activity Study.

Figs. 10 and 11 are the tabulations of 5-min ratings for crews which were preparing a floor area for a concrete pour. Their work consisted of cleaning and oiling the wood forms, placing bulkheads, layout, and some reinforcing bar placement. The delays observed in these ratings fell into both of the delay categories previously defined under the heading Activity Study.

Case 4.—The work observed for this case consisted of the relocation of

portable floor forms beginning with the crane hook-up and ending when the form is in its new position and unhooked. This type of form is made up of structural members spanned by a timber deck. The beams rest on rollers that are attached to the side bearing walls. The rollers are adjustable vertically so that the form may be dropped and removed after the floor (or roof) has gained sufficient strength. The form is attached to the crane by cable and rolled outboard from the building and flown to a new position.

Several complete operations were observed. The work cycle was broken down into the following three operations: (1) Hook-up (four hooks); (2) removal and relocation (flying); and (3) unhook (four hooks). The crew and equipment to perform the work consisted of two carpenters, one crane operator and a 25-ton hydraulic truck crane. The forms were 20 ft wide by 35 ft long.

Average time for each operation was: (1) Hook-up—9.7 min; (2) remove and reset—6.3 min; (3) unhook—1.0 min; and (4) Total—17.0 min. The average time for the entire operation was 17 min. The best time for hook-up was 2.8 min. The worst time for hook-up was 16.4 min. The best time for removal and reset was 2.9 min, and the worst time was 10.5 min. The best time for unhook was 0.3 min, and the worst time was 2.1 min.

There has been no attempt to show how to improve methods in this study, though it is obvious from the spread between best and worst times of the work elements that improved efficiency is possible. In most cases, the worst times were the result of mechanical difficulties or delays while waiting for a tool or for a crew member to appear.

The primary objective in this brief study was to obtain an average time for moving the forms to be used to verify or establish the cost of this relatively simple operation. This particular contractor was planning to use this same forming method on a future larger project. He had estimated that it would take 30 min to fly the forms. Based on the average actual time of 17 min, the contractor had saved about 43% of his estimated crew and equipment costs.

62

CONCLUSIONS

Although the intent herein was not to prove that time-lapse photography is a superior method of data collection, it is the writer's opinion that photographic means have definite advantages over conventional data collection methods. One camera can replace several men when collecting data. In addition, the film is a superior record when compared with the data sheets tabulated using the stop watch method. The film is a complete record of the work. The analyst may observe each man and machine individually as often as he wishes without doubt with regard to the accuracy of this visual data.

ACKNOWLEDGMENT

The data for the case studies presented herein were collected and analyzed using time-lapse equipment belonging to the Department Of Civil Engineering, University Of Florida, Gainesville, Fla. The writer wishes to acknowledge the helpful suggestions and assistance of Court Collier.

APPENDIX.—BIBLIOGRAPHY

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ACKNOWLEDGMENTS

Sverdrup and Parcel, Inc., and Moffatt, Nichol and Taylor, project design engineers, also supervised the construction for the sponsor, Multnomah County. Competitive bids for the work were received by the County and the four contracts were awarded as follows:

1. River Piers - Manson Construction and Engineering Co., \$1,908,516. Awarded October, 1955.
2. River Superstructure - American Bridge Division, U.S. Steel Corp., \$2,270,443. Awarded May, 1956.
3. East Approaches - Kuckenbergl Construction Company, \$2,971,571. Awarded May, 1956.
4. West Approaches - Donald M. Drake Company, \$1,178,300. Awarded July, 1956.

Journal of the
CONSTRUCTION DIVISION

Proceedings of the American Society of Civil Engineers

PHOTOGRAPHIC ANALYSIS FOR CONSTRUCTION OPERATIONS

By John W. Fondahl,¹ M. ASCE

SYNOPSIS

The problems of applying methods-study techniques to construction operations are reviewed. Based on these problems, certain requirements for a successful analysis method are developed. A method that meets these requirements is presented.

METHODS STUDY APPLIED TO CONSTRUCTION-PROBLEMS
AND REQUIREMENTS

The term "methods study" is used here in the more limited sense, implying formalized procedures such as stop-watch time studies, micromotion studies, and data analysis by process and multiple-activity charts. Utilizing such procedures, methods study has undeniably made tremendous contributions to present-day manufacturing processes. However it has contributed surprisingly little to one of the largest, most important manufacturing industries, namely construction.

Construction management claims that its problems differ from those of other manufacturing industries because it is required to manufacture:

- (1) a custom product
- (2) that is built-in-place
- (3) by a non-permanent work force
- (4) performing non-repetitive operations.

Note.—Discussion open until October 1, 1960. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. This paper is part of the copyrighted Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, Vol. 86, No. CO 2, May, 1960.

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When it is suggested that methods study and other industrial engineering technique be applied to construction, these factors are cited as inherent obstacles. Furthermore, it is generally claimed that the problems of both field execution and office estimating fall more nearly into the realm of art rather than science. Proper solutions depend on the individual "know-how" of the superintendent or on the keen judgment of the estimator.

The record seems to indicate that these obstacles either are real or that construction management firmly believes them to be real, since they have been little contested. A few companies employ "time studies," but these are usually confined to the cycles of large pieces of equipment. Historically, one of the founders of the science that developed into industrial engineering began in the construction field. Frank Gilbreth was a masonry contractor, and his improvements in bricklaying techniques, presented in the early 1900's, could bear review today by all of construction management. But Gilbreth soon turned to the more fruitful fields of shop manufacturing.

Obstacles become challenges, and the challenges are great ones when there is as much at stake as the level of productivity in the construction industry. Each of the four characteristics mentioned earlier, merits closer examination to determine how genuine and insurmountable an obstacle it presents.

A Custom Product.—This custom product is usually fabricated from common materials that have been used before by methods that have been used before. Although the overall structure may be unique, the individual cubic yards of earth excavated, buckets of concrete placed, or square feet of formwork built, erected, and stripped, are usually similar to thousands of other such units on the same job or on certain past jobs.

A Built-In-Place Product.—This condition presents a much greater challenge than that presented by industrial manufacturing. The industrial operator usually works at a fixed station under the same conditions for a long period of time. The construction worker moves continuously on the job and is affected by different working and climate conditions. Under these circumstances it is difficult to justify many of the possible improvements that would otherwise lead to more efficient methods. Jigs and specialized equipment, for example, lack mobility. Scientifically designed layouts of work locations may involve costs that could profitably be spread over several hundred cycles at one station but not over five or six cycles each at many locations.

It does not follow, however, that jigs, specialized equipment, and improvement of work layouts are ruled out. They must be developed with a knowledge of the variable working conditions and an understanding of the effects of each. Therefore a technique to analyze systematically and improve work methods or to develop estimating data should provide some means for taking into account and evaluating the many, variable work conditions.

A Non-Permanent Work Force.—There are two aspects of this condition. One involves the labor hired for the job which normally must come from the union local in whose jurisdiction the job is located. The second involves the supervisory personnel including foreman, craft superintendents, and sometimes the general superintendent.

The construction worker is a temporary employee not only because he must be hired locally but also because job activity, as well as overall company activity, continually fluctuates. It is difficult to justify special training for an individual employee who may be working for a competitor in another month. The easiest way out is to permit each man and foreman to go about his job as he sees fit, assuming that somewhere along the line he has acquired a know-

ledge of the economical ways of performing his type of work. Management, of course, decides the overall scheme of action and the choice of major equipment and methods, but details are usually left to the transient individual on the job. The result is that five foremen, given the same job to do, will probably perform it in five different ways. It would seem that one of these ways is better than the others; it also would seem likely that the best way of the five would fall short of a method devised in advance with careful planning.

The challenge for management to accept its full responsibility of determining the best methods of operation, including the details, is so different in construction than in other businesses except that it is more difficult to face. The non-permanent work force is one of the reasons for this difficulty. The contractor who makes no attempt to meet this challenge will not be able to compete with a contractor who can devise a successful method for meeting it. Such a method must provide a means for determining, down to the details, what is the best way to accomplish a given operation. But equally important is the requirement that this method must include a means to present and "sell" this work plan to the supervisory personnel who will have charge of its execution. This leads to the second aspect of the non-permanent workforce obstacle.

Supervisory personnel are, at best, only semi-permanent members of the organization. Construction superintendents and foremen come frequently from job to job and from place to place. Tenure of employment is not as important to the individual as it is in most industrial situations. The contractor must deal with independent and individualistic men. Because management has largely relinquished control of methods and details to the immediate supervising foreman or craft superintendent, these men often, quite naturally, resent and resist those efforts by higher management to step back into the picture. The human relation problems in bringing about the adoption of improved methods are very possibly much greater than the technical problems of developing them.

While definite problems are created by the field work force in construction, it should not be overlooked that real opportunities also are created by this condition. New men with fresh ideas and critical views continually pass through the organization. These men may keep their ideas and pick up new ones from each company for which they work. On the other hand the alert company can pick up ideas and improved techniques from its men on all levels. When methods are detailed by management, criticism and suggestions should be encouraged. What is needed is a technique by which changes may be evaluated and the reasons for adopting one step rather than another justified by fact rather than by hunch or intuition.

Non-Repetitive Operations.—It is easy to point out many construction operations that are highly repetitive within the course of a single job. Trucks may haul loads of earth over the same route hour-after-hour, day-after-day, month-after-month on some excavation or embankment contracts. A cableway may run through the same cycle while placing thousands of buckets of concrete in a large dam.

But what is more important to appreciate is the broader concept that even for those operations that will not be repeated under the same conditions, there are repetitive components which are essentially the same on different jobs. While the overall cycle involved in a crane-and-bucket concrete-placing operation may never be exactly duplicated again after the placement is completed, the component parts of the operation may be very nearly duplicated on hundreds of concrete placing operations. The time it takes to land the bucket or to unhook from one bucket and hook on to a full one may be similar on operations

that otherwise appear very different. The time it takes to spot the bucket over the point of discharge, once it has been swung to that point, depends on several factors that might be isolated and taken into account. The time of actual discharge involves factors such as size and type of bucket, consistency of concrete, width of forms, and spacing of reinforcing steel. But these factors also could be conceivably isolated and considered.

What is needed, then, are analysis techniques that make it possible to study the effects of different job conditions on operation components. If these are understood, most operations may then be considered to be made up of repetitive parts. However, construction cost accounting does not offer such an analysis technique. Stop-watch time study is a possibility but a rather unsatisfactory one. Only limited detail can be recorded and the effects of some conditions may be overlooked or never appreciated.

Review.—The foregoing discussion of the obstacles to a methods-study type of approach to construction work indicates that the problems are not insurmountable. The characteristics of construction magnify certain difficulties beyond the proportions encountered in other industries. Techniques for methods analysis and improvement to be successfully used in construction must recognize the importance of these problems and provide a means for solving them. Summing up the requirements indicated, techniques are needed that:

1. Supply information about construction operations that can be converted to tangible working data on time and cost.
2. Provide very complete documentation of the operation in order that the many varying conditions under which work is performed may be taken into account in the analysis.
3. Provide effective means of presenting findings to supervisory personnel in a clear and understandable manner.
4. Permit an evaluation of changes in methods and provide a factual justification for methods adopted.
5. Permit maintenance of a convenient file of data on past operations that will provide complete documentation and permit study of component parts of operations when necessary.

Another characteristic of construction work that has a bearing on the success of an analysis technique is that most work involves crews of men engaged in interdependent activity. Frequently one or more machines also becomes an important part of crew operations. To properly analyze such work, data is needed on each man and each machine making up the team, and these must cover both individual and simultaneous activity. This information might be gained by employing a battery of industrial engineers, each armed with stop watch and pad, but such an approach is prohibitively expensive, impractical because of a lack of properly trained personnel, and psychologically unsatisfactory on a construction operation. Therefore another requirement for a successful analysis technique for construction operations may be stated as follows:

6. It must offer a practical means for following and providing data on the individual and simultaneous actions of a crew of men or of men and machines working together.

The writer has no knowledge of any techniques fulfilling these requirements that are widely used in the construction field. The closest approach in general use is the development of cost accounting data supplemented by job reports,

histories, and photographs. These fall far short of placing method improvement or cost estimating on a scientific basis.

AN ANALYSIS TECHNIQUE FOR CONSTRUCTION OPERATIONS

An analysis technique fulfilling all of the requirements proposed would be a useful tool for construction management. The method that will be discussed appears to have the desired characteristics. It consists of three phases common to most analysis techniques: data collection, data analysis, and effective presentation of findings. The data collection phase is accomplished by photographing construction operations with a movie camera. Instead of motion pictures at conventional speeds, however, individual exposures are taken at regularly timed intervals. The data-analysis phase is accomplished by studying the filmed operation with the aid of a projector which permits viewing the movie film one frame at a time. An essential accessory on this projector is a frame counter. Knowing the intervals between individual exposures, the frame counter permits the simple determination of elapsed time for any operation photographed. It is also essential that the film may be easily cranked backwards as well as forwards to make reviewing of the operation a simple matter. The presentation phase requires projecting and viewing the particular operations for which changes have been developed during the analysis stage.

Motion picture studies have long been used by industrial engineers. The Gilbreths proposed the use of micromotion studies as early as 1912. Micromotion study involves the analysis of movies usually filmed at normal, rapid camera speeds such as 1,000 frames per min (or 16 frames per sec). A more recent variation of micromotion study began to find industrial application in the late 1940's. It was developed by Marvin E. Mundel and is termed memomotion study. Its principal difference is that the motion pictures are taken at unusually slow speeds. Speeds of 100 frames per min are commonly used, but speeds as slow as 50 frames per min and 1 frame per sec are also frequently used. For both micromotion and memomotion studies, the ideal equipment arrangement is a movie camera coupled to an external synchronous motor drive. This motor drive may have a gear shift arrangement permitting speeds ranging from 50 frames per min to 1,000 frames per min.

The data needed for analyzing many common construction operations can be obtained at speeds even slower than those normally included in memomotion work. Most of the field work undertaken by the writer has been performed at speeds of 20 frames per min which allows a 3-sec interval between pictures. This gives a convenient and satisfactory unit for most operations equal to 0.05 min. There is nothing sacred about this interval, however, and there are undoubtedly operations that might be more successfully analyzed with either a shorter or longer time lapse. With intervals of this length or longer it is possible to trip the camera manually while watching a stop watch. The automatic operation using an external motor drive still has a number of advantages that will be discussed later. But manual operation permits less elaborate equipment, much greater mobility, and the elimination of the need for an AC or DC power source. All of these are matters of importance in developing a successful method adaptable for use on construction jobs.

The equipment and procedure for field work and for analysis and presentation will be described in detail after advantages and possible uses of the technique have been discussed.

ADVANTAGES OF ANALYSIS TECHNIQUE PROPOSED

The analysis technique discussed has many advantages, some of which are readily apparent. Before suggesting uses of the technique, these advantages will be examined.

1. The simultaneous activities of each member of a crew of men or of men and machines may be recorded precisely. The interdependent functions of each crew member may be studied by charting the activities of every man, one at a time, by re-examining the film as many times as is necessary.

2. One observer can record crew activities. Crew activities are the rule rather than the exception in construction work. To get as accurate working data for analysis purposes by stop-watch time study, almost as many observers as crew members would be required. This is normally impractical.

3. Neither the observer who operates the camera nor the analyst, who often would be the same person, needs to be highly skilled in industrial engineering to achieve worthwhile results. Recording the operation with the movie camera is much less difficult than making a stop-watch time study in the field. The techniques of analysis can be determined later in the office after viewing the operation several times. Development of useful data and operational improvements should be within the capabilities of the contractor's engineer and other personnel. However, this statement does not imply that specialized professional competence is not recommended or not more likely to achieve maximum benefits.

4. The technique is very economical as compared to other means of obtaining equivalent data. A single observer is required in the field. The necessary equipment represents a modest investment. And the film costs are very low because the pictures are taken at such a slow speed. With a 3-sec interval between exposures and 4,000 frames per 100 ft roll, one roll of film will cover $3\frac{1}{3}$ hr of continuous operation. With typical commercial discounts the total costs for film and processing to cover this time of continuous operation might be between \$7 and \$8 for black and white and between \$11 and \$12 for color, using 16 mm film.

5. A tremendous wealth of detail is available on the hundreds of pictures taken that will serve to record the many conditions under which the work was performed. An observer may make notes, draw sketches, and even take photographs (these steps are also recommended with the proposed technique), but it is not possible by these methods to record as much information affecting the operation as by continuous filming. As indicated earlier, a real obstacle to the systematic improvement of construction operations or the collection of useful data for estimating and planning is that operations seldom continue or are repeated under the same set of conditions. It appears that the best solution is to record and evaluate the effect of each condition.

There is a second important aspect to the advantage of the wealth of detail recorded in filming. It is not always possible to foresee what conditions are important to record for later analysis of an operation. With the movie technique, future studies are possible that involve breakdowns of an operation into different components or that analyze the effects of conditions not originally recognized. This is not possible with stop-watch time study.

6. Analysis of film can be made at any later date. The wealth of detail recorded will still be preserved. Perhaps immediate analysis may be undertaken

for the purpose of method improvement on a current job. But when slack time permits or future jobs with similar operations come up, further analysis and new information can be obtained from films taken earlier.

7. Films may be easily indexed and filed for future use. Similar operations from different jobs may be spliced together for filing purposes.

8. A graphic, easily understandable presentation of operations analysis and improvements is possible. The method permits findings and recommended changes to be passed on to job supervisory personnel in a manner that is much more likely to be successful than mere figures and charts. It is not only a more understandable presentation but one that is fair to job supervision and not likely to result in changes that are not really justified. This is true because job supervision may be given the opportunity to review the operation and defend it or explain conditions not known to the observer or analyst.

9. Evidence is preserved showing the original methods by which an operation was performed. Analysis may result in improvements of this operation over a period of time. Moreover, each step may represent a simple and obvious change when viewed in retrospect. It is easy to forget the original methods and to fail to appreciate the value of improvements. A comparison of the original operation, recorded on film, with the final operation makes possible an evaluation of savings. These may be compared to the costs of applying the technique to help determine if the returns justify its continued use.

10. The film obtained in using this technique provides excellent material for instruction and development of personnel. The evolution of profitable changes can be illustrated to company members on all levels to create a frame of mind conducive to further improvements. Group viewing of past operations may encourage suggestions and discussion of problems. Methods developed on one job may be passed on to other jobs.

These ten advantages warrant consideration of the method as a useful analysis tool with particular applicability to construction operations. All requirements for an effective technique that were developed in our early discussion are fulfilled.

SUGGESTED APPLICATIONS OF PROPOSED TECHNIQUE

The film record obtained by the proposed technique is one well documented in detail, accurate, and showing the simultaneous actions of all crew members. A number of formal methods have been developed in industrial engineering practice to analyze operations where such data has been obtained. These methods include the construction of process charts and multiple-activity charts, both of which have numerous variations. Simply stated, the process chart is a condensed representation of the type and sequence of all steps involved in a particular job. The multiple-activity chart is a graphic representation of the simultaneous activities of a crew of men or of men and machines. Once constructed, the steps and activities shown on these charts are questioned in accordance with well-developed check lists. This approach leads to systematic improvements and seems to promise the most extensive benefits.

It is felt that the trial and adoption of the movie study technique in the construction industry will be much more likely if worthwhile results can be obtained with a minimum of specialized training by personnel already employed. This is probably even more true in the case of the analysis stage than of the field work required to produce the film. A contractor that might not hesitate

REPOS DE LA FACULTAD DE INGENIERIA

to hire a professional photographer to take pictures might be quite reluctant to hire specialized engineering talent to develop better methods for performing his work. Actually neither outsider seems necessary. Every construction firm should have personnel qualified to do the field work and also able to produce worthwhile results in the analysis and application phases. Once some success has been achieved, management would have less reluctance to seek specialized skills. However, this would probably not be necessary because the personnel who made the original efforts will study and attempt applications of more refined and formalized methods. The next logical step is to develop new analysis techniques particularly suited to the characteristics of the industry.

In this paper no attempt is made to present formalized methods, either existing or proposed. Five possible fields of application for the movie analysis technique are offered and general approaches are suggested.

Methods Improvement.—Constant improvement of methods is essential in a competitive industry. Some of these changes come in dramatic fashion after sudden inspirations. But consistently improved performance depends on frequent modifications, both big and small, and these result from careful study of existing operations. Such study on construction work is often based on direct observation, supplemented by a good knowledge of costs. For important problems, stop-watch time study data is sometimes collected.

The film analysis technique offers another basis for careful study. Among its advantages that are important for this application are:

1. Viewing an operation under conditions favorable to calm and constructive criticism.
2. Re-viewing of an operation as many times as desired and as slowly or fast as desired.
3. Pictures of the operation that give almost complete details of the conditions under which it was performed.
4. The possibility of breaking the operation into component parts and obtaining accurate time data even where the cycle is irregular and the observer unskilled in time study methods.

Having obtained a film showing a complete cycle or several cycles of an operation, the operation may be broken down into a number of component parts. This may be accomplished by cranking the film back and forth until definite break points are noted and agreed upon. A corresponding frame-counter reading at each such point permits simple determination of the time required to perform each operational component. The pictures themselves, supplemented by field documentation, provide a record of personnel and equipment taking part in the work. Knowing labor and equipment costs, the cost of each operational component may be calculated. The recorded data also provide a record of delays and causes. Once costs are determined for each operational component and delay, primary attention can be focused on the most important aspects of the problem.

It is advisable to examine the overall operation before studying individual parts in detail. The steps may be listed in the sequence in which they occur. Then the necessity of performing the entire operation and each of its component parts, as well as the order of performance, may be first questioned. There is no sense in making a detailed study of the method used in a step that might be eliminated or that should be performed at a different point in the sequence with certain necessary changes.

The most logical target for a methods' improvement study is a highly repetitive operation that is just getting started. Such operations should receive careful and early attention. The effect of any improvement that is made will be multiplied many times and the sooner made, the more times multiplied. Changes can be justified cost wise for a highly repetitive operation that cannot pay their way in fewer cycles.

Important opportunities for profitable methods improvement of a broader nature are offered by less repetitive operations also. It may not be possible to apply the improved method on the same job that indicated its desirability. But its application on future jobs may make valuable contributions to a company's long-range success.

One possible type of improvement illustrating the latter point is a change in design practice over which the contractor has control. For example, certain films of form erection indicated delays and difficulty in the field assembly of shop-built form panels. Unforeseeable variations in field conditions prevented precise fits and necessitated hand sawing and other modifications causing long delays. An alert superintendent would relay such problems back to the form designer. However, the movie analysis provided much better information for evaluating how serious these delays were and how much might profitably be spent to cure them on future work. The film indicated not only the direct delays but the adverse effect on other related cyclic operations. When similar work was encountered again, the designer might devise a new scheme permitting a simple and rapid means of modification during field assembly. A second example, somewhat similar, resulted from an analysis of the removal of individual pieces of form hardware as shown on films of a form stripping operation. Several pieces required unusually long times. Re-examination of the film indicated that the scaffolding was poorly located with respect to the hardware in question. This scaffolding was built integrally onto the form panel. This defect had gone undetected. Once brought home to the designer, more care could be given to future detailing of scaffolding.

A second type of improvement of a rather broad nature might be illustrated by a study of operational delays. Almost every operation involves several delays that account for a substantial amount of time. The specific delay, however, may not occur again. Many of these can be traced to a failure to have the right tool at the right time or to the lack of instructions as to what to do next. A related source of lost time is the rehandling of materials or the repetition of work because there has been no advance planning. A remedy for this general category of delays is the preparation of a simple pre-plan for each operation. This would indicate what is to be done; the labor, equipment and tools required to do it; and an outline of how it is to be accomplished. Films of operations could not only provide justification for such a policy but could indicate the effectiveness with which it was being carried out. This would probably be a by-product of other studies.

In seeking improved methods, the film analysis technique permits examination of the abnormal cycle as well as timing the average cycle. Where an operation is filmed over numerous cycles, the times can be listed. Usually the average cycle receives the most attention. However, the records of the unusually slow and the unusually fast cycles often have important information to offer. Scanning the tabulated cycle times, these abnormal cycles can be located, observed again, and carefully studied. The conditions responsible for the very long cycle may be discovered and possibly avoided in the future. More

important, it may be possible to duplicate the conditions resulting in the very short cycles and to adopt this procedure in the future. The type of information needed for such studies is generally lost in other analysis techniques.

Trouble-Shooting.—Responsible contractors establish cost accounting systems for each job, breaking the job into a number of activities and indicating a budgeted amount of money for each. When actual field costs differ substantially from budgeted costs, there is an indication that something is wrong. It may be that field work is being poorly executed or that field methods do not follow the plan envisioned by the estimator. Or it may be that the estimator based his figures on an unrealistic method or was overly optimistic about production. The cost accounting system can indicate that a problem exists and can show the area in which it exists. But no matter how detailed the system is, it usually does not pin point either the trouble or the responsibility for the trouble.

Assuming that the cost item involved is an important one and that management is aware of the problem early, or that the same type of operation will occur on future jobs, it is very desirable to determine the cause of the discrepancy between budgeted and actual costs. By filming and analyzing one or more complete cycles of the operation, the cost accounting figure can be verified or challenged and trouble-spots may be isolated. Careful study by both job supervision and the estimator should result in constructive criticism. Both will desire to justify their part in the work, and each can make contributions to help the other when given such an opportunity.

A further advantage in connection with trouble-shooting applications is that a full cycle of a long operation can be recorded on the job and brought into the home office for study. The erecting, stripping, and repair of forms for a repetitive concrete placement may represent a cycle of 3 or 4 days. Top management and estimating personnel seldom can devote that amount of continuous time to field observations on one project. But when studies are made by other methods and sent back to the home office, there usually is insufficient detail to explain completely how and under what conditions the operation is being performed. The film analysis technique overcomes these difficulties.

Presentation and Education.—Finding a method improvement or operation shortcoming is only part of the job of accomplishing a cost reduction. The improvement must be put into effect or the shortcoming eliminated. In either case, a "selling" job is required. Many worthwhile improvements that might result from formal and detailed studies by highly paid outside consultants mean only an unjustified expense if job supervision cannot be convinced of their value. Suggestions, even when supported by figures and charts, are often more easily sold to home office management than to the man actually in charge of performing the work. Yet it is the support of the latter that is essential.

A film of past work permits a clear and understandable demonstration to supervision of the conditions that led to a suggested change. As pointed out before, it also gives the field man an opportunity to explain and defend existing methods. Otherwise, in some cases, changes may be forced upon him to the detriment of job costs as well as job morale.

The critical viewing of films of their company's operations provides an excellent means for making personnel conscious of method improvement opportunities and of the advantages of good planning and organization. To drive home a point, an operation may be viewed with the same time interval between frames as was used in the filming. Watching a crew of men standing idle during the

span of an unnecessary delay is much more effective than a mere presentation of written facts and figures.

For the education of engineers and foremen, the study of films showing various methods and the development of time and cost data from them can be a very valuable by-product of the movie analysis technique.

Estimating Data.—The common procedure in estimating new work is to draw on past experience where it is available. This past experience, at best, is recorded in the cost data obtained from jobs having similar operations. However, the cost data has very limited direct application, even after adjustment for changes in price and wage levels. It has been pointed out that in construction work similar types of operation are normally performed under very different conditions on each job. The cost data must be modified by a judgment factor to give a quantitative determination of how much more or less difficult the operation at hand is as compared to that on the past job. Such adjustments might be made on a sounder basis if films were on file to show the conditions under which the historical operation was performed. This would assume that the operation is important enough in the future job to warrant the time spent in viewing such films.

Considering this procedure with a much broader viewpoint, the possibility should be studied of developing estimating data that minimizes the degree of individual judgment required for its use. When the application of electronic computers, capable of performing tedious calculations and drawing information from storage sources, is suggested for construction estimating, the necessity of this great degree of individual judgment is cited. It is suggested that a long range program based on analysis of data obtained by the movie technique could put estimating on a more scientific basis and even, possibly, permit computer applications.

A competent industrial engineer can predict with reasonable accuracy how long it will take a person to perform a given task. For example, how long will it take for a man to stand up, walk across the room, pick up a book, and return to his chair? There have been developed tables giving the number of time units required for certain elemental movements. For these, almost any conceivable sequence of movements can be assembled to represent an operation by combining the times required for such motions as Stand, Walk (per pace), Reach, Grasp, Turn Body, etc. While the application of these detailed elemental times may not be immediately practical for construction estimating, a parallel system involving the times required for recurring elemental parts of repetitive operations may have value.

Consider the case, mentioned earlier, of the concrete placing operation with bucket and crane. This basic operation is repeated thousands of times by individual contractors, but every placement varies in some respects. The overall operation might be broken down into a number of component parts, and the conditions affecting the time for these component parts might be studied. With such information, the construction estimator might be able to assemble an artificial operation in the fashion that the industrial engineer predicts the time for a series of movements.

To carry the illustration further, assume the concrete placing operation is broken down as follows:

- A. Unhook from empty and hook on full bucket
- B. Hoist and swing bucket to dump location
- C. Grasp and spot bucket ready to dump

- D. Dump bucket
- E. Swing and lower bucket to fill location
- F. Spot and land bucket

The time to perform each component is affected by a number of conditions. By analyzing numerous film records, all showing in detail the conditions that existed for any single placement, these components can be studied and the effect of various conditions isolated. For example, the time to "hoist and swing bucket to dump location" might depend on a number of conditions such as:

1. Height of hoisting
2. Angle or distance of swing
3. Necessity to boom out or back
4. Visibility of dump location or reliance on signalman
5. Size of bucket
6. Size and type of crane
7. Skill of operator

Some of these conditions may have considerable importance and others have little effect. It appears that the task of evaluating each of several components for each of several conditions will be a great one. If more dependable estimating for a highly repetitive type of work resulted, the effort could be justified. Moreover, it is probable that findings leading to better methods would be developed long before data collection was finished. The concrete-placing operation has been cited merely to illustrate the approach; setting and stripping framework, for example, may be a more fruitful area of study. Whatever the subject, the method of approach is generally the same.

The need for keen estimating judgment would not be eliminated even if an artificial operation could be developed with considerable accuracy. However, the application of judgment would be confined mainly to the necessary allowance for delay time, both avoidable and unavoidable. This delay time is of considerable importance in most cycles, amounting to perhaps 25% to 50% of the total time. The fact that its effect is isolated is very worthwhile, since once its importance is fully felt, efforts to minimize the delay portion of operation cycles will be more pronounced. In addition, by isolating such non-productive time, a measure of job supervisory efficiency might be established.

Methods and Equipment Selection.—Method and equipment selection, to be intelligent and correct, must be based on facts. All too often they are not available, and the adopted plan is based on intuition or on the familiarity of the job superintendent with one of the alternatives. For example, even on the same job, superintendents and foremen will argue the merits of one type of form hardware versus another. The comparative material costs are relatively simple to determine, but comparative labor costs are often matters of opinion. Reliable data on the time to install a single tie or to remove it, the time to make necessary adjustments, and the time to patch the different size holes left in the concrete, is lacking.

Conventional sources of data often do not give results in sufficient detail to serve as a dependable guide. Cost accounting data may indicate a lower unit price on past jobs for one method than another. However, many cost components are generally lumped in any cost accounting item, and these components may be in different proportions on different jobs even though the work appears similar. In such cases, this apparent factual basis for method selection may be completely misleading.

The data needed to develop accurate times for estimating purposes will also serve as a basis for method and equipment selection. Once a job has been successfully obtained, method and equipment studies should be repeated in greater detail. If a set of data has been developed by the movie analysis technique, its application in job planning should be even more productive than in estimating, since more detailed study is justified.

Data for both estimating and planning can be continually improved as time goes on. Experiments can be undertaken with different size crews, with different capacities of equipment, and with variations in equipment types and accessories. Where these experiments do not lead to immediate method improvements, they will at least produce data that may aid future choices.

DETAILED DESCRIPTION OF EQUIPMENT AND METHODS

Camera and Tripod.—A good movie camera capable of producing a clear picture is a prime requirement. The 16 mm film gives the analyst more detail with which to work than does 8 mm film.

A three-lens turret is desirable. A regular lens, a wide-angle lens, and a telephoto lens may all be used to advantage, sometimes while filming a single operation. For example, the wide-angle lens will permit pictures showing the entire scene of the operation including the relative position of equipment and material sources. The regular lens will permit concentration on the movements of a crew engaged in the principal activity in progress. The telephoto lens will permit sequences to be filmed of the detailed motions of one of the crew members. If the turret is equipped with a handle, quick changes can be made from one lens to another without missing any exposures and without disrupting lens settings. This requires a view-finder that may also be changed quickly to correspond to the focal length of lens being used. A vari-focal (or zoom) lens was not tried. Such a lens has a variable focal length that permits any angle of view within a certain range. The range may be nearly as great as that from a wide-angle to a telephoto lens. This would be an advantage because the maximum degree of detail could be obtained by adjusting the lens to just cover the required area of activity.

A full winding of the spring motor drive in the camera, used by the author, permitted the taking of over 700 pictures. At a 3-sec interval this is equivalent to more than a $\frac{1}{2}$ hr operation. There is no necessity to interrupt filming even at the end of this period since the camera may be rewound a turn or so at a time between exposures.

Pictures may be taken over a period of several hours while following work at a single location. Therefore the camera should be tripod mounted. It should be possible to rotate easily the tripod head in both horizontal and vertical directions and to clamp it quickly in any position. Telescoping legs are desirable. They may be easily adjusted for difficult camera locations. Moreover, compact equipment is important when position changes involve ladder climbing and movements through restricted openings. Sharp, pointed tripod feet have been found advantageous in setting up on narrow scaffolding planks and other confined footings.

Timing Devices.—If the interval between pictures is long enough, the camera can be tripped manually. In this case a stop watch hung from or near the camera is the simplest timing device. A conscientious operator is capable of

achieving satisfactory results with manual operation. While any one interval between exposures may be incorrect by perhaps as much as 50%, there should be no cumulative error. The time derived from a large number of frames should be closer than a single interval to the corresponding total time measured by the stop watch. No greater accuracy is warranted.

The principal disadvantage of manual operation is that the operator must stay at the camera and has no time for other activity. It should be readily apparent that detailed documentation during filming is very important for later analysis. Even though the pictures will show the scene of operations in full detail, many questions need to be answered. For example, what is causing a delay or where is a man going who leaves the work location or what is taking place on the far side of a vertical form panel, etc? To obtain answers to these questions for the analyst, the camera operator should be able to leave the camera and should also have the time to record his findings. Obviously, a single operator cannot do these things while tripping the camera shutter every few seconds.

One solution to this problem is a second operator, but this doubles the labor requirement for obtaining data. A second solution is an automatic drive. Such automatic devices are standard for micromotion study. They consist of an external, alternating-current motor, with a gear box, that drives the camera at a selected speed. This equipment is mounted beside the camera on a base plate which, in turn, is mounted on the tripod head. Available standard equipment could probably be further geared down to the slower speeds that seem desirable for construction studies and could be converted for battery operation. Another alternative would be the design and construction of special equipment. While this custom equipment could also be designed to drive the camera directly, making periodic re-winding unnecessary, a simpler arrangement might be achieved with a timer and solenoid employed merely to trip the shutter as in manual operation. Direct current power sources or spring motor drives introduce problems of timing accuracy that must be considered. If a battery is chosen as a power source, it should be of such capacity that a single charging would provide ample power for a whole day's filming.

In deciding between manual and automatic operation the disadvantages of decreased mobility must be weighed against the advantages of better documentation. There are situations where either type of operation may be preferable to the other. Therefore, it is recommended that the operator have equipment for both manual and automatic operation.

Other Field Equipment.—An exposure meter, properly used, is recommended, since correct exposure is necessary to give clearly defined detail on the film. A note pad is essential. Information about the operation must be recorded and elapsed time for interruptions in picture taking must be logged. A well-designed bag or carrying case for camera, accessories, film, and tools will provide protection for equipment.

A major piece of equipment which has not been tried but is suggested as a possibility is a tape-recorded type dictaphone. These units are available in very small sizes including their battery power source. If manual operation were being used, the dictaphone would permit the operator to record remarks on the tape and reference them to stop-watch times or to frame counter readings. This could be done while pictures were being taken. Even with automatic operation, the dictaphone might offer an advantage. It would encourage more complete documentation since it is easier to record observations orally and one can continue to watch them while recording. Here again the question of mobility must be balanced against the advantages of this type of equipment.

Field Operation—Common sense and planning are required to obtain good pictures. The operation to be followed should be reviewed in advance to estimate how long it will take, over what area it will take place, and where most of the action will occur in any one location. Suitable camera positions are often extremely difficult to find and should be chosen in advance if possible. It is desirable to be as close to the operation as possible in order to record detail but, at the same time, to be far enough away that the entire work scene and all members of the crew can be included by using the wide-angle lens. Lighting is very important and changes during the course of the day should be anticipated. To avoid interruptions, camera positions should not be in the paths of equipment or workers. Sometimes an operation will require a choice as to what portion will be filmed. When a large vertical form panel is being set, pictures can be taken on one side or the other but not both, unless two cameras are employed.

Any delays in picture taking may be indicated on the film by covering the lens to produce one or more blank frames. If the camera is stopped during the delay, then the starting time of the delay and the time picture taking is resumed should both be logged in the notes.

Valuable information can be recorded during an operation by occasional side shots. For example, the time at which the next ready-mix truck arrives at the site, or the destination of the crew member who leaves the scene to get more nails or a different tool, can be shown. These facts may help the analyst in suggesting operation improvements. Before and after an operation has been filmed, a series of miscellaneous shots may be taken to show the area surrounding the work location and to note special details that affect the operation. These will supplement the notes and sketches prepared by the person conducting the study.

Periods ranging from 4 days to 2 weeks were spent on different projects experimenting with the field operations for this analysis technique. During that time there was no indication of objections or hostility by the men on the job or their union representatives. There was interest in the procedure and its purpose, and questions were answered as fully and clearly as possible. Most operations were filmed over continuous periods of $\frac{1}{2}$ hr to one-half shift. The writer was unable to detect any change in the level of activity when picture taking was commenced or completed.

Film and Processing.—For micromotion studies of shop manufacturing operations, black and white film is used almost exclusively. Its higher speed is desirable for indoor work, and it is more economical. Most construction work is outdoors, and the slower color film can be used. Proper exposure is more critical. Under some conditions this can be a decided disadvantage. For example, in photographing a pipe-laying operation in a deep trench, series of pictures were taken alternately of trench-bottom activities and trench-side activities. The frequent changes in camera setting required by color film were avoided by use of black and white film. The pictures taken into the trench were somewhat underexposed, and the other pictures were somewhat overexposed, but all were useable. Cost of film and processing is about 50% higher for color. Where the color is an aid to the analyst this extra expense can generally be justified. When the work is some distance from the camera and a large number of men are in the crew while others, including inspectors and engineers, appear for intervals, color helps to distinguish one individual from another.

Film selection also depends on availability and processing service. Many camera stores do not stock black-and-white film because of the small demand

for it. Therefore it should be purchased in sufficient quantity before leaving for the job site. In some locations processing service is faster for black and white film and in other locations it is faster for color film. Service may range from less than 1-day's time to 1 or 2 weeks or more. Where job-site analysis is planned with the objective of immediate method modifications, processing time is very important. It is conceivable that a mobile processing kit would be a necessary item of equipment.

Film Analysis Equipment.—Individual frames on films may be viewed at length. Therefore the projector used for analysis purposes must be equipped with a low wattage bulb or an effective blower or generally both. The film is turned slowly and frequently stopped, and this may be done simply by a hand crank. It is essential that this cranking be done easily in both directions. A frame counter is a necessary accessory on the projector as it gives the length of each operation and also serves as an index for rapidly finding a given point on the film. The film may be projected on a small shadow box screen set on a table top on which the analyst works. Standard printed forms will assist in indexing the contents of various films, in documenting and logging any delays on each film, and in performing analysis studies.

CONCLUSION

This paper has suggested the use of an analysis technique for construction operations and has indicated its advantages, proposed several types of applications, and described in some detail the equipment and procedure. The writer feels that in many situations this method will furnish more useful data than other possible analysis methods and will overcome certain obstacles to the successful improvement of construction operations.

Such improvements can be attained through changes in performance that are completely within the domain of management. When formal approaches to methods' study are suggested, the remark that "the unions won't let us" is too common. In most cases this is an excuse rather than a valid reason.

The writer's experience, admittedly limited, has been that the average worker on an engineering construction project is willing to perform a reasonable day's work. His output could be increased markedly, but chiefly by planning his work in advance and giving him better instructions, by seeing that he has the right tools at the right time, by not requiring him to perform unnecessary operations, by making him part of a correctly sized crew, and by not slowing him down as a result of avoidable delays. All of these should be management functions.

Our nation's Number 1 industry deserves more attention directed towards increasing the level of production. The analysis method suggested here is supported by only limited field application on construction projects. It may provide a useful tool. It is hoped that it will receive further trial in construction and that better defined procedures for field work and film analysis, adapted to construction, will be developed.

ACKNOWLEDGMENTS

This paper results from studies being performed for the Bureau of Yards and Docks, of the United States Navy Department, for improving the training of

the personnel and operations of the Naval Construction Battalions as well as for the general improvement of Navy construction and maintenance operations.

Clarkson Oglesby, F. ASCE, Department of Civil Engineering, Stanford University, reviewed and made numerous helpful revisions in this report.

The Industrial Engineering Department, Stanford University, made photographic equipment and analysis equipment available for the author's use.

The following men extended full cooperation and all possible aid in allowing experimentation and trial of the technique on their construction projects:

William Swigert, President, Pacific Bridge Company, Alameda, Calif.;

John Dean, Project Manager, Pacific Bridge Company, Oroville, Calif.;

Robert Haney, Project Manager, General-Pacific Bridge, North Vancouver, British Columbia;

Oscar Holmes, M. ASCE, Owner, Oscar C. Holmes, Inc., Menlo Park, Calif.;

and

Joe Perez, Superintendent, Oscar C. Holmes, Inc., Palo Alto, Calif.

PHOTOGRAPHIC ANALYSIS FOR CONSTRUCTION OPERATIONS¹

Discussion by Robert F. Borg

ROBERT F. BORG,²F. ASCE.—The method of photographic analysis presented by Mr. Fondahl should provide a rewarding technique to construction management interested in some of the fundamental problems of our industry. Too often, as the author points out, we are content to simply let habit take its course, and permit operations to proceed along the path of least resistance, without seeking to improve them. The specific applications possible with the techniques described in the paper are only hinted at by the author, and this writer would like to present, herewith, a broader view of this field.

Mr. Fondahl concentrates most of his thought and his technique on essentially small scale, individual team, or gang activities. There is much work still to be done in this field, and it can be done both in the laboratory and on the job. Surely, we in the industry are all interested in more bricks to be laid per day, more cubic yards of concrete placed per shift, more square feet of tile placed per day per setter and helper and so forth. It is a pity that the author has not provided some actual photographic illustrations and their analyses, but it is hoped that in his closure he may be able to do this.

The writer's experience, from 20 years in the construction industry, indicates that the basic problem lies elsewhere than in increasing the efficiency of the individual tasks. Essentially, the efficiency sought by the author would result not only through analyzing the rudimentary components of the various individual trades, that by providing continuity for the various trades. It is this continuity that is basic to efficient construction, and perhaps more decisive than whether it is 500 bricks per day or 550 bricks per day, for example, that a bricklayer can lay. Certainly, few activities undertaken by man exceed, in physical size, a modern construction job, and not many products of his physical work exceed it in logistics and complexity.

A building operation requires the close coordination of between 40 and 60 subcontractors and suppliers, and scores of men and tools, most of which are in one way or another interdependent. The manipulation of these forces, so as to provide the correct cues for each trade, each mechanic and each piece of equipment or material is the problem really worthy of study and one to which we hope Mr. Fondahl will next direct his attention. What does it matter how many square feet of forms a gang can erect in one day if there aren't enough footings poured in advance to erect on, or if the plumber isn't ready for us to close his pipe trench under the footings, or if the reinforcing details were completed too late for bars to have arrived at the job, or if unexpected rock has slowed down the excavation, and so on, and on. In every one of these

¹ May, 1930, by John W. Fondahl.

² Genl. Mgr., Kreisler-Borg Constr. Co., White Plains, N. Y.

interrelated trades is the core of analysis of construction operations. Surely, Frank Gilbreth, as the author pointed out, turned from analyzing "bricklaying techniques" to more "fruitful fields", because there are indeed more fruitful fields in the broader aspects of analyzing field operations.

Just as the skilled aerial surveyor can examine photographs of terrain and derive intelligence and knowledge, so can the skillful analysis of memo-motion pictures and micro-motion pictures reveal consequential data. The memo-motion pictures, described by the author, had 3 sec intervals between pictures. What happens to the results when the intervals are stretched to 30 days between pictures? The accompanying illustrations, (Figs. 1-18) make the results startlingly evident. It enables us to study a broader view of the project operations. "Broader" means that overall construction planning and techniques are analyzed to provide the proper scheduling and coordination of the various parts of the work. This is done primarily in order to yield the greatest amount of unbroken stretches of continuity in the work for the greatest number of trades and men.

The accompanying illustrations were progress photographs made by a professional photographer during the course of construction of a building project by the firm with which the writer is associated. The job shown is that of the construction of Public School 27, Yonkers, N. Y. This building, the total approximate cost of which is \$893,390 00 consists of a thirteen classroom and two kindergarten addition to a small existing school building. The building also has a large octagonal shaped all purpose room, kitchen, stage, library, faculty room, and offices. The building is constructed on a reinforced concrete foundation with a structural steel and steel joist frame. The floors are poured concrete on corruform, the roof pre-cast lightweight concrete planks. The building features aluminum windows and entrances, terrazzo and asphalt tile floors, and glare reducing tempered glass.

From an inspection of these figures, we may learn the following:

1. Was the contractor's chosen sequence of operations for demolition effective? (West to East, or back of photograph towards front) the result was the efficient removal of old buildings and debris.

2. Did the foundation sequence that was chosen result in the desired ultimate completion sequence? (The owner desired that the classroom wing and boiler room be ready for occupancy before the rest of the building. The classrooms are in the two storey wing in the rear and in the one storey wing at left. The boiler room is in the angle left in the old building.) Foundations were started in the classrooms first (May, 1959). The steel was erected first in the classrooms (June, 1959). The boiler room area was delayed, however, and the steel was not erected until August, 1959.

3. Was access road for rock excavation (lower right, May, 1959) best, in view of the circumstances? The route seems shortest and most direct, particularly for access by materials trucks after the start of the classroom superstructure in (July, 1959).

4. The steel joist erection in June, 1959 was performed by stacking joists in bundles at various levels. Does this method give the best result? This makes the most efficient use of a crane for hoisting into place. Bundles are landed on floors quickly, the cranes dismissed, and the joists are separated by hand using only one man per joist.

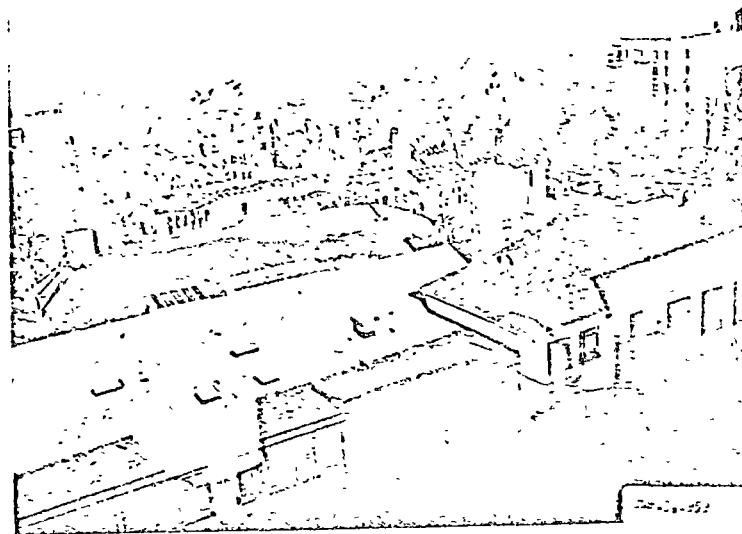
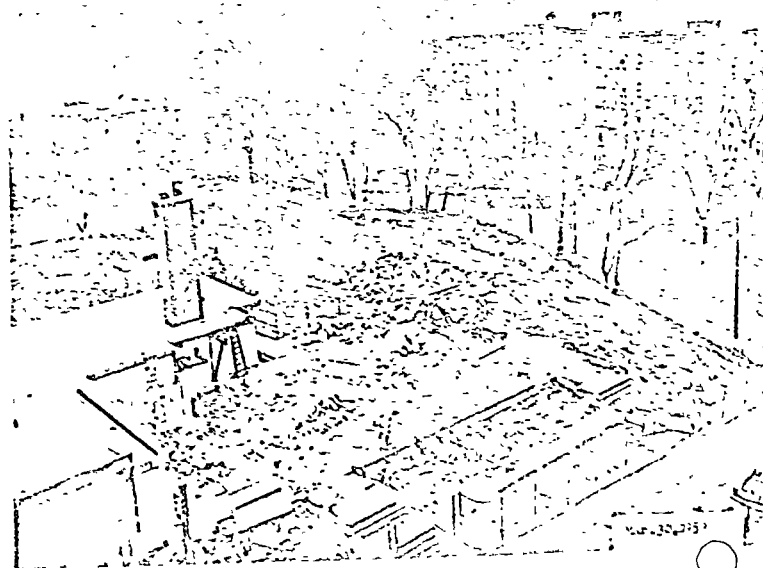


FIG. 1.—DEMOLITION OF EXISTING BUILDINGS COMMENCED, 3% COMPLETE.



CONSTRUCTION SITE GRADING UNDERWAY.

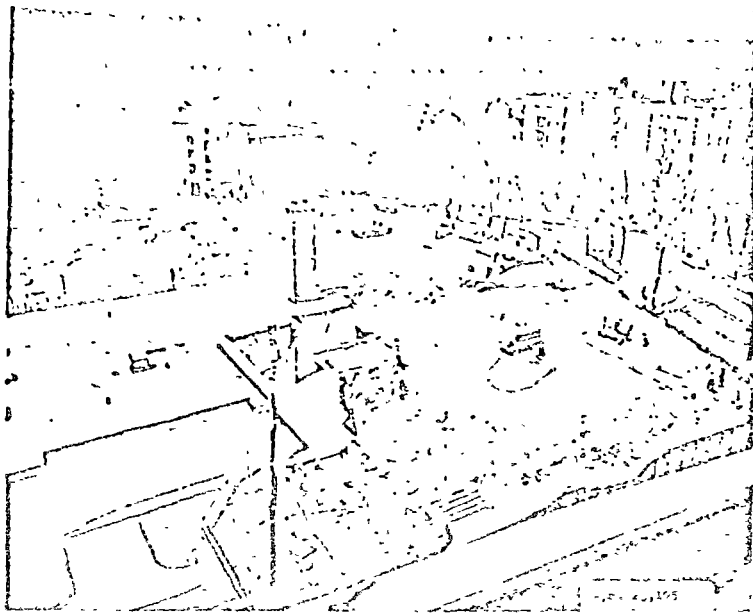


FIG. 3.—FOOTINGS COMMENCED ON CLASSROOM WING, ROCK BEING EXCAVATED ALL PURPOSE WING, 10% COMPLETE.

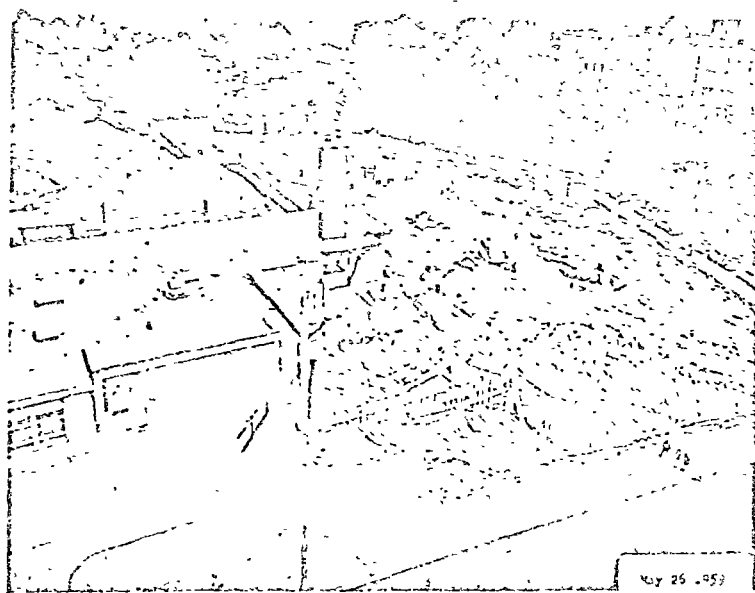


FIG. 4.—FOUNDATION WALLS AND WATERPROOFING UNDERWAY IN CLASSROOM WINGS, FOUNDATIONS COMMENCED BOILER ROOM, 19.5% COMPLETE.

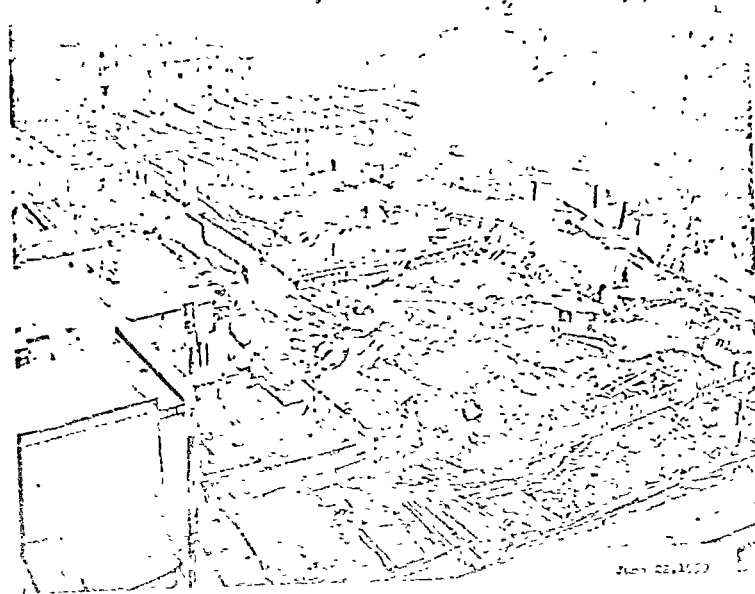


FIG. 5.—STRUCTURAL STEEL AND JOIST ERECTION PROCEEDING CLASSROOM WING, FOUNDATIONS BOILER ROOM COMPLETE, FOUNDATIONS COMMENCED ALL PURPOSE WING, 29.5% COMPLETE.



FIG. 6.—ROOF DECK AND CONCRETE FLOORS INSTALLED CLASSROOM WING, WATERPROOFING OF FOUNDATIONS COMPLETE, STEEL DOORS AND FRAMES DELIVERED, 35% COMPLETE.

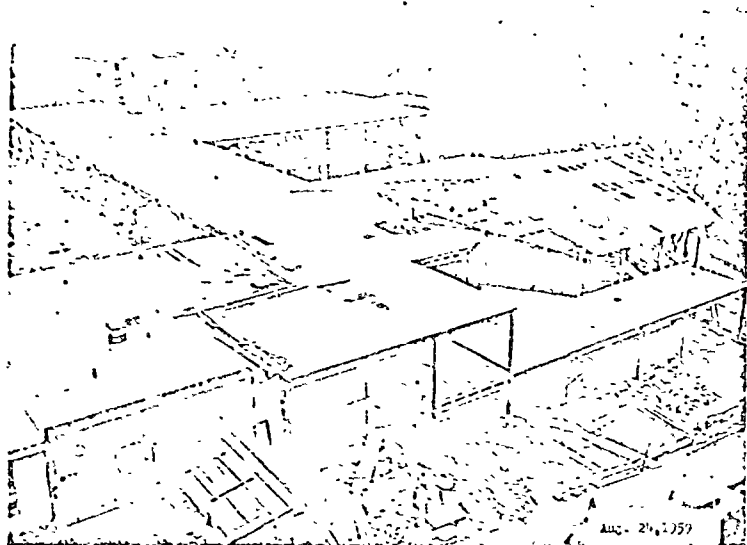


FIG. 7.—ALL STRUCTURAL STEEL AND BAR JOISTS ERECTED, ROOF DECK, CONCRETE ON CORRUGATED METAL, AND SLABS ON GROUND, BEING COMPLETED, MASONRY, CARPENTRY, STEEL STAIRS, AND DRAINAGE COMMENCED. 41.5% COMPLETE.

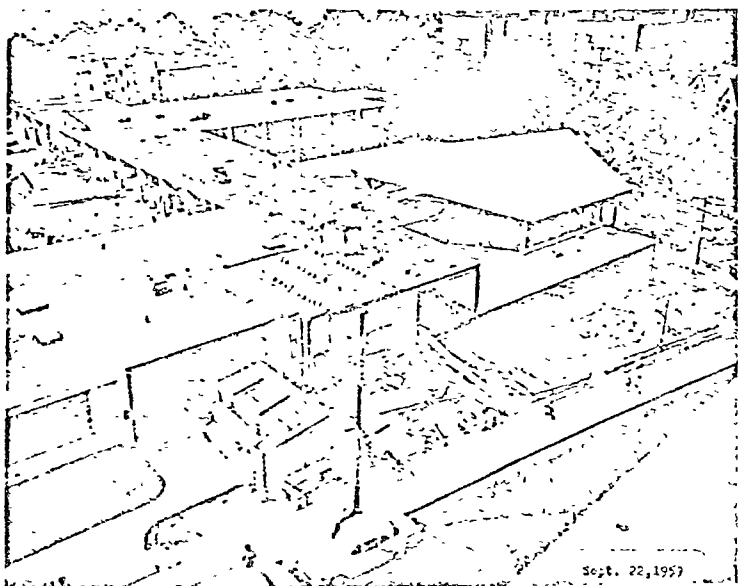


FIG. 8.—ROOFING COMMENCED, ALUMINUM WINDOWS DELIVERED. 50% COMPLETE.

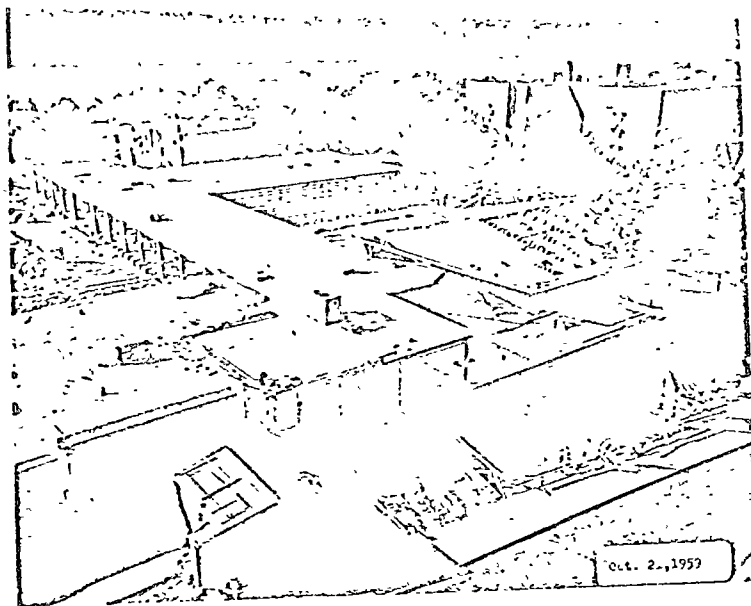


FIG. 9.—EXTERIOR WALLS UNDERWAY, WINDOWS BEING INSTALLED, PLASTERING UNDERWAY. 60% COMPLETE.

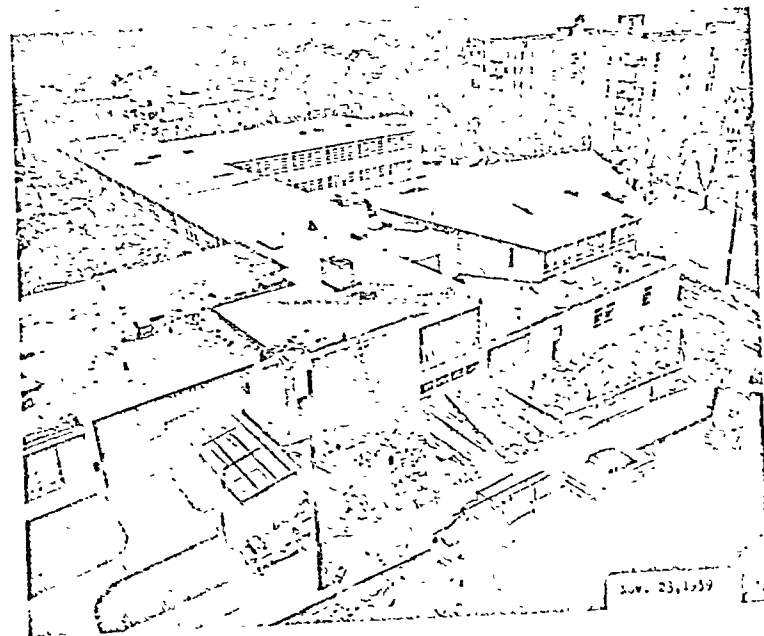


FIG. 10.—EXTERIOR WALLS OF FIFTH FLOOR, GLAZING AND CORKING COMMENCED. 71% COMPLETE.



FIG. 11.—MASONRY AND GLAZING COMPLETED, ROLLUP GRILLES INSTALLED, WOOD FLOORING, CHALKBOARDS HARDWARE COMMENCED, TEMPORARY HEAT IN OPERATION. 75% COMPLETE.

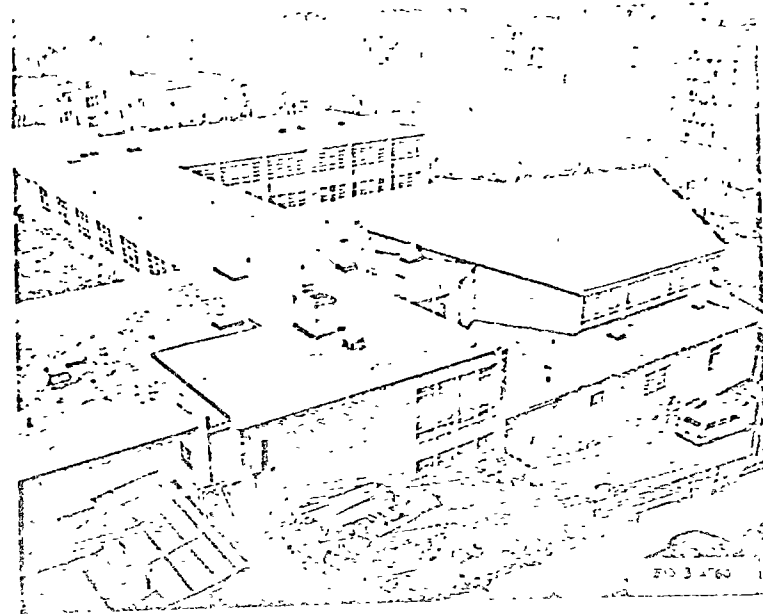


FIG. 13.—RESILIENT FLOORS, PAINTING, COLD GLAZED ENAMEL, TOILET STALLS, VENETIAN BLINDS AND ALUMINUM RAILING COMMENCED, PLASTER AND TERRAZZO COMPLETE. 90.5% COMPLETE.

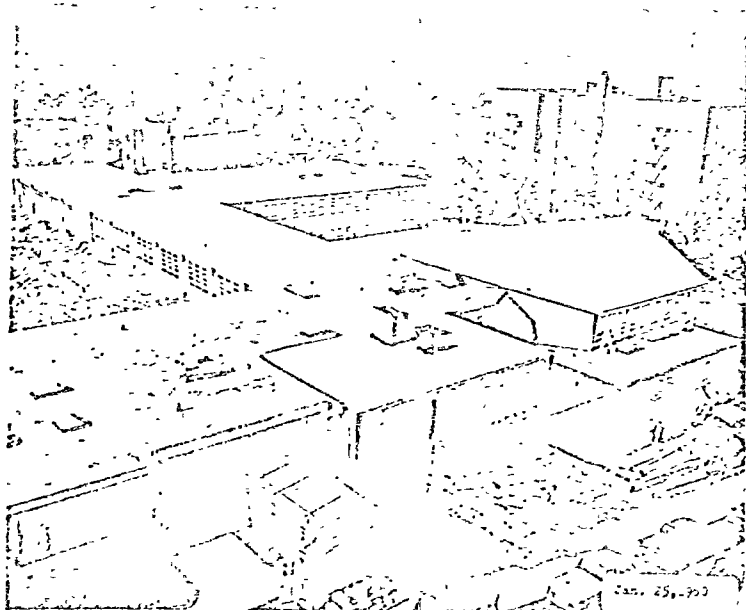


FIG. 12.—MILLWORK, TILE, TERRAZZO, FURNISHINGS AND EQUIPMENT COMMENCED. 81.5% COMPLETE.

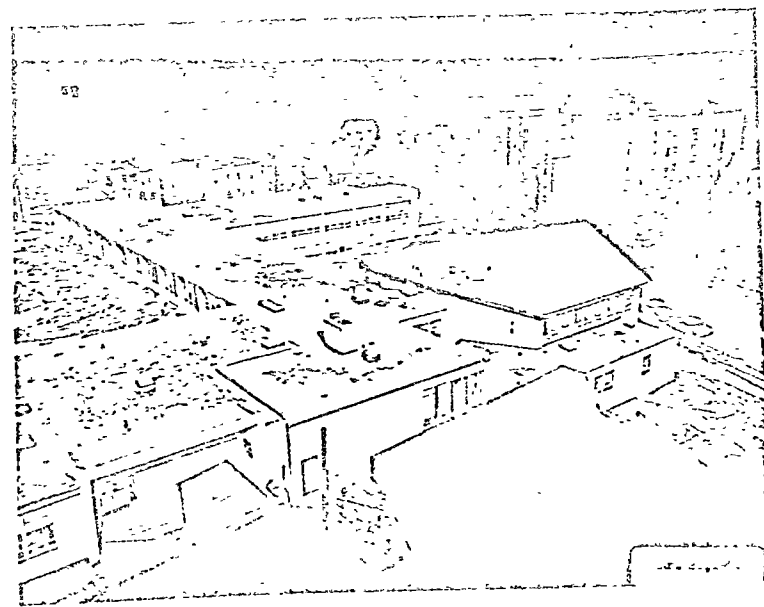


FIG. 14.—OUTSIDE STAIRS COMMENCED, TOILET ACCESSORIES INSTALLED, CLASSROOMS OCCUPIED. 95% COMPLETE.

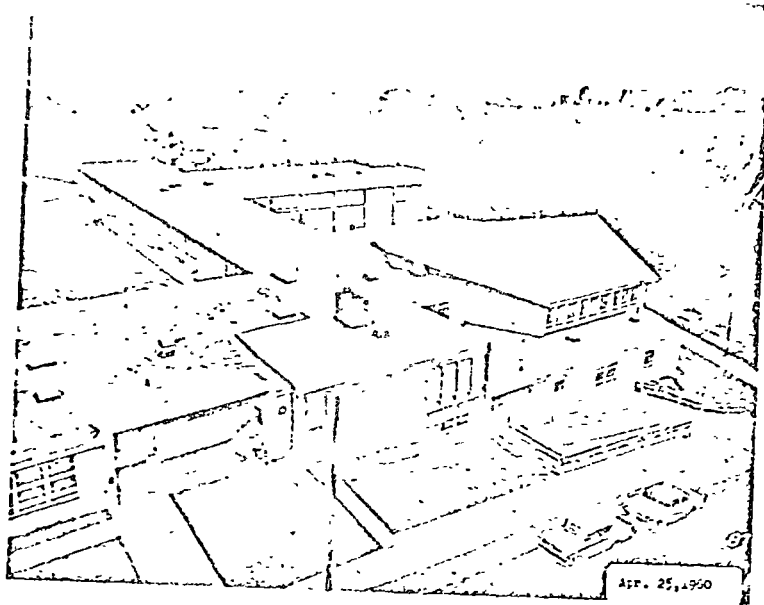


FIG. 15.—OUTSIDE WALKS COMPLETED, TOPSOIL DELIVERED. 97% COMPLETE.

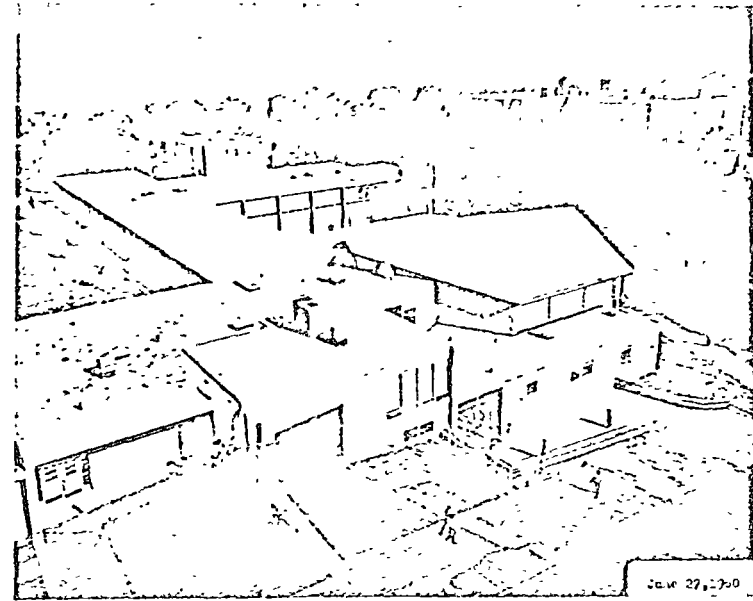


FIG. 17.—LAWNS AND PLANTING COMPLETE. 100% COMPLETE.

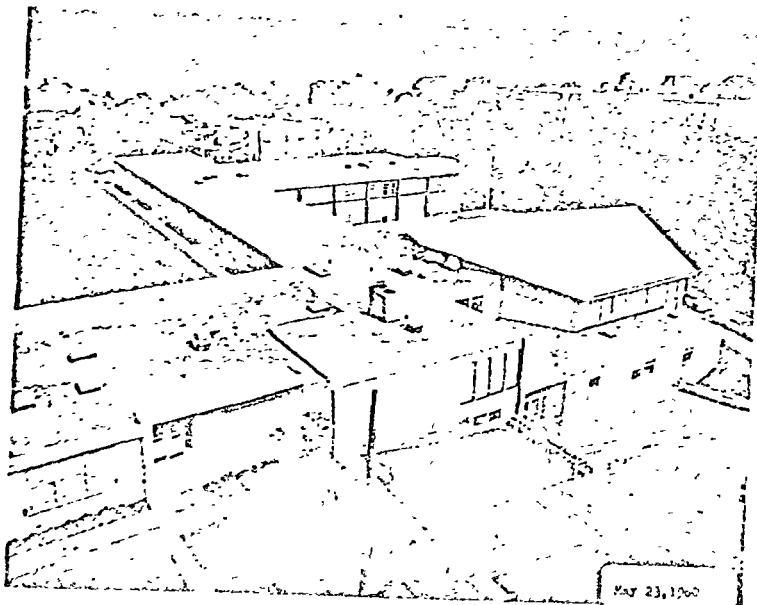


FIG. 16.—OUTSIDE RAILINGS AND FIRE HOSE INSTALLED.

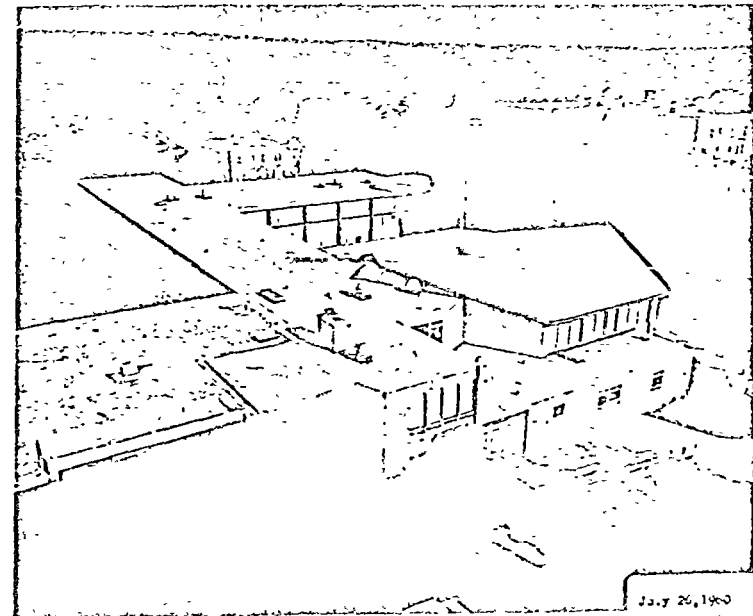


FIG. 18.—COMPLETED PROJECT, BIBLIOTECA DE LA...

The lightweight pre-cast concrete roof deck was done in two trips in July 1959, and in August, 1959. Is this the least costly? No; the extra trip by the roof deck subcontractor cost an additional \$175.00 because of the need for an extra move for his equipment, men, and crane. It was evidently unavoidable, however, if the classroom wing was to be kept ahead of schedule.

6. What effect did winter weather have on the job from November, 1959 through March, 1960? The outside site work is at a virtual standstill, class rooms are enclosed, the roof is tight, and work is proceeding on interior finishes using temporary heat. Classrooms were occupied in March, 1960.

7. Was the site work behind schedule? Walks started as soon as the ground was thawed (April, 1960), but topsoil was spread somewhat late (May, 1960); outside rails were installed somewhat late (May, 1960), lawn and landscaping was installed within a regional seasonal allowable tolerance (June and July, 1960).

Clearly, it would have been desirable to have a shorter interval for some of the photographs, particularly in the earlier stages. The monthly interval used, however, can be useful in furnishing a quantitative analysis of each photograph by comparing the photographs with monthly progress payments. As an example compare Figs 6 and 7 with the percentage gains for the following phases of work for the 27 day period from July 20 to August 24: Concrete and Cement 24%; Reinforcing Steel 5%; Structural Steel 1%; Open Web Joists 5%; Masonry 35%; Roof Deck 83%; Carpentry 20%; Miscellaneous Metals 60%; Furring, Lathing & Plastering 1.5%; Drainage System 30%.

A quantitative analysis, by item, if made monthly, and if compared to the monthly memo-motion photos, could yield information of vast use to the construction engineer.

In summarizing, a photographic analysis of construction operations as proposed by Mr. Fondahl, can be useful in examining crews and methods in which micro-motion and memo-motion pictures ranging in intervals of 1,000 frames per minute to 3 sec are used. It can also be useful when, as proposed by this writer, intervals of greater duration up to for example, 30 days are chosen. It is in the latter type of studies that the construction engineer gains information relating to the broader aspects of project management, and job coordination.

Mr. Fondahl is to be congratulated for bringing a basic tool to the attention of the profession.

Acknowledgments.--Photographs by H. Bernstein used with permission of the architect, Eli Rabineau, and the owner.

DIVISION DEL DOCTORADO

Video tape recording

Here's a new tool for IE's. New in the sense that few IE's have tried using video tape on the job. Actually, like so many "new" things, it has been available commercially for several years. During this time, its primary use has been in the television industry where it's familiar to you as the "instant replay" feature of sports events. More recently, business and industry have adapted the technique and equipment to marketing as well as personnel training — in activities ranging from assembly of products to supervision and selling techniques.

Since it came to market, there have been improvements in the equipment, particularly cameras, lenses, and monitors — the major elements of a video system. At the same time, prices have become attractive. For about \$2,500 — more or a little less, depending upon what you want — you can get everything you need to begin getting "instant replays" of just about any activity you want to analyze.

The three following articles, which comprise this special report, explain three different ways in which IE's of three countries have used video tape on the job.

The first article details the manner in which Akiyuki Sekina has used video tape in Japan to achieve better time study results by group pace rating. One IE records the operation with a video camera. Away from the job, a group of IE's pace rate the work during play back on a video monitor.

Australia is the locale of studies of work methods in the construction industry, using the video tape technique to record and analyze methods. Peer and Academy describe their studies in the second article.

In the third article, Louis Vits explains how he used

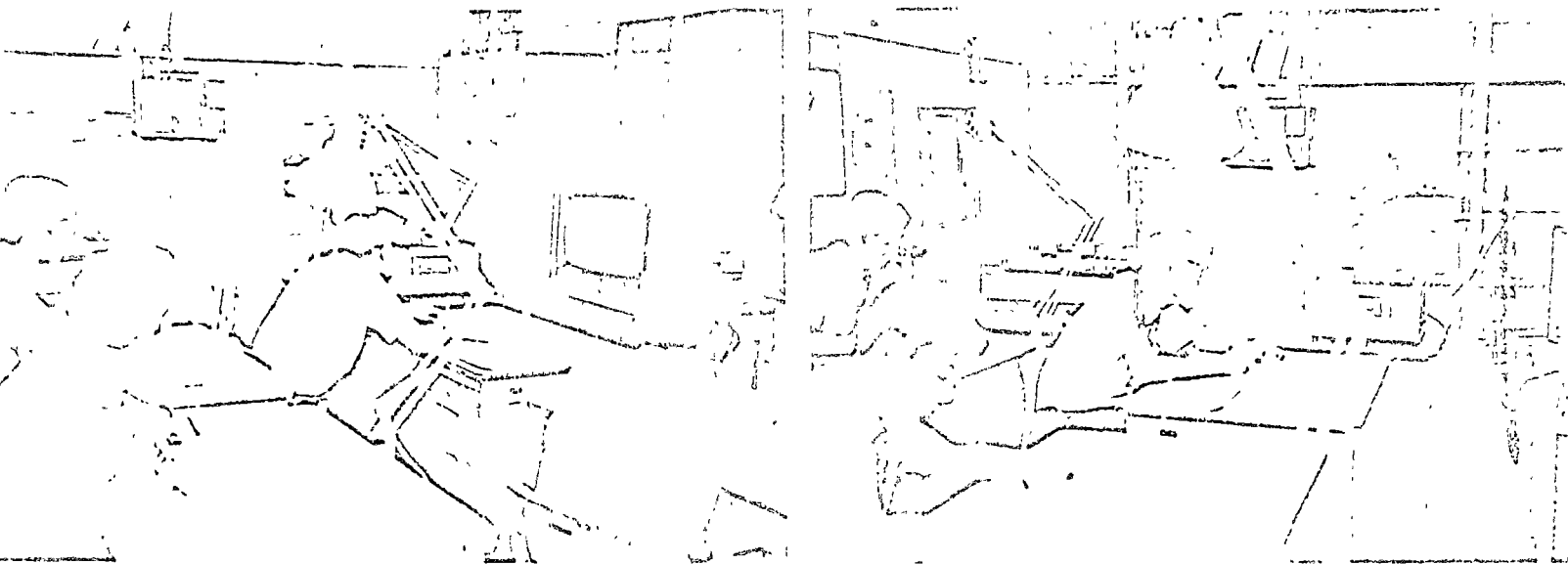
video tape advantageously to help develop improvements in an assembly line at Mirro Aluminum, in the U.S.A.

Varied as they are, the uses described in these three articles do not cover all the ways in which you might use the technique in industrial engineering. Here are some others. We can't claim that these additions complete an all-inclusive list; we do hope they will stir your imagination to see still more ways in which you can use video tape to help you improve your effectiveness in industrial engineering.

- Provide a reliable record of the methods and conditions upon which time standards and job evaluations for an operation are based.
- Train IE's (and possibly others) in pace rating, using your own operations for benchmarks.
- Teach methods improvement techniques to supervisors and others in your organization.
- Provide visual and audio assistance in presenting proposals of improvements and the solutions of problems.
- Analyze unsafe practices and hazardous conditions.
- With the addition of a suitable (and available) time control device, you can use a video camera and recording tape for timelapse photography studies.
- Record the flow of materials and units for plant layout and material handling studies.
- Make slow-motion analyses of the operation of machinery and equipment.
- Record the volume and frequency of vehicular and foot traffic in a great variety of situations.

To learn how to use the technique, turn the page.

ROBERT S. RICA, Editor



2. Away from the job, video tape record is displayed on a monitor while a group of IE's performs pace rating.

is reduced. But the high cost cannot be avoided completely.

- Cinefilms are often developed by an outside firm, jeopardizing company security.

- A special driving device is required for both camera and projector to maintain accurate recording and reproducing speeds.

- Sounds attending an operation are sometimes helpful in pace rating. Cinefilm distorts the sounds unless it is recorded and projected at a fixed speed.

On the other hand, VTR has several advantages.

- The tape recording is available for analysis immediately after recording; no special processing of the tape is required.

- The tape can be repeatedly erased and reused; it is economical.

- Company security can be maintained.

- Recording and reproducing speeds are accurate. Time data is reliable, and element times can be read from the projection. The typical error in tape speed is within 0.2 percent (10).

- The equipment can be used for work sampling observations by adapting it for automatic remote recording. A special sampling timer is commercially available.

- VTR is sensitive to the relatively low light levels of most work areas.

- Both sound and picture are recorded on the same tape.

- The projection screen can be divided into two or more sections so that two or more recording may be projected simultaneously. For example, a benchmark of the operation pace may be observed along with a recording of work to be rated.

- The video camera performs silently, does not disturb workers.

- VTR tapes may be projected in a lighted area.

- Even at normal speed, a tape runs without change for a period that is more than adequate.

Considering all its advantages, VTR provides an improved method of time study. It affords the practical means of utilizing group pace rating to improve the precision of time standards.

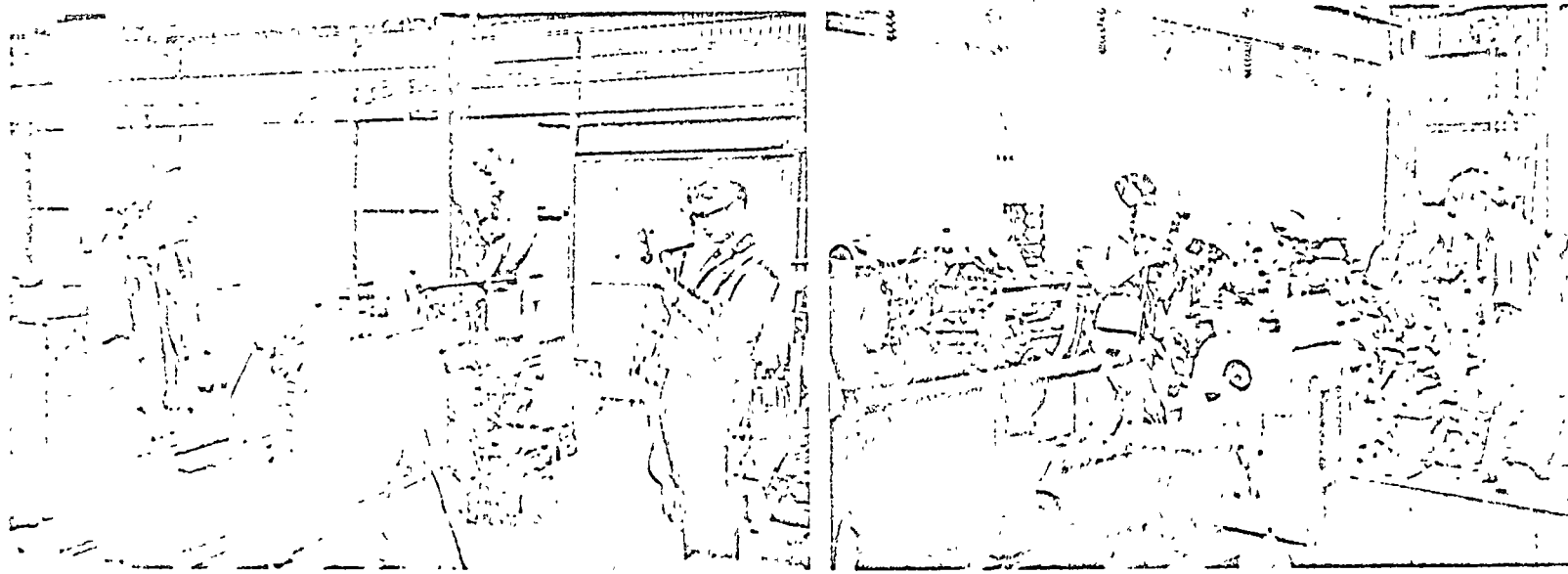
Application of VTR

Five steps describe the application of the VTR technique to the development of time standards.

1. **Record.** The video camera is used to record the work. To get a clear picture of all elements, it may be necessary to record from different angles, Figure 1. It is recommended that two additional tapes be used: one to explain the work under study,

New time study technique uses video tape recording equipment to record an operation on the job site. Away from the job, IE's record element times, observe methods. But pace rating by a group — instead of an individual — is the greatest advantage.

AKIYUKI SAKUMA, Aoyama-gakuin University, Tokyo, Japan



1. IE, with video equipment, records adequate number of cycles of an operation that requires a time standard.

IE SPECIAL REPORT

Video time study

One of the basic tasks for the modern IE is still the establishment of time standards with necessary precision. A survey, Reference (1), conducted in Japan showed that 83 percent of the IE departments of selected industries assigned great importance to work measurement. The setting of time standards is still a major task of an IE department.

In the past few decades, better methods for accurately setting standards have been sought. The need remains, although many new techniques have been developed.

Setting standard times by direct observation and by work sampling are typical time study techniques that are widely used today. With these techniques it is feasible to set time standards with adequate speed and economy, but not necessarily with sufficient accuracy. The process of time rating is frequently the rea-

son for poor accuracy — and the resultant lack of precision of the time standards.

The required accuracy for rating is not a fixed value. It varies, depending upon the uses to be made of the standards. But it is generally agreed that time standards for work measurement should have a precision of ± 5 percent, 95 percent confidence. The results of many studies of pace rating, however, find standard deviations ranging from 5.1 to 19.7 percent (2) through (9).

Group rating

To overcome the problem of pace rating accuracy, many methods have been developed. One is a group rating system suggested by J. K. Loudon, H. A. Schell, E. M. Mansor, and others. But their methodologies have not been applied to actual in-

dustrial time study because:

- Observation by a group of observers in a work area creates an undesirable psychological pressure on the workers; working paces are apt to be distorted.

- The presence of many observers at the work area requires a significant increase in time study manpower.

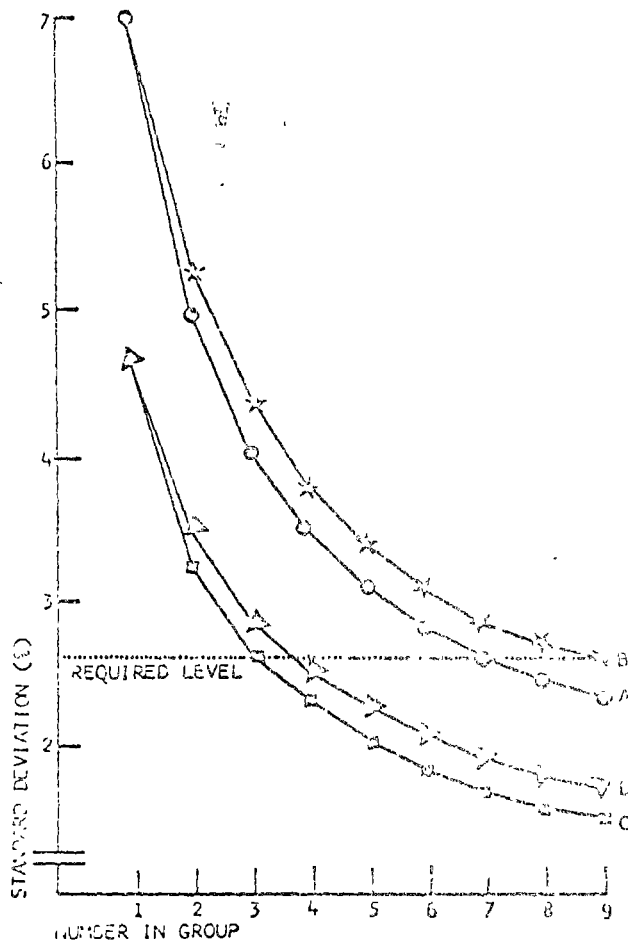
- Some work areas cannot physically accommodate a group of observers.

To perform group rating on the shop floor, it is necessary to first record the work with a facsimile recording process. Two means exist: cinefilm and video tape recording (VTR).

Cinefilm has several disadvantages:

- It is expensive to record all the work to be pace rated. If work sampling is used with cinefilm, the cost

Curves A and B are based on 7 percent standard deviation in ratings by one individual, a value selected from studies of pace rating accuracy. Curves C and D are based on results of ratings by experienced time study men in an automotive plant, using the VTR technique. Curves B and D are modifications of A and C, respectively, to correct for bias.



and another for the rating process (see Step 2).

2. Selection. The original tape record sometimes includes irregular motions or extraneous elements that are unsuitable for pace rating. Analysis of the tape — the time study — is more effective if these are eliminated. A new tape, omitting these elements, can be reproduced accurately from the original, and used for analysis.

3. Time measurement. Using a stop watch or other timing device, element times are read from the projection of the tape and recorded on paper. The tape can be rerun to pick up missed readings or to check accuracy.

4. Pace rating. Elements of the work are rated by a group of qualified H's or time study technicians, Figure 2. It is helpful to first project and review a benchmark tape re-

ording before attempting to rate the work under study. In addition, or instead of the benchmark tape may be projected simultaneously alongside the recording under study. As in Step 3, tapes may be rerun for further analysis. The accuracies of group ratings are examined in Figures 3 and 4.

5. Calculation. Group averages of pace ratings may be used to factor the element times. Time standards are then computed in the normal manner. The video tapes can be filed, to become a valuable accurate record of the time study for future reference if needed.

Time standards determined by the VTR technique should be more accurate than those developed by traditional time study. The recording of element times can be more accurate. Using group rating, the pace factor certainly should be more ac-

curate. In fact, use of the VTR technique can result in more accurate pace rating by any one individual (Figure 3) because:

- It is easier to concentrate on the rating process away from the work area. Also, the recording may be studied repeatedly to arrive at a confident rating.

- A benchmark recording may be observed simultaneously.

- In direct time study, the cycles used for time measurement are often different from those used for rating, increasing the opportunity for error. The VTR technique permits timing and rating the same cycle or cycles.

When studying short-cycle, repetitive work, several cycles may be recorded for later study. To analyze long-cycle and non-repetitive work, a recording of one cycle may be rerun repeatedly to develop the data for calculating time standards. In such cases, it may be noted, less precision in the standards is usually required.

Survey of VTR users

To check the acceptability of the VTR technique, 12 engineers in an automotive plant tried it for two months in 35 different operations, including assembly, forming, welding, painting, etc. Their answers to a follow-up questionnaire are summarized by number of engineers and classification of their answers:

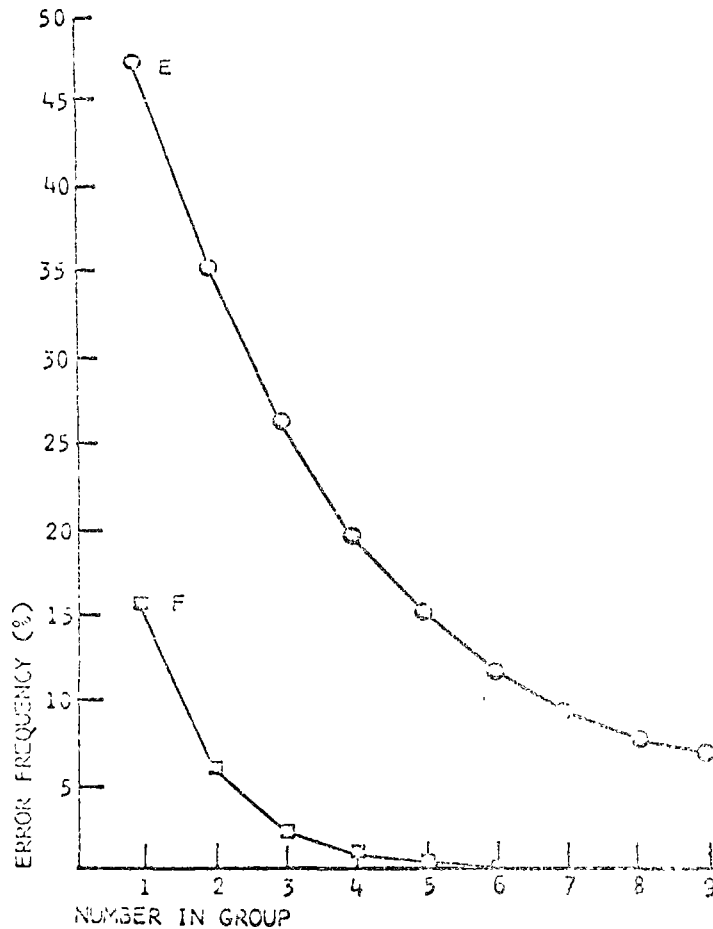
1. What was your impression of the work pace as viewed on the VTR monitor compared with the actual work pace?

- 7 no difference
- 2 somewhat slower
- 2 slower
- 1 no opinion

2. What is your opinion of the comparative ease of performing pace rating by the VTR technique?

- 6 easier
- 4 same
- 1 more difficult
- 1 no opinion

Figure 1 Frequency of rating error computed from curve B of Figure 3, assuming normal distribution for the rating error. Curve E shows the frequency of error exceeding the 5 percent level, curve F depicts the frequency of error exceeding the 10 percent level.



3. Was the quality of the pictures on the monitor screen suitable for rating?

- 7 good
- 1 suitable
- 1 not suitable

4. What are some advantages of VTR rating?

- Workers can understand and accept the validity of the standards.
- Rating can be done in a good environment.
- Better judgement of work pace.
- Screen image brighter and clearer than projection of 8mm cinefilm.
- Work can be observed repeatedly.

Acknowledgement

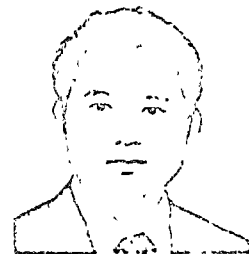
The author acknowledges the cooperation of the Isuzu Automobile Company in conducting VTR trials.

Also, he is indebted to Dr. Marvin E. Mundel for constructive comments and suggestions.

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The use of video tape recording equipment as an independent technique or in combination with existing practices has added a new dimension to research and management studies in Australia's construction industry.

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IE SPECIAL REPORT

Video methods analysis

It is a matter of history that productivity studies were first developed against a building industry background. In fact, Gilbreth, a pioneer in this field, was working as a brick-layer and contractor when he began his experiments. Ironically, his ideas found acceptance and application in all manufacturing industries other than building, and for several decades, this industry's product and construction methods remained unchanged.

The building industry's reluctance to adopt his methods may be attributed to two main causes:

First, the spur of international competition forced most industries to seek ways of reducing the costs of their products. Thus, they were receptive to the new methods and technologies proposed by Gilbreth and his contemporaries. No such impetus existed for the building industry. Having a captive home market, it continued with its established methods and passed the costs of so doing on to its clients.

The second cause lay in the great variability of working conditions peculiar to the building industry. This coupled with a prevailing high labor turnover, restricted the contractor's opportunities of profitably applying the results of production studies, thus, there was little justification for any such effort and expense.

The building industry's first basic change in attitude occurred after World War II. The shortage of labor and capital, necessary to meet the outstanding demands for construction, drove this normally conservative industry to seek new materials and techniques that would increase productivity and reduce costs. Building research has since been steadily growing, and an increasing amount of this research has

been devoted to the whole building process as well as the construction methods employed. Such work involves measurement and analysis of on-site production, and requires both development of techniques suited to working conditions in this industry and adaptation of those used in other industries.

With the advent of relatively cheap video tape recording (VTR) equipment, (which has the ability to record simultaneously on tapes, audio and visual information that can be reproduced later on a television screen), the Division of Building Research, Commonwealth Scientific and Industrial Research Organization (CSIRO), decided to examine its suitability for on-site studies. After an initial trial with one camera and one tape unit, a mobile laboratory was assembled and a series of studies was carried out, Reference (1). A schematic presentation of the system is given in Figure 1.

Experience has now been gained on a number of building sites and this paper aims to compare the effectiveness of the procedure developed with that of the other techniques available.

Production studies

Construction differs from most other industries in that the work place changes while the products remain in place. This recurrent changing of work place causes wide variation in working conditions. In addition, the product usually differs greatly from one project to the next, so that the working time for apparently similar operations is dependent on many parameters. Thus, the results obtained from a study on one site cannot be applied to the same operation on another site un-

less the influence of each of these parameters is defined separately.

Another characteristic of the building industry which complicates production studies is that construction is mainly comprised of teamwork. As the functions of individuals tend to overlap, observation and measurement cannot be divided up tidily.

Consequently, much of the methodology well proven in other industries can find only very limited application in construction. Dressel (2) was the first to identify the requirements for successful measurement of productivity in building, and he developed a technique for group observation which concentrated mainly on the analysis of unproductive time elements. Peer (3) extended and simplified this approach to include analysis of the direct work elements, thus enabling a fully detailed study to be made. Times are recorded on a chart that also enables the relationships between tasks and the work of individuals to be determined. This technique, whereby all the individuals of the group are observed simultaneously, is based on systematic sampling with a fixed interval of one minute.

VTR vs other techniques

The evaluation of VTR as a new aid for studying building operations involves comparison with such other techniques as: a) Time Study; b) Random Activity Sampling; c) Systematic Activity Sampling; and d) Film Analysis.

More detailed techniques, which aim to eliminate unnecessary movements by breaking down an operative's work into motion components and then developing the best possible pattern of movement, are at

at this stage only of secondary importance to this industry. Analysis needed to save seconds is pointless when minutes and even hours are wasted through bad organization.

None of the above four techniques is entirely satisfactory. They have to be combined to meet the accuracy required before results are validly applicable to different work situations and different study objectives. VTR complements rather than supplants these older techniques. Therefore, to evaluate its usefulness, the main characteristics and range of application of the others should be discussed first.

Time Study is a continuous procedure using a stopwatch to measure the elements of a specified operation. It is the most suitable and widely used technique for studying the work of an individual but, as construction work is mainly comprised of teamwork, its application would normally require as many observers as there are members of a crew. Hence, this technique is impractically expensive and suffers from the further disadvantage that the results compiled from such individual observations often cannot be assembled with the accuracy needed to analyze the work of the team as a whole. Consequently, this technique is, at best, only suitable for studying repetitive short-cycle operations, becoming prohibitively costly when applied to non-cyclic operations of long duration.

Random and Systematic Activity Sampling are statistically based methods in which a large number of observations are made at prescribed time intervals. Here, the whole group is observed simultaneously and each observation records what is happening at the instant. The number of occasions on which each work item or delay is observed provides an estimate of the total time spent on each element of the operation.

In *Random Activity Sampling* these observations are made at random intervals defined by using statistical tables of random numbers. The number of these instantaneous observations required depends on the desired degree of accuracy and detailing. When properly used it can provide a rapid, inexpensive, and reliable means for determining the utilization of large workforces or sets of machines. In the building industry it is suitable for obtaining

a general breakdown of or whole construction process rather than for analyzing single operations, for which *Systematic Activity Sampling* is more appropriate. The need to observe at random intervals arises only where there are periodic features in the activity being studied and the sampling frequency is too low to detect them.

As most building operations are stochastic in nature, *Systematic Activity Sampling* with a constant time interval is more suitable than randomly spaced observations, particularly in view of the long duration of such operations. Random observations also have the disadvantage that there is nothing for the observer to do while waiting for the new cycle. With systematic activity sampling any such spare time can be put to increasing the number of observations, thus providing more accurate and detailed results. It also provides time records on a chart form or field sheet (1), (3) which directly determines the relationships between operations and individuals in teamwork. This version of activity sampling has proved to be the best available for studying nearly all building operations excepting those consisting of very short periodic cycles.

Time Study and Activity Sampling techniques are similar in that each supplies only written information. The only way of recording all

facts relevant to the methods and circumstances influencing the work is to write them down during observation. Details which were not considered worth recording at that time cannot be reestablished and are lost to the study. Obviously this difficulty would not arise in film analysis where operations are recorded on a cinefilm which can be repeatedly replayed for analysis. Because of the long duration of construction work, however, this technique has practically no application to building site production studies. Recording building operations would require an operator to stand by each camera to replace film about every 4 minutes for a 16 mm film 100 feet long used at a speed of 16 frames per second. In addition the editing of so much film would be very laborious.

These difficulties led to the use of time-lapse photography, where single pictures are taken at predetermined time intervals by a fixed camera. The resultant "stills" can later provide a basis for activity sampling or be run at from 2 to 25 frames per second to highlight the most time-consuming work elements. It is, however, unusual for a whole team to be visible from a single camera position, and attempts to overcome this by using a distant vantage point causes the individual subjects to appear too small for details to be distinguished. There-

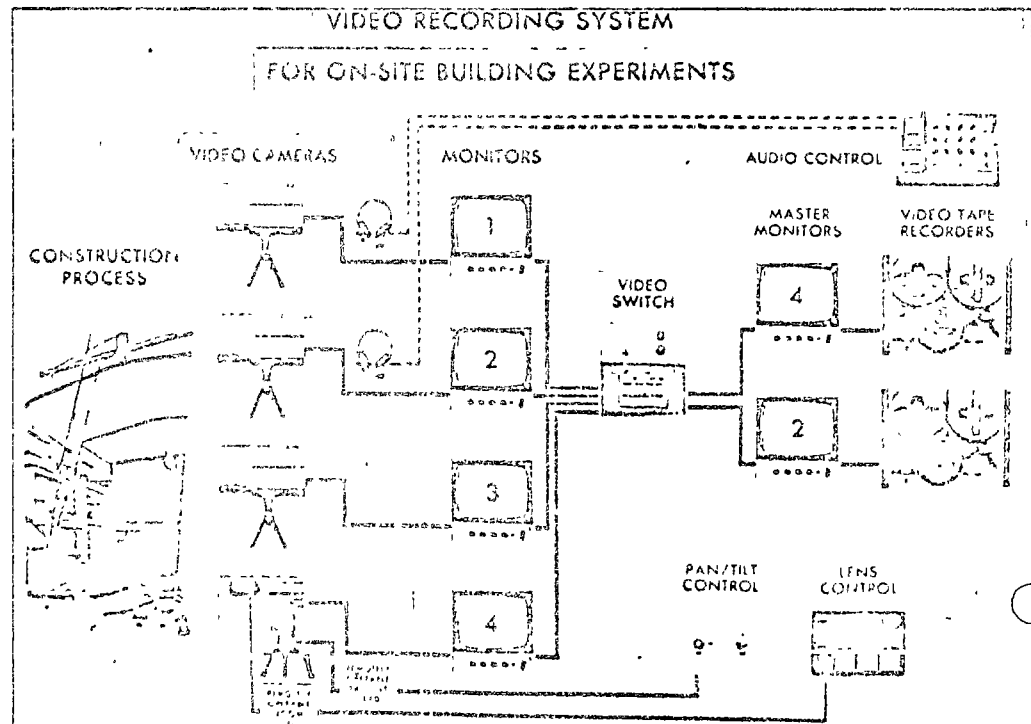


Figure 1. Video tape recording system for on-site building construction studies.

fore, this technique has only limited special uses.

VTR advantages

With video tape recording it is practicable, at the building site, to simultaneously record and edit both audio and visual information. The accuracy of such a permanent record is much enhanced by the opportunity for cumulative observation through replaying. Everything that happens during the study can be captured by using several cameras, and this material may be analyzed later in any desired degree of detail because all records relate to a common time base.

When cameras are placed at several vantage points the most informative picture can be selected for the record. This ability to electronically edit is an important advantage of VTR because the selection is made with simultaneous views of all the current activity, and offers a good understanding of the interrelationships between the tasks of the individuals in the observed team. The multi-camera system has the further advantage that should one camera fail the record can still be maintained with little or no loss of information. This is especially important in building because the opportunity to observe a particular operation often comes but once. Furthermore, since much of the measuring or analysis can proceed simultaneously with the recording, the lack of some details required for analysis can be discovered while these are still obtainable.

Because of these advantages VTR gives more accurate and complete information than is obtainable from movie film.

The TV pictures are transmitted at 30 frames per second. Since each frame consists of two interleaved fields, the speed of the recording is, in effect, doubled to 60 fields per second. This enables the recording of an event with an accuracy of one-sixtieth of a second, which is even higher than the filming speed (16-32 frames per second) normally used for cinematograph studies. Consequently, this technique can provide valid data for the most detailed studies likely to be needed in the building industry.

By comparison with stopwatch time study, the only practicable continuous technique previously avail-

able, VTR has the advantage that a whole team or operation can be recorded simultaneously by the one observer coordinating the study. This, together with the possibility of replaying to obtain additional details during analysis, gives a higher standard of accuracy than is attainable with stopwatches. In contrast to either time lapse or continuous film recording, with VTR it is possible to monitor the picture during the recording, and control picture quality by adjusting the electronic system to the prevailing light conditions. The Vidicon-type cameras used are capable of providing a bright picture even when working in the lowest intensity illumination at which building work can proceed. Furthermore, as VTR provides a continuous audio-visual record of the operation, it has the advantage, in regard to accuracy of sequence and timing, over either of the statistical methods of activity sampling.

As to versatility, any required accuracy can be obtained provided the cameras are able to follow an operation. Problems may arise when operatives are continually changing their working place and level, or where working space is too small for even a wide angle lens to cover the operation. This may occur in some finishing operations but, provided a multi-camera setup can be used and remote control pan-tilt heads and zoom lenses are available, almost all such problems can be overcome with little difficulty. Other possible obstacles which may be encountered, and ways of dealing with them, have already been described in another paper (1).

The limitations of the other techniques have already been discussed. An important advantage of VTR is the ability to use it in combination with these techniques. For instance, when applying systematic sampling to an operation for long duration, specially interesting segments can be video recorded.

With a black and white picture there is some difficulty in identifying the members of the working team observed and this may be important for analyzing the work load of individuals, or for performance rating when the calculation of individual standard times is required. This difficulty disappears if it can be arranged for operatives to wear distinguishing clothing. Average per-

formance rating of the whole team, however, is relatively easy.

The VTR technique has been used by the Division to study unproductive time on building sites (2). The investigations were carried out on eight building sites of different contractors, chosen at random from those available at the time. A total of 31 operations were recorded and analyzed, ranging from concreting foundations for a dwelling, to placing precast facade units for a multi-level building. It is instructive to report that more than 90 percent of the total unproductive time recorded in this study could be traced back to management. Further studies currently being conducted include the investigation of the various materials and methods used for constructing dwellings in Australia.

Various applications

An important feature of VTR is the possibility of using the information stored on video tapes for a wide range of supplementary purposes such as:

- a. To provide a basis for discussion between the building site supervision and management.
- b. To convey to others valuable experience gained, especially when this concerns introduction of new working methods.
- c. To furnish material for use in technical education courses and for training of new employees.
- d. To provide an information feedback to the designer, enabling him to see how well or badly his ideas as to assembly sequences or difficult operations worked out.

The highlighting of such applications serves to emphasize that production studies in construction are still in their infancy. Up till now the main concern has been to reveal sources of inefficiency and to compare existing construction methods, whereas in manufacturing industries the development of "Predetermined Time Standard methods" has permitted a more scientific approach to management through synthesis and matching of interdependent working procedures. These methods provide what are, in effect, sets of predetermined standard data for work elements which are so small that they may be applied to any type of manual work, much in the same way as letters of the alphabet pro-

vide the raw material for an infinite variety of books.

Operations composed of manageable tasks, performed at a fair price, are just as attractive to those planning the reliable performance of building work as they are in any other industry. However, because of the continuous changing of work place and great variation in attendant working conditions for performing apparently similar building operations, predetermined time standards have, apart from some preliminary trials, not been applied in the building industry as yet. VTR appears to be the only technique suitable for recording both the work elements and the connective information that must be ascertained if predetermined time standards are to be validly applied in building and construction. Any changeover to industrialization may promote this development.

All work study techniques have limitations, and it is therefore important that each should be capable of receiving the support of other methods. In this respect, a special feature of VTR is that it may be combined with other existing techniques to provide an effective investigation tool for research and management in the building industry. Its proper use ensures the obtaining of reliable results for the very wide range of studies which may be encountered in the construction process.

A significant advantage of VTR has been its ready acceptance on building sites studied by the Division of Building Research. Operatives can see and understand the nature of the record being taken. The probability of successfully conducting, on an Australian building site, either Time Study or Activity Sampling investigations would be extremely low because of understandable suspicions as to the purpose of the records being taken.

Another advantage of the audio-video recording technique is the readiness with which it may be applied. This has been discussed in detail by Peet and Crowle in (1), but it should be noted here that the capability involves more than just the ability, at very short notice, to move equipment to a building and to start taking pictures. The facility for combining analysis and recording, and the ability of the analyst to observe the work from more than

one viewpoint at a time, allows an experienced operator to refine his system of observation to suit the current experimental objectives within minutes of starting the study, and to continue to refine it as the study proceeds.

Comparative costs

As to the economic aspect of VTR, direct cost comparisons with Time Study or Activity Sampling techniques would not be adequate as the audio visual information obtained with this technique is so much wider in scope.

In comparing cost only, Time Study will generally be more expensive for studying teamwork than VTR despite the relatively high initial investment in equipment for the latter. The cost difference will depend on the size of the team and the number of observers required. Provided one observer can follow the whole team without difficulty, as is the case in most building operations, Activity Sampling will be cheaper to apply than VTR when only direct costs are considered. When it is possible to use VTR records for additional purposes, such as remedying oversights in the original observational plan, to support the analysis of other studies with different objectives (4), or more generally to aid education, job training, and communication of exper-

ience video taping is likely to be more rewarding. Presentation uses need to be foreseen in some detail so that the recording can be planned with their requirements in mind.

Figure 2 shows the costs comparison of equipment and expendables for VTR and cine photography. More recent $\frac{1}{2}$ -inch video tape equipment is significantly cheaper to buy and use than the $\frac{1}{2}$ -inch equipment on which this paper was based. The comparison considers the simplest unit comprising one observer manually operating a single camera. The first cost of VTR is greater than that for 8 mm film equipment, but the high cost of film compared to video tape erodes the first-cost saving after twenty hours of recording. The 16 mm equipment is more expensive than VTR in the first place, and much more expensive in running cost.

A fully effective construction study requires that the work be viewed from more than one angle at a time, and that a continuous written or charted record be kept, based upon the images received from multiple cameras. This can be done with VTR, since the images from all cameras can be displayed simultaneously on separate monitors at a central point, leaving the study coordinator free to write his record.

The coordinator is in audio con-

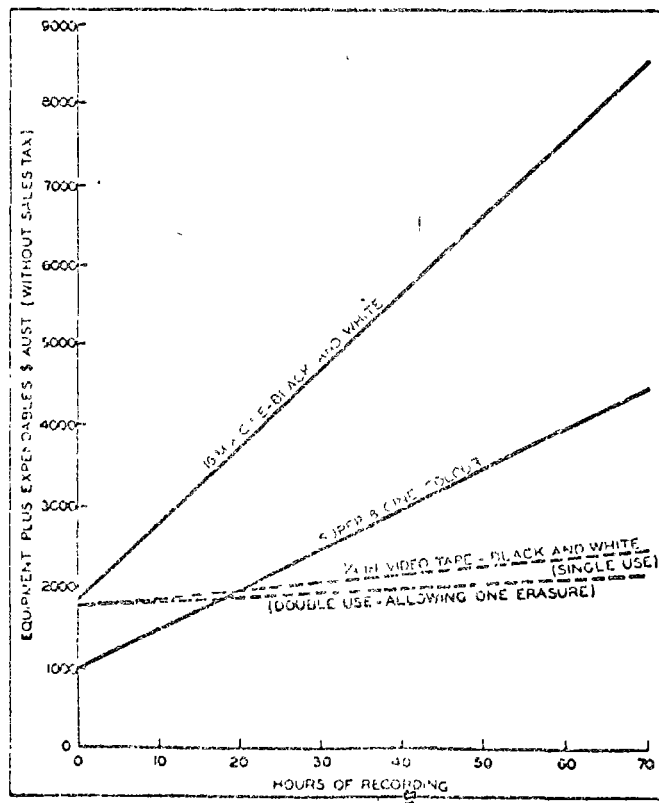


Figure 2. Comparative equipment and expendables costs between simplest VTR and single camera cine-photography units.

tact with the camera operators and can direct the study as the work proceeds, Figure 3. He can also operate one of the cameras by remote control. This procedure, used by the Division of Building Research, has substantially reduced office time during analysis.

Conclusions

This paper has been concerned with the evaluation of video tape recording (VTR) as a technique for conducting production studies of building and construction work.

Construction differs from the work in most other industries insofar as most of its operations are performed as teamwork, and both the work place and product are continuously changing. Because of these special characteristics, many principles and techniques, proven adequate for production studies in other industries, are of limited use in building research.

The rapid development of inexpensive video tape recorders and cameras has widened the parameters of production study methods. The VTR technique has proved to be capable of providing results, sufficiently accurate for the most detailed studies which might be required in the building industry. The only limitation to its application is the operator's physical ability to follow the activity with cameras.



Figure 3. Operators of manually controlled cameras are in voice contact with the chief observer directing the study.

The *Vidicon* type cameras used, operated satisfactorily even when working in the lowest intensity illumination at which building work can proceed. Furthermore, the equipment can be moved to a building site on very short notice, can commence recording in a half hour or less after arrival, and the pattern of recording and analysis needed for the particular experiment can then be very quickly developed. The difficulty of identifying individual members of the working team, when using black and white television, may be a limiting factor for studies where it is essential to distinguish between operatives. This may be overcome by having the workers wear distinguishing articles of clothing.

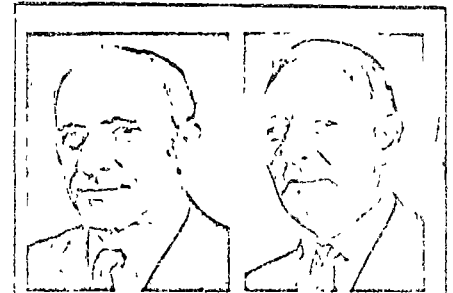
The recorded visual and audible information can be stored on tape, and can be used for a wide range of purposes other than production studies. They include education, job training, and communication of experience. The same video records may also be analyzed for other studies with different aims. A direct economic comparison between this technique and others usable in the building industry is not relevant because of the much wider range of the information obtained. The economics of this technique depend, therefore, very much on the extent to which the additional possibilities of this additional information can be utilized.

Different work situations require different work measurement techniques according to the need for accuracy and the permissible cost. It cannot be expected that a single investigative tool will comply with all the possible requirements of an industry. Each study technique has its strong and weak points. VTR, however, has proved to be an accurate, reliable aid to research and management studies in the building industry. It adds a new dimension to production studies in this industry and can be used as an independent technique or in combination with the existing ones, depending on the aim of the study and the type of operation observed.

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The advantage of using video tape equipment in methods analysis is twofold in that not only does the video taping provide extremely reliable data, it also furnishes visual results to the people being studied and more easily wins their acceptance and cooperation.

Louis J. Vits, Miro Aluminum Company, Manitowoc, Wisconsin

IE SPECIAL REPORT

Video tape for cost reduction

The real problem in cost reduction is persuading the people involved to give the idea a try. Many an idea has gone down the drain for lack of enthusiasm and effort by the people concerned.

Doing an analysis of a department or jobs in a department is relatively easy. The hard part is convincing the foreman and all the people involved that everyone will benefit from a little "rocking of the boat" and that no tidal waves will be generated. This is where video tape has been a great help.

The use of video tape was new to us. We in the Industrial Engineering Department discussed its possible applications in the areas of methods improvement, employee training, and grievance procedures. We decided to try it first for methods improvement.

Equipment

We first rented video tape equipment to see if we actually could use it advantageously. Later we purchased a set of units consisting of camera, zoom lens, tapes, monitor, and recorder. It cost \$2,100.

The monitor may be used during taping of an operation to check the quality (framing, focus, lighting) of the pictures being recorded on the tape. The monitor is also used for viewing tapes later, and away from the operation. The recorder permits us to record explanatory notes and operation sounds (where they're significant) during taping.

Additional pieces of equipment include a camera tripod on wheels to facilitate positioning, and a dolly to hold the recorder and monitor.

Use of equipment

The manager of the Reproduction Services Department had formerly been the company photographer so the video tape equipment was put under his control. He conducted a two-hour training session with the engineer who would operate the camera, then went along as an advisor during the filming sessions.

One reason that a minimum amount of training was required to attain a reasonable quality picture is that the engineer watched the picture on the monitor while it was being taken. He was able to see the focus and lighting quality and adjust for them while taking the pictures. This was especially important when standing about 25 feet away from the work area with a zoom lens and zooming in for close-ups of the hands of an operator. Understanding the effect of available light on picture quality is the main requirement when taking video tape pictures.

The quality of the first pictures was not professional, but it was good enough for analysis. Picture quality has since improved with increased usage.

It takes about one-half hour to set up the equipment at a work site and remove it when taping is completed.

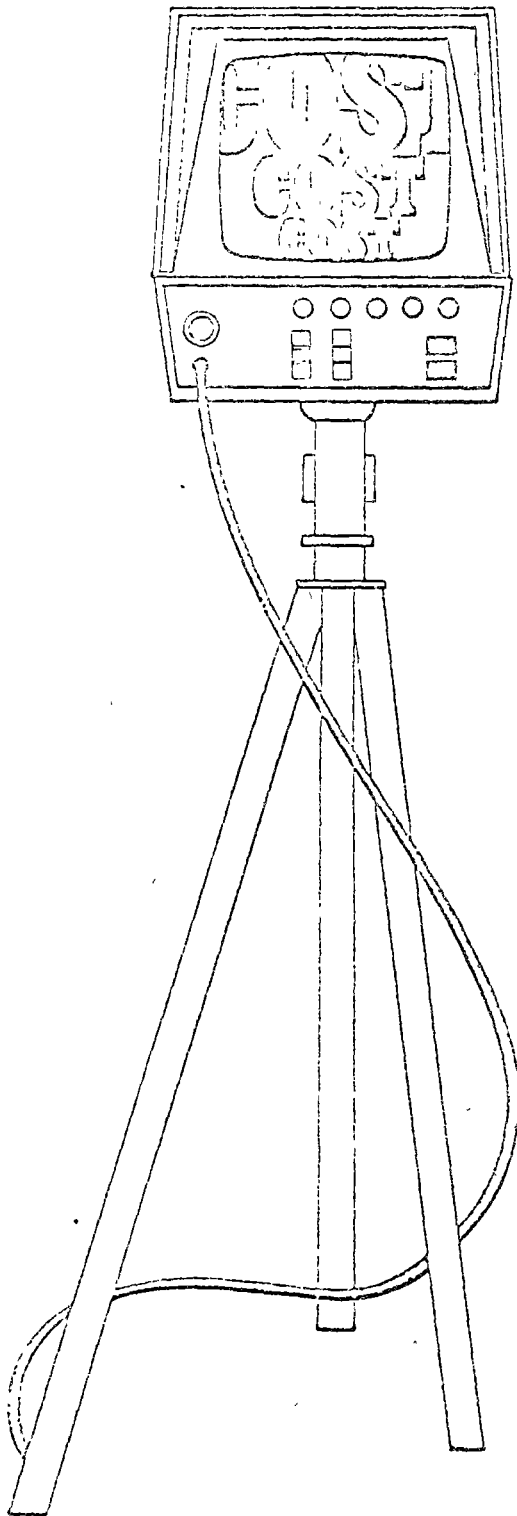


Figure 3. Group discussions among team members were a vital part of the analysis procedure.



not be considered.

We then set about analyzing the video tape pictures of the "assemble-to-pack" multi-operator electric percolator unit. Every minute detail of each operation was scrutinized to see if it added value to the finished product. If what was being done increased the cost but not the value, we tried to eliminate it or reduce the cost of doing it.

In analyzing the video tape pictures, the team leader took the team through the same steps he had taken in comparing the time study description with films. The video tape of each operation was run and re-ran until it was felt that all wasted motions were identified.

After discovering where the differences were between the time studies and the pictures, and noting the wasted motions, we proceeded to look for better methods. If the department supervision could spot the inefficiencies, they would be easier to correct. If the other team members didn't spot a poor method, some guidance from the team leader led them to it. Some things were discovered that hadn't been caught by the team leader when he previewed the video tape.

In the final meeting, after the team had agreed on many changes, we included the operators from the line. The video tape pictures were shown to them. At the same time, we told them about the changes we were going to try if they already had not been tried. Some new tools and

methods were actually tried out on the line. We asked them to help us by giving us their ideas and comments. This bit of salesmanship seemed to eliminate all resistance to change. The operators tried all the ideas and even contributed some of their own.

Results

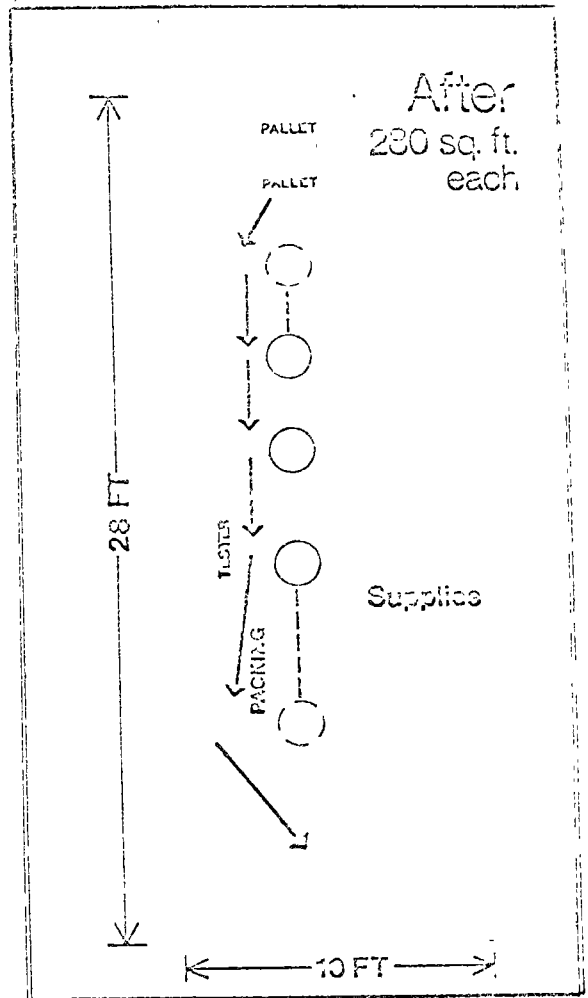
Improvements that evolved from team analysis of the video tape included:

- Considerable reduction of walking by condensing space and revising operations.
- Replacement of obsolete air tool and hand tools with new air tools.
- Adoption of screw stick and driver to replace use of individual screws.
- Elimination of a testing operation by obtaining vendor certification of one component.
- Redesign of final testing unit.

Implementation of all improvements resulted in:

- Annual savings of \$83,000 with an investment of \$8,000 for jigs, fixtures, benches, and tools. The assembly lines were rebalanced with three operators replacing five on each line.
- Floor space saving of 40 percent.
- Reduction of indirect costs through better material handling and less damage to components, Figure 4.
- The video tape equipment more than paid for itself in its first test.

Figure 4. The results of the study are reflected in the restructured assembly line.



Louis J. Vits joined Metro Aluminum Company as a time study man after graduating from the Industrial Engineering College, Chicago. Presently he is a methods engineer in the Industrial Engineering Department.

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Figure 1. Configuration of assemble-pack line prior to analysis study.

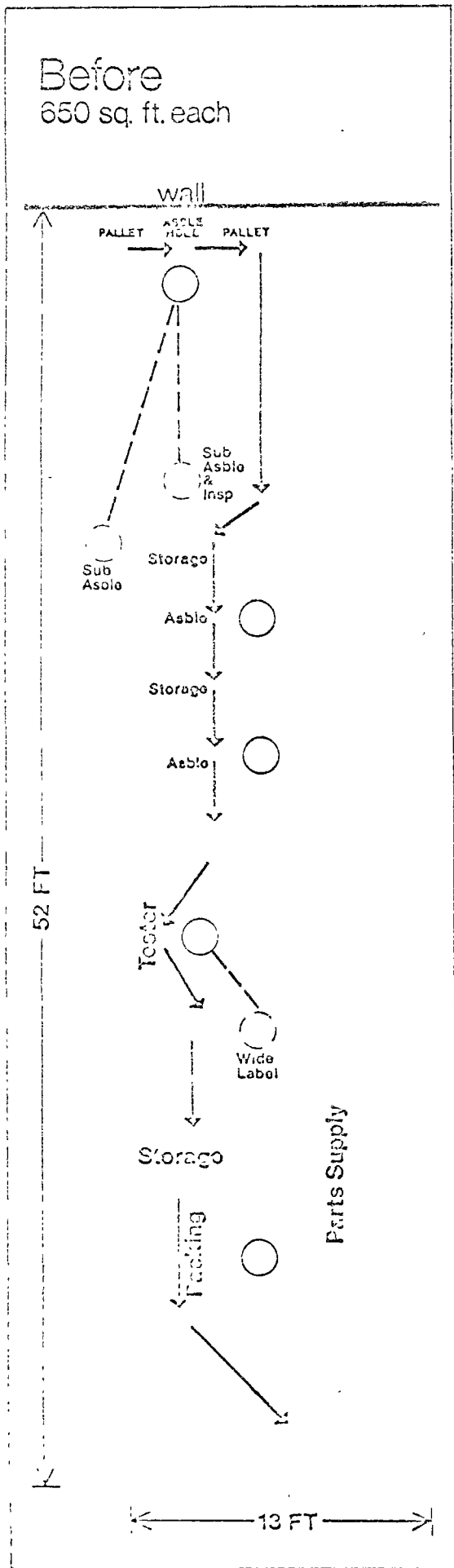


Figure 2. Video tape camera permits simultaneous editing and filming of production line activities.



The methods project

The Industrial Engineering Department, in cooperation with plant management, selected the assembly and packing of electric percolators for the first methods study. Four assembly lines produce on a yearly basis thousands of units per year. Plant management selected one assemble-pack unit to be studied, Figure 1. The workers in this unit were told that pictures would be taken of them working, and that any methods changes made would be tried first on that unit.

A team was appointed to conduct the study. It comprised: a leader from Industrial Engineering (the author), the Plant Superintendent, a time study engineer, two foremen, and two set-up men. The four assembly lines are in two different departments; each was represented on the team by a foreman and a set-up man.

Video recording

As shown in Figure 1, there were five operators in the unit. Two remained in place, three moved about to perform their operations. The camera was mounted on the wheeled tripod, and the monitor and recorder were placed on the dolly to facilitate moving the equipment between work stations. Figure 2 shows the film filming work at one station.

An average of five minutes of pictures were taken at each work station. After completing a series of pictures, the engineer immediately replayed them to insure that good results were achieved. To get the

desired coverage some pictures were redone (right over the old footage). When all the pictures were done the operators were then called over to view the film. This helped to eliminate or reduce the resistance from the operators on this project. Altogether, one and one-half hours were spent in taking the pictures, netting 38 minutes of video tape.

Analysis

The engineer's next step was to compare the elemental description from the current time studies with the video tape to see if the description compared accurately with the pictures. Any differences were noted. These differences were then analyzed as to whether or not they improved the unit.

While studying these results, the engineer kept this thought in mind: "Does the operation or element add value to the item? If it doesn't, could it be eliminated or reduced?" The engineer put together a quick cost analysis of what he found. It showed a potential of over 20 percent reduction in cost if all ideas for improvement could be implemented.

After the engineer had completed his preliminary studies and cost analysis of the unit he called the team together for meetings. Figure 3. The ground rules laid down in the first session were:

1. Our goal was to reduce the cost of the end product.
2. We would have one 1-hour session per week for six weeks.
3. All improvements would be implemented within four months.
4. Due to the time element, major design changes in the product could

operation independent on these vehicles for transportation will normally cost the owner upward of \$9,000 per year. Undue restriction of vehicles on any except the smallest jobs may adversely and severely affect the engineering supervision of the work.

CLIFFORD ALLEN BETTS,³ F. ASCE.—As a check list or reminder this well-thought-out paper will be appreciated by many construction men even though they have their own ideas and methods gleaned from experience.

It is customary for contractors to rely on their cost records for both past and future reference. Therefore, such items as temporary heating sheds for painting, concrete work, carpentry, and the like, should be charged to work items rather than being thrown into an overhead catch-all.

It is not every contractor that saves United States government checks to use in lieu of costly performance bond payments. This has been done, however, and a United States check proved as good as a bond.

One contractor, who was responsible for furnishing the construction camp school as well as other buildings, refused to hire a well-recommended master mechanic because he had six children and the school did not have room for them. Later, he was prevailed upon to hire the man and found him more valuable than the cost of school enlargement.

The owner's field engineer should handle this concrete control and keep the end product at maximum efficiency at all times, with no lag because of testing. This may involve changing mixes or materials.

Engineers can also advantageously cover the preparation of progress charts and the obtaining of progress photographs that often tell valuable stories and supply much needed information.

An unusual type of progress chart (see Fig. 3) was developed by the writer to show relative progress of several phases of the construction (which is similar to Moffat Tunnel Progress Chart). Instead of the usual linear chart,

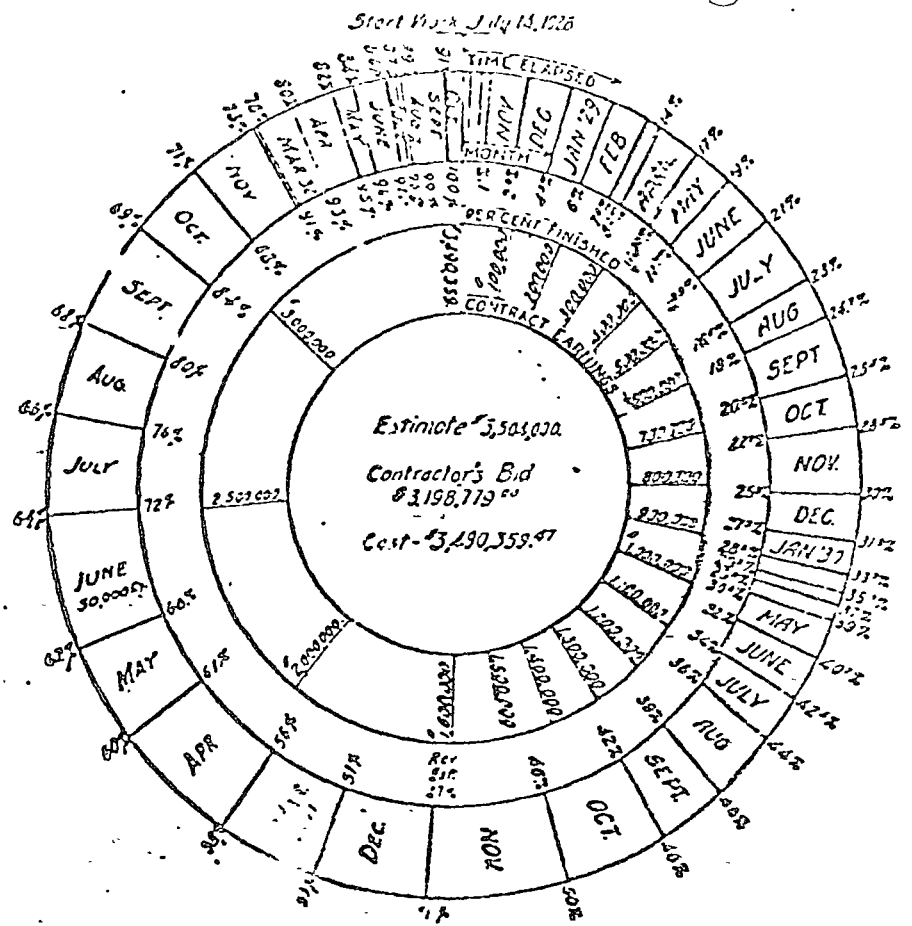


FIG. 3.—OWYHEE DAM GENERAL CONSTRUCTION COMPANY CONTRACT PROGRESS CHART 1926-1932

it was in the form of a circle so that each item appeared graphically in its relation to the others and the work was completed at 360°. This facilitated coordinating the work and it showed at a glance when one phase was out of step with the others. This circular chart, with different items shown in concentric rings, works well in combination with linear progress records and who shall say that progress is not important.

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Journal of the
CONSTRUCTION DIVISION
 Proceedings of the American Society of Civil Engineers

OWNER'S RETURN FROM CPM—FACT OR FICTION¹

By Lewis W. McBride,² F. ASCE

INTRODUCTION

When the Critical Path Method (CPM) is mentioned today, most of those familiar with its use think of construction proceeding along previously planned lines with the critical path highlighting the activities which control the scheduled progress. Although this is a major application in the construction business, CPM has been found to be a valuable management tool for planning, analysis of a plan, and monitoring progress as the plan is executed. In fact, CPM can be applied profitably to any job, project, or program which can benefit from efficient time management.

The owner's interest in a facility during both the planning and construction phases always involves one or more of several factors: the initial and total cost, time required for design and construction, date the facility is desired or needed, functional use, and aesthetics. Some projects may be monuments or works of art for which the time aspect plays a minor role, but most projects have a time requirement based on a need date or, as in the case of a commercial facility, the desire for an early return on an investment. For all types and classes of construction, cost is always a major concern.

The Corps of Engineers is in a unique position, being an agency not only responsible for both design and construction, but also one which is the owner, represents the owner, or acts for him for many civil works and military construction projects. As an owner it uses CPM in the planning and management of many activities. Some questions are frequently asked: "Why should an owner use CPM?" "If CPM benefits the owner, is it worth the cost to him?" "Will owners continue to use CPM after their past experiences with it?"

The Corps of Engineers uses the team Network Analysis System in ref-

¹Note.—Discussion open until November 1, 1970. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. This paper is part of the copyrighted Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, Vol. 95, No. CO1, June, 1970. Manuscript was submitted for review for possible publication on November 15, 1968.

²Presented at the September 30-October 4, 1968 ASCE Annual Meeting and National Meeting on Structural Engineering held at Pittsburgh, Pa.

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erence to the broad application of CPM in all of its design and construction activities. It has used this system successfully for many special projects and major programs since 1962. A recent survey reveals that 23 % of its active construction contracts contain the specified provisions for use of network analysis system to schedule and control 56 % of the dollar value of construction currently in progress under the supervision of the Corps. This extensive employment of the system demands an understanding by the personnel who must use it and provides ample motivation for appropriate training.

CPM IN PLANNING

Owner's Needs in Planning.—The requirements of an owner or his agent are not confined to the details of construction alone but extend to overall planning and management of major programs including many construction projects which must be developed, funded, designed, built, and operated or maintained. There are certain basic elements needed by all owners.

Coordinated Overall Program Plan.—The planning for a major program is frequently more complex than the construction of individual projects. The owner's planning must be comprehensive in scope including not only his own activities but those activities to be performed by others which are inter-related to his own. He is concerned with a variety of important areas of consideration in addition to construction. These would include feasibility studies and investigations, financing, economic analyses, acquisition of real estate, design of the separate facilities, and separate procurements.

Most Economical Cost.—All owners have certain monetary limitations, the investment value is of primary concern for most programs. The initial investment value is usually measured in dollars which are largely controlled by design, but the initial cost is also affected by time available for accomplishing the work, timely completion, and delays. Some investment values are measured by media other than money. The value of many projects built by the Corps of Engineers is measured in national defense capability or protection of human life.

Early Completion of Usable Facilities.—Few investments are of value to an owner until the facility is built and ready for its intended use. Many facilities are already needed before planning is started, and the earliest practicable completion date is of great importance to the owner.

Funding and Financial Requirements During Construction.—During the planning phase the owner is always concerned with financial resources to be needed during the various time periods throughout the development of a program. He must make available sufficient resources from month to month or year to year to avoid costly delays without unnecessarily reserving excessive financial resources for long periods of inactivity prior to the time the funds are needed for orderly progress. This means that he must be able to anticipate the realistic need for funds each month or year throughout the design and construction phases of development.

Fulfilling Owner's Funding Needs.—In this context two CPM systems are helpful. One is used by the owner or his agent for program or project development, design, and construction, and the other by the contractor to control construction and to bid his contract. The contractor's plans discussed under the heading "CPM in Construction."

Owner's Program Plan by CPM.—The owner's CPM must necessarily include his own activities and all activities of others that would have impact on his own actions or upon other parts of the project for which the owner maintains control. Although any one of these activities by others may be complex enough in itself to warrant detailed breakdown and planning, the owner's network might well include these items as single activities. The owner's plan must be comprehensive in scope and include all phases of the development. The owner's CPM is used as the basis for analysis of the program and determination of the many time frames that affect the project. In the planning stage the analysis data can be used for many decisions which could result in a better coordinated effort for completion at a reasonable date. These determinations include such items as:

1. Dates by which A/E contracts must be awarded and design completed.
2. Dates by which financial arrangements must be completed for the various phases of the work.
3. Dates by which real estate appraisals, negotiations, and acquisition must be started and completed for various increments.
4. Dates by which the various construction contracts must be advertised and awarded.
5. Dates to specify for completion of construction for each contract or separately usable feature of work.
6. Dates by which orders must be placed for owner furnished items of equipment and materials.
7. Milestone dates to specify for completion of a portion of a project or joint occupancy by two or more contractors or users.
8. The date by which occupancy can be expected by the owner.

Anticipating Financial Requirements.—In addition to the data for decisions on time staging, the owner's CPM provides data for forecasting monetary requirements during each time phase. This data is provided by estimating the cost to the owner for each activity and assigning that value to the activity. Funds for any one activity should be on hand before starting that activity, yet it is undesirable to freeze financial resources far in advance of the time needed. The forecast of obligations can be made by tabulating each activity value under the month in which the start of that activity will occur. Since CPM provides two start dates for each activity, i.e., the earliest date by which it can start and the latest date by which it must start, two tabulations are useful. One tabulation may be made by early start dates and another by late start dates. A total of the values of such activities for each month on these tabulations defines the parameters within which a specific schedule may be established. These data reveal the parameter funds which must be available for obligation each month to provide for completion of the overall project on time. They also reveal the maximum amount of funds which could be profitably used. Definition of these parameters can be very important when the inevitable adjustments in the scheduled progress must be made. A regular forecast of work placement values, or costs, can be made by preparing the tabulations based on completion dates in lieu of start dates. These forecasts have been found very useful in the Corps of Engineers, as many major projects span many years over which the Congress provides funds year by year. The reasonable requests for appropriations can be made and schedules can

be logically adjusted when factors provided differ from the scheduled amount requested.

Preliminary Construction Analysis.—A preliminary analysis of construction by CPM, even in summary form, is often used for determining reasonable construction times. Potential conflicts and bottlenecks which can develop into a major crisis are frequently discovered in this preliminary analysis during the planning stage. This early detection of such conditions allows advance planning and selection of the most desirable alternate course of action while averting the expense of the fully developed crisis. The result of this analysis is lower cost and earlier completion for the owner.

CPM IN CONSTRUCTION

Responsibility for Preparation.—The CPM used for scheduling and controlling construction is usually the contractor's responsibility, but in some cases the owner may profitably furnish the construction CPM.

Contractor Prepared CPM.—The requirements are stated in the contract with the details of the CPM network and reports of progress to be furnished by the contractor and approved by the owner. This has the following advantages:

1. It is a good communication vehicle to reveal the contractor's plan to the owner for the owner's planning of interrelated activities. Logic restraints are clearly shown on the diagram, whereas assumptions were previously necessary when bar charts were used for control.
2. It stimulates more detailed planning by the contractor which usually results in better coordination, fewer delays, fewer claims, and earlier completion by the contractor.
3. It permits evaluation of the impact on the contractor's work of anticipated and actual changes in the job.
4. It can be used to provide progress and payment data and to avoid many manual calculations.
5. Updating permits refinement of occupancy dates, needed delivery dates for owner furnished items, and date of final completion.

Owner Prepared CPM for Construction.—In emergency cases where the completion date may be vital to the national defense, and construction and design must be performed concurrently, the Corps of Engineers has effectively prepared and furnished to the contractor the CPM to identify the time available for accomplishment of each activity on a Cost-Plus-Fixed-Fee (CPFF) type contract. This was the case, for example, in the expansion of the Bell Helicopter plant at Saginaw, Texas. On this job, only 150 calendar days were available to obtain criteria, design and build work valued in excess of \$2,500,000. The owner's CPM analysis was used to determine the type of contracting procedure necessary. CPFF was selected. The CPM prepared by the owner was then used by the contractor to perform the work. The project was actually completed 3 days ahead of the required date, although only 75 days were available for the construction period.

Owner's Interest in the Contractor's CPM.—Since preparation of the contractor's CPM and execution according to this plan of operation is usually the contractor's responsibility, some may question why the owner is interested

in more than the contractor's reports of progress. It is true that the owner has little or no control of the contractor's cost or management of construction under normal conditions. However these factors do have influence upon and are influenced by many activities that the owner controls such as interim financing and owner furnished materials. Therefore, the contractor's management is of vital concern to the owner as it does have marked effect on his plans and actions.

Updating for Progress.—Realistic plans and appropriate actions can only result when the CPM is updated to reflect the impact of actual happenings. The data obtained from the initial CPM, being based on estimates, will rarely remain unchanged even for a single activity, and controlling activities will vary from time to time from those on the initial critical path as the work progresses. Updated data must be used by the owner to determine dates for needed actions on his part to preclude subsequent delays, to revise future planning based on original logic and actual developments, and to evaluate probable impact on progress of actual changes to the work. Updated information is usually furnished in the form of computer printouts in a variety of arrangements. Each listing, or sort, serves a certain purpose to provide data not previously available from other control systems such as job status on the basis of float, realistic forecasts of milestone and completion dates, activities which must be started or completed during the next report period, and activities which need attention to make up lost time.

There are numerous ways in which updating and progress reporting may be accomplished. These include: posting and redrafting time-scaled network diagrams, time-scaled charts on magnetic or peg board with movable nodes and arrows, manual computations on diagrams or in tabular format, and computer analyses providing various sorts or listings. While these various methods may be employed satisfactorily in using CPM for some types of work, the most effective updating for construction progress is done by computer analysis. The dynamic conditions surrounding construction work require rapid response and evaluation of impact of constant change introduced by the many variables. These include weather conditions, acts of God, effects of the labor market on productivity, availability of materials, and changes in the design or functions of the facility. With the rapid rate at which construction can progress and the continual variations from the original estimates, manual updates are generally too slow and consequently more expensive than the rapid computer analysis. The manual graphic techniques of updating are more readily understood by the untrained person; however, they have usually failed to be responsive to the needs of management for construction on a timely basis.

Construction Progress Reporting.—Whether computer printouts or some other report formats are used, more meaningful reports can be submitted to the owner by the contractor utilizing CPM. When dollar values are assigned to activities, the contractor's earnings are also automatically computed as a side benefit of updating the CPM by computer. This eliminates the necessity for a separate manual computation of earnings for partial payment purposes. These earnings to date divided by the value of the contract will also provide a percentage of completion which is desired by most owners on their reports. The rapid response afforded by computers permits receipt of management information for making timely decisions and taking actions necessary to avert delays, rather than learning why a delay occurred after it already

happened. This is the type of reporting that is worth dollars in the bank to an owner.

CONTROLS AND LIMITATIONS

The basic purpose for any construction schedule is control of time and cost.

Control of Costs.—From the owner's standpoint one of the more important controls is of cost. It goes almost without saying that funds are always limited. For control of these funds the owner needs current and comprehensive information on which to base decisions. In the field of costs the CPM will furnish valuable information on the effect of proposed changes. The owner can study the impact of these changes on the construction schedule and their side effects on other activities and weigh the desirability of the proposed change against the resulting increase in both money and time.

Control of Time.—Time is also directly related to money. The expression "Time is money" takes on more meaning with every wage increase and resulting cost index curve. It is to the owner's interest to see that the contractor efficiently manages his work. The CPM represents his management effort to minimize the time spent on the job and to optimize the labor and equipment required. From the contractor's standpoint this management tool is necessary to meet competition, maintain his profit level, and continue the market demand for his services. The owner's stake in this is the benefit obtained from lower bids and more favorable costs for the seemingly inevitable changes. The proper use of CPM will forestall delays that are flagged as developing. A properly updated CPM is a most effective method of communication which red flags the owner's responsibility as well as the contractor's. It pinpoints the requirements for timely approval of submittals whether they be test results, certifications, materials, or shop drawings, and the schedules which the owner must meet for delivery of owner-furnished materials which must be installed by the contractor.

Legal Issues and Limitations.—When time is of an essence and the schedule indicates delays or potential delays for which the owner must decide the necessity or desirability of directing acceleration of one or more activities, the proper use of CPM can preclude claims based on useless acceleration of unnecessary activities. CPM furnishes a much firmer basis than has ever been available under other control systems for a fair settlement of many legal questions. Through the logic inherent in the system, it is practical to evaluate the impact of changes in the work, including ripple or side effects, now a consideration in all Government contracts, on any part of the job. The causes and effects of delays which arise and those time extensions which are justly due can be readily determined. Legal disputes may be avoided through better management, but where such disputes do arise, a fair and equitable agreement can often be reached on the factual basis furnished by CPM. This system is frequently used in filing and refuting claims and can be used to advantage during settlement because of the logical presentation it affords.

UNDERSTANDING OF CAPABILITIES OF CPM

CPM is not a panacea and must be properly used to be effective. Some of its criticisms has resulted from failure to understand fully the system or

properly apply it. In some cases the results have been expenditures of money, without the compensating savings. The potential value of CPM is great, but the major question today is whether the system will survive its misuse. It must be used properly or the system can be destroyed by human failure to apply it in a practical way.

Evidences of Lack of Understanding.—Poor specifications in some construction contracts requiring inappropriate information attest to the lack of understanding by the specification writer of how CPM should be used in a practical way. Such specifications frequently result in useless information to the builder or owner. Efforts to update and report by the use of time-scaled network diagrams on a large construction job seldom result in more than a historical record which is never truly up-to-date until the job is completed. Such efforts seldom provide timely management data or up-to-date schedules while the work is in progress. This generally denotes lack of understanding of how computer data from CPM should be used by the manager.

CONCLUSION

In the Corps, CPM has helped accomplish more work with the same work force, complete projects in less time, reduce effort and costs, and to meet seemingly impossible schedules demanded in support of the national defense program. In short, the benefits to this owner from CPM are indeed fact, not fiction.

Journal of the
CONSTRUCTION DIVISION
Proceedings of the American Society of Civil Engineers

FIRST FIVE YEARS OF THE CRITICAL-PATH METHOD

By William J. Gleason, Jr.,¹ A. M. ASCE, and Joseph J. Ranieri²

SYNOPSIS

Observations regarding the use of the critical-path method (CPM), and some of its extensions, since its first appearance in 1953, are presented. Types of users and various projects planned and scheduled by CPM are also examined. The need for proper training before using CPM is reviewed, and a case history of an actual CPM installation is outlined. A sample problem with an arrow diagram and resource usage based on different availabilities of resources is included. The basic critical-path analysis was performed, and the fundamental schedule information was computed. Then, a resource scheduling algorithm was applied to the project assuming unlimited resource availabilities. The data calculated in this way is the daily usage of each resource throughout the life of the project, with the assumption that each job has been started as early as possible.

Among the results of this admittedly unrealistic first pass at the problem will be the peaking of several crafts, for example. Then, the craft requirements are adjusted to known levels and a new schedule is computed in which the resource usage curves will peak less sharply, although the project completion may be extended.

In the trial-and-error method, which is usually performed on an electronic computer, better schedules are worked out. The schedules are better because they reflect existing situations and incorporate the best information available at the time.

Note.—Discussion open until August 1, 1954. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. This paper is part of the copyrighted Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, Vol. 90, No. CO1, March, 1954.

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INTRODUCTION

In the five years since network analysis methods were first considered, and then applied to an industrial project, both private industry and government in the United States, and in several other countries, to some extent, have accepted this new technique as a significant management tool. Of the many network systems³ that have arisen, two are of real significance now (1964). These are the critical-path method⁴ (CPM) and the program evaluation review technique (PERT). The purpose of this paper is to consider some recent developments of CPM. Specifically, the writers will examine the following: (1) The evolution of CPM⁵ and its growing acceptance by industry and government;⁶ (2) observed and reported experience in implementing (CPM) within an organization; and (3) current aspects of CPM, especially the development and application of the resources planning and scheduling method (RPSM). A detailed example of manpower allocation by RPSM is included.

EVOLUTION

The beginnings of CPM and the accounts of its first applications have been recorded. The references at the end of this paper include a number of sources for this historical information.

At first, CPM was used primarily in the construction industry. In fact, construction is still one of the areas of most frequent application of CPM. Although the first users of CPM did little more than construct arrow diagrams and plan and schedule their projects accordingly, they immediately realized the benefits of this new approach. Project managers found, for example, that they had a clear picture of the project, readily communicable to everyone including new personnel, and that they could receive timely and accurate data as the basis for sensible decisions.

As managers became more confident in their application of CPM, and as the system itself was extended and refined, it became apparent that the principles of network analysis were applicable to projects in industries other than construction. Soon projects in engineering, plant maintenance, refinery operation,⁷ highway planning,⁸ construction,⁹ and many other areas were at least

³ Kelley, James E. Jr., and Walker, M. R., "Critical-Path Planning and Scheduling: An Introduction," *Mauchly Assoc., Inc.*, Fort Washington, Pa., 1959.

⁴ Boshun, George A. W., "Helping the Executive Make up His Mind," *Fortune*, April, 1962.

⁵ Kelley, James E. Jr., "Critical-Path Planning and Scheduling: Mathematical Basis," *Operations Research*, May-June, 1961, pp. 296-320.

⁶ Stoen, Major E. S., "The Critical-Path Method as Used in the Canadian Army," *Mauchly Assoc., Inc.*, Fort Washington, Pa., May, 1961.

⁷ Reeves, Eric, "Critical-Path Speed Refinery Revamp," *Canadian Chemical Processing*, October, 1960.

⁸ Schramm, L. F., "Highway Men Take a Lesson From Industry," *Contractors and Engineers*, June, 1960.

⁹ Boshun, George A. W., "The Critical-Path Method for Project Planning and Control," *Contractors and Engineers*, July, 1961.

being partially planned, scheduled, and controlled by this unconventional method. CPM was accepted as a new way of thinking. It was welcomed as a set of principles with applicability because of the similar underlying characteristics and requirements in all projects. Therefore, management began to take advantage of features of the system other than the basic arrow diagramming.

With CPM, the development of alternative plans becomes possible easily, especially when commercially available electronic data-processing equipment and tested network-technique programs are used. Knowing this, management began to work with precise increments of time on projects and to develop alternative plans in which time was considered by itself, then with respect to other resources. These other resources include men, equipment, materials, working area, and money. As might be expected, the acceptance of a new system lagged behind its development. Although a technique for working out minimum cost-schedules had been developed by the originators of CPM in the early days of their approach, consideration of costs by network means still was not accepted. However, allocation of other resources and manpower leveling on a single-project basis are now (1964) going on.

Possibly the most important advantage resulting from these four or five years of using CPM is that management has clearly defined for itself the genuinely separate functions of planning and scheduling. Management has also realized that CPM is an effective means for control. From its first tentative usages in construction, CPM has been accepted on such a variety of projects as these: The design and construction of a new chemical plant, the overhaul and modernization of a large naval vessel, the planning and building of a hospital without adversely affecting the operation of existing facilities, planning a new type of ship, and replacing a senior executive in a large corporation.

EXPERIENCE IN TRAINING AND IMPLEMENTATION

The experience of users in terms of immediately measurable goals (reduction of overtime, saving in equipment rentals, realization of bonus payments for an early completion date) is now a matter of substantial record. At this time (1964) in fact, the direct economic benefits of the correct application of CPM are almost taken for granted.

The experience of those companies that have had training programs in network techniques and have begun to implement the system more fully on their projects, with their newly trained men integrated into the established organization, has been less spectacular and less well-known, but more significant in the long run. This experience will prove significant because it will mean that CPM as a management principle and an information system serving as a basis for sound management decision-making, will have permeated the organization.

Of course, the difficulties that arise during the training period and the early weeks and months of working with CPM vary with the organization, its personnel, and the abilities of the consulting firm brought in to do the job. For example, to convince top management of the usefulness of the network approach, but to fail to orient middle management and those at the working levels, is a guarantee of failure.

This actual example of the beginning of a CPM installation will illustrate the trouble that a major government agency was willing to take to build a strong foundation for the system. For some time, top management had been

March, 1964

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CRITICAL-PATH METHOD

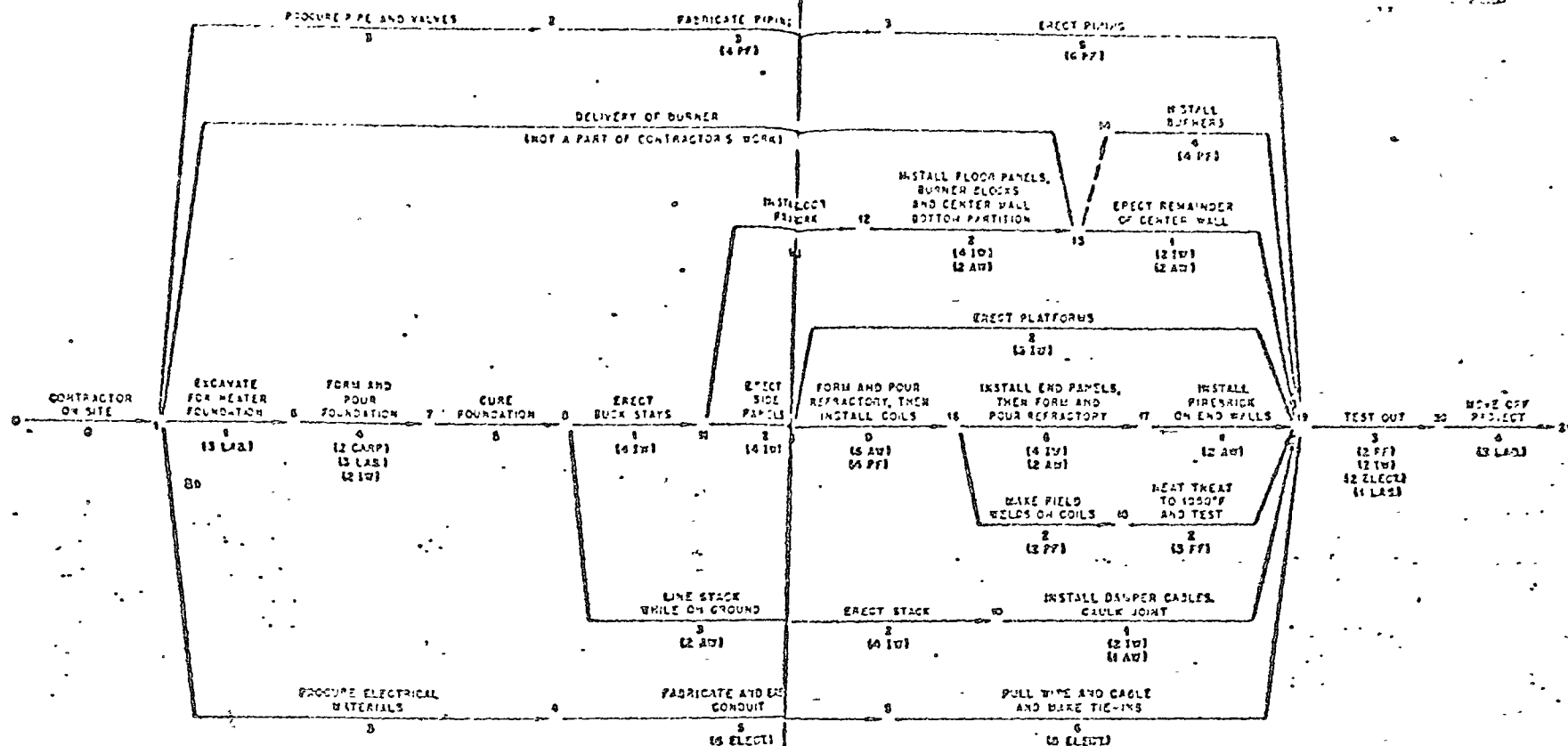


FIG. 1.—SIMPLIFIED ARROW DIAGRAM,

RECOVERY HEATER INSTALLATION

investigating the possible use of CPM to improve its conventional methods of planning, scheduling, and control. Senior men searched out users in several areas to understand what the system had done for them, as well as to learn what problems and shortcomings had arisen. Because the information resulting from these questions was mostly favorable, the agency invited a consulting firm to conduct orientation seminars for senior management-level personnel at two sites. The focus of these two seminars was a demonstration project appropriate to the business of the agency, and the presentation included the use of CPM to plan a specific project, as well as to plan the optimal use of available manpower. Orientation and training sessions then were authorized for other levels of management, and the installation of a reporting and monitoring system that would become a part of the structure of the agency was authorized. From that time, most significant milestones during the life of the contract will be:

(1) The agency will complete the construction of a power facility, which will be a major milestone in the arrow diagram technique.

(2) The delivery of the hundreds of components that will go into this project will be controlled through the establishment of early and late time boundaries. Thus, project management will not only know every delivery date, but will also be able to gauge accurately the effect of delays.

(3) A planning organization will be established within the agency, between top management and the operating divisions, to apply CPM as standard operating procedure. Agency personnel then will operate this reporting and monitoring system and will implement CPM and associated techniques as directed by management.

(4) When the agency has achieved the desired results from this system and understands it reasonably well, it will be authorized to make changes of other extensions to CPM. One will be to conduct further studies on the most economical way to accelerate a project. Various techniques, called risk-earn-cost expediting (MCE), management will receive data from such an array of schedules for expedited activities, with time associated costs, can be constructed, and the cost can be chosen. Ultimately, the areas of cost control and estimating will be expanded.

The need for education at all levels is important. It is comparable to the problems faced in the early 1950's when only a few firms were making tentative gestures in the direction of electronic computers. Then, as now, people were fearful that the introduction of a new tool, really a new concept, into their organization would be disruptive. Not only have computers become part of the fabric of modern industry, but some of the same people who moved from antagonism to acceptance now have another new concept to worry about. The chances that history will repeat itself (that acceptance will follow antagonism) are excellent.

CURRENT ASPECTS OF CPM

Aside from the technical developments in the field, two aspects are of practical interest in regard to CPM. One is the growth of acceptance from the original nucleus of construction companies.¹⁰ The second is the use of resources planning and scheduling method (RPSM) as an extension of the original CPM system.

As mentioned previously, most firms have used only basic CPM. But to avoid the problems that inevitably arise from fluctuations in the supply of resources, including shortages, the system has been extended to include an evaluation of the implications of resource limitations on a project and the correction of deficiencies. Once the basic critical-path analysis has been performed and fundamental schedule information has been computed, a resource scheduling algorithm may be applied to the project, assuming unlimited resource availabilities. The data calculated in this way will be the daily usage of each resource throughout the life of the project, with the assumption that each job has been started as early as possible.

Among the results of this unrealistic first attempt at solving the problem will be the peaking of several crafts, for example. The data may show that 100 carpenters are needed, when management know that only 40 are available in the area at the time. So the craft requirements are adjusted to known levels. A new schedule then may be computed in which the resource usage curves will peak less sharply, although the project completion date may be extended. In this trial-and-error method, better schedules will be worked out, better in that they will reflect existing situations and will incorporate the best information available at the time. Of course, resources other than manpower can be calculated in the same way. Computer programs have been written that allow management to consider the effects of known limitations of several resources: Men, equipment, and materials. The most recent of the RPSM programs, prepared for the IBM 1620 computer, enables the manager to consider up to eight crafts per job and 26 crafts for the entire project.

An example of applying CPM and RPSM to the installation of a recovery heater has been chosen for the purpose of this paper. Fig. 1 shows a simplified arrow diagram of a recovery heater installation, from the appearance of the contractor on the site to final test and moving of equipment and personnel off the premises. In this diagram, detailed steps have been omitted.

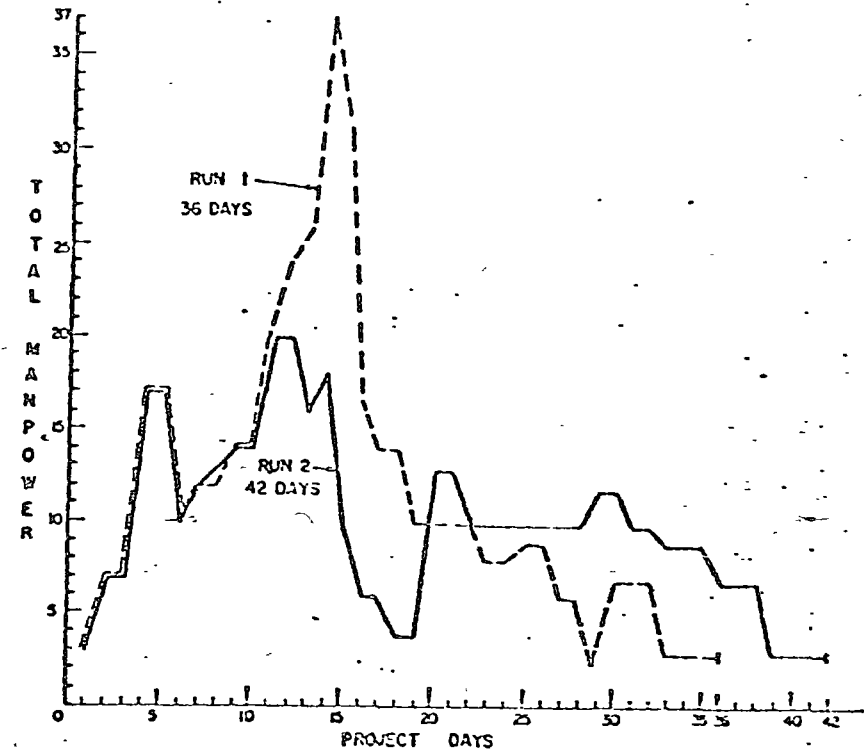


FIG. 2.—MANPOWER CURVES, TOTAL FORCE

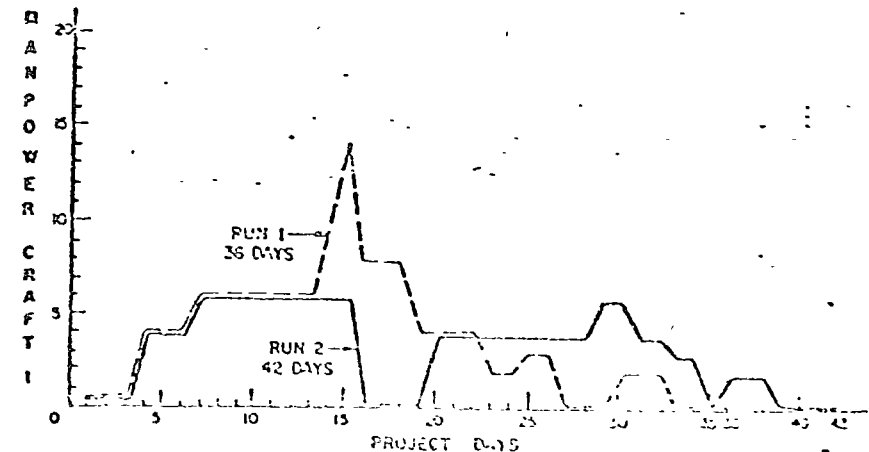


FIG. 3.—MANPOWER CURVES, CRAFT 1, PIPEFITTERS

When the first computer run was made, on the basis of normal time for all jobs, the output showed a 36-day duration (Fig. 2 through 5). This time was satisfactory to the project manager. Next it was necessary to determine how many men from each of six crafts would be needed on each of the 36 days. The first computer run of the RPSM program, on the assumption of unlimited

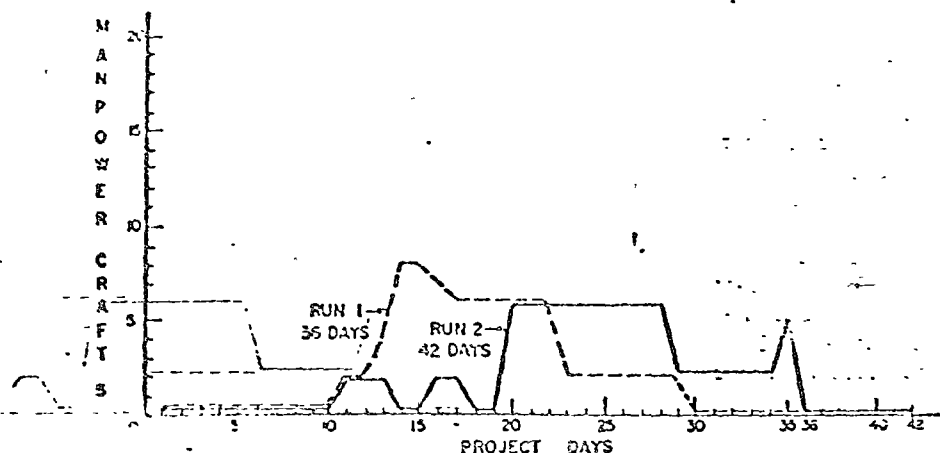


FIG. 4.—MANPOWER CURVES, CRAFT 5, ASBESTOS WORKERS

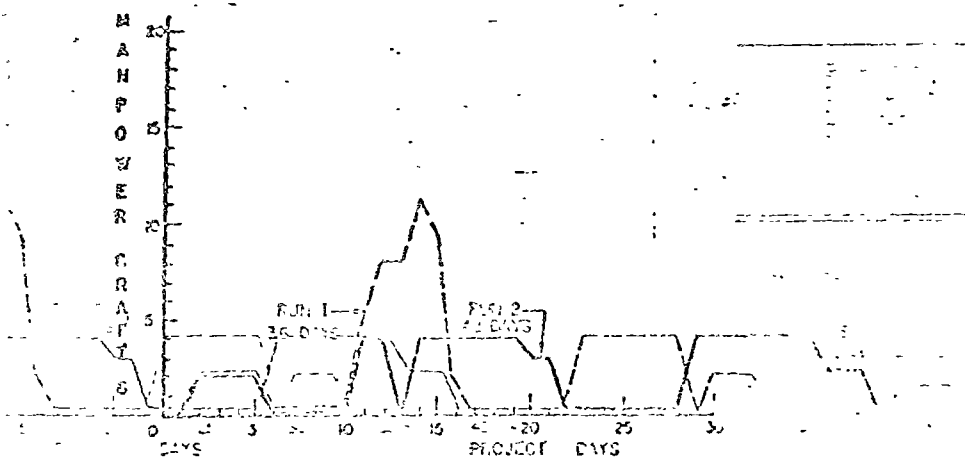


FIG. 5.—MANPOWER CURVES, CRAFT 6, IRONWORKERS

manpower would be necessary to perform the work, especially for pipefitters and ironworkers (Table I). Even if these peak requirements of the project were met, the contractor would not work

employer's reputation. Actually, three or four such RPSM runs may be necessary before management is satisfied with both the duration and the manpower (or other resource) allocations. On large, complex projects, six runs may be made. Both this combination of managerial judgment and the capability of the RPSM program and the computing system to supply information quickly means that this trial-and-error method results in a fast and accurate technique. It is valuable even for a contractor in a labor market of good supply, for it is economical and important for him to allocate his crafts as smoothly as possible over the life of the project and to build and maintain a reputation as a dependable employer.

Another development in this field of network analysis is that owners at industrial and governmental levels are beginning to specify CPM usage by their contractors. Although this procedure is still exceptional, these approaches have already been noted in mandatory CPM applications.

(1) Specification require all bidders to submit a general network with their bids, and the successful bidder must amplify his plan after the contract is awarded.

(2) The bid package includes a general arrow diagram reflecting the thinking of the designer, and contractors must expand the network.

TABLE I.—CRAFT REQUIREMENTS

Craft	Peak Requirements	
	36-days schedule	42-days schedule
Pipefitters	14	6
Carpenters	2	5
Laborers	3	3
Electricians	3	8
Asbestos Workers	8	6
Ironworkers	11	4

(3) After an award is made, the owner, engineer, and contractor must jointly prepare a network that is mutually satisfactory. Monitoring and updating also become a joint effort. In this way, misunderstandings are minimized, problem areas are evident in advance, and the effect of changes in the project will be immediately apparent.

(4) A consulting firm may be called in to work with the owner, engineer, and contractor on the implementation of a project by CPM. The major advantage of using such assistance, in addition to the fact that the outside firm will bring expertise to the assignment, is the objectivity of the professional approach with which it will perform. In this situation, the usual biases of the men associated with the project as owner or contractor can be overcome.

CONCLUSIONS

In the five years since network analysis techniques were first applied to real projects, they have come to be accepted by private business and industry, and by the government. At first, the critical-path method was used primarily in the construction industry, but it soon began to spread to many other types of industry. Now, it is considered not only a new management tool but also a new way of approaching a project. The principles are known to be applicable to any type of project in which a unique goal is to be met by the accomplishment of a number of activities that are related to one another more or less intricately. CPM enables management-by-exception by freeing managers from concern with operating details that can be controlled routinely. Used with minimum-cost-expediting and resources planning and scheduling method, CPM has assisted management in these ways: (1) The entire project is seen as an entity; (2) critical activities are identified; (3) interrelationships and responsibilities are defined; (4) duplication of effort is minimized; (5) activities are tightly controlled at the operating level; (6) activity and project times and costs are correlated; (the cost of activity compressions or stretchouts are known and a decision on time can be made with full knowledge of the effect on costs); and (7) manpower requirements can be controlled effectively, subject to availabilities and the project duration.

The major requirement for effective implementation of the system is the education of personnel at all levels within an organization. It has been established that such a thorough educational program is not only worthwhile but necessary if the full potential of CPM is to be realized.

Journal of the
CONSTRUCTION DIVISION

Proceedings of the American Society of Civil Engineers

QUANTITY SURVEYS FOR COST ESTIMATES

By George W. Heller,¹ F. ASCE

SYNOPSIS

Estimating materials and installed equipment quantities is a numerical representation of the physical characteristics of a construction project for the purposes of this paper, so that a construction cost can be estimated. Procedures are broadly outlined, methods of evaluation are examined, and examples of these methods are presented. The classification of the kinds of materials, by employment, on a job, are described, as well as the factors which influence the materials selected and the quantities required.

INTRODUCTION

This paper deals with estimating for materials used and equipment to be installed in construction work and is, of course, applicable to every type of construction work. An accurate estimate of these items is perhaps one of the most critical parts of any estimate as it should be possible to determine these two items with a great deal of accuracy and thereby form the basis of the estimate. This is critical because all of the variables or variations in bids are predicated on the materials and the installed equipment. Although this paper

Note.—Discussions open until August 1, 1964. For extended closing date or for a written request that it be filed with the Executive Secretary, ASCE, this paper is part of the copyrighted Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, Vol. 90, No. CO1, March, 1964.

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possible variations in the value of variables. Adjustment of variables, however, should be approved from the responsible individuals. If the problem is discovered after the work is finished the corrective action might require a repair or rework. The Quality Control Manual should contain directions for writing, approving, following, and documenting repairs.

PERFORMANCE OF QUALITY CONTROL ORGANIZATION

The performance of the quality control organization itself should be subject to management evaluation. A system of periodic audits are often planned to verify compliance with the quality control program. The scope of the audits can also include an evaluation of the performance of the quality control organization. Performance indicators can be developed and used as a basis for judgment. It would be relevant in such an audit to inquire into the skill and qualifications of the test and inspection personnel. Do they provide complete and objective documentation consistent with the importance of the area being inspected? Are they providing timely investigation of failures and chronic defects? And, more importantly, do they anticipate problems and contribute to their prevention? Do the inspectors understand the plans, specifications and program requirements? Has the quality control supervisor outlined a program to his inspectors that will provide coverage for all areas in the program? Has he backed this up with definite instructions to his inspectors? Is follow up performed on repairs of defective work and is adequate documentation provided to prove that the repair was completed satisfactorily? Is the quality control file maintained so that information can be readily retrieved? Does the organization delve into investigations and statistics for their own end?

The answers to these and similar questions will provide the insight needed by management to appraise the performance of the organization.

SUMMARY

Some of the major aspects of administering the quality control effort on a large construction project have been presented herein. The difficulty of managing the effort is increased because of the many different operations and pressures. An efficient and smoothly run program depends on comprehensive plans capable of accomplishment. It is felt that the quality of a constructed product would benefit from a planned systematic approach and a method has been proposed where input from all directions is collected, evaluated, and organized so that it can be understood by all levels. Planning, organizing, managing and controlling the program is considered. The ultimate goal is the attainment of a project having a known quality level. The system is subject to gradual improvement through continuous feedback as the project is designed and constructed.

REFERENCES

Journal of the CONSTRUCTION DIVISION

Proceedings of the American Society of Civil Engineers

PROJECT PLANNING AND CONTROL BY TIME-SHARING COMPUTER

By Norman L. Scott¹ and E. Lile Murphree, Jr.,² Members, ASCE

INTRODUCTION

The use of the critical path method (CPM)(2,3) for construction project planning and control has grown during the past decade to the point where it seems pointless to defend or condemn it. It is unquestionably here to stay. The purpose of this paper is to point out some important aspects of its proper use and to describe a recently developed technique for more nearly realizing the potential of CPM.

A basic understanding of CPM is assumed in the subsequent analysis. In addition, an elementary knowledge of batch processed digital computers for solving engineering, construction and business problems is helpful, but not essential.

MODEL OF PROJECT

The CPM network itself may be thought of as a model of the real project with which one may think logically about the interdependencies of the various elements of the project. The model is not, however, reality. Any deductions made from it must be related to the real project before the model can be reliable and useful. Preparing the model requires a thorough understanding of the project. It follows that the more people who get into the act of preparing, challenging, and revising the network, the more likely it will be to represent reality to an acceptable tolerance. A CPM network prepared by a person isolated from the actual work is apt to be worthless. In short, no CPM model can be a substitute for engineering or managerial judgment. It can, however, serve

¹Now in discussion open until August 1, 1972. To extend the closing of the discussion, a written request must be filed with the Executive Director, ASCE, 1801 Alexander Bell Dr., Reston, Va. 20191. This paper is part of the copyrighted Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, Vol. 98, No. C61, March, 1972. Manuscript submitted for review for possible publication on October 11, 1970.

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to quantify certain information only guessed at or known intuitively before.

Yet the success of CPM as a planning and control tool is the monitoring of the work at frequent intervals. Monitoring every two weeks has been found by the writers to be satisfactory in most cases. By comparing actual progress with planned progress, developing or potential problems can be recognized before they get out of hand. It is impossible for anyone to precisely know a project before it has begun its start; there are simply too many unknowns. Specific examples of unknowns which can affect the project plans are: (1) Subcontractors, labor, and suppliers who do not perform as planned; (2) design changes; (3) unexpected foundation or other site conditions; and (4) that most unpredictable factor of all, the weather. The only possible way to keep a project close to a reasonable schedule is to continually replan, in view of the latest information available. This continual monitoring and replanning is the key to keeping a project moving. This is precisely what an experienced superintendent does when he reassigns a crew to other work when he finds that unexpected conditions (e.g., water in an excavation) preclude the original assignments. But looking ahead a few hours, days or weeks is not enough. Intelligent decisions on a longer term must be made. The crucial difference is that with CPM, the replanning can be done on a strategic basis instead of on a tactical basis.

PROCESSING BY COMPUTER

If updating and replanning the project is periodically undertaken during the life of the project, the sheer manual effort of making the basic calculations can become a burden. Further, in order for the calculations to have relevance to the real project, the traditional working-day calculations must be converted to calendar days, an onerous and error-inviting undertaking. And finally, each display of the results (listing, bar chart, etc.) must be prepared anew, by hand, for each update.

As a result of the massive effort to manually update even a small network of, for example, 100 activities, it is not reasonable to expect it to be done often enough to be meaningful. The answer to the problem of processing has been the use of a digital computer. Machine processing of CPM models is firmly established and growing with the increasingly ready availability of computers. This is because its costs are competitive with manual processing and its accuracy is far greater.

Every job presented to the machine in the typical batch processing operation is based on these assumptions: (1) The entire set of data for the run is available to the machine as needed; (2) the entire program is available as needed; (3) the entire resources of the central machine and its peripherals are devoted to the program being run; and (4) there is to be no interruption of the execution of the program once it is started.

The implicit goals of the batch mode of operation to the user are important for the following reasons.

1. All jobs presented to the machine must queue up according to some priority, and the jobs must be run one after the other.
2. A program which severely restricts the portion of the machine's resources which are available to the entire computer during the batch

3. No changes to data can be made once the program has begun execution, so that if a data error is detected during execution, the entire run must be aborted, the error corrected, the job resubmitted and placed again at the end of the input queue to await its turn to be processed.

The practical result of this mode of operation is that the elapsed time from submission of the job to the actual receipt of correct results can be anywhere from hours to weeks, depending on several factors, which include: (1) Whether the computer is located in-house or at a remote site; (2) whether the user has actual physical control of the machine (open-shop operating policy) or if he must submit his work to a disinterested third party who actually schedules the work and operates the machine (close-shop operating policy); and (3) whether or not errors exist in the submitted data (a detected error requires a resubmission of the entire job). Furthermore each program ties up all the resources of the machine and makes it unavailable for any other use so that the user must pay for parts of the computer which he does not, in fact, use.

The time delay from submission of the job to receipt of correct results is of vital importance if the machine is being used as a partner, with the user in an iterative situation such as engineering design. In this case, the man makes decisions and submits them to the machine. Then the machine makes calculations based on the decisions and presents the results to the man, who in turn makes new decisions based on the new information, etc. The time delay is no less important in the CPM updating situation where work now in progress is being monitored by the process. A delay of days can be serious so any practical technique to reduce the time lag to minutes or seconds should be of compelling interest to the knowledgeable project manager. The following sections describe a practical technique for reducing time lag, called time-sharing, and summarize the important features of representative commercially available time-sharing services.

TYPICAL AVAILABLE TIME-SHARING SERVICES

The time-sharing computer is now common in most major cities. The larger cities often have two or more systems aggressively competing for business. At last count, Chicago had at least seven time-sharing services and new entries are still being contemplated. Not long ago, the leading time-sharing service reported that it served 61 cities from 31 centers. Competition is very keen and a report on typical price structures would be quickly out of date. Time sharing is the fastest growing segment of the already rapidly expanding computer industry.

The services offered by the different time sharing computer companies vary considerably. Usually the charges are based on hours of terminal connection time plus a charge for use of the central processing unit (usually in seconds). Never pricing policies also consider whether the subscriber is using his own programs or program in the common library.

Not all time-sharing services have a CPM or PLR (Program Evaluation and Review Technique) program in the common user library. Obviously if one is seeking to do project planning and control with a time sharing computer, it is most economical to subscribe to a service which has a CPM or PLR in its working program in the common library. Alternately, the user could use a CPM

programmer modify an existing card program and store it on the central computer for his individual use.

Placing a program on a time-sharing computer, however, has an important drawback. CPM programs are relatively long and the user pays monthly storage charges for privately stored programs based on the number of characters. In evaluating a time-sharing service it is important that the program be capable of handling projects of the size to be monitored, have a calendar day conversion routine, and perhaps other features that may be of special importance to the user.

The time-sharing program with which the writers are most familiar (University of Illinois Civil Engineering Systems Laboratory)(8) is written to accept precedence diagram networks (circle notation)(1) but will eventually

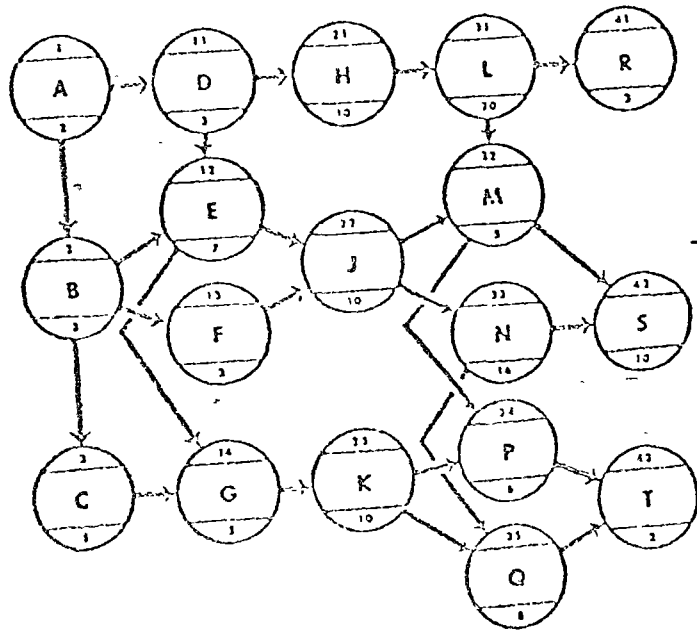


FIG. 1.—CPM DIAGRAM—CIRCLE NOTATION

accommodate arrow notation as well. To the writers' knowledge, all of the other CPM programs that reside in commercially available time-sharing libraries are written for arrow notation.

The University of Illinois Time-Share CPM program has been written especially for the Burroughs B-5500 computer. Communication with the machine is through conventional teletypewriters and regular voice-grade telephone lines. The operators have a tape punch and reader which allows inputting from punch cards and a tape cutting allow a more efficient use of operator or computer time. Generally, input is entered directly to the computer from the keyboard. All interaction with the computer is through a 20-character terminal language (TOL) especially designed for CPM, (8) and is implemented by the Time-Share Translator & Control program (1, 2, 3, 4).

```

??PUN CCPM/ILL←
5:CCPM/ILL=01 80J 1245 FROM 01/14
WHAT PROGRAM
CPM←
INPUT SECURITY CODE
DEBDEBDEB
WHAT DO YOU WANT TO DO
START A NEW PROJECT WITH CODENAME ACE←
END←
WHAT DO YOU WANT TO DO
RESUME INPUT FOR ACE←
NETWORK FOR ASCE ILLUSTRATIVE PROJECT←
PROJECT STARTING DATE IS 1/2/69←
OPERATIONS←
1 2 ACTIVITY A 11,2←
2 3 ACTIVITY B 12,13,3←
3 1 ACTIVITY C 14
11 3 ACTIVITY D 21,12←
12 7 ACTIVITY E 22,14←
13 3 ACTIVITY F 22←
14 5 ACTIVITY G 23←
21 10 ACTIVITY H 31←
22 10 ACTIVITY J 32,33←
23 10 ACTIVITY K 34,35←
31 20 ACTIVITY L 41,32←
32 5 ACTIVITY M 42,34←
33 16 ACTIVITY N 42,35←
34 6 ACTIVITY P 43←
35 8 ACTIVITY Q 43←
41 3 ACTIVITY R←
42 10 ACTIVITY S←
43 2 ACTIVITY T←
END←
WHAT DO YOU WANT TO DO
SOLVE ACE←
CPA OUT PUNCH 1:CCPM/ILL=1
DATA HAS BEEN SENT TO BACKGROUND
WHAT DO YOU WANT TO DO
END←
PROGRAM TERMINATED

```

FIG. 2.—NETWORK DESCRIPTION AS INPUT THROUGH TELETYPE MACHINE

March, 1972

The first step in using the program is to prepare a network that models the construction project. This network is normally prepared in circle notation with activities described on the nodes. Each activity is given a number, a description, and an estimated duration time. The program will also accept

ASCE ILLUSTRATIVE PROJECT

OPRM	OPR	DESCRIPTION	EST	EFT	LST	LFT	TF
1	2	ACTIVITY A	1/ 2/69	1/ 8/69	1/ 2/69	1/ 8/69	0
2	3	ACTIVITY B	1/ 8/69	1/ 9/69	1/ 8/69	1/11/69	2
3	1	ACTIVITY C	1/ 9/69	1/10/69	2/ 5/69	2/ 8/69	10
11	3	ACTIVITY D	1/ 8/69	1/ 9/69	1/ 8/69	1/ 9/69	0
12	7	ACTIVITY E	1/ 9/69	1/20/69	1/13/69	1/22/69	2
13	3	ACTIVITY F	1/ 9/69	1/14/69	1/17/69	1/22/69	6
14	3	ACTIVITY G	1/20/69	1/27/69	2/ 8/69	2/13/69	13
21	10	ACTIVITY H	1/ 9/69	1/23/69	1/ 9/69	1/23/69	0
22	10	ACTIVITY J	1/23/69	2/ 3/69	1/22/69	2/ 5/69	2
23	10	ACTIVITY K	1/27/69	2/10/69	2/13/69	2/27/69	13
31	20	ACTIVITY L	1/23/69	2/20/69	1/23/69	2/20/69	0
32	3	ACTIVITY M	2/20/69	2/27/69	2/20/69	2/27/69	0
33	15	ACTIVITY N	2/ 3/69	2/25/69	2/ 5/69	2/27/69	2
34	8	ACTIVITY O	2/27/69	3/ 7/69	3/ 3/69	3/11/69	2
35	3	ACTIVITY P	2/25/69	3/ 7/69	2/27/69	3/11/69	2
41	3	ACTIVITY Q	2/20/69	2/25/69	3/10/69	3/13/69	12
42	10	ACTIVITY R	2/27/69	3/13/69	2/27/69	3/13/69	0
43	2	ACTIVITY S	3/ 7/69	3/11/69	3/11/69	3/13/69	2

PROJECT COST = 1 0
PROJECT DURATION = 90

CRITICAL OPERATIONS OR OPERATIONS HAVING A TOTAL FLOAT LESS THAN 11
1 2 11 12 13 21 22 31 32 33 34 35 43

CRITICAL OPERATIONS OR OPERATIONS HAVING A TOTAL FLOAT LESS THAN 01
1 2 11 12 13 21 22 31 32 33 34 35 42 43

CRITICAL OPERATIONS OR OPERATIONS HAVING A TOTAL FLOAT LESS THAN 21
1 2 11 12 13 21 22 31 32 33 34 35 42 43

CRITICAL OPERATIONS OR OPERATIONS HAVING A TOTAL FLOAT LESS THAN 101
1 2 11 12 13 21 22 31 32 33 34 35 42 43

FIG. 4.-NETWORK ANALYSIS AS OUTPUT ON TELETYPE MACHINE, SHOWING INFEASIBLE SCHEDULE

...and accumulated the total cost of use...
...Notice that the network in Fig. 1 has one starting activity (A) and one ending activity (R, S, and T). The problem with this network is that

enough so that the scheduled time of following operations is not delayed or distorted. For example, the activity, Form-Retaining Walls precedes Cast Concrete-Retaining Walls, but if the retaining wall is large, some concreting will start before the formwork is complete. The two major activities must

ASCE ILLUSTRATIVE PROJECT

OPRM	OPR	DESCRIPTION	EST	EFT	LST	LFT	TF
1	2	ACTIVITY A	1/ 2/69	1/ 8/69	12/25/68	12/27/68	-6
2	3	ACTIVITY B	1/ 8/69	1/ 9/69	1/27/68	1/ 1/69	-6
3	1	ACTIVITY C	1/ 9/69	1/10/69	1/24/69	1/27/69	11
11	3	ACTIVITY D	1/ 8/69	1/ 9/69	1/27/68	1/ 1/69	-6
12	7	ACTIVITY E	1/ 9/69	1/20/69	1/ 1/69	1/10/69	-5
13	3	ACTIVITY F	1/ 9/69	1/14/69	1/ 7/69	1/10/69	-2
14	3	ACTIVITY G	1/20/69	1/27/69	1/27/69	2/ 3/69	5
21	10	ACTIVITY H	1/ 9/69	1/23/69	1/ 1/69	1/15/69	-6
22	10	ACTIVITY J	1/20/69	2/ 3/69	1/13/69	1/24/69	-6
23	10	ACTIVITY K	1/27/69	2/10/69	1/ 3/69	2/17/69	5
31	20	ACTIVITY L	1/23/69	2/20/69	1/25/69	2/12/69	-6
32	3	ACTIVITY M	2/20/69	2/27/69	2/12/69	2/19/69	-8
33	15	ACTIVITY N	2/ 3/69	2/25/69	1/25/69	2/17/69	-6
34	8	ACTIVITY O	2/27/69	3/ 7/69	2/27/69	2/27/69	0
35	3	ACTIVITY P	2/25/69	3/ 7/69	2/27/69	2/27/69	0
41	3	ACTIVITY Q	2/20/69	2/25/69	3/15/69	3/13/69	12
42	10	ACTIVITY R	2/27/69	3/13/69	2/27/69	3/13/69	0
43	2	ACTIVITY S	3/ 7/69	3/11/69	2/27/69	3/ 1/69	-8

PROJECT COST = 1 0
PROJECT DURATION = 90

CRITICAL OPERATIONS OR OPERATIONS HAVING A TOTAL FLOAT LESS THAN 11
1 2 11 12 13 21 22 31 32 33 34 35 43

CRITICAL OPERATIONS OR OPERATIONS HAVING A TOTAL FLOAT LESS THAN 01
1 2 11 12 13 21 22 31 32 33 34 35 42 43

CRITICAL OPERATIONS OR OPERATIONS HAVING A TOTAL FLOAT LESS THAN 21
1 2 11 12 13 21 22 31 32 33 34 35 42 43

CRITICAL OPERATIONS OR OPERATIONS HAVING A TOTAL FLOAT LESS THAN 101
1 2 11 12 13 14 21 22 23 31 32 33 34 35 42 43

FIG. 4.-NETWORK ANALYSIS AS OUTPUT ON TELETYPE MACHINE, SHOWING INFEASIBLE SCHEDULE

...and accumulated the total cost of use...
...Notice that the network in Fig. 1 has one starting activity (A) and one ending activity (R, S, and T). The problem with this network is that

and ending operations, in contrast to most CPM processors which are restrictive in that they require a single start and single end operation.

To set-up the network on the time-sharing computer the freeform input would be as shown in Fig. 2. The first integer entered is the activity number and the second is the duration. A third integer can be entered before the description for the cost of the activity or it may be omitted without affecting the input format. The activity description is entered after that and then the integers defining the operations that follow.

Typical output from the program is shown in Fig. 3. Again the activity number, duration, cost (if used) and description are listed in numerical order. The print-out shows the early start, early finish, late start, and late finish in calendar dates. The last column is the total float.

To update the CPM network, the activities that have been completed are reported to the program in the same manner as the original date. A new starting date is also entered reflecting the updating date. The command SOLVE sends the data to a background computer program, and a new dated schedule is printed out on the high speed printer or selected output can be received on the teletypewriter.

ACTUAL PROGRESS VERSUS ORIGINAL SCHEDULE †

For each updating, most CPM programs furnish output which projects the date of completion based on current progress, but there is no indication as to

```

??RUN CCPM/ILL-
5:CCPM/ILL-01 BOJ 1245 FROM 01/14
WHAT PROGRAM
CPM-
INPUT SECURITY CODE
HEADING
WHAT DO YOU WANT TO DO
RESUME ACE-
INPUT FILE ACE HAS BEEN REOPENED
TARGET DATES-
LATE FINISH TIME-
3/1/69 FOR 43-
END-
WHAT DO YOU WANT TO DO
SOLVE ACE-
CPM OUT PUNCH 1:CCPM/ILL=1
DATA HAS BEEN SENT TO BACKGROUND
WHAT DO YOU WANT TO DO
PROGRAM TERMINATED

```

whether or not the project is on schedule. Some card programs have been modified to show activities that have fallen behind previously established date goals. In the writers' experience this problem can be resolved quite simply by setting a target date into the machine for final completion or completion of major project segments.

Obviously, if a final completion date was chosen which exceeds the time of all activities along the critical (longest) path then all activities will show some float. If no completion date were set, activities on the critical path would show zero total float (last column in Fig. 3). If the desired completion date is before the time derived by adding up durations along the critical path, then the TF column will show negative values. When this occurs dates in the LST and LFT columns are earlier than dates in the EST and EFT columns.

At first this may seem contradictory, but actually the headings retain their significance. The early finish date is still the earliest that the activity can be completed under the present and predicted rate of progress. The latest finish time is the latest that activity can be completed to finish the total project on time. The amount of negative float then tells exactly how far the project is behind and calls attention to those activities and their logic which are delaying completion.

Fig. 4 shows the output from the network in Fig. 1. Completion dates for activities S and T are set earlier than they would normally occur. (See Fig. 5 for keyboard routine to make this change.) The program computes and prints negative float for the activities that are affected. The activities with negative TF must be accelerated by the number of days shown if the two completion date goals are to be attained.

FUTURE DEVELOPMENTS

Obviously, the time-sharing computer has very important convenience advantages over card operated computers. The person monitoring the project need to know nothing about operating a computer, he does not need to know any programming either. All he needs to understand is the relatively simple routine of entering data in the prescribed format and the procedures for obtaining output. In the University of Illinois program the commands to the computer are generally natural and conversational.

Bar chart printouts are possible with the University of Illinois time-sharing system. Fig. 6 presents a bar chart for the output shown in table 1 of Fig. 3. The headings at the top are in working days' duration. The activity number (in parentheses) and description are printed directly over each bar representation. The total length of the bar is from early start to late finish. The 1's are from early start to early finish and the 0's represent the total float in the activity. Asterisks are used to represent bars for activities that are critical.

At the current stage of development it is not yet possible to get an immediate turnaround with the University of Illinois system. Although immediate turnaround is not absolutely essential for efficient use of the time-sharing concept it would be desirable for project use. In any case, with CPM project simulation, the operator can change duration and logic to allow at least a minimum schedule. This concept is particularly important when it is desired to conserve resources, i.e., men and equipment. Circle notation networks are particularly easy to modify, and many of these modifications can be done at the keyboard without redrawing the network.



Several of the commercially available time-sharing services provide improved terminals for CPM calculations which aids the simulation process. These programs are written for arrow notation and are consequently somewhat difficult to rewire for resource constraints or other changes in network logic as the operator runs through the simulation process.

At the time of this writing many improvements are being made to the CPM programs available for time sharing. The construction industry can expect to see the various services providing programs to handle precedence diagrams (circle notation networks) as well as arrow notation. Calendar dates will be added by those not now having the feature. Plotter programs to draw networks

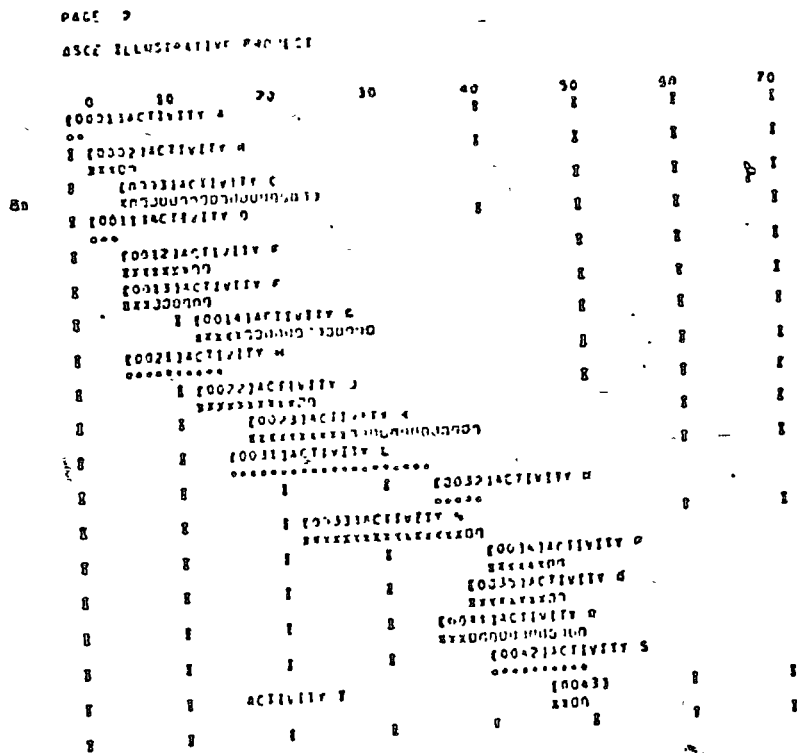


FIG. 6.--COMPUTER-GENERATED BAR CHART FOR FEASIBLE PROJECT SCHEDULE

after changes have been made can be expected. Resource decisions will be made easier by programs which handle such problems directly and routinely on-line.

CONCLUSIONS

The use of time-sharing computers for project management has become a reality. The construction industry has many problems which can be solved by the use of computers. The use of time-sharing computers allows the construction professional to use the power of the computer without the expense of owning one. This is particularly true for small firms and individuals who do not have the resources to purchase and maintain their own computer systems. The use of time-sharing computers also allows for the sharing of software and data between different users, which can be a significant cost saving. The construction industry is a complex one, and the use of computers can help to streamline the process and reduce the risk of error. As technology continues to advance, the use of time-sharing computers will become even more widespread and valuable.

must be available to justify the expense of the remote terminal service. Most time-sharing services provide other programs that are of value or have the ability to accept small privately written programs in BASIC, FORTRAN, or ALGOL languages.

CPM can shorten construction time significantly if a carefully prepared network is updated regularly as construction proceeds. Updated schedules, coupled with frequent meetings of key personnel involved in the project, will greatly improve the practices that have delayed jobs so often in the past. Regular meetings provide a simple and practical communication mechanism among people who can take action. CPM forms the basis of the management information system upon which decisions and action can be based. Everyone connected with the construction industry should be in favor of speeding construction time. Contractors know that jobs discharged quickly have a better earning potential than those that are not. Owners realize monetary gains from the interest saved on construction funds and the increased operating revenues that result from earlier occupancy.

The remote-terminal time-sharing computer is a step toward improving construction scheduling, and therefore deserves the attention of all of those interested in faster moving jobs.

ACKNOWLEDGMENTS

The work reported herein was performed at the University of Illinois Civil Engineering Systems Laboratory, Urbana, Ill., and sponsored by the U.S. Department of Commerce under provisions of the State Technical Services Act of 1967, and by various contractors and engineers who have sponsored management systems development work at the Laboratory. Copies of the program described herein and further information concerning it can be obtained from the Director, Civil Engineering Systems Laboratory, University of Illinois, Urbana, Ill. 61801.

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Journal of the
CONSTRUCTION DIVISION
 Proceedings of the American Society of Civil Engineers

ESTIMATING COSTS OF EARTHWORK VIA SIMULATION²

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INTRODUCTION

The major bid item on many highway construction projects is the earthmoving operation. The contractor's profit may be directly related to how accurately the field operations are simulated by the estimator in his analysis of this item.

One of the problems facing the estimator, in developing a unit price estimate for the earthmoving operation is the selection of the equipment fleet to be used. Usually there are several alternatives available. These normally depend on what equipment is uncommitted at the time that the project is started. In addition to the selection of the equipment fleet, the estimator must also build into his analysis the managerial policy decisions that will govern the operation of the fleet on the job.

The best approach to this selection process is usually based on the optimization technique for analyzing the consequences of each of the alternatives and the selection of that combination of policy decisions and fleet composition that results in the maximum productivity or minimum cost, or both. The approach usually followed, however, considers only that alternative that is intuitively most attractive. This alternative is used as the basis for a single complete unit price analysis. This tendency toward suboptimization is partially due to the time constraint imposed by the bidding situation, but more importantly it is usually due to the estimator's feeling that it would be impossible to accurately determine the full consequences of each of the choices available.

This paper presents a technique for determining the effects of fleet decisions and management policy decisions on the productivity of a specific earthmoving operation. The technique is based on the data of a complete

Note.—Discussion open until August 1, 1972. To extend the closing date one month a written request must be filed with the Executive Director, ASCE. This paper is part of the copyrighted *Journal of the Construction Division*, Proceedings of the American Society of Civil Engineers, Vol. 95, No. CO1, March, 1972. Manuscript received for review for possible publication on May 3, 1971.

² Presented at the April 19-23, 1971, ASCE National Structural Engineering Meeting, held at Baltimore, Md. (Preprint 1359).

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Journal of the
CONSTRUCTION DIVISION
Proceedings of the American Society of Civil Engineers

COMPUTER PROGRAM FOR LEVELING RESOURCE USAGE

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SYNOPSIS

The critical path method (CPM) study for a construction project does not provide all the information requisite to a comprehensive and practical schedule for that project. An investigation into the results of such a study is necessary to reveal the demands that would be placed on construction resources and the rates of change of these demands. The process by which this latter investigation is made and which, further, attempts to bring these usages and rates within workable limits is commonly referred to as "resource leveling." The object is to "level" the day-to-day, week-to-week usages of resources, principally manpower, within the current availability of those resources.

The leveling problem differs from CPM in that it is not susceptible to precise mathematical statement. There is as much difficulty attendant with deciding how a leveling problem shall be approached as with performing the operations once decided on. Lack of general agreement as to how leveling should be accomplished and the apparent uniqueness of each construction-project problem seem to preclude the formulation of a "universal" program capable of solving any and all leveling problems.

The program described herein has been formulated with three purposes in mind: (1) The manipulations built into the program have been designed with simplicity and logical directness as objectives, and the program is to operate within full view of the user; also, features have been incorporated that provide the user with the ability to manipulate his problem data to test alternate plans and schedules; (2) the program is so constituted as to be readily adaptable to innovation; the testing of leveling schemes is as much an objective as the working of problems; (3) the intent is that by making available a basic program that can be modified or refined or, if it is warranted, completely replaced, this entire topic of resource leveling may be examined with greater

Note.—Discussion open until October 1, 1965. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. This paper is part of the copyrighted Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, Vol. 91, No. CO1, May, 1965.

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cannot be limited to the case in the past. This is an important problem that must be dealt with effectively if recent progress in the development of construction management techniques is to be continued.

INTRODUCTION

The accomplishment of the CPM phase of planning and scheduling a construction project leaves undone an important task that must be performed if the benefits of the CPM study are to be fully realized. This operation is known by several names, probably the most common of which is "resource leveling" or sometimes simply "manpower leveling." The earliest presentations of the CPM expressly recognized the need for further investigation into the results of a CPM study for a given project with regard to the demands that would be placed on construction resources and the rates of change of these demands. While CPM continues to become more widespread in its usage, it is suspected that few of its users, even the most experienced, have at their disposal an efficient method for examining and solving this important companion problem. The results of the CPM study for a project may appear quite feasible on the surface, but investigation is likely to reveal that exceedingly high levels of resource requirements or far-ranging swings in such requirement levels make revisions or modifications of the CPM schedule as first rendered a necessity.

The basic problem, i.e., the need to efficiently use the resources that are required to accomplish the work, confronts every manager of construction whether CPM is used or not. The objective, of course, is to "level" the day-to-day, week-to-week usages of resources, principally manpower, within the current availability of those resources. Further, transitions from one level of usage to another should not be so abrupt as to cause disruption in the steady flow of construction activity.

A few of the adverse influences working against efficient project operation which are present when wide variations in resource usage occur are as follows: (a) Hiring and layoff processes involve extra cost; the same is true of shipping equipment to and from the project site, whether it be contractor-owned or rented; (b) new men are less familiar with a project, and hence less efficient, and supervisors require time to become familiar with the capabilities of new people; and (c) the better tradesmen naturally search out those projects or employers having a reputation for providing longer periods of sustained employment.

Whereas systematic attempts were made to solve the resource leveling problem before computers were applied to construction management, computer-oriented methods of planning and scheduling of construction work, most notably CPM, has provided the construction manager with a significant tool for the proper use of project resources. Before CPM became available there were few systems for selecting the "best" order of activities for a given project which could, in turn, be used in preparation for the attempt at leveling resource usage. The concepts of "float" and "event time boundaries" within which an activity must be accomplished have provided a logical solution on which leveling can be superimposed.

The early computer-oriented CPM fully recognized the companion problem of

of resource leveling. It generally has not been emphasized, however, that the solution of the second problem is more involved than that of the first. Acceptance of the logic and assumptions of CPM has come with relative ease, and the resulting program is one of precise mathematical steps. There is only one CPM solution for a given arrow diagram.

The same cannot be said, however, of the problem of resource leveling. If assumptions could be agreed on, a precise mathematical solution could perhaps be provided. So large a number of assumptions would be necessary, however, that they would probably not be widely accepted. Also, it should become apparent that the assumptions must vary with the specific project problem submitted. These factors lead to the conclusion that a "universal" program capable of solving all resource leveling problems is not likely to appear in the immediate future.

The program to be described herein is intended as an intermediate step toward a scheme to solve the ultimate in resource leveling problems. In order to accomplish this purpose it is necessary to provide a means of arriving at usable solutions to present, practical, less-than-ultimate problems.

TABLE 1.—LIST OF PROJECT ACTIVITIES

Activity	Activity Description	Number of Fitters	Estimated Days
	Install Main Steam Piping System:		
A	Erect pipe: Boiler to cold-spring weld	8	10
B	Erect pipe: Throttle valve to c-s weld	8	15
C	Install hangers	5	7
D	Cold spring pipe, make final weld	6	3
E	Perform hydrostatic test	4	2

Notation.—The symbols adopted for use in this paper are defined where they first appear, and are listed alphabetically in the Appendix.

DIFFERENCES BETWEEN THE CPM AND LEVELING PROGRAMS

An example will serve to review, briefly, the methods which have been used to cope with the resource use problem and it may serve to clarify the various complications that are encountered.

Table 1 lists five activities which are but a part of an entire steam power plant construction project. Opposite each activity description are values representing the number of pipefitters required to perform the activity and the estimated number of working days that will be required to execute the activity. (Time units, for use herein, will be "working days" unless otherwise noted).

A number of things should be apparent concerning this selection of activities:

1. Using only five activities to represent the installation of a main system in a power plant is probably an oversimplification of the work involved;
2. the main steam system is only one of perhaps 30 or 40 piping systems that would be undergoing installation in the power plant example given;

3. The nature of the activities is but one phase of the entire construction and engineering project.

4. The network of pipefitters required to perform the work involved in each activity constitutes but one of many resources necessary to accomplish each of the activities listed.

Factors such as these may affect the degree of accuracy of a CPM network, but the validity of the program will remain unimpaired. The results, although imperfect, are usable. Such factors, not properly handled, will have a far more disastrous effect on the leveling solution, however.

The basic principles and assumptions on which CPM has been developed can be, and indeed frequently are, illustrated by a simple arrow diagram consisting of approximately five activity arrows. The logic and arithmetic used to solve such a simple diagram, however, remain valid regardless of the size of the diagram to which they are applied.

The same is not true of the resource leveling problem. A diagram such as the one that will be presented subsequently herein perhaps is susceptible to general agreement as to the leveling solution that could be pronounced "best." It should be readily apparent, however, that any scheme devised for arriving at this "best" solution for a simple problem such as this, would likely be ineffective for leveling resources for a larger or more complicated network. To illustrate:

1. By oversimplifying the representation of the work involved in installing this system will misleading results be obtained? Should not there be a larger number of activities, and, if there were, would not the resulting resource usage be different than that shown?

2. Is not this but one group of a considerably larger number of activities which place demands on the one resource considered?

3. Is not the task of installing the mechanical systems of this plant, along with the attendant demands on available resources, but a part of the entire project that must be considered in its entirety as regards resource allocation and relative importance of same?

4. What other resources that may be required for each of these five activities? May not the availability of the following be just as important as that which is shown? (a) pipefitter welders; (b) welding machines; (c) stress-relieving machines; (d) layout engineers; (e) electricians; (f) tugger hoists; and (g) yard handling equipment.

5. When more than one resource is involved, which one is to be considered paramount? Is there a priority order for the resource requirements of an activity? Is there a priority order for the resource requirements of the project as a whole?

6. What of the relative levels of availability of the resources and the interplay of these as regards any given activity and the project as a whole? When a manager is to determine the availability levels within which the project is to operate (and these almost always are arbitrary within certain bounds) what is there on which he can base this judgment?

7. If a satisfactory solution were found for one resource leveling problem, is it not likely that the same scheme or program will yield a satisfactory solution to the next problem?

The above and other considerations which may occur to the reader give rise to the suspicion that any system or scheme or computer program which claimed to be capable of providing "the best" solution to a resource level problem is either oversimplifying the situation or making assumptions which if fully understood, would not necessarily be acceptable to construction managers.

For these reasons the program presented herein is designed with the following objectives:

1. The manipulations of activities which have been built into the program are intended to be as logical and direct as possible. The criteria used arrive at a "trial solution," are, it is felt, those which an experienced construction manager might be expected to use in an attempt to solve his resource leveling problem. An effort has been made to keep these activity moves within the "view" and understanding of the manager in order that he may apply his judgment to make alterations in the planning and scheduling as required. Also, several features have been incorporated that provide the manager with the ability to manipulate his problem in order to seek out better solutions.

2. The computer is to be used as a "workhorse" for testing not only variations on network logic and activity schedules but also for testing alternative schemes for the manipulation of activities. One approach to the design of a computer program for solving the resource leveling problem would be that must first be decided what the entire scheme is to be before a program is written to accomplish its ends. Although this method would seem to be logical, it is highly unlikely that such an approach will be entirely fruitful. The difficulty is that it is virtually impossible adequately to test a scheme if it may be devised without resorting to a computer. Even the simplest of problems and trial schemes take a considerable amount of time to test by manual methods. Perhaps, in the future, sophisticated programs will be written which will make evaluations and decisions which must presently be made by the user. However, much more practical data must be collected before that point is reached.

3. It is intended, in disclosing the program in detail, to encourage others to take an interest in this problem and to come forward with substitutions or variations on this basic scheme. One such refinement, for example, would be to superimpose on the scheme additional criteria for manipulation of activities. It is hoped this program is sufficiently basic that it may be modified, preset, refined, and biased to suit the tastes of the experimenter. Also, the hope is that it will be found to be of practical value to apply the program as it is now written and that the construction industry may have the benefit of a useful tool immediately and that data may be collected thereby with which to suggest improvements.

EXAMPLE PROBLEM

Before the appearance of CPM it was quite common to represent a network for construction project activities in the manner shown in Fig. 1. Most often the sequence selected followed the experience of the person making the schedule. Usually, not too much objection would be raised as the pattern was fairly familiar and any differences generally would be a matter of personal preference.

case. The contractor would not find it too difficult to work within the general schedule, and if he made any attempt at resource leveling at all it probably took the form shown in Fig. 1, namely, adding the requirements of the most important one or two (perhaps three) resources to determine the daily total requirements for the project. Since minor shifting might then occur until the

ACT	ACTIVITY DESCRIPTION	DAYS, MONTH OF																											
		1	2	3	4	5	8	9	10	11	12	15	16	17	18	19	22	23	24	25	26								
	INSTALL MAIN STEAM PIPING SYSTEM																												
A	ERECT PIPE - BLR TO CS WELD	8	8	8	8	8	8	8	8	8																			
B	ERECT PIPE - THROTT & TO CS WELD	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8													
C	INSTALL HANGERS														5	5	5	5	5	5									
E	COLD SPRING, MAKE FINAL WELD																									6	6	6	
F	PERFORM HYDROSTATIC TEST																											4	4
	NUMBERS OF PIPEFITTERS REQUIRED	16	16	16	16	16	16	16	16	16	16	15	13	13	13	13	11	11	10	4									

FIG. 1.—CONVENTIONAL BAR CHART (SINGLE RESOURCE)

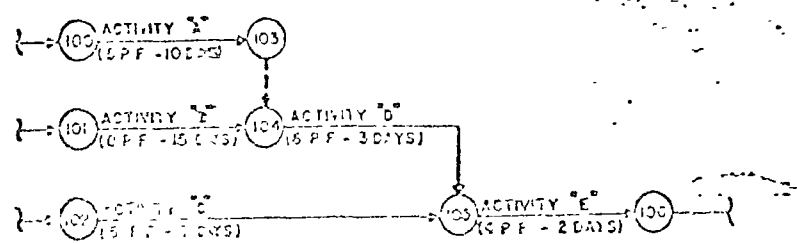


FIG. 2 — ARROW DIAGRAM

levels of the requirements were somewhat consistent and were within the realm of feasibility. It can be seen that criteria for attacking the leveling problem were few and fairly simple. The construction of possible individual activity resource requirements was probably not particularly difficult. It was a matter of time for the system for finally exploring the sequence of activity values. The criteria were not finally agreed on and applied to a set of

tion based on past experience, intuition, persuasiveness of individual personalities, and the sheer lack of time to explore more than a few of the more obvious possibilities.

The CPM-oriented construction manager faced with this example problem would provide a plan for accomplishing the work, which would be acceptable to all concerned. This would take the form of the "official" arrow diagram for that project. For the sample part of the example power plant project, this diagram might look something like that shown in Fig. 2.

At this point it is imperative that there be a clear understanding of an important premise that appears, to the author at least, to be axiomatic and upon which this paper is based. The solution of the planning and scheduling problem depicted by the arrow diagram, although pronounced "official" by those with the authority to do so, is neither the only nor the "best" solution possible. At most it is the "best" solution arrived at after careful consideration of all the factors which were available to that point. Not among the available factors that bear on the ultimate selection of an arrow diagram configuration and the execution of the work was the effect of the resulting work schedule on resource usage. (It will be remembered that an arrow diagram is constructed assuming unlimited resources.)

TABLE 2.—VALUES RETURNED BY CPM PROGRAM

I	J	TE(I)	ST	Y	FT	TL(J)	FF	TF	ACT
100	103	202	202	10	212	220	0	8	A
101	104	200	200	15	215	220	0	5	B
102	105	205	205	7	212	223	6	11	C
103	104	212	212	0	212	220	3	8	D
104	105	215	215	3	218	223	0	5	E
105	106	218	218	2	220	225	0	5	F

Any scheme for the solution of the resource leveling problem which takes from management the ability to review and revise the entire plan, or any part thereof, for accomplishing the work and substitutes some mathematical solution that is beyond the "view" or comprehension or control of management distorts the true purpose of these management tools. Those who contribute to the development of an arrow diagram and the CPM solution, do so with the understanding that each sub-plan which they contribute and which becomes part of the entire diagram merely is a plan, probably one of many which could be conceived, for the part of the project in which they are included. There is even a sub-plan, much less the integrated schedule, beyond the control of management to change, or consider for change, would be to alter the basic rules on which a CPM solution is structured. Any resource leveling program should be so devised as to encourage frequent review of the sub-plans (the CPM part included) in light of the results provided by the program. Applying this to the sample problem, the values returned for each activity by the CPM program appear in Table 2. A brief review of the relationship of these values to understanding the project:

- I = activity number of the total project with a corresponding demand on time and resources;
- J = an event (node), the point in time at which one or more activities have been completed and one or more activities may be started;
- I = identifying number assigned to the node at the tail of an activity arrow;
- J = identifying number assigned to the node at the head of an activity arrow;
- TE(I) = earliest event time of the I-node of an activity;
- ST = starting time of an activity (at the outset ST = TE(I) for all activities);
- Y = normal-time duration of the activity;
- FT = finish time of an activity (at the outset FT = ST + Y for all activities);
- TL(J) = latest event time of the J-node of an activity;
- FF = free float for an activity ($FF = TE(J) - (ST + Y)$, or $FE = TE(J) - FT$);
- TF = total float for an activity ($TF = TL(J) - ST + Y$), or $(TF = TL(J) - FT)$; and
- ITF = interfering float for an activity ($ITF = TF - FF$), or $(ITF = TL(J) - TE(J))$.

Fig. 3(a) further illustrates the relation of the various values that are derived from the CPM solution for each activity.

One minor point which might cause confusion is that concerning the values shown in Table 2, and subsequent tables, for "TE(I)" and "ST" for each activity. The first day during which work may be performed on an activity is the day following the value given by the CPM program. It is necessary that this or some similar rule be adopted to simplify the arithmetic used in the CPM and leveling programs, and this seems to be the standard convention. For example, the activity illustrated in Fig. 4 (activity, "C") has a normal duration (Y). The simplest computation which will yield TE(J), the earliest event time of the J-node, (which, of course, also is TE(I), the earliest event time of the I-node for subsequent activities originating at that node) is

$$\text{Max}(TE(i) + Y = TE(J)) \dots \dots \dots (1)$$

Once accustomed to the idea that all event times are given as of the end of the day noted, the reader should experience little difficulty in visualizing the results of the arithmetic used.

In the left-hand part of the chart in Fig. 3(a) are repeated, from Table 2, those values for each activity which are necessary to produce the leveling program bar chart that appears in the right-hand part of the figure. TE(I) and TL(J) for each activity are represented by vertical lines at the right edge of the column representing the appropriate working day. These are the event-time boundaries for that activity. During the execution of the floating process in the leveling program, TE(I) may be relocated to the right, toward the end of the project. The J-node, however, under this program but remains fixed as does the normal duration of the project. It remains true that CPM normal duration, $(TE(J) - TE(I))$, in the leveling program is constant. In all instances, starting time, ST, and float values given by the CPM program for an activity are repeated in the leveling program.

The decision to maintain unchanged all TL(J) values, and hence the duration of the project, throughout the program follows a second important premise which, like the one mentioned earlier, is basic to this discussion. Properly constituted, a leveling program should reveal trouble spots so that the user can re-evaluate the input data or assumptions and make changes as necessary to yield a feasible schedule. The length of the project should not be extended until all other possible remedies have failed to level resource usage as desired. Trouble areas should not be concealed by restoring too quickly to this solution. In this program trouble spots are flagged by the values "EXTEM," the excess of a resource requirement for a day over the resource availability for that day. Rarely, is the data supplied by the user so precise and rigid that

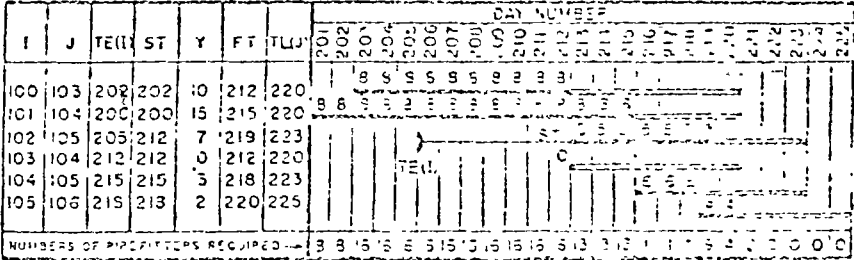
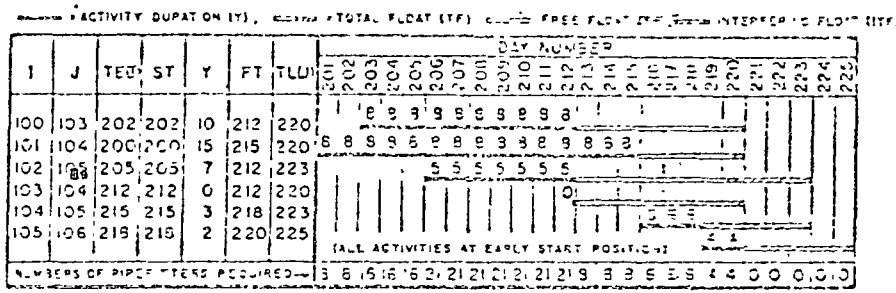


FIG. 3 - BAR CHART (a) LEVELING PROGRAM TRIAL NO. 1: CPM OUTPUT ACTIVITY LOCATION (SINGLE RESOURCE) (b) LEVELING PROGRAM TRIAL NO. 2: FLOATED ACTIVITY LOCATION (SINGLE RESOURCE)

alterations cannot be made. Indeed, incentive to investigate new and different approaches is quite desirable. If a project is to be lengthened, this decision should come from management, not from the internal workings of an imperfect leveling scheme.

In using this approach an additional important benefit is realized - that the concepts of total float and free float on the leveling program can be used to the leveling solution. These can be retained for use in the leveling program process that should be a part of project control by CPM.

In Figs. 3 (a) and (b), the values for each activity are represented by a bar chart. The left extremity of the bar is the starting time (ST) and day number. The right extremity, or to the right of TE(I) (b), will be the float

the left end of the bar is the activity and its length is the activity duration (A). As will be explained subsequently herein the activity is split into a number of segments (except in trial 1). The right end of the first shaded (activity) segment of the bar is the finish time (FT). The entire remainder of the bar, open part (if any) and cross-hatched part combined, between FT and TL(J), is total float (TF). The left extremity of the cross-hatched part of the bar is TL(J). If FT and TE(J) are not coincident the part of the bar between them is left open and this represents free float (FF). If there is no open part in the bar there is, of course, no free float for the activity and TE(J) equals FT. The cross-hatched part of the bar, lying between TE(J) and TL(J), is commonly known as interfering float (ITF).

PROGRAM METHOD

The flow chart for this program is found in Fig. 5. Undoubtedly, the accomplished programmer will be able to find many ways to improve on its

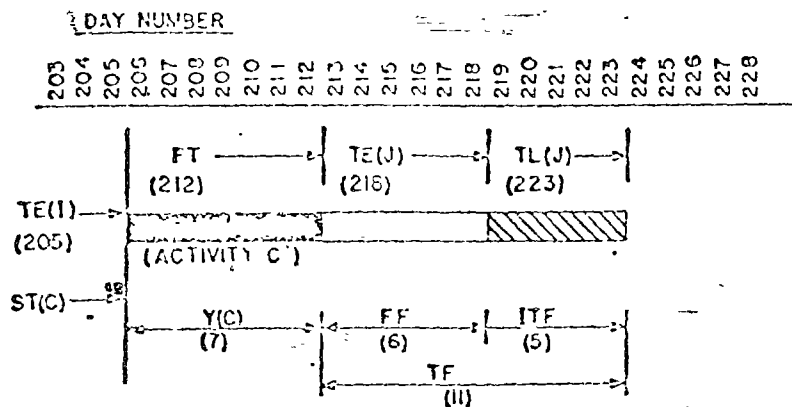


FIG. 4.—CPM ACTIVITY BAR

efficiency. Extensive format parts that are necessary to keep track of the operations performed and to properly organize results have been omitted in the interest of brevity. A complete list of all notation is found in the Appendix. A brief outline of the program follows:

I. Data which must be supplied:

- Activity data from the CPM program, as in Table 2;
- values supplied by user.

1. Activity Character.—Determination for each activity as to whether it may be split into segments in its performance or that it must be performed as a block, i.e., once started the activity must carry through to completion. (0 = "Cannot be split", 1 = "Can be split.") If an activity is "split" it is split during the leveling process the number of times this is done on the days on which these gaps or splits occur will be printed.

results. The decision as to which activities can be split has an important effect on the problem solution and is one of the manipulative opportunities that is under the control of the user.

2. Resources.—Determination of the resources which are to be considered. As presently written nine resources can be handled and all nine can be used for any and all activities. This number could be expanded if the need arose.

3. Priority.—Selection of the job-wise priority order for the resources considered. Other priority orders, of course, could be tested in subsequent runs.

4. Requirements.—Determination of the requirements of each activity for each resource.

5. Availability.—Determination of the level of availability of each resource. Each resource availability level can be present to any curve desired. These levels can be varied to test for different results in subsequent runs.

6. Activity Order.—Selection of the order in which the activity cards are to be fed to the program. This order will have an effect on the outcome except in the simplest of problems. There are several criteria for systematically selecting the ordering of activities, and, of course, the mathematical possibilities of ordering activities are more numerous than could be tested in a reasonable time even with a relatively small number of activities.

7. Miscellaneous.—(a) Number of activities; (b) normal project duration; as was examined previously this program does not alter the normal duration of the project; if the user wishes to consider such a change he can do so, but the program will not take such license with the data supplied; and (c) number of trials desired; as presently written trial 1 is computed in the all-early-start position; trial 2 is not, of itself, usable; trial 3 is computed after the floating operation; experimentation to the time of writing indicates that subsequent trials usually yield no changes in the results.

II. Operation of the program:

1. The CPM data and other data supplied is printed in proper format. Also computed and printed with this information are ITF and a value known as "HOLD" ($HOLD = TL(J) - ST$). The use of this value will be explained subsequently.

2. Trial 1, Daily Resource Requirements.—Beginning at the first day each activity is examined in its turn to determine whether it is scheduled for performance on that day. If $ST < D \leq FT$ the activity is so scheduled. If this condition exists the requirement of the activity for each resource is added to the appropriate resource requirement running total, TRRQ. After the execution of the last activity the total resource requirement for each resource for that day, $TRRQ(1) \dots TRRQ(RMAX)$, is printed; and the excess, if any, of each of these, $EXTEM(1) \dots EXTEM(RMAX)$, over the total availability of each resource for that day, $TRAV(1,D) \dots TRAV(RMAX,D)$ also is printed, all in proper format. Each subsequent day is treated similarly until the entire number of normal-duration days have been so handled. At that point the grand totals of the daily resource requirements for each resource are printed, $RUNTOT(1) \dots RUNTOT(RMAX)$. These totals are used to inspect the action which has occurred during subsequent trials.

3. Trial 2, Daily Resource Requirements.—Beginning with the first day ($D=1$) and the first resource ($R=1$) a total requirement for that resource, $TRRQ(1)$, is computed as in trial 1. If this amount is in excess of the avail-

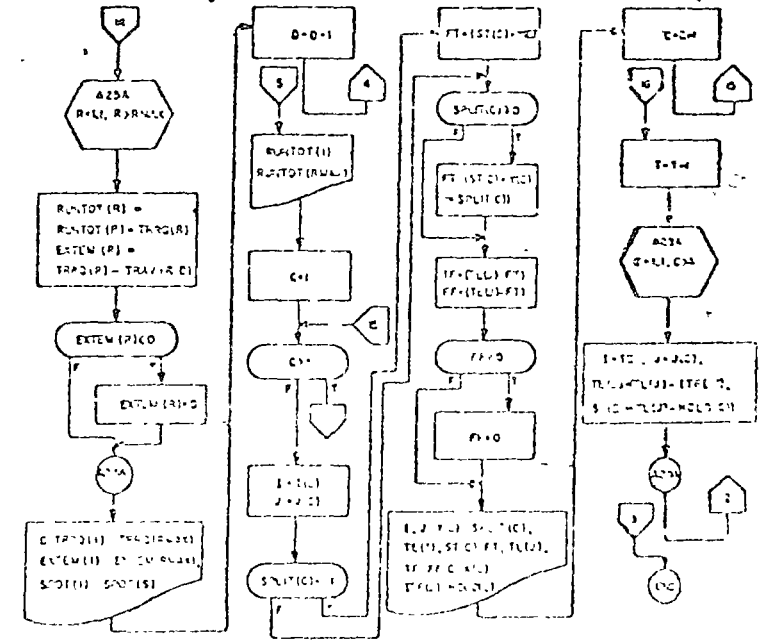
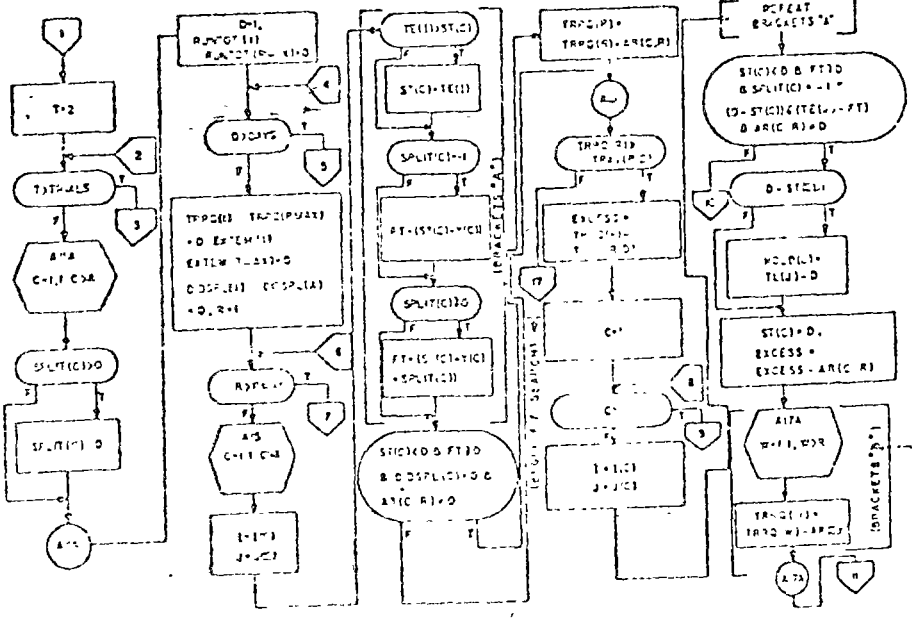
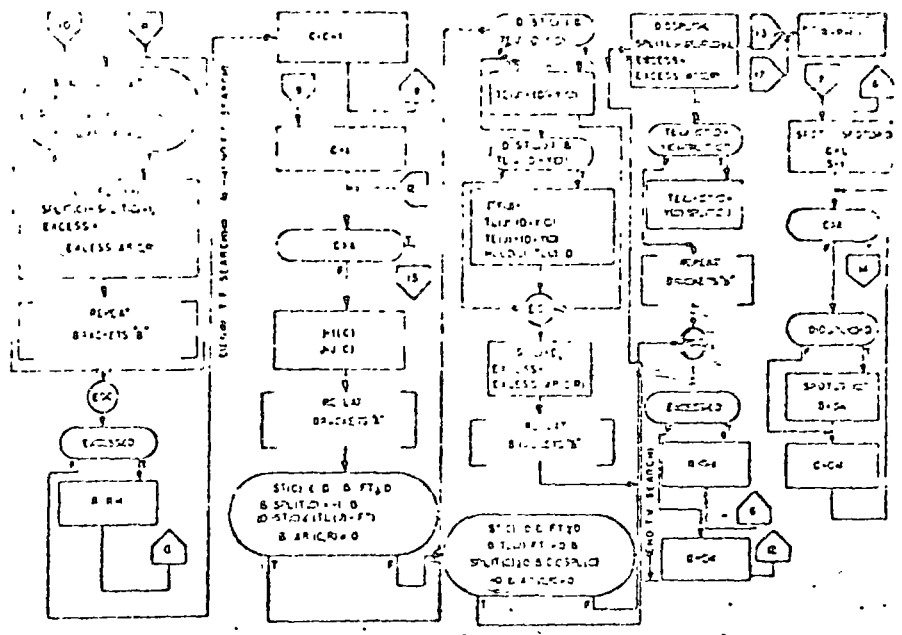
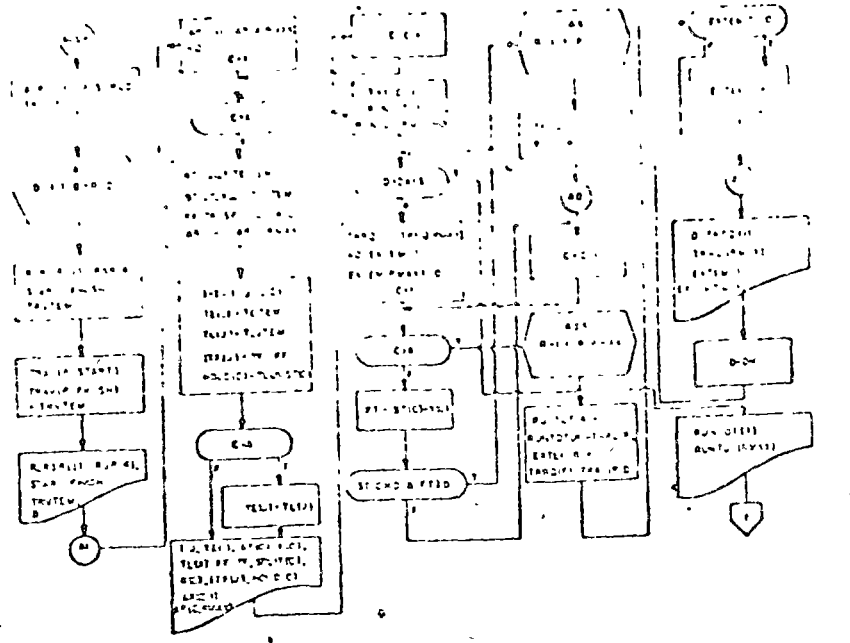


FIG. 5 - RESOURCE LEVELING PROGRAM

FIG. 5 - CONTINUED

1. The activities scheduled for that day an attempt is made immediately to reduce the excess to zero in the following fashion:

a. The activities scheduled for performance during that day are examined, in order, and the first such activity which has sufficient free float (FF) available will be moved to the right; if sufficient free float is not available the activity will not be disturbed until all other activities scheduled for that day have been similarly examined with regard to their available free float and moved if possible;

b. If the excess has not been reduced to zero at the conclusion of the examination of all activities for available free float the activities scheduled for performance during that day are examined once more, again in order, and the first such activity that has sufficient total float (TF) available will be moved to the right; if sufficient total float is not available the activity will not be disturbed. All activities scheduled for that day will be so examined until the excess has been reduced to zero, if possible;

c. If, after having examined all activities in this fashion, an excess continues to exist the value of the excess, EXTEM(1), is stored as is the value of the total resource requirement for that day, TRRQ(1).

The next resource (R=2) is considered for the same day (D=1) in similar fashion, as is each succeeding resource, until the last resource (R=RMAX) has been so treated for that day. At this point the values TRRQ(1) . . . TRRQ(RMAX), EXTEM(1) . . . EXTEM(RMAX) and the identifying number (CPM order of activities), K(C), of any activity which has been split are printed and these storage locations are cleared for use during the process for the succeeding day. Consideration then moves to the next day (D=2) and the entire process is repeated. The program thus proceeds until the final day (D=DAYS) has been computed. At that point the grand totals of the daily resource requirement for each resource are printed, RUNTOT(1) . . . RUNTOT(RMAX). Almost always some of these totals for trial 2 will differ from those in trial 1, hence, this table is unusable except as a record of the action of the program during trial 2. The reason for this will be explained in subsection 7.

4. Trial 2, Results of the Leveling Process. - A table is printed at the end of the preceding sequence listing the values of all the items that describe each activity. Some of these values will differ from those in the similar table printed at the outset, and these new values will disclose the shifting of activities which has been brought about by the process described in the preceding paragraph. The values included in the table are I, J, Y, SPLIT (if the activity is "splittable" the number of times split is printed, TE(I), ST, FT, TL(J), TF, FF, C (the order number of the activity in the program run), K (the original CPM order number of the activity, ascending order of I's, subascending order of J's), ISD, and OLD. As is the case with the table "Trial 2, Resource Requirements" this "Trial 2, Results of Leveling" table is not usable except as a record of the action of the program during trial 2.

5. Trial 2, Total Resource Requirements. - This is a repeat of the operation described in subsection 3, except that the results now are valid. The only change is that the total resource requirements of the activities scheduled for performance during that day are now the results of this action. It is noted that the table "Trial 2, Total Resource Requirements" is not usable except as a record of the action of the program during trial 2.

tion described in subsection 4, except that the results now are valid. (See the following subsection for further explanation.) Experimentation to the time of writing indicates that additional trials make no changes in the results; however, a greater variety of problems must be run before it can be stated flatly that there is no set of circumstances peculiar to a particular problem which will produce results that will be different in trials subsequent to trial 3.

7. The action of the leveling process during trial 2 for trial 3 for that matter) on a non-splittable activity frequently will proceed as follows: An excess of resource requirement, TRRQ, over resource availability, TRAV, occurs. As a result, an activity is viewed as a candidate for shifting. The scheduled start time of the activity is located more than one day to the left of the day under consideration. The activity is found to have sufficient Free Float available (or Total Float as the case may be) to allow the activity to be moved toward the end of the project until the scheduled start time of the activity, ST, equals the day under consideration (remembering that work on the activity begins on the day following start time). It is readily apparent that for those prior days during which this activity had been scheduled for performance there has been included all resource requirement values, AR(C,R) . . . AR(C,RMAX), for this activity in the values already printed out for total resource requirements, TRRQ(1) . . . TRRQ(RMAX). These total figures are, therefore, in error by said amounts. To overcome this and to provide the method by which the problem solution is refined by subsequent trials the new values for ST are permanently retained, in these instances, and when the next trial proceeds the totals will be computed properly.

When a splittable activity is to be moved the same action does not occur, and start time (ST) is not revised in these instances. The part of the activity that is scheduled for performance during days prior to the day under consideration is not moved, and the remainder of the activity is simply moved one day toward the end of the project.

The action described for the non-splittable activity in the first paragraph sometimes results in the lowering of a total resource requirement, TRRQ, for a prior day to such a level that an activity which had been moved to reduce the excess could, under new circumstances, remain scheduled for performance during that day. If such were the case, the subsequent trial would recognize this, and an activity (splittable or non-splittable) which had been removed from that day might be allowed to remain.

It also occurs frequently that a non-splittable activity is "pushed" ahead one day at a time through an area of high usage of one or more resources. This action is contrasted with that described at the outset of this subsection in that the movement is not triggered a day past the point of beginning, hence no incorrect daily total resource requirement is left in a prior day's figures. In this case start time (ST) is not permanently changed. If, as a result of the permanent location of other non-splittable activities, "vacancies" occur, some of these latter non-splittable activities may find places nearer the beginning of the project than they had been found in the previous trial.

From the foregoing it can be seen that the same leveling process of successive trials using the identical process during each trial, and forming only in that manner with the data supplied at the beginning of each trial are all shifting times (ST) changed by the action described in the first paragraph of this subsection. This is accomplished by the use of the value HOLD (AR(I), J) (J - ST) for each activity. Also, any day (I) value of the

activities likewise restored by the use of the value "ITF" ($ITF = TL(J) - TL(I)$) for each activity and other activities are restored to their original positions, all early starts, and all splits are removed at the beginning of each leveling run.

The results of the leveling run can be put in hand for use by the user for general use and for further testing of the availability of resources for new or different projects.

IMPERFECTIONS OF THE PROGRAM

Brief mention should be made of some of the more obvious imperfections or fallacies of the described program.

1. Whatever the order selected for the activities in a leveling run a bias is introduced, but the bias itself is changing and unpredictable. For example:

a. Using CPM order (ascending order of I's, subsascending order of J's) as representative of the order in which activities will be performed although the assumption may bear little relation to truth; perhaps late start order is more appropriate;

b. using ascending order of total float so as to make a limited movement of an activity (within float boundaries) more productive; the free floats will not necessarily fall in the same order; more important, after some floating has taken place the order will not necessarily remain ascending and the same would be true if descending order of total float were initially used to order the activities; and

c. placing activities with the highest demands on resources at the top of the list; if only slight reductions are needed the bias will tend to produce larger-than-necessary corrections; if the reverse of this order is selected too many activities may be relocated before the desired reduction is affected.

2. Relocating an activity without regard to the area into which it is placed is, to some at least, not a proper treatment of the problem. Lack of sufficient computer storage is the chief deterrent to taking this factor into account.

3. Relocating an activity strictly on the basis of an excess of requirement over availability for one resource considered along is a scheme of non-criticism. Suppose there is a similar excess for another resource during that day. Would not it be better to be more selective in choosing the activity to be removed? Perhaps an activity could be found that contains the proper combination of resource requirements, and which, if moved, would solve that day's problem, whereas the program as now written might move two or more activities to accomplish the same end.

CONCLUSIONS

The CPM study for a construction project, although extremely valuable, is not necessarily the end of our computer leveling study.

The program offers a more complete picture of a project by which the construction industry can "get down to earth" in that it is placed on the concept of leveling for the leveling solution, not the CPM study to which it is compared.

could be made static or unchangeable. Rather both should remain open for review in the light of new insights as they become available. The theory is set forth that a leveling program of itself should not lengthen a project and that the concepts of event time boundaries, float, and critical path should not be abandoned when entering into the leveling phase of a problem solution.

In keeping with the theory that the user should be provided as much control as possible over this problem solution the program requires that he decide such things as (1) the "splittable" character of an activity, (2) the selection of the resources that are to be considered, (3) the job-wise priority of resources, (4) the activity resource requirements, (5) the availability of resources, and (6) the order in which activities are to be considered for shifting.

APPENDIX.—NOTATION

The following symbols have been adopted for use in this paper;

- A = total number of activities in a given problem;
- AR = one-day requirement of an activity for a resource;
- B = number used in interation of resource availability data;
- C = common subscript of variables related to a given activity;
- D = day number;
- DAYS = normal duration of project (from CPM solution);
- DIDSPL = indicator that an activity has been split on a given day and therefore cannot be split again;
- EXCESS = difference between a resource requirement and the corresponding resource availability for a given day;
- EXTEM = computed as the EXCESS but stored temporarily;
- FF = free float;
- FINISH = last day of a level of resource availability, used as a subscript for TRAV;
- FT = finish time of an activity;
- HOLD = $TL(J) - ST$;
- I = number of node at the tail of an arrow;
- ITF = interfering float;
- J = number of node at the head of an arrow;
- K = number of activity when in CPM order;
- R = number of resource in project priority order;
- RCD = the total number of resource availability data cards;
- RMAX = the total number of resources;
- RSR = alphabetic storage of resource descriptions;
- RUNTOT = cumulative total of daily resource requirements for a resource;
- S = interation subscript for SPOT;
- SPLIT = code for splittability and number of days split;
- SPOT = day upon which an activity was split;
- START = day preceding the first day of a level of resource availability, used as a subscript for TRAV;
- ST = start time of an activity;

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INFORMATION RETRIEVAL

The key words, abstract and reference "cards" for each article in this Journal represent part of the ASCE participation in the FJC information retrieval plan. The retrieval data are placed herein so that each can be cut out, placed on a 3 x 5 card and given an accession number for the user's file. The accession number is then entered on key word cards so that the user can subsequently match key words to choose the articles he wishes. Details of this program were given in an August 1962 article in CIVIL ENGINEERING, reprints of which are available on request to ASCE headquarters.

PERT AND CPM TECHNIQUES IN PROJECT MANAGEMENT

By Restan M. Aras,¹ M.ASCE, and Julius Surkis²

SYNOPSIS

The size and complexity of projects that face today's 1964 technical management have brought about a re-examination of the traditional planning and scheduling procedures and an exploration of possible alternatives. Adaptations of the familiar Gantt Chart Method were tried, but because the method was unable to interrelate various facets of a project, it was inadequate. An integrated view of the new management techniques in planning, scheduling, and monitoring projects known as PERT and CPM is presented herein.

INTRODUCTION

During the last few years, 1957-1964, the traditional approach has been set aside, and a totally new concept in planning and scheduling has been advanced. These new techniques analyze the structural characteristics of projects by the use of networks.

The first of these techniques originated in 1957, when consultants from the Remington Rand UNIVAC Division of the Sperry Rand Corporation were asked by the DuPont Corporation of Wilmington, Del., to help devise a scheduling

Note.—Discussion open until August 1, 1964. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. This paper is part of the copyrighted Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, Vol. 90, No. CO1, March, 1964.

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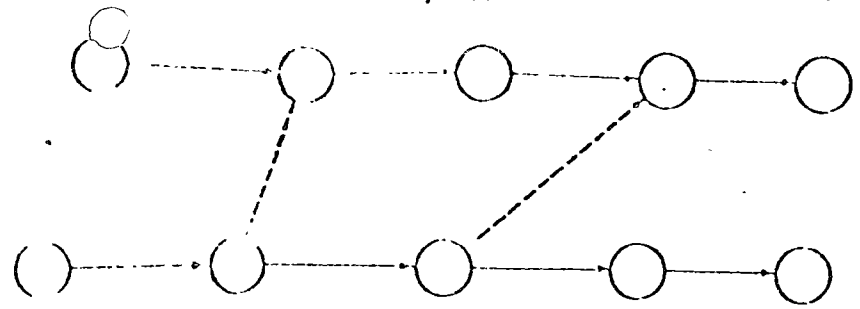


FIG. 4

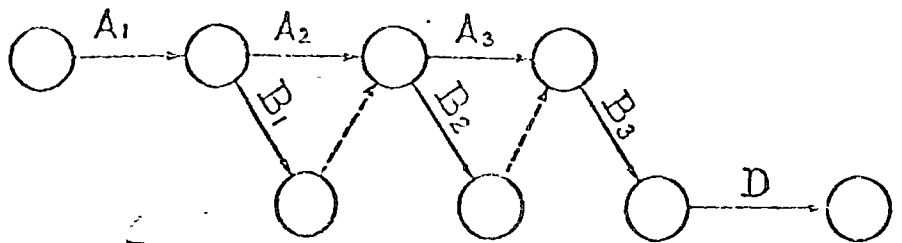
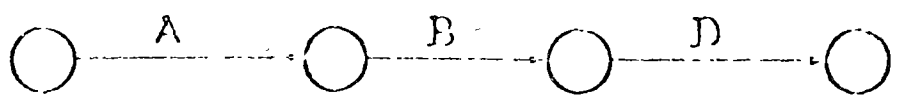


FIG. 5

When an activity is dependent on the completion of many other activities, this situation may be handled as indicated in Fig. 2, in which activity A is shown to start only after B, C, and D are completed. In a similar manner, if the completion of an activity is the milestone for the start of a number of activities, the network model will be as shown in Fig. 3, in which B, C, and D can start only after the completion of A.

Two chains of activities that can progress independently may have an interdependence between some of their events. This is shown by using a dummy activity to join the two events in question (Fig. 4).

When an activity, B, dependent on an activity, A, may start as soon as a portion of A is completed, it is advisable to subdivide the activities into sub-activities and show their interdependence as in Fig. 5.

TIME ESTIMATES

As the problem of estimating the duration of activities arises, a proper consideration must be given to the interdependence between the two networks, 1 and 2.

It was mentioned previously that PERT was created to facilitate research and development projects. To cope with the uncertainty involved in such ventures, three time estimates are requested from competent personnel for the accomplishment of the activities in question. These are the "most likely," "optimistic," and "pessimistic" estimates for the duration of the activity. Utilizing mathematical techniques, these estimates are translated into measures that are descriptive of the uncertainty involved.

It is assumed that the most likely time has a high chance of materializing; therefore, a high probability is associated with it. By a similar assumption, low probabilities are associated with the optimistic and pessimistic time estimates, because their chance of materializing is low. An analytical expression is found to fit these three values.

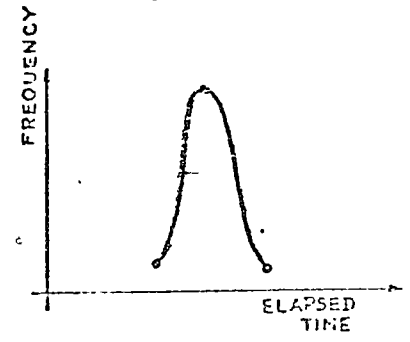
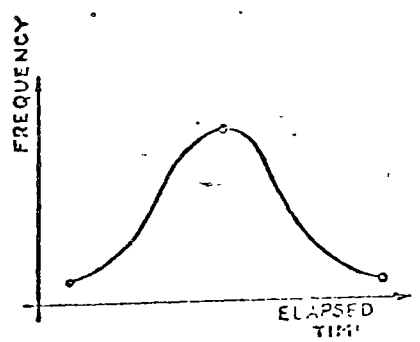


FIG. 6

The estimating equation that results gives an expected value for the duration of the activity

$$t_e = \frac{a + 4m + b}{6} \dots \dots \dots (1)$$

in which a is the optimistic time estimate; m equals the most likely time estimate; and b denotes the pessimistic time estimate.

The expected value is a statistical term that corresponds to "average" or "mean." To give a measure of uncertainty associated with the process, use is made of another statistical term: variance.

In the case under consideration, the expression for variance is

$$\sigma_{t_e}^2 = \left(\frac{b - a}{6} \right)^2 \dots \dots \dots (2)$$

4 *PERT Summary Report—Phase I, July, 1953, Office of Naval Research, Washington, D. C., 1953, 0-619678

If the variance is large, the uncertainty associated with the accomplishment of the activity is high. The converse is true if the variance is small ($\sigma^2 \rightarrow 0$). The variance is a direct function of the "distance" between the optimistic and pessimistic time estimates.

To get an estimate for the probability of meeting a schedule, a normal probability distribution is used. The probability of meeting a schedule is

$$\frac{1}{\sqrt{2\pi}} \int_{-\infty}^z e^{-1/2z^2} dz \dots\dots\dots (3)$$

In which

$$z = \frac{T_s - T_e}{\sigma_{T_e}} \dots\dots\dots (4)$$

T_s represents the scheduled time; T_e indicates the earliest expected time; and σ_{T_e} describes the accumulated standard deviation. Eq. 3 can be evaluated by making use of normal probability tables.

Because CPM deals with "deterministic" situations, only one time estimate for the accomplishment of an activity is considered. (This is comparable to having a PERT time estimate with $a=m=b$.)

CRITICAL PATH CONCEPTS

When project activities are plotted according to the arrow diagramming technique described in a previous section, it can be seen that numerous paths exist between the "start" and "end" of the project network. By adding the duration of all the activities forming a path, various "durations for project completion" are obtained. The longest of these durations is the critical time for project completion, and the path associated with it is the "critical path." The critical path is important because it controls the project completion time. Before applying the actual computational methods, the basic ideas of critical path techniques will be explained.

Regardless of the different concepts for estimating the duration of an activity in PERT and CPM, the basic computations are identical. Depending on the approach, it is helpful to find what the earliest and latest possible times are for the occurrence of an event, or what the earliest and latest times are for the start and termination of an activity. It should be noted that an "event" occurs only when all the activities terminating at that event are completed.

Because activities are so closely related, the following explanation will be given in terms of activity (i-j) represented as a line or a job that starts at event (i) and terminates at event (j) and is followed by the event (j). The event (i) is the start of the activity and the event (j) is the end of the activity. The duration of the activity (i-j) is denoted by $D_{i,j}$ and is related to the performance of the

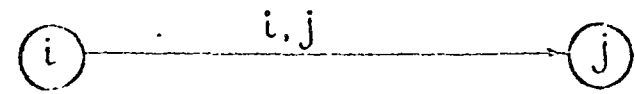


FIG. 7

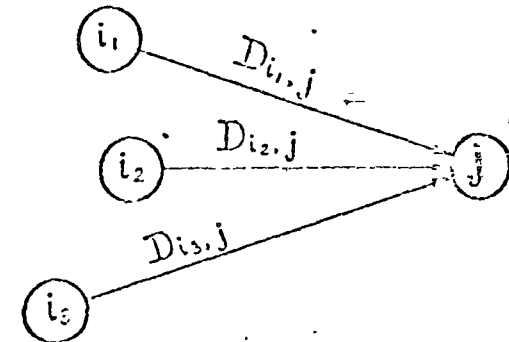


FIG. 8

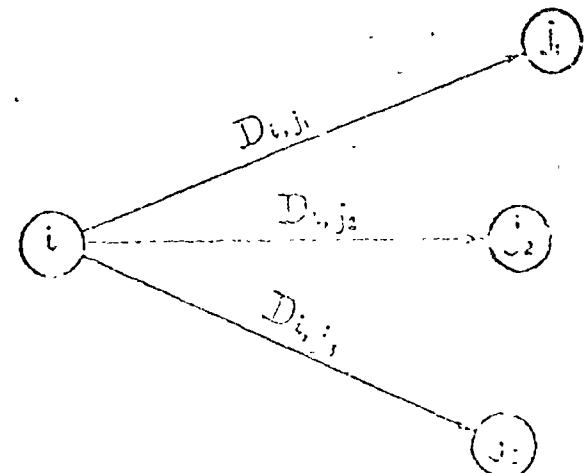


FIG. 9

technique to be used in the construction, maintenance, and shutdown of chemical process plants. The technique devised by James F. Kelly, Jr. of UVAAC, and Morgan R. Walker of D.P.P., "Critical Path Method" (CPM). This is a method of scheduling and controlling the progress of a project.

The PERT system was developed by the United States Air Force. The project was sponsored by the Air Force and the Department of Defense. The program of Operation, the program consulting firm of Booz, Allen, and Hamilton, and the Lockheed Missile Systems Division was directed to study and formulate improved methods for the planning and control of the complex programs that were to implement the development of the Fleet Ballistic Missile (Polaris). The method developed by this group is called Program Evaluation Review Technique (PERT).

The PERT system has been adopted by the Air Force under the name of Program Evaluation Procedure (PEP). Other variations of PERT exist with the following names: PERT I, PERT II, PERT III, PERT/TIME, PERT/COST. However, as of June 1962, the Department of Defense and the National Aeronautics and Space Administration have asked their respective organizations to adopt a uniform approach to planning and control procedures on major weapon systems.

PERT is used for projects that involve research and development work in which the intellectual effort and the manufacture of component parts is new and is usually being attempted for the first time. Hence, the time and cost estimates never can be predicted with adequate certainty, and probabilistic concepts are used to obtain time estimates. CPM, on the other hand, is applied to projects that are of a more "deterministic" nature, like construction applications, in which costs and time estimates can be predicted with a greater amount of certainty.

Despite the great popularity of PERT and CPM, the bulk of the literature on these subjects is either of a descriptive nature addressed to management level readers and the "informed layman," or of a highly technical and mathematical nature, directed to the systems and operations research analysts. The purpose herein is to present the basic concepts of the network technique that underlie both the PERT and CPM approaches, and to develop the mechanics and mathematics of the methods.

FUNDAMENTALS OF THE MODEL

A project can be viewed as a group of activities, jobs, and operations, performed in a certain sequence, to reach an objective. Each one of the jobs and operations that make up a project are time and resource consuming and will be referred to as an "activity," a common term in both PERT and CPM.

Each activity has a beginning and an end point that are points in time that can be viewed as milestones of the project. These points in time are called "events."

A network diagram that will satisfy the previous definitions can be developed as a series of milestones, or "events," and corresponding to events, are joined by arrows, or "activities." Such a model is also a convenient way to represent the progress of a project.

TABLE 1

No.	Activity	Preceding	Concurrent	Following
A	Move in	-	-	B,F,M
B	Cleaning	A	F,M	C
C	Roadway Excavation	A	-	G,H
D	Reinforcing Bars	E	-	J
E	Forms	G	-	D
F	Concrete Mix Plant	A	M,B	E
G	Structure Excavation	C	E	J
H	Roadway Earthfill	C	C,L	-
I	Aggregate	M	D	-
J	Mix and Place Concrete	I,D,F	-	L
K	Strip Forms and Cure	J	-	-
L	Backfill and Compact	K	H	-
M	Aggregate Plant	A	E,F	I

TABLE 2.—DEPENDENCE MATRIX

	A	B	C	D	E	F	G	H	I	J	K	L	M
A	.	F				F							F
B	P	.	F			C							C
C		P	.				F	F					
D				.	P				C	F			
E				F	.		P						
F	P	C				.				F			C
G			P		F		.	C					
H			P				C	.				C	
I				C					.	F			
J				P		P			F	.	F		
K										P	.		F
L								C			F		
M	P	C				C			F				

The plan is developed with the determination of project activities and their interrelationships. A convenient way to accomplish this is to form a table of activities as shown in Table 1.

To make certain that every interrelationship is established, the following sample questions may be asked for each activity:

- (1) What precedes it? Which other activities must be completed before this activity can begin?
- (2) What follows it? Which activities can not start until this activity is complete?
- (3) What can be concurrent with it? Which other activities can be done at the same time?

The answers to these questions may be shown in a systematic way in form of a Dependence Matrix, as indicated in Table 2.

The matrix presentation contains redundant information, and only an upper or lower triangular matrix may be used. The full matrix has the advantage of providing a check to the answers of the questions. In the final form, values of C must be symmetrical, and every F should have a P for its symmetrical element, and vice versa.

The following rules must be followed in forming a network that will express the properties shown in the matrix presentation:

- (1) Each defined activity is shown by a unique arrow.
- (2) Arrows show only the relationship between different activities; the length and the beating have no significance.
- (3) Arrow direction indicates the general progression in time. The arrow head represents the point in time at which an "activity completion event" takes place. In a similar manner, the arrow tail represents the point in time at which an "activity start event" occurs.
- (4) When a number of activities terminate at one event, this indicates that no activity starting from that event may start before all activities terminating at that event have been completed.
- (5) If one event takes precedence over another event that is not connected by a specific activity, a dummy activity is used to join the two events. Dummy activities have no duration or cost.
- (6) Events are identified by numbers. An effort should be made to have each event identified by a number higher than the immediately preceding event. If this rule is not followed, events should be "ranked."³
- (7) Activities are identified by the numbers of their starting event and ending event.

The principles and the rules stated in the preceding paragraph will be further clarified by a few examples.

Many activities in a project are concurrent. A logical way to show these activities would be to join two events by two or more arrows corresponding to each activity. But these activities are identified by their beginning and ending event number, a duration, a cost, and the ambiguity that would be caused by multiple arrows.

³ See "Project Management" by R. H. Myers, McGraw-Hill Book Co., New York, N. Y., 1959, p. 100. Copyright © 1959, McGraw-Hill Book Co., New York, N. Y., 1959, p. 100.

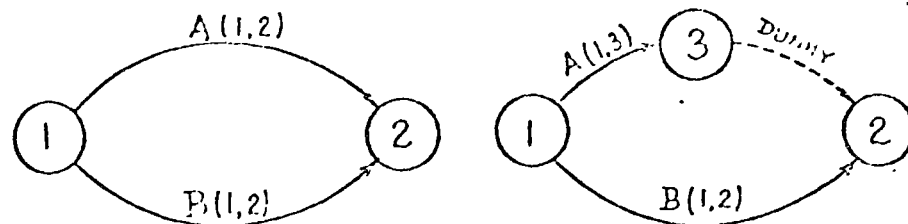


FIG. 1

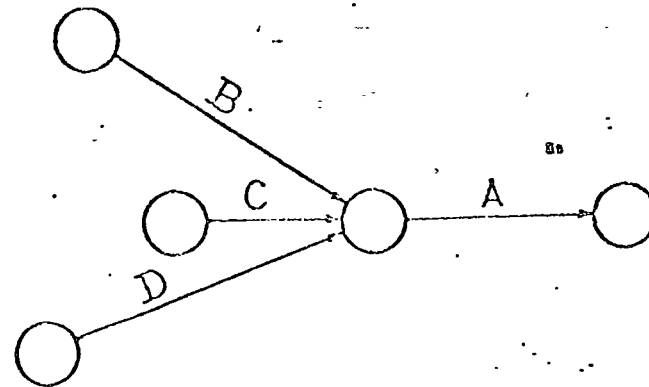


FIG. 2

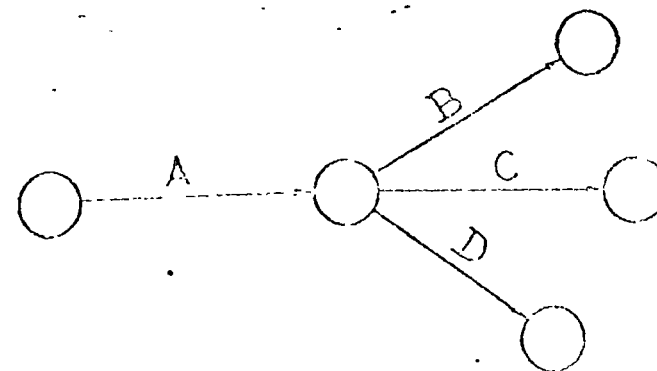


FIG. 3

activity. (PERT, the duration is called "expected elapsed time estimate" or "scheduled elapsed time," depending on the status of the PERT network.)

Relative to a project start time and completion time, each event has an "earliest node time (earliest expected time)" and a "latest node time (latest allowable time)." Let the relative occurrence time of the project be denoted by ENT₀ (earliest node time) and let it be equal to zero. Denote the earliest occurrence of event i by ENT_i and the duration of activity (i, j) by D_{ij}.

In the general case, it is possible to have more than one activity coming into an event. Because event j occurs only when all activities terminating at j are complete, the earliest occurrence of an event j, ENT_j, is

$$ENT_j = \max [ENT_i + D_{ij}] \dots \dots \dots (5)$$

In which i < j and ENT₀ = 0. Let

$$[ENT_{i_1} + D_{i_1j}]$$

and

$$[ENT_{i_2} + D_{i_2j}] < [ENT_{i_3} + D_{i_3j}]$$

then ENT_j is determined by

$$[ENT_{i_3} + D_{i_3j}]$$

as shown in Fig. 8.

Similarly, assuming the completion time of the project to be LNT_n (latest node time) and denoting the occurrence time of the terminal event in the project by the latest occurrence of an event i by LNT_i

$$LNT_i = \min [LNT_j - D_{ij}] \dots \dots \dots (6)$$

In which i < j and LNT_n is equal to ENT_n or a specified project completion time. Let

$$[LNT_{j_1} - D_{i_1j}] < [LNT_{j_2} - D_{i_2j}] \text{ and } [LNT_{j_3} - D_{i_3j}]$$

Then LNT_i is determined by

$$[LNT_{j_1} - D_{i_1j}]$$

as shown in Fig. 9.

The relationship between the various types of float used in CPM and PERT is illustrated in Fig. 10. The equivalent of

nomenclature between the two systems and properties related to each activity in the project is shown in Table 3.

The maximum available time equals the duration of a job, that job is termed "critical." Generally, in a project, there is a path from the "start" to the "finish" on which this condition prevails. This path is termed the "critical path."

FLOAT AND SLACK

To facilitate the planning and scheduling aspects from the analysis, it is necessary to introduce a concept that concerns itself with the leg that may occur on certain jobs during the project without affecting the over-all project duration. This situation arises when the maximum time available for a job exceeds the duration of the job. In CPM, this is referred to as "float," and a corresponding concept in PERT is termed "slack."

TABLE 3

CPM		PERT	
Earliest Start Time	EST _{ij} = ENT _i	Earliest Expected Time	T _{Ei}
Earliest Finish Time	EFT _{ij} = EST _{ij} + D _{ij}	T _{Ei} + t _{ei}
Latest Finish Time	LFT _{ij} = LNT _j	Latest Allowable Time	T _{Lj}
Latest Start Time	LST _{ij} = LFT _{ij} - D _{ij}	T _{Lj} - t _{ei}
Max. Available Time	LFT _{ij} - EST _{ij}	T _{Lj} - T _{Ei}

There are four types of float that are in use in CPM:

- Total Float: LNT_j - ENT_i - D_{ij}
- Free Float: ENT_j - ENT_i - D_{ij}
- Independent Float: Max(0, ENT_j - LNT_i - D_{ij})
- Interfering Float: LNT_j - ENT_i

The concept of slack can be defined as the difference between the earliest and latest occurrence times of an event.

$$SLACK = T_{Lj} - T_{Ei} \dots \dots \dots (7)$$

The relationship between the various types of float used in CPM and the slack concept used in PERT is illustrated in Fig. 10.

TIME 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

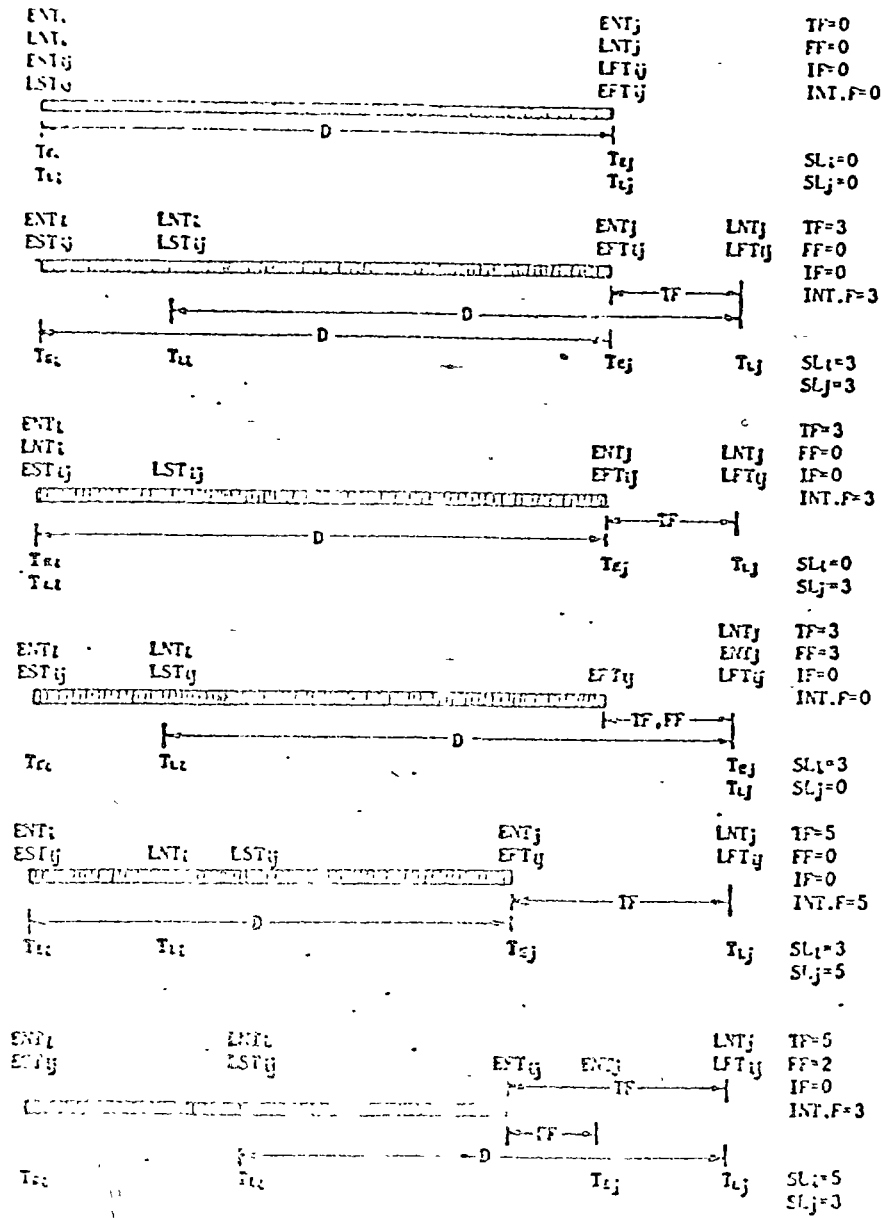


FIG. 10

"Total float" is the difference between the earliest finish and the latest finish, or the difference between the earliest start times and the latest start times of an activity. It is a measure in time units, showing by how much the completion of an activity can exceed the earliest finish time without affecting the total duration of the project.

"Free float" of an activity is the difference between the earliest finish date and the earliest of the earliest start times of its direct successor activities. Free float is a measure by which the completion of an activity can exceed the earliest finish times without affecting any other activity.

"Interfering float" is the difference between total float and free float. The existence of this type of float in an activity indicates that the activity completion in this range does not change the duration of the project but decreases the floats of subsequent activities.

"Independent float" is the difference between the earliest finish time and the latest start time of an activity, if this difference is positive. Otherwise, the independent float equals zero. It is rare to have a significant amount of independent float in project networks. The independent float is a measure of the amount the activity completion can be delayed without affecting another activity or project duration.

Slack, which is a concept in PERT similar to "float" in CPM, represents the lag between the earliest and the latest occurrence of an event. Float and slack have been emphasized because it is felt that a proper understanding of these concepts would lead to more effective project planning and scheduling.

NETWORK COMPUTATIONS

A systematic method for determining the critical activities consists of establishing the earliest node times (earliest event occurrence) and the latest node times (latest event occurrence) for all the events and applying a simple test to determine if an activity lies on the critical path.

A project consisting of twelve activities is shown in Fig. 11. Numbers over the activity arrows show the duration of these activities (assumed to be weeks herein). These durations may be the result of three estimates, as in PERT, or one normal time estimate, as in CPM.

Event 1 occurs at the start time of the project, which will be called Time Zero for convenience. Activity 1-2 requires five weeks for completion. Thus, the earliest time Event 2 may occur is $0 + 5 = 5$. This earliest time will be called earliest node time and shall be abbreviated as ENT. Following the same reasoning, ENT for Event 3 is found to be 9. For computing the ENT for Event 4, it should be observed that the earliest time Event 4 may occur is either $ENT(3) + \text{DURATION}(3-4)$ or $ENT(2) + \text{DURATION}(2-4)$. Because an event occurs only when all the activities terminating at that event are completed, ENT for Event 4 is the maximum of the two expressions shown previously (i.e., $9 + 5 = 15$). For computing ENT(5), the same reasoning applies. ENT(5) is the maximum of $ENT(4) + \text{DURATION}(4-5)$ and $ENT(3) + \text{DURATION}(3-5)$ [i.e., $ENT(5) = 13$]. Following this procedure, values of ENT for all the events are obtained. ENT(5) = 33 means that the project in question can only be completed in 33 weeks, under normal conditions.

Starting with the project completion and working backward, the latest time at which events may be permitted to occur in order to complete the project

within the period already chosen can be calculated. Latest node time (LNT) for the last event is taken to be the same as the ENT of the last event. Occasionally, LNT may differ from ENT to reflect a "directed date" given by the client or a "re-scheduled date" set by the management. In these cases, although the results of the computations differ, the principles remain the same. In the subsequent discussion, it will be assumed that $LNT = ENT$ for the last event.

The latest occurrence of Event 8 is 33, and Event 7 should therefore occur at $LNT(8) - \text{DURATION}(7-8)$ so as not to delay the project completion time.

TABLE 4 - DURATION MATRIX

	LNT	0	5	9	15	19	23	26	33
ENT	1	1	2	3	4	5	6	7	8
0	1		5						
5	2			4	9				
9	3				6	7	11		
15	4					3	8		
19	5						4	5	
23	6							3	
26	7								7
33	8								

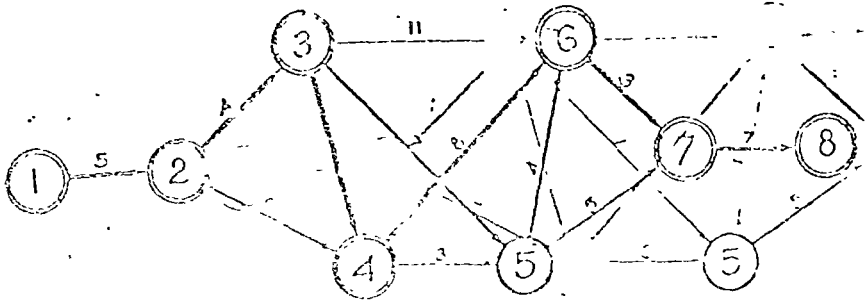


FIG. 11

FIG. 11

Thus, $LNT(4) = 15$. Following the same reasoning, $LNT(6) = LNT(7) - 1 = 19$. ($LNT(7) = 33 - 3 = 30$) For finding $LNT(5)$, two alternatives must be considered: $LNT(5) = LNT(7) - \text{DURATION}(5-7)$ and $LNT(5) = LNT(6) - \text{DURATION}(5-6)$. The first alternative is not applicable since event 7 has not been completed. The second alternative is applicable since event 6 has been completed. The maximum of the two results ($LNT(5) = 15$) is entered at the top of column 5. In the subsequent discussion, all the values of LNT's will be

The computations for LNT's and ENT's can be done in an orderly fashion if a duration matrix approach is used. Such a matrix for the project under examination is shown in Table 4, all the activities being numbered so that $i < j$ in all activities. Thus, the duration matrix is an upper triangular matrix. The duration of activity $i-j$ is shown as the element (i, j) of the matrix. If an element is entered in the lower triangular part of the matrix, the numbering of the activities is not being followed, this is inconsistent. $ENT(1)$ is 0 and is entered in the column of LNT's next to 1. Looking at column 2, it is seen that there is only one element, $D_{1,2} = 5$. This duration added to $ENT(1)$ gives $ENT(2)$, which is 5. In a similar manner, by adding $D_{2,3} = 4$ to $ENT(2)$, $ENT(3)$ is obtained as 9. Column 4 contains two elements: $D_{2,4} = 3$ and $D_{3,4} = 6$. Adding the two values to the ENT's yields

$$ENT(4) = ENT(2) + \text{DURATION}(2-4)$$

$$ENT(4) = ENT(3) + \text{DURATION}(3-4)$$

Taking the maximum of the two, $LNT(4)$ is found to be 15. This process is continued until $ENT(8)$ is found. In each step, to compute $ENT(i)$, elements

TABLE 5

Event	ENT or T _E	ENT or T _L	Slack
1	0	0	0
2	5	5	0
3	9	9	0
4	15	15	0
5	19	19	1
6	23	23	0
7	26	26	0
8	33	33	0

of column j are considered and added respectively to the ENT's existing on the same row. The maximum of these additions gives $ENT(i)$.

To compute the LNT's, $ENT(8) = 33$ is entered at the top of column 8. Considering the seventh row of the matrix, which contains two elements, $D_{5,7}$ and $D_{6,7}$, $LNT(5)$ is computed as the difference $LNT(8) - \text{DURATION}(5-7) = 33 - 7 = 26$. The result is entered at the top of column 5. Following this, the sixth row of the matrix is examined, and the element $D_{5,6} = 3$ is subtracted from $LNT(7)$, which is 26. This gives $LNT(5) = 23$. This comparison shows that it contains two elements. These are respectively the LNT's appearing at the top of the column containing

$$LNT(5) = LNT(7) - \text{DURATION}(5-7)$$

$$LNT(5) = LNT(6) - \text{DURATION}(5-6)$$

$LNT(5)$ is the maximum of these two expressions ($LNT(5) = 19$). By continuing this process through event 4, all the LNT's are found, $LNT(1)$



ADDITIONAL DEVELOPMENTS

To get the full benefit of a project management system, there are other factors that should be considered: (1) Optimization of an activity, such as cost, reduction of waste, etc., and (2) combination of cost and time for progress evaluation. Many of the various groups are being directed towards the incorporation of the previously mentioned considerations. Presently, these are still in a stage of development, they cannot be fully developed.

OPTIMIZATION

The use of the normal activity duration for all activities in projects may not always be sufficient to reduce the total project duration, therefore, to a more costly schedule may be necessary. A common practice in project management has been to apply the same time to all activities in order to obtain the compression in schedule. However, concentrating on activities that are on the critical path is more fruitful, because any reduction in a critical activity (provided that it lies on the only critical path) results in a corresponding reduction in the total project time. (The usual goal in carrying out this project scheduling process is to keep the cost increase to a minimum.)

To formulate a curve for the procedure, it is necessary to provide cost data for the duration of normal and crash activities. In carrying out the reduction on the critical activities, those reductions that have the smallest increase in cost per unit of time are sought. A new schedule for the whole project is then prepared, in which compressed activities are somewhere between the normal time and crash time. The determination of the exact position cannot be accomplished easily by hand computation, because it is lengthy and involved. The existing methods^{5,6} are computer oriented and ensure maximum saving at a minimum cost increase. The computations result in a curve that relates time and cost (Fig. 13).

This curve could be referred to as the "direct cost" curve. Associated with a project, there are direct costs such as overhead, salaries, (indirect costs) etc. The sum of these two curves (the direct and the indirect costs) have to be considered in the decision of schedule compression. This new curve is termed as the "total cost curve."

COST TRADEOFF CURVE

In recent years, the concept of tradeoff has been made to bring cost and time into consideration. A project work-breakdown structure is developed up to the level of activity by forming a tree-like structure of activities. The activities are further divided into "sub-items" and "sub-items" than

... (1) A defined system of planning is formulated
(2) A clear view of the scope of a project is obtained
(3) A time for completion is established
(4) A cost for completion is established

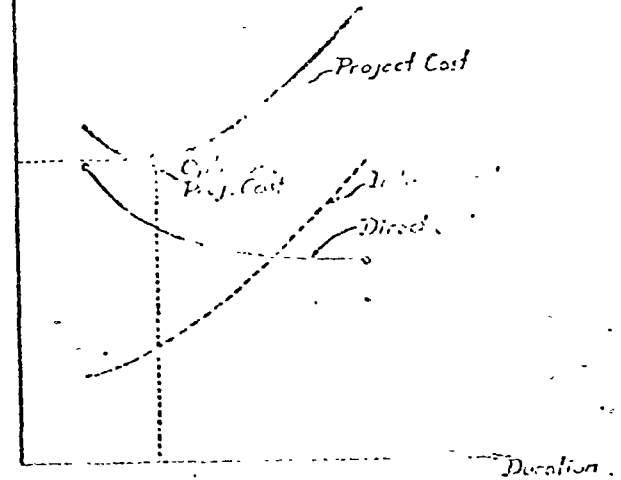


FIG. 13

are divided into successively lower levels, until one item reaches the level at which the end item subdivision becomes a "manageable" unit in terms of cost and scheduling. These subdivisions then are divided into work packages. The work package is the lowest level of breakdown that constitutes the cost control unit and may have one or more activities attached to it. Parallel to the work-breakdown structure, a cost breakdown structure is formulated that consists of "charge numbers" by which costs can be assigned.

Thus, by tying in the cost concept with the scheduling, better control can be established in the project. In the Appendix, an example of the project work-breakdown structure and the corresponding cost structure is presented with a simplified sample hierarchy to illustrate the concept.

CONCLUSIONS

Another project management (PERT or CPM) system is developed and evaluated to see how good it is. The first review of the project is done. A cost curve is developed. The project is then scheduled. The project is then scheduled and the project is then scheduled. The project is then scheduled and the project is then scheduled.

- (1) A defined system of planning is formulated
(2) A clear view of the scope of a project is obtained
(3) A time for completion is established
(4) A cost for completion is established

TABLE 9

EV	T _E	T _L	Slack
1	0	0	0
2	5	5	0
3	9	93	83
4	6	93	83
5	15	15	0
6	25	50	25
7	30	30	0
8	50	50	0
9	70	83	13
10	80	93	13
11	85	93	13
12	65	65	0
13	85	85	0
14	95	93	0
15	102	102	0
16	110	110	0
17	93	103	13
18	103	121	13
19	125	125	0
20	126	123	0
21	153	153	0
22	157	157	0
23	177	177	0
24	207	207	0
25	177	192	15
26	207	207	0
27	257	257	0
28	2	219	12
29	2	257	0
30	277	287	0
31	177	237	95
32	277	267	0
33	277	277	0

- (C) Evaluation is made of the evolution of alternate plans.
 (D) Assignment of time periods, resources, and responsibility is fixed.

Because PERT and CPM generally are applied to complex projects, the benefits and speed of electronic digital computers capable of handling such quantities of data can not be overemphasized in the implementation of these techniques.

ACKNOWLEDGMENTS

The writers are indebted to UNIVAC Division, Sperry Rand Corporation, New York, N. Y. for giving them the opportunity to investigate the PERT and CPM techniques described herein.

APPENDIX--ILLUSTRATIVE EXAMPLE

A simplified highway construction project will be presented to illustrate the application of PERT and CPM techniques.

The project consists of a road way with two culverts. The ordered project network is shown on Fig. 14. The duration matrix with the resulting EMT and LNT values is shown on Table 7. The specific activity descriptions and their durations, as well as the CPM calculations, are given in Table 8. Certain items, such as clearing and excavation, are done in sections. The numbers in parentheses refer to these sections. The corresponding PERT results are given in Table 9.

Fig. 15 shows the project work breakdown structure. The project is viewed as being made up of two main divisions: Highway and structures. They are further broken down in levels until the activities are reached. The numbering code structure (Fig. 16) attaches a number to each item on all levels. It can be seen, all highway items can be grouped between 120000 and 111000, and structural items can be grouped between 110000 and 115000.

It will be noted that as the levels get lower, the numbers increase. This special numbering system streamlines sorting and grouping codes.





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~~PLANEACION~~ PROGRAMACION ~~DE OBRAS~~ y
CONTROL DE AVANCE DE OBRA

ING. JOSE CASTRO ORVAÑANOS

de dicho personal, para hacer los ajustes o modificaciones que sean necesarios.

III.- PLANEACION Y PROGRAMACION DE OBRA.

Como una herramienta importante en la planeación y programación de obra, se ha venido desarrollando la técnica conocida como

METODO DE LA RUTA CRITICA o C.P.M. (Critical Path Method)

Historia:

Esta técnica se inició en 1957 cuando la Du Pont Corporation de Wilmington, Del., pidió a la Remington Rand Univac Division (filial de la Sperry Rand Corporation), que desarrollara una técnica de programación que debería usarse en la construcción y mantenimiento de plantas de productos químicos. Directamente intervinieron en este proyecto James E. Kelley y Morgan R. Walker.

Junto con esta técnica se desarrolló el PERT (Program Evaluation Review Technique), por iniciativa de la Marina de los Estados Unidos, con el objeto de planear y controlar los complejos programas para desarrollar el cohete "Polaris".

La diferencia básica entre los dos métodos es que el CPM es un método determinístico y el PERT es uno probabilístico, por lo que no es práctico este último en la industria de la construcción.

Para su estudio, el método de la ruta crítica se ha dividido en tres fases:

Fase I.- Elaboración de la red de actividades.

Para poder representar gráficamente las actividades a ejecutar, y las secuencias de las mismas, se han desarrollado dos tipos de notaciones:

CPM

CRITICAL PATH METHOD
(Método determinístico)

CPA

CRITICAL PATH ANALYSIS

CPS

CRITICAL PATH SCHEDULING

LESS

LEAST COST AND ESTIMATING SCHEDULING

PERT

PROGRAM EVALUATION RESEARCH TASK
(Método probabilístico)

Ventajas

Más sencilla la programación para computadora.

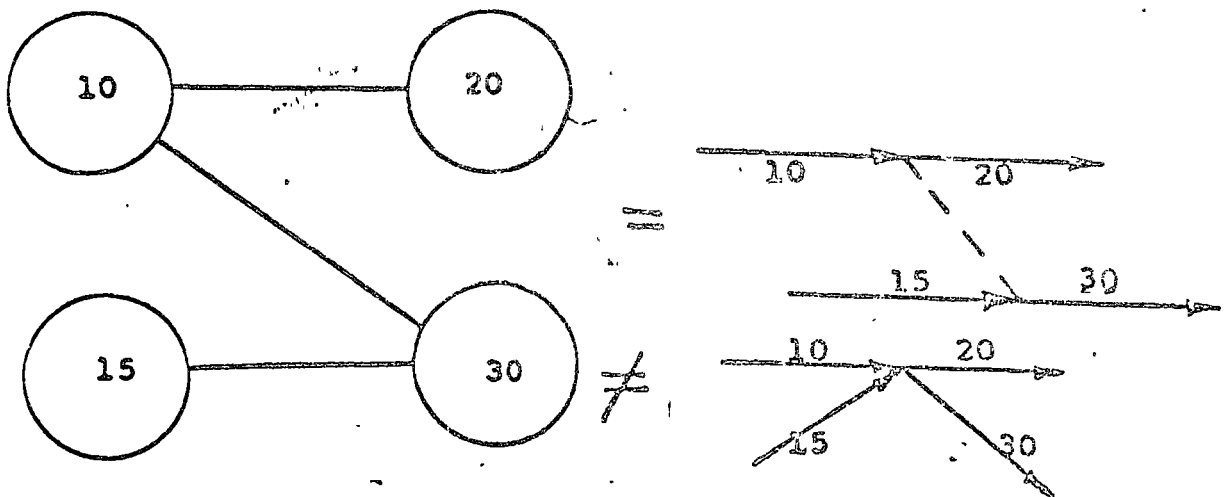
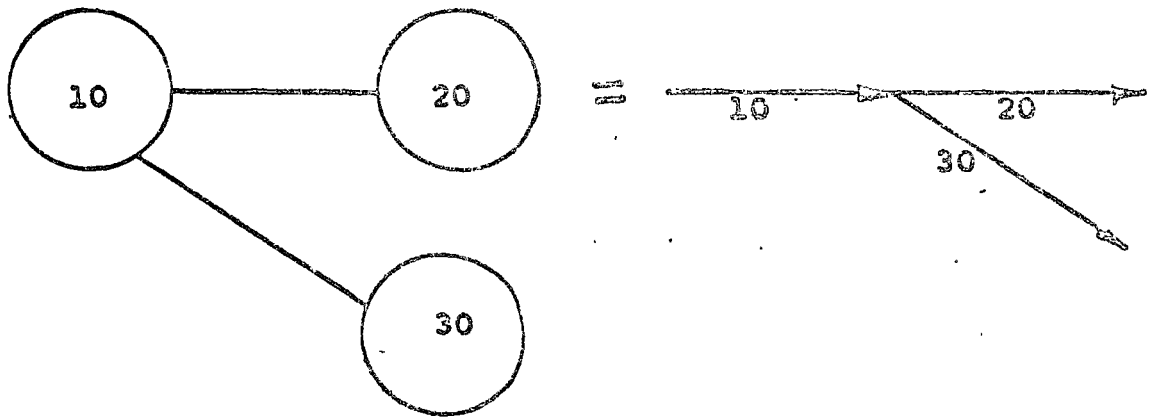
a) Notación de flechas:

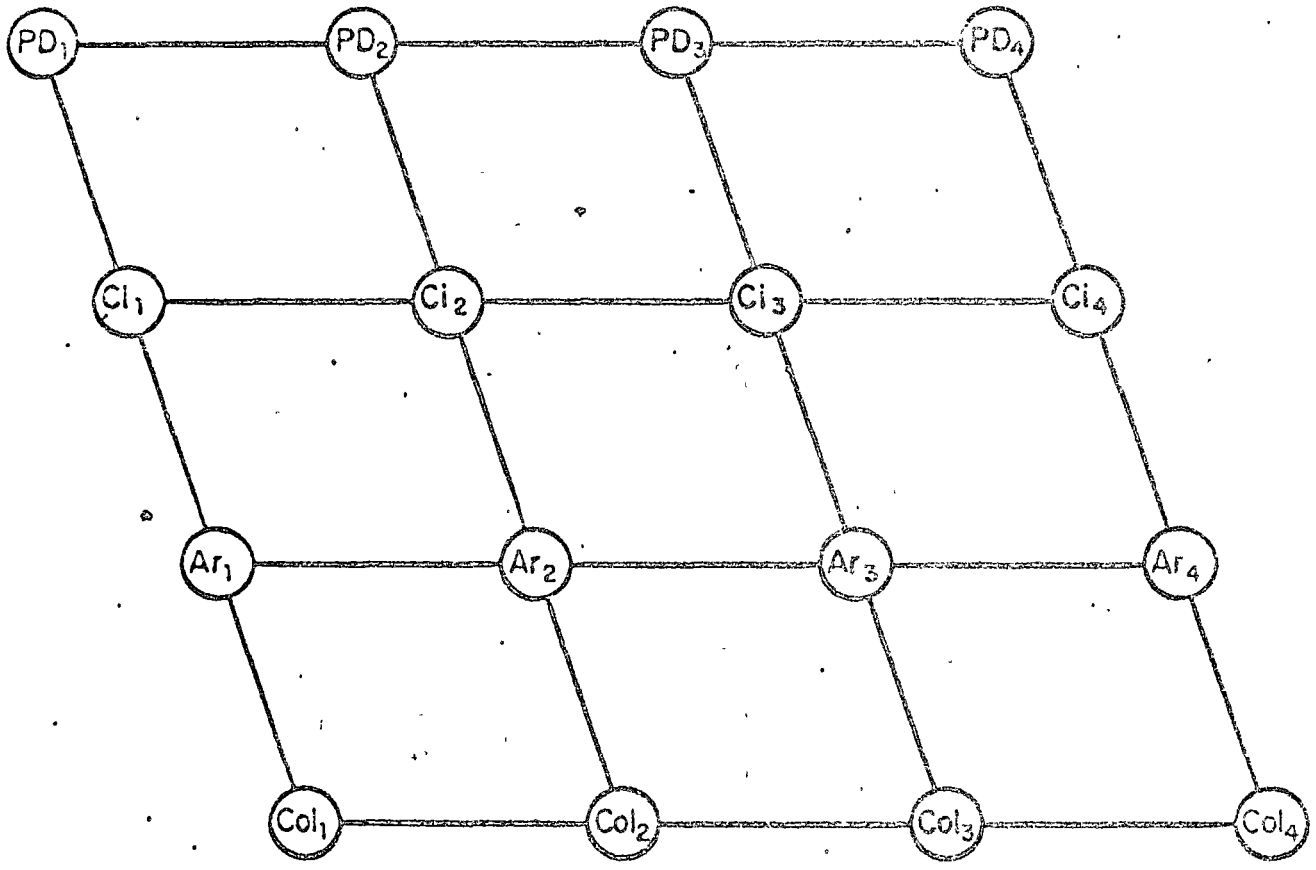
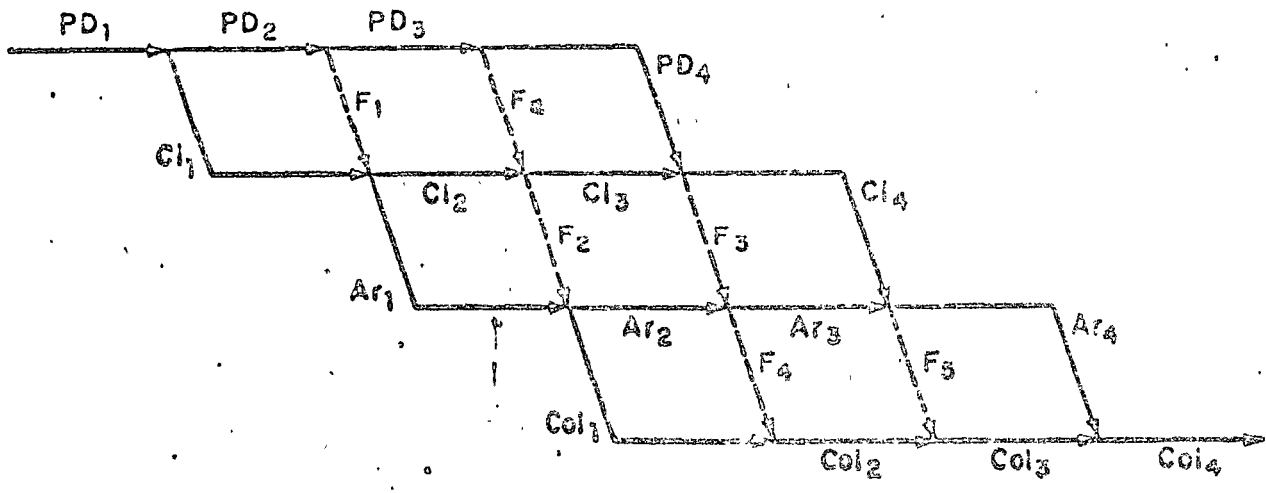
1. No existen actividades ficticias ($t = 0$; $s = 0$):

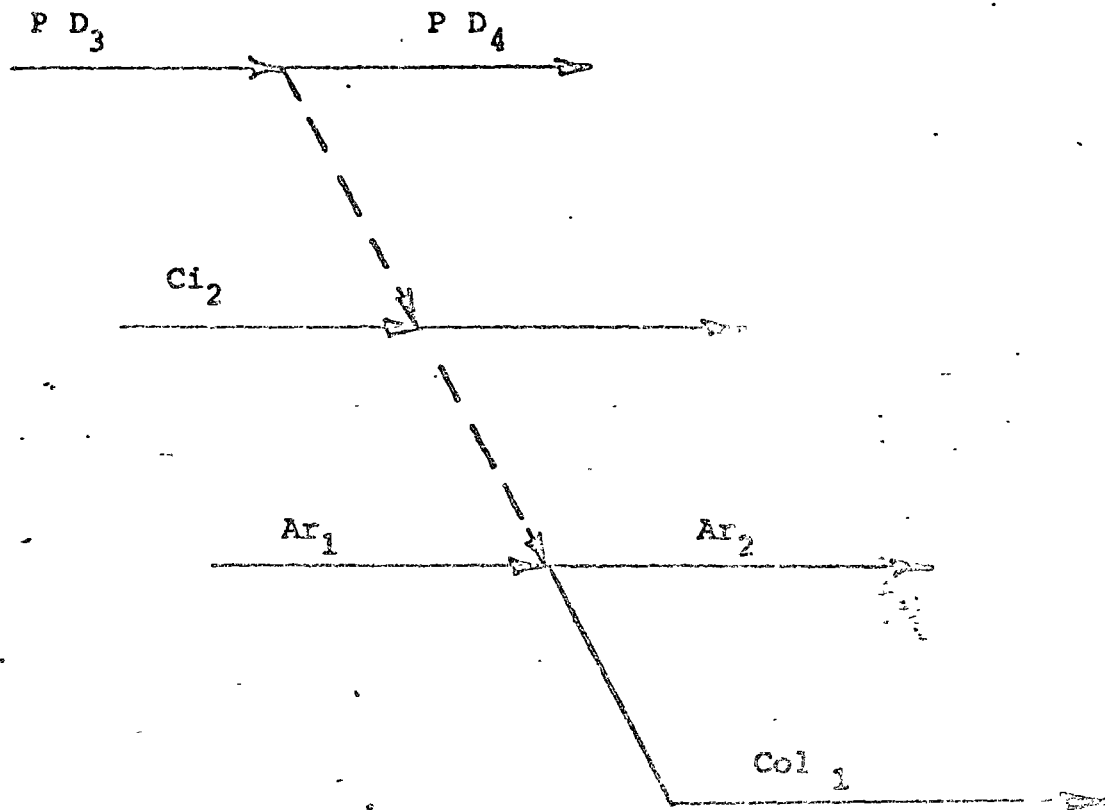
Evita muchos errores.

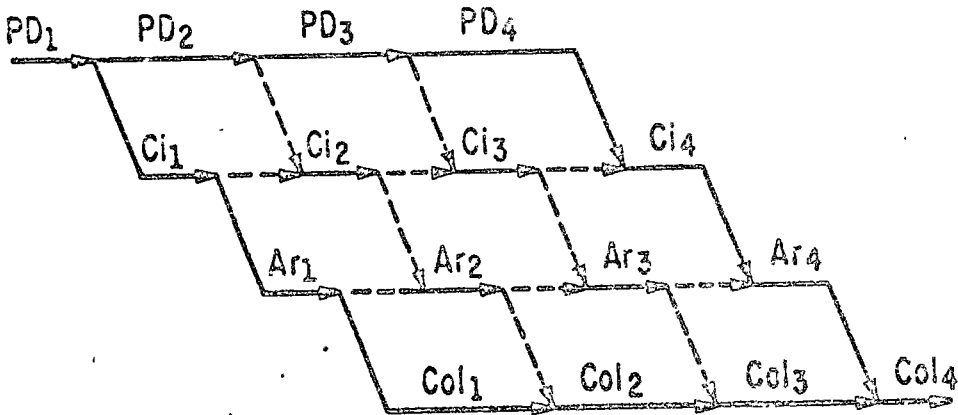
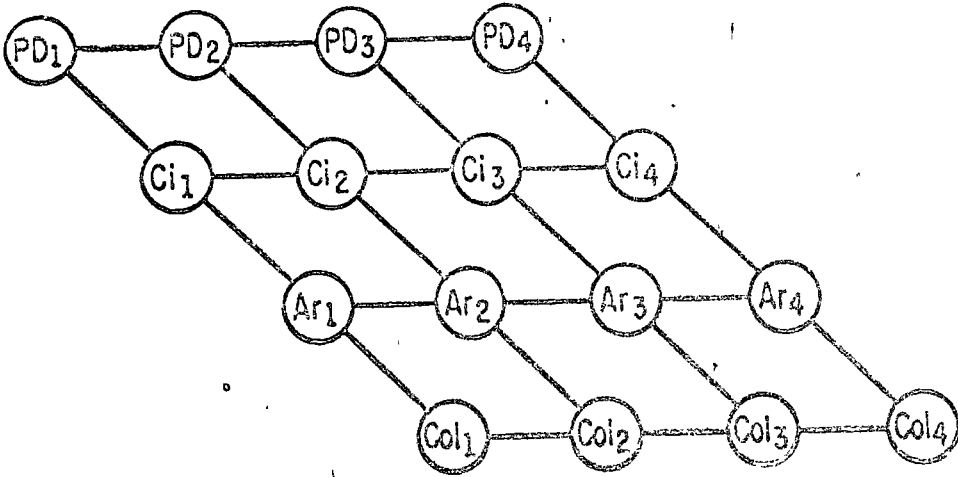
b) Notación de círculos:

2. Más fácil de realizar y de modificar o corregir el programa









El desarrollo de esta fase implica:

1. Conocimiento de lo que se va a hacer.
2. Experiencia constructiva.
3. Conocimiento de los recursos con los que se puede disponer.
4. Prever las situaciones que van a prevalecer en la obra.
5. Criterio para el desglose de actividades (conocimiento y experiencia en la aplicación del método).

Hipótesis en las que se basa:

1. "Indivisibilidad de actividades".
Esto implica la imposibilidad de traslapar actividades; expresado de otra manera: debe estar terminada -- 100% una actividad para poder iniciar otra actividad subsecuente.
2. "Independencia de actividades".

Fase II..- Cálculo de información relacionada con tiempos y su representación gráfica.

PI: primera fecha de inicio.
UI: última fecha de inicio.
PT: primera fecha de terminación.
UT: última fecha de terminación.
HT: holgura total.
HL: holgura libre.
HI: holgura con interferencia.
HP: holgura particular = (lag)

Definiciones:

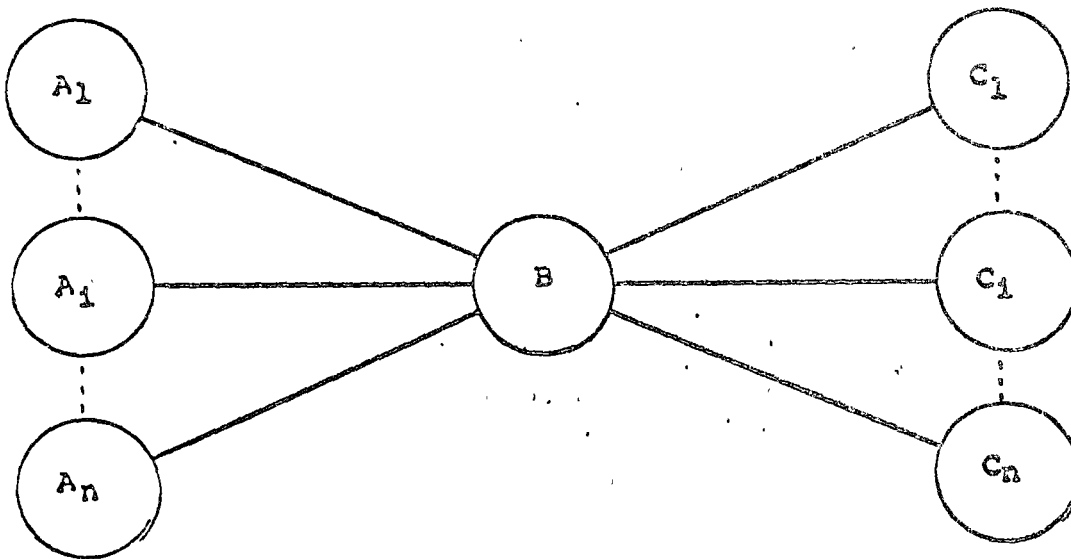
- (HT)_B : Holgura total de B.- Lapso de tiempo que puede ser pospuesta la terminación de la actividad B, sin que se modifique la fecha de terminación de la obra.
- (HL)_B : Holgura libre de B.- Lapso de tiempo que puede ser pospuesta la terminación de la actividad B, sin que se modifique la fecha de inicio de ninguna de las actividades subsecuentes.

$(HI)_B$: Holgura con interferencia de B.- Lapsos de tiempo que puede ser pospuesta la terminación de la actividad B, sin que se modifique la fecha de terminación de la obra, aunque modificando por lo menos el inicio de una de las actividades subsiguientes.

$(HP)_{B-C_1}$: Holgura particular de B- C_1 .- Lapsos de tiempo que puede ser pospuesta la terminación de la actividad B, sin afectar la fecha de inicio de la actividad C_1 .

Actividad crítica: aquella actividad cuya holgura total = 0 (es parte de la ruta crítica).

Ruta crítica: Conjunto de actividades (críticas) que determinan la duración de la obra.



Fórmulas:

$$(PI)_B = \text{mayor } (PT)_{A_i}$$

$$(PT)_B = (PI)_B + (\text{duración})_B$$

$$(UI)_B = (UT)_B - (\text{duración})_B$$

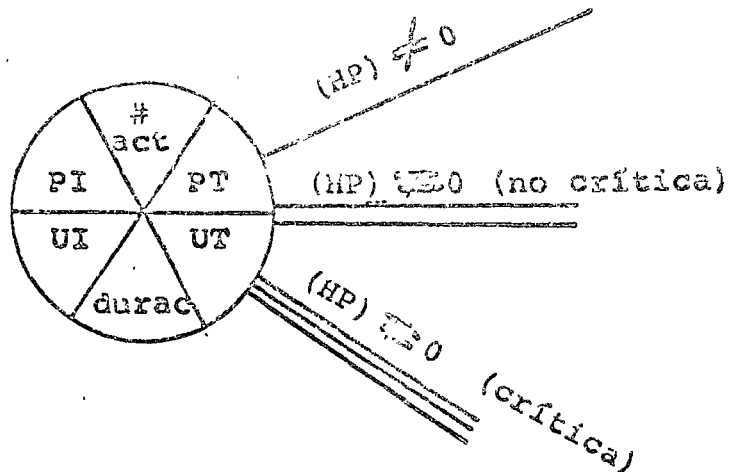
$$(UT)_B = \text{menor } (UI)_{C_i}$$

$$\begin{aligned}
 (HT)_B &= (HL)_B + (HI)_B \\
 &= (UT)_B - (PT)_B \\
 &= (UI)_B - (PI)_B
 \end{aligned}$$

$$(HP)_{B-C_1} = (PI)_{C_1} - (PT)_B$$

$$(HL)_B = \text{menor } (HP)_{B-C_1}$$




Notación para facilitar el cálculo de la fase II.

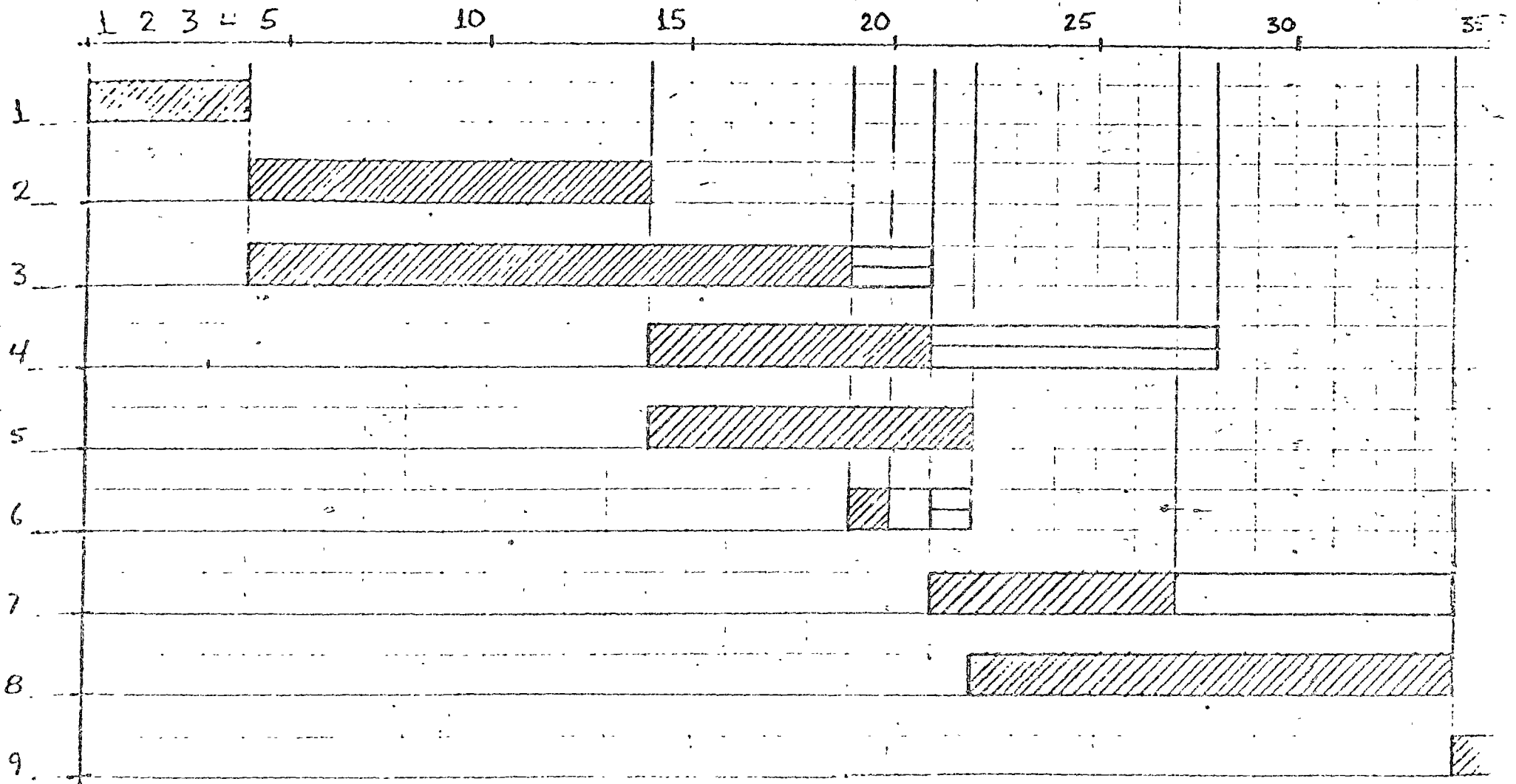


NOTAS:

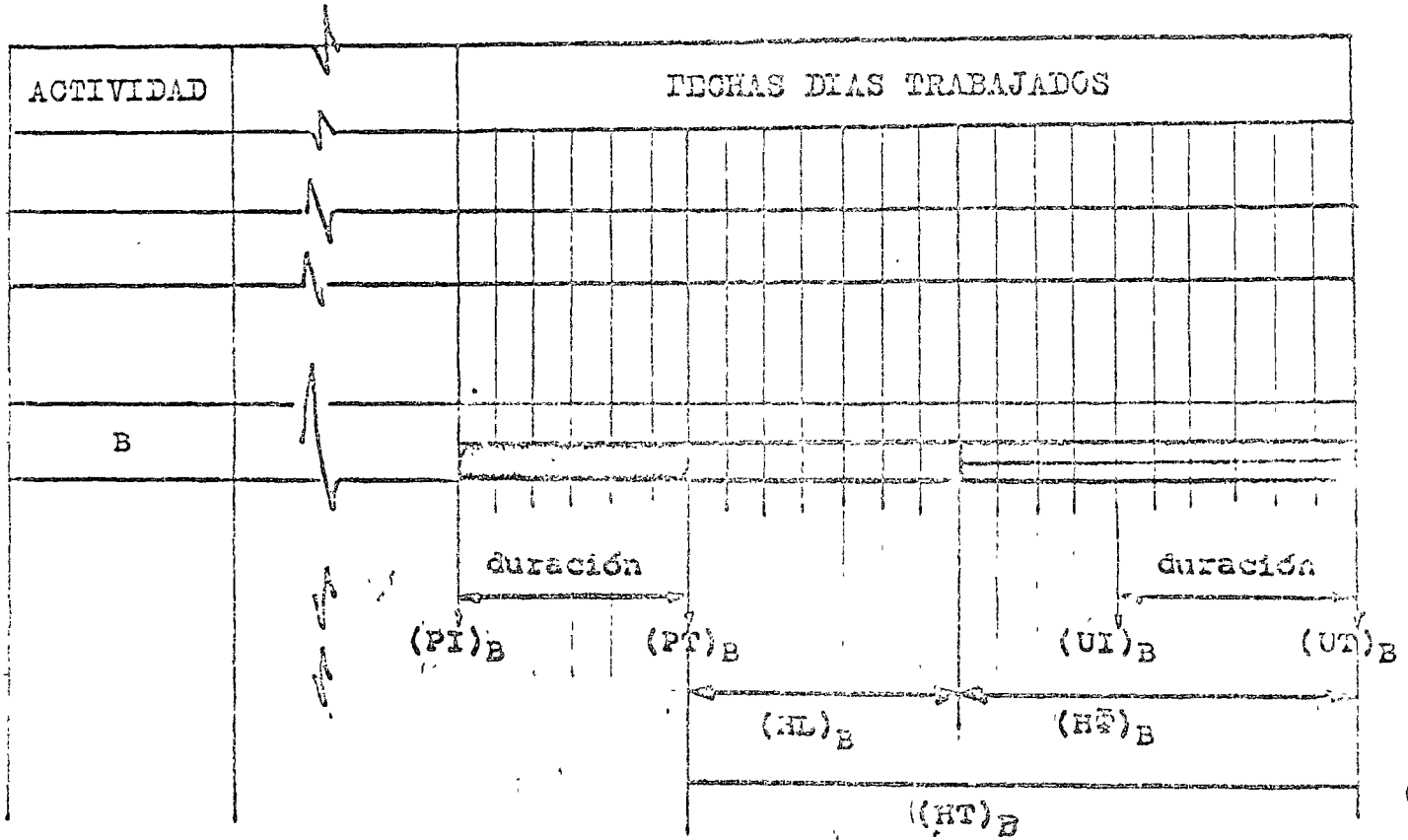
1. No es recomendable que toda la gente tenga acceso a esta información: proveedores, etc.
2. Los resultados obtenidos se basan exclusivamente en lo representado en el diagrama de actividades y en las duraciones supuestas para cada actividad y que dependen del método de construcción, recursos disponibles y rendimientos considerados.

Programa de barras

Actividad 
Holgura libre 
Holgura con interferencia 



Representación gráfica de la información obtenida de la fase II.



Fase III.- Relación tiempo-costo.

Implica el contar para cada una de las actividades del programa con el tiempo normal de ejecución y su costo correspondiente, así como con el tiempo mínimo en que físicamente es posible realizar esa actividad (no importando la eficiencia) y también su costo correspondiente.

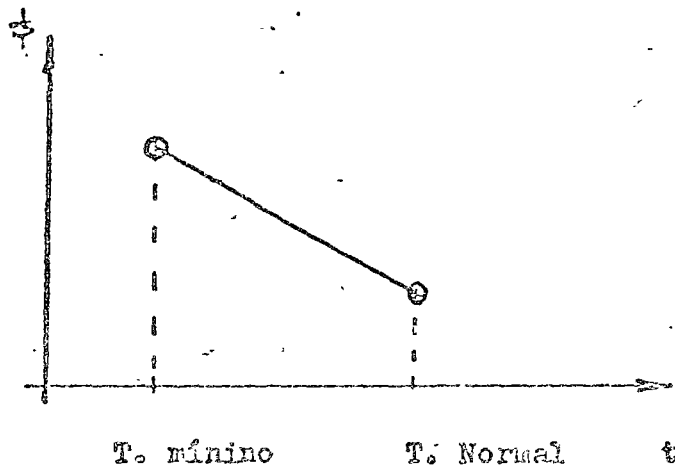
Hipótesis en la que se basa (además de las dos citadas con anterioridad):

"La variación tiempo costo para cada actividad es lineal"

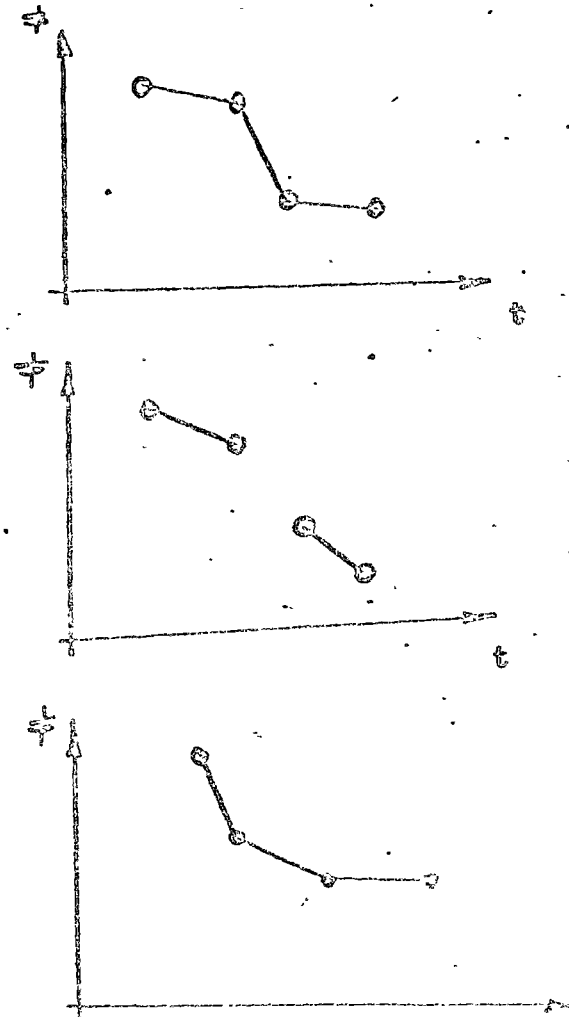
Sólo analiza la metodología para la detención de la relación costo directo mínimo-tiempo y que puede sintetizarse en el cumplimiento de los siguientes puntos:

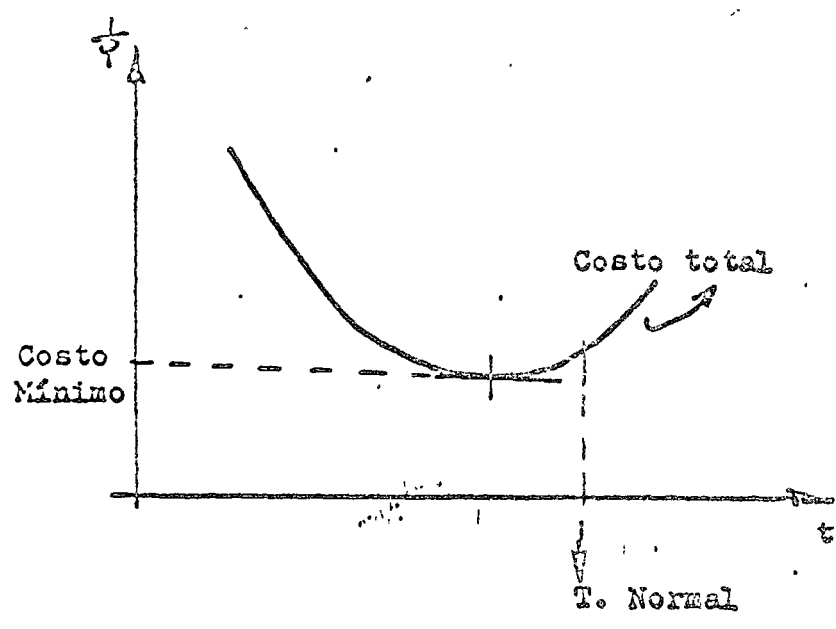
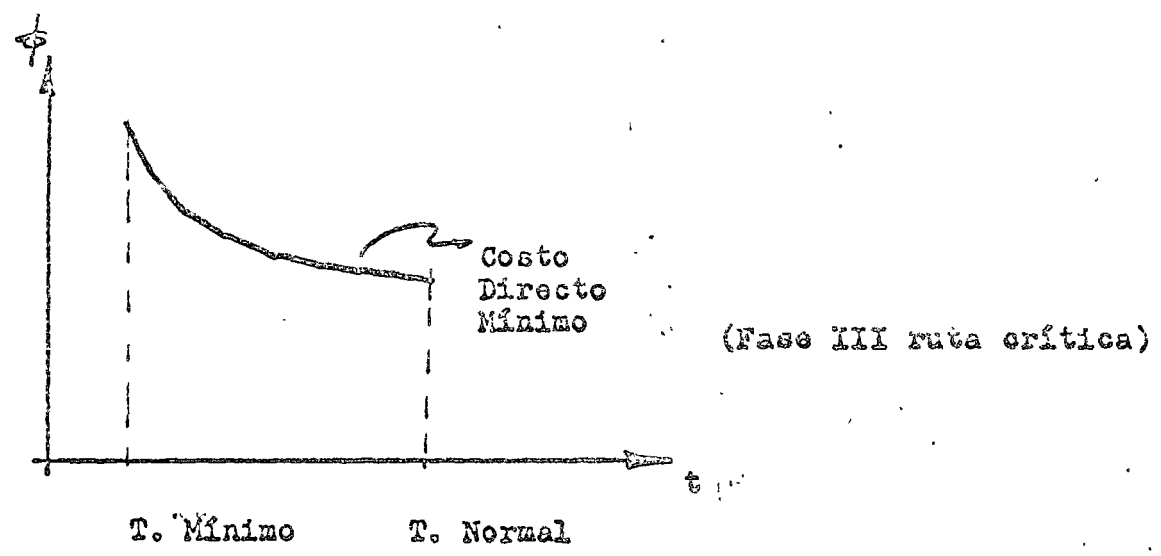
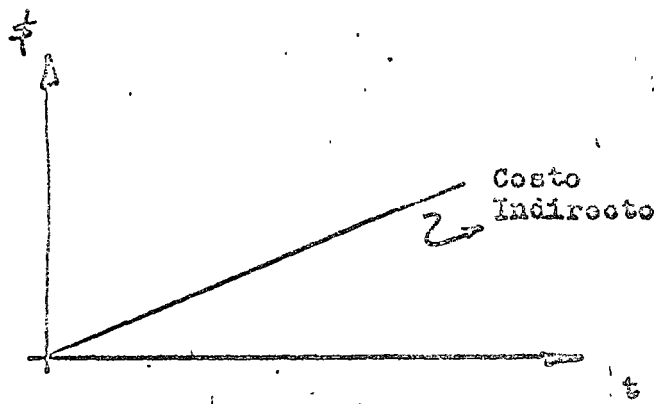
Hipótesis

Relación lineal tiempo-costo
para cada actividad



Realidad





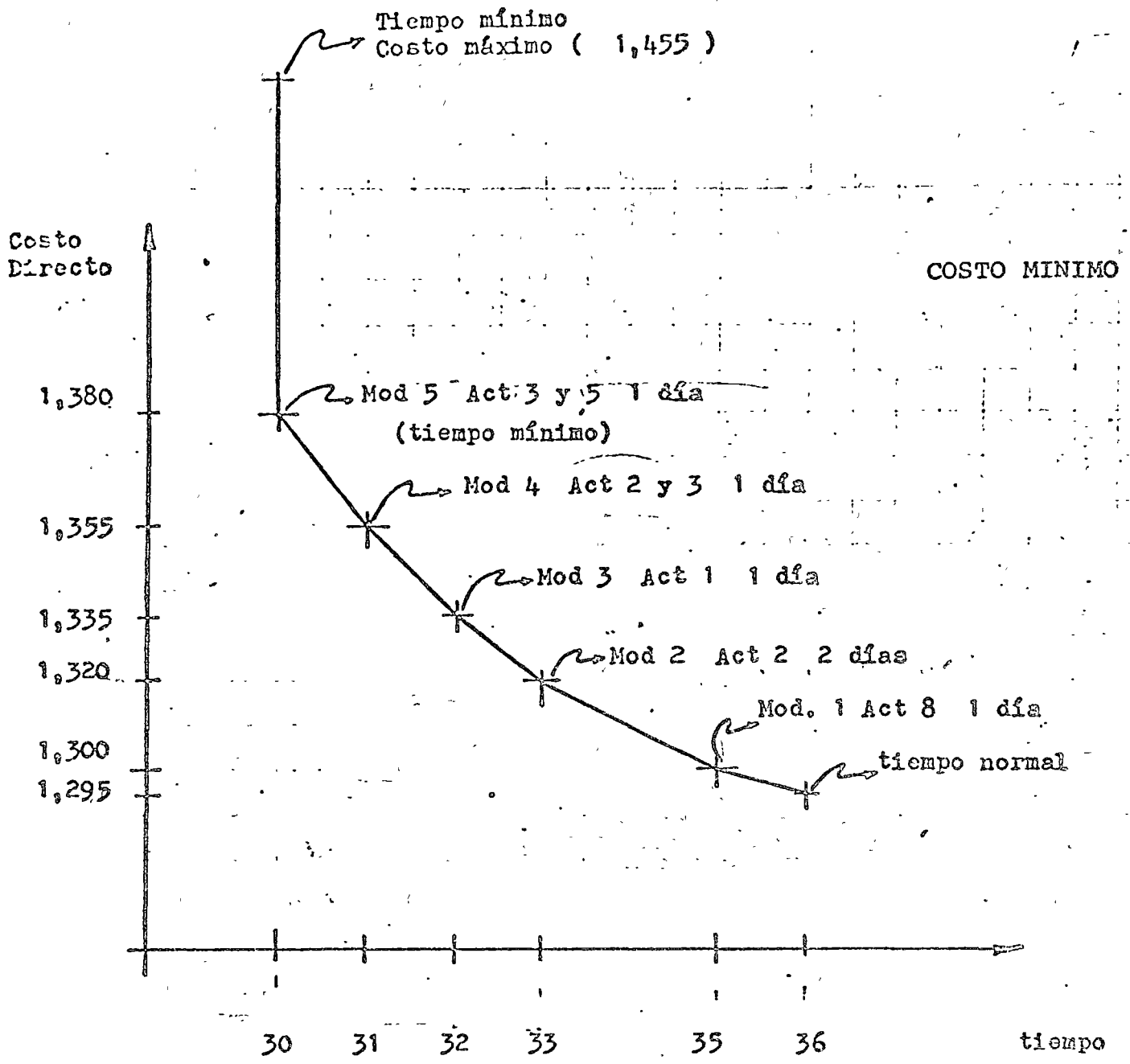
1. Hacer una reasignación de recursos, aprovechando los datos de criticidad u holguras de las distintas actividades del programa.
2. Que la modificación que se haga de la duración de las actividades sea exclusivamente en aquéllas que sean críticas.
3. Que las actividades cuyas duraciones de ejecución se cambien no dejen de ser críticas.
4. La alternativa que deberá escogerse al modificar la duración de las actividades críticas, será aquélla cu ya pendiente costo/tiempo sea menor.

Además del programa general de obra será conveniente contar también con los siguientes programas, que se derivan directamente del general:

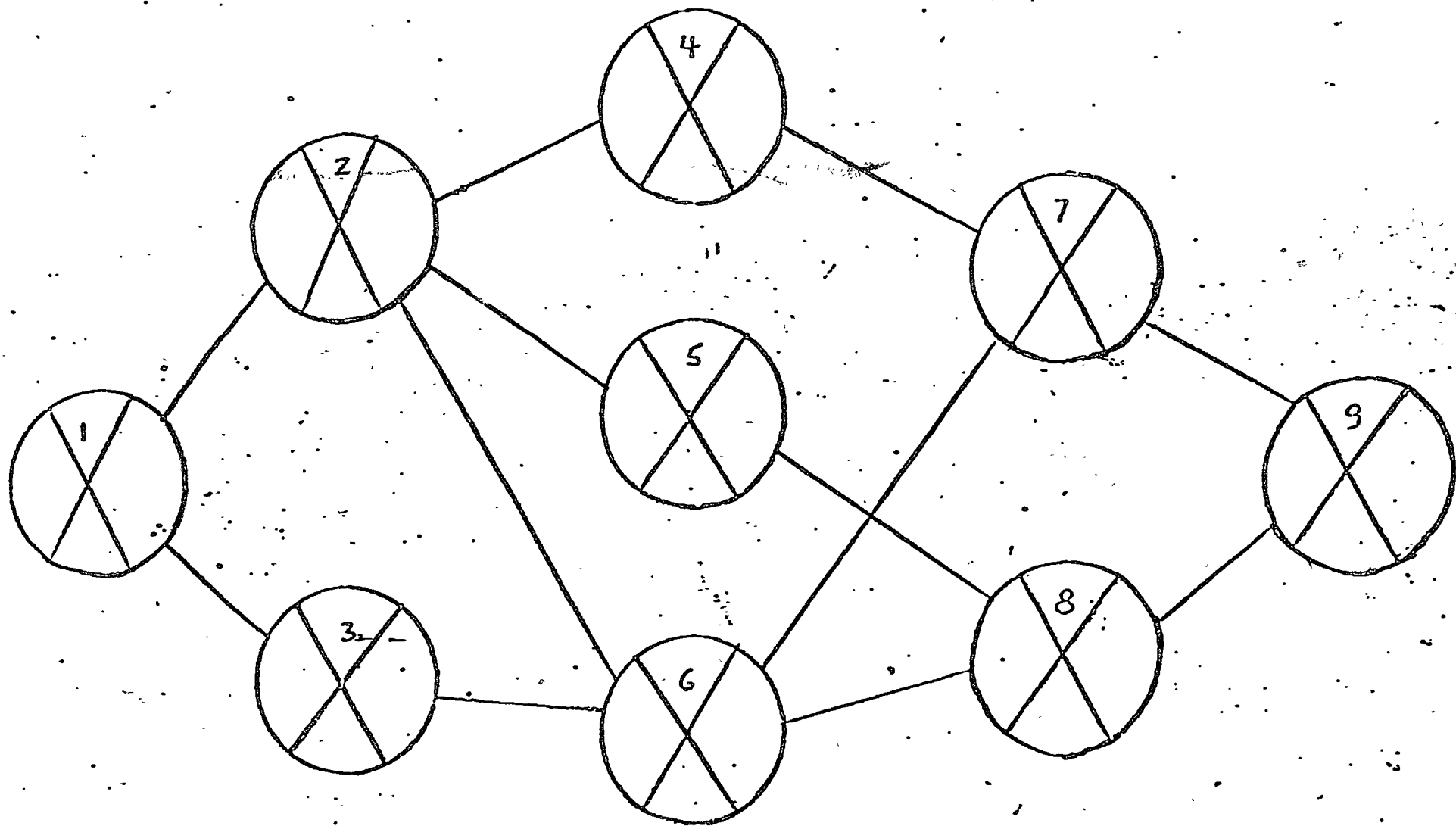
1. Ingresos y egresos.
2. Flujo de caja.
3. Financiamiento.
4. Compras.
5. Sub-contratos.
6. Personal.
7. Equipo y herramienta.

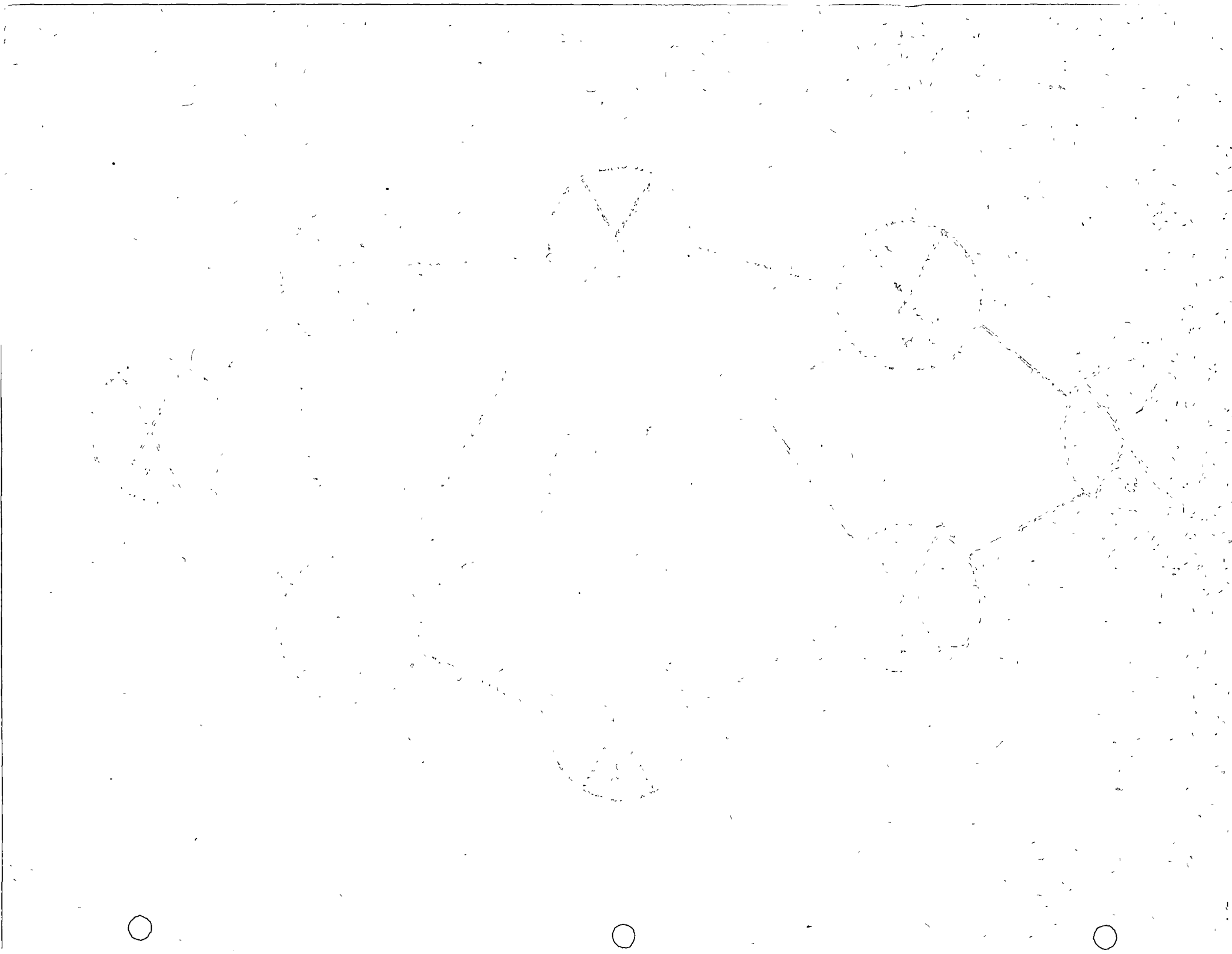
E J E M P L O :

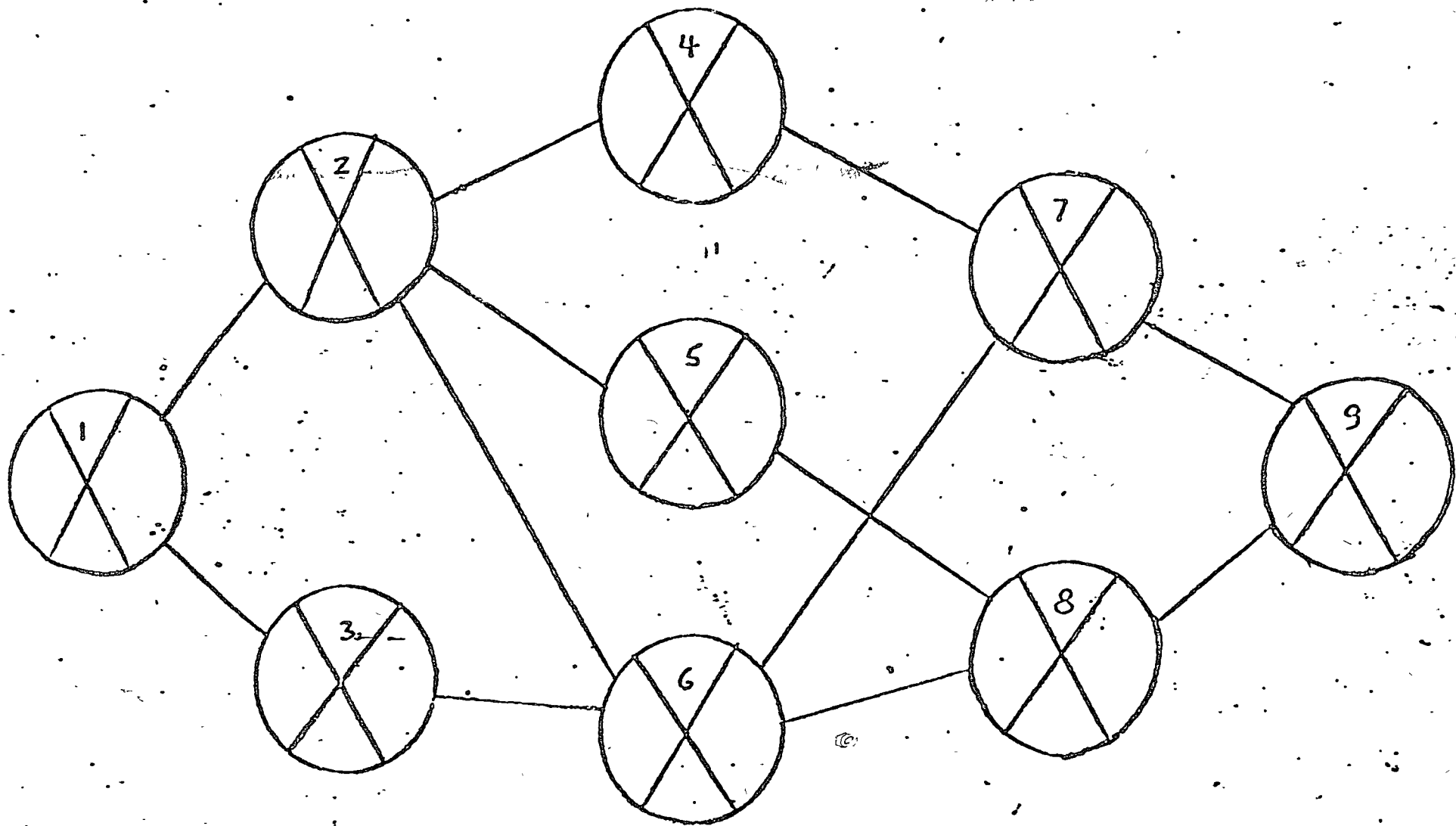
ACTIVIDAD	NORMAL		LIMITE		$\Delta \$$ Δt
	TIEMPO	COSTO	TIEMPO	COSTO	
1	4	150	3	165	15
2	10	160	7	190	10
3	15	140	13	160	10
4	7	145	6	150	5
5	8	130	5	175	15
6	1	200	1	200	-
7	6	140	4	180	20
8	12	110	11	115	5
9	2	120	2	120	-
		<u>1,295</u>		<u>1,455</u>	

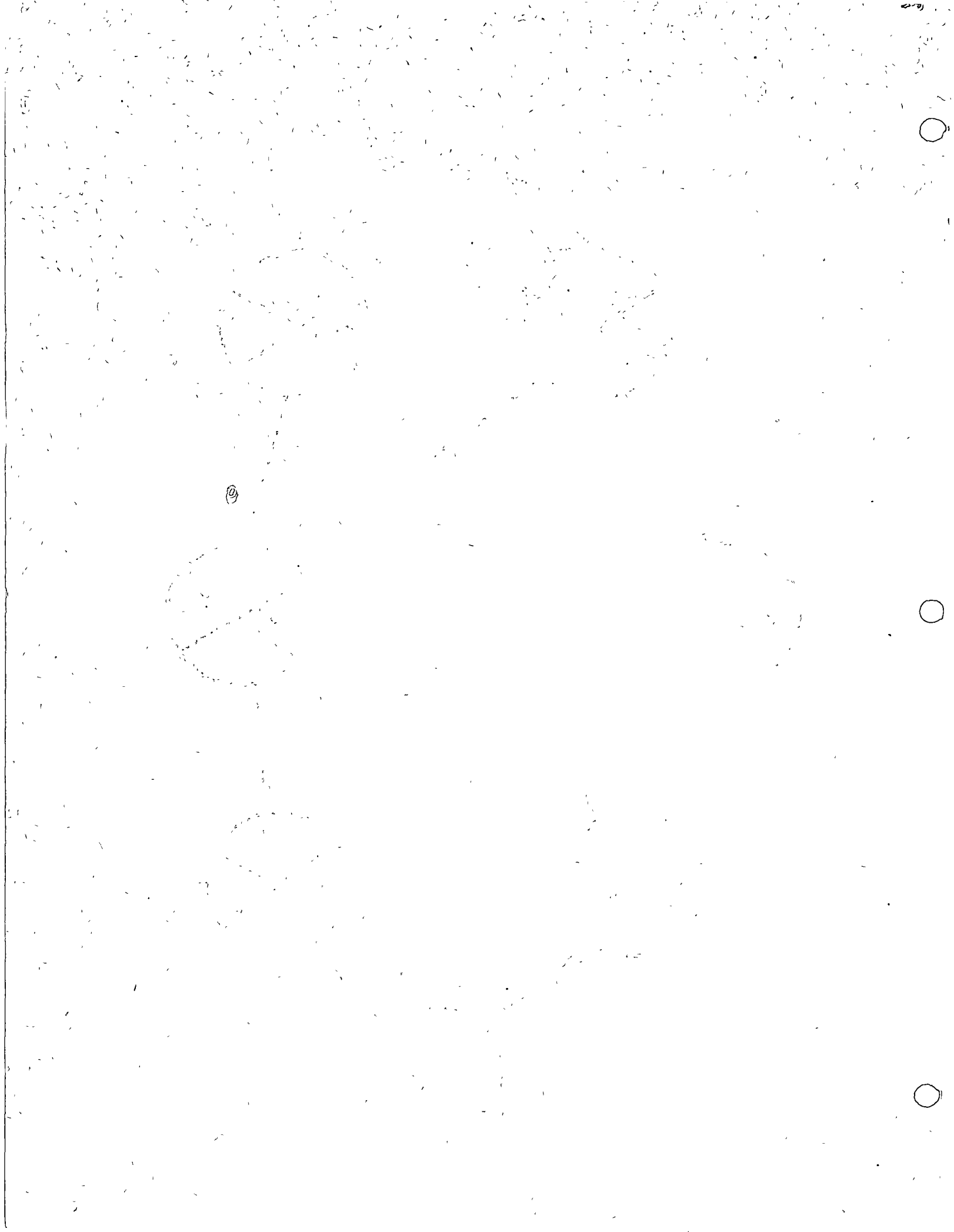


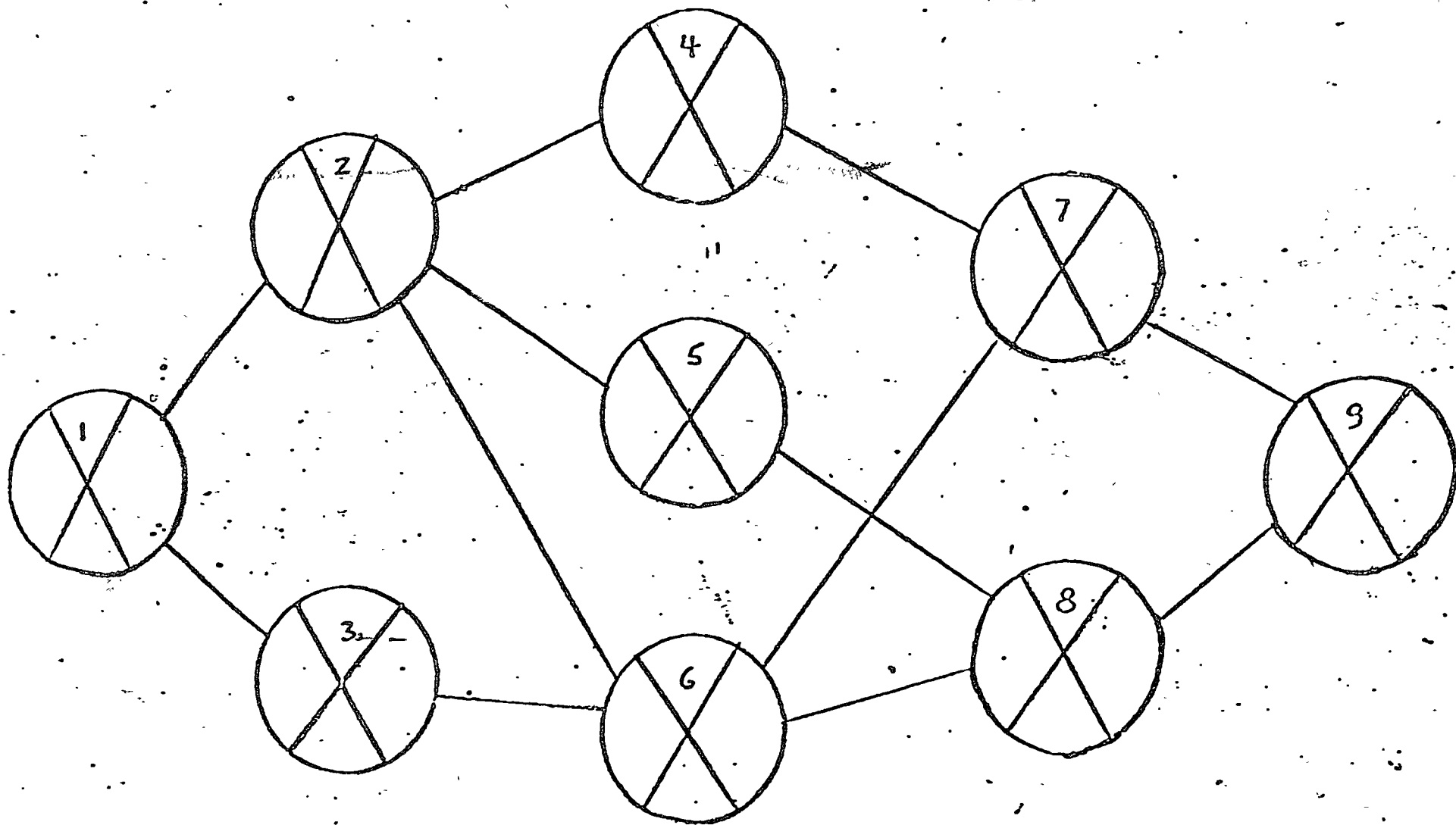


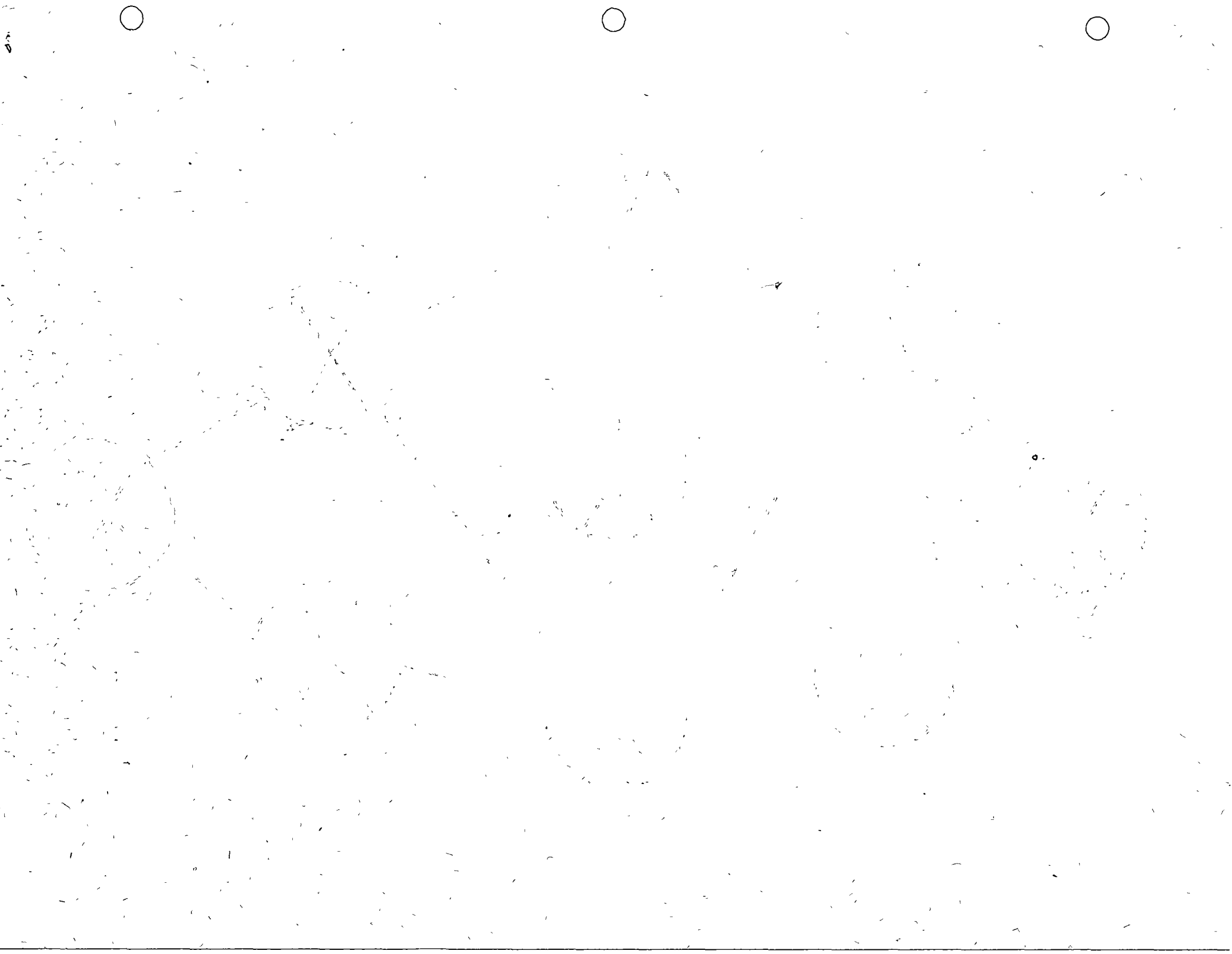


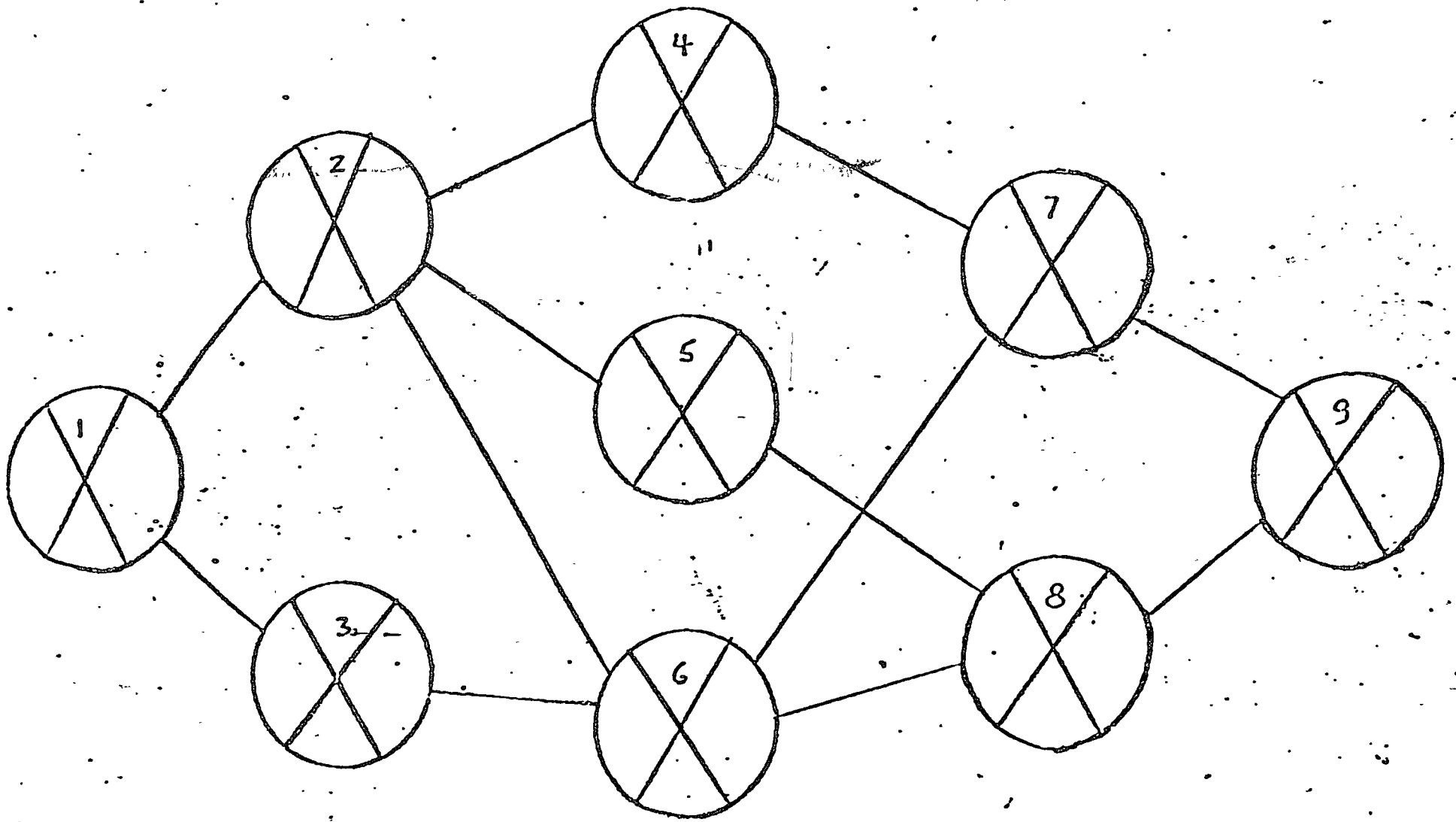


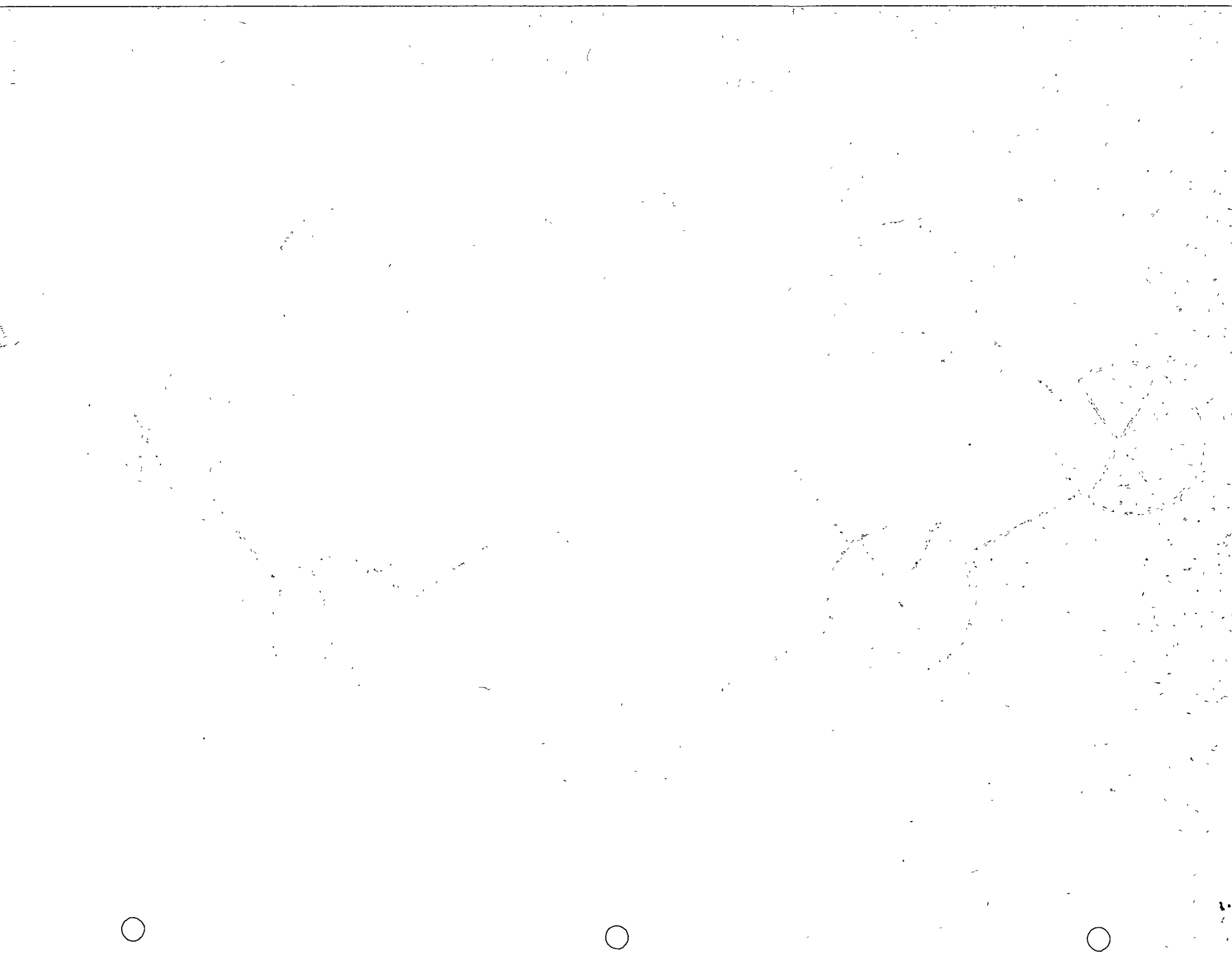


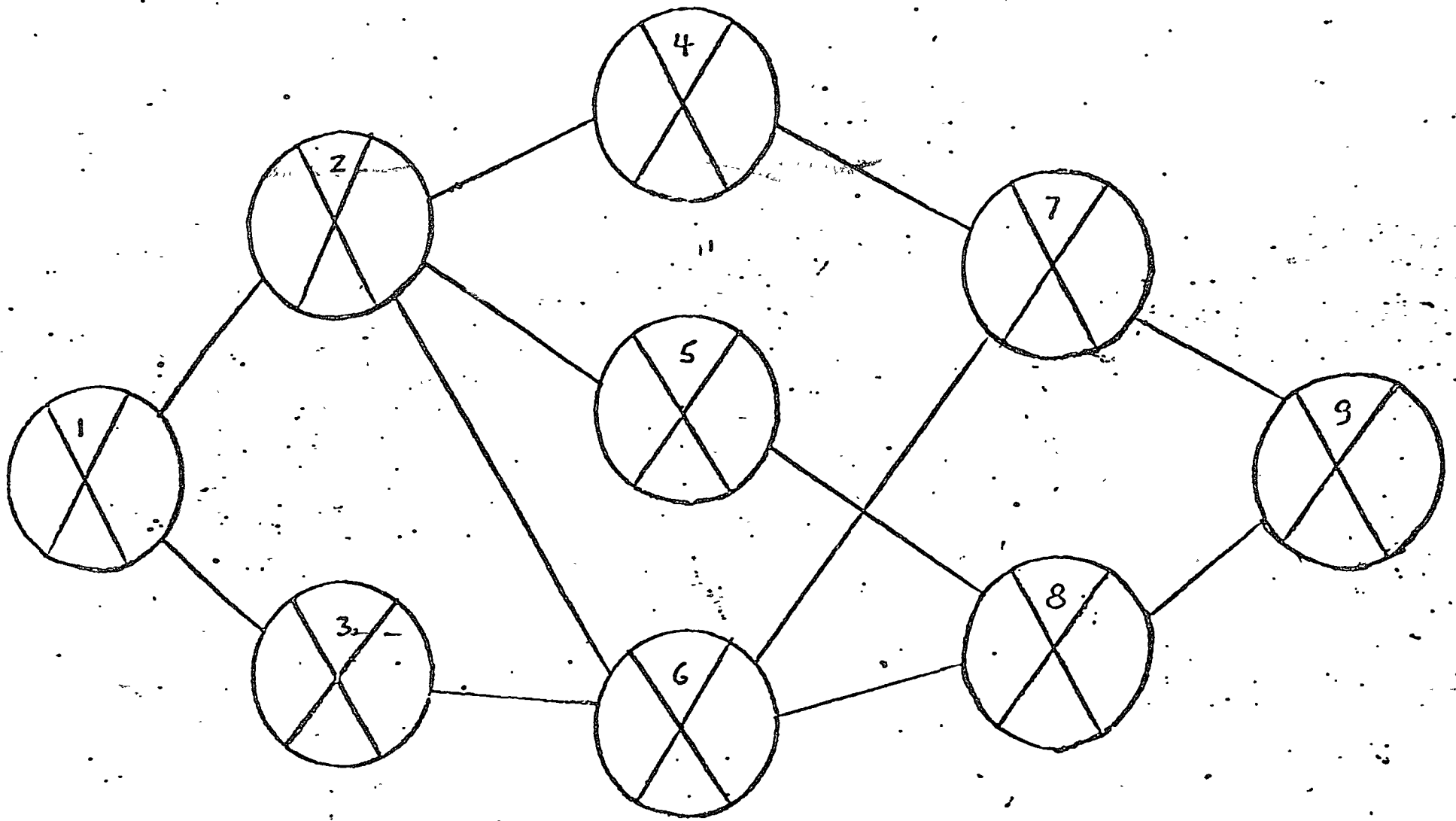


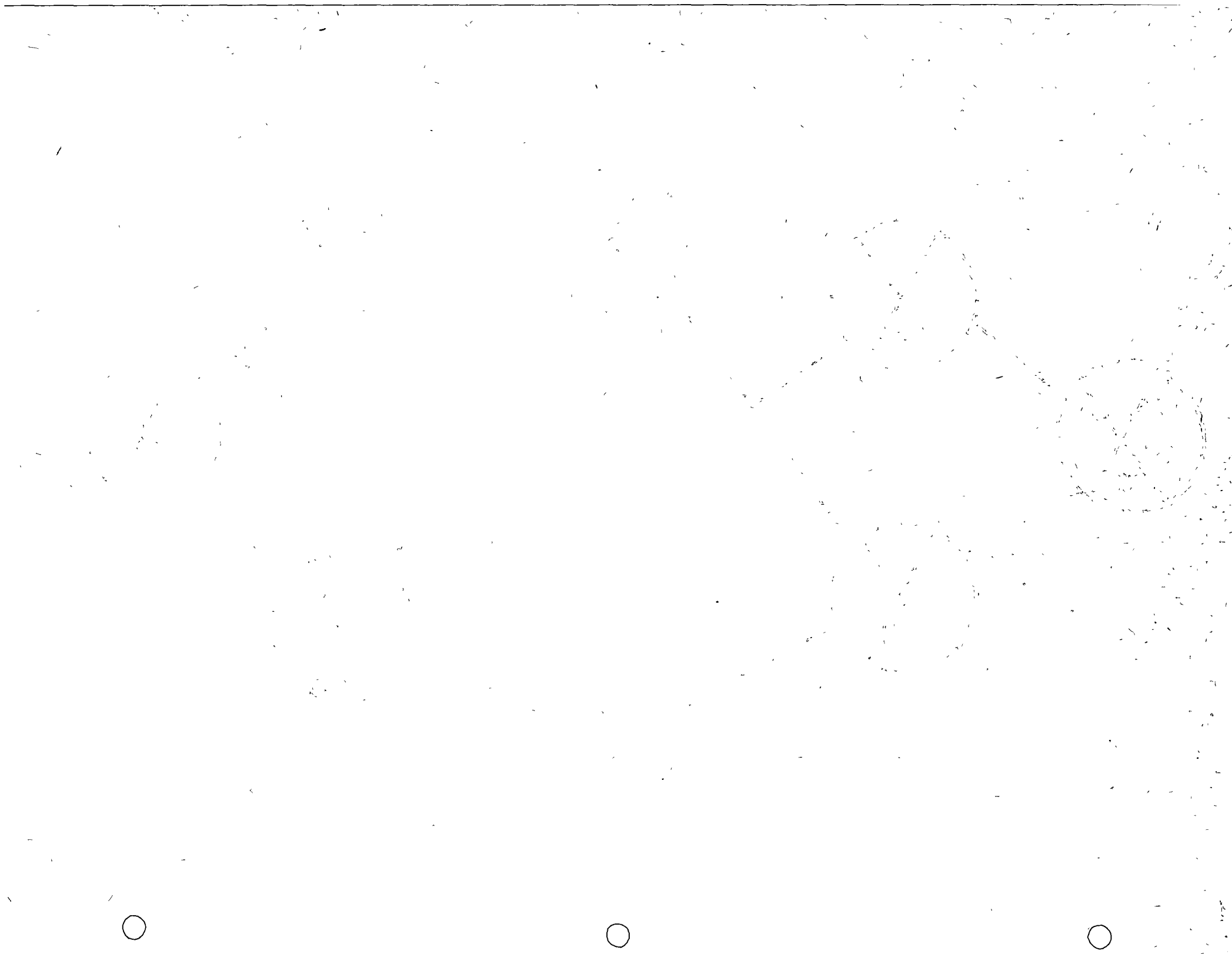


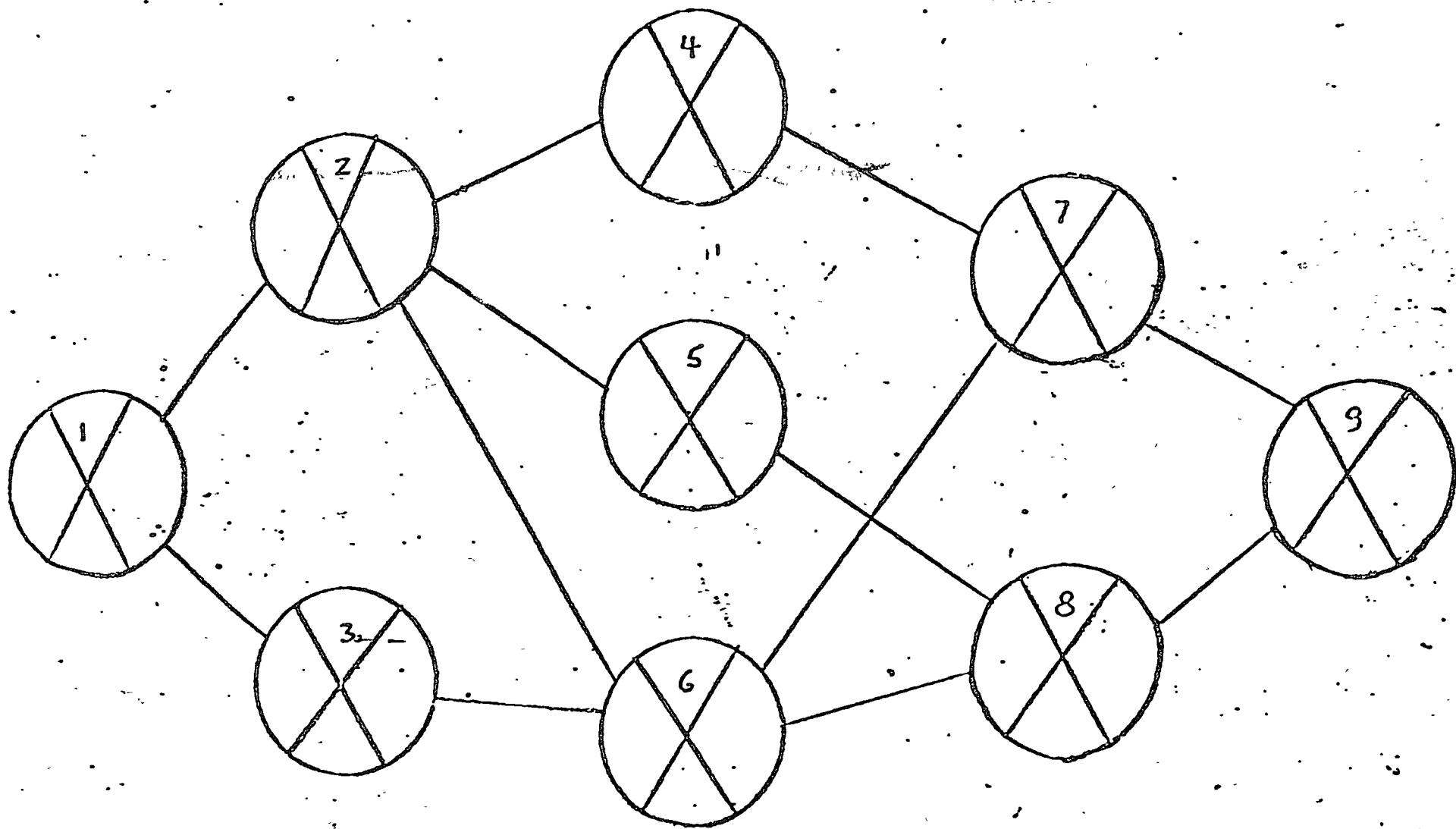


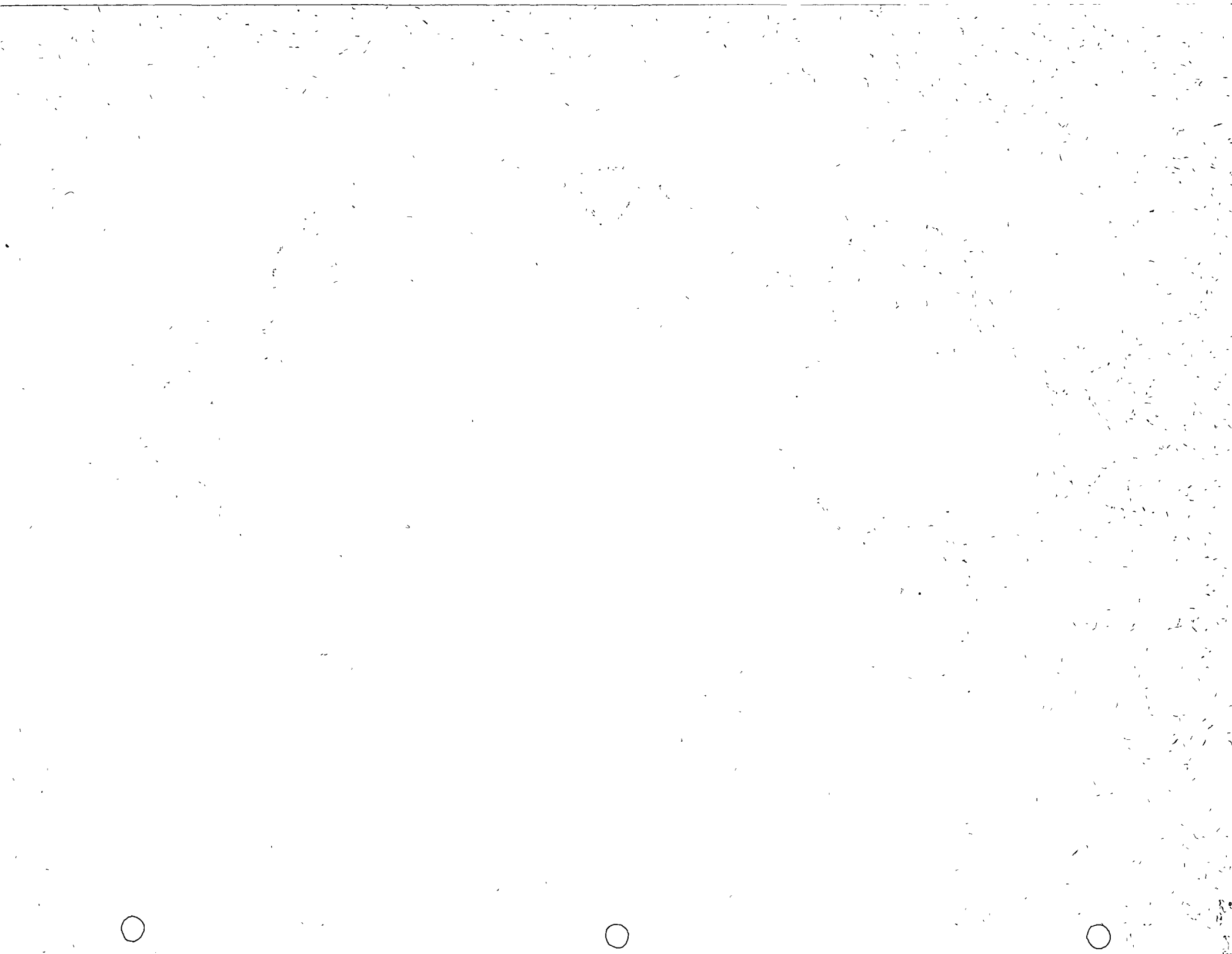




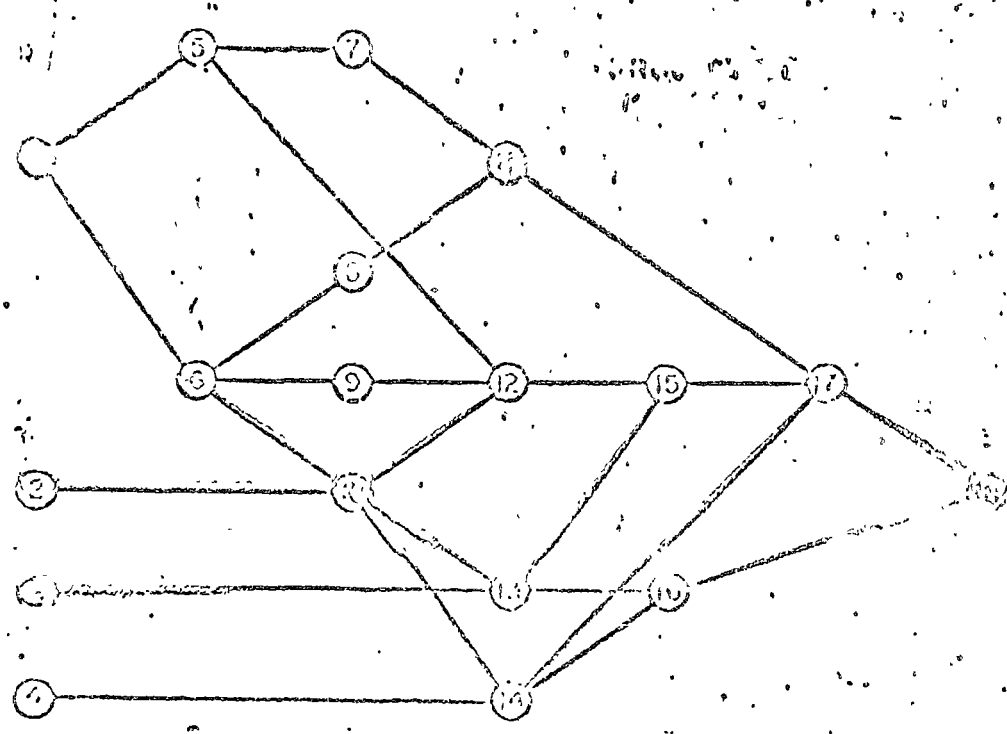
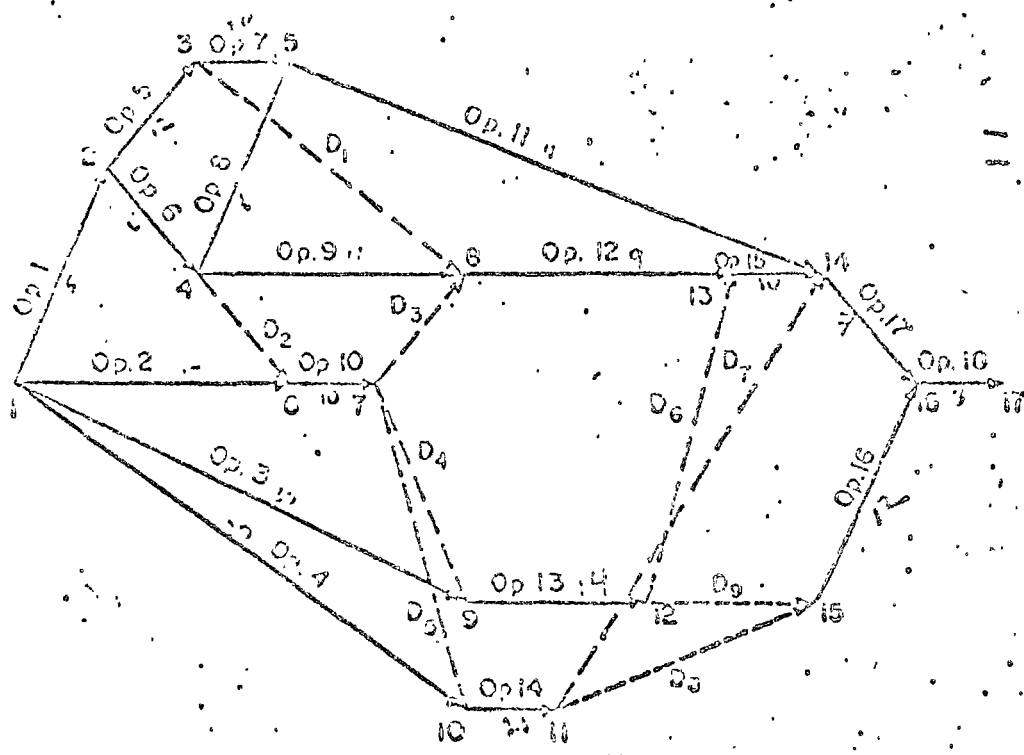


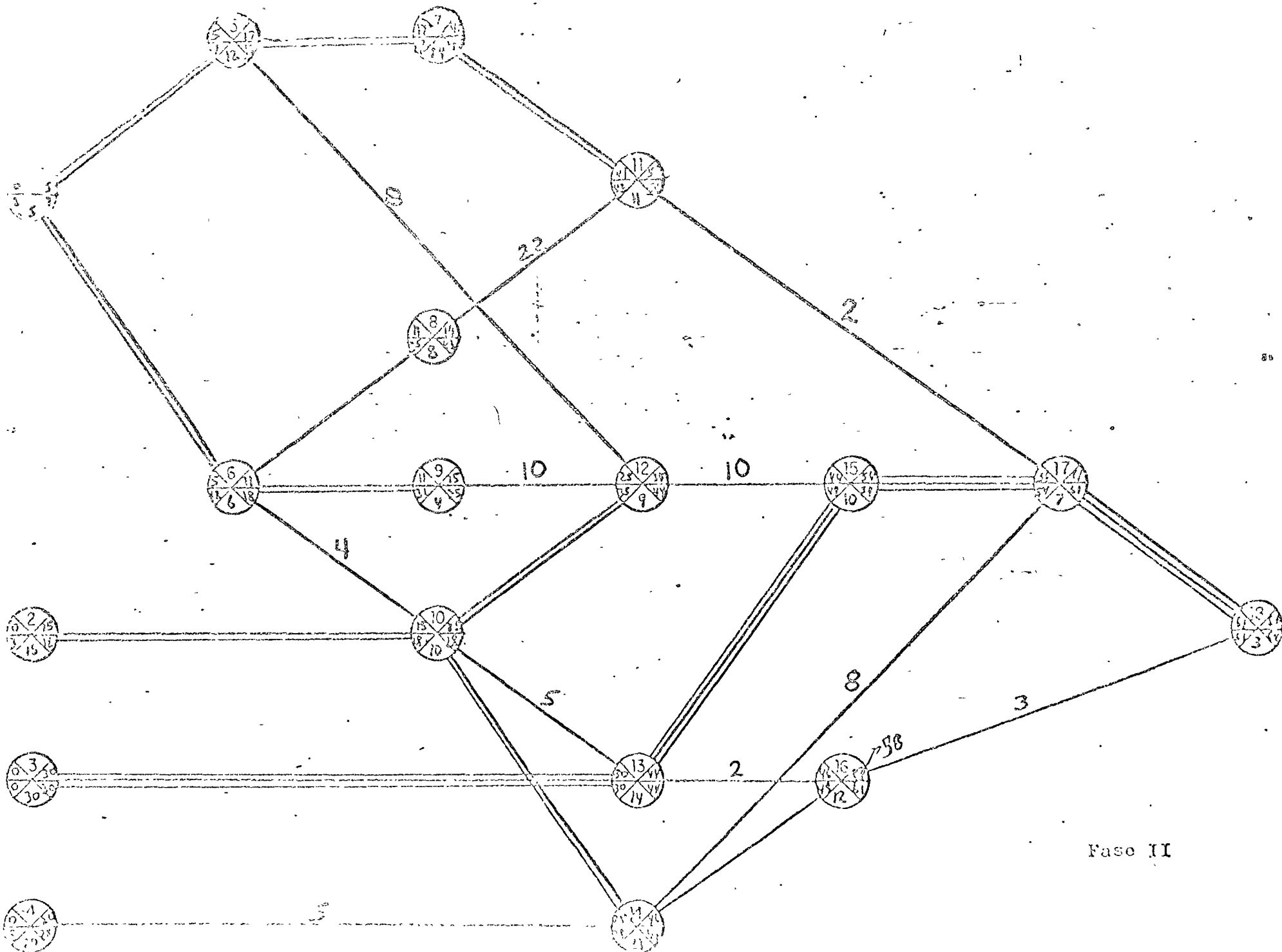






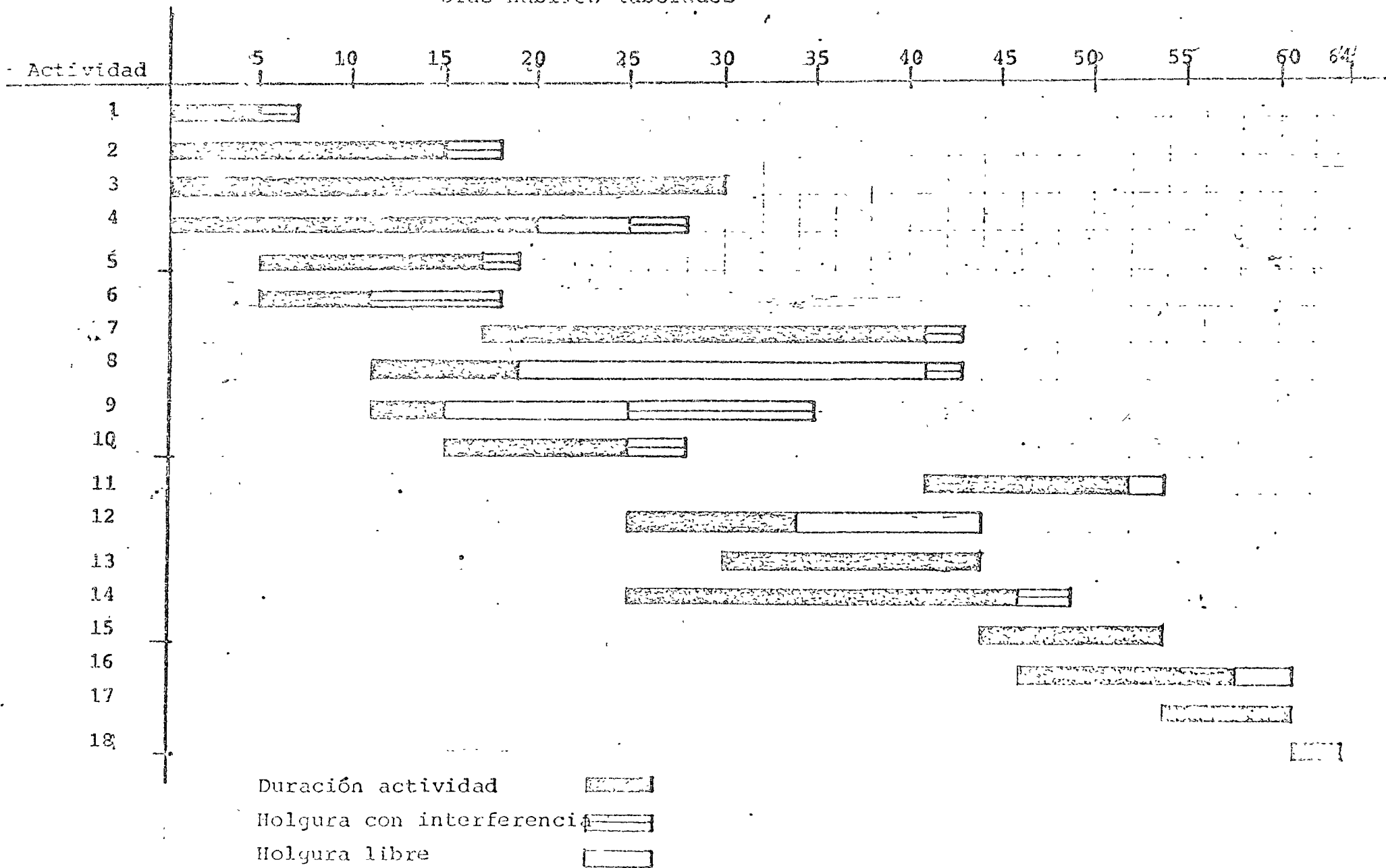
yo ch... 29 11

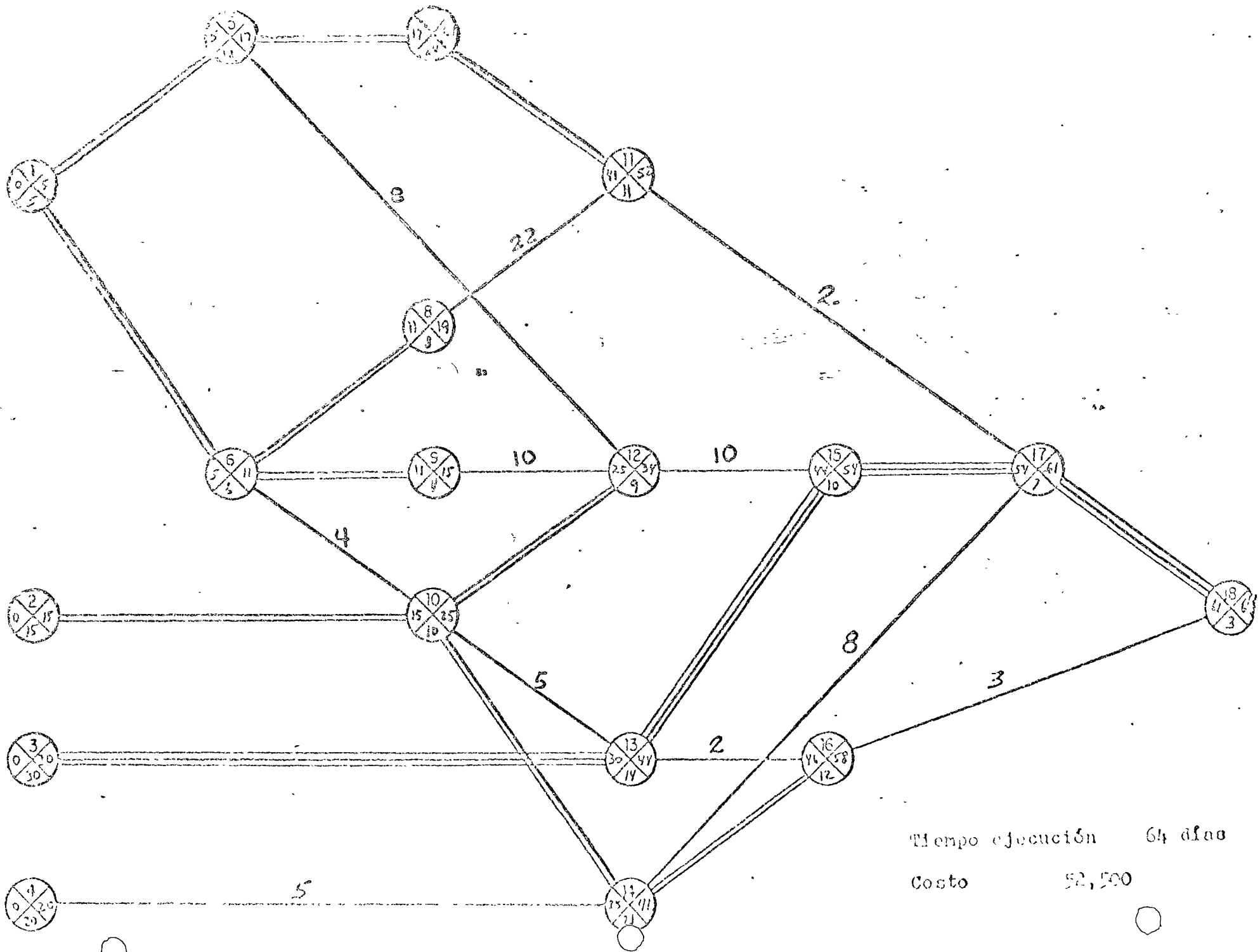




Fase II

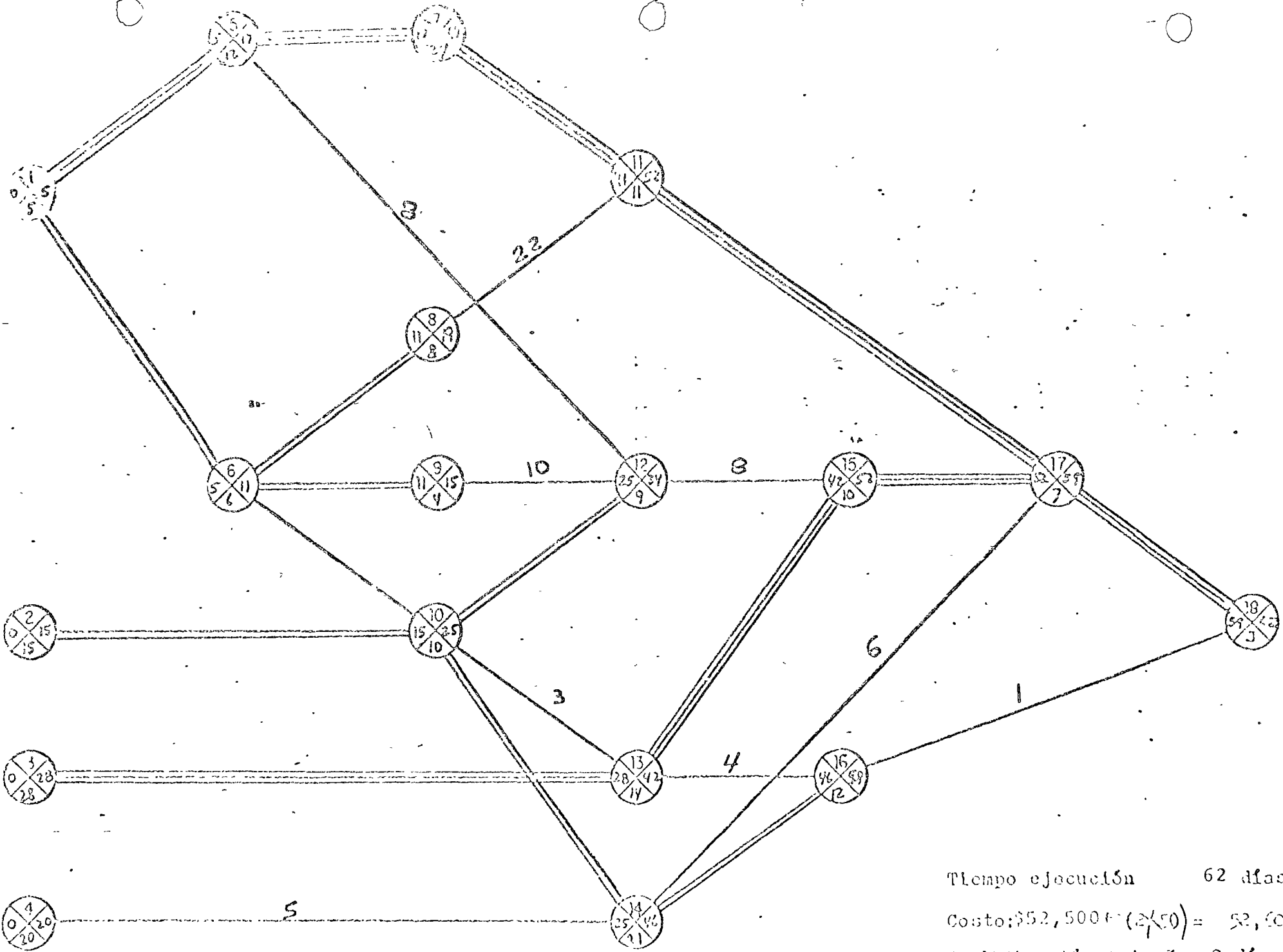
Días hábiles laborados



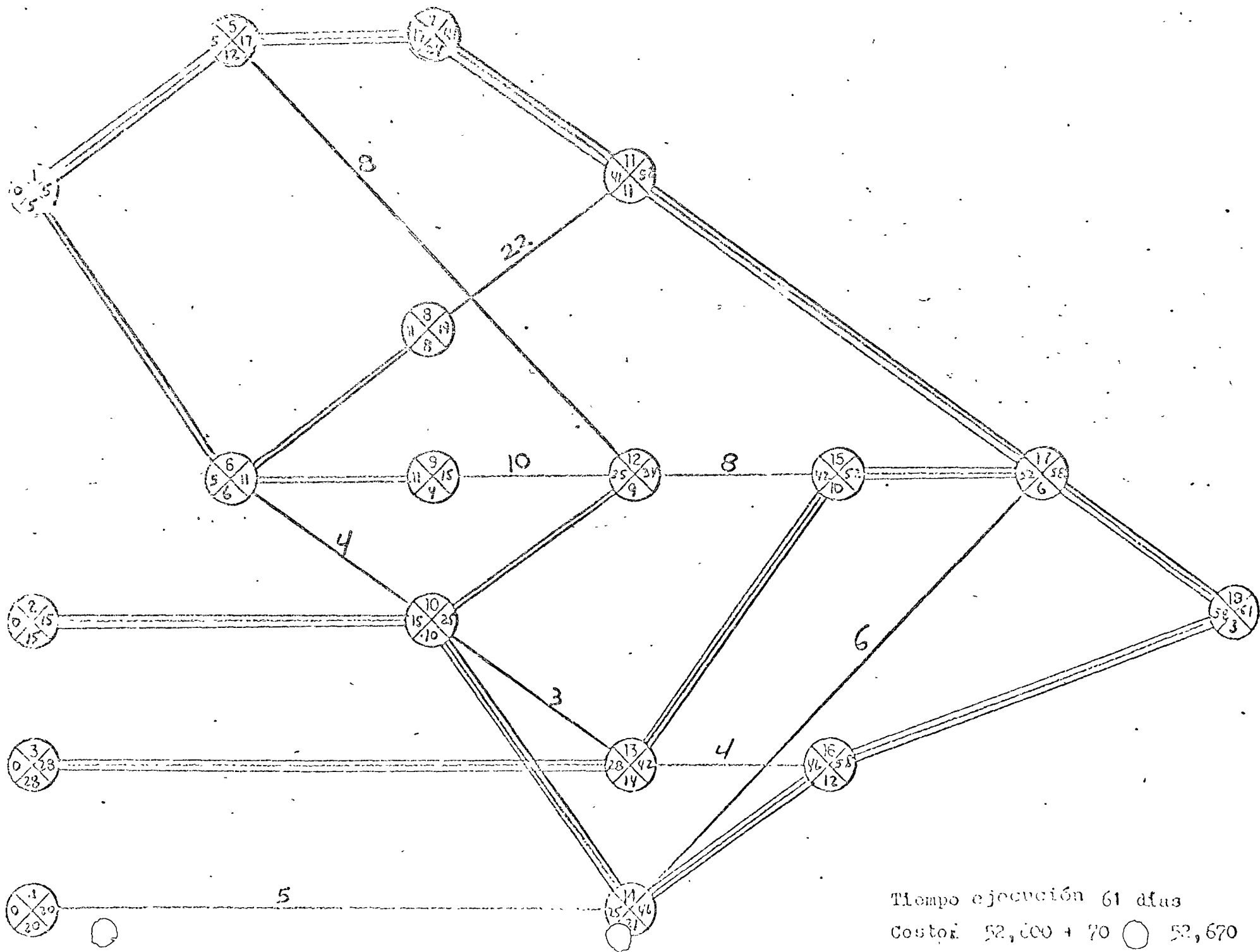


Tiempo ejecución 64 días
 Costo 52,500

B



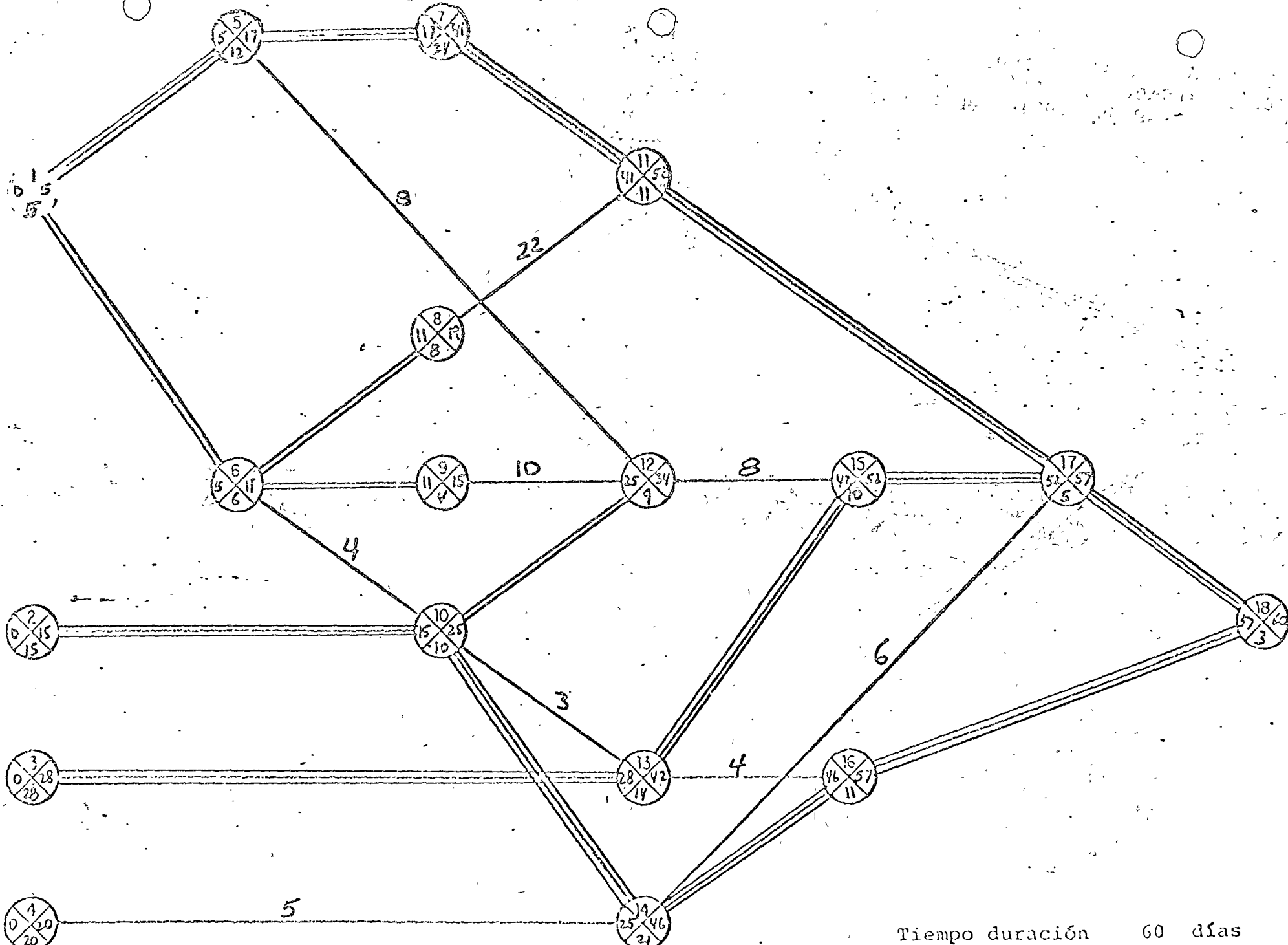
Tiempo ejecución 62 días
 Costo: \$52,500 + (2)(50) = 52,600
 Modificación Act. 3: 2 días



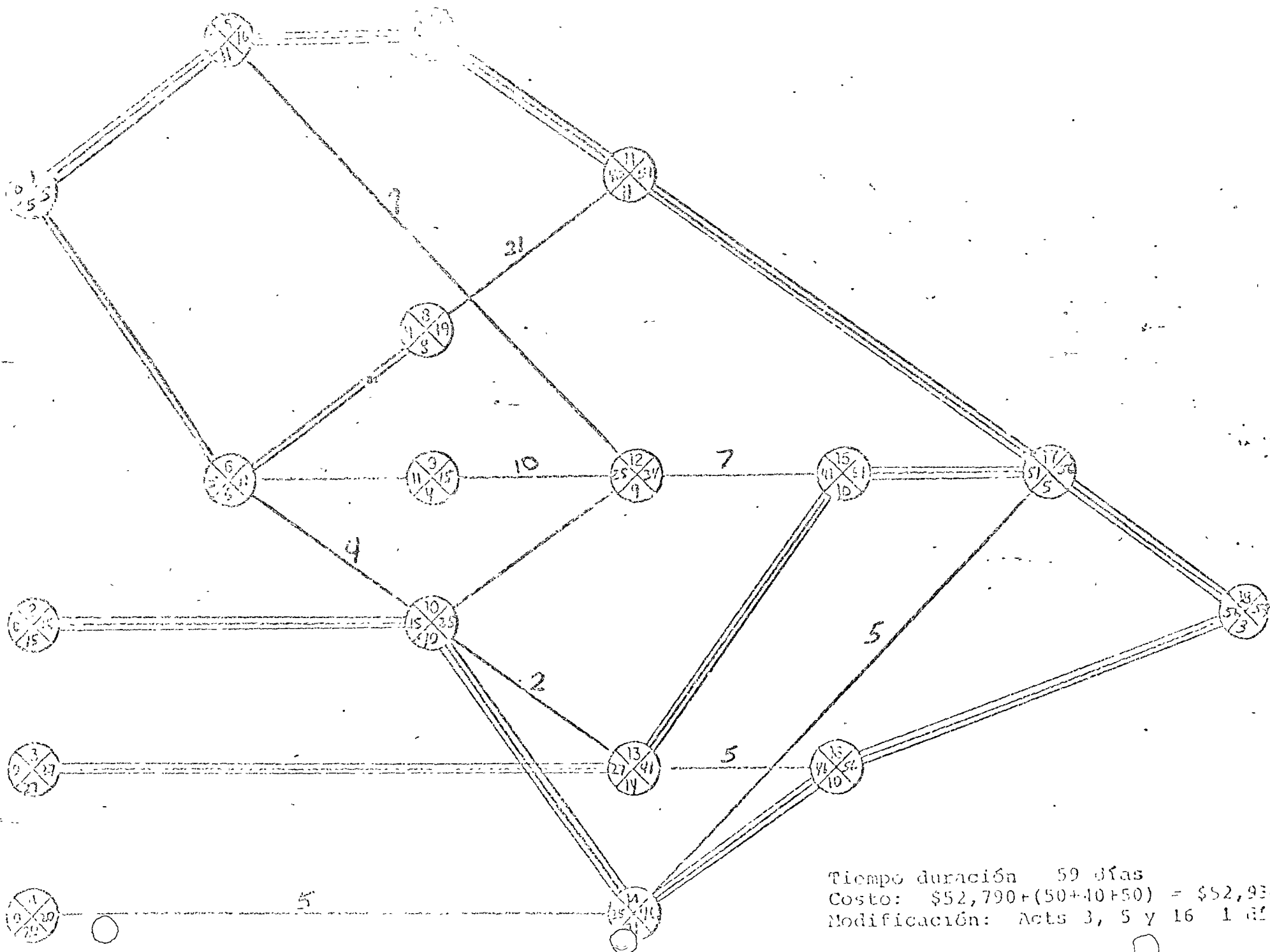
Tiempo ejecución 61 días

Costo: 52,000 + 70 ○ 52,670

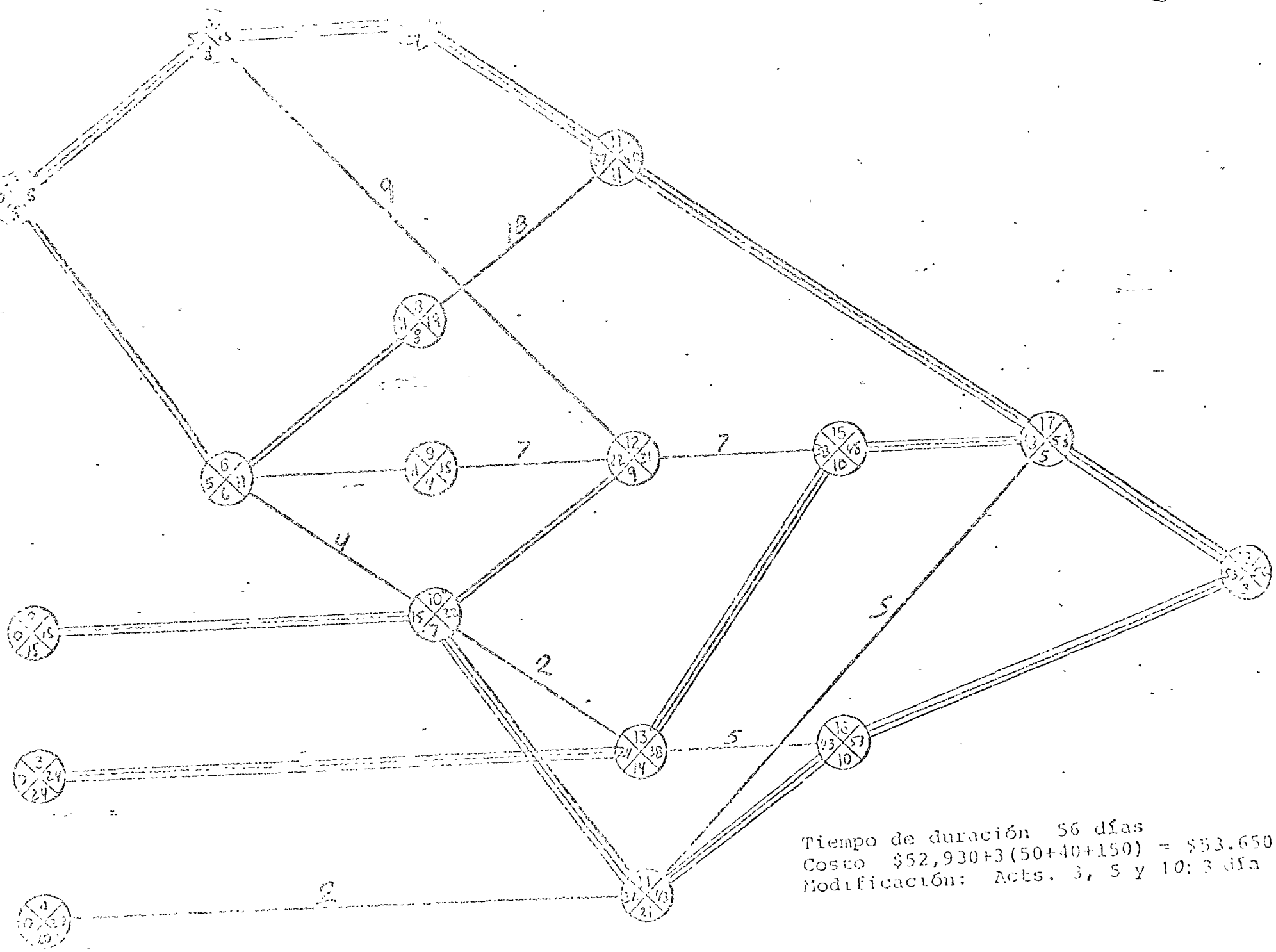
Costo total: 52,670



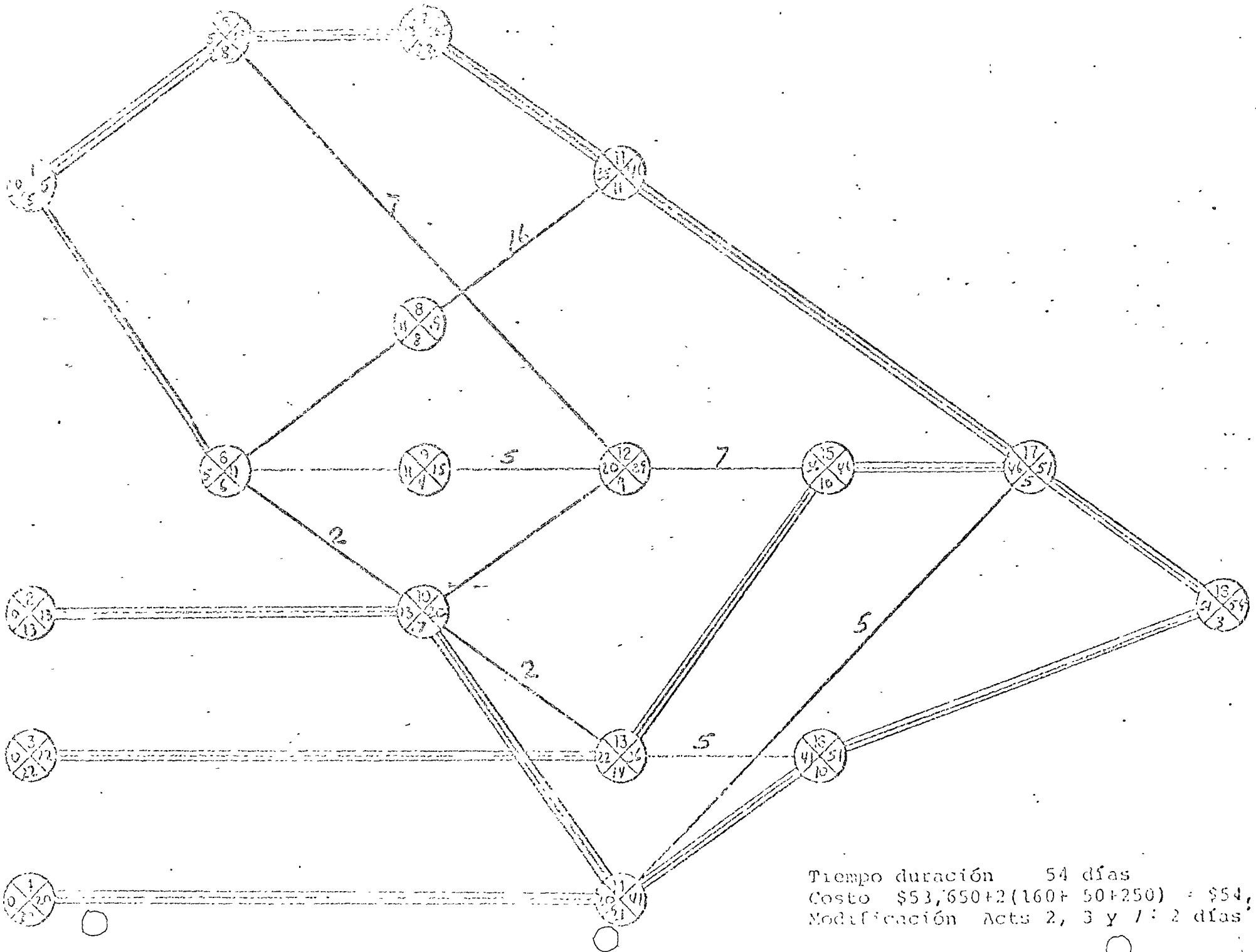
Tiempo duración 60 días
 Costo \$52,670 + (70 + 50) = \$52,790
 Modificación: Acts. 16 y 17 1 df.



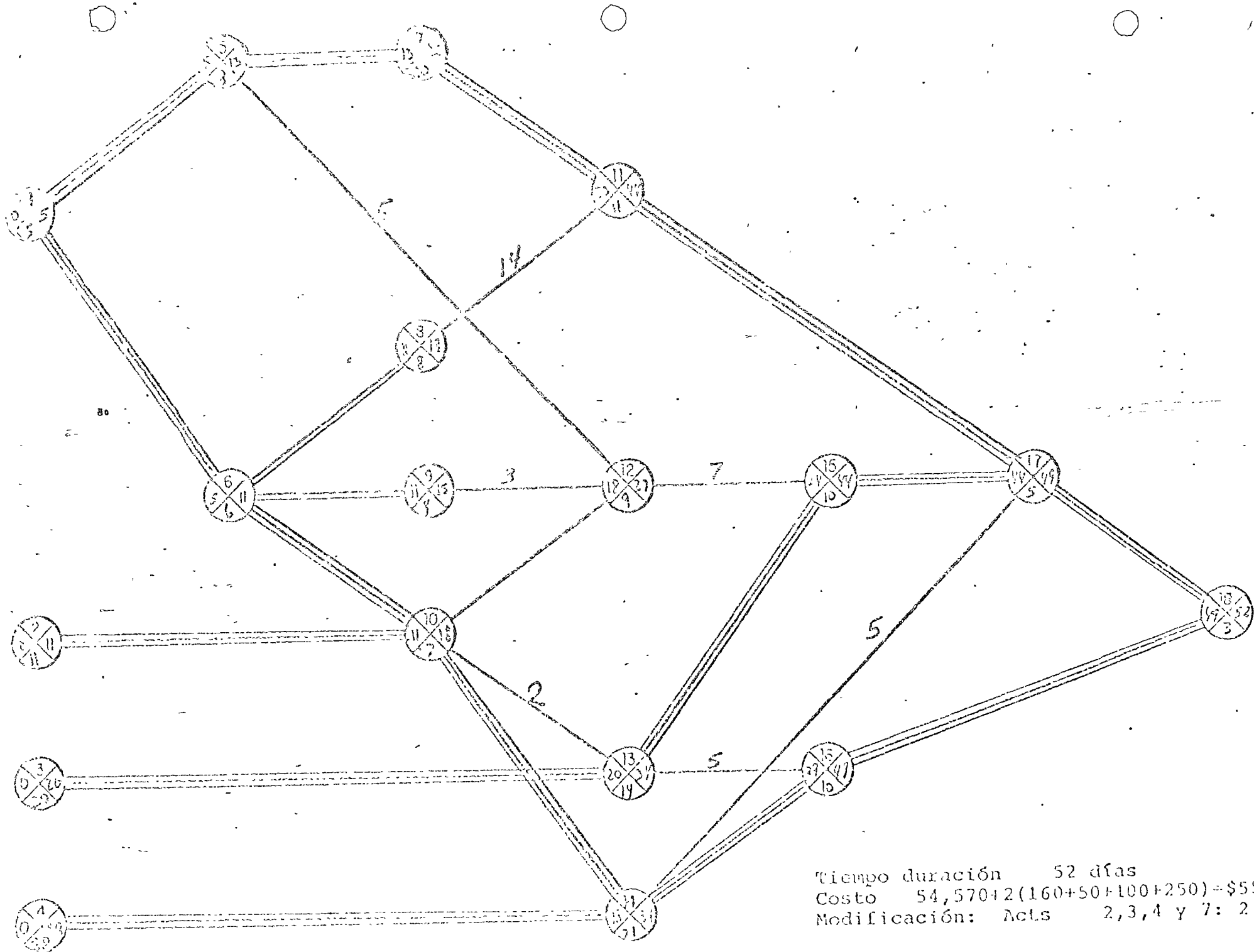
Tiempo duración 59 días
 Costo: \$52,790 + (50 + 40 + 50) = \$52,930
 Modificación: Acts 3, 5 y 16 1 día



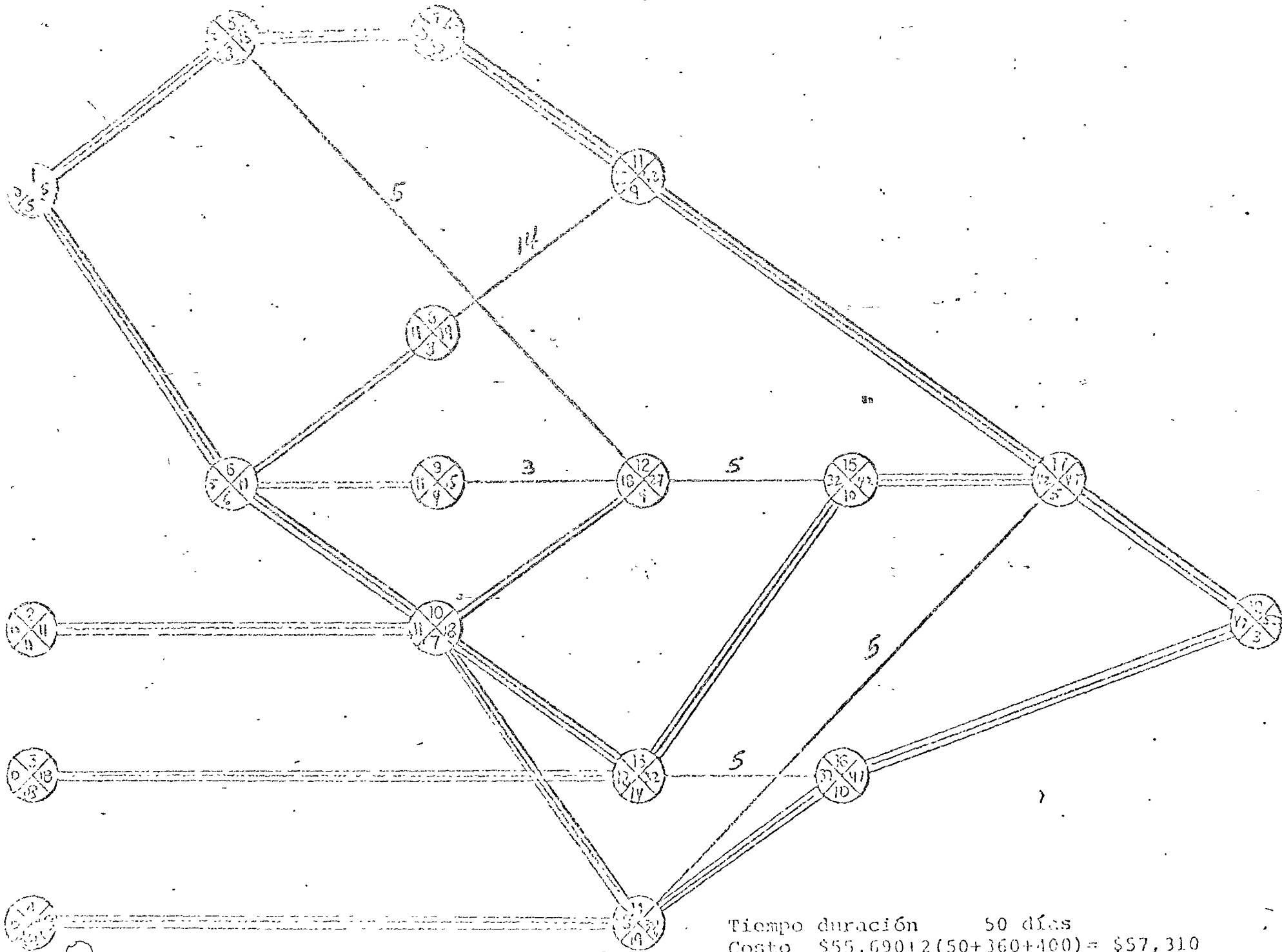
Tiempo de duración 56 días
 Costo \$52,930 + 3(50+40+150) = \$53.650
 Modificación: Acts. 3, 5 y 10: 3 día



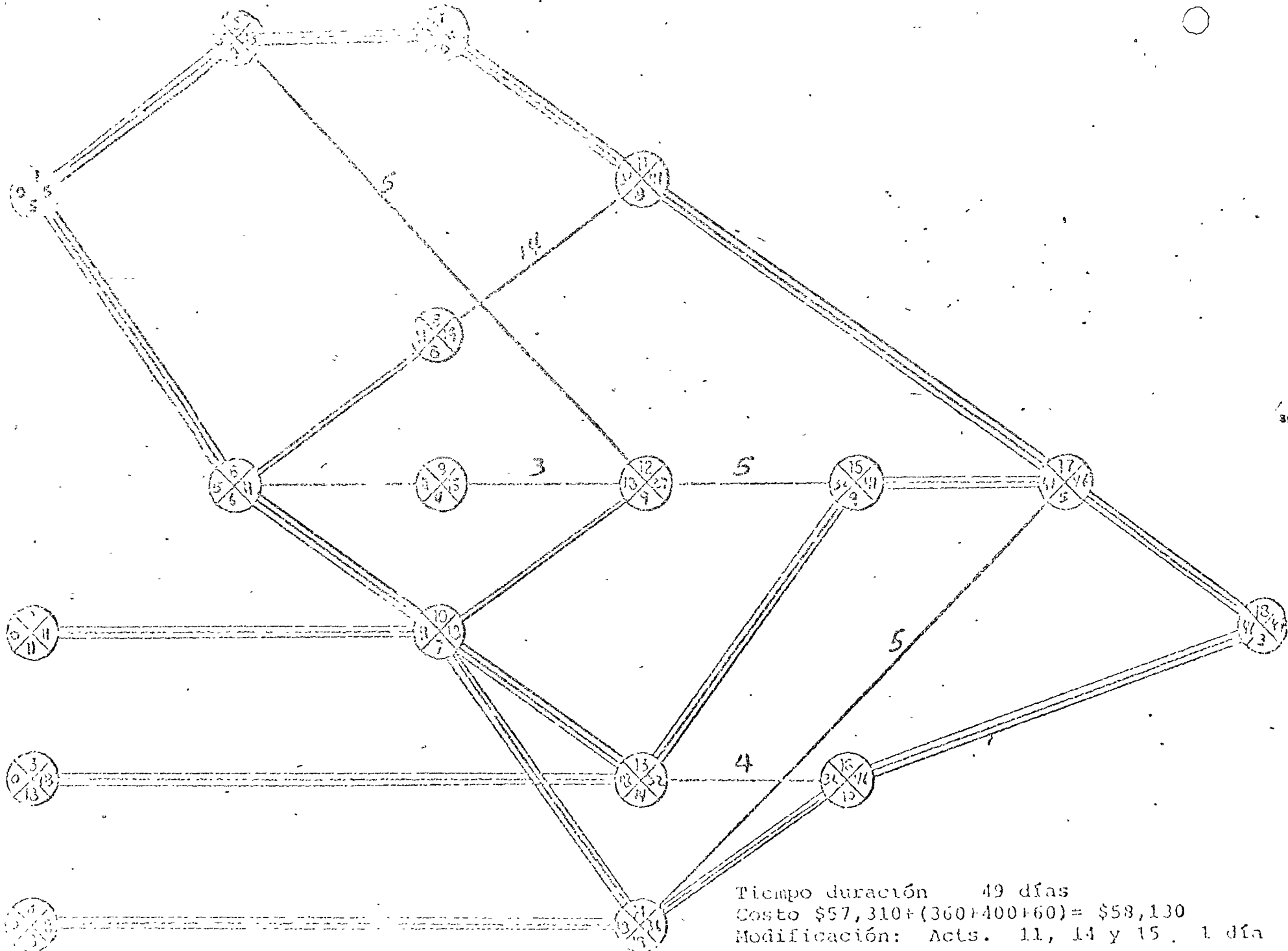
Tiempo duración 54 días
 Costo \$53,650 + 2(160 + 50 + 250) = \$54,5
 Modificación Acts 2, 3 y 1: 2 días



Tiempo duración 52 días
 Costo $54,570 + 2(160 + 50 + 100 + 250) = \$55,670$
 Modificación: Acts 2, 3, 4 y 7: 2 días

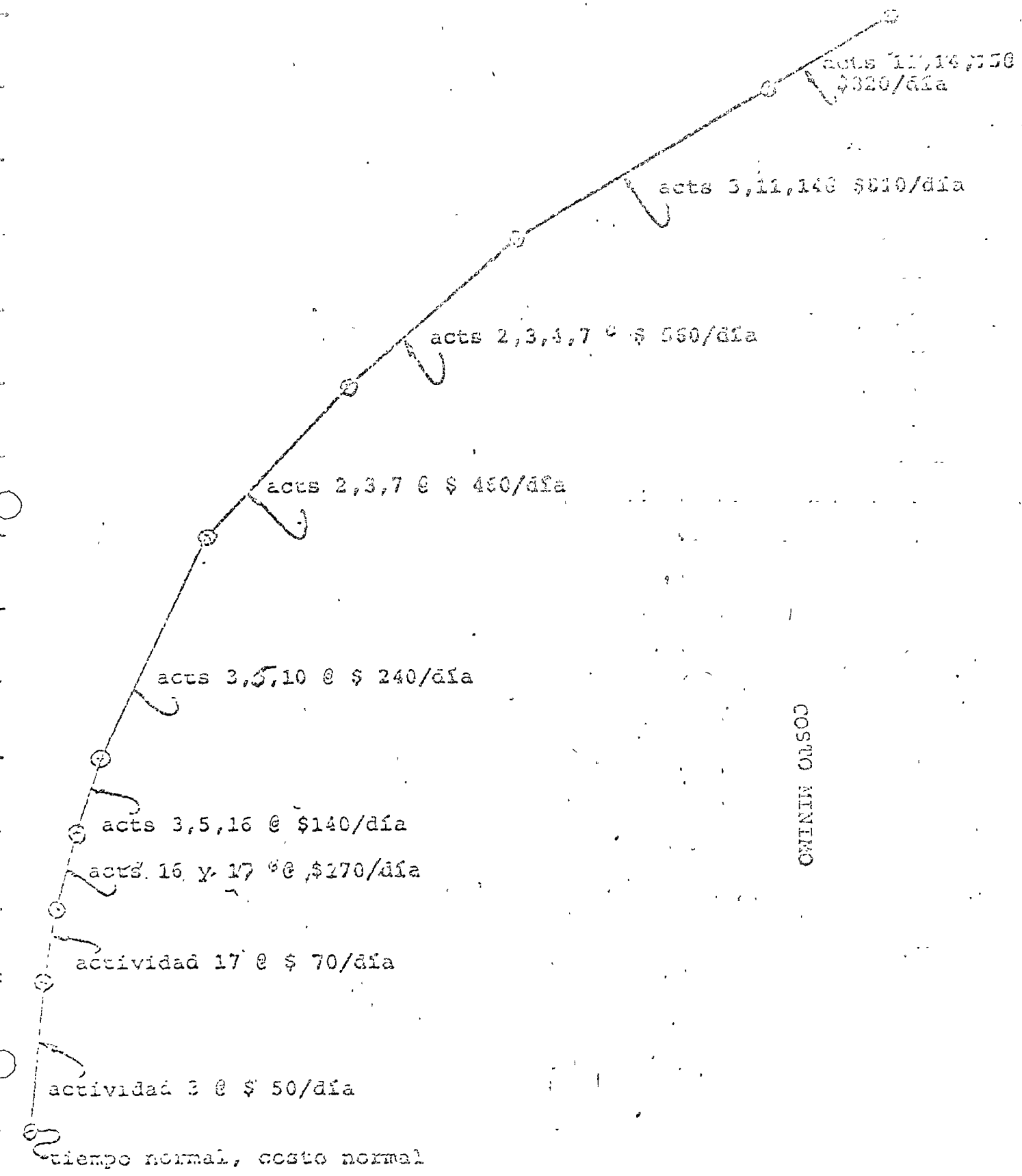


Tiempo duración 50 días
 Costo \$55,690 + 2(50+360+400) = \$57,310

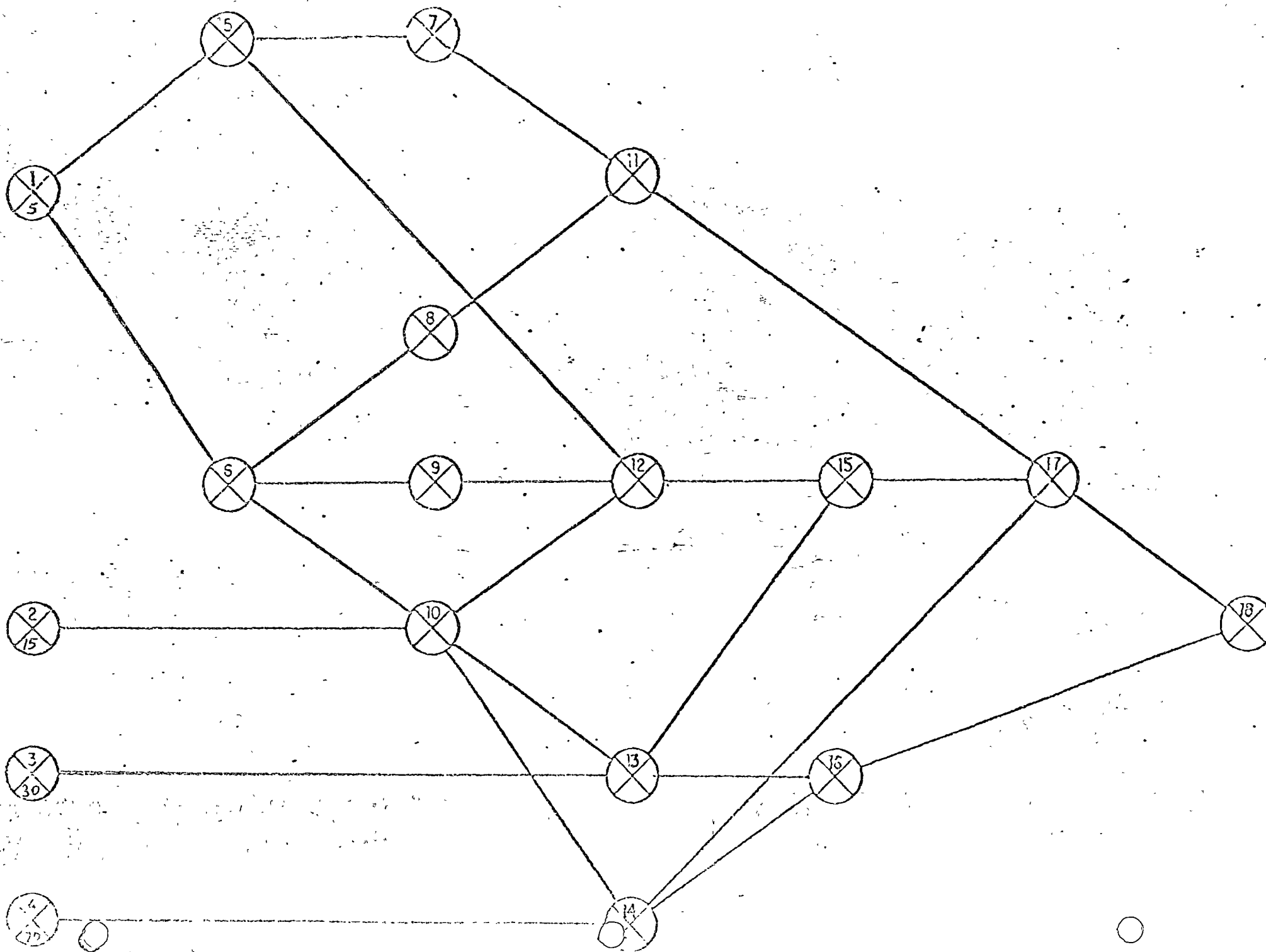


Tiempo duración 49 días
 Costo \$57,310+(360+400+60)= \$58,130
 Modificación: Acts. 11, 14 y 15 . 1 día

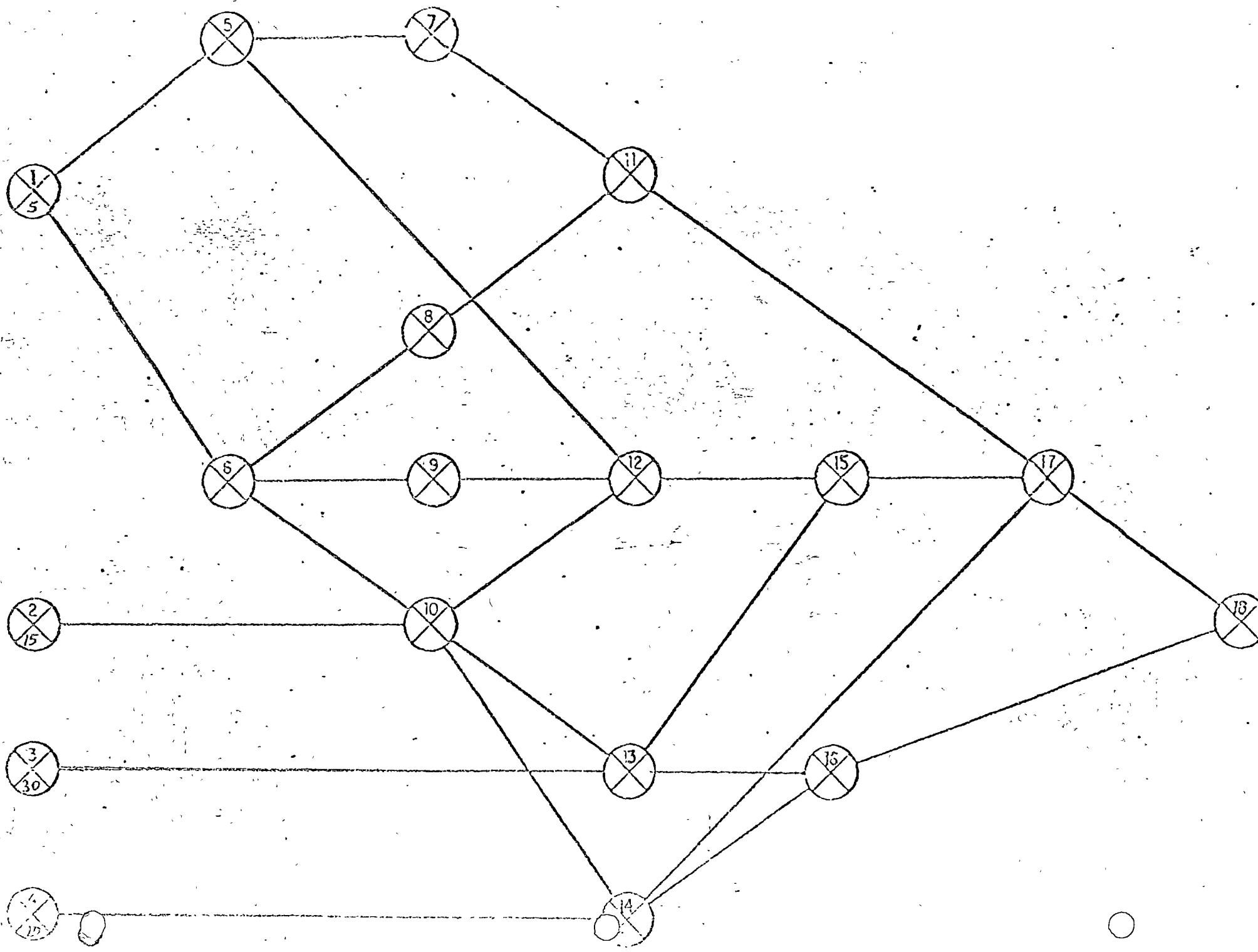
53,000 54,000 55,000 56,000 57,000 58,000



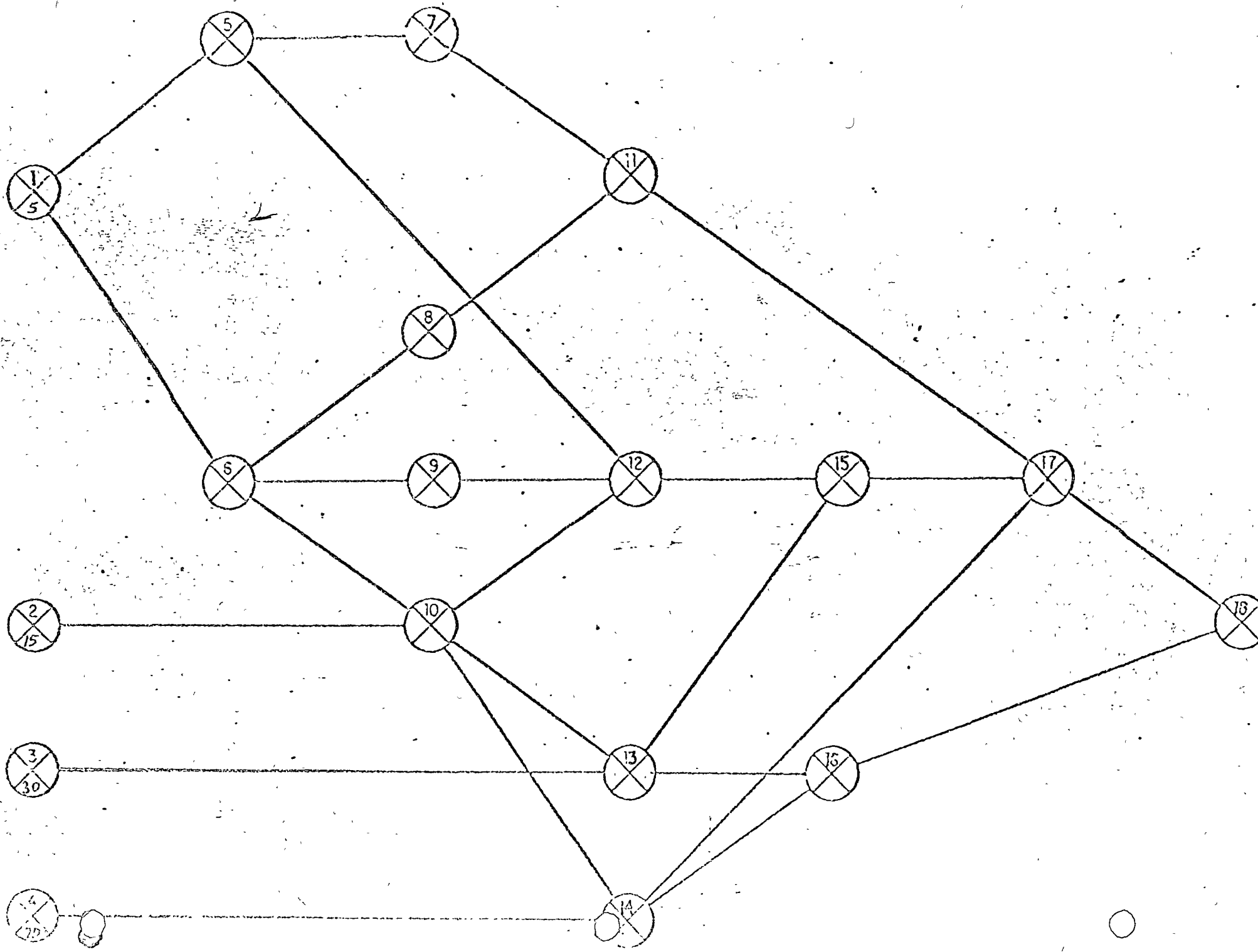
COSTO MINIMO



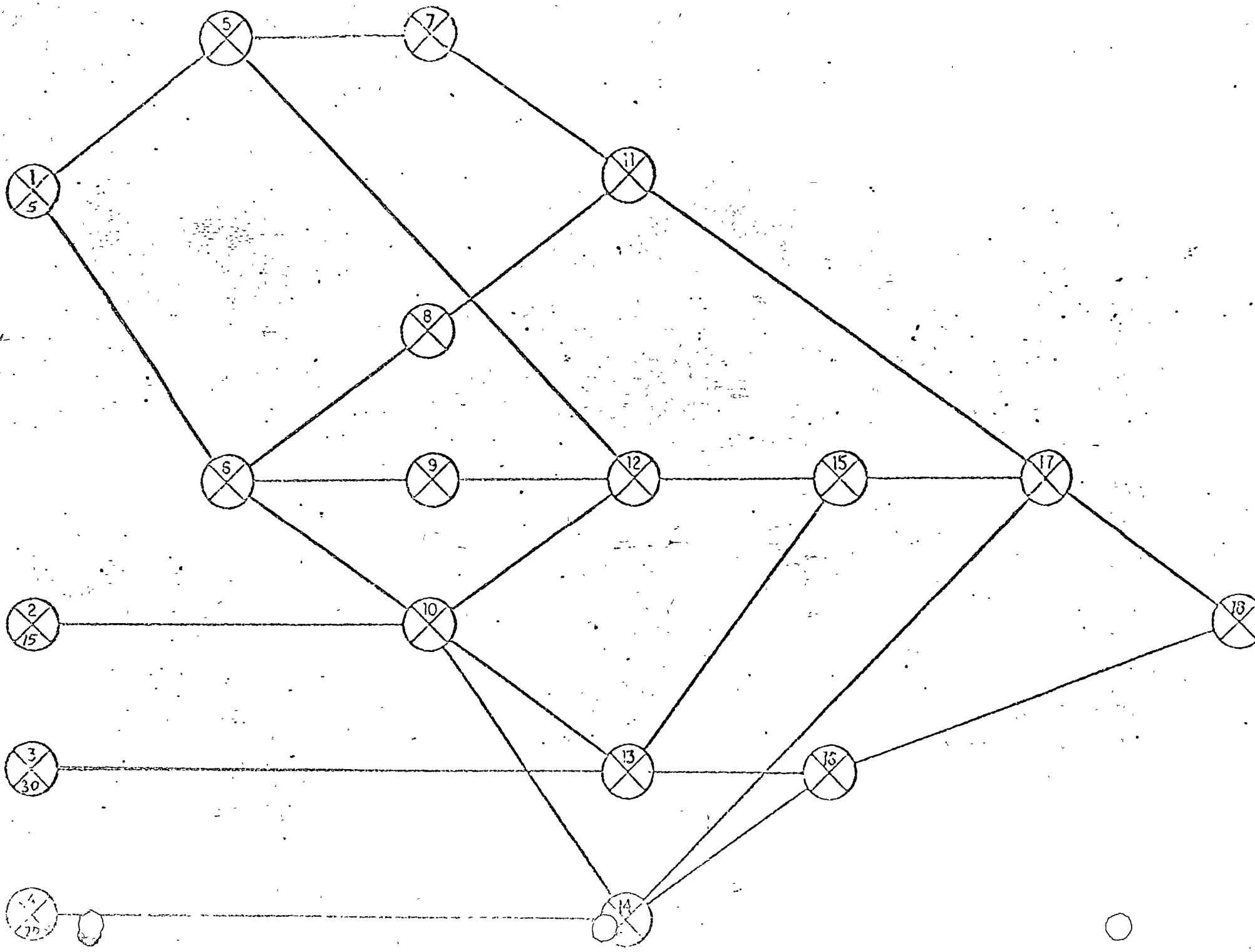




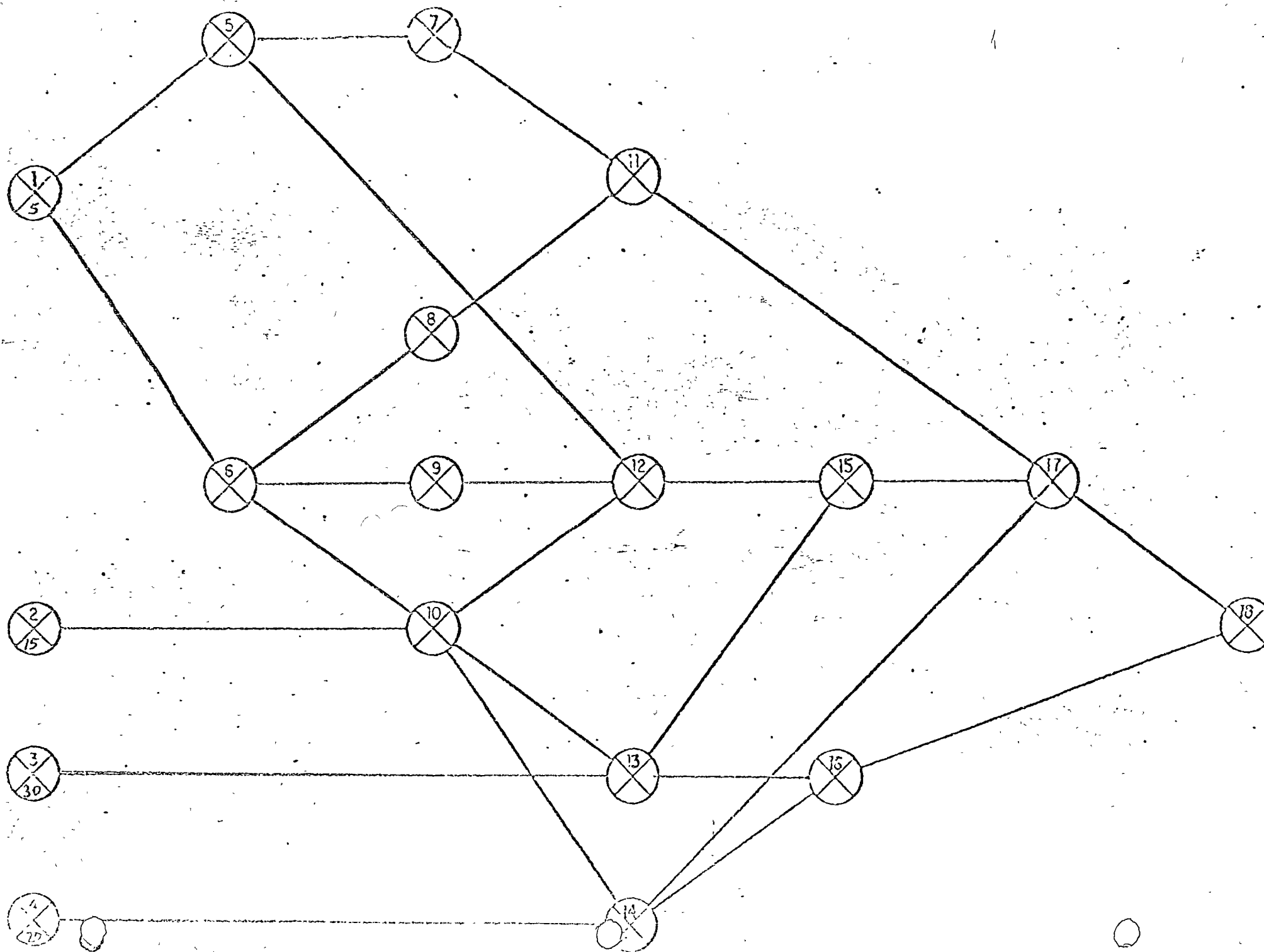




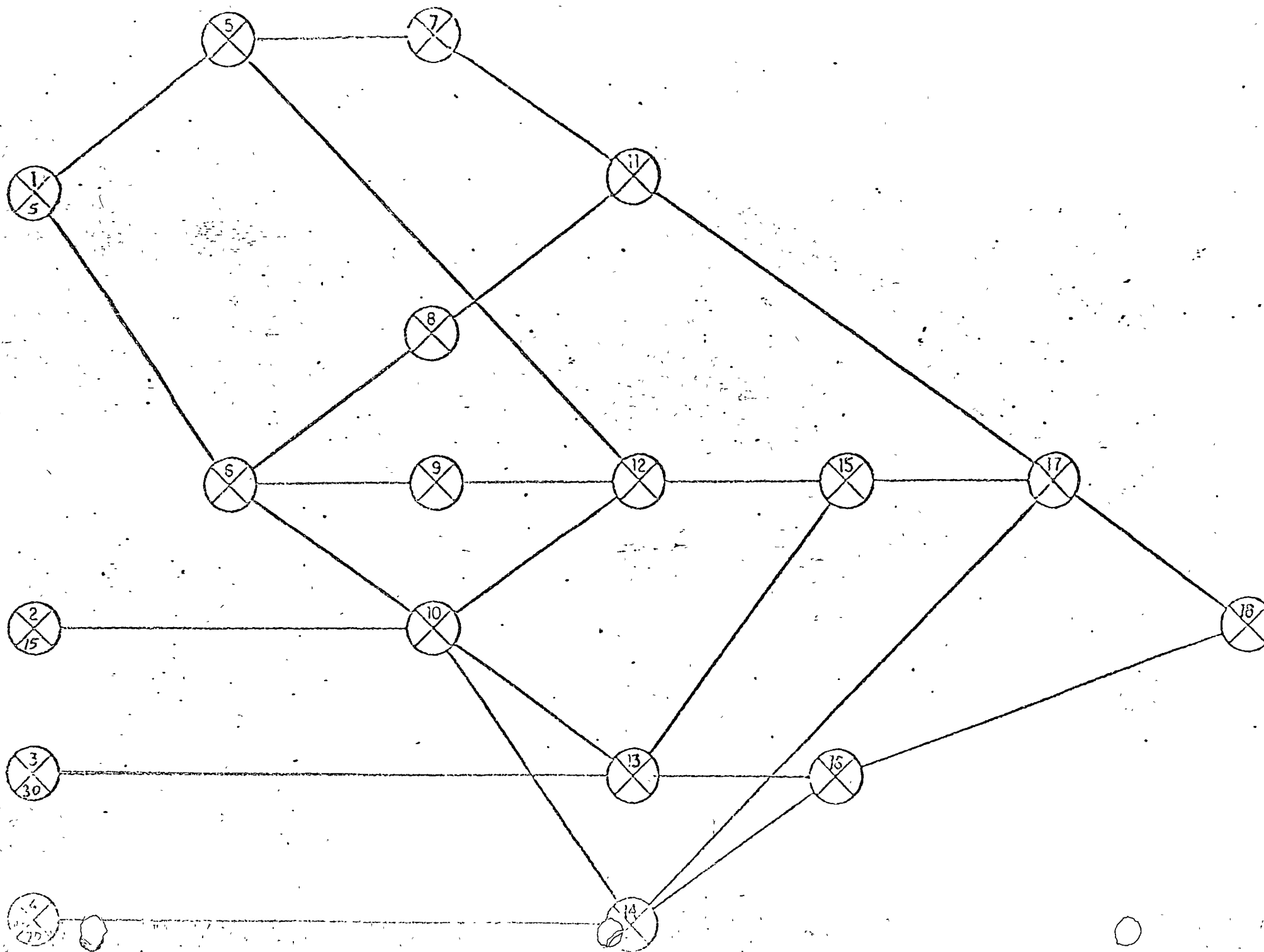








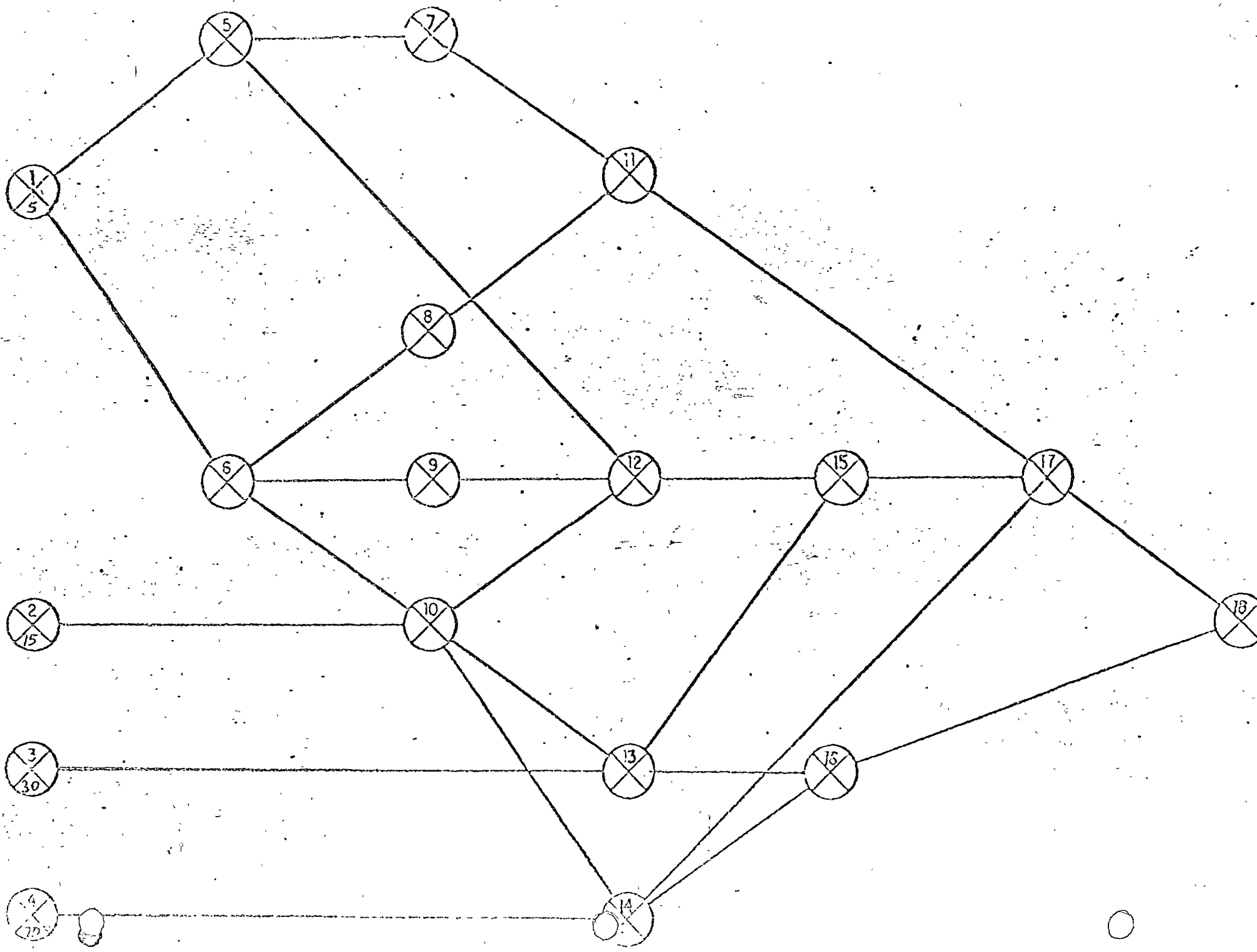




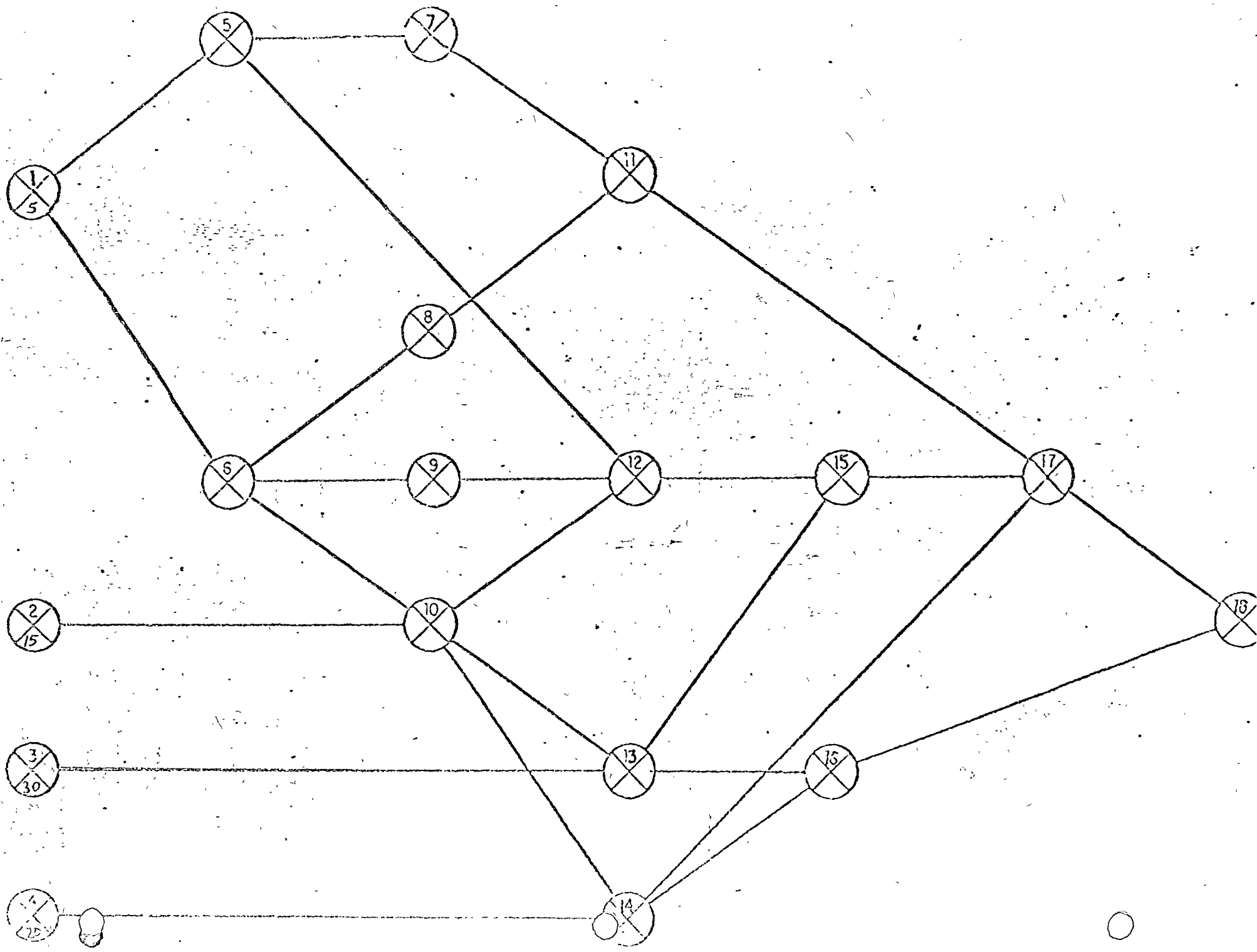


4

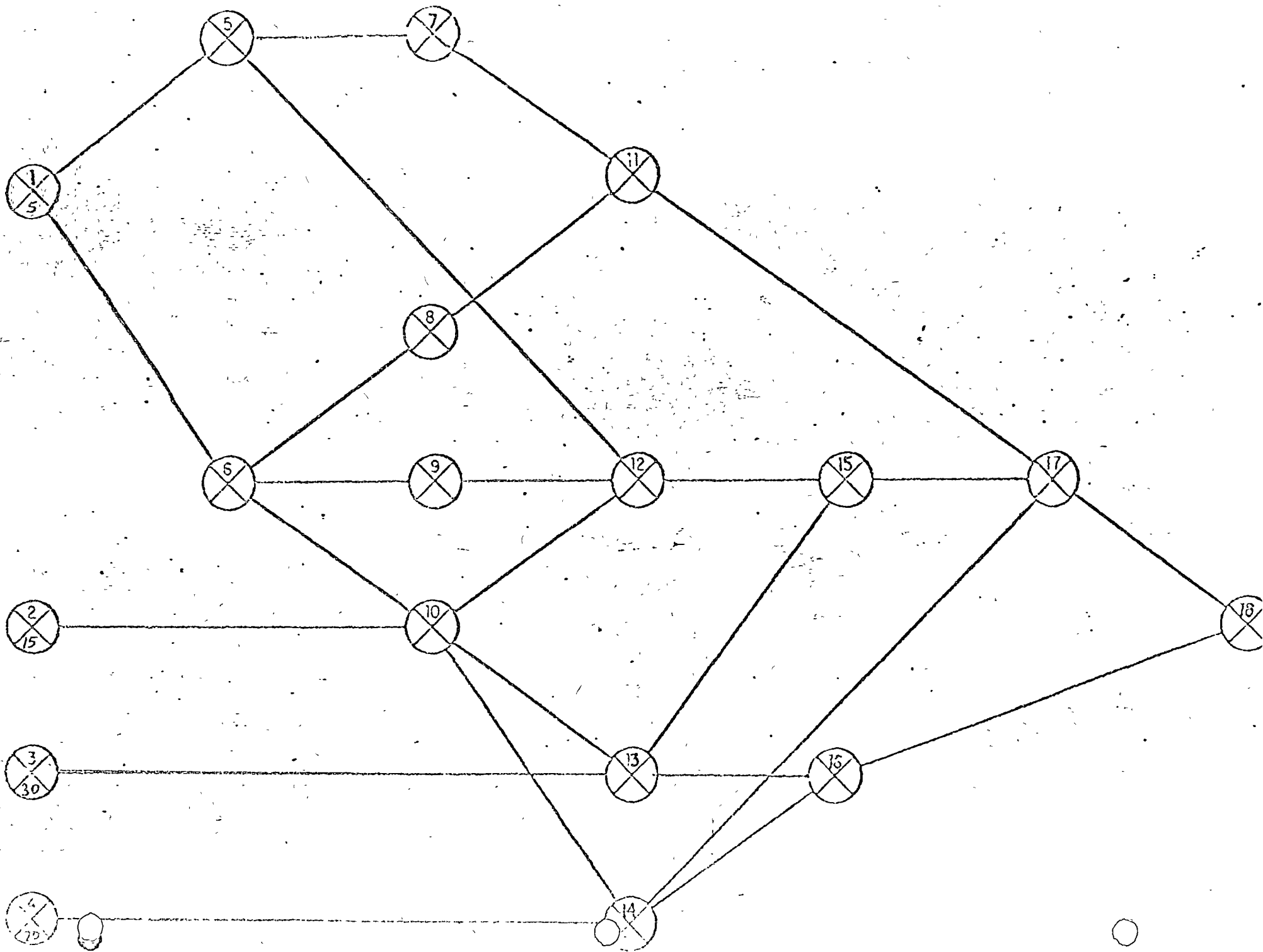




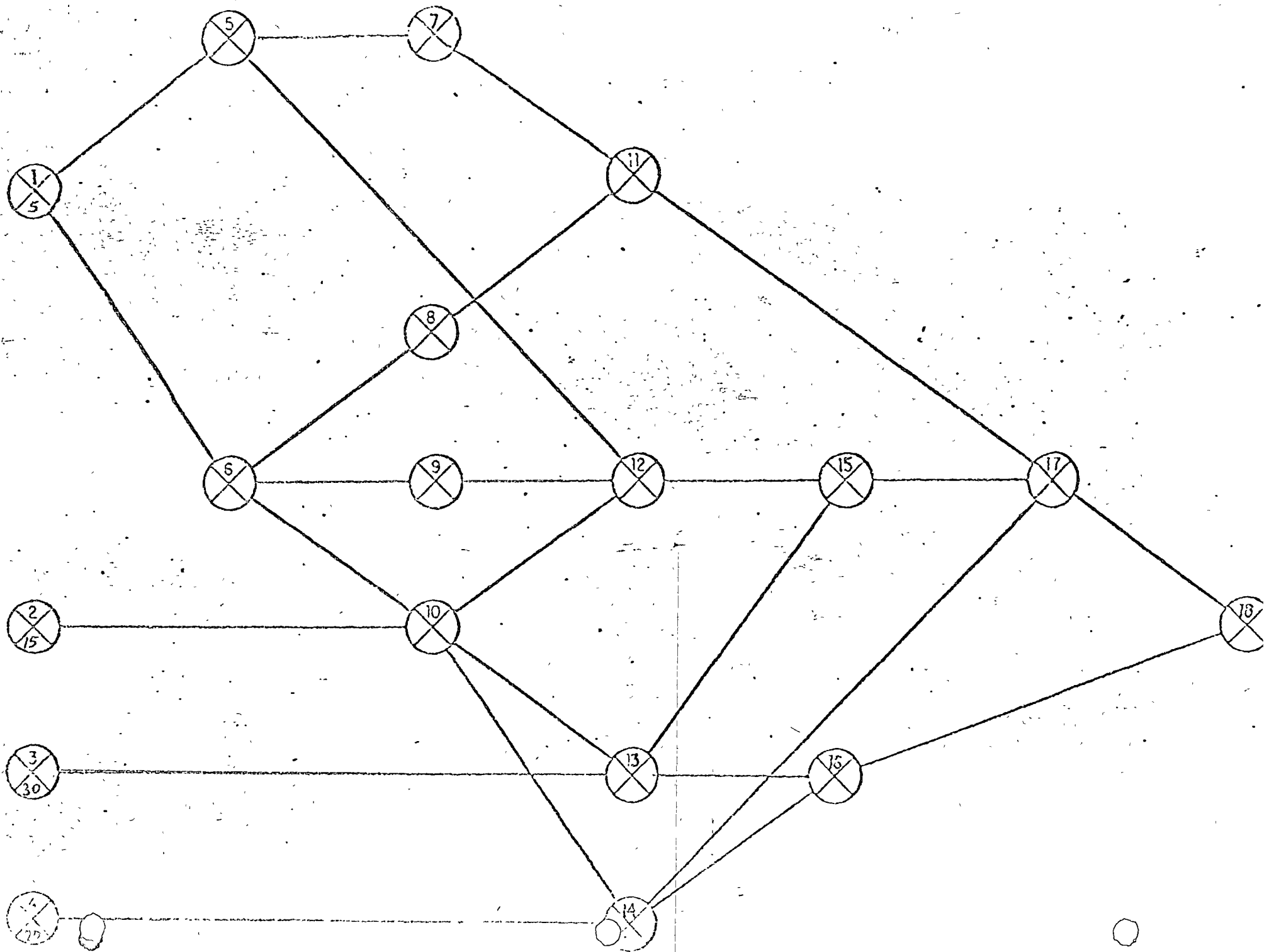




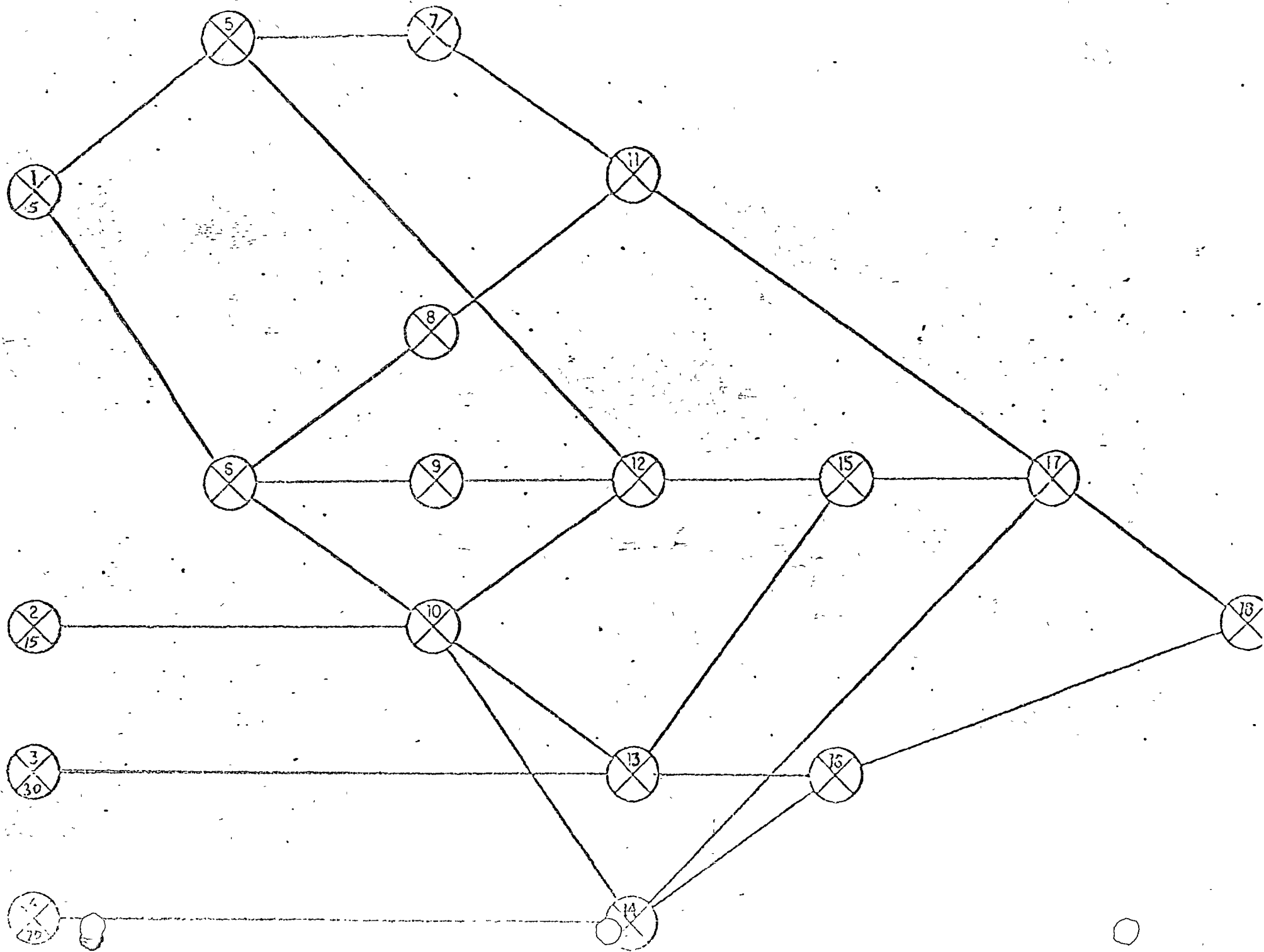








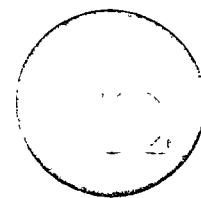








centro de educación continua
facultad de ingeniería, unam



PROGRAMACION PRESUPUESTO Y CONTROL DE OBRAS

COSTOS Y PRESUPUESTOS DE OBRAS DE EDIFICACION

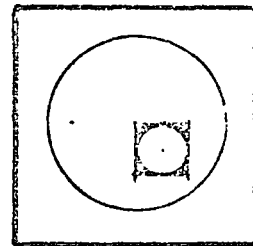
ING. EDGAR FERNANDEZ GOMEZ.

UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO



CENTRO DE EDUCACION CONTINUA

FACULTAD DE INGENIERIA



COSTOS Y PRESUPUESTOS DE OBRAS DE EDIFICACION

1. DEFINICIONES Y ALCANCES DE LOS CONCEPTOS BASICOS

COSTO.- De acuerdo al diccionario de la lengua española, - "Costo es lo que se paga por una cosa"; en un sentido mas amplio "Costo es el conjunto de bienes económicos, expresados en unidades monetarias, erogados para lograr un fin."

Generalmente dentro del Ramo de la Construcción, este concepto se interpreta como: El conjunto de bienes económicos, expresados en unidades monetarias, erogados para la realización de un proyecto o una obra.

PRESUESTO.- Según el diccionario de la lengua española, - "Presupuesto es lo que se supone previamente, cómputo anticipado de los gastos o ingresos".

En el sentido que comunmente se entiende en México, cuando este vocablo es aplicado a un aspecto de construcción es el siguiente:

Presupuesto es el conjunto ordenado de los costos de las partes integrantes de un proyecto, calculados previamente a la ejecución de este.

De acuerdo a esta definición, la palabra Presupuesto resulta ser sinónimo de "Presupuesto de Costos".

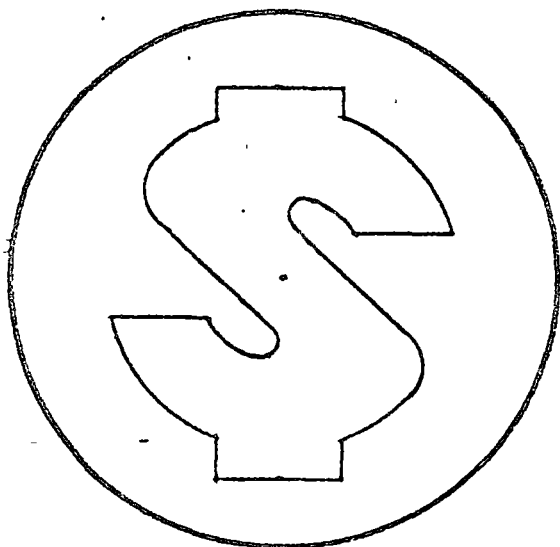
Un presupuesto está integrado por diversas clases de cargos ó costos, tales como Costos Directos, Indirectos, Contingencias, Honorarios, etc. Esta clasificación de los costos - obedece a su identificación con el Proyecto mismo.

Asimismo la presentación de un presupuesto se puede dividir en precios unitarios, unidades de obra, y los conceptos de trabajo correspondientes.

Las definiciones de cada uno de los conceptos anteriores - las expresaremos a continuación:

PRECIO UNITARIO

Remuneración ó pago en moneda que el Contratante deberá cubrir al Contratista por unidad de Obra y por concepto de trabajo que ejecute.



UNIDAD DE OBRA

Unidad de medición señalada en las especificaciones para cuantificar el concepto de trabajo para fines de medición y pago.



CONCEPTO DE TRABAJO

Conjunto de operaciones manuales y mecánicas, así como materiales, que el Contratista emplea en la realización de la Obra de acuerdo a Planos y Especificaciones, dividido convencionalmente para fines de medición y pago.



PRECIO UNITARIO
DIVISION DE CARGOS

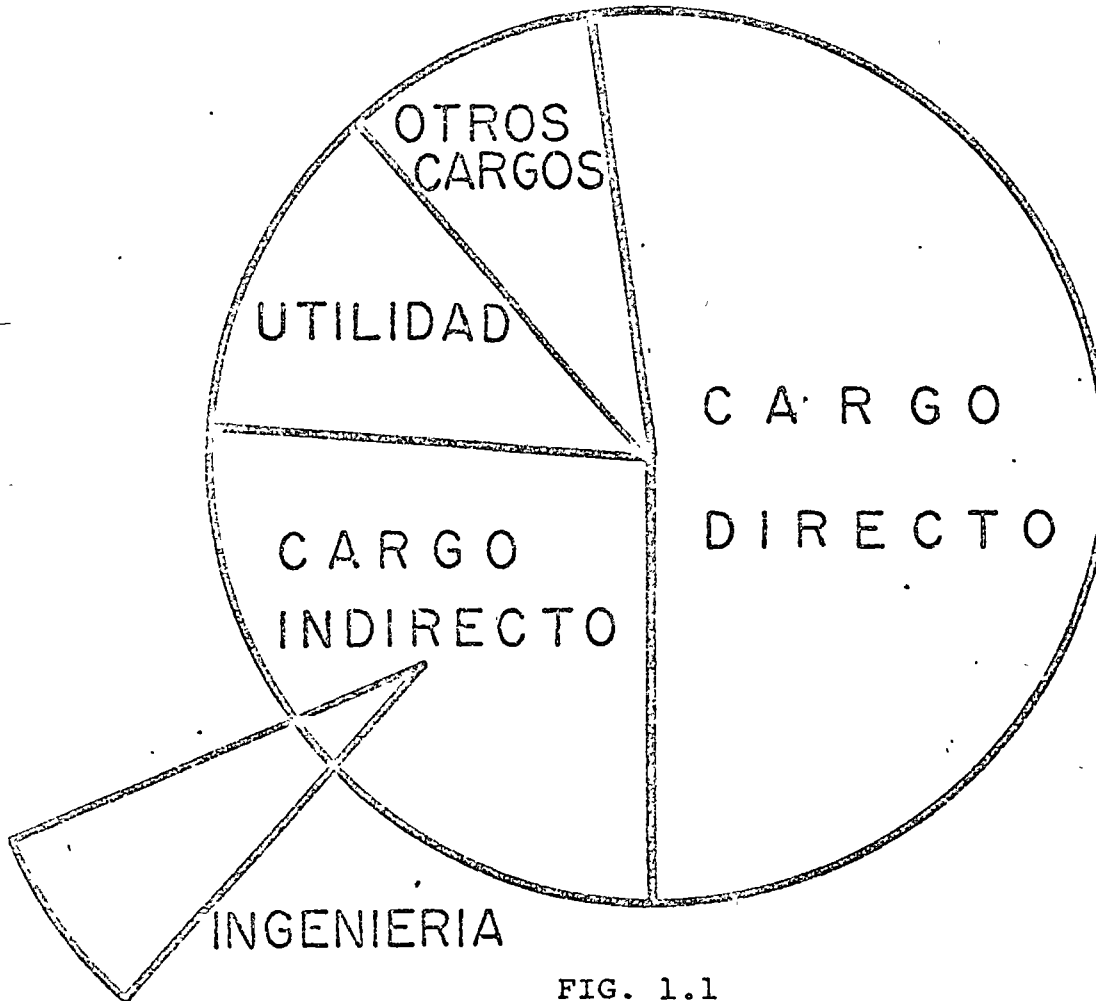


FIG. 1.1

El precio unitario como unidad está compuesto por diversos -- cargos reunidos en cuatro grandes divisiones como lo muestra la Figura No. 1.1.

Esta división corresponde a Obras de Construcción sobre pro-- yectos terminados. Cuando deba la misma Compañía realizar el - proyecto de Ingeniería. podrán cargarse los gastos relativos en la división de Cargos Indirectos, Oficina Central y si es- te cargo no se desea su prorrato en el precio unitario, se - considerará como un contrato separado del de Construcción.

El porcentaje gráfico señalado es aproximado y representa la influencia proporcional que por cada peso del precio unitario le corresponde a cada uno de los cuatro grandes grupos que lo integran.

C A R G O S

D I R E C T O S

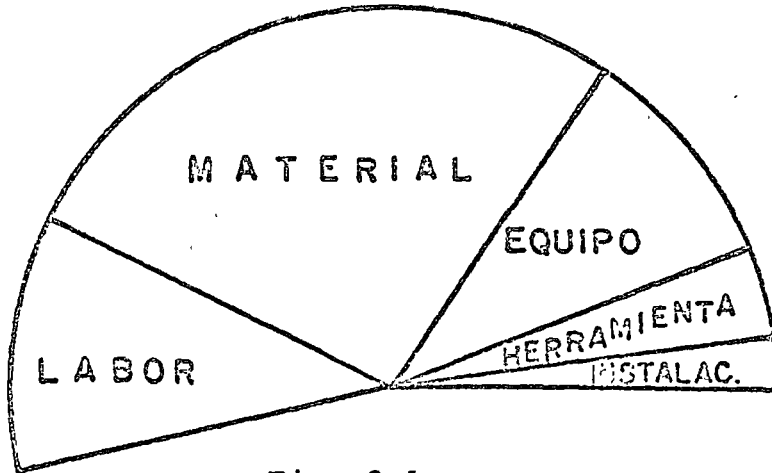


Fig. 2.1

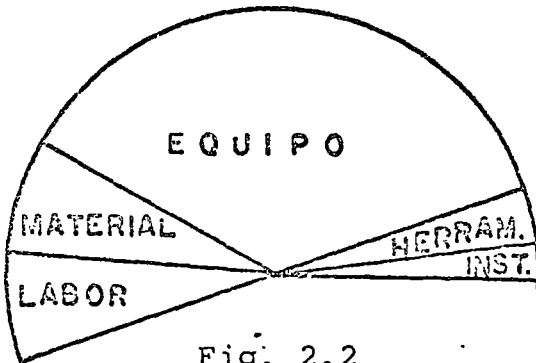


Fig. 2.2

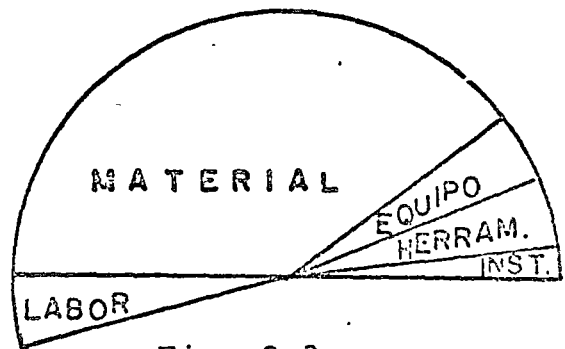


Fig. 2.3.

CARGOS DIRECTOS.- Son los que se derivan de las erogaciones por mano de obra, materiales, equipo, herramienta, e instalaciones efectuadas exclusivamente para realizar dicho concepto de trabajo.

Los análisis detallados de costos directos permiten determinar los porcentajes de participación de cada uno de los cargos que afectan directamente, el resultado final del costo directo.

La Fig. 2.1 representa los porcentajes gráficos aproximados por cargos directos en obras de edificación donde la labor presenta un porcentaje de participación aproximado del 25% al

35 %, el material 45% al 55%, el equipo del 10% al 20%, la herramienta del 1% al 1.5% y las instalaciones de 0.5% al 1%.

La Fig. 2.2 representa los porcentajes gráficos aproximados por cargos directos en obras de infraestructura ó pesada; en este caso el Parámetro Equipo representa el porcentaje mayor 60% al 70% indicando el uso de equipos pesados de capital importancia para la realización de la obra, la labor puede representar una variación del 10% al 20%, materiales 15% al 25%, herramienta 0.5% al 1%, instalaciones 0.5% al 1%.

La Fig. 2.3 representa los porcentajes gráficos aproximados por cargos directos en Plantas Industriales, el Parámetro de Materiales aparece muy amplio en proporción a las otras partes y es resultado del incrementar en forma excesiva los conceptos electromecánicos e instrumentación con una gran cantidad de material de proceso como tuberías, recipientes, equipo, etc., para el funcionamiento de la Planta, éste desde luego varía con el tipo de Planta y de proceso propio de la misma, sin embargo, las estadísticas muestran siempre que el porcentaje de presencia mayor en obras de este tipo, corresponde a los materiales y equipo de proceso, con una variación aproximada entre el 70% al 80%, el equipo de construcción y herramienta del 5% al 9%, la mano de obra del 15% al 25%, y las instalaciones del 0.5% al 1%.

C A R G O D I R E C T O S

C A R G O P O R M A N O D E O B R A

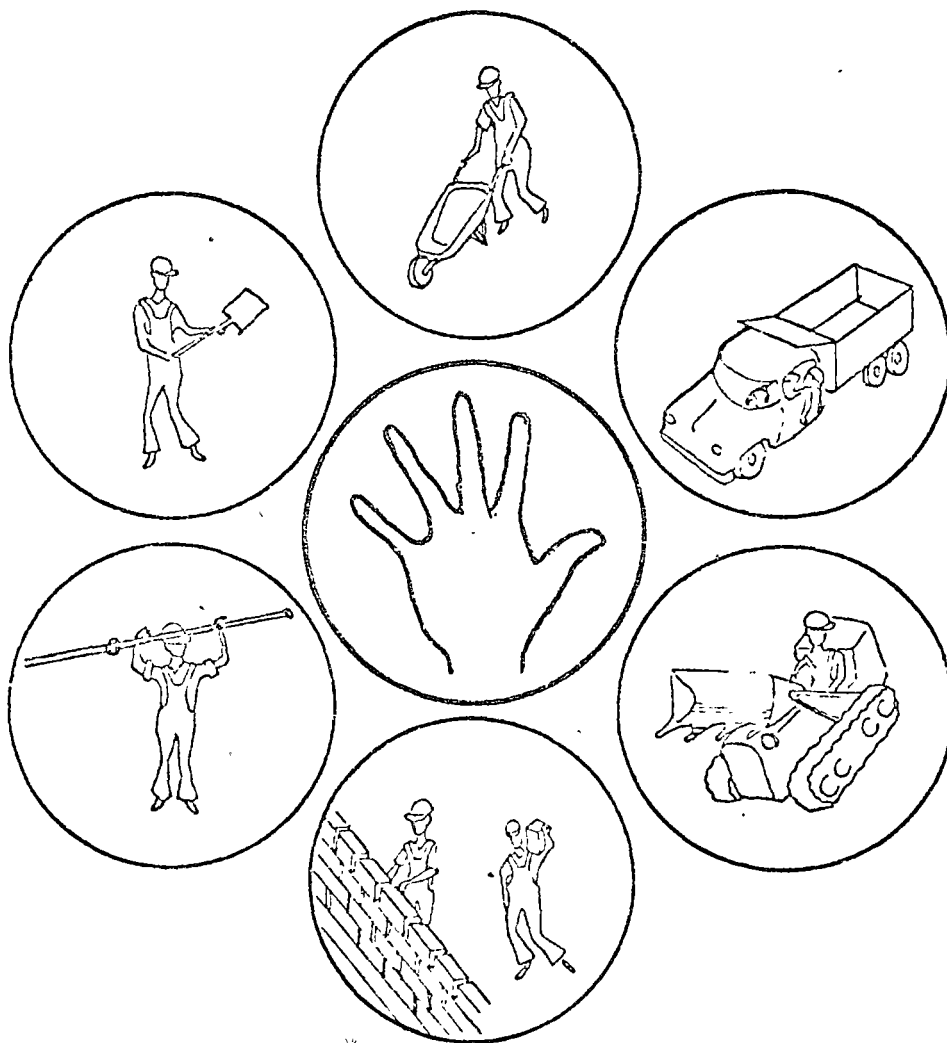


Fig. 3.1

Los cargos por Mano de Obra son los resultantes de prorratear el pago de salarios al personal individual ó por cuadrilla que interviene única y exclusivamente en forma directa en la ejecución del trabajo de que se trate, entre las unidades de producción (rendimiento que dicho personal realice en un tiempo determinado)

$$Mo = \frac{S}{R}$$

C Á R G O S D I R E C T O S
S A L A R I O S

Variable

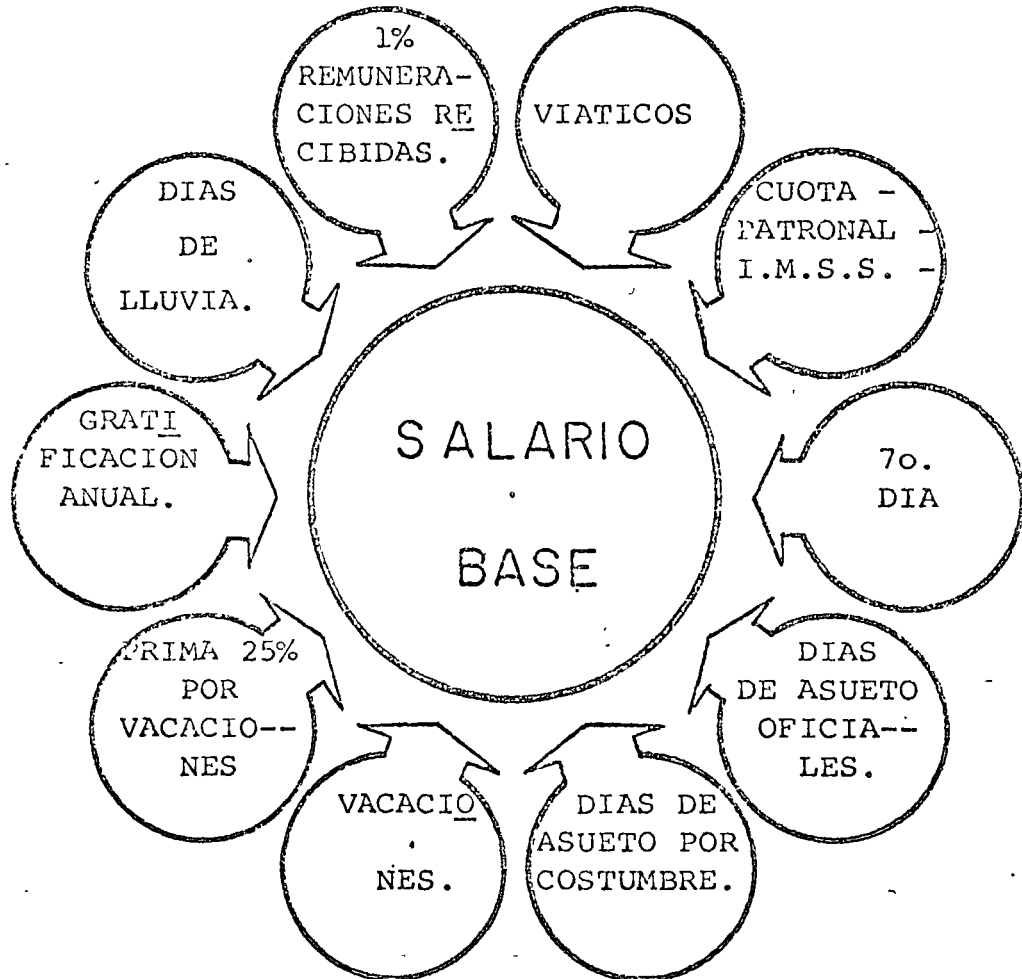


Fig. 3.2

Factores y porcentajes que afectan el salario base para convertirlo en salario real.

CARGOS DIRECTOS

SALARIO

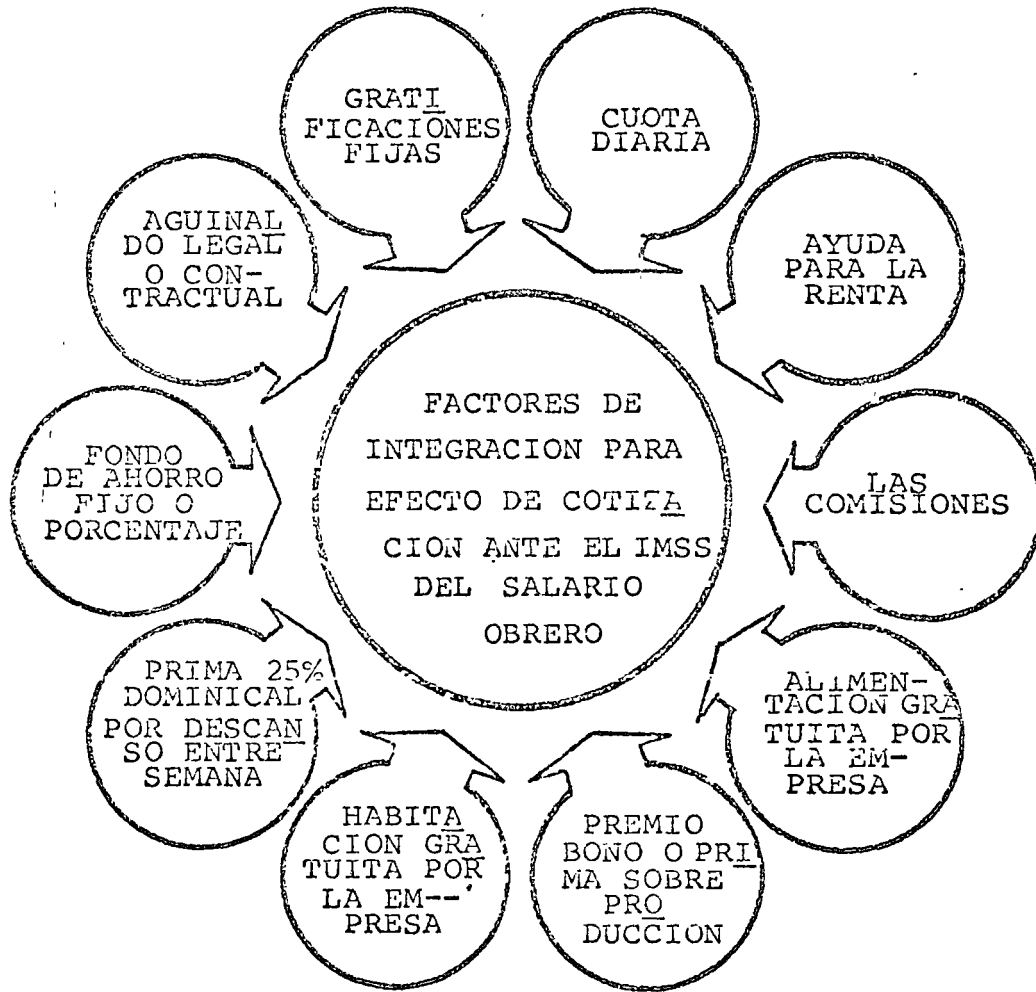


Fig. 3.3

NOTA 1.1 El salario mínimo legal de la zona respectiva no podrá ser descontado en forma alguna, aunque haya factores distintos que adicionen la cuota diaria.

NOTA 1.2 Con respecto al concepto de horas extraordinarias de trabajo o servicios extraordinarios en días de descanso semanal u obligatorio no se pudo lograr acuerdo alguno, por sostenerse criterios legales totalmente opuestos.

C A R G O S D I R E C T O S

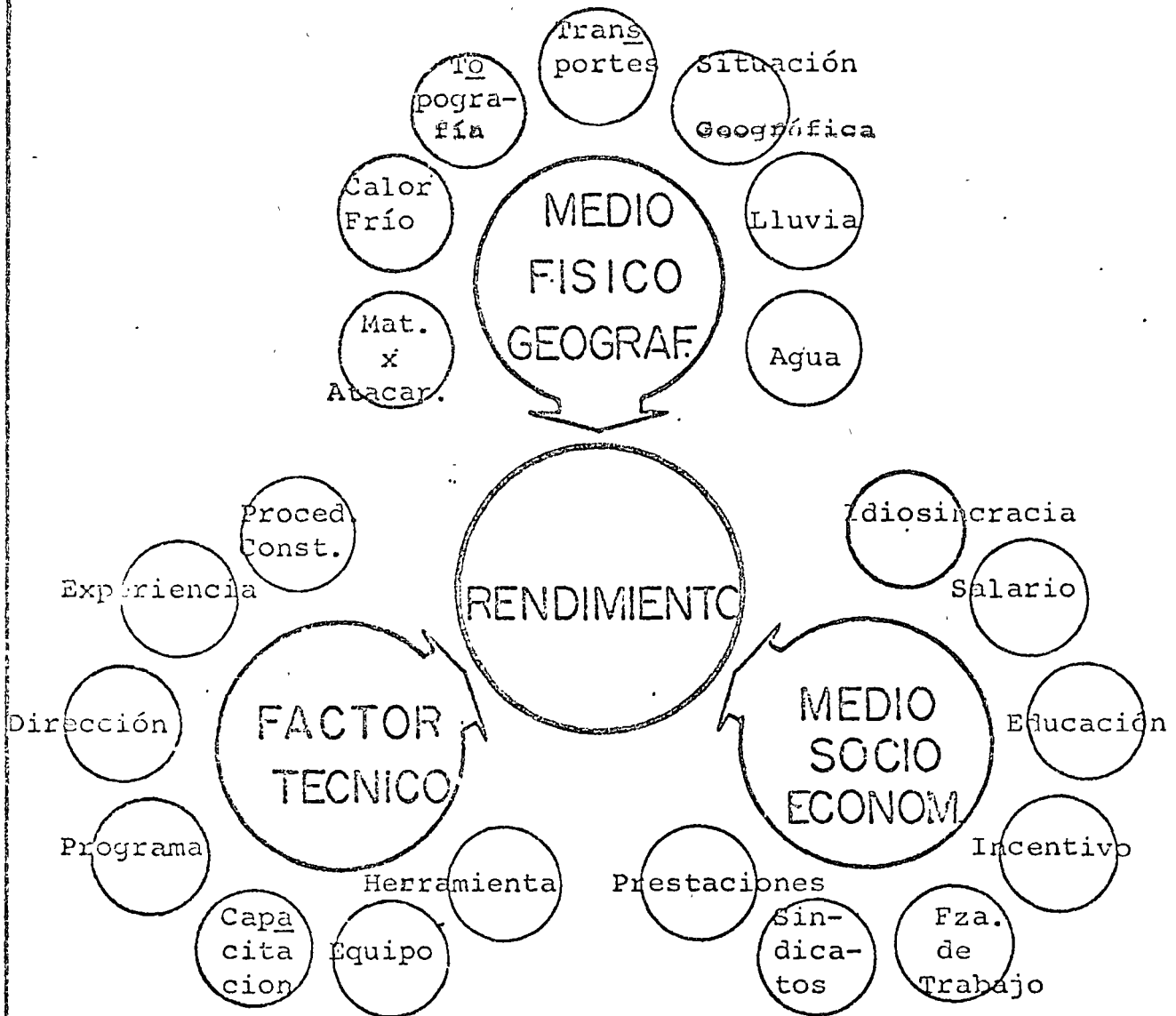


Fig. 3.4.

Factores de influencia que afectan la capacidad de -- producción del personal individual ó por cuadrilla y que determinan los rendimientos.

Siendo la capacidad de producción de primordial importancia en la determinación del costo, la minuciosa investigación del sitio de la obra, facilitará los conocimientos necesarios para obtener los rendimientos adecuados.

C A R G O S D I R E C T O S

M A T E R I A L E S

CARGO DIRECTO POR MATERIALES.-

Las erogaciones que efectúa el Contratista para adquirir los materiales necesarios para la ejecución -- del concepto de obra, determinan el cargo directo -- por materiales.

Estos pueden ser permanentes, ó sea que forman parte integrante de la Obra, y temporales ó auxiliares que son consumidos en la Obra después de uno ó varios usos.

Los materiales son adquiridos del mercado ó producidos en la Obra, los adquiridos sufren una variación según Fig. 4.1 y los segundos, son motivo de un análisis especial..

C A R G O S D I R E C T O S

M A T E R I A L E S

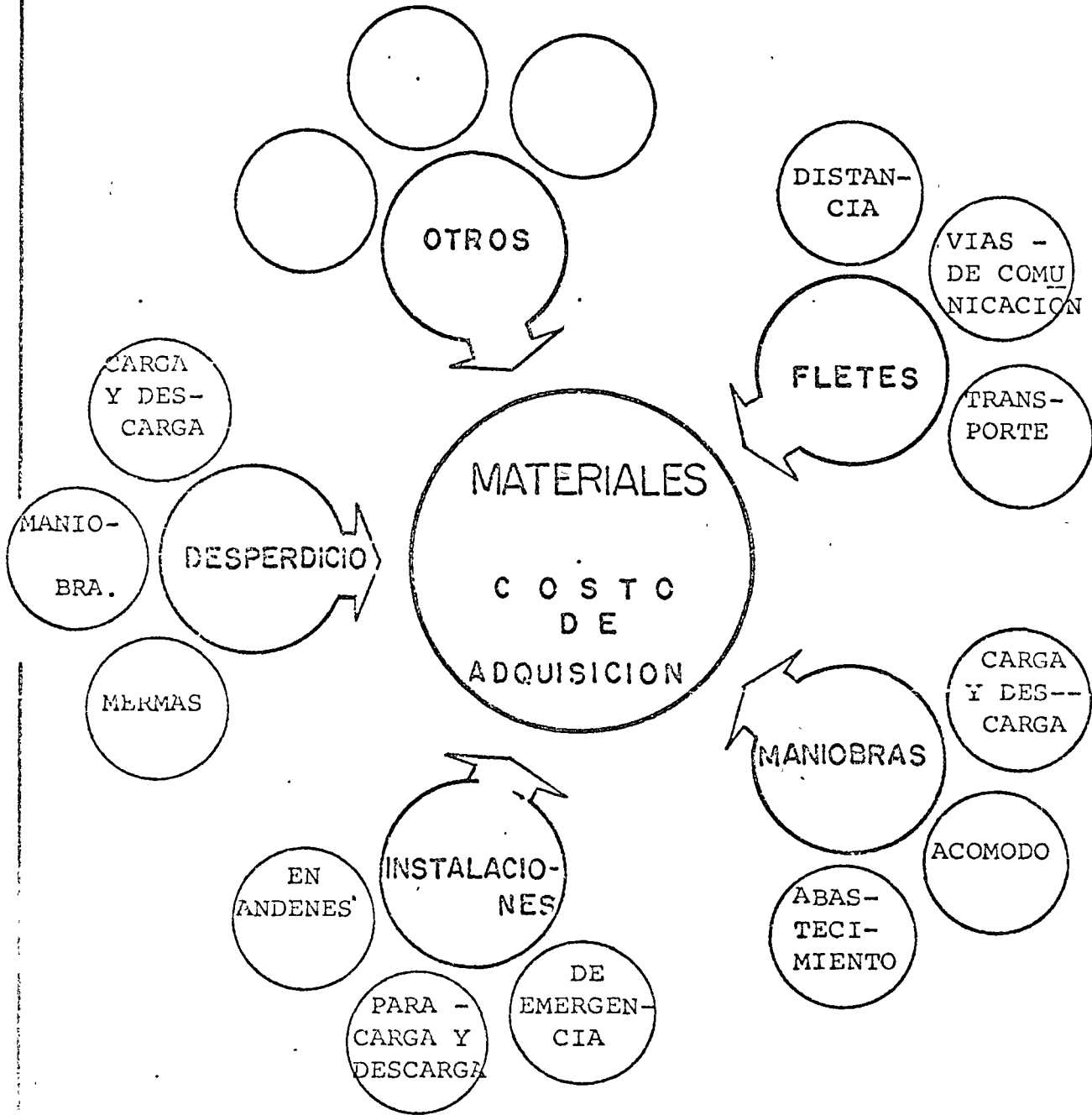


Fig. 4.1

Factores de influencia que determinan el incremento de costo sobre el costo de adquisición.

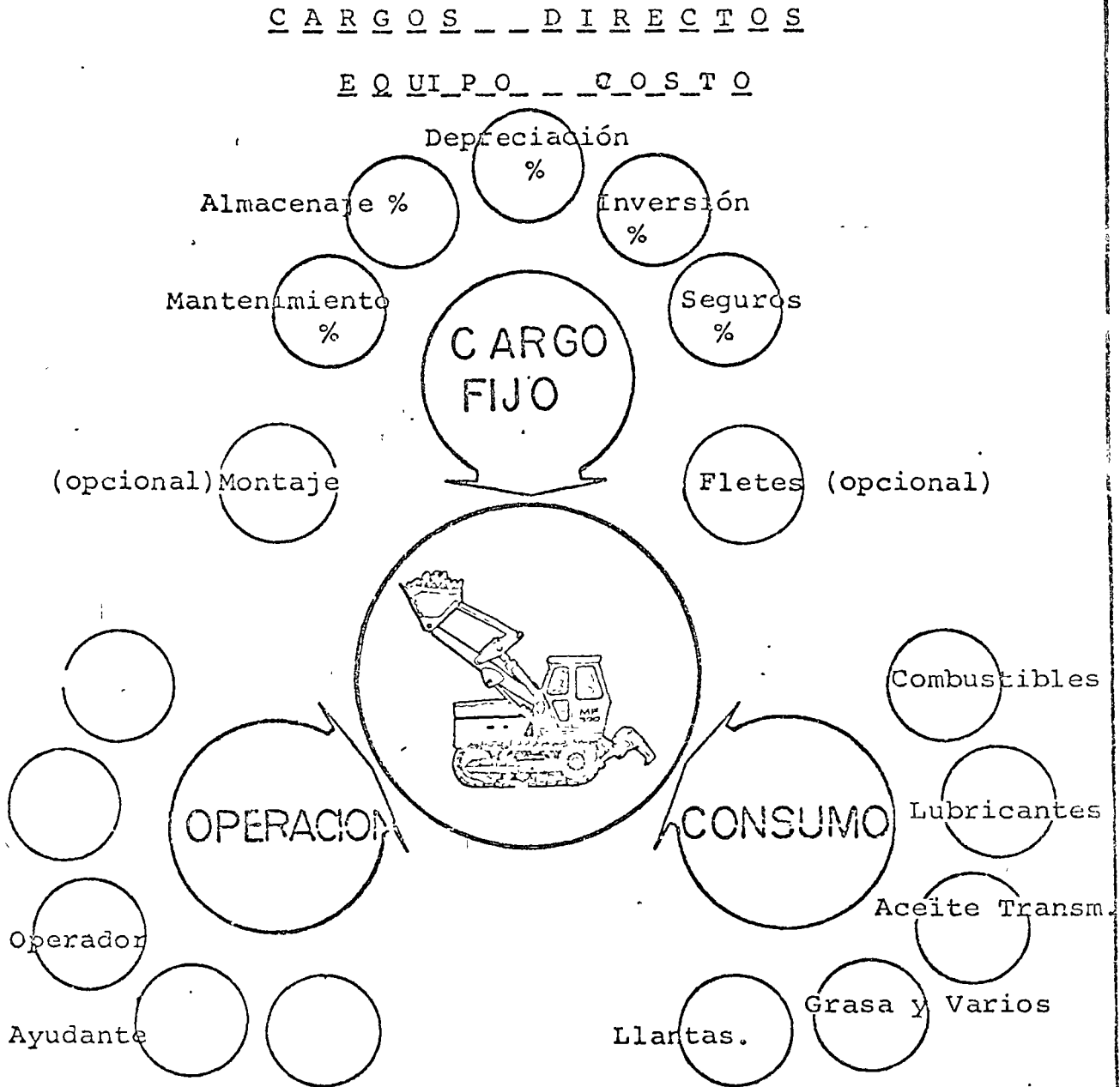


Fig. 5.1

CARGO DIRECTO POR EQUIPO.- Lo determinan según las bases y - normas generales para la contratación y ejecución de Obra Públicas, los cargos fijos, los de consumo y los de operación - por un tiempo determinado y dividido por el rendimiento efectivo que dicho equipo realice en el mismo tiempo determinado de costo.

$$CM = \frac{HMD}{RM}$$

Sin embargo, como lo muestra la figura 5.1, los cargos se dividen como todos los costos ó sea una Labor, un Material y el Equipo Intrínseco.

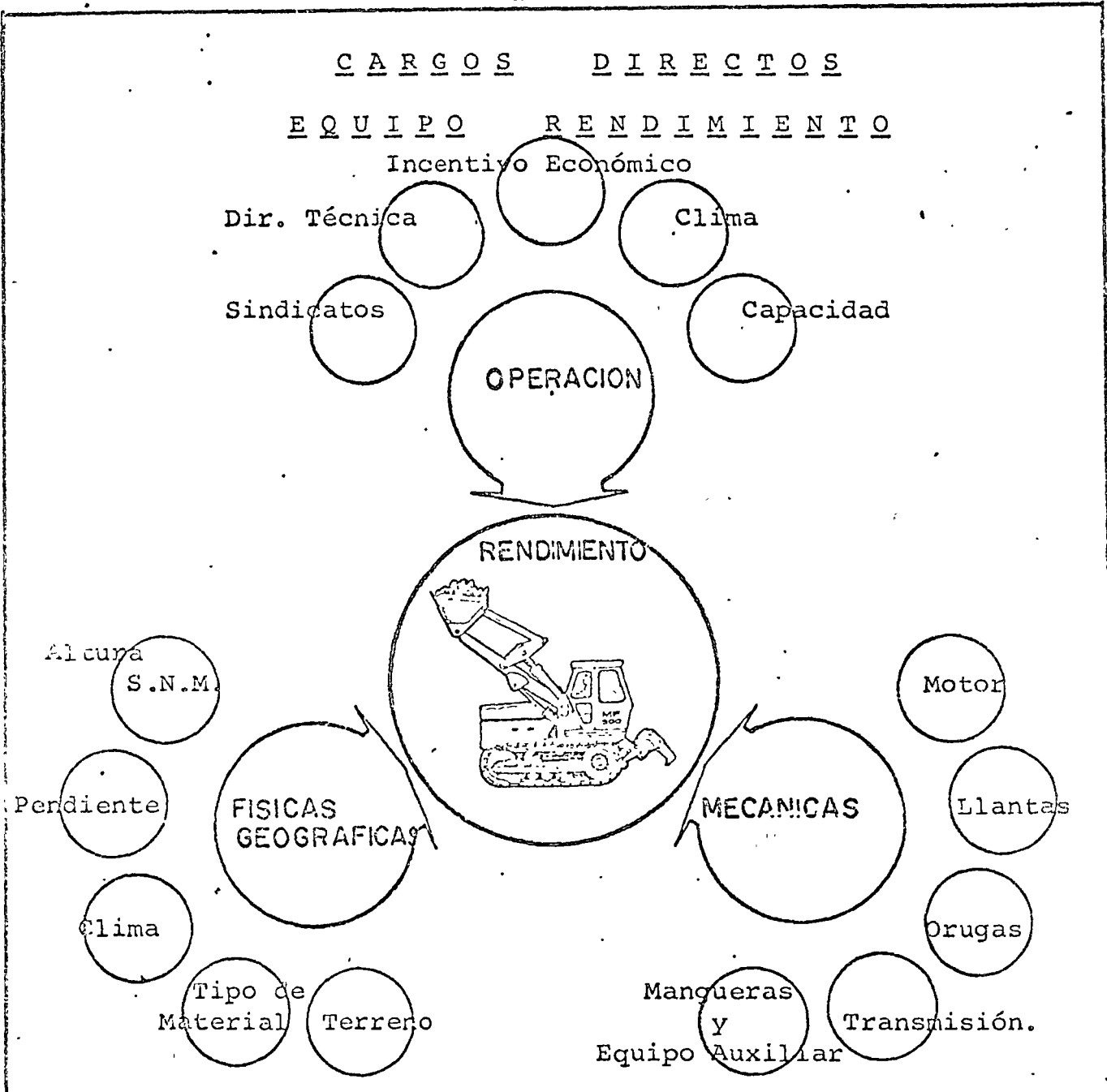


Fig. 5.2

Casi todos los factores que determinan la variación de los rendimientos del equipo, están señalados en esta gráfica, los factores principales son afectados por otras y así sucesivamente, por esto para determinar los rendimientos más adecuados, es necesario llevar datos estadísticos de diversos tipos de obras, estos valores serán definidos en clase posterior.

CARGOS DIRECTOS
HERRAMIENTA DE MANO
INSTALACIONES



Fig. 6.1

El cargo por herramienta de mano, corresponde al consumo ó desgaste de la herramienta utilizada en la ejecución de los conceptos de obra y se determina en función de un porcentaje de la mano de obra. Dicho porcentaje se determina con estadísticas.



Fig. 7.1

El cargo por instalaciones corresponde a las erogaciones realizadas por el Contratista para construir las instalaciones accesorias, necesarias para realizar conceptos de trabajos de finidos y no deberá incluir ninguna instalación de servicio general en la obra.

P R E C I O U N I T A R I O
C A R G O S I N D I R E C T O S

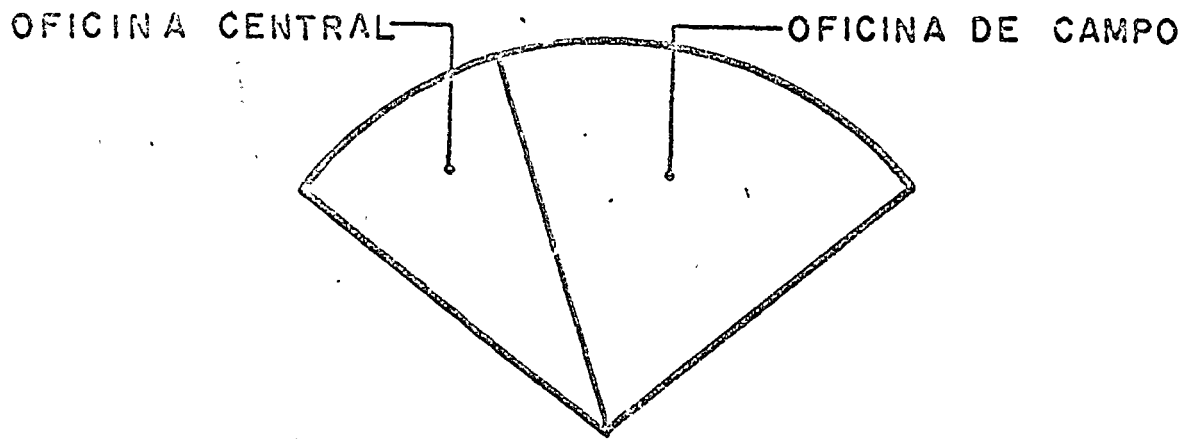


Fig. 8.1

TODOS LOS GASTOS QUE SE REALIZAN PARA LA CONSTRUCCION DE UN -- PROYECTO NO CONSIDERADOS EN LOS CARGOS DIRECTOS SE DENOMINARAN CARGOS INDIRECTOS COMO MUESTRA LA FIG. 8.1 SE DIVIDEN EN GASTOS DE OFICINA CENTRAL Y GASTOS DE OFICINA DE CAMPO.

LAS FIG. 8.2 Y 8.3 MUESTRAN LOS DIVERSOS FACTORES QUE INTEGRAN DICHOS CARGOS SEGUN LAS BASES Y NORMAS GENERALES PARA LA CON-- TRATACION Y EJECUCION DE OBRAS PUBLICAS, ESTOS CARGOS SE EX-- PRESAN COMO UN PORCENTAJE DEL COSTO DIRECTO OBTENIDO DEL RESULTADO TOTAL DE LOS CARGOS INDIRECTOS ENTRE EL TOTAL DE LOS CAR-- GOS DIRECTOS MULTIPLICADO POR CIEN.

$$\% \text{ DE CARGOS IND} = \frac{\text{CARGOS IND.}}{\text{CARGOS DIRECTOS}} \times 100$$

CARGOS INDIRECTOS
OFICINA CENTRAL

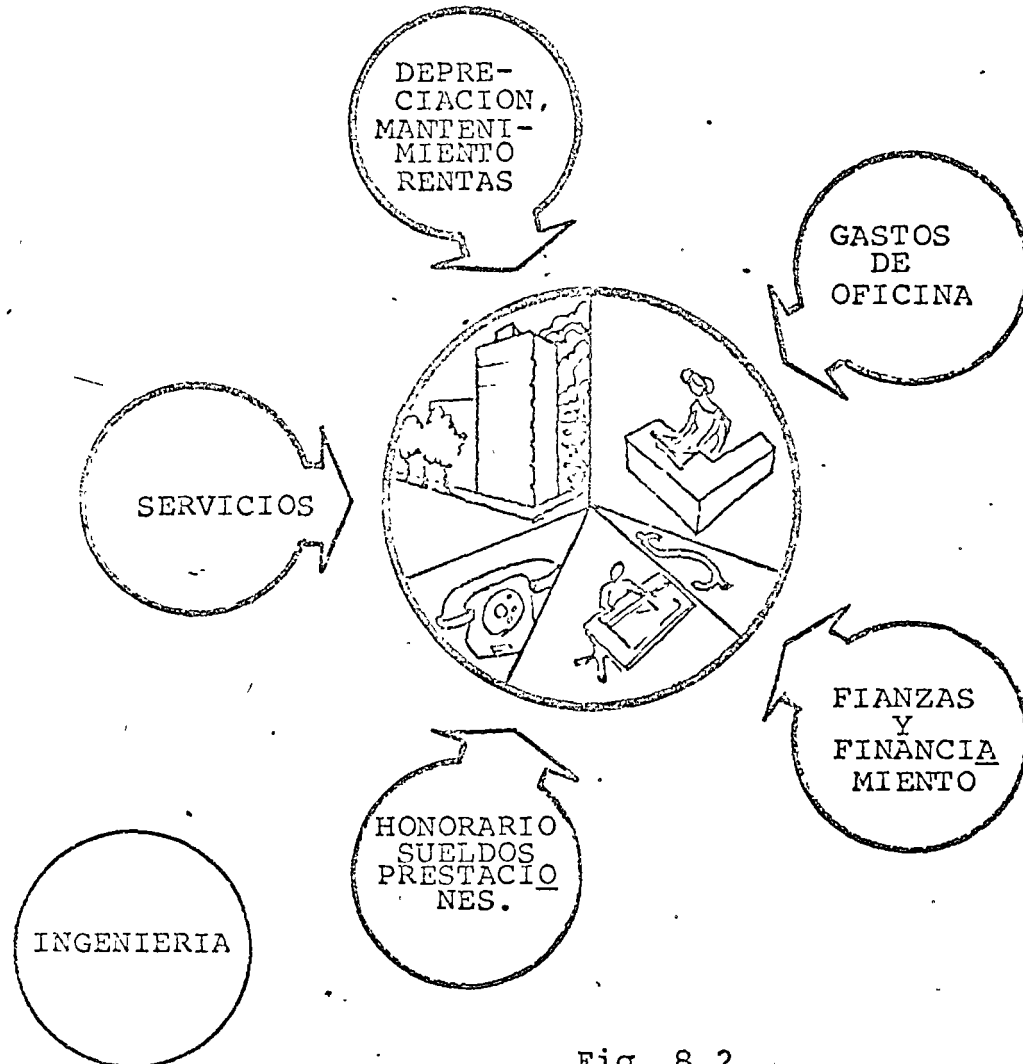


Fig. 8.2

(OPCIONAL)

Factores de influencia que determinan los cargos indirectos de Oficina Central.
Ver Anexo 1

CARGOS INDIRECTOS
OFICINA DE CAMPO

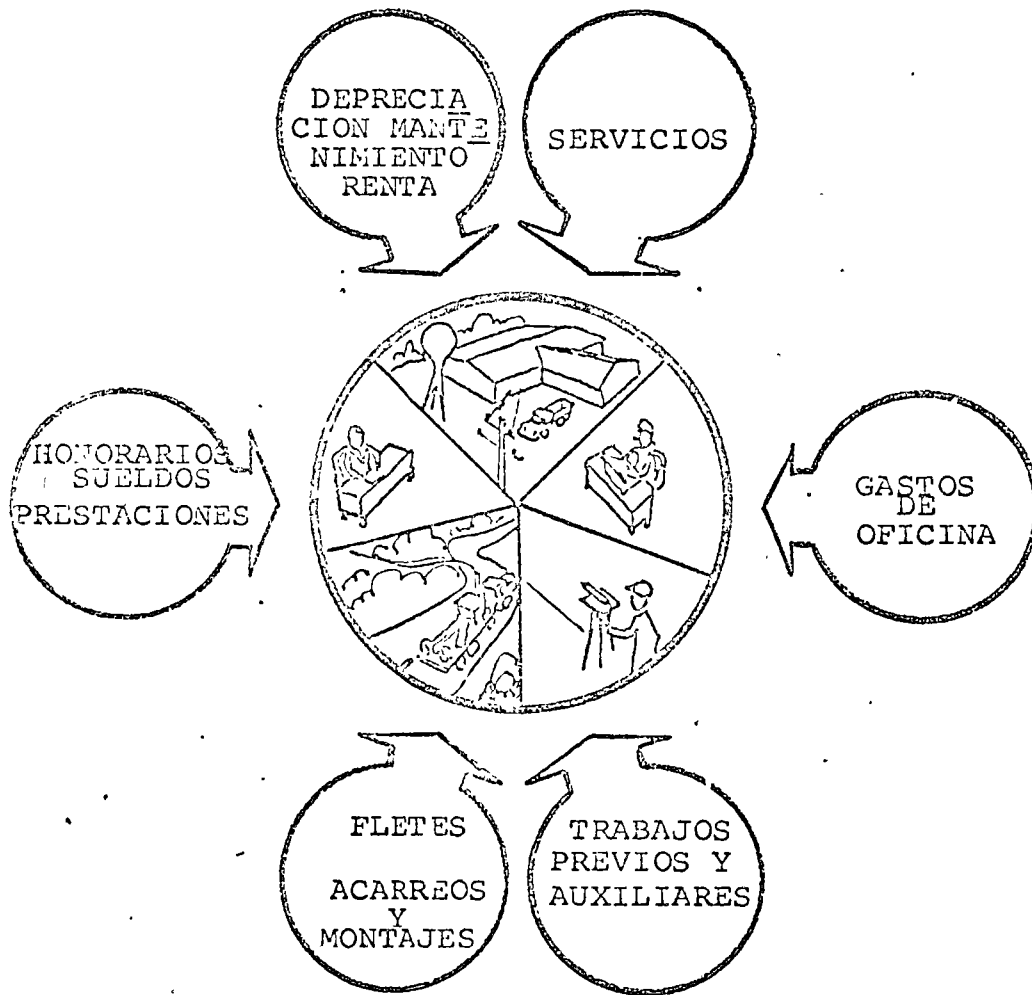


Fig. 8.3

Factores de influencia que determinan los cargos indirectos de la Oficina de Campo.
Ver Anexo 1.

A N E X O I

BASES Y NORMAS GENERALES PARA LA CONTRATACION Y EJECUCION DE OBRAS PUBLICAS

9.3. A continuación se enlistan los gastos generales más frecuentes que deberán tomarse en consideración para integrar el cargo indirecto.

	Admón. central	Admón. de obra
	X De posible aplicación - No aplicable	
9.3.1. Honorarios, sueldos y prestaciones.		
1. Personal directivo	X	-
2. Personal técnico	X	X
3. Personal administrativo.	X	X
4. Personal en tránsito	-	X
5. Cuota patronal de Seguro Social e impuesto adicional sobre remuneraciones pagadas para ítems 1 a 4	X	X
6. Pasajes y viáticos	X	X
7. Consultores y asesores	X	-
8. Estudios e investigaciones	X	-
9.3.2. Depreciación, mantenimiento y rentas.		
1. Edificios y locales	X	X
2. Campamentos	-	X
3. Talleres	-	X
4. Bodegas	-	X
5. Instalaciones generales	-	X
6. Muebles y enseres	X	X

	Admón. central	Admón. de obra
	X De posible aplicación - No aplicable	
9.3.3. Servicios.		
1. Depreciación o renta y operación y -- vehículos	X	X
2. Laboratorio de campo	-	X
9.3.4. Fletes y acarreos.		
1. De campamentos	-	X
2. De equipo de construcción	-	X
3. De plantas y elementos para instalaciones	-	X
4. De mobiliario	-	X
9.3.5. Gastos de oficina.		
1. Papelería y útiles de escritorio	X	X
2. Correos, teléfonos, telégrafos, radio.	X	X
3. Situación de fondos	-	X
4. Copias y duplicados	X	X
5. Luz, gas y otros -- consumos	X	X
6. Gastos de concursos	X	-
9.3.6. Fianzas y financiamientos.		
1. Primas por fianzas	X	-
2. Intereses por financiamientos	X	-

Admón.
central

Admón.
de obra

X De posible aplicación
- No aplicable

9.3.7. Trabajos previos -
y auxiliares.

1. Construcción y con-
servación de cami-
nos de acceso -
2. Montajes y desman-
telamientos de ---
equipo, cuando así
proceda -

X

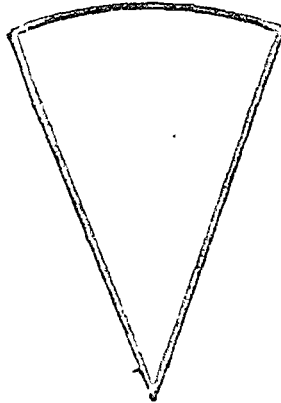
X

* 9.3.8. Imprevistos

Proposición de mo-
dificación en trá-
mite -

X

P R E C I O U N I T A R I O
C A R G O S A D I C I O N A L E S



OTROS CARGOS

Fig. 10.1

Las Normas y Bases Generales para Contratación y Ejecución de Obras Públicas .. Los define claramente como aquellos - correspondientes a las erogaciones que realiza el Contratista por estipularse expresamente en el contrato de Obra, como obligaciones adicionales y que no están comprendidas dentro de los cargos directos, ni en los Indirectos, ni en la Utilidad y se expresa generalmente como un porcentaje - sobre la suma de los cargos directos, indirectos y utilidad.

PRECIO UNITARIO
CARGOS ADICIONALES

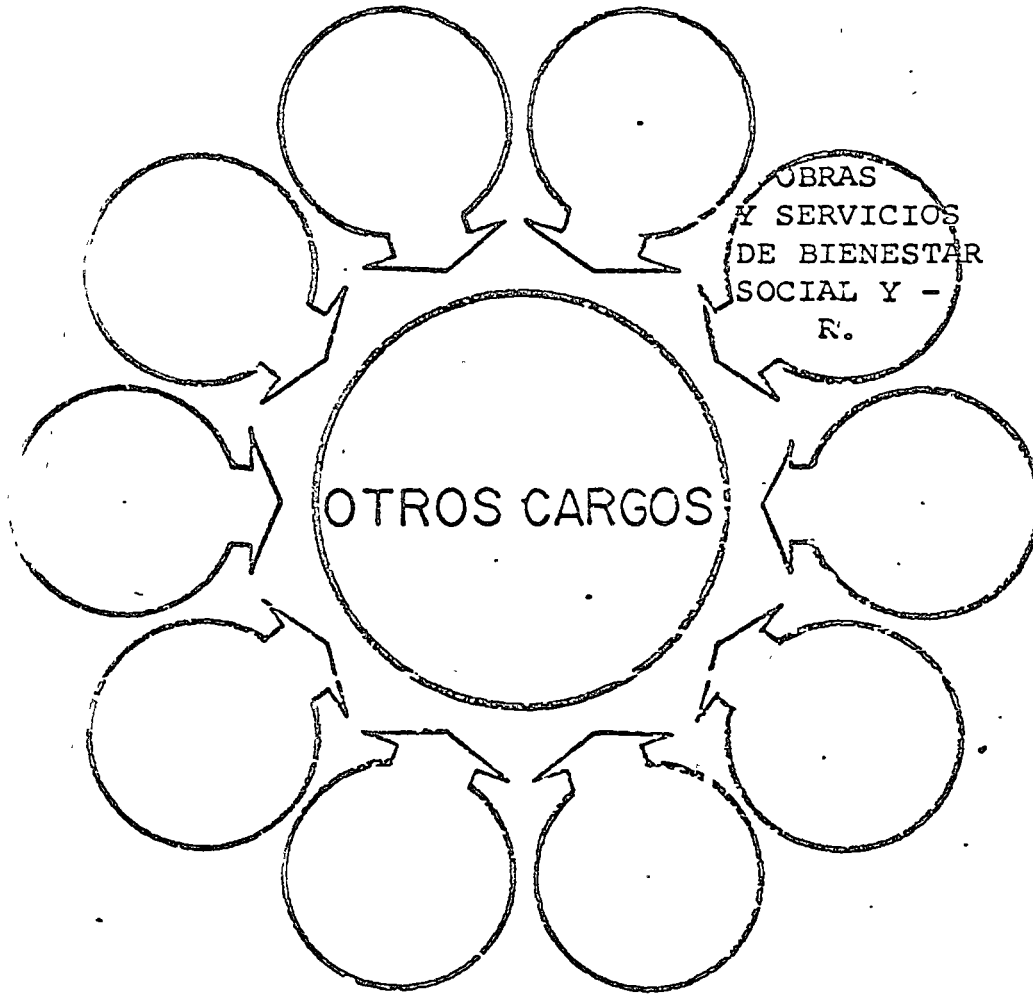


Fig. 10.2

Integración del Cargo Adicional.

CONTINGENCIAS.- Es la partida presupuestal que se calcula para cubrir los costos imprevistos, en el desarrollo del proyecto, de acuerdo con la incertidumbre que se tenga en los datos básicos empleados para el cálculo del presupuesto.

ESCALACION.- Es la partida presupuestal que se calcula para cubrir las variaciones esperadas en los costos a un futuro.

Dicho de otra manera: es la diferencia entre los costos actuales y los costos que se tendrán durante la ejecución del proyecto, que no es posible precisar, pero que de acuerdo a estadísticas se espera que surgirán.

HONORARIO.- Es la remuneración económica a que toda empresa tiene derecho, al desarrollar un trabajo profesional y cuyo monto dependa de los gastos originados de la propia subsistencia de la empresa y la utilidad, que de acuerdo a sus políticas, desee percibir.

3. CICLO BASICO DE UN PRESUPUESTO.

Como hemos apuntado anteriormente, un presupuesto entre otros muchos factores, está basado en estadísticas, registros de resultados, experiencias pasadas, todas ellas obtenidas de proyectos concluidos, realizados.

Si bien hemos de hablar de un ciclo de un presupuesto, esto es solamente en sentido figurativo, pues nunca o casi nunca un presupuesto se repite por iguales que sean las obras, ya que de una obra a otra cambiarán las condiciones, si se quiere en un mínimo, pero cambiarán. Por decir algo, supongamos las escuelas, tipo que desarrolla el comité constructor de escuelas, podrá tratarse de dos edificios exactamente iguales, pero forzosamente tendrán que estar ubicados en sitios distintos, posiblemente con únicas diferencias en: la topografía del lugar, resistencia del suelo, climatología, factores que reflejados en el presupuesto, arrojarán resultados diferentes. Es más, si a esto aunamos la diferencia en tiempo en que se inicie la obra y otra, tendremos posiblemente diferencias en precios de materiales, en tabuladores de salarios, etc. (esto también por la diferencia en sitios de construcción.)

A continuación presentaremos un diagrama de secuencias para el cálculo de presupuestos de construcción.

INSTRUCTIVO PARA RECOPIACION DE DATOS
PARA PRESUPUESTOS DE OBRAS FORANEAS

A.- CÓNCPTOS GENERALES

1.- Elementos Basicos.-

El investigador deberá contar con los siguientes elementos, antes de salir hacia la Plaza por investigar:

- a) Conocimiento absoluto de todos los planos relativos a la obra.
- b) Estudio detallado y resumen de las especificaciones generales y complementarias.
- c) Dominio absoluto de todos los conceptos y cantidades de obra.
- d) Lista de materiales necesarios para la ejecución de la - obra con cantidades lo más aproximadas posible de los -- mismos.
- e) Lista de conceptos de mano de obra, también con volúmenes por ejecutar de los mismos.
- f) Conocimiento de la localización precisa del sitio de la - obra.
- g) Preferentemente contactos con personas de la localidad - que puedan colaborar a hacer la investigación o aportar datos importantes.
- h) Conocimiento del procedimiento aproximado que se seguirá para la construcción.

2.- Investigación de Materiales.-

Deberán tomarse en cuenta los siguientes puntos, para la recopilación de cotizaciones de materiales:

- a) En caso de necesitar materiales que no existan en el mercado en cuestión averiguar de donde llegan habitualmente y si hay posibilidad de obtenerlos en otras plazas distincas a esa.

- b) Tratar de obtener siempre un mínimo de tres cotizaciones para cada material, con el máximo descuento que sea posible conseguir.
- c) Pensar en la posibilidad de fabricar nosotros ciertos materiales, especialmente de los provenientes de bancos - (arena, grava, tepetate, etc.), y averiguar las condiciones que influirían en su explotación y tratamiento (rentas, concesiones, permisos, etc.).
- d) Investigar siempre hasta que fecha son válidas las cotizaciones obtenidas y en que términos se sostienen los descuentos ofrecidos.

3.- Investigación de Mano de Obra.-

Para la mano de obra, el investigador deberá considerar los siguientes puntos:

- a) Si es o no operante el Seguro Social y hasta que punto o en que magnitud debe tenerse en cuenta.
- b) Si existe uno o varios sindicatos y en su caso investigar de que clase es o son y que tan estrictos son, pero sobre todo la magnitud de las exigencias económicas que habitualmente tienen.
- c) Obtener un tabulador de precios de mano de obra del sindicato a los sindicatos.
- d) Aclarar cual es el salario mínimo legal
- e) Anotar los salarios reales por día para todas las categorías de todas las especialidades (incluyendo carpinteros, herreros, pintores, yeseros, etc.) operantes en la Plaza.
- f) Investigar muy a fondo la disponibilidad y eficiencia de la mano de obra local y el sitio más cercano para obtenerla y cuanto cuesta (punto e). En este caso investigar - costo de viáticos para operarios llevados de otra localidad

Dirigirse a tres o cuatro obras en proceso de construcción y hablar con los maestros o sobrestantes, nunca con los Ingenieros o Arquitectos responsables, a menos que sean conocidos o recomendados y obtener de ellos los costos unitarios reales de mano de obra.

4.- Investigación de Subcontratos.-

Para este capítulo regirán básicamente los mismos puntos que en el capítulo 2.

Entendemos por subcontratos: Instalación Hidráulica y Sanitaria, Instalación Eléctrica, Herrería, Carpintería, Yesería, Pintura, etc.

Siempre es conveniente pensar en la posibilidad de ejecutar nosotros directamente uno o varios de estos trabajos, siempre y cuando los datos aportados por el investigador sean reales y ventajosos para la compañía.

5.- Fleteros Locales.-

Es necesario conocer perfectamente la disponibilidad y costo de flotillas de camiones para hacer fletes locales o para los siguientes trabajos. Extracción de tierra, venta de tierra para rellenos, introducir arena, grava, tabique, tepepate, etc.

En caso de no haber en la localidad, buscar en lugares cercanos y averiguar en que términos trabajarían en nuestra plaza.

B.- CUESTIONARIO

I - DATOS DEL LUGAR

1.- Del sitio preciso de la obra:

- a) Describa las características, propias del terreno incluyendo las del subsuelo. (topografía, agua freática, capa resistente, etc.).
- b) Colindancias y límites del terreno.- Descripción.
- c) Localización respecto a la población.- Anexe un croquis de localización respecto al centro de la ciudad y donde aparezcan: Aeropuerto, estación de FF.CC. estación de Autobuses, Teléfonos, Institución Bancaria, etc.

- d) Características de los accesos al lugar de la obra y distancias de los mismos.
- e) Disponibilidad y Costo de energía eléctrica.
- f) Disponibilidad y Costo de agua y drenaje.

2.- De la ciudad investigada:

- a) Condiciones climatológicas de la localidad.- Tiempo y magnitud de lluvias, temperaturas, fenómenos meteorológicos, etc.
- b) ¿Existen laboratorios de Ingeniería?.
- c) ¿Hay lugares donde hagan copias heliográficas?.
- d) ¿Hay algunos otros contratistas trabajando en la región?
¿Quiénes son?

¿Con que equipo cuentan? Si están por desocuparlo, investigar posibilidad de obtenerlo en renta.

- e) Cuanto cuestan los fletes de equipo y materiales (cemento, varilla, madera, muebles de baño, etc.) desde la Ciudad de México y desde otras Plazas importantes más cercanas, Investigar en FF.CC. y en camión.
- f) ¿Que Instituciones Bancarias hay en la localidad? ¿Cuales son sus matrices en México?.
- g) ¿Hay posibilidad o antecedentes de importación de materiales? ¿En que condiciones?.
- h) ¿Que empresa (s) aerea (s) vuela (n) a la plaza investigada? ¿Con que frecuencia? ¿Con que equipo? ¿Cual es el costo de pasaje y de express aereo?.
- i) ¿Que líneas de autobuses? ¿Cuánto cuentas pasajes y express?
- j) ¿Hay ferrocarril?
- k) ¿Hay posibilidad de obtener teléfono en la obra? ¿Cual es la tarifa de teléfonos?.
- l) ¿Hay alguno o algunos telex en la ciudad? ¿Quién los tiene?.
- m) ¿Que otras obras se encuentran en construcción actualmente en la ciudad? ¿Quién las esta haciendo?

- n) ¿Hay escuela de Ingeniería en la localidad? ¿De que clase? ¿Se pueden conseguir estudiantes para trabajar en la obra? ,Con que horario y de que precio?
- o) Investigar en la oficina de Obras Públicas local que costo tendrían Licencias provisionales que pudieramos necesitar (tapial, ocupación de banqueta, etc.) y obtenga un ejemplar del reglamento de construcciones y Servicios Urbanos vigente en la actualidad.
- p) Investigue disponibilidad de combustibles y lubricantes.
- q) ¿Hay distribuidora de refacciones de equipo de construcción y de transporte? ¿De que magnitud? ¿De que marcas?
- r) ¿Hay talleres mecánicos? ¿De que magnitud y de que tipo?
- s) ¿Hay días festivos especiales o tradicionales de la región?

II.- MATERIALES:

Aquí deberá llevar el investigador ya elaborada una lista de materiales perfectamente especificados y con cantidades aproximadas necesarias para la obra.

Es importante no olvidar: materiales de Instalación Sanitaria, de Instalación Eléctrica, Yeso, Pintura, Herrería, Carpintería, etc.

III.- MANO DE OBRA:

Igualmente deberá llevar la lista de conceptos en que se requiere conocer el costo unitario de mano de obra operante en la localidad, con especificaciones y volúmenes de obra.

IV.- SUBCONTRATOS:

Independientemente de obtener precios de materiales y mano de obra para la elaboración de subcontratos directamente por la Compañía, el investigador deberá solicitar a personas o empresas de la localidad presupuestos de los mismos, para lo cual deberá llevar suficientes copias de planos y especificaciones, recordando que deberá obtener un mínimo de tres presupuestos por cada partida.

V.- OBSERVACIONES PERSONALES:

Aquí deberá anotar el investigados cualquier dato que juzgue necesario y no este expresamente solicitado en los puntos anteriores.

Asimismo deberá escribir sus impresiones personales sobre fenómenos políticos, económicos, sociales, sindicales, etc. - que puedan en un momento dado afectar los costos de la obra o la intervención de nuestra compañía en una obra en la localidad investigada.

NOTAS:

- 1.- Todos los presupuestos y cotizaciones deberán venir por escrito y firmadas, con indicación de vigencia y descuentos.
- 2.- Este reporte deberá ser entregado por el investigador a mas tardar 24 horas después de su regreso a México, D.F., y escrito a máquina, con todos sus anexos, catálogos, - fechado y firmado por el investigador.
- 3.- En su caso, deberá el investigador anexar constancia de su visita en el lugar de la obra emitida por quien designe la convocatoria.
- 4.- Deberá anexar al informe, una relación de los gastos efectuados durante la investigación, para compararla con el presupuesto elaborado previamente.



ESPECIFICACIONES GENERALES

PREPARACION Y MOVIMIENTO DE TIERRA

Se ha considerado limpia, trazo y nivelación del terreno - a profundidad máxima de 10 cm.

CIMENTACION

Se ha considerado excavación para la trabe de cimentación - en terreno tipo "A" a profundidad indicada.

Relleno compactado de tepetate 10 cm. de espesor en toda - la plataforma de losa de cimentación.

Acarreo del material sobrante de la excavación con recorri - do a distancia de 5 Km.

Para losa y trabe de cimentación se ha considerado concreto $f'c=150$ Kg/cm². con impermeabilizante integral en proporción de 0.50 Kg. de impermeabilizante en polvo por cada 50 Kg. - de cemento.

La losa se reforzará a base de acero de refuerzo $f_y=4000$ - kg/cm². y malla electrosoldada 66-10/10

La trabe se reforzará a base de Armex 15-30-4

ESTRUCTURA

Se ha considerado a base de losas, trabes y cerramientos de concreto $f'c=150$ Kg/cm². reforzado $f_y=4000$ Kg./cm²., Armex 10-10-3, malla electrosoldada 66-6/6 y 66-3/3.

ALBAÑILERIA

Muros-A base de block e estruido de barro rojo 6x12x24 cm. ó similar acabado natural aparente reforzados con castillos de concreto ahogados con 1 ϕ 5/16".

En patio de servicio se ha considerado un firme de concreto $f'c=100$ Kg./cm.² de 8 cm. de espesor.

En exteriores se han considerado losas precoladas de concreto de:

80 x 40 x 6 cm. para peatones y
60 x 28 x 5 cm. para automoviles

Para el tinaco se han considerado 2 caballetes soporte, a base de tabique, acabados con aplanado de mezcla, cal-arena.

ACABADOS

En pisos, acabado pulido con llana metálica integral a la losa de concreto.

En patio, acabado escobillado.

En techos, "tirol" sobre la losa de concreto.

En baños y cocina en las áreas indicadas, se ha considerado - lambrin de azulejo 11 x 11 cm. blanco del país de 2a. calidad, el resto será a base de aplanado de yeso

En las áreas indicadas de baños y cocinas, se ha considerado piso de mosaico de pasta de un color, imitación cerámica.

PINTURA.

En muros aplanados de yeso en baños y cocinas, se ha considerado pintura de aceite.- En plafones, se aplicará pintura de aceite directamente sobre el acabado de la losa de concreto.

En puertas y ventanas metálicas se aplicará pintura de aceite sobre el "primer" anticorrosivo que viene de taller.

En puertas de madera se ha considerado acabado a base de pintura de aceite tipo medio brillo.

INSTALACION SANITARIA Y MUEBLES

Se ha considerado para muebles:

INODORO "VITROMEX" Mod. Troyano, blanco, completo con accesorios, con tapa de plástico gris oxford.

LAVABO "VITROMEX" Mod. Jazmin, blanco, completo con accesorios y llaves Nibco.

REGADERA tipo cebolla Nibco Mod. 295-B con llaves y accesorios Nibco.

FREGADERO porcelanizado Mca. Cinsa de 1.05 x 0.85 m. con gabinete y llaves Nibco.

CALENTADOR Semi-automático de 40 lts. Mca. Cinsa 40 Lts. Mod. I 10 AEG.

LAVADERO Prefabricado en concreto gris con niple y tapón de empotrar.

TINACO cilíndrico horizontal de asbesto cemento con capacidad indicada 1100 Lts. ó 700 Lts. según el tipo de unidad.

ACCESORIOS PARA BAÑO de porcelana color blanco de sobreponer, lote formado por jabonera de lavabo, jabonera de regadera, portarrollo, gancho sencillo, portacepillo y toallero.

INSTALACION DE MUEBLES Desagües de tubo galvanizado para lavabo y fregadero. Lavadero desagüe por un tubo galvanizado directo al piso.

Alimentaciones a base de tubería de acero galvanizado ϕ 13 mm.

Coladera de piso en regadera con cespól de plomo.

Toma de agua para medidor con tubería galvanizada y llave de nariz Nibco.

HERRERIA

PUERTAS METALICAS con perfiles tubulares de lámina Cal. 20 con preparación para vidrio en la parte superior, tablero estriado tipo Diamante en lámina Cal. 20 en la parte inferior con marco metálico y chambrana en perfiles Cal. 20.

VENTANAS METALICAS a base de perfiles tubulares de lámina Cal. 20 con repizón integral para muro de ancho 12 cm.

Botaguas de lámina en colindancia a base de lámina galvanizada Cal. 22

CERRAJERIA.

Se han considerado para:

Puertas principales: Chapa Fanal, S.A., Modelo 460 - 5cr. de cilindro elíptico.

Puerta de entrada Posterior: Chapa Fanal, S.A. Modelo 175 - PD ó PP.

Puertas de intercomunicación: Chapa Fanal, S.A. Modelo - 264 - 265 cr.

IMPERMEABILIZACION

En desplante de muros: Especificación 1 - 358 de "Protexa"

Especificaciones "Protexa" como sigue:

- En Azoteas:
- 1 - Limpieza de la superficie
 - 2 - Imprimación con Emultex T.P.
 - 3 - Se sellarán tubos salientes y cuellos de B.A.P. con plasticem.
 - 4 - Asfaltex 500 a 1.5 Kg/m².
 - 5 - Permafelt con 10% de traslape.
 - 6 - Asfaltex 500 a 1.5 Kg/m².
 - 7 - Permafelt con 10% de traslape
 - 8 - Asfaltex 500 a 2.0 Kg/m²
 - 9 - Riego de grano de marmol No. 2
 - 10 - Como terminación pasta blanca reflectiva a base de cal-cemento blanco y polvo de marmol y agragando plastificante

Garantía por 5 años.

CARPINTERIA

PUERTAS tipo tambor forrados por ambas caras con fibracel duro 5 mm. con bastidor de madera de pino, espesor de puerta - 35 mm., marco en madera 3/4" x 6" con batiente sobre puesto,

aluchambranas de 1/2" x 1/2", bisagras de 3" x 3" con perno del país.

CLOSETS sencillos con tabla corrida de 3/4" y división intermedia, tubo niquelado para ganchos y cortineros para cortina corrida en vez de puerta.

VIDRIERA
En ventanas y zona indicada en puertas: vidrio claro medio - doble del país 3 mm.

En baño espejo de 35 x 51 cm. con marco de aluminio

Repisa de vidrio 10 x35 cm. con 2 mensulas

DRENAJES

Drenajes de tubo de concreto de ø 15 cm. incluyendo excavación, tendido y relleno a 70 cm. de profundidad.

Registros prefabricados de concreto de 40 x 60 cm. a 75 cm. de profundidad con tapa.

Caja de pie del lavadero prefabricada de concreto de 35x35x30 cm. con tapa con orificios.

INSTALACION ELECTRICA

Se han considerado:

- Salidas de Alumbrado
- Salidas de Concreto
- Salidas de Timbre
- Tableros QO-2 y alimentación switch c/cartuchos,
- Acometida Compañía de Luz.

A base de: Tubo conduit poliducto marca Rex o Tubflex en los diametros indicados.

Conductor de cobre electrolítico puro con aislamiento termo plástico del tipo TW-600 Volts, marca conductores Monterrey, Condumex o Phelps Dodge.

Accesorios de bakelita cafe de la marca Royer o IUSA y table
ro QO-2 square - D

LIMPIEZA

Se ha considerado limpieza en:

Vidrios, azulejo, muebles sanitarios, chapas de cerrajería -
de muros aparentes, pisos y limpieza general de toda el área
dejándola libre de escombros.

CATALOGO DE CUENTAS

INTRODUCCION

Toda empresa está integrada por personas que desarrollan - dentro de ella múltiples funciones y que por su calidad humana tienen diferentes mentalidades, a todas ellas se requiere unificarlas sobre la cobertura de los elementos que integran las funciones de dicha empresa, con el fin de minimizar y jerarquizar esfuerzos, para lograrlo será necesario contar con una herramienta común e indispensable para llevar una adecuada identificación de costos, ya sea en el aspecto Contabilidad, en el aspecto Presupuesto, Control Presupuestal ó bien Estadística; esta herramienta se le da el nombre de "Catálogo de Cuentas".

Definición

Catálogo de cuentas es un sistema simbólico generalmente numérico o alfa-numérico que permite desglosar e identificar lógicamente y uniformemente todos los conceptos que intervienen en el costo de un proyecto y/o de una empresa.

Objetivos

3.1 Debe unificar los criterios respecto al alcance de ca-

da uno de los elementos en que se divida.

Mediante un lenguaje numérico identifica todas las operaciones que impliquen un costo, para la empresa.

Debe organizar lógicamente todos los elementos que implican un costo.

Características

Todo Catálogo debe estar planeado en una forma tal, -
que permita agrupar o desglosar, unir o separar los -
conceptos que forman cada una de las partes fundamenta
les y que forman los costos de la empresa.

Contemplan una sola forma para clasificar un concepto.
Identificará todos los costos que se requieran para el
buen manejo de la empresa.

Diferenciará las partes principales.

Costo Directo

Costo Indirecto Presupuestos, controles, estadísti
cas.

Cuentas de resultados generales

Cuentas de Orden.

Su flexibilidad será tal, que se adapte a todos los -
proyectos y controles que se manejen en la empresa.

Estará basado en las políticas empresariales.

Todo Catálogo debe ir acompañado de un instructivo - que permita y facilite su comprensión y su manejo, - así como de un reglamento de aplicación, pues sin este, el Catálogo no funcionará ni dará la información deseada.

Aplicaciones

La comunicación eficiente es vital para un empresa, - esta se facilita enormemente si los conceptos mencionados en la documentación que la empresa genera, son - identificados por un número de cuenta.

Un Catálogo de Cuentas bien planeado, sirve como lista de verificación de todos los conceptos que se involucran en un presupuesto, lo que evita omisiones o duplicidades.

El control de costos de un proyecto, no se concibe, si no es fundamentado en un Catálogo de Cuentas.

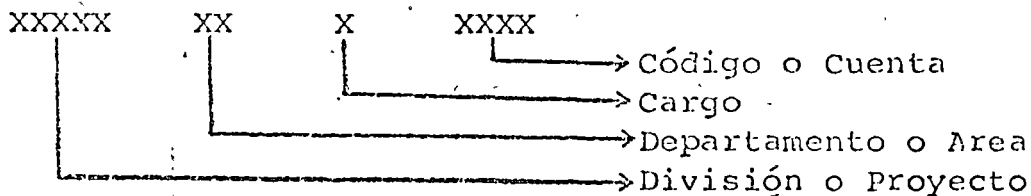
mas, éste es un factor de importancia en la calidad de resultados que arroje el control.

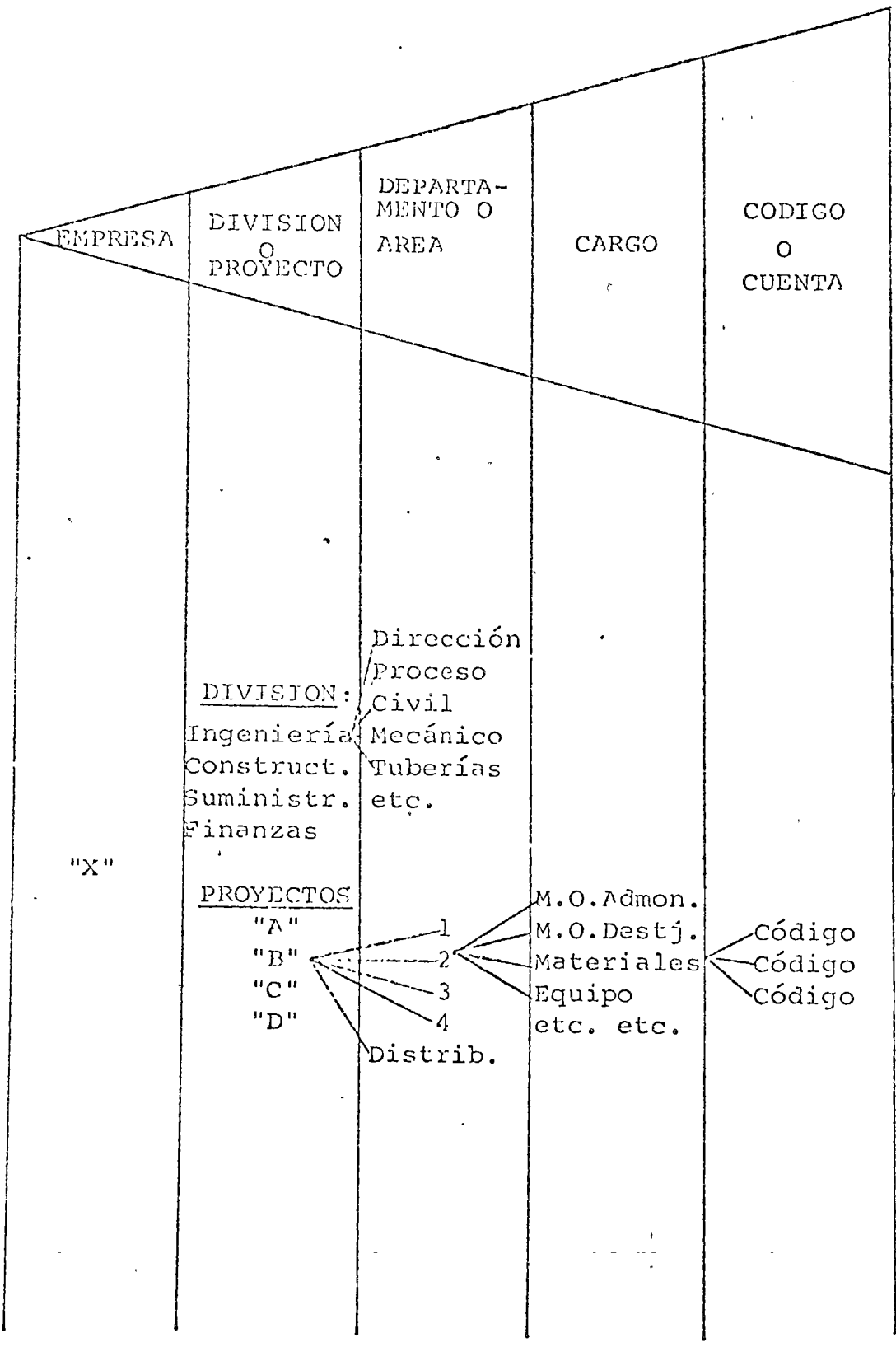
- 5.4 En la programación también tiene un papel preponderante, además de servir como lista de verificación, identifica los tiempos programados, con los costos correspondientes, ya sea en los presupuestos o en los resultados de costos.
- 5.5 Es indiscutible su aplicación en los archivos y estadísticas que maneje la empresa.
- 5.6 Así mismo, es el paso esencial y básico para introducir información a las máquinas de computación.

EN RESUMEN, la idea que debe prevalecer en el estudio de un Catálogo de Cuentas, es la simplificación del mismo, sin perder de vista los objetivos básicos requeridos para su desarrollo efectivo, así como la facilidad de usarlo totalmente manual, manual con asistencia mecanizada o completamente mecanizado, en todas las etapas de un proyecto y operaciones de una empresa, es decir en la planeación, organización, desarrollo y control, añadiendo a ello, el registro ordenado y lógico que permita el establecimiento de estadísticas confiables, aplicables a futuras labores y proyectos de la Empresa.

Se anexa como vía de ejemplo un Catálogo de Cuentas que podría ser utilizado en una empresa que maneja proyectos completos de Diseño y Construcción.

Este ejemplo trata de describir y aclarar lo que puede obtenerse en forma general o detallada, siguiendo la "Teoría del Abanico" (Fig. 1), la cual permite conocer en primer lugar los Costos Totales de la empresa, en segundo lugar, los Costos Totales de cada una de las divisiones que forman la empresa o proyecto que se esté efectuando; en tercer lugar, los Costos Totales de cada uno de los departamentos que forman cada División o las Areas - en que haya sido dividido un proyecto; en cuarto lugar el desglose por tipo de costo (mano de obra, material, etc.) y por último y quinto lugar los costos por código en que haya sido dividido el Area.





TEORIA DEL ABANICO

Fig. No. 1

USO DEL CATALOGO DE CUENTAS

De acuerdo a lo indicado en la Descripción General, el número de cuenta está formado por doce dígitos, que forman cuatro grupos, El sentido en que se usarán estos grupos, se expone a continuación:

Primer Grupo (Dígitos del 1o. al 5o.)

NUMERO DE PROYECTO O DIRECCION.- Identifica la obra, proyecto o Dirección de la compañía, de que se trate.

Se usará el número que identifica una Dirección, cuando se trate de conceptos que no formen parte de una obra o proyecto, como -- puede ser el caso de: Normas y Procedimientos, personal en tránsito, incapacidades, etc.

En el caso de conceptos que forman parte de una obra o proyecto, se usará el número correspondiente que haya sido asignado por la Dirección de Desarrollo.

Debe tenerse especial cuidado en los números que identifican a las Direcciones de la Compañía, de anteceder estos por tres ceros.

Segundo Grupo (Dígitos 6o. y 7o.)

NUMERO DE AREA O DEPARTAMENTO.- Identifica las áreas de una obra o proyecto (de la 01 a la 30), los departamentos que formen parte de las Direcciones o grupos de conceptos perfectamente identificados, como es el caso de gastos indirectos, honorarios, contingencias, etc.

Al identificarse aquí nuevamente las Direcciones, como es el caso por ejemplo: Dirección de Construcción (47), es para que estos números sean usados para efectuar cargos propios de la Dirección misma.

Los números de área de una obra o proyecto serán designados al iniciarse los trabajos relativos, ya sea la cubicación de la obra, el estimado, el diseño, etc., por el responsable de la ejecución y difundidos entre quienes intervendrán en su desarrollo.

Tercer Grupo (Dígito 8o.)

CARGO.- Clasifica los conceptos de acuerdo a los elementos fundamentales de costo, esto es en: Mano de obra, materiales, etc.

Cuarto Grupo (Dígitos del 9o. al 12o.)

CODIGO.- Identifica las partidas o actividades que forman una obra, proyecto o que se ejecutan en una Dirección.

Para el caso de las partidas enlistadas a continuación, únicamente, se usarán los dos primeros dígitos del código, seguidos de dos ceros para completar los cuatro dígitos que lo forman.

a)	Partidas de Obra Civil	Códigos 0001 a 0999
b)	Soportería	Códigos 3600 a 3699
c)	Pintura	Códigos 3700 a 3799
d)	Partidas de obra eléctrica	Códigos 4000 a 4499
e)	Partidas de instrumentación	Códigos 4500 a 4999
f)	Consultorías	Códigos 5000 a 5099

En todas las demás partidas enlistadas en el catálogo, se usarán los cuatro dígitos del código, según se especifican.

Únicamente para las obras o proyectos que así se especifique, al inicio de estos, o para manejar controles, tales como pagos a --destajistas, etc., se usarán los cuatro dígitos según se indican en el catálogo, en todas las partidas, incluso en las arriba enlistadas.

A fin de ilustrar el uso del catálogo de cuentas, se incluyen al final unos ejemplos.

CARGOS

El "Cargo" siempre tendrá un dígito, del 1 al 9 y que permit identificar el costo de que se trata, según se señala a continuación:

CARGO

1. Obra de Mano por Administración.

Este número se empleará para identificar todos los costos pagados por obra de mano, a través de la lista de raya y no-mina.

2. Obra de Mano por Destajo.

Este número se empleará para identificar los costos de obra de mano pagados por destajos.

3. Materiales

Este número se empleará para identificar los costos de materiales integrantes del proyecto u obra.

4. Equipo Permanente

Este número se empleará para identificar los costos de los equipos integrantes del proyecto u obra.

5. Sub-Contratos

Este número se empleará para identificar los costos, por subcontratos de un proyecto u obra.

6. Equipo de Construcción.

Este número se empleará en casos especiales y a petición de la Dirección de Construcción, para identificar los costos directos de equipo de construcción.

7 a
9 Disponibles

CODIGOS COSTOS DIRECTOS

El "Código" siempre estará formado por cuatro dígitos, del 0001 al 9999.

A.1 · 0001 a
0999

OBRA CIVIL

0001 a
0099

DISPONIBLES

0100

Preparación y Movimiento de Tierras

Topografía (Incluye trazo y nivelación del terreno)

Desmonte

Demoliciones

Despalme

Cortes y excavaciones (Incluye carga)

Acarreos

Rellenos y terraplenes

Drenes y Bombeos

Disponibles

0200

Cimentaciones

Excavaciones, acarreos (Incluye carga)

Rellenos (Incluye compactación)

Plantillas

Cimbras y obra falsa (Incluye habilitación, cimbrado y descimbrado).

Acero de refuerzo y presfuerzo (Incluyendo habilitación y servicios de presfuerzo)

Anclas y perfiles ahogados (Incluyendo fabricación y colocación).

Concreto

Bases de equipo

Misceláneos (Incluye: Pilas, pilotes, tablestacas, etc. y todos los conceptos que no se indican en los sub-códigos anteriores).

Disponibles.

0300 Estructuras de Concreto

Cimbras y obra falsa (Incluyendo habilitado, cimbrado y descimbrado).

Acero de refuerzo y de presfuerzo (Incluyendo habilitación y servicios de presfuerzo).

Anclas, placas y perfiles ahogados (Incluyendo fabricación y colocación).

Concretos

Precolados

Presforzados

Misceláneos (Incluye todos los conceptos que no se indican en los sub-códigos anteriores).

Disponibles

0400 Estructuras Diversas

Acero (Incluye montaje)

Rejillas y placas metálicas (Incluye colocación)

Madera (Incluye montaje)

Techos diversos (Incluye todos los tipos, excepto los de concreto).

Disponibles

0500 Albañilería y Acabados

Muros (Incluye todos los tipos de muros, excepto los de concreto)

Cadenas y castillos

Pisos (Incluye todos los recubrimientos y los acabados en pisos)

Plafones

Refractarios

Recubrimientos y acabados (No incluye el recubrimiento de pisos, pero si el de muros, plafones y otros)

Disponibles

0600

Varios

Instalación sanitaria y muebles

Herrería

Cerrajería

Impermeabilización

Carpintería

Vidriería

Drenajes, canalones, bajadas y accesorios.

Disponibles para varios

0700 a

0999

Disponibles

A.2 1000 a

2999

OBRA MECANICA

1000 a

1049

Agitadores y Mezcladores

Líquido sólido

Líquido gas

Líquidos inmiscibles

Líquidos miscibles

Movimiento de líquidos

Sólido-sólido

Especiales

1050 a

1099

Ventiladores

Flujo radial

Flujo axial

Especiales

1100 a

1149

Torres de Proceso

Destilación

Absorción
Adsorción
Extracción
Intercambio iónico
Desorción
Torres de enfriamiento
Especiales

1150 a
1199

Deareadores

Charolas
De espumas
Al vacío
Especiales

1250 a
1299

Transmisión de calor

Tubos de agua
Tubos de humo
De recuperación
Calentador a fuego directo
Especiales
Evaporadores
Tubos cortos verticales
Tubos largos verticales
Tubos horizontales
Película descendente
Circulación forzada
Combustión sumergida
Solar
Especiales

1300 a
1349

Cambiadores de calor

Carcaza y tubos
Hervidores
Doble tubo
Placas

Espiral
Tubos aletados
Serpentines
Especiales

1350 a
1399

Filtros

De presión
De gravedad
De vacío
Osmosis inversa
Especiales

1400 a
1449

Hornos

Rotatorios
Alto horno
Hogar abierto
Convertidor
Incineradores
Eléctricos
Especiales

1450 a
1499

Eyectores y sistemas de vacío

Eyectores
Bombas de vacío
Especiales

1500 a
1549

Compresores y sopladores

Centrífugos
Rotatorios
Reciprocantes
Especiales

1550 a

1599

Transportadores

De banda
De guseno
De rodillo
De rastras
Neumáticos
Vibrotorio
Especiales

1600 a

1649

Elevadores

De cadenas
De canjilones
De carga
De paletas
De personal
Especiales

1650 a

1699

Equipo Móvil y Grúas

Grúas viajeras
Grúas radiales
Monorrieles
Camiones y camionetas
Montacargas
Diablos
Especiales

1700 a

1749

Bombas

Centrífugas
Periféricas
Desplazamiento positivo
Especiales

1750 a

1799

Molinos y Trituradores

De quijada
De martillos
De bolas
De barras
De cilindros
Micro pulverizadores
Especiales

1800 a

1849

Reactores

Químicos
Nucleares
Especiales

1850 a

1899

Separadores y centrifugadores

Centrífugos
Choque
Gravedad
Electrostáticos
Especiales

1900 a

1949

Tanques y Tolvas

Recipientes atmosféricos
Tolvas
Especiales

1950 a

1999

Tanques a presión

Recipientes a presión
Especiales

2000 a

2019

Plantas paquete

Tratamiento de agua
Tratamiento interno de calderas y torres de enfriamiento
Unidades de refrigeración
Generadores de gas inerte
Sistemas de aire acondicionado

2050 a

2999 Disponibles

3000 a

3399 Tuberías, válvulas y accesorios

3000 Tuberías

3001 Acero al carbón

3005 Aluminio

3010 Acero inoxidable

3015 Cobre y bronce

3020 Fierro fundido

3025 P V C

3030 Recubiertas

3035 Vidrio

3040 Aleaciones y materiales especiales

3045 Asbesto-Cemento

3050 a

3099 Disponibles

3100 Accesorios

3101 Acero al carbón

3105 Aluminio

3110 Acero inoxidable

3115 Cobre y bronce

3120 Fierro fundido

3125 P V C

3130 Recubiertas

3135 Vidrio

3140 Aleaciones y materiales especiales

3145 Asbesto-cemento

3150 a	
3199	<u>Disponibles</u>
3200	<u>Válvulas</u>
3201	Acero al carbón
3205	Aluminio
3210	Acero inoxidable
3215	Cobre y bronce
3220	Fierro fundido
3225	P V C
3230	Recubiertas
3235	Vidrio
3240	Aleaciones y materiales especiales
3245 a	
3299	Disponibles
3300	<u>Tornillos, espárragos y empaques</u>
3301 a	
3999	Disponibles
A.3 3400 a	
3799	<u>DUCTERIA, AISLAMIENTO, SOPORTERIA Y PINTURA</u>
3400	<u>Ductería</u>
3401	Acero al carbón
3405	Aluminio
3410	Acero inoxidable
3415	Recubiertas
3420	Aleaciones y materiales especiales
3425 a	
3499	Disponibles
3500	<u>Aislamiento</u>
3510	Obra Civil
3520	Equipos
3530	Tuberías y accesorios

3535 a
3599 Disponibles

3600 Soportería

3610 Obra Civil
3620 Equipo
3630 Tuberías
3640 Obra eléctrica
3645 a
3699 Disponibles

3700 Pintura

3710 Obra Civil
3720 Equipo
3730 Tubería
3740 Obra eléctrica
3745 a
3799 Disponibles

A.4 3800-4
3999 PRUEBAS, ALTERACIONES Y CARGOS A TERCEROS

3800 Pruebas, para terminación mecánica

3810 Arranque y preoperación

3820 a
3899 Disponibles

3900 Alteraciones

3910 Ingeniería
3920 Construcción

3930 a
3949 Disponibles

3950 Cargos a Terceros

3960 a
3999 Disponibles

A.5 4000 a
4999

OBRA ELECTRICA

4000 Tierras y pararrayos.

Conductores eléctricos y accesorios para conexio-
nes.

Electrodos, puntas de pararrayos y rehilctes

Disponibles

4100 Fuerza Alta Tensión y Subestaciones

Conduit y accesorios (para conduits)

Charolas y ductos

Conductores eléctricos y accesorios

Tableros

Transformadores

Interruptores, desconectadores, fusibles y arran-
cadores.

Condensadores, resistencias, reactores, limitado-
res de corriente de corto circuito.

Generadores

Baterías, cargadores, inversores.

Disponibles

4200 Fuerza baja tensión y Control

Conduits y accesorios (para conduits)

Charolas y ductos

Conductores eléctricos y accesorios para conexio-
nes.

Tableros

Transformadores

Interruptores, desconectadores, fusibles y arran-
cadores.

Condensadores, resistencia y reactores, limitado-
res de corriente de corto circuito.

Generadores

Baterías, cargadores, inversores

Artefactos eléctricos

Disponibles

4300 Alumbrado y Contactos Monofásicos

Conduits y accesorios (para conduits)
Conductores eléctricos y accesorios para conexio-
nes.
Tableros
Transformadores
Interruptores, desconectadores, fusibles y arran-
cadores.
Unidades de iluminación
Artefactos eléctricos
Disponibles

4400 Sistema de Comunicaciones, señalización y alarmas

Teléfonos
Sonido
Relojes
Alarmas
Conduits y accesorios (para conduits)
Conductores eléctricos y accesorios para conexio-
nes.
Tableros
Interruptores, desconectadores, fusibles y arran-
cadores.
Baterías, cargadores, inversores
Aparatos, bocinas
Artefactos eléctricos
Disponibles

A.6 4500 a
4999

INSTRUMENTACION

4500 Aparatos de Control y/o Medición

Transmisores.- Pueden ser de: Temperatura, siste-
ma termal, medición tipo potenciómetro, presión, -
presión diferencial, nivel, gasto, densidad, aná-
lisis peso, velocidad, nivel no diferencial, etc.

Rotámetros.- Pueden ser de: Transmisores, regis-
tradores, indicadores, etc.

Medidores

Receptores.- Pueden ser de: Gráfica circular, ti-
po miniatura, gráfica circular con control, tipo
miniatura con control, etc.

Indicadores.- Pueden ser: de Temperatura, siste-
ma termal, indicadores de sistema termal con con-
trol, tipo potenciómetro, tipo potenciómetro de
control, de precisión, de presión con control, --
análisis, nivel, análisis con control, presión di-
ferencial, presión diferencial con control, etc.

Manómetros

Switches

Controladores ciegos

Disponibles

4600 Tableros de control de Instrumentación

Frentes de tablero abiertos por detrás.

Gabinetes

Tableros con estructura para salas de instrumen-
tos

Tableros gráficos

Consolas

Disponibles

4700 Conductores de señales

Tubo de cobre

Tubo de plástico

Multitubo (bundle de cobre)

Multitubo (bande de plástico)

Accesorios (fittings) para tubería aire instrumentos

Disponibles

4800 Líneas de Alimentación

Tubo galvanizado

Tubo de cobre
Accesorios
Válvulas de aislamiento

Disponibles

4900 Elementos finales de control

Válvulas neumáticos
Válvulas eléctricas
Válvulas hidráulicas
Válvulas auto-operadas
Actuadores pueden ser: Neumáticos, eléctricos, -
hidráulicos, etc.
Reactores saturables
Rectificadores de silicio controlados.

Disponibles

5000 CONSULTORIAS Y ESTUDIOS

Consultoría Técnica
Consultoría Jurídica
Consultoría de Avalúos
Consultoría de Mercadotecnia
Mecánica de Suelos
Perforación de pozos profundos
Topografía

Disponibles

5100 a

6099

Disponibles.

CODIGOS COSTOS INDIRECTOS

9601 PERSONAL TECNICO
9602 PERSONAL ADMINISTRATIVO
9603 PERSONAL DE COMPRAS
9604 PERSONAL DE CONTROL DE COSTOS
9605 PERSONAL DE PROGRAMACION
9606 PERSONAL DE ALMACEN
9607 PERSONAL DE VIGILANCIA
9608 a
9619 DISPONIBLES
9620 OFICINA
9621 ASIST. TECNICA ENTRE DIRECCIONES
9622 CARGOS PROYECTOS Y OBRAS TERMINADAS
9623 PRUEBAS Y ENTRENAMIENTO No. 1
9624 PRUEBAS Y ENTRENAMIENTO No. 2
9625 NORMAS Y PROCEDIMIENTOS
9626 PERSONAL EN TRANSITO
9627 PROMOCIONES
9628 DISPONIBLE
9629 DIAS FERIADOS

9630 INCAPACIDADES

9631 PERMISOS CON GOCE DE SUELDO

9632 OTRAS PERCEPCIONES Y VIATICOS

9633 PERMISO SIN GOCE DE SUELDO

9634 VACACIONES

9635 SEGURO SOCIAL CONT. PATRONAL

9636 IMP. 1% ADICIONAL I.S.P.T.

9637 GRATIFICACIONES

9638 AGUINALDOS

9639 VIVIENDA TRABAJADORES- PATRONAL

9640 LIMPIEZA Y MANTENIMIENTO

9641 HONORARIOS (Terceros)

9642 GASTOS DE FIN DE AÑO

9643 MATERIAL DE DIBUJO

9644 COPIAS FOTOSTATICAS

9645 RENTAS DE INMUEBLES

9646 INSTALACIONES PROVISIONALES

9647 AMORT. GASTOS INSTALACION

9648 RENTAS EQUIPO Y MAQ. (PROP. DE LA EMPRESA)

9649 RENTAS EQUIPO OFICINA (PROP. DE LA EMPRESA)

9650 RENTAS EQUIPOS Y MAQ. (Terceros)

9651 REP. MENORES Y REFACCIONES

9652 REP. MAYORES Y REFACCIONES

9653 LUZ, FUERZA Y AGUA

9654 EFECTOS Y UTILES DE ESCRITORIO

9655 COMUNICACIONES

9656 GASTOS DE VIAJES

9657 HIGIENE Y SEGURIDAD

9658 GASTOS SINDICALES

9659 FLETES Y ACARREOS

9660 RELACIONES PUBLICAS Y ATENCIONES

9661 CONTROL DE CALIDAD Y PRUEBAS

9662 HERRAMIENTA CONSUMIBLE

9663 HERRAMIENTAS MENORES

9664 MATERIALES DE CONSUMO

9665 DEPRECIACION

9666 OTROS IMPUESTOS Y DERECHOS

9667 SEGUROS DE DAÑOS

9668 SEGUROS Y FIANZAS

9669 GASTOS NO DEDUCIBLES

9670 DONATIVOS EXENTOS

9671 OTROS GASTOS

9672 a

9699 DISPONIBLES

INSTRUCTIVO PARA DESARROLLAR CUBICACIONES
OBRA CIVIL

El presente instructivo ha sido formulado para que el trabajo de cubicación se elabore bajo un mismo criterio, así mismo se establecen formas para que se lleve un determinado orden de operaciones que faciliten su revisión.

CUBICACION

En la obtención de volúmenes, superficies, longitudes, unidades y piezas de los elementos que intervienen en la construcción, generalmente ésta se elabora desglosada, según los materiales y elementos que intervienen en una construcción.

MOTIVO

Conociendo las cantidades de materiales que intervienen en la obra, podrá asignárseles el costo correspondiente, tanto por el material mismo, como por la mano de obra necesaria para la colocación de estos en su posición definitiva.

CONSIDERACIONES BASICAS

Se deberá comenzar calculando el área del edificio por cubicar, que servirá como referencia general, dividiéndola en áreas interiores y exteriores.

Al estar efectuando la cubicación, es necesario de alguna manera ir señalando sobre el plano, los conceptos ya considerados, así como indicar los errores de diseño observados a simple vista. Para ésto utilizaremos colores como sigue:

Amarillo	}	Conceptos ya considerados
Café		
Azul		
Negro		

Rojo { correcciones al diseño e
indicaciones al mismo.

Es frecuente también, que una parte del sistema no se haga - necesario cubicar y entonces tenemos que diferenciarla de la parte que se va a tomar en cuenta, para lo que utilizaremos el color verde, pintando con el, lo que no se considere o elimine.

La descripción de los materiales deberá de hacerse de acuerdo a lo indicado en los planos y en las especificaciones de diseño y construcción, dándose preferencia a los planos.

FORMAS

Las formas impresas que se utilizan en la cubicación civil, son las siguientes:

- 1) Forma LM-1 Denominada hoja de trabajo.
- 2) Forma LM-2 " " " "

01 CIMENTACION

1) LIMPIEZA Y TRAZO

M2

Para cubicar este concepto se determinará el área del edificio en planta baja, considerando sus dimensiones entre ejes con 2 metros adicionales perimetralmente. (Ver Fig. I)

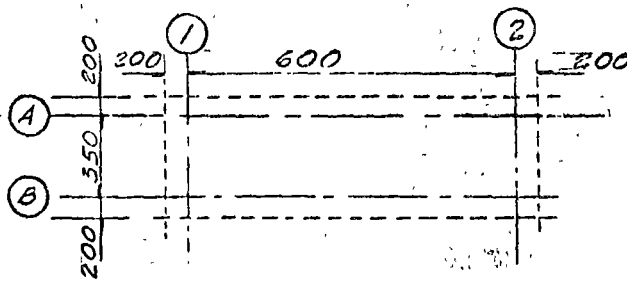


Figura I

- | | | |
|----|---------------------------------|---------------|
| 2) | DEMOLICIONES (Indicar material) | Pza., M2 ó M3 |
| 3) | DRENADO DEL TERRENO | M3 |
| 4) | POZO DE BOMBEO | Pza. |
| 5) | EXCAVACION | M3 |

Indicar si es a mano o a máquina, considerando una franja perimetral según los siguientes desplantes: (Ver Fig. 2)

- a) De 0.00 a 2.00 Mts. una franja de 0.50 mts.
- b) De 2.00 a 4.00 Mts. una franja de 0.80 mts.
- c) De 4.00 a 6.00 Mts. una franja de 1.20 mts.
- d) De 6.00 a 8.00 Mts. una franja de 1.50 mts.
- e) De 8.00 a 10.00 Mts. una franja de 1.75 mts.

Nota: Cuando la separación entre dos excavaciones sea menor o igual a 50 cms. se excavará corrido.

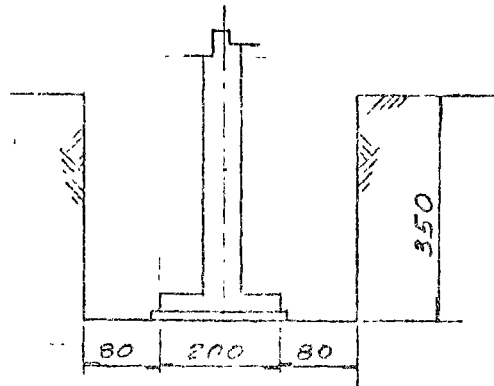


Figura 2

6) EXCAVACION PARA TUBERIA

M3

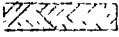

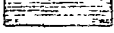
(Considerar una franja según los siguientes diámetros).

DIAMETRO		ANCHO en cms.	PROFUNDIDAD en cms.
mm.	pulg.		
76	3	60	100
102	4	60	105
152	6	60	110
203	8	70	115
254	10	70	120
305	12	80	125
356	14	80	130
406	16	90	135
457	18	90	140
508	20	110	140
610	24	120	160
762	30	140	175
914	36	160	210

7) RELLENO PRODUCTO DE LA EXCAVACION

M3

(Indicar procedencia) c/mat. de excavación o c/material de banco.

El volumen total de excavación  menos el volumen del concreto  igual a relleno
(Ver Fig. 3) 

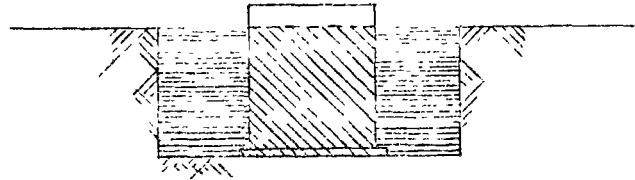



Figura 3

8) ACARREO DE MATERIAL SOBRANTE, PRODUCTO DE LA EXCAVACION. M3

El volumen total desplazado por elementos de cimentación  mas un X % de abundamiento.
(Ver figura 4)

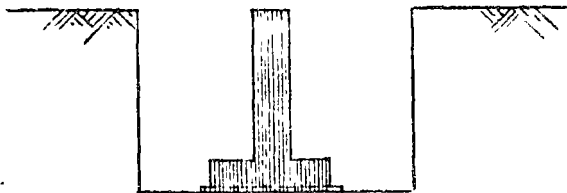


Figura 4

- 9) ATAGUIA (Indicar material, profundidad e hincado) ML. ó PZA.
- 10) PILOTES (Indicar tipo, material, profundidad, diámetro, longitud) (Ver Fig. 5) PZA.

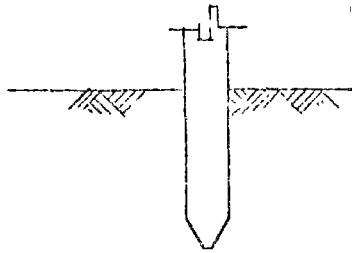


Figura 5

- 11) PILAS (Indicar tipo, material, profundidad, diámetro, longitud) (Ver Fig. 6) PZA.

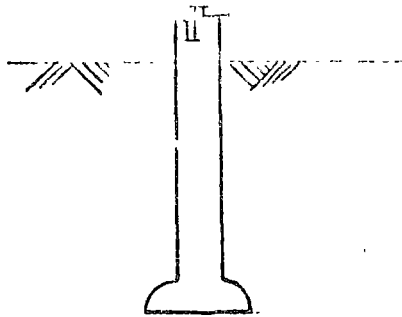


Figura 6

- 12) PLANTILLA DE CONCRETO M2

Indicar material y espesor. A la superficie de la

sección de desplante se le sumará una franja perimetral de 10 cms. de ancho a menos que se indique otra dimensión. (Ver Fig. 7)

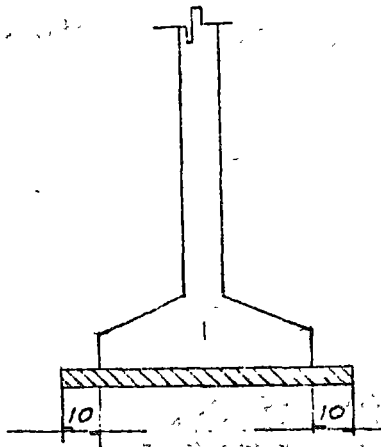


Figura 7

13) CIMENTACION DE MAMPOSTERIA O MUROS.

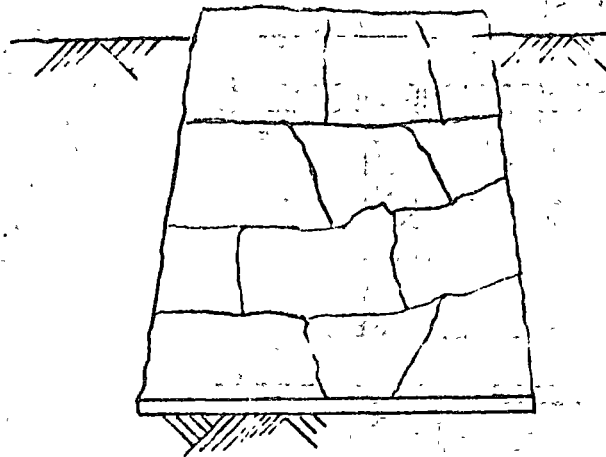


Figura 8

CONCRETO: Para ubicar este elemento en cimentación o estructura, se pueden tomar las dimensiones a ejes sin considerar desperdicio.

- 14) CONCRETO EN ZAPATAS. (Indicar resistencia y especificaciones en general) M3
(Ver Fig. 9)

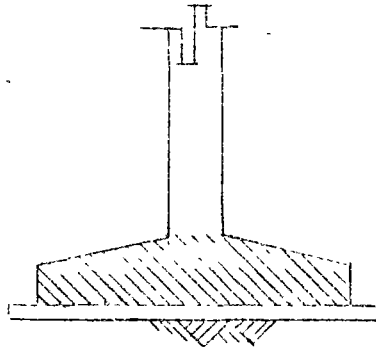


Figura 9

- 15) CONCRETO EN DADOS (Indicar resistencia) M3
(Ver Fig. 10)

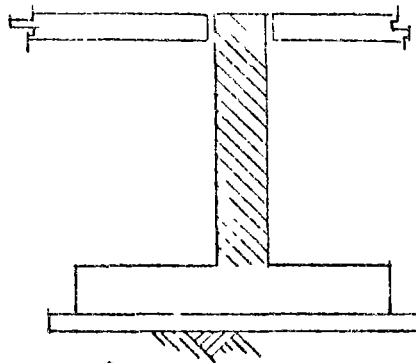


Figura 10

- 16) CONCRETO EN CONTRATRABES (Indicar resistencia)
(Ver Fig. 11)

M3



Figura 11

- 17) CONCRETO EN LOSAS DE CIMENTACION Y MUROS
DE RETENCION (Indicar espesores)
(Ver Fig. 12)

M3

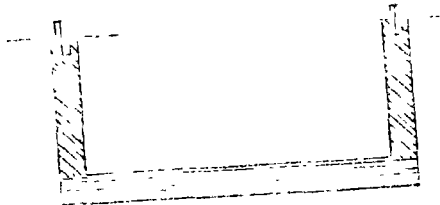


Figura 12

- 17') CONCRETO EN CASCARONES DE CIMENTACION
(Indicar resistencia y espesor)
(Ver Fig. 13)

M3

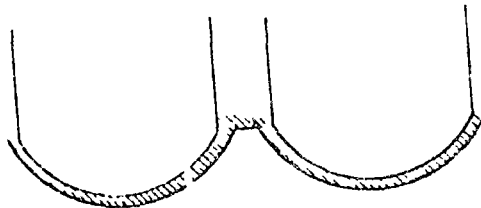


Figura 13

18) CONCRETO EN BASES DE EQUIPO (Indicar resistencia)
(Ver Fig. 14)

M3

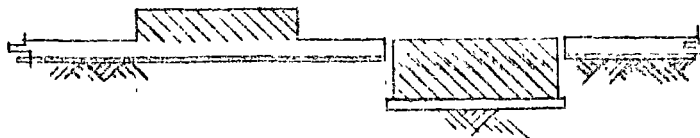
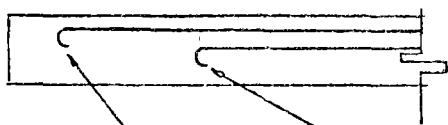


Figura 14

ACERO DE REFUERZO

Al cubicar el acero de refuerzo no se considerarán desperdicios, solamente ganchos, traslapes y escuadras.

DIAMETRO #	PULG.	GANCHOS PARA ESTRIBOS	GANCHOS EN CABECE- RA O IN- TERMEDIOS	TRASLAPES	ESCUA- DRAS.
2	1/4"	8	11	25	10
2.5	5/16"	10	13	25	15
3	3/8"	12	15	30	18
4	1/2"	18	19	40	24
5	5/8"	24	23	50	30
6	3/4"		30	60	35
7	7/8"		34	70	40
8	1"		46	80	50
10	1 1/4"		59	100	64
12	1 1/2"		70	120	70



gancho de
cabecera

gancho
intermedio

Figura 15

19) ACERO DE REFUERZO: a) ZAPATAS. (Ver Fig. 16)

Kgs.

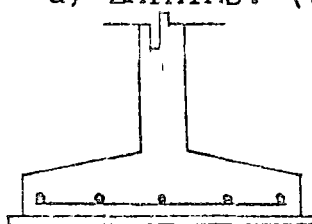


Figura 16

b) DADOS.

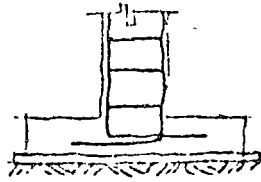


FIG. (17)

c) CONTRATEABES.

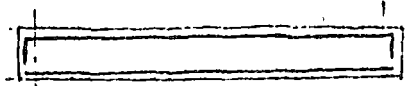


FIG. (18)

d) LOSAS DE CIMENTACION

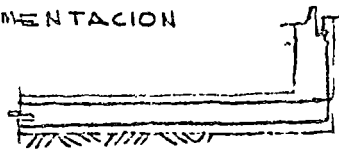


FIG. (19)

e) MUROS DE RETENCION .

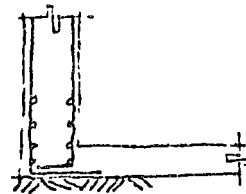


FIG (20)

f) BASES DE EQUIPO.

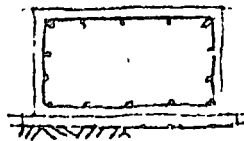


FIG. (21)

20) REGISTROS EN CONTRATEABES DE CIMENTACION. (INDICAR DIMENSIONES)

PZA.

21) IMPERMEABILIZACION INTEGRAL.

M²

(INDICAR DOSIFICACION)

22) RECIBIR ESTRUCTURA METALICA, CONCRETO EXPANSIVO

M²

(INDICAR DOSIFICACION Y ESPESOR)

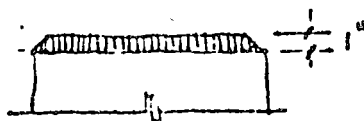


FIG (22)

23) ANCLAS, INCLUYENDO COLOCACION

PZA.

(INDICAR TIPO, DIAMETRO, DIMENSION Y CAMISA)

* CIMBRA. PARA CUBICAR ESTA PARTIDA SE CALCULARA LA SUPERFICIE EN CONTACTO CON EL ELEMENTO DE CONCRETO DE QUE SE TRATE, SE DEBE SEPARAR LOS ELEMENTOS INDICANDO TIPO DE CIMBRA APARENTE, TRIPUSY, OUELA, ETC.

20) CIMBRA EN a) ZAPATOS

M²

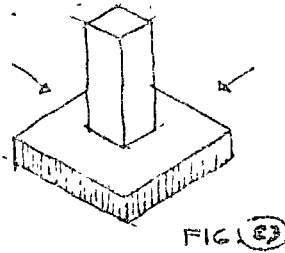


FIG. (23)

b) DADOS.

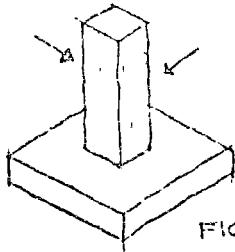


FIG. (24)

c) CONTRAABRIGOS.

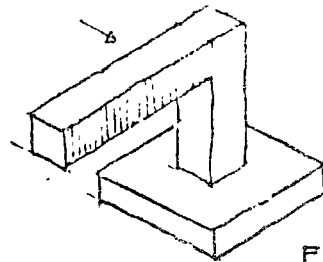


FIG. (25)

d) LOSA DE CIMENTACION

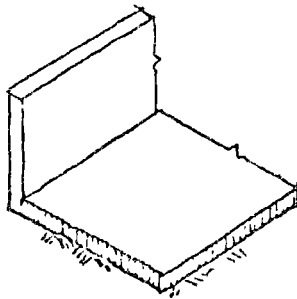


FIG. (26)

e) MUROS DE RETENCION

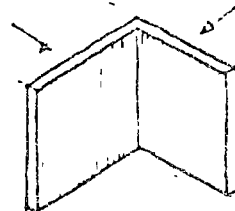


FIG. (27)

= 77 =

f) BASES DE EQUIPO.

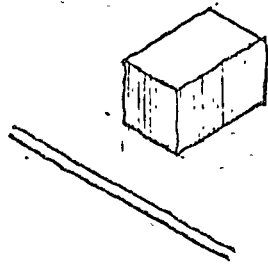
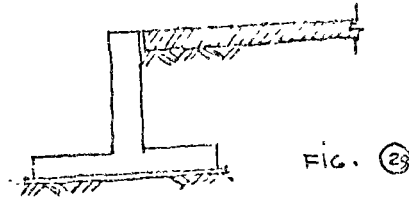


FIG. (28)

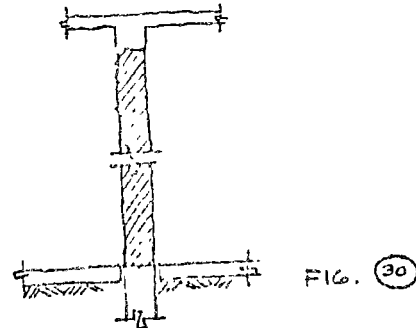
= 16 =
02. ESTRUCTURA

1) CONCRETO EN LOSA DE PISO.
(INDICAR RESISTENCIA)



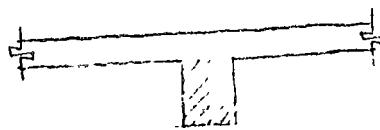
M³

2) CONCRETO EN COLUMNAS.
(INDICAR RESISTENCIA)



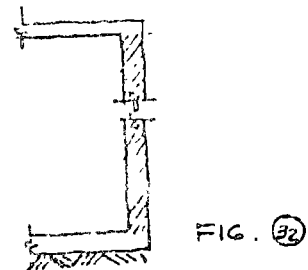
M³

3) CONCRETO EN TRABES.
(INDICAR RESISTENCIA)



M³

4) CONCRETO EN MUROS.
(INDICAR RESISTENCIA)



M³

5) CONCRETO EN LOSAS DE ENTREPISO Y AZOTEA.
(INDICAR RESISTENCIA)



M³

M.³

6) CONCRETO EN CASCARONES.

(INDICAR RESISTENCIA)

M.³ 1/2

7) CONCRETO EN LOSA RETICULAR

(INDICAR SI INCLUYE BLOCKS Y SONOTUBO Y RESISTENCIA DEL CONCRETO.)

M.³

8) CONCRETO EN ESCALERAS.

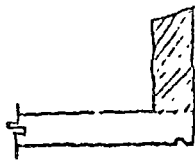
(INDICAR RESISTENCIA)



FIG. 24

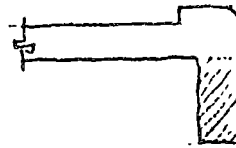
9) CONCRETO EN PRETILES Y FALDONES.

M.³



PRETEL

FIG. 25



FALDON

10) ACERO DE REFUERZO EN:

a) LOSA DE PISO (MALLA, LAC O ACERO DE REF.)

MALLA LAC (SUMANDO 10.2 COP. 25)

KGS.
M²

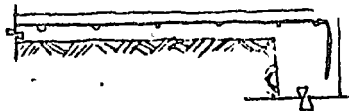


FIG. 26

b) COLUMNAS.

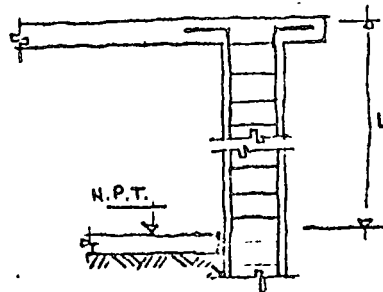


FIG 27

c) TRABES.

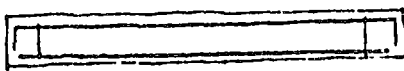


FIG. 28

d) MUROS



FIG. (39)

e) LOSAS

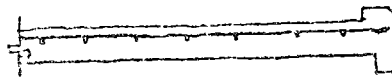


FIG. (40)

f) CASCARONES

g) ESCALONES

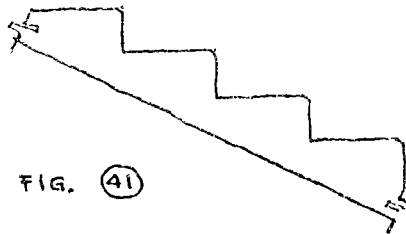
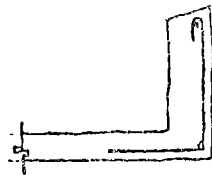
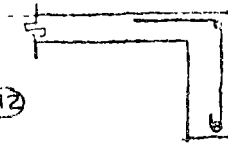


FIG. (41)

h) PRETILES Y FALDONES



PRETIL



FALDON.

FIG. (42)

11) ELEMENTOS DE ESTRUCTURA PRECOLADOS.

PZA.

12) ELEMENTOS DE ESTRUCTURA PREFORZADOS

PZA.

13) ELEMENTOS DE ESTRUCTURA POSTENSADOS

PZA.

14) CIMBRA EN:

a) LOSA DE PISO.

M²

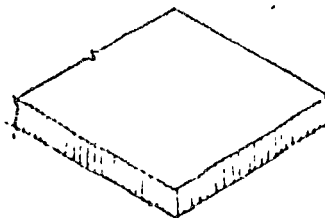


FIG. (43)

b) COLUMNAS.

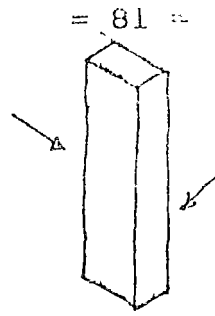


FIG. (44)

c) TRABES.

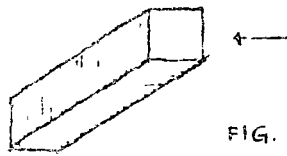


FIG. (45)

d) MUROS.

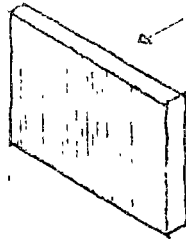


FIG. (46)

e) LOSAS DE ENTREPICO Y AZOTEA.

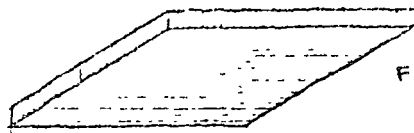


FIG. (47)

f) CASCARONES

g) ESCALONES.

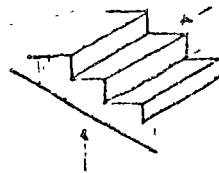


FIG. (48)

h) PRETILES Y FALDONES

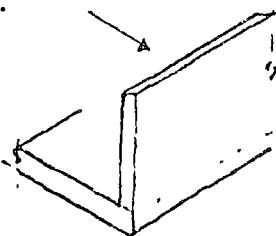
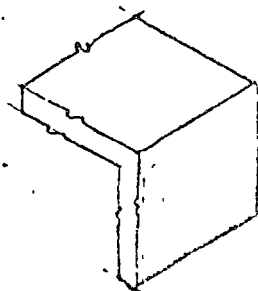


FIG. (49)



- 15) ESTRUCTURA DE ACERO (LIGERA, SEMIPEBADA, PESADA) M³.
- a) COLUMNAS.
 - b) TRABES.
 - c) ARMADURAS PRINCIPALES.
 - d) ARMADURAS SECUNDARIAS.
 - e) CONTRAVIENTOS.
 - f) CONEXIONES.
- 16) REJILLA IRVING M²
(INDICAR MATERIAL Y TIPO) "
- 17) ESCALONES IRVING M²
(INDICAR MATERIAL Y TIPO)
- 18) PLACA ANTIDESLIZANTE M²
(INDICAR ESPESOR)
- 19) BARANCALES ML.
(INDICAR DIMENSIONES Y SEPARAR POR TIPO)
- 20) ESCALERAS MARINAS ML.
(INDICAR DIMENSIONES Y SEPARAR POR TIPO)
- 21) PROTECCION ESCALERAS MARINAS ML.
(INDICAR DIMENSIONES Y SEPARAR POR TIPO)
- 22) ESCALERAS METALICAS ML.
(INDICAR DIMENSIONES Y SEPARAR POR TIPO)
- 23) PLATAFORMAS M²
(INDICAR DIMENSIONES Y SEPARAR POR TIPO)
- 24) PASARELAS M²
(INDICAR DIMENSIONES Y SEPARAR POR TIPO)
- 25) LOSAS DE SIPOREX M²
- 26) BLOCKS DE LOSA RETICULAR PZA.
(INDICAR DIMENSIONES Y TIPO)
- 27) TECHOS DE LAMINA M²
(ASBESTO, PLASTICO, ACERO)

28) CUMBRERA, REJATES.

(INDICAR MATERIAL)

29) JUNTAS EN LOSA DE PIED.

ML.

a) JUNTAS DE CONTRACCION.

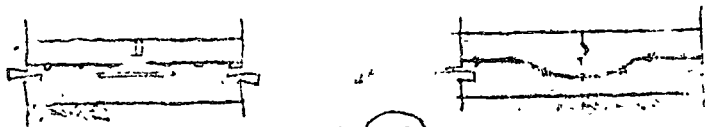


FIG. (50)

b) JUNTAS DE COLADO.



FIG. (51)

c) JUNTAS DE EXPANSION.

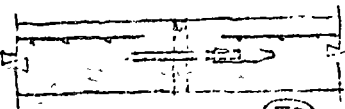


FIG. (52)

d) JUNTA DE CONSTRUCCION

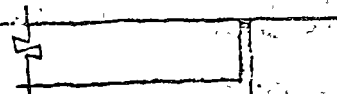


FIG. (53)

= 34 =
OB. ALBAÑILERÍA

1) FIRMES DE CONCRETO.

(INDICAR ESPESOR Y RESISTENCIA)

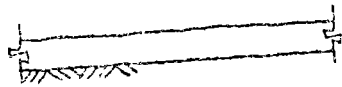


FIG. (54)

M²

2) MUROS DE TABIQUE RECOCIDO.

(INDICAR DIMENSIONES Y COLOCACION)

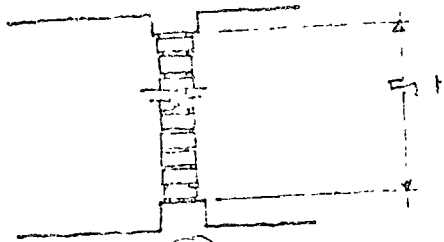


FIG (55)

M²

3) MUROS DE TABIQUE LIGERO O TABICON.

(INDICAR DIMENSIONES Y COLOCACION)

M²

4) MUROS DE TABIQUE COMPRIMIDO

(INDICAR DIMENSIONES Y COLOCACION)

M²

5) MUROS BLOCK HUECO VIDRIADO

(INDICAR DIMENSIONES Y COLOCACION)

M²

6) MUROS BLOCK HUECO RECOCIDO

(INDICAR DIMENSIONES Y COLOCACION)

M²

7) MUROS TABIQUE REFRACTARIO.

(INDICAR DIMENSIONES Y COLOCACION)

M²

8) MUROS TABIQUE ANTIACIDO

(INDICAR DIMENSIONES Y COLOCACION)

M²

9) MURO BLOCK CONCRETO.

(INDICAR DIMENSIONES Y COLOCACION)

M²

10) MURO PIEDRA.

(INDICAR DIMENSIONES, COLOCACION Y ACABADO)

M²

11) MURO BLOCK VIDRIO

(INDICAR DIMENSIONES Y COLOCACION)

12) MURO DE CELOCIA.

(INDICAR TIPO, DIMENSIONES Y COLOCACION)

ML.

13) CASTILLOS AHOGADOS EN EL BLOCK.

(INDICAR REFUERZO Y RESISTENCIA DEL CONCRETO)

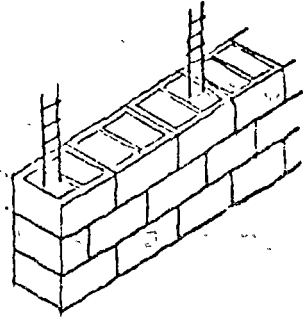


FIG. (56)

DE CONCRETO

14) CASTILLOS. (INDICAR DIMENSIONES Y REFUERZO)

ML.

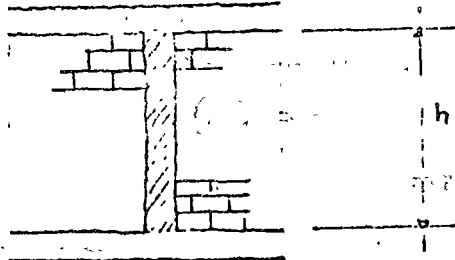


FIG. (57)

15) CADENAS DE CONCRETO.

(INDICAR DIMENSIONES Y REFUERZO.)

ML.

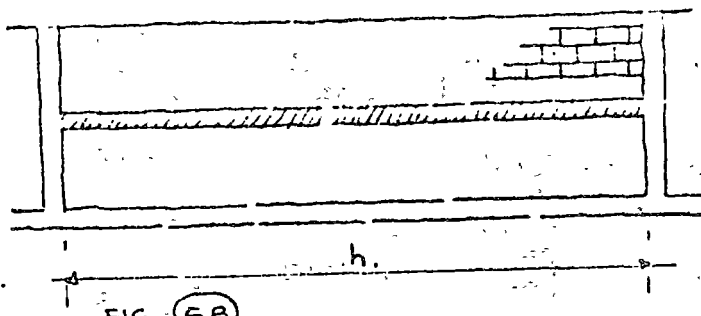


FIG. (58)

16) CERRAMIENTOS DE CONCRETO.

(INDICAR DIMENSIONES Y REFUERZO)

ML.

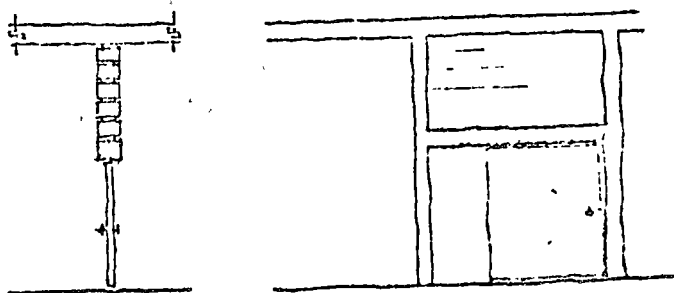


FIG. (59)

ML.

17) REPIZON DE CONCRETO.

(INDICAR DIMENSIONES Y ACERO DE REFUERZO)

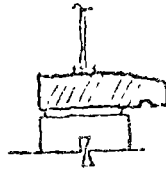


FIG. (60)

ML.

18) DALA DE CONCRETO.

(INDICAR DIMENSIONES Y ACERO DE REFUERZO)

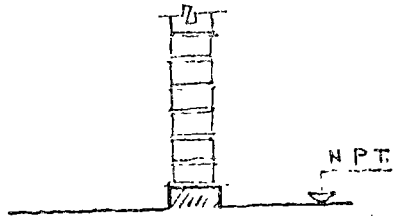


FIG. (61)

ML.

19) CHAFLAN DE CONCRETO.

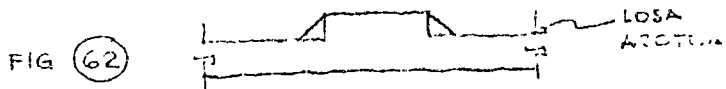


FIG (62)

ML.

20) IMPERMEABILIZACION DE SPLANTE DE MUROS

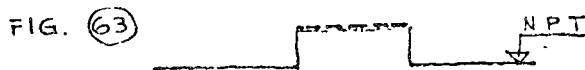


FIG. (63)

M²

21) IMPERMEABILIZACION EN MUROS.

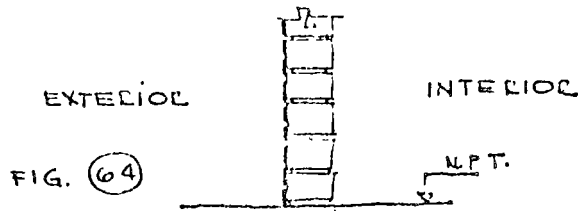


FIG. (64)

M²

22) IMPERMEABILIZACION CUBIERTA DE SIPOREX.

23) IMPERMEABILIZACION CUBIERTA DE CONCRETO

M²

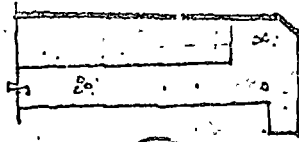


FIG. (65)

✓ 24) IMPERMEABILIZACION LOSAS DE CIMENTACION

M²

25) IMPERMEABILIZACION CUBIERTAS DE CASCARON.

M²

26) RELLENO Y ENTORTADO.

M²

(INDICAR MATERIAL Y ESPESOR)



FIG. (66)

27) ENLADILLADO DE AZOTEA.

M²

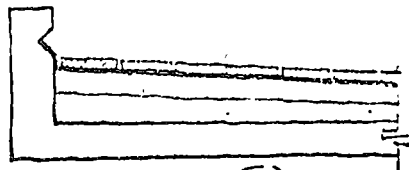


FIG. (67)

28) SACOINELAS.

ML.

(INDICAR DIMENSIONES Y REFUERZOS)

29) RODAPIE.

ML.

(INDICAR MATERIAL Y DIMENSIONES)

04 - MUEBLES E INSTALACION SANITARIA E HIDRAULICA.

PZA.

1) INODORO.

(INCLUYENDO ASIENTO, MARCA Y TIPO.)



PZA.

2) LAVABOS.

(MARCA Y TIPO)

PZA.

3) BIDEETS

(MARCA Y TIPO)

PZA.

4) MINGITORIOS

(MARCA Y TIPO)

PZA.

5) FUENTE BRADLEY

(INCLUYENDO INSTALACIONES)

PZA.

6) BEBEDEROS.

(MARCA Y TIPO)

PZA.

7) VERTEDEROS.

PZA.

8) FITOGUARDAS.



PZA.

9) - REFINERIAS - - - - -
10) X ACCESORIOS PARA BAÑO.

a) PAPELERAS.

b) JAPONESAS.

c) TOALLEROS.

d) GANCHOS.

e) GOTEROS.

SALIDA

11) 10) INSTALACION MUEBLES SANITARIOS.

a) INODORO.

b) MINGITORIO.

c) LAVABO.

d) VERTEDEROS.

e) REGADERAS.

f) FLEGADEROS.

g) BEBEDEROS.

h) Bideets

PZAS

12) 10A) FLUXOMETROS. (INDICAR MARCA Y TIPO)

CEBRUPUR EN MUEBLES MINGITORIOS BIDEETS



30) REGISTROS DE TABIQUES.

PZA.

(INDICAR DIMENSIONES, ACABADO Y TAPA.)

31) REGISTROS DE CONCRETO.

PZA.

(INDICAR DIMENSIONES, ACABADO Y TAPA)

32) COLOCACION DE PUERTAS Y MARCOS.

M².

M².

33) COLOCACION VENTANERIA

M².

34) COLOCACION CLOSETS.

PZA

(INDICAR DIMENSIONES)

35) COLOCACION CORTINAS METALICAS

M².

M².

36) COLOCACION BARANDALES.

ML.

37) COLOCACION MAMPARAS.

M².

38) COLOCACION CHAMBRANA METALICA.

ML.

39) COLOCACION TINACOS.

PZA.

40) COLOCACION CALENTADORES.

PZA.

41) COLOCACION MUEBLES SANITARIOS:

PZA.

a) INODOROS

b) MINGITORIOS

c) LAVABOS.

d) BIDEETS.

e) VERTEDEROS

42) COLOCACION ACCESORIOS PARA BAÑO.

PZA.

a) PAPELETAS.

b) GANCHOS PARA WC.

c) JABONERA

d) TOALLERO

e) GOTEROS.

43) FOLJADO DE ESCALONES

PZA.

(INDICAR DIMENSIONES)

44) ALFAR DAS.

ML.

(INDICAR DIMENSIONES)

50) TRINCHERAS.

ML

(INDICAR DIMENSIONES Y MATERIAL)

51) MAESTELINADO.

M²

(INDICAR MUROS, COLUMNAS, TECHO, ETC.)

= 91 =

05 - HERBERIA

- 1) PUERTAS. PZAS.
(INDICAR MATERIAL, SEPARAR POR TIPO Y DIMENSIONES)
- 2) VENTANAS. PZAS.
(INDICAR MATERIAL, SEPARAR POR TIPO Y DIMENSIONES)
- 3) COCTINULS METALICAS. M².
(INDICAR MATERIAL Y SEPARAR POR TIPO)
- 4) MAMPARAS PARA BAÑOS. M².
(INDICAR MATERIAL Y DIMENSIONES)
- 5) CANCELLES. M².
(INDICAR MATERIAL Y SEPARAR POR TIPO)
- 6) REJAS. M².
(INDICAR DIMENSIONES Y TIPO)
- 7) FLASHING. ML.
(INDICAR MATERIAL, DIMENSIONES, SEPARAR POR TIPO)
- 8) TAPA. JUNTS.S. ML.
(INDICAR MATERIAL Y DIMENSIONES.)
- 9) REPIZONES METALICOS. ML.
(INDICAR MATERIAL Y DIMENSIONES)
- 10) CELOCIAS METALICAS. M².
(INDICAR MATERIAL Y DIMENSIONES)
- 11) MOSQUITEROS. M².
(INDICAR MATERIAL)
- 12) MOLDURAS. ML.
(INDICAR MATERIAL Y DIMENSIONES)
- 13) CAMPANAS. PZAS.
(INDICAR MATERIAL Y DIMENSIONES.)
- 14) DUCTOS. ML.
(INDICAR MATERIAL Y DIMENSIONES)
- 15) ENREJADOS O ALAMBRADOS. M².
(TIPO DE MATERIAL, MARCA)

06. CARPINTERIA

- 1) PUERTAS. PZA.
(INDICAR DIMENSIONES, CLASE Y SEPARAR POR TIPO)
- 2) VENTANAS. PZA.
(INDICAR DIMENSIONES, CLASE Y SEPARAR POR TIPO)
- 3) CLOSETS. PZA.
(INDICAR DIMENSIONES, CLASE Y SEPARAR POR TIPO)
- 4) LAMBLINES. M²
(INDICAR CLASE E INCLUIR BASTIDOR Y MEDIDAS)
- 5) PLAFONES. M²
(INDICAR CLASE Y SEPARAR POR TIPO)
- 6) BARRANDAS. ML.
(INDICAR DIMENSIONES, PASAMANOS, SEPARAR POR TIPO)
- 7) CANCELES. PZA.
(INDICAR CLASES, SEPARAR POR TIPO Y DIMENSIONES)
- 8) CELOSIAS M²
(SEPARAR POR TIPO)
- 9) VIGAS PZA.
(INDICAR CLASE)
- 10) ESCALONES PZA.
(INDICAR CLASE, SEPARAR POR TIPO)
- 11) REPISONES ML.
(INDICAR DIMENSIONES)

07. ACABADOS

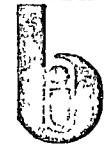
= 93 =

- 1) RECUBRIMIENTO DE MOSAICO M.²
(SEPARAR MUROS DE PISO)
- 2) RECUBRIMIENTO DE CERAMICA M.²
(SEPARAR MUROS DE PISO)
- 3) RECUBRIMIENTO DE GRANITO M.²
(SEPARAR MUROS DE PISO)
- 4) RECUBRIMIENTO DE AZULEJO M.²
(SEPARAR MUROS DE PISO)
- 5) RECUBRIMIENTO DE MARMOL M.²
(SEPARAR MUROS DE PISO)
- 6) RECUBRIMIENTO DE MADERA M.²
(SEPARAR MUROS DE TECHO)
- 7) RECUBRIMIENTO DE PIEDRA M.²
(SEPARAR MUROS DE TECHOS)
- 8) RECUBRIMIENTO DE LADRILLO M.²
(SEPARAR MUROS DE PISOS)
- 9) RECUBRIMIENTO LOSETA DE BARRO M.²
(SEPARAR MUROS DE PISOS)
- 10) RECUBRIMIENTO DE PLASTICO M.²
(SEPARAR MUROS DE TECHO)

11)

ONT.	C O N C E P T O	SECCION	ALTURA LONGITUD	CANT.	TOTAL	UNIDAD	DESCRIPCION DE OBRA

PLANTA _____
 EDIFICIO _____
 EDGAR _____
 AREA _____



BUFETE INDUSTRIAL
 DEPARTAMENTO DE CUBICACIONES
 ESTIMADO CANTIDAD DE OBRA

PROYECTO N° _____ PLANO N° _____
 ESTIMO _____ REVISO _____
 FECHA _____ HOJA _____ DE _____



SALARIOS BASE TOTALES PARA ESTUDIOS DE PRECIOS UNITARIOS
INCLUYENDO AUMENTOS POR DIAS NO LABORABLES, SEGURO SOCIAL.
INFONAVIT, Y EDUCACION.

CATEGORIA	SALARIO NOMINAL		I DIAS NO LABORABLES	II IMSS-INFO-EDUC.			III = I + II		SALARIO TOTAL
	DIA	SEMANA		(A)	(B)	(C)	FACTOR	FACTOR	
Peón	38.00	266.00	13.04		12.46		25.50	1.671	63.50
Ayudante	45.00	315.00	15.45		12.48		27.95	1.621	72.93
Albañil	60.00	420.00	20.60		16.66		37.26	1.621	97.26
Fierrero	65.00	455.00	22.31		18.04		40.35	1.621	105.35
Carpintero	70.00	490.00	24.03		19.43		43.46	1.621	113.46
Vibradorista	50.00	350.00	17.16		13.87		31.03	1.621	81.03
Chofer	60.00	420.00	20.60		16.66		37.26	1.621	97.26
Cabo	75.00	525.00	25.75		20.82		46.57	1.621	121.57
Operador	90.00	630.00	30.90		24.98		55.88	1.621	145.88
Sobrestante	120.00	840.00	41.20		33.30		74.50	1.621	194.50

Instructivo:

- I Días no laborables: Séptimo día, días festivos, días de tradición enfermedades no profesiona-
les, vacaciones, días de lluvias=81 días
Días pagados: 365 días calendario + 15 aguinaldo + 1.5 prima.381.5 días
Factor $\pm 381.5 \div (365-81) = 34.33 \%$
- II A) IMSS 19.6875% sobre salario mínimo + I y 15.9375% sobre categorías superiores + I
- B) INFONAVIT 5.0000% sobre salario nominal
- C) EDUCACION 1.0000% sobre salario nómina + I

FACTOR II Calculado = Mínimo 19.6875% de IMSS + 5% INFO + 1% EDUC.
Superior 15.9375% de IMSS+5% INFO + 1% EDUC.

MINIMO 67.1%
SUPERIOR 62.1 %

RELACION DE COSTOS DE MATERIALES
BASICOS USADOS

TIPO DE MATERIALES	UNI-DAD	PRECIO	TIPO DE MATERIAL	UNI-DAD	PRECIO	TIPO DE MATERIAL	UNI-DAD	PRECIO
Arena	M3.	45.00	Varilla de	Ton	2,512.97			
Grava	M3.	45.00	3/8" de 4000 kg/cm2.			Tubo albañal de 15 cm. ø	Pza.	4.50
			Varilla ½" de 4000 Kg/ cm2.	Ton	2,493.42	Tubo albañal de 20 cm.	Pza.	5.50
Tezontle	M3.	40.00	Varilla 5/8"			Tepetate	M3.	30.00
Cemento	Ton	375.00	de 4000Kg/cm2.	Ton	2,473.86	Triplay 5/8		
Madera	P.T.	2.70	hasta 1½"	Ton	2,453.93	1.22 x 2.44	Hoja	280.00
Agua	M3.	10.00				Block extruido		
Clavo	Kg.	4.00				6x12x24	Pza.	0.50
Alambre	Kg.	4.00				Electromalla		
						6.6-10/10	M2.	5.35
Alambrón	Kg.	2.44				Refuerzo Armex		
Varilla 3/8" de 2530 Kg/ cm2.	Ton	2,248.97				15.30.4	M1.	9.50
						Electromalla		
						6/6-6/6	M2.	9.25
						Refuerzo Armex	M1.	5.90
						10x10x3		
Varilla 5/16" de 4000 Kg/ cm2.	Ton	2,552.00	Diesel	Lt.	0.40			
			Gasolina	Lt.	1.00			
			Aceite	Lt.	5.50			

ANALISIS DE COSTOS UNITARIOS BASICOS USADOS
PARA MATERIALES

Concreto premezclado f'c=100Kg/cm². T.M.A.
40 mm.

Concreto en planta		\$ 191.00
Descuento 6%	(-)	11.46
Transporte a la obra		35.00
Ingresos Mercantiles 4%		7.18
Desperdicios 2% x \$221.72		4.43
		\$ 226.15

1
50
=

UNIDAD M3.	C.D.	\$ 226.15
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Concreto premezclado f'c=150 Kg/cm² T.M.A.
40 mm.

Concreto en planta		\$ 211.00
Descuento 6%	(-)	12.66
Transporte a la obra		35.00
Ingresos mercantiles 4%		7.96
Desperdicios 2% x\$241.30		4.82
		\$ 246.12

UNIDAD M3.	C.D.	\$ 246.12
------------	------	-----------

ANALISIS DE COSTOS UNITARIOS BASICOS USADOS PARA
MANO DE OBRA

Mortero: Cemento-arena 1:4

Cemento	0.355 Ton	\$ 375.00	\$ 133.12
Arena	1.100 M3.	45.00	49.50
Agua	0.260 M3.	10.00	<u>2.60</u>
			\$ 185.20

1 Peón	\$ 63.50
1/20 Cabo	<u>6.08</u>
	\$ 69.58

Rendimiento (69.58 ÷ 2.5 M3.)	\$ 27.83
Herramienta 5% de M.O.	<u>1.39</u>

UNIDAD M3. C.D. \$ 214.42

= 97 =

ANALISIS DE COSTOS UNITARIOS BASICOS USADOS
PARA MANO DE OBRA

Cuadrilla albañilería

1 Albañil			\$ 97.26
1 Peón			63.50
1/20 Cabo	\$ 121.57		<u>6.08</u>
			\$ 166.84

UNIDAD	JORNAL	C.D.	\$ 166.74
--------	--------	------	-----------

Cuadrilla Fierro

1 Fierrero			\$ 105.35
2 Ayudantes	\$ 72.93		145.86
4 Peones	63.50		254.00
1/5 Cabo	121.57		<u>24.31</u>
			\$ 529.52

UNIDAD	JORNAL	C.D.	\$ 529.52
--------	--------	------	-----------

Cuadrilla colados concreto

1 Sobrestante			\$ 194.50
4 Albañiles	\$ 97.26		389.04
2 Carpinteros	113.46		226.92
10 Peones	63.50		<u>635.00</u>
			\$1,445.46

UNIDAD	JORNAL	C.D.	\$1,445.46
--------	--------	------	------------

Cuadrilla de cimbra

1 Carpintero			\$ 113.46
1 Ayudante			72.93
1/5 Cabo	\$ 121.57		<u>6.07</u>
			\$ 192.46

UNIDAD	JORNAL	C.D.	\$ 192.46
--------	--------	------	-----------

FECHA:

OBRA:

P.U. No. 4

ESPECIFICACION: ACARREO DE MATERIAL SOBRAANTE DE LA EXCAVACION A UNA DIST. DE 5 KMT.

UNIDAD. M³

MATERIALES:	CANT.	U	P.U.	IMPORTE
S U M A				
MANO DE OBRA:				IMPORTE
carga 2 peones x 3.50 = 127.00 ÷ 25 M ³				5.08
Acarreo 1er Km. 2.50 x 1.30 abund =				3.25
Km. subsecuente 4 Km. x 1.25 x 1.30 =				6.50
S U M A				14.83
HERRAMIENTA Y EQUIPO:				IMPORTE
S U M A				
COSTO DIRECTO				14.83 / M ³
INDIRECTOS				

FECHA:

OBRA:

P.U. No. 5

ESPECIFICACION: RELLENO DE TIERRATE COMPACTADO 10cm DE ESPESOR
 CON AGUA Y PISON DE MANO

UNIDAD = M³

MATERIALES:	CANT.	U	P.U.	IMPORTE
Agua	0.06	M ³	10.00	0.60
S U M A				0.60
MANO DE OBRA:				IMPORTE
1 Peon	63.50 =	63.50		
1/20 Cabo	121.57 =	6.08		
		69.58		
Rendimiento	8.00 M ³ /Sor.			
Costo/M ³	= 69.58 ÷ 8 =			8.70
S U M A				8.70
HERRAMIENTA Y EQUIPO:				IMPORTE
	0.03 x	8.70		0.26
S U M A				0.26
COSTO DIRECTO				9.52
INDIRECTOS				

FECHA:

OBRA:

P.U. No. 2

ESPECIFICACION: CIMBRA DE CONTACTO EN LOSA DE CIMENTACION

UNIDAD = M²

MATERIALES:	CANT.	U	P.U.	IMPORTE
Madera en costados 4"x1"				
1.10 x 3.54 x 1.1 PT	4.28	PT	2.70	11.56
11.56 ÷ 6 usos = 1.93				1.93
Clavo 0.250 kg/m ² x 3.54	0.885	Kg	4.00	3.54
alambre #18 0.150 kg/m ² x 3.54	0.531	Kg	4.00	2.12
Diesel 1lt/m ² x 3.54	3.54	l/m ²	0.40	1.42
S U M A				9.01
MANO DE OBRA:				IMPORTE
1 Carpintero	113.46			
1 Ayudante	72.93			
1/5 Cabo	121.57 = 6.07			
	192.46 / Jor.			
Rendimiento 10 M ² /Jor.				
Costo: 192.46 ÷ 10 =				19.24
S U M A				19.24
HERRAMIENTA Y EQUIPO:				IMPORTE
0.03 x 19.24				0.58
S U M A				0.58
COSTO DIRECTO				28.83/m ²
INDIRECTOS				

FECHA: OBRA: P.U. No. 10

ESPECIFICACION: MALLA ELECTROSOLDADA

6/6 - 10/10 EN LOSA DE DISO

UNIDAD = M²

MATERIALES:	CANT.	U	P.U.	IMPORTE
Malla electrosoldada	1.10	M ²	5.35	5.88
alambre recocido #18	0.015	kg	5.00	0.07

S U M A 5.95

MANO DE OBRA:	IMPORTE
1 fierros 1 05 35	
2 Ayudantes \$ 72.93 145.86	
1/10 cabo 121.57 12.15	
↑ 263.36	

Rendimiento = 150 M² / Jornal - cuadrilla

Costo / M² = $\frac{263.36}{150 M^2} = 1.75$

S U M A 1.75

HERRAMIENTA Y EQUIPO:	IMPORTE
0.03 x 1.75	0.05

S U M A 0.05

COSTO DIRECTO	7.75
INDIRECTOS	

FECHA:

OBRA:

P.U. No. 11

ESPECIFICACION: REFUERZO TIPO ARMEX 15.30.4

UNIDAD = ML

MATERIALES:	CANT.	U	P.U.	IMPORTE
Refuerzo Armex 15.30.4	1.10	ML	9.50	10.45
Alambre recocido #18	0.015	Kg	5.00	0.07

S U M A

10.52

MANO DE OBRA:

IMPORTE

1 fierrez	105.35
2 Ayudantes \$72.93 =	145.86
1/10 Cabo 121.57 =	12.15
	\$ 263.36

Rendimiento = 90. ML/jornal-curculilla

Costo = $263.36 \div 90 =$

2.93

S U M A

2.93

HERRAMIENTA Y EQUIPO:

IMPORTE

0.03 X 2.93

0.09

S U M A

0.09

COSTO DIRECTO

13.54

INDIRECTOS

PRECIO UNITARIO

FECHA: OBRA: CENTRO DE EDUC. CONTINUA P.U. No. 13

ESPECIFICACION: CUBIERTA DE MADERA A BASE DE TABLEROS DE TRIPLAY 5/8 MARINO PARA LOSAS DE 10CM ESPESOR. (LOSA Y CERRAMIENTO)

CONSIDERANDO UN AREA DE CONTACTO DE $260 \times 4.88 = 17.57 m^2$ UNIDAD = m^2

MATERIALES:	CANT.	U	P.U.	IMPORTE
Triplay 5/8 2 hojas $\times 260.- \div 6$ usos:	1	lote	373.33	520.13
Tabla 6"x1" = $250 m^2 \times 1.20 \times 10.76 \times 2.70 \div 6$ usos	1	lote	14.53	17.57 m ²
barrotē 2"x4" = $61.56 ML \times 2.2 FT/ML \times 2.70 \div 6$ usos	1	lote	60.94	
pantal 4"x4" = $48.80 ML \times 4.4 FT/ML \times 2.70 \div 15$ usos	1	lote	38.65	
clavo $0.26 kg/m^2 \times 17.57 m^2 \times 100$	1	lote	18.27	
Diesel $1 Lt/m^2 \times 17.57 m^2 \times 0.40$	1	lote	7.02	
Frontera $8.48 \times 0.15 \times 10.76 \times 1.20 \times 2.70 \div 6$ usos	1	lote	7.39	
S U M A 570.13				29.60
MANO DE OBRA:				IMPORTE
1 Carpintero	113.46			
1 ayudante	72.93			
1/20 Cabal	121.57	6.08		
192.47				
Rend. Habilitado $16 m^2/Jornal.e.$ Costo = $192.47 \div 16 \div 6$ usos				2.00
Rend. Cimbra y descimbra = $12 m^2/dia$				
costo / m^2 $192.47 \div 12$				16.03
S U M A				18.03
HERRAMIENTA Y EQUIPO:				IMPORTE
	0.03×18.03			0.54
S U M A				0.54
COSTO DIRECTO				48.17
INDIRECTOS				
PRECIO UNITARIO				

FECHA:

OBRA:

P.U. No. 17

ESPECIFICACION: MURO DE BLOCK EXTRUIDO DE BARRO

ROJO DE 6x12x24 ACABADO APARENTE
6m

UNIDAD = M²

MATERIALES:	CANT.	U	P.U.	IMPORTE
Block 6x12x24 64 Pzas + 15% desp.	74	Pza	0.50	37.00
Mortero	0.025	M ³	214.42	5.36

S U M A 42.36

MANO DE OBRA: IMPORTE

1 albañil 97.26

1 peon 63.50

1/20 cubo 121.57 6.08

7 166.84

Rendimiento: 12 m²/hor. Costo/m² = 166.84 ÷ 12 m² = 13.89

aparentado: rend. 40 m²/hor costo = 166.84 ÷ 40 m² = 4.17

S U M A 18.06

HERRAMIENTA Y EQUIPO: IMPORTE

0.03 x 18.06 0.54

S U M A 0.54

COSTO DIRECTO 60.96

INDIRECTOS

PRECIO UNITARIO

FECHA:

OBRA:

P.U. No. 18

ESPECIFICACION: DRENAJE CON TUBERIA DE CONCRETO DE 15 CM ϕ
 INCLUYENDO EXCAVACION Y RELLENO A 70 CM DE PROF PRO-
 MEDIO

UNIDAD: ML

MATERIALES:	CANT.	U	P.U.	IMPORTE
Tubo de concreto de 0.15 mt. de ϕ	1.10	MT	4.50	4.95
Mortero cemento-arena 1:4	0.001	M ³	214.42	0.21

S U M A

5.16

MANO DE OBRA:

IMPORTE

Excavación: 1 Poin = 63.50				
1/20 Cabo 6.08				
69.58				
Rendimiento 14 ML/Jor Costo/ML 69.58 ÷ 14				4.97
Colocación tubo Cuadrilla \$ 166.74 Rend. 25 ML: 166.74 ÷ 25				6.67
Relleno Comp. \$ 69.58 ÷ 20 ML Rend. - costo —				1.74

S U M A

13.38

HERRAMIENTA Y EQUIPO:

IMPORTE

0.03 x 13.38				0.40

S U M A

0.40

COSTO DIRECTO

18.94

INDIRECTOS

CENTRO DE EDUCACION CONTINUA
CASA TIPO "A"

R E S U M E N

Limpieza y trazo	\$ 338.40
Cimentación	4,768.85
Estructura	8,633.22
Albañilería y Acabados	14,644.66
Inst. Sanitaria y Muebles Baño	5,893.83
Herrería	1,589.60
Carpintería	2,554.00
Cerrajería	385.50
Impermeabilización	1,162.20
Vidriería	791.10
Limpieza	1,186.50
Pintura	762.76
Inst. Eléctrica	<u>1,571.00</u>
Total.	\$44,281.62

Area Construida: 72.23 M2.

Costo/M2. = $\frac{44,281.62}{72.23}$ = \$ 613.06 Costo directo

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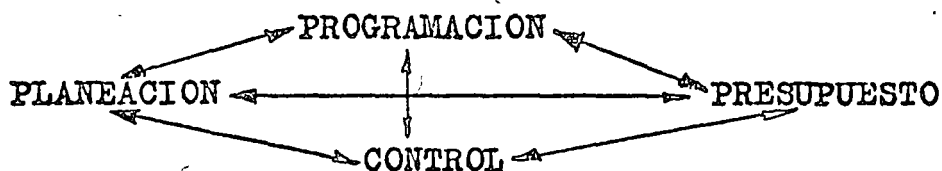
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I.- INTRODUCCION.

Dada la complejidad y la competencia que existe en la actualidad en el campo de la industria de la construcción, es de definitiva importancia que la elaboración y ejecución cuidadosa de la planeación, programación, presupuestos y control de obra, se realice en forma integral bajo una misma política general.

No es posible pensar en la elaboración racional de un presupuesto, si éste no está basado en experiencias reales obtenidas con anterioridad, así como tampoco es posible hablar de un control efectivo de una obra si no se está trabajando con los elementos integrantes del presupuesto y programa respectivos; y ni siquiera poder contar con un presupuesto y programa si no se ha trabajado previamente en la planeación de la misma.



Trataremos pues de desarrollar los diversos temas, sin olvidar en ningún momento que todos están íntimamente ligados entre sí, y que el menospreciar u olvidar alguno de ellos, sólo conduce al fracaso en forma irremediable.

II.- CATALOGO DE CUENTAS.

Es el catálogo de cuentas un sistema que permite indentificar y ordenar en forma consistente todos los

movimientos contables que se realicen en una institución determinada.

En realidad, es la herramienta básica de comunicación entre los departamentos de planeación, programación, presupuestos y control de obra, y en la que se plasman las diversas necesidades de información.

El catálogo de cuentas debe básicamente:

1. Proveer un sistema uniforme y consistente de identificación de los movimientos contables que se vayan a operar.
2. Ser suficientemente flexible para poder integrar en un momento dado alguna nueva necesidad de la institución que está operando el sistema.
3. Facilitar el manejo de información para poder llevarse un efectivo control de costos y oportuno control de avance de obra.
4. Ayudar a la integración estadística de la información que se vaya obteniendo.

Al formular un catálogo de cuentas será necesario:

1. Definir los niveles de información requerida y las necesidades de todos y cada uno de los diversos departamentos de la institución.
2. Establecer los rangos de clasificación de conceptos para cada nivel.
3. Procurar que sea suficientemente lógico, con el objeto de que su uso sea sencillo y rápido, así como para que se adapte a todos los tipos de proyectos que se manejen en la institución.
4. Elaborar una codificación que será parte integral del sistema y que satisfaga las necesidades y políticas establecidas.

Para el correcto uso y aplicación del catálogo establecido es recomendable:

1. Convencer a todo el personal que deba tener algún contacto con él, de la necesidad e importancia que tiene para una empresa su establecimiento y correcto uso.
2. Tomar en consideración las experiencias y sugerencias

ESTUDIO : Ciclo alimentador de roca a la trituradora y ciclo receptor de piedra triturada.

ACTIVIDAD : Producción de agregado de 1 1/2" para sub-base y base de un camino.

MAQUINARIA : (Solo lo que interviene directamente en los ciclos en estudio)

* Un traxcavo caterpillar 951 de capacidad de cuchara de 1 1/4 Yd³ (0.99 M³)

* Una trituradora cedarapids., de circuito cerrado -- (Primaria de quijadas de 10" x 36 " y secundaria de dos rodillos de 30 " x 22 " .

* Camiones de volteo de 7 m³ (número variable de unidades.)

DESCRIPCION DE LOS CICLOS :

I.- ALIMENTADOR DE ROCA A LA TRITURADORA

- a) Carga de los camiones con el traxcavo.
- b) Acarreo a 400 metros
- c) Descarga en la tolva de la trituradora
- d) Regreso de los camiones .

II.- RECEPTOR DE PIEDRA TRITURADA

- a) Llenado de camiones por la trituradora.
- b) Acarreo al banco de almacenamiento a 100 metros
- c) Descarga
- d) Regreso

COEFICIENTES DE ABUNDAMIENTO

1).- 1 M³ banco = 1.60 m³ roca

2).- 1 M³ roca = 1.15 m³ grava.

TIEMPOS OBTENIDOS DEL ANALISIS DE LAS PELICULAS :

I.- Ciclo alimentador de Roca a la Trituradora :

a) Carga de un camión por el traxcavo	2.41 minutos
b) Acarreo	2.92 minutos
c) Descarga	0.69 minutos
d) Regreso	2.06 minutos

II.- Ciclo receptor de grava

	<u>7 m³ grava</u>	<u>8.05 m³ grava</u>
a) Acomodo del camión bajo la banda	0.34 min.	0.39 minutos
b) Llenado	13.54 min.	15.57 minutos
c) Acarreo	1.60 min.	1.84 minutos
d) Descarga	0.90 min.	1.04 minutos
e) Regreso	0.74 min.	0.85 minutos

7 M³ de roca = 8.05 M³ de grava .

ANALISIS DE PELICULA # 3

OBRA: V.M.

HOJA: 1/1

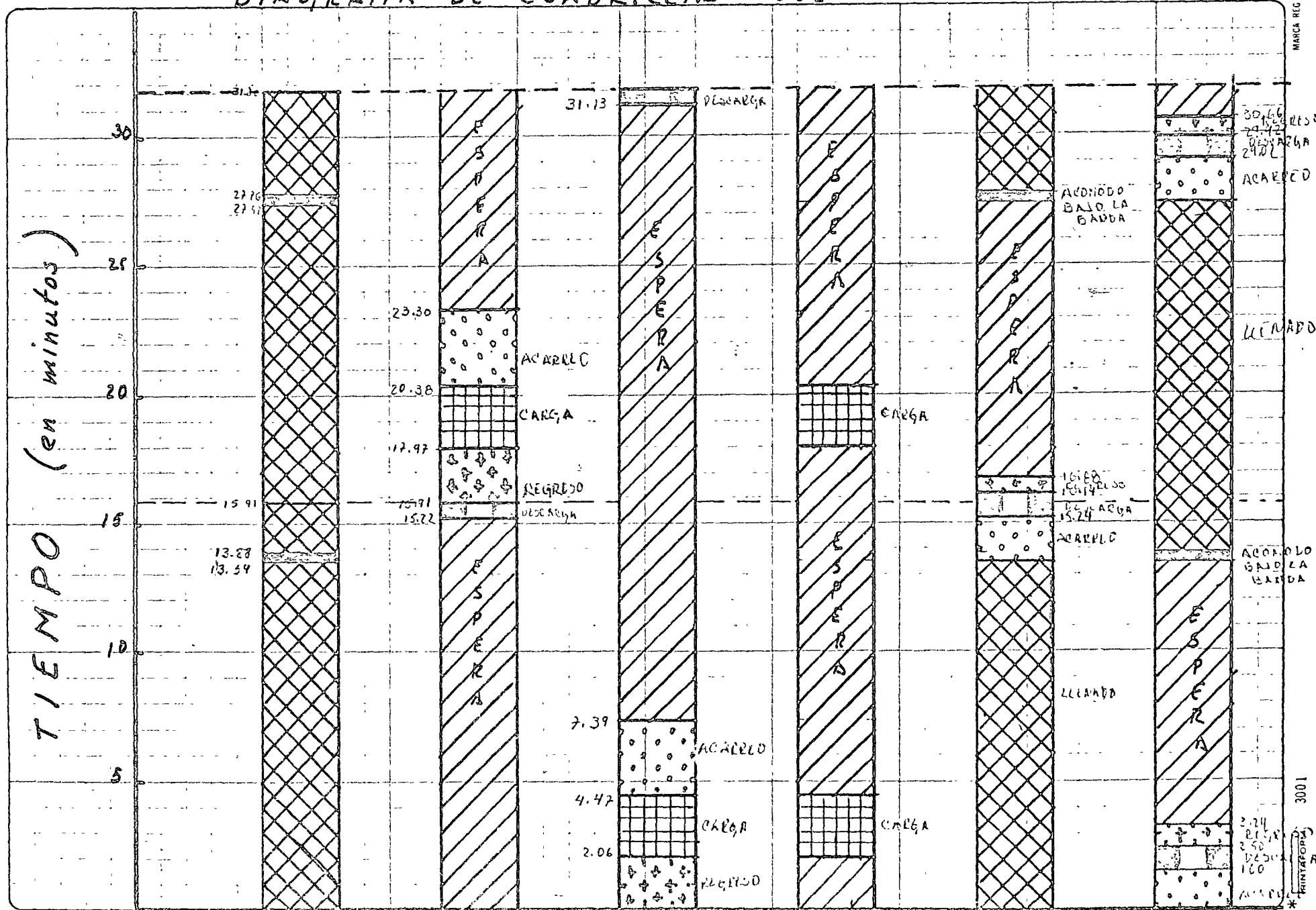
INTERVALO: 1 CUADRO / 2 SEG.

FECHA: Sept. 26, 73

13:05 horas	CONTADOR DE CUADROS		TIEMPO		%	ACTIVIDAD
	del - al	#	segundos	minutos	tiempo	
	PRODUCCION DE GRAVA DE 1 1/2"					
	000 - 017	17	34	0.57	3	REGISTRO EN LA PLANTA TRITURADORA, CAMION DE 7 M3, DESCARGANDO EN LA TRITUR.
	017 - 275	258	516	8.60	45	REGRESO AL BANCO DE ROCA - CARGA - A CARREO.
	275 - 570	295	590	9.83	52	ESPERA EN LA TRITURADORA.
				19.00	100	
	570 - 588	18	36	0.60	3	DESCARGA
	588 - 935	347	694	11.57	56	REGRESO AL BANCO DE ROCA-CARGA-ACARREO
	935 - 1185	250	500	8.33	41	ESPERA
				20.30	100	
	1185 - 1207	22	44	0.73		DESCARGA

14:50 HRS	INTERVALO : 1 CUADRO / 4		SEGUNDOS			REGISTRO EN EL BANCO DE ROCA
	000 - 037	37	148	2.47	8	TRASCAMO CARGANDO AL CAMION
	037 - 464	427	1708	28.47	92	ESPERA QUE LLEGUE EL CAMION
				30.94	100	
	464 - 501	37	148	2.47	21	CARGA
	501 - 638	137	548	9.13	79	ESPERA
				11.60	100	
	638 - 676	38	152	2.53		CARGA

DIAGRAMA DE CUADRILLAS DEL METODO EMPLEADO.



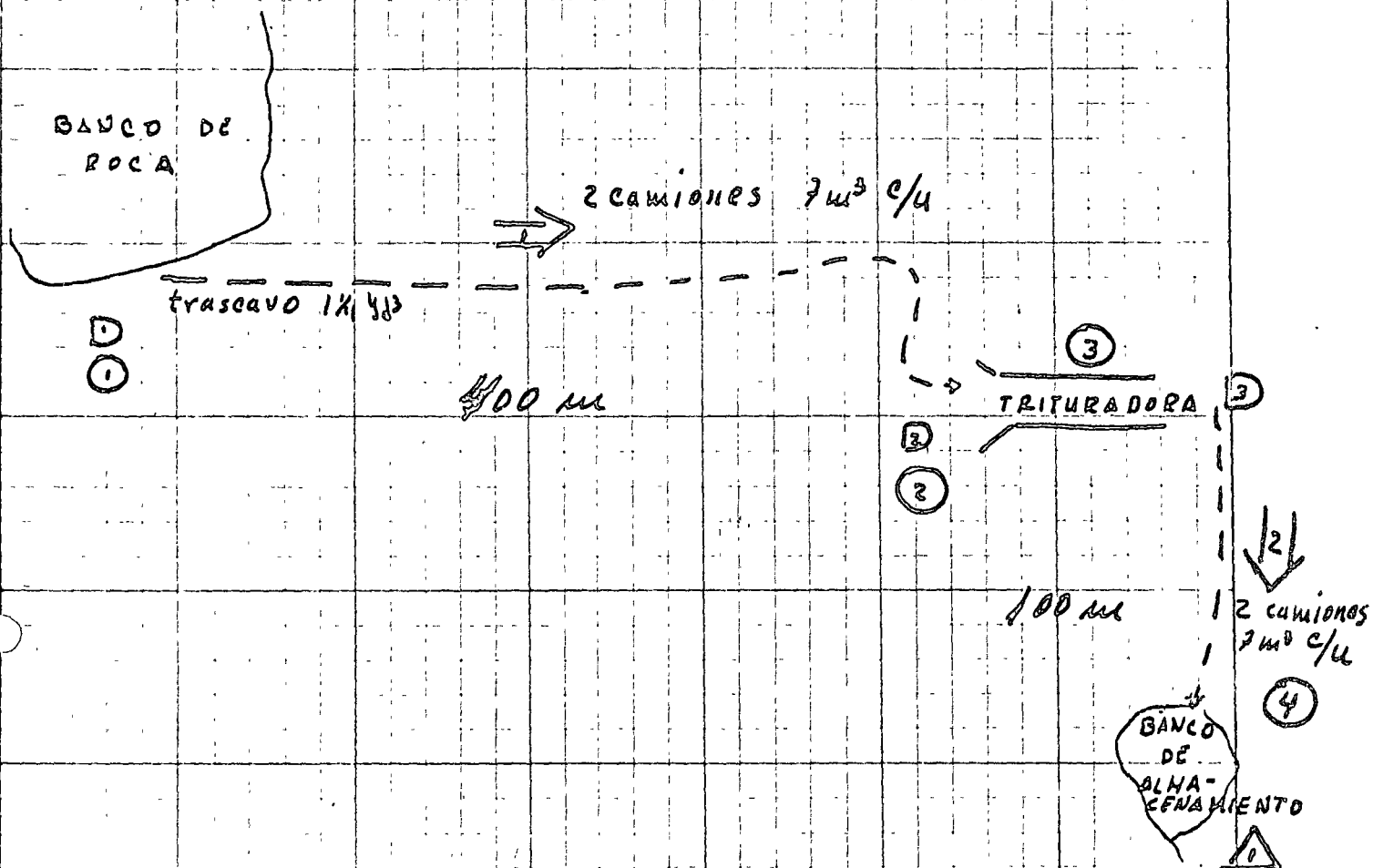
MARCA REG

3001

* PINTAFORMA

DIAGRAMA DE FLUJO

DEL METODO EMPLEADO



O = operación

D = retraso

⇒ = transporte

△ = almacenamiento

CARTA DE PROCESAMIENTO

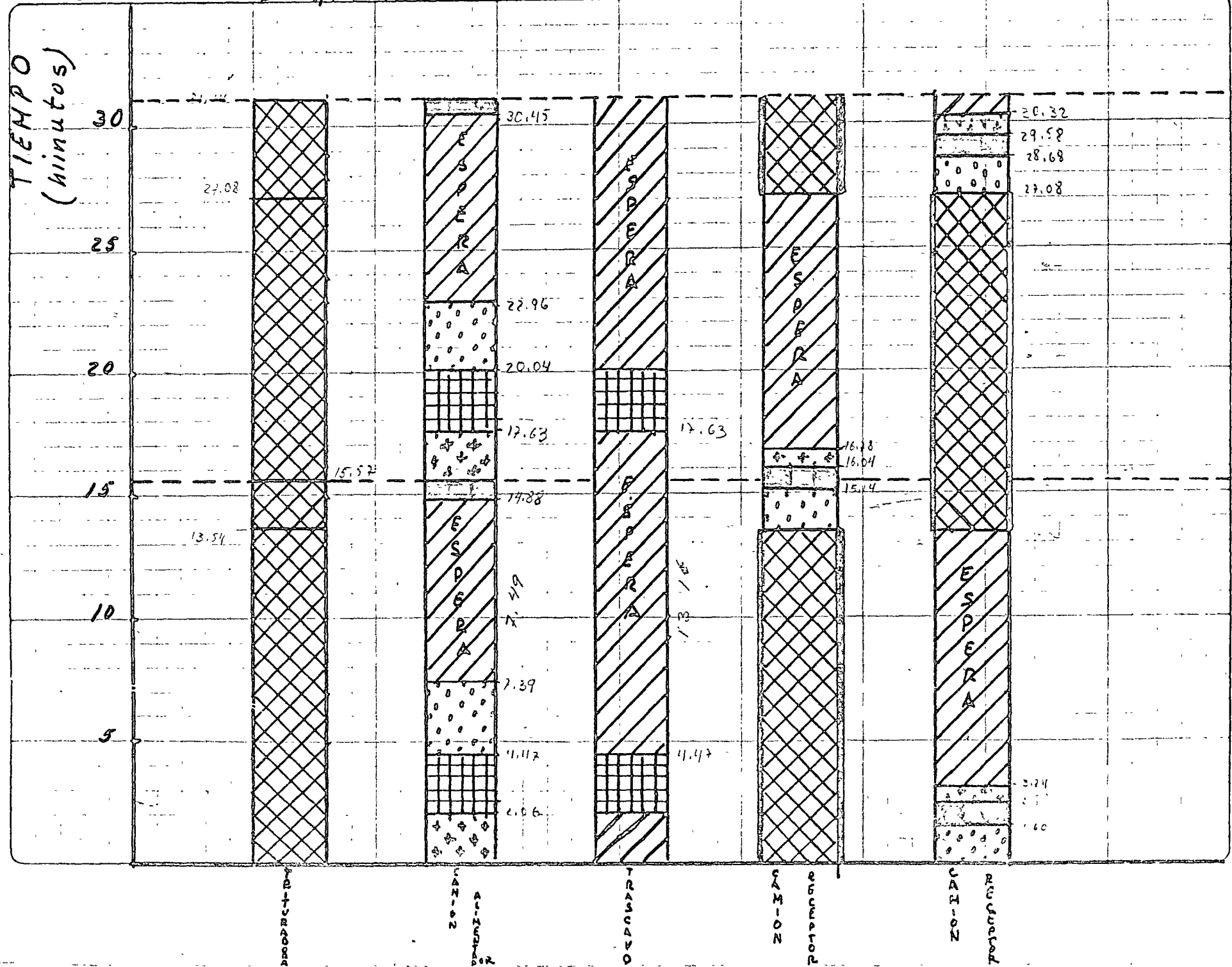
METODO USUAL

Distancia Mts	Tiempo Minutos	Simbo- lo	D E S C R I P C I O N
400	13.50	○	Material esperando que llegue un camión.
	2.41	○	Material cargando en el camión por un trascavo
	2.92	→	Material transportado en camión hacia la trituradora.
	11.90	○	Material sobre los camiones esperando que la tolva se vacie.
100	0.69	○	Material descargado sobre la tolva
	15.57	○	Material triturándose y llenando los camiones
	0.39	○	Material triturado esperando que se acomode el camión.
	1.84	→	Material triturado transportado al banco de almacenamiento
	1.04	△	Material triturado descargado en el banco de almacenamiento
		△	Material triturado almacenándose

R E S U M E N

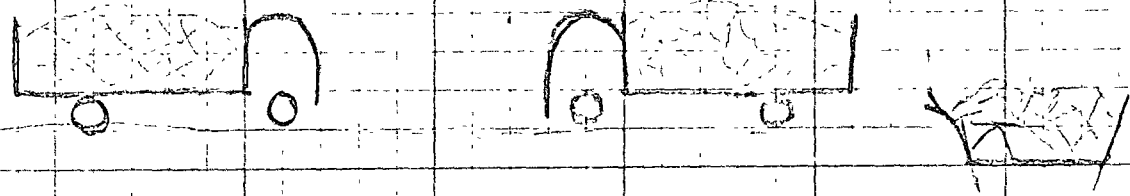
EVENTO	NUMERO	TIEMPO MIN	DISTANCIA MTS
○	4	19.71	500
○	3	25.79	
→	2	4.76	
△	1		
		50.26	500

DIAGRAMA DE CUADRIAS DEL METODO PROPUESTO



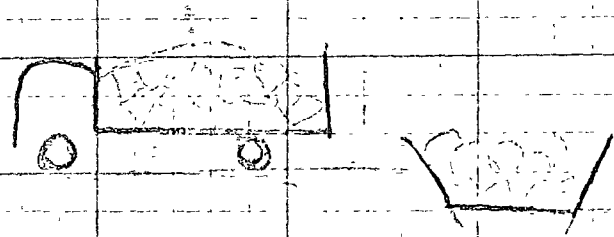
METODO USUAL

$D = 11.90 \text{ min}$



2 CAMIONES ALIMENTANDO A LA TRITURADORA.

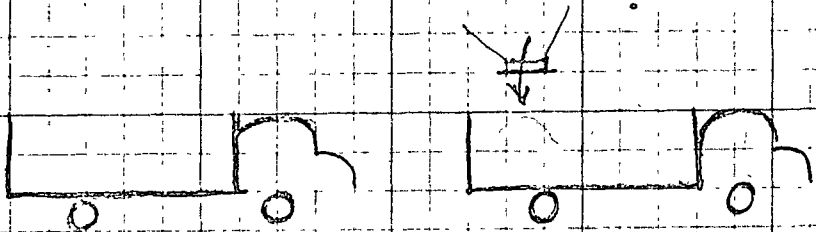
$D = 7.49$



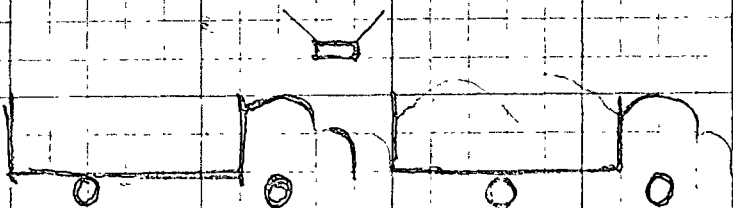
1 SOLO CAMION ALIMENTANDO A LA TRITURADORA

METODO PROPUESTO

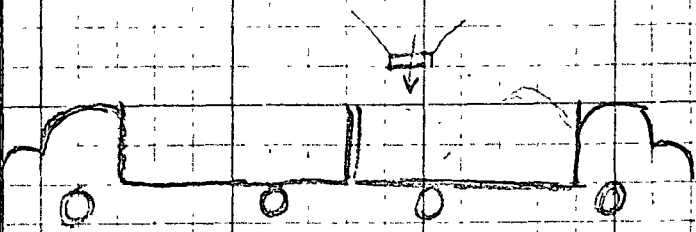
METODO USUAL.



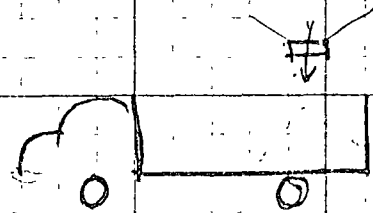
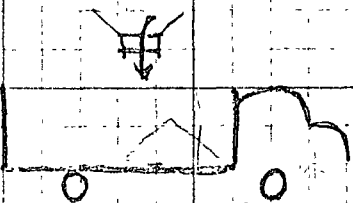
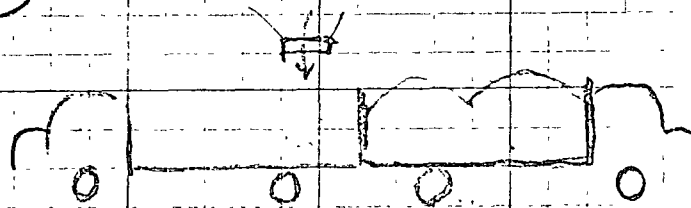
$\Delta = 0.34 \text{ min}$



METODO PROPOSTO



$\Delta = 0.0 \text{ min}$



CARTA DE PROCESAMIENTO
METODO PROPUESTO

Distancia Metros	Tiempo Min.	Simbolo	Descripción
	13.16	①	Material esperando que lleque un camión.
	2.41	②	Material cargado por el trascavo al camión.
400	2.92	→	Material transportado en camión hacia la tritadora.
	7.49	②	Material sobre el camión esperando que la tolva se vacie.
	0.69	③	Material descargado sobre la tolva.
	15.57	③	Material triturandose y llenando camiones.
100	1.84	→ ₂	Material triturado transportado al banco de almacenamiento
	1.04	④	Material triturado descargado en el banco de almacenamiento.
		⚠	Material triturado almacenandose hasta que se necesite.

12

RESUMEN

EVENTO	NUMERO	TIEMPO MIN.	DIST. MTS.
①	4	19,71	500
②	2	20,65	
→	2	4.76	
⚠	1		
		45.12	500

COMPARACION DE METODOS


EVENTO	METODO USUAL			METODO PROPUESTO			DIFERENCIA		
	NUMERO	TIEMPO MIN	DISTANCIA MTS.	NUMERO	TIEMPO	DISTANCIA	NUMERO	TIEMPO MIN.	DIST. MTS
	4	19.71		4	19.71		0	0	
	3	25.79		2	20.65		-1	- 5.14	
	2	4.76	500	2	4.76	500	0	0	0
	1			1			0		
		50.26	500		45.12	500	-1	- 5.14	

DIAGRAMA DE LUBRILLA (2º METODO PROGRESIVO)

14

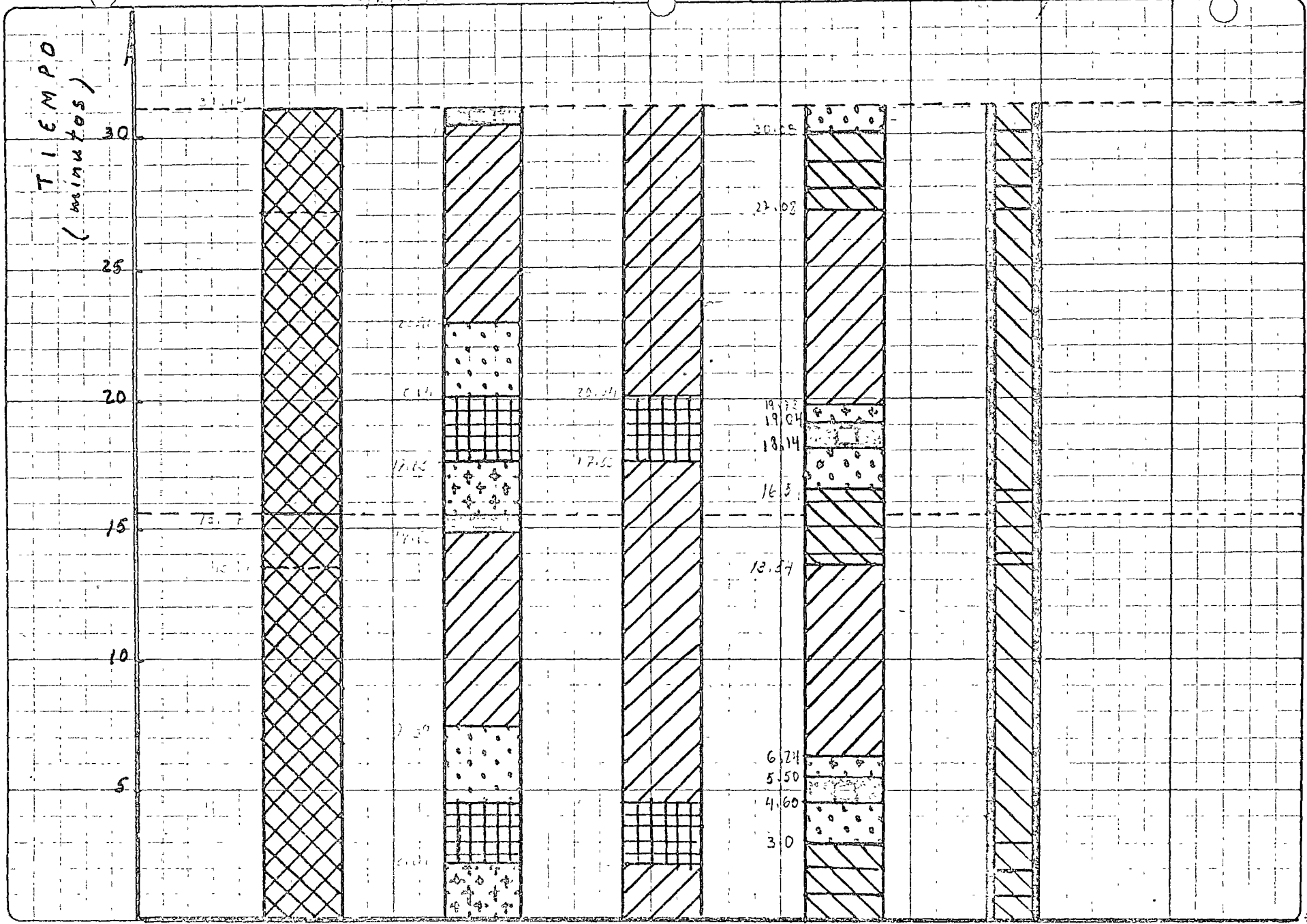
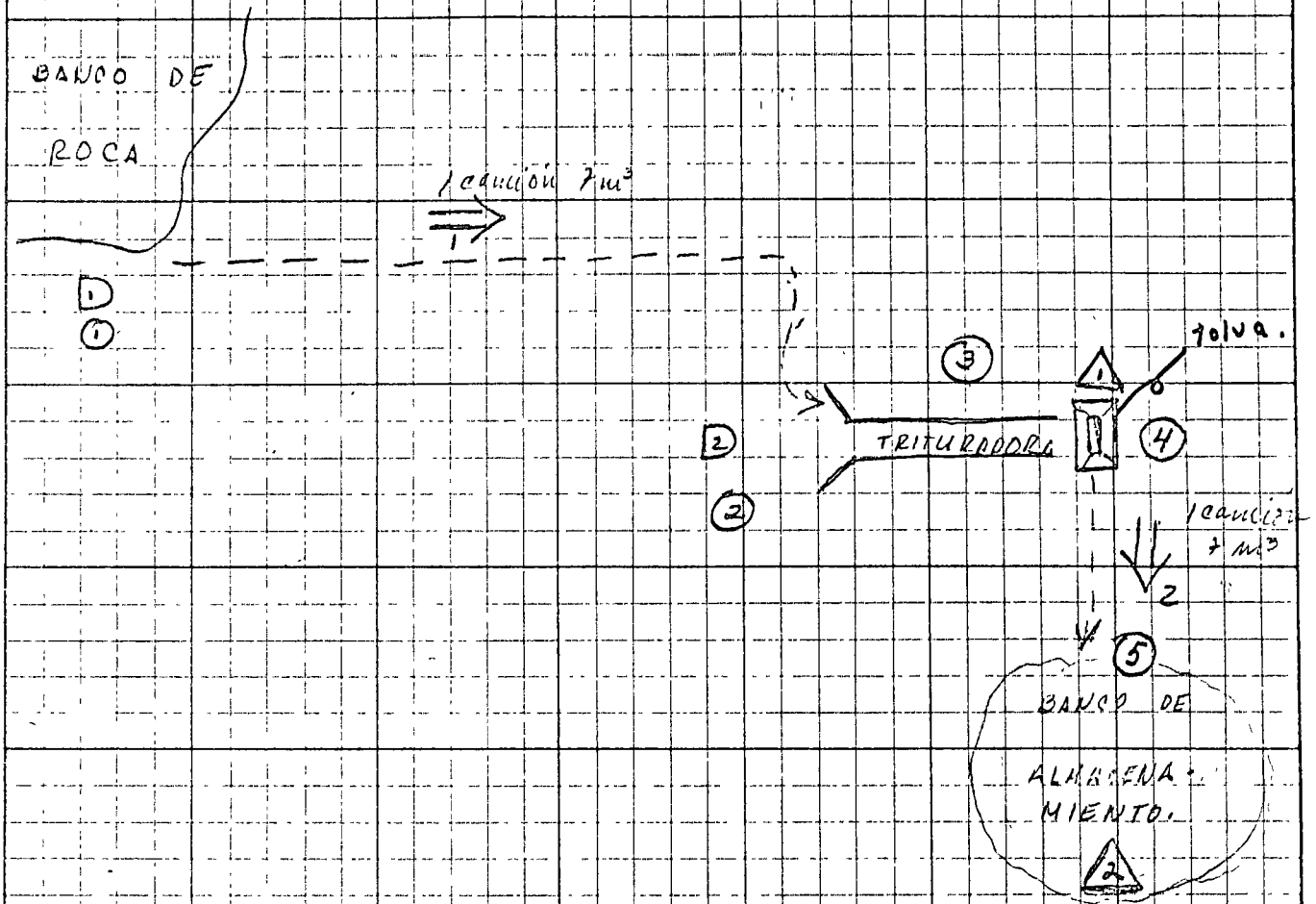


DIAGRAMA DE FLUJO

(2º METODO PROPUESTO)



CARTA DE PROCESAMIENTO
2o. METODO PROPUESTO

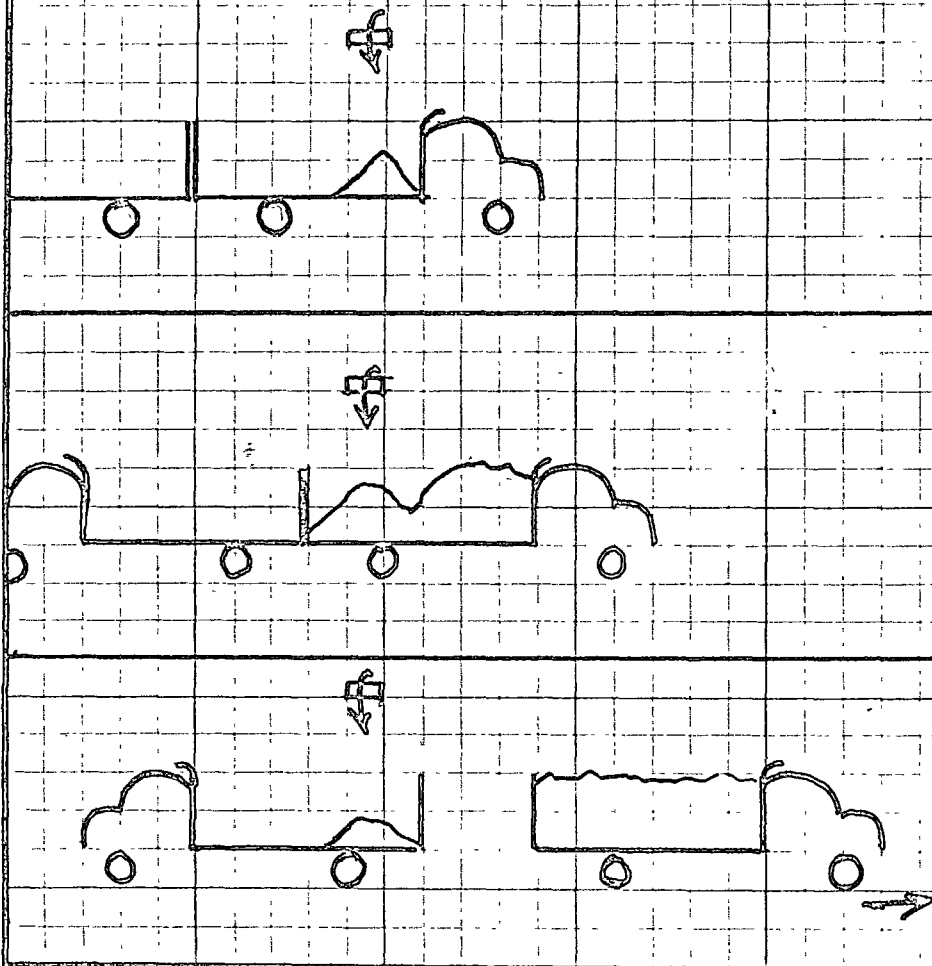
DISTANCIA MTS	TIEMPO MIN	SIMBOLO	DESCRIPCION
	13.16	D	Material esperando que llegue un camión.
	2.41	O	Material cargado por el trascavo al camión.
400	2.92	→	Material transportado hacia la trituradora.
	7.49	2	Material sobre el camión esperando que la tolva se vacie.
	0.69	2	Material descargado sobre el embudo de la trituradora.
	15.57	3	Material triturandose y llenando la tolva para grava.
		△	Material almacenándose en la tolva.
	3.00 X 1.15	4	Material descolgado sobre un camión direct. de la tolva
100	1.84	→	Material transportado al banco de Almacenamiento.
	1.04	5	Material descargado en el banco de almacenamiento
		△	Material almacenándose hasta que se necesita
500	48.12		

R E S U M E N

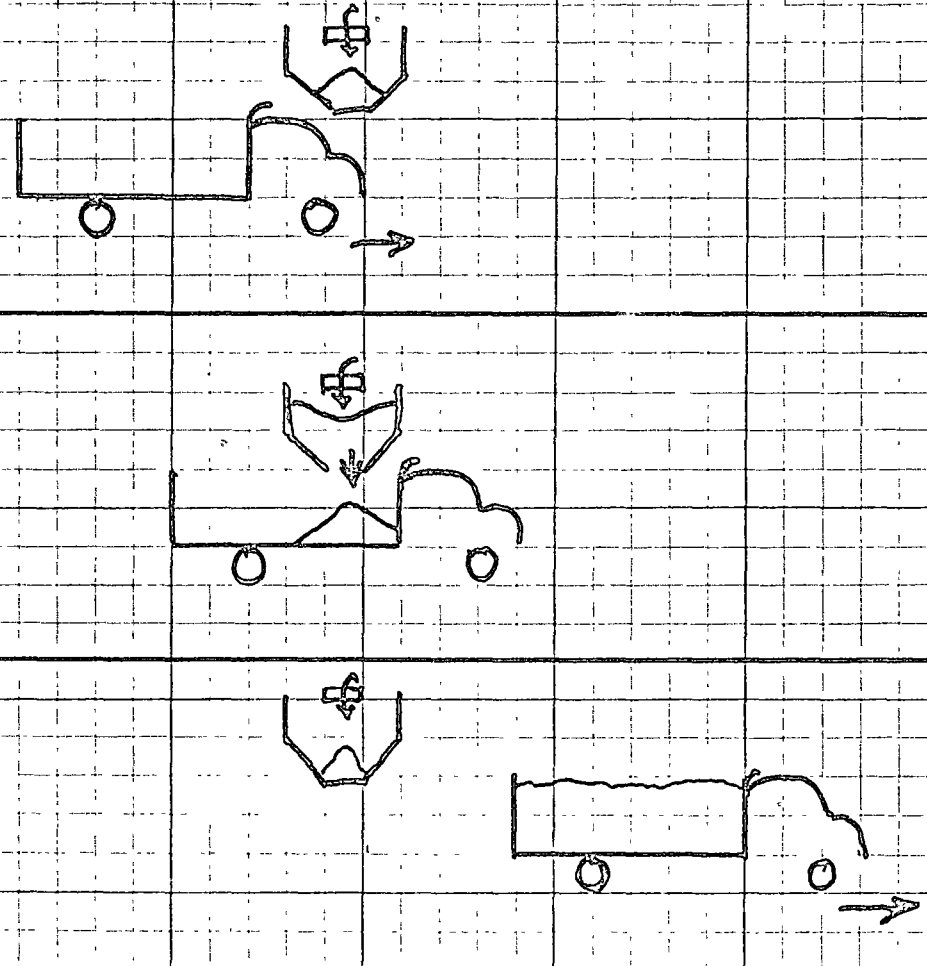
EVENTO	NUMERO	TIEMPO MIN.	DIST. MTS.
○	5	23.16	500
D	2	20.65	
⇨	2	4.76	
△	2		
		48.57	500

EVENTO	METODO USUAL			METODO PROPUESTO 2a. alternativa			DIFERENCIA		
	NUMERO	TIEMPO MIN.	DISTANCIA METS.	NUMERO	TIEMPO MIN.	DIST. MTS.	NUMERO	TIEMPO MIN.	DIST. MTS.
○	4	19.71	500	5	23.16	500	+ 1	+ 3.45	0
D	3	25.74		2	20.65		- 1	- 5.14	
⇨	2	4.76		2	4.76		0	0	
△	1			2			+ 1		
	10	50.26	500	11	48.57		+ 1	- 1.69	0

METODO USUAL



METODO PROPUESTO (2ª ALTERNATIVA)



DOS CAMIONES RECEPTORES DE GRAVA
LLENANDOSE DIRECTAMENTE DE LA BANDA DE
LA TRITURADORA.

AHORRO DE UN CAMION RECEPTOR DE GRAVA
ADAPTANDO UNA TOLVA AL SISTEMA.

ESTUDIO : Ciclo de acarreo de Concreto premezclado , por peones con botes.

ACTIVIDAD : Colado de losa de entrepiso (1er. nivel) , - para una vivienda.

CUADRILLA :

* 2 Hombres llenando botes en la artesa con pa las.

* 7 hombres acarreamo el concreto con botes.

DESCRIPCION CICLO :

a) Llenando del bote en la artesa

b) Acarreo hasta la losa por colar .

c) Descarga del Concreto

d) Regreso a la artesa

TIEMPOS OBTENIDOS DEL ANALISIS DE LA PELICULA

- a) Llenando del bote en la artesa...10 seg.... 9%
- b) Vuelta y subida al 1er. nivel22 seg... 20 %
- c) Acarreo sobre el 1er. nivel.....24 seg... 22 %
- d) Descarga..... 4 seg... 3 %
- e) Regreso sobre el 1er. nivel.....26 seg...23 %
- f) Bajada y vuelta.....26 seg... 23 %

	112 seg.	100 %
	112 seg.	100 %

ANÁLISIS DE PELÍCULA # 12

OBRA: E. R.

HOJA: 1/1

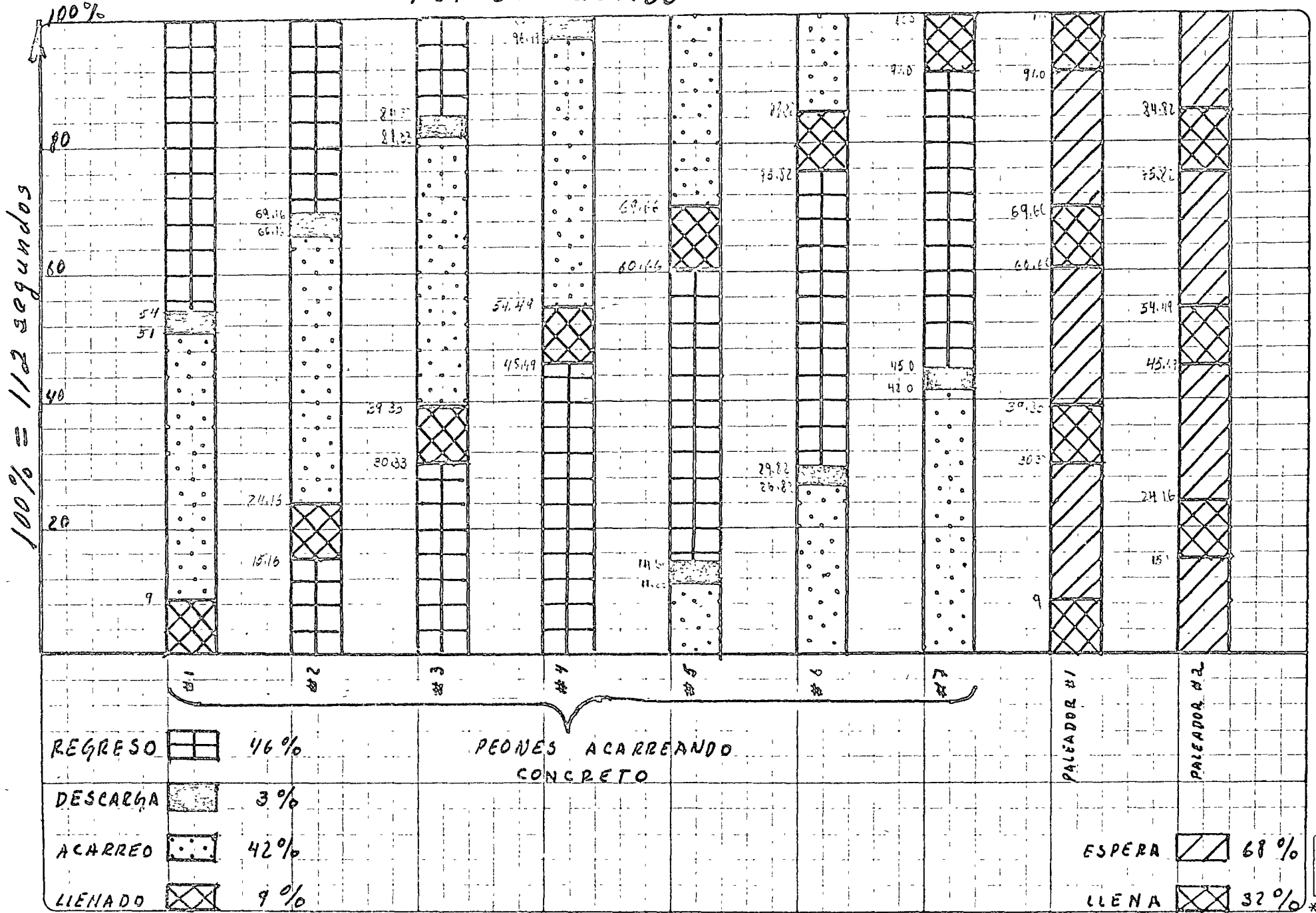
INTERVALO: 1 CUADRO / 2 SEG.

FECHA: 17/I/74

CONTADOR DE CUADROS		TIEMPO		%	ACTIVIDAD
Del - al	#	segundos	minutos	tiempo	
COLADO LOSA DE ENTREPISO (.1er. NIVEL)					
0 - 5	5	10	0.17	9	PEON SIN CASCO , CAMISA AZUL CLARO LE LLENAN EL BOTE.
5 - 15	10	20	0.33	17	SUBE AL 1er. NIVEL
15 - 27	12	24	0.40	21	ACARREA SOBRE LA LOSA
27 - 30	3	6	0.10	5	DESCARGA
30 - 42	12	24	0.40	21	REGRESA SOBRE LA LOSA
42 - 58	16	32	0.53	27	BAJA Y DA VUELTA
			1.93	100	
58 - 63	5	10	0.17	9	LE LLENAN EL BOTE
63 - 74	11	22	0.37	20	DA VUELTA Y SUBE LA ESCALERA
74 - 87	13	26	0.43	23	ACARREA SOBRE LA LOSA .
87 - 89	2	4	0.07	4	DESCARGA
89 - 101	12	24	0.40	21	REGRESA SOBRE LA LOSA
101- 114	13	26	0.43	23	BAJA LA ESCALERA Y DA VUELTA
			1.87	100	
114- 118	4	8	0.13	7	LE LLENAN EL BOTE

DIAGRAMA DE CUADRILLAS

METODO USADO

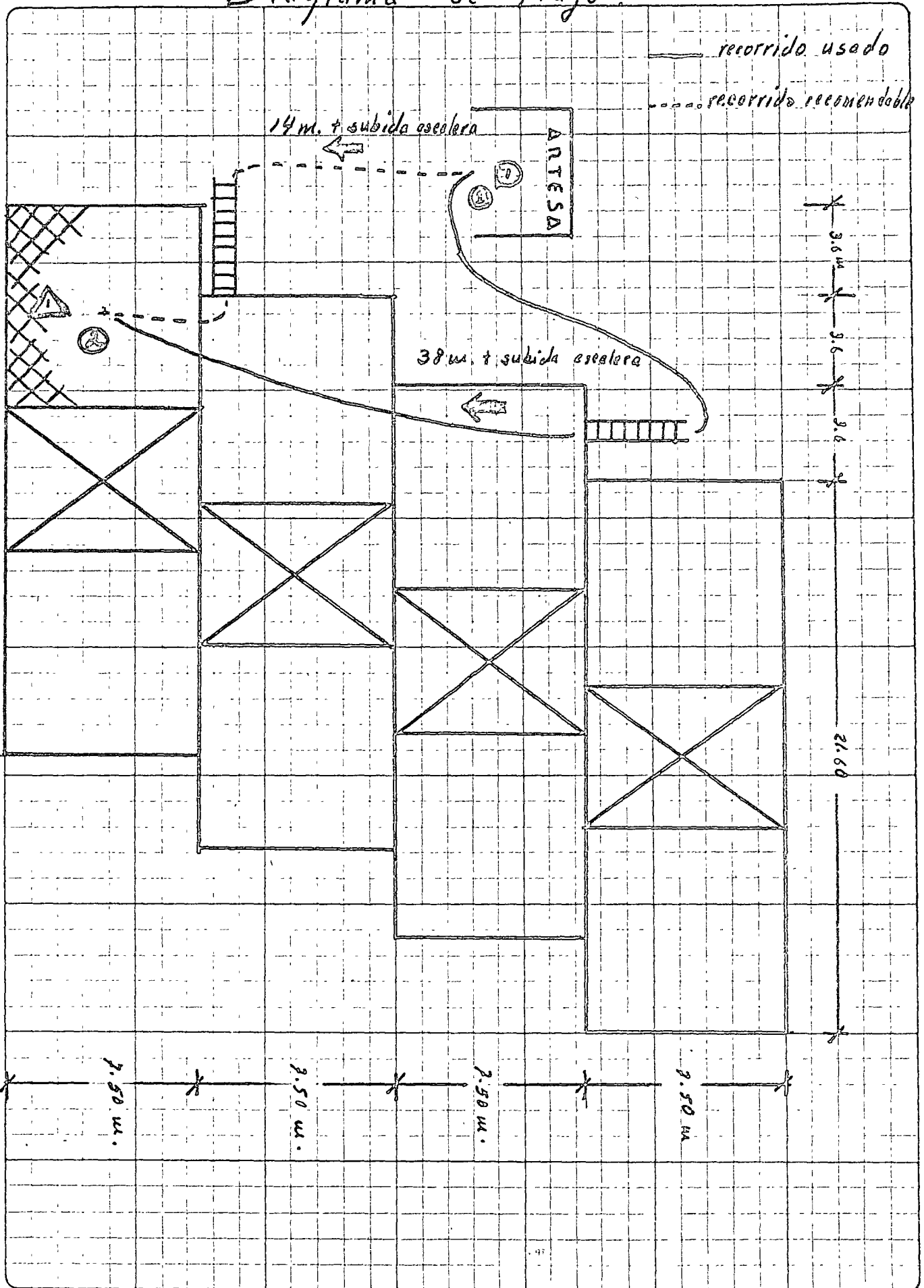


MARCA REG

3001

* RINTAFORM

Diagrama de flujo



UNIDAD DE MATERIAL = 0.015 m³ de concreto

CARTA DE PROCESAMIENTO

(METODO USADO)

DIST. (mts.)	TPO. (segundos)	SIM- BOLD	DESCRIPCION
	24	D	Concreto en la artesa esperando que llegue un peón.
	10	O	Concreto vaciado al bote con pala.
3B+S	46	⇒	Concreto acarreado en bote por un peón.
	4	⊙	Concreto descargado sobre la cimbra.
		△	Concreto almacenándose en la cimbra

s = subida al primer nivel.

CARTA DE PROCESAMIENTO

(METODO RECOMENDABLE)

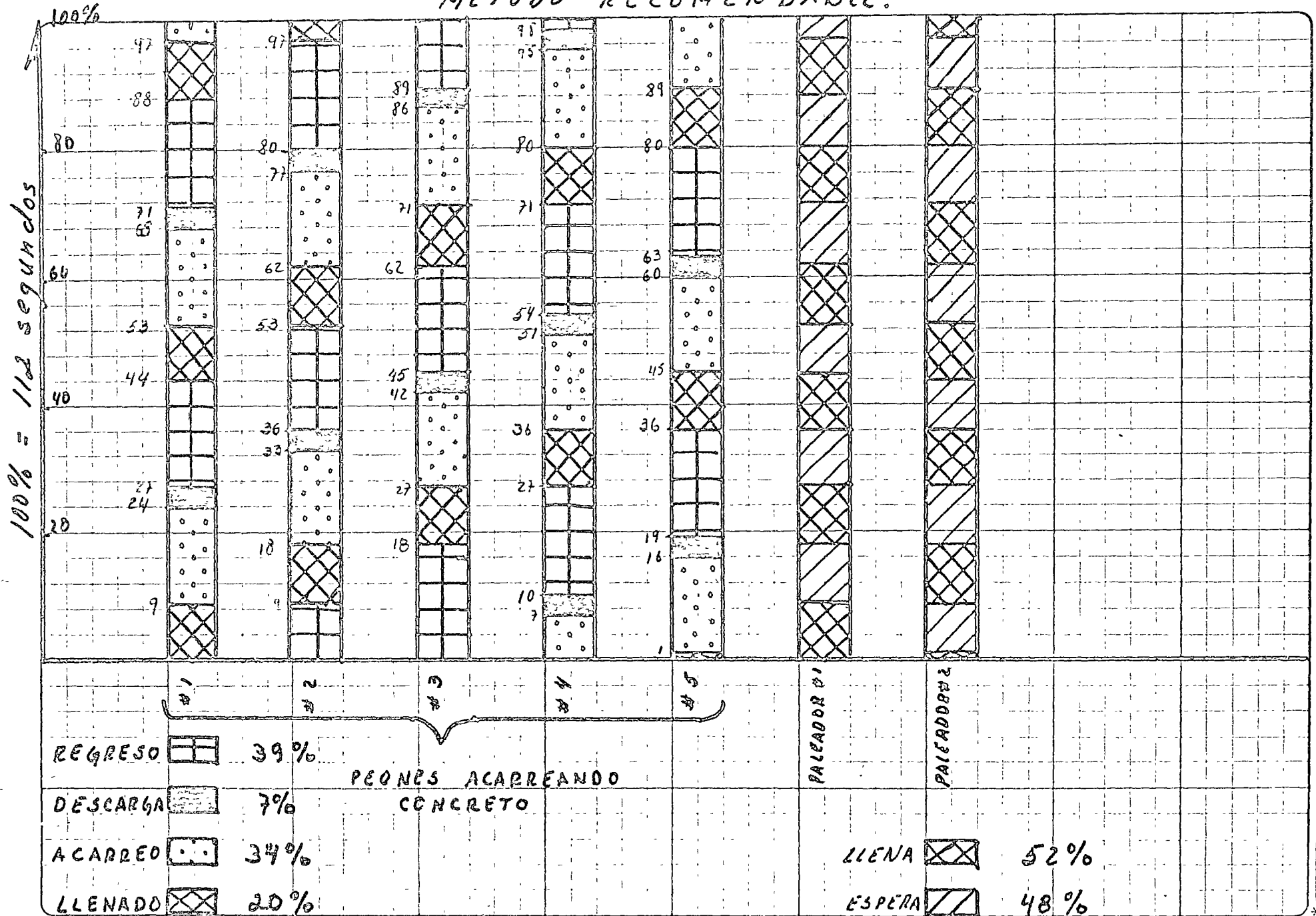
DIST. (mts.)	TPO. (segundos)	SIM- BOLD	DESCRIPCION
	9	D	Concreto en la artesa esperando que llegue un peón.
	10	O	Concreto vaciado al bote con pala.
14+S	17	⇒	Concreto acarreado en bote por un peón.
	4	⊙	Concreto descargado sobre la cimbra.
		△	Concreto almacenándose en la cimbra.

COMPARACION DE METODOS

EVENTO	METODO USADO			METODO RECOMENDABLE			DIFERENCIA		
	NUMERO	TIEMPO seg.	DIST. mts.	NUMERO	TIEMPO seg.	DIST. mts.	NUMERO	TIEMPO seg.	DIST. mts.
O	2	14		2	14		0	0	
D	1	24		1	9		0	-15	
⇒	1	46	3B+S	1	17	14+S	0	-29	-24
△	1			1			0		
		84	3B+S		40	14+S		-44	

DIAGRAMA DE CUADRILLAS

METODO RECOMENDABLE.



MARCA REG

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* HINTAFORM

= 100 =

CENTRO DE EDUCACION CONTINUA
CASA TIPO "A"

No. de Cuenta	Concepto	Unidad	Cantidad	Unitario	Total
✓	<u>Limpieza y trazo</u>	M2.	120.00	2.82	\$ <u>338.40</u>
	Total Limpieza y Trazo				\$ 338.40
✓	<u>Cimentación</u>				
	Excavación de 0.2 Mt.	M3.	8.67	14.33	124.24
✓	Acarreo de material <u>so</u> brante de excavación a 5 Km. de distancia	M3.	11.27	14.83	167.13
	Relleno de tepetate	M3.	7.25	9.56	69.31
	Acarreo de material <u>te</u> petatoso para relleno	M3.	9.42	30.00	282.60
✓	Concreto f'c=150 Kg/cm2. en losa de cimentación	M3.	7.25	319.24	2,314.49
	Trabes.	M3.	1.04	319.24	332.00
✓	Cimbra de contacto en: Losa de cimentación	M2.	3.54	28.83	102.06
	Acero de refuerzo f'y=4000 Kg/cm2.	Kg.	90.00	3.71	333.90
	Malla electrosoldada 6/6-10/10	m2.	72.54	7.75	562.18
	Refuerzo tipo Armex 15x30x4	M1.	35.52	13.54	<u>480.94</u>
	Total Cimentación				\$ 4,768.85
	<u>Estructura</u>				
✓	Concreto f'c=150 Kg/cm2. en Losa de cubierta	M3.	7.77	331.30	2,574.20
	Cerramientos	M3.	0.66	331.30	218.66

Losas precoladas de con
creto f'c=100 Kg/cm2. con
malla 6/6-10/10 de:

80x40x6 cm.	Pza.	16.00	28.00	448.00
60x28x5 cm.	Pza.	22.00	17.00	374.00
Colocación de ventanas metálicas	M2.	11.22	23.50	263.67
Colocación de puertas metálicas	M2.	1.79	23.50	42.06
Colocación de puertas de madera	M2.	10.83	25.25	273.40
Colocación de muebles sanitarios	Pza.	7	25.00	175.00
Colocación de accesorios para baño, de empotrar	Pza.	6	25.00	150.00
Colocación de coladeras de piso	Pza.	2	8.00	16.00
Acabado de piso con <u>ce</u> mento pulido a llana - metálica	M2.	61.85	5.60	346.36
Acabado de piso con <u>mo</u> saico de cemento de - 20x20 cm. de pasta en color, imitación cerá mica.	M2.	10.69	52.00	555.88
Acabado de cemento esco billado en patio de ser vicio.	M2.	6.54	3.50	22.89
Acabado de tirol en <u>te</u> chos	M2.	67.01	9.00	603.09

Lambrin de azulejo del Paíz de 2a. de 11x11 cm. color blanco	M2.	10.48	94.00	985.12
Aplanado de yeso en techos.	M2.	10.69	9.50	101.55
Emboquillado de mezcla en puertas y ventanas	Ml.	66.85	5.20	<u>347.62</u>

Total Albañilería y Acabados \$ 14,644.66

✓ Instalación sanitaria y
muebles

✓ Inodoro Mca. Vitromex Modelo Troyano blanco con tapa de plástico color gris oxford	Pza.	1	386.00	386.00
✓ Lavabo Mca. Vitromex Mod. Jazmin color blan co con accesorios Nibco.	Pza.	1	265.00	265.00
✓ Regadera tipo Cebolla Mca. Nibco Mod. No. - 295 B con llaves y - accesorios Nibco.	Pza.	1	127.00	127.00
✓ Fregadero porcelanizado Mca. Cinsa de 1.05x0.85 mt. con gabinete	Pza.	1	660.00	660.00
✓ Lavadero prefabricado - de cemento gris con Niple y tapa	Pza.	1	63.00	63.00
✓ Calentador semiautomático de 40 lts. Mca. Cinsa - 10 AEG.	Pza.	1	660.00	660.00
✓ Tinaco cilíndrico horizon tal de 1100 Lt. de capa- cidad.	Pza.	1	850.00	850.00

Accesorios para baño de porcelana color blanco para empotrar (Jaboneta para lavabo, jabonera - para regadera, portarro llo, gancho, portacepillo y toallero).

Lote 1 74.50 74.50

Instalación de muebles sanitarios con alimentaciones de tubería de cobre.

Salida 7 240.00 1,680.00

Toma y medidor de agua de ½"Ø con llave de nariz para jardín Mca. - Nibco. Mod. 191 s/p

Pza. 1 200.00 200.00

Drenaje con tubería de concreto de 15 cm. Ø incluyendo excavación y relleno a 70 cm. de profundidad promedio.

Ml. 19.50 18.94 369.33

Registro prefabricado de concreto de 40x60x75 cm. con tapa de concreto.

Pza. 2 174.00 348.00

Caja de piel del lavadero de 35x35x30 cm. - con tapa con orificio sin coladera

Pza. 1 75.00 75.00

Coladeras de piso

Pza. 2 68.00 136.00

Total de Instalación Sanitaria y Muebles. \$ 5,893.83

Herrería

Ventanas de perfiles tubulares de lámina calibre No. 20 con repison integral.

V1 de 1.00x2.10 mt.	Pza.	3	197.00	591.00
V2 de 1.50x2.10	Pza.	1	165.00	165.00
V3 de 1.05x1.00	Pza.	1	105.00	105.00
V4 de 1.20x0.60	Pza.	1	119.00	119.00

Puertas metálicas con
perfiles estructurales
y vidrio lámina Cal.
No. 20 estriada en la
parte inferior.

De: 0.85x2.10 mt.	Pza.	1	305.00	305.00
Soporte para calentador	Pza.	1	26.00	26.00
Botaguas de lámina galv. de cm. de desarrollo	Ml.	9.95	28.00	<u>278.60</u>

Total Herrería \$ 1,589.60

Carpintería

Puertas de tambor con
cubiertas de fibracel
de 5 mm. de:

1.00x2.10	Pza.	1	233.00	233.00
0.85x2.10	Pza.	3	222.00	666.00
0.75x2.10	Pza.	1	222.00	222.00

Puertas de tambor con -
cubiertas de fibracel y
mirilla de vidrio de:

0.85x2.10 mt.	Pza.	1	233.00	233.00
---------------	------	---	--------	--------

Carpintería

Closet de 0.80x2.00x
2.70 mt. con entrea
ños.

	Pza.	1	400.00	400.00
--	------	---	--------	--------

Closet sencillo solo
con tablero, tubo y -
preparación para corti
na.

	Pza.	2	400.00	<u>800.00</u>
--	------	---	--------	---------------

Total Carpintería \$ 2,554.00

Cerrajería

Chapa de puerta principal Mca. Fanal Mod. 460 5 CR cilíndrico eliptico	Pza.	1	102.50	102.50
Chapa de entrada Mca. - Fanal Mod. 175 - PD	Pza.	1	55.50	55.50
Chapa de intercomunicación Mca. Fanal Mod. 264-265- CR.	Pza.	5	45.50	<u>227.50</u>
Total Cerrajería				\$ 385.50

Impermeabilización

Impermeabilización en - azotea	M2.	78.00	14.90	<u>1,162.20</u>
Total Impermeabilización				\$ 1,162.20

Vidrieria

Vidrio claro medio doble del País, de 3 mm.	M2.	12.15	54.00	656.10
Espejo de 35x51 cm.	Pza.	1	92.00	92.00
Repisa de cristal con mensulas	Pza.	1	43.00	<u>43.00</u>
Total Vidrieria				\$ 791.10

Limpieza

Limpieza de vidrios	M2.	24.30	4.02	97.68
Limpieza de azulejos	M2.	10.40	2.90	30.16
Limpieza de muebles sa nitarios	Pza.	7	5.98	41.86

Limpieza de chapas	Pza.	7	3.50	24.50
Limpieza de muros apa rentes	M2.	210.00	2.90	609.00
Limpieza de mosaico	M2.	10.69	2.18	23.30
Limpieza general	M2.	120.00	3.00	<u>360.00</u>
Total Limpieza				\$ 1,186.50

Pintura

Esmalte en ventanas metálicas	M2.	11.22	8.00	89.76
Esmalte de puertas me tálicas	M2.	3.58	11.00	39.38
Pintura de aceite so bre plafones de yeso	M2.	10.69	8.00	85.52
Pintura de aceite sobre muros de cocina y baño.	M2.	38.73	8.00	309.84
Barniz en puertas de - madera	M2.	21.66	11.00	<u>238.26</u>
Total Pintura				\$ 762.76

Instalación eléctrica

Salidas de alumbrado	Salida	10	61.00	610.00
Salidas de contacto	Salida	7	61.00	427.00
Salida de timbre	Salida	1	94.00	94.00
Acometida eléctrica	Lote	1	55.00	55.00
Tablero QO-2 con 2 in terruptores de 1x20 A.	Pza.	1	385.00	<u>385.00</u>
Total Instalación eléctrica.				\$ 1,571.00

FABRICACION E INSTALACION DE TUBERIA SOLDADA DE ACERO AL CARBON

GENERAL.

Se ha determinado, a partir de instalaciones químicas grandes, que cada 100 conexiones o fittings empleados, se dividen de la siguiente manera:

	%	
Bridas	38	
Codos	40	
Tees	8	
Reducciones	10	
Nozzles	2	
Caps	<u>2</u>	100

De acuerdo con lo anterior, se ha formulado la siguiente Tabla, para cada 100'-0" de longitud de tubería:

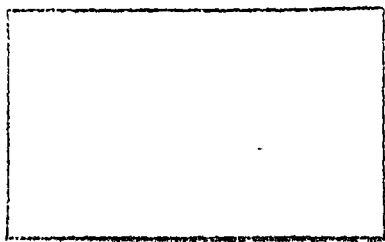
NO. DE CONEXIONES PARA CADA 100'-0"	BRIDAS	CODOS	TEES	REDUCCIONES	CAPS. & NOZZLES
10	3.8	4	0.8	1.0	0.4
15	5.7	6	1.2	1.5	0.6
20	7.6	8	1.6	2.0	0.8
25	9.5	10	2.0	2.5	1.0
30	11.4	12	2.4	3.0	1.2
40	15.2	16	3.2	4.0	1.6
50	19.0	20	4.0	5.0	2.0

La cantidad de juntas soldadas correspondientes, es como sigue:

						No. Total
10	3.8	8	2.4	2	0.4	16.6
15	5.7	12	3.6	3	0.6	24.9
20	7.6	16	4.8	4	0.8	33.2
25	9.5	20	6.0	5	1.0	41.5
30	11.4	24	7.2	6	1.2	49.8
40	15.2	32	9.6	8	1.6	66.4
50	19.0	40	12.0	10	2.0	83.0

Para tubería recta, asumiendo emplear tramos de 20', se requieren hacer 5 juntas soldadas por cada 100'-0".

109
CONDICIONES GENERALES



para el
Suministro de Maquinaria por Explotación*
establecidas bajo los auspicios de la
COMISION ECONOMICA PARA EUROPA
DE LA ORGANIZACION DE LAS NACIONES UNIDAS

GINEBRA - Marzo de 1953

CLAUSULA SUPLEMENTARIA
REVISION DE PRECIO

En caso de producirse alteraciones en los costos de los materiales y/o en los salarios relativos al contrato durante la vigencia de éste, los precios convenidos se someterán a revisión aplicando la siguiente fórmula :

$$P1 = \frac{Po}{100} (a + b \frac{M1}{Mo} + c \frac{S1}{So})$$

en donde :

P1 = Precio final de facturación.

Po = Precio inicial de la mercadería estipulado en el contrato y válido en la fecha de _____ (1).

M1 = Promedio (2) $\frac{\text{de los precios}}{\text{(o índices de precio)}}$ para _____

(tipo de materiales que se empleen) _____

durante el período _____ (3).

Mo = $\frac{\text{precio}}{\text{(o índices de precio)}}$ para los mismos materiales en la fecha arriba fijada para Po _____

S1 = Promedio (2) $\frac{\text{de los salarios (incluidas cargas por leyes sociales)}}{\text{o índices (4) de los salarios (incluidas cargas por leyes sociales)}}$ para _____

(precisar las categorías de la mano de obra y cargas anexas) durante el período _____ (3).

So = $\frac{\text{salarios (incluidas cargas por leyes sociales) o índices (4)}}{\text{de los salarios (incluidas cargas por leyes sociales)}}$ para las mismas categorías, en la fecha arriba fijada para Po.

(1) Se recomienda que las partes adopten en lo posible como precio inicial el vigente en la fecha del contrato y no el de una fecha anterior. Normalmente el precio no comprende los costos de embalaje, transporte y seguros.

(2) Aritmético o apreciado.

(3) Precisar este período, que puede ser definido como una parte o la totalidad del plazo de entrega.

(4) Si el índice usado incluye las cargas sociales legales no será necesario tomar en cuenta estas cargas nuevamente.

b, c, representan el porcentaje contractualmente admitido de los elementos particulares del precio inicial cuya suma es igual

(a + b + c = 100).

a = parte fija = _____

b = cuota de materiales = _____

c = cuota de salarios (incluidas cargas por leyes sociales) = _____

Si fuera necesario, b, y eventualmente c, pueden ser descompuestos en tantos porcentajes parciales (b1, b2, b3....) como variables se tomen en cuenta (b1 + b2..... + bn = b).

Documentación. - Para determinar los valores de los materiales y de los salarios se entiende que las partes se refieren a los siguientes documentos :

1. Materiales : $\frac{\text{precios}}{\text{(o índices de precio)}}$ de _____ (naturaleza de los materiales).

publicados por _____ bajo los títulos _____.

2. Salarios : $\frac{\text{salarios (incluidas cargas por leyes sociales)}}{\text{o índices de salarios (incluidas cargas por leyes sociales)}}$ publicados por _____

titulados _____ (5).

Modalidad de aplicación. - En caso de entregas parciales que se facturen separadamente, el precio final se calculará para cada entrega parcial.

Periodo de aplicación. - La cláusula de revisión regirá durante el plazo de entrega con sus prórrogas previstas en el párrafo 7.2, pero en ningún caso se aplicará después de terminada la fabricación.

Tolerancia de revisión. - La revisión de los precios no tendrá lugar si la aplicación de la fórmula conduce a una variación en más o en menos de _____ (6).

Reserva. - Si las partes desean que a partir de cierto porcentaje de variación en más o en menos sea corregida la fórmula de variación o reemplazada por un sistema de cálculo más preciso, deberán así estipularlo expresamente.

(5) Usar en lo posible índices especiales de la industria mecánica y eléctrica.

(6) Indicar en % la tasa que la variación deba sobrepasar, en más o en menos, para que la fórmula sea aplicada.



CONTABILIDAD BASICA Y CONTABILIDAD DE
COSTOS.

=====

PREFACIO.

Este curso podría haber sido subtulado como "Contabilidad para no contadores". Por cada contador profesional hay docenas de otras personas en la industria y en el gobierno que necesitan entender los conceptos básicos de contabilidad para poder desarrollar sus trabajos apropiadamente.

El objeto de este curso es proporcionar un conocimiento fundamental de contabilidad para personas que no esperan llegar a ser contadores, pero necesitan entender los conceptos básicos de contabilidad y obtener una visión de la estructura y de las características de operación de los sistemas contables.

Las personas que no son contadores necesitan tener un conocimiento básico de los conceptos fundamentales, definiciones y terminología de contabilidad y de las técnicas básicas y políticas comunmente empleadas en sistemas contables. Pero generalmente tienen el tiempo limitado para dedicarlo al estudio de estos conceptos. Así que, este curso aunque conciso, trata tanto contabilidad general como contabilidad de costos juntos, ambos relacionados con temas tales como depreciación, control presupuestal y usos administrativos de la información contable. Muchos temas de importancia para contadores profesionales, tales como historia contable, filosofía y teoría, son considerados de menor importancia para nosotros los ingenieros y su alcance está fuera de este curso.

PARTE I

ALGUNOS CONCEPTOS BASICOS.

IMPORTANCIA DE LA CONTABILIDAD EN LA INDUSTRIA. Entre más grande es el tamaño de una compañía, más importante es la contabilidad desde el punto de vista de control interno. En un negocio pequeño es posible tener contacto personal con todos sus asuntos. A medida que el tamaño del negocio au

menta, el control ejecutivo deja de ser un asunto de contacto personal para depender en aumento de cosas tales como presupuestos, reportes de costos, variaciones, reportes de estados de pérdidas y ganancias, y balances. El crecimiento de la industria ha propiciado el aumento de la importancia de la contabilidad.

IMPORTANCIA DEL CONOCIMIENTO DE CONTABILIDAD AL CONSTRUCTOR. La importancia de la contabilidad como un medio de control, hace deseable a cualquier persona ocupando un puesto de responsabilidad, el entender los principios básicos de contabilidad. Aún aquellas personas cuyas actividades los ponen en contacto con solo una parte de los registros contables, pueden actuar más inteligentemente si entienden como estos registros intervienen en el conjunto general del proyecto de las cosas. Cada promoción al ocupar una posición de mayor responsabilidad administrativa, es probable que aumente el contacto individual de la persona con contabilidad. Como resultado de tal promoción, es probable que una persona tenga que basar muchas de sus decisiones en números y reportes proporcionados por el Sistema contable ó bien tenga que decidir la forma en que se deban llevar los registros contables.

TEMA DE ESTE CURSO. Este curso presenta en una forma concisa, los principios esenciales de contabilidad general y de contabilidad de costos. Para cualquiera trabajando en el campo de producción, la contabilidad de costos es de especial importancia. Aunque el énfasis principal a través de éste curso es en la clase de información que uno puede obtener de los registros contables, también se menciona la clase de información que uno no puede obtener de la contabilidad.

Cuando una persona tiene un panorama general de los fundamentos contables como una base, los detalles de un sistema contable le son inteligibles, sin este panorama, quizás nunca los podría realmente entender. Por lo tanto el objetivo de este curso es proporcionar un conocimiento con el cual una persona pueda llenar sus propios requisitos en práctica y las bases con las cuales pueda desarrollar una apreciación de los usos y limitaciones de la contabilidad.

¿QUE ES CONTABILIDAD? Contabilidad es el arte de registrar, clasificar y sumarizar de un modo significativo y en términos de dinero, transacciones y acontecimientos los cuales son, por lo menos en una parte, de un carácter financiero, y como consecuencia interpretación de los resultados así obtenidos.

EL PUNTO DE VISTA DEL BALANCE. Un análisis del balance proporciona un acercamiento conveniente a los principios básicos de contabilidad. El balance es un informe obtenido del libro Mayor de contabilidad que da una imagen de las condiciones financieras de una empresa a una fecha específica. Al través del establecimiento en terminos de dinero de lo que la empresa posee (sus activos) y de lo que la empresa debe (sus pasivos), el balance establece una valuación monetaria del capital de los accionistas en la empresa. Esto se ve, una vez obtenido lo que queda para los accionistas después de deducir lo que la empresa debe (sus pasivos) y de lo que la empresa posee (sus activos). Lo antes mencionado puede expresarse en forma de una ecuación como sigue:

CAPITAL = Valuación en las cuentas de lo que la empresa posee menos lo que la empresa debe.

ó expresado más brevemente:

CAPITAL = ACTIVO - PASIVO.

LIMITACIONES DE LAS VALUACIONES CONTABLES. Se debe tener en mente que los valores de los activos que se encuentran en los balances son cantidades que resultan de la aplicación formal y sistemática de las reglas contables.

Las reglas sistemáticas para determinar los valores asignados a los activos en las cuentas a menudo dan valores que son muy diferentes de los valores en el mercado.

CALCULO DEL VALOR DEL CAPITAL.- El modo que el capital es deducido de las cantidades de los Activos y Pasivos puede ser ilustrado de la siguiente manera:

La Compañía "Maquinaria del Valle, S.A.", es una compañía que renta un almacén para equipo de construcción que no esta en uso y también actúa como una bolsa de maquinaria de construcción de segunda mano. Las cuentas muestran que al 1o. de Marzo de 19__ la compañía tenía un saldo de \$15,200.00 en su cuenta de cheques. Es propietaria de un terreno que le costo \$100,000.00 y de un cobertizo que le costó \$20,000.00 y hace las veces de Sala de exposición. Sus cuentas por cobrar \$6,000.00 de la Cía. Constructora MAR, S.A y de la Cía. Constructora SUR, S.A. Sus cuentas por pagar de \$2,100.00 a la revista "Noticias mensuales de Construcción" y de \$12,000.00 a la Cía. de Transportes Columbia, S.A., la Compañía no tenía otros activos ó pasivos.

Los activos se pueden enlistar como sigue:

—Saldo en la cuenta de cheques..\$	15,200.00
—Cuentas por cobrar de la - - Const. Mar, S.A.	6,000.00
—Cuentas por cobrar de la Const. Sur, S.A.	18,000.00
—Terreno.	100,000.00
—Cobertizo	20,000.00
TOTAL DE ACTIVOS. \$ 159,200.00	

Los pasivos pueden enlistarse como sigue:

— Cuenta por pagar del "Noticias Mensuales de Const." \$	2,100.00
— Cuenta por pagar de Transpor- tes Columbia, S.A.	12,000.00
TOTAL DE PASIVOS. \$ 14,100.00	

El capital del negocio puede ser determinado restan-
do como sigue:

ACTIVO	\$ 159,200.00
PASIVO	\$ 14,100.00
CAPITAL	\$ 145,100.00

DETERMINACION DE LAS GANANCIAS RETENIDAS. Otro tema-
interesante acerca de la Cía. Maquinaria del Valle, S.A. que--
no se ha mencionado, es que la inversión original de los - --
accionistas (los propietarios) era de \$75,000.00. Esta está --
representada por 50 acciones con un valor nominal de \$1,500.00
cada una.

La valuación del capital obtenida de los libros es -
de \$145,100.00. Es evidente que esta cantidad es \$70,100.00 -
mayor que la inversión hecha por los accionistas. Estos - -
\$70,100.00 representan la porción de las utilidades que se han
obtenido en ejercicios contables anteriores y que han sido de-
jados en el negocio en lugar de haber sido entregados a los -
propietarios como dividendos. El nombre contable para tal can-

tividad es "Ganancias Retenidas". Siempre que el valor actual del CAPITAL en libros es menor que el valor inicial del Capital la cantidad de "Ganancias Retenidas" es negativa y el termino "deficit" es usado en el balance.

UN BALANCE SIMPLE. Para propositos de una declaracion financiera formal, es conveniente reescribir la ecuacion que define el Capital como la diferencia entre Activos y Pasivos para leerse como sigue:

$$\text{ACTIVO} = \text{PASIVO} + \text{CAPITAL}$$

Esta es la forma comun de la ecuacion del balance. El balance formal implica una dosificacion y una tabulacion de varios conceptos de esta ecuacion. Esto se puede ilustrar como sigue:

COMPANIA MAQUINARIA DEL VALLE, S.A.

Balance al 1º de Marzo de 19__

ACTIVO		PASIVO Y CAPITAL	
Efectivo	\$ 15,200.00	Cuentas por pagar	\$ 14,100.00
Cuentas por cobrar	\$ 24,000.00	Capital Social	\$ 75,000.00
Terrenos	\$ 100,000.00	Ganancias Reteni-	
Edificaciones.	\$ 20,000.00	das.	\$ 70,100.00
TOTAL	\$ 159,200.00	TOTAL	\$ 159,200.00

Debera notarse que en este balance las cuentas por cobrar individuales se han combinado dentro de una sola cantidad. El saldo en la cuenta de cheques referido como "Efectivo" es frecuentemente usada para referir los saldos de las cuentas en los bancos comerciales.

Se ha hecho referencia a las posibles limitaciones de las valuaciones en el balance. Una simple ilustracion acerca de este punto se puede obtener al notar que el terreno esta valuado a su costo o sea a \$100,000.00. Obviamente el valor presente en el mercado puede ser mayor o menor que este costo.

INTRODUCCION AL DEBE Y AL HABER. El origen historico del uso de las palabras "debe y haber" en contabilidad se remonta a los dias del uso de registro de partida simple en los libros de contabilidad en los cuales el principal objeto era llevar un record de las cantidades que debian los clientes (los deudores) y de las cantidades que se le debian al vendedor (los acreedores). El debe se aplica para indicar "el debe"

y el haber para indicar a "el se le debe". Hacer un cargo a una cuenta de un cliente (el debe) era simplemente registrar una cantidad que el cliente nos debía; y acreditar una cuenta (el haber) era registrar una cantidad que nosotros le debíamos al vendedor.

La costumbre era que cuando el cliente pagaba su cuenta debía ser acreditada; y cuando se le pagaba a un vendedor, su cuenta debía ser cargada. Subsecuentemente, se volvió costumbre en contabilidad que el debe se mostrara en el lado izquierdo de las cuentas el haber en el lado derecho de las cuentas.

Con el desarrollo del registro de doble partida en los libros de contabilidad y con la elaboración de los sistemas contables, la derivación original de las palabras debe y haber perdió su significado y fué insatisfactorio como una base para entender el significado de estas palabras en la contabilidad moderna y la que se usaba anteriormente es que el debe se refiere en el lado izquierdo de una cuenta y el haber en el lado derecho.

El debe puede referirse como una cantidad de dinero registrada en el lado izquierdo de una cuenta y el haber como el registro de una cantidad de dinero en el lado derecho de una cuenta.

BASES DEL REGISTRO DE LA DOBLE PARTIDA EN LOS LIBROS DE CONTABILIDAD. El registro de la doble partida, esta basado en la ecuación del balance. El activo debe ser siempre igual a la suma del pasivo más el capital. Ninguna transacción o cuenta puede alterar esta igualdad. Algunas transacciones son meramente el intercambio de un activo por otro, como ocurre cuando compramos un mueble de oficina con efectivo o como cuando una cuenta por cobrar es saldada con su pago en efectivo. Otras transacciones pueden involucrar un incremento en un activo con un correspondiente aumento en un pasivo, como ocurre cuando una presa de Maquinaria es comprada a crédito. Pero cualquier transacción que altera la diferencia entre Activos y Pasivos necesariamente provoca un cambio en el capital.

Consecuentemente, cualquier evento que cambia el balance de cualquier cuenta del activo o del pasivo necesariamente cambia el balance en otra cuenta del activo o del pasivo o en una cuenta del capital. Esto es lo que se llama el carácter doble o transacciones comerciales que permiten el registro de la doble partida en contabilidad.

REGLAS PARA EL CARGO Y CREDITO DE CUENTAS. Los siguientes convencionalismos deben ser observados con respecto al lado izquierdo y derecho de las cuentas:

Para cuentas del activo, el lado izquierdo (el debe) es el lado positivo de la cuenta y el lado derecho (el haber) es el lado negativo de la cuenta.

Para cuentas del pasivo, del capital, el lado derecho de la cuenta (el haber) es el lado positivo de la cuenta, y el lado izquierdo (el debe) es el lado negativo de la cuenta.

De los convencionalismos anteriores, conjuntamente con los requisitos de la ecuación del balance se derivan las siguientes reglas para el cargo y crédito de cuentas:

- | | |
|---|--|
| <p>1.- Si se aumenta un activo por una transacción, cargue la cuenta apropiada del activo.</p> <p>2.- Si un pasivo es disminuido por una transacción, cargue la cuenta apropiada del pasivo.</p> <p>3.- Si el capital es disminuido por una transacción, cargue la cuenta apropiada del capital (usualmente una cuenta de gastos)</p> | <p>1.- Si un activo es disminuido por una transacción, acredite la cuenta apropiada del activo.</p> <p>2.- Si un pasivo es aumentado por una transacción acredite la cuenta apropiada del pasivo.</p> <p>3.- Si el capital es aumentado por una transacción acredite la cuenta apropiada del Capital (usualmente una cuenta de <u>ingresos</u>.)</p> |
|---|--|

Como conveniencia para memorizar, estas reglas pueden ser sumarizadas como sigue:

CUENTA	SI ES AUMENTADA	SI ES DISMINUIDA.
ACTIVO.....	Cargue la cuenta	Acredite la cuenta.
PASIVO O CAPITAL.	Acredite la cuenta	Cargue la cuenta.

O inversamente, los adientos en las cuentas pueden interpretarse como sigue:

CUENTA	UN CARGO SIGNIFICA (EL DEBE)	UN CREDITO SIGNIFICA. (EL HABER)
ACTIVO.....	Un aumento	Una disminución.
PASIVO O CAPITAL	Una disminución	Un aumento.

Es conveniente simbolizar una cuenta, con sus lados respectivamente del debe y el haber, en forma de esqueleto como una larga T. Usando una T para representar todas las cuentas del pasivo, otra para representar todas las cuentas del activo y una tercera para representar todas las cuentas del capital, las reglas para el cargo (el debe) y el crédito (el haber) de cuentas pueden ser representadas simbólicamente como sigue:

A		=	P		+	C	
Debe	Haber		Debe	Haber		Debe	Haber
+	-		-	+		-	+

Si las reglas anteriores son observadas y si un asiento completo es hecho para cada transacción, se observa que cada asiento hecho en los libros sera balanceado con respecto a la ecuación básica de contabilidad. Activo = Pasivo + Capital.

LOS CARGOS DEBEN SER IGUALES A LOS CREDITOS. Necesariamente si cada transacción es registrada apropiadamente de acuerdo a (1) la ecuación del balance y (2) de acuerdo a las reglas para el crédito y cargo de cuentas, se tendrá que para cada transacción la suma de los cargos en el libro mayor será igual a la suma de los créditos. Esto nos proporciona un medio de checar que puede ser hecho para cada transacción y este chequeo nos revelará una gran variedad de posibles errores. También por supuesto, si por cada transacción registrada, la suma de los cargos iguala a la suma de los créditos, esta igualdad se mantendrá en cualquier tiempo en el libro mayor. Cuando un contador dice, "El libro mayor esta en Balance", significa que esta prueba fué aplicada al libro Mayor y no fallo.

EJEMPLO: ¹¹⁰ PARA ILUSTRAR CARGOS Y CRDITOS. El siguiente ejemplo contiene un ciclo contable completo. El ejemplo se inicia con las cuentas de balance para una empresa al comienzo de un periodo contable (un mes, un trimestre, un semestre o un año) e ilustra los efectos que ocurren durante el periodo. El ejemplo concluye con la preparación del balance al final del periodo y de un estado de resultados, mostrando las ganancias o las pérdidas netas del periodo.

COMO ANALIZAR UNA TRANSACCION COMERCIAL EN TERMINOS DEL DEBE Y EL HABER. Con el fin de determinar la forma de hacer un asiento para una transacción en específico, nos debemos hacer preguntas tales como ¿Ha sido un activo aumentado o disminuido por esta transacción? En caso que si ¿Cuál activo (el efectivo, una cuenta por cobrar de un cliente en particular, una mercancía vendida etc.) y cuanto? ¿Ha sido aumentada o disminuida una cuenta del pasivo por esta transacción? En caso que si ¿Cuál cuenta (una cuenta por pagar a

un acreedor en particular) y cuanto?

TABLA 1-1

TRANSACCIONES DE LA COMPAÑIA MAQUINARIA DEL VALLE, S.A.

DURANTE EL MES DE MARZO DE 19__

A.- Balances iniciales al lo. de Marzo de 19__, eran como sigue:

CUENTA	DEBE	HABER	<u>Las Ctas. por cobrar eran:</u>
- Efectivo	\$15,200.00		Const. Mar, S.A. \$6,000.00
- Ctas. p/co- brar	24,000.00		Const. Sur, S.A. 13,000.00
- Terrenos	100,000.00		
Edificios	20,000.00		
- Cuentas por Pagar		\$14,100.00	<u>Las ctas. por pagar eran.</u>
- Capital Social		75,000.00	Noticias Mens. de la Const. \$ 2,100.00
- Provisiones rete- nidas.		70,100.00	Transp. Columbia \$ 12,000.00 S.A.
	<u>159,200</u>	<u>159,200</u>	

- B.- Se recibieron \$8,000.00 de Const. Sur, S.A.
- C.- Se liquido la cuenta "Noticias Mensuales de la Const. \$2,100.00
- D.- Se recibio una cuenta de \$6,000.00 de la Cía. Estructuras, S. A. por la ampliación del cobertizo.
- E.- Se recibieron \$1,500.00 del Ing. Manuel Vázquez por concep-
to de alquiler de almacenaje de una Motoconformadora.
- F.- Se pagaron \$800.00 a "Noticias Mensuales de la Construcción" -
por concepto de publicidad durante marzo.
- G.- Se recibieron \$2,000.00 de Acuario, S.A. por concepto de co-
misión de la venta de una revolvedora.
- H.- Se le facturaron \$5,000.00 a Const. Mar, S.A. por concepto -
de comisión en la venta de un camión de volteo.
- I.- Se ~~le~~ pagaron \$3,000.00 a cuenta a Estructuras, S.A.
- J.- Se tomo a revisión la factura de Noticias Mensuales de la -
Construcción, correspondiente al anuncio del mes de Marzo -
\$900.00

K.- Se facturaron \$2,500.00 a Const. Sur, S.A. por la renta de espacio en la Sala de exhibición del mes de Marzo.

L.- Pago del salario del Gerente, Sr. Fernando Alvarez \$7,000.00.

Para determinar si se ha efectuado un cambio en el capital, recuerde que $\text{Capital} = \text{Activo} - \text{Pasivo}$, si la transacción cambia la diferencia entre la suma de activos y la suma de pasivos, entonces ha habido un cambio correspondiente en el capital. Por ejemplo, si una transacción disminuye el activo de la cuenta de efectivo en \$1,000.00 y no cambia ningún otro activo o pasivo entonces ha habido una disminución de \$1,000.00 en el Capital.

La siguiente tabla muestra las transacciones de esta compañía durante Marzo.

TABLA 1-2

DEL LIBRO MAYOR DE LA COMPAÑIA MAQUINARIA DEL VALLE, S.A. REPRESENTA POR CUENTAS Y MOSTRANDO LOS ASIENTOS CORRESPONDIENTES AL MES DE MARZO DE 19...

ACTIVO		=	PASIVO	+	CAPITAL
<u>Efectivo</u>			<u>Ctas. por Pagar</u>		<u>Capital Social</u>
A 15,200.00	2,100.00C		14,100.00A		75,000.00A
B 8,000.00	800.00F	C 2,100.00	6,000.00D		
E 1,500.00	3,000.00I	H 3,000.00	900.00J		
G 2,000.00	7,000.00L				
<u>Ctas. por Cobrar</u>					<u>Ganancias Retenidas</u>
A 24,000.00	8,000.00B				70,100.00A
H 5,000.00					
K 2,500.00					
<u>Terrenos</u>					<u>Ingresos y Gastos</u>
A 100,000.00					<u>Pérdidas y Ganancias</u>
				F 800.00	1,500.00I
				J 900.00	2,000.00K
				L 7,000.00	5,000.00M
					2,500.00N
<u>Edificaciones.</u>					
A 20,000.00					
D 6,000.00					

Se deberá tener atención especial a las siguientes explicaciones de cada asiento.

ASIENTO A. Si nuestro libro mayor ha sido usado para los periodos contables precedentes (Vr.gr. Febrero) los balances iniciales para Marzo deberán estar ya en el libro Mayor, las cuentas del activo tienen balances en el debe; las cuentas del pasivo y del capital tienen balances en el haber. Con estos balances

iniciales las cuentas T aparecen como sigue:

Efectivo	Ctas. por Cobrar	Ctas. por Pagar.
A 15,200.00	A 24,000.00	14,100.00 A
Terrenos	Edificaciones	Capital Social
A 100,000.00	A 20,000.00	75,000.00 A
		Ganancias Retenidas
		70,100.00 A

NOTESE que la suma de las cantidades de las cuentas en el debe son iguales a la suma de las cantidades en el haber. Los demás asientos se explicaran durante la clase.

TABLA 1 - 3

EL LIBRO MAYOR DE LA COMPAÑIA MAO. DEL VALLE, S.A. REPRESENTADO POR CUENTAS T MOSTRANDO LOS BALANCES DE LAS CUENTAS AL FINAL DE MARZO DE 19__

Efectivo	Ctas. por Cobrar.
A 15,200.00 2,100.00 C	A 24,000.00 8,000.00 B
B 3,000.00 300.00 F	H 5,000.00
E 15,000.00 3,000.00 I	K 2,500.00
G 2,000.00 7,000.00 L	✓ 31,500.00 8,000.00 ✓
✓ 26,700.00 12,900.00 ✓	23,500.00
13,800.00 13,800.00	23,500.00

Terrenos	Edificaciones.
A 100,000.00	A 20,000.00
	D 6,000.00
	26,000.00
	26,000.00

Ctas. por Pagar.
C 2,100.00 14,100.00 A
I 3,000.00 6,000.00 B
900.00
✓ 5,100.00 21,000.00 ✓
15,900.00
15,900.00

Capital Social	Ganancias Retenidas
75,000.00 A	70,100.00 A

Pérdidas y Ganancias			
F	800.00	1,500.00	E
J	900.00	2,070.00	G
L	700.00	5,000.00	H
		2,500.00	K
	3,700.00	11,000.00	
	2,300.00		
		2,300.00	

BALANCE DE CUENTAS

La tabla 1-3 muestra el libro Mayor en cuentas T después que se han sumariado los asientos que se han cerrado los balances cada cuenta. Notese el modo como esto es mostrado en una cuenta, tomemos como ejemplo la cuenta del efectivo. La suma de debes (cargos) es de \$26,700.00; y la suma de haberes (créditos) es de \$12,900.00; estos totales fueron escritos con números pequeños. (pequeños)

La diferencia fué determinada como sigue:

$$\$26,700.00 - \$12,900.00 = \$13,800.00$$

Esta diferencia, claro es el balance (balance deudor) de la cuenta y como consecuencia es mostrado en el lado del debe abajo de la raya horizontal. Si la misma cantidad \$13,800.00 es también mostrada en el lado del haber, arriba de la línea, entonces la suma de todos los créditos arriba de la línea será igual a la suma de todos los cargos arriba de la línea. Por lo tanto, todos los asientos arriba de la línea pueden ser ignorados en cálculos subsecuentes del balance de la cuenta. Notese que esta práctica es congruente con las reglas para cargar y acreditar una cuenta; en efecto un asiento balanceado es hecho en la cuenta con este procedimiento de sumariación.

Es conveniente hacer notar que las cuentas se llevan dentro del "Sistema contable Actual" es decir que los ingresos se muestran dentro del periodo contable en el que se ganan aunque no se hayan recibido durante ese periodo, los gastos se muestran en el periodo contable donde se aplicaron aunque no se hayan pagado durante ese periodo.

BALANZA DE COMPROBACION. Para cada transacción asentada en el Libro Mayor de la compañía (Tabla 1-3) los cargos igualan los créditos. Por lo tanto el total de los balances en el debe, deben ser iguales al total de los balances en el haber.

La tabla 1-4 muestra el enlistado de los balances de las cuentas y los totales del debe y el haber. Tal enlistado llamado balanza de comprobación es tomado al final de cada periodo contable.

TABLA 1-4

CIA. MAQUINARIA DEL VALLE, S. A.

BALANZA DE COMPROBACION AL 31 DE MARZO DE 19__

CUENTA	DEBE	HABER
-Efectivo.....	\$ 13,800.00	
-Cuentas por Cobrar.....	23,500.00	\$
-Terrenos.....	100,000.00	
-Edificaciones.....	26,000.00	
-Cuentas por pagar.....		\$ 15,900.00
-Capital Social.....		75,000.00
-Ganancias Retenidas.....		70,100.00
-Pérdidas y Ganancias.....		23,100.00
	<hr/>	<hr/>
TOTALES	\$ 163,300.00	\$ 163,300.00

Esto sirve para dos propósitos. Uno es para proporcionar un chequeo parcial de cualquier error numérico en los libros. El otro es para proporcionar un sumario de las cantidades en el libro mayor, tal sumario da una gran parte de la información necesaria para la preparación del balance final del periodo y para el estado de pérdidas y ganancias (usualmente llamado estado de resultados).

Aunque la balanza de comprobación es un chequeo de los errores numéricos, hay errores que no se pueden detectar por medio de la balanza de comprobación. Por ejemplo el omitir por completo una transacción, el hacer un asiento en una cuenta equivocada, o el mismo error numérico puede asentarse en el debe y en el haber.

DETERMINACION DEL ESTADO DE PERDIDAS Y GANANCIAS PARA EL PERIODO. La cuenta de Pérdidas y Ganancias tiene un balance en el haber de \$2,300.00 Esto muestra una ganancia en el mes de Marzo de \$2,300.00 y un incremento neto en el Capital de la misma cantidad durante el mes de Marzo.

Es facil visualizar en este ejemplo la forma en que se obtuvo contablemente la ganancia durante el mes de Marzo. Ya que solo fueron siete asientos. Pero esto no hubiera sido práctico si en lugar de siete asientos hubieran sido, digamos setecientos. A todas luces se ve que es necesario hacer una clasificación de los gastos y de los ingresos y asentar los cambios del capital en el Libro Mayor de acuerdo a esta clasificación. Algunas cuentas de ingresos y gastos se ilustran al final de este ejemplo en el catálogo de cuentas.

Se debe hacer una observación respecto a la cantidad de la ganancia obtenida de \$2,300.00. Nuestras cuentas no han tomado en cuenta el factor de las edificaciones (el cobertizo) de la Cía. Maquinaria del Valle, S.A., tienen una vida limitada. Alguna parte pequeña de los \$26,000.00 que costo este activo fijo deberá ser cargada como un gasto del mes de Marzo de 19___. Tal cargo reducira la ganancia de los \$2,300.00. Este importante tema sobre el tratamiento contable de la depreciación de activo fijo se tratará en la 2a. parte del curso.

PREPARACION DEL LIBRO MAYOR PARA EL COMIENZO DEL PROXIMO PERIODO CONTABLE. En este ejemplo tan simple en el cual todos los cambios en el Capital han sido asentados en una cuenta, solo un asiento es necesario para preparar las cuentas para comenzar Abril. Este asiento es para trasferir el balance de la cuenta "Pérdidas y Ganancias" a la cuenta de "Ganancias Retenidas". Para transferir el balance tenemos que cargar \$2,300.00 a la cuenta de "Pérdidas y Ganancias" y acreditar la misma cantidad a la cuenta "Ganancias Retenidas". Identificando este asiento con una M las dos cuentas afectadas aparecen como sigue:

Pérdidas y Ganancias		Ganancias Retenidas.	
F 300.00	1,500.00 E	70,100.00	A
J 900.00	2,000.00 G	2,300.00	M
L 7,000.00	5,000.00 H	72,400.00	
	2,500.00 L		72,400.00
2,300.00			
M 2,300.00	2,300.00		

La cantidad neta de la cuenta temporal del Capital llamado "Pérdidas y Ganancias" ha sido transferido a la cuenta permanente del Capital llamada "Ganancias Retenidas"

PREPARACION DEL BALANCE GENERAL DE LA TERMINACION DEL PERIODO. La Tabla 1-5 Es el balance general de la Cía. Maquinaria del Valle, S.A., mostrando la condición del negocio al final

del mes de Marzo. Toda la información presentada en este balance se ha obtenido de la balanza de comprobación la cantidad que aparece en la cuenta "Ganancias Retenidas" incluye la ganancia neta de Marzo.

TABLA 1 - 5

CIA. MAQUINARIA DEL VALLE, S.A.

BALANCE GENERAL AL 31 DE MARZO DE 19__

ACTIVO		PASIVO Y CAPITAL	
Activo Circulante		Pasivo	
Efectivo.	\$ 13,800.00	-Ctas. x pagar.	\$ 15,900.00
Ctas. x cobrar.	<u>23,500.00</u>		
	\$ 37,300.00		
Activo Fijo		Capital	
Terrenos.	\$100,000.00	-Cap. Social	\$75,000.00
Equipificaciones.	<u>26,000.00</u>	-Gan. Reten.	<u>72,400.00</u>
	<u>126,000.00</u>		<u>147,400.00</u>
TOTAL	\$ 163,000.00	TOTAL	\$163,000.00

En este balance los activos han sido subdivididos en dos clases en general, activos fijos y activos circulantes, los activos circulantes consisten del efectivo, de las cuentas, por cobrar y de otros activos que pueden convertirse en efectivo dentro de un tiempo relativamente corto. Los activos fijos son en general propiedades que permanecen un tiempo relativamente largo en poder del negocio.



CATALOGO DE CUENTAS

OBRAS

A C T I V O

CLASIFICACIONES

101.- C A J A

102.- B A N C O S

107.- RETENCION DE ESTIMACIONES DEL CLIENTE

109.- PREESTIMACION DE AVANCE DE OBRA

(Análisis por conceptos del Contrato)

113.- SUB-CONTRATISTAS

114.- EMPLEADOS

115.- DEUDORES Y ACREEDORES

227.- A L M A G E N

 Materiales

 Refacciones

 Papelería y Artículos de Oficina

 Resguardo-Consumo

301.- GASTOS DE ORGANIZACION E INSTALACION

304.- INVERSIONES Y GASTOS AMORTIZABLES

 01.- Herramientas

 02.- Instrumentos de Ingeniería

 03.- Equipo de Radio-Comunicación

 04.- Instrumental Médico

 05.- Equipo de Campamento

 06.- Cimbras

 07.- Diversos

305.- OTROS GASTOS POR AMORTIZAR

P A S I V O

402.- PROVEEDORES

403.- SALARIOS POR PAGAR

404.- DEBITOS DEFERIDOS NO COBRADOS

405.- PROVISION PARA IMPUESTOS

01.- Secretaría del Patrimonio Nacional

02.- Ingresos Mercantiles Federal

03.- Productos del Trabajo

04.- 1% para la Enseñanza

05.- Seguro Social

06.- Ingresos Mercantiles Estatal

07.- Obras de Beneficio Regional

08.- Varios.

C A P I T A L

500.- OFICINA MATRIZ

- 01.- Remesas en Efectivo
- 02.- Refacciones y Materiales
- 03.- Rentas de Activo Fijo
- 04.- Diversos
- 05.- Estimaciones

503.- PERDIDAS Y GANANCIAS

I N G R E S O S

701.- INGRESOS EXENTOS POR ESTIMACIONES

702.- INGRESOS GRAVADOS POR ESTIMACIONES

703.- INGRESOS EXENTOS POR OBRAS EN ADMINISTRACION

704.- INGRESOS GRAVADOS POR OBRAS EN ADMINISTRACION

705.- OTROS INGRESOS

E G R E S O S

801.- COSTO DE OBRA

(Según Catálogo)

especifico

802.- GASTOS GENERALES

(Catálogo anexo) *hoja 41 y 42*

803.- OTROS GASTOS

MANUAL DEL CATALOGO DE CUENTAS

PARA

OBRAS

101.- C A J A

SE CARGA:

- 1.- Por la dotación provista para el fondo fijo de Caja.
- 2.- Por incrementos a la dotación.

SE LIBERA:

- 1.- Cuando desaparezca el fondo fijo de Caja, mediante la restitución del citado fondo, por parte de la persona encargada de éste.

S A L I D O:

Siempre será el mismo (importe de la dotación más los incrementos): estará formado por efectivo y comprobantes de gastos menores, debidamente autorizados por las personas indicadas.

102.- BANCOS

SE CARGA:

1.- Por los depósitos bancarios efectuados generalmente por los siguientes conceptos:

- a) Remesas de Oficina Matriz
- b) Anticipos de Clientes
- c) Cobro de Estimaciones
- d) Cobros por Obras en Administración
- e) Cobro de Títulos de Crédito
- f) Venta de Equipo, Refacciones y Otros
- g) Etc.

2.- Y en general, por los depósitos bancarios efectuados por cualquier otro concepto.

SE DEBENA:

1.- Por los cheques expedidos por la obra, generalmente por los siguientes conceptos:

- a) Pago por Sueldos y Rayas
- b) Pagos a Proveedores
- c) Pago de Impuestos y Cuotas
- d) Compras al Contado
- e) Reposiciones al Fondo Fijo
- f) Remesas a Oficina Matriz

2.- Y en general, por los cargos efectuados por el banco, comisiones, cobranzas, etc.

SALDO:

De naturaleza deudora, representa la disponibilidad en bancos a favor de la empresa.

N O T A : Los pagos de clientes recibidos en las obras, deberán reportarse de inmediato a la oficina matriz y sólo deberán conservarse en la cuenta bancaria de la obra, las partidas que así lo autorice la Oficina Matriz.

107.- RETENCION DE ESTIMACIONES DEL CLIENTE

SE CARGA:

- 1.- Por el importe de las retenciones en estimaciones hechas por los clientes.

SE ABONA:

- 1.- Por la recuperación de las retenciones sufridas.

S A I D O:

De naturaleza cuadora, representa las retenciones de estimaciones, generalmente por atraso en el cumplimiento de los Contratos de obra.

NOTAS: Estas retenciones se conocerán directamente en la obra, al formular el cliente la estimación y determinar la tetención por atraso o, por comunicación de la Oficina Matriz.

Debe tenerse cuidado de no duplicar el registro de estas retenciones.

El Superintendente de la obra es el responsable de acelerar la ejecución para lograr la devolución de la retención, ya que si no es así puede llegar a convertirse en una sanción definitiva.

109.- PRE-ESTIMACION DE AVANCE DE OBRA

SE CARGA:

- 1.- Por el importe del avance de obra a precio de venta según contrato, efectuado en la semana.

SE ABONA:

- 1.- Por el importe de los trabajos a precio de venta aceptados por el cliente.

S A L D O:

De naturaleza deudora, representa (al precio de venta pactado con el contrato) el importe del avance de obra no aceptado aún por el cliente.

N O T A: En la obra se llevará administrativamente el análisis por cada concepto del contrato, para que en todo momento se conozca:

- . El total contratado
- El total ejecutado
- El total aceptado por el cliente
- La diferencia por ejecutar
- La diferencia no aceptada por el cliente.

113.- SUB-CONTRATISTAS

SE CARGA:

- 1.- Por anticipos o entregas a los sub-contratistas, a cuenta de trabajos.
- 2.- Por el importe de los artículos que se les proporcionen para el desarrollo de los trabajos sub-contratados.
- 3.- Por otros conceptos a cargo de sub-contratistas.

SE ABONA:

- 1.- Por el importe de los recibos autorizados, por trabajos ejecutados.
- 2.- Por devoluciones de efectivo.
- 3.- Por devoluciones de artículos proporcionados para el desarrollo de los trabajos.

SALDO:

De acuerdo a su naturaleza, deudora o acreedora, representa el importe entregado a cuenta de trabajos o el saldo pendiente de pagar a los sub-contratistas.

NOTA: Las retenciones que la obra haga a los sub-contratistas en garantía de los trabajos ejecutados, se registrarán en la cuenta 115.- DEUDORES Y ACREEDORES.

114.- EMPLEADOS

PRESTAMOS

1.- Por el importe de los préstamos concedidos a los empleados de la obra.

ABONOS

1.- Por los abonos efectuados por los empleados de la obra.

SAVEDOS

De naturaleza deudora, representa analíticamente el total de adeudos por préstamos a los empleados, pendientes de recuperar por la obra.

115.- DEUDORES Y ACREEDORES
(Saldo Deudores)

DE CARGA:

- 1.- Por los adeudos de terceros para con la obra, no provenientes de las operaciones normales.
- 2.- Por las dotaciones entregadas a los empleados, para los siguientes conceptos:
 - a) Viáticos
 - b) Gastos de Representación.
 - c) Otros conceptos.

DE ABONOS:

- 1.- Por los pagos de terceros a la obra.
- 2.- Por la comprobación de gastos u otros conceptos, por los empleados.

SALDO:

De naturaleza deudora, representa el total de adeudos de terceras personas para con la obra y el importe de las entregas hechas a empleados y que están pendientes de comprobar.

117.- ALMACÉN

SE CARGA:

- 1.- Por las diversas refacciones, materiales y artículos recibidos de la Oficina Matriz o adquiridos en la obra.
- 2.- Por la devolución al Almacén de refacciones, materiales o artículos que no se utilizaron en la construcción.
- 3.- Por los artículos que se contabilizarán en \$1.00 (vales resguard de consumo).

SE ABOYA:

- 1.- Por salidas de refacciones, materiales y artículos para su utilización en la ejecución de la obra.
- 2.- Por salida de refacciones, materiales y artículos enviados a otras obras o a la Oficina Matriz.
- 3.- Por devoluciones a Proveedores.

S E D O:

De naturaleza deudora, representa la existencia física de materiales, artículos y refacciones, almacenados en la obra.

N O T A : Cuando se reciban artículos que de inmediato se utilizarán en la obra, se formulará la "Nota de Entrada y Salida Inmediata" y no se afectará el Kardex de Almacén por la entrada y por la salida de artículos.

301.- GASTOS DE ORGANIZACION E INSTALACION

SE CARGA:

- 1.- Por las inversiones en instalaciones para la obra, sujetos a amortización.
- 2.- Por los gastos de organización, hechos por la obra.

SE ABONA:

- 1.- Por la aplicación cuando se estime conveniente, de la AMORTIACION ACUMULADA.

NOTAS:

De naturaleza deudora, representa el importe de los gastos de instalación y organización, hechos por la obra y que están pendientes de amortizarse.

N O T A: El criterio de amortización, que será fijo, se establecerá previamente en Oficina Matriz.
Algunas instalaciones se autorizan por el cliente, y son reembolsables, éstas deberán formar parte del costo?

304.- INVERSIONES Y GASTOS AMORTIZABLES

Definición:

Se refiere a todas aquellas inversiones y gastos efectuados por la obra, tales como herramientas, instrumentos de ingeniería equipo de radio-comunicación, instrumental médico, equipo de campamento, cimbra, diversos, etc., y cuya aplicación a resultados se hará en forma paulatina.

Amortización:

Por la aplicación a resultados de las partes que se vayan amortizando.

Base de Cálculo:

La naturaleza deudora, representa analíticamente el valor de las inversiones o gastos susceptibles de amortización, efectuados en la obra.

NOTA: El criterio de amortización, que será fijo para cada grupo de artículos, será establecido previamente en la oficina Matriz.

305.- OTROS GASTOS POR AMORTIZAR

EN CARGA:

- 1.- Por todos aquellos gastos anticipados efectuados por la obra y cuya aplicación a resultados se hará en forma paulatina, - tales como rentas, seguros, etc.

EN ABOGADO:

- 1.- Por la aplicación a resultados de las partes que se vayan - abogando.

S A L D O:

De naturaleza deudora, representa el importe pagado a cambio de servicios futuros.

402.- PROVEEDORES LOCALES

EN CARGA:

- 1.- Por los pagos a Proveedores.
- 2.- Por los anticipos a Proveedores.

En Débito:

- 1.- Por las compras a crédito a Proveedores locales.
- 2.- Se abona en rojo por devoluciones de artículos que no obedecen a las características señaladas, que son defectuosas o por cualquiera otra circunstancia.

S. A. D. O.:

De naturaleza acreedora, representa los adeudos a cargo de la obra por concepto de compras a crédito, únicamente a proveedores locales.

NOTA: Los anticipos a proveedores se registrarán en esta cuenta y sólo se reclasificarán en hoja de trabajo, para efectos de la información que mensualmente se envía a la Oficina Matriz.

115.- DEUDORES Y ACREEDORES
(SALDOS ACREEDORES)

REGLÓN

- 1.- Por el cumplimiento parcial o total de las obligaciones enumeradas en el renglón de abono.

DETALLES

- 1.- Por el importe de las cuotas sindicales, retenidas a los empleados.
- 2.- Por el importe de la participación de los trabajadores en las utilidades de la empresa.
- 3.- Por retenciones a sub-contratistas en garantía de trabajos desarrollados.
- 4.- Por los adeudos de la obra para con terceros, no provenientes de operaciones normales, Etc.

SALDO:

De naturaleza acreedora, representa las obligaciones de la obra, por operaciones que no son el objeto principal de la misma.

409.- SALARIOS POR PAGAR

SE CARGA:

- 1.- Por la justificación del Cajero, del importe recibido para el pago de salarios al personal de la obra.

SE ABONA:

- 1.- Por el importe de salarios devengados por el personal de la obra.

SALDO:

Esta cuenta generalmente estará saldada; su saldo, en caso de tenerlo, será siempre acreedor y representa el importe de los salarios devengados por el personal de la obra y cuyo importe no ha sido pagado, o en su caso, justificado por el Cajero.

404.- SALARIOS DEVENGADOS NO COBRADOS

SE CARGA:

- 1.- Cuando se paguen a los empleados de la obra los salarios devengados, que no hayan cobrado en su oportunidad.
- 2.- Por los salarios devengados no cobrados, que se apliquen a los adeudos de los empleados para con la empresa.

DEBITOS:

- 1.- Por los salarios devengados no cobrados en su oportunidad por los empleados de la obra.

CREDITOS:

De naturaleza acreedora, representa el importe a favor de los empleados de la obra, por concepto de salarios no cobrados oportunamente.

Nota: El contador llevará un minutarario especial en el que guarde copias de las pólizas de ingreso a bancos por este concepto.

En el reverso de estas pólizas se listarán las personas que no cobraron, con objeto de que cuando se presenten a hacerlo el contador ante la fecha de pago a la altura del nombre, para cancelar administrativamente el adeudo.

La suma de los importes no cancelados será igual al que aparezca en los registros contables, sirviendo de base para las cancelaciones.

405.- PROVISION PARA IMPUESTOS.

SE CARGA:

1.- Por los enteros a las diferentes dependencias oficiales por concepto de: Impuesto sobre la Renta, Impuesto Sobre Ingresos Mercantiles Federal y Estatal, Impuesto Sobre Productos del Trabajo, 1% para la Enseñanza, cuotas al Seguro Social, Obras de Beneficio Regional, Etc.

DEBIDA:

1.- Por las diferentes provisiones a cargo de la obra, o retenciones a los trabajadores por concepto de Impuesto sobre la Renta, Impuesto Federal y Estatal Sobre Ingresos Mercantiles, - Impuesto Sobre Productos del Trabajo, 1% Patronal, cuotas obrero-patronales al Seguro Social, Obras de Beneficio Regional, etc.

S. L. D. O.:

De naturaleza acreedora, representa la provisión para cumplir con las obligaciones fiscales de la obra.

500.- OFICINA MATRIZ

SE CARCA:

- 1.- Por el total de cada una de las Estimaciones aceptadas por el cliente.
- 2.- Por la devolución a Oficina Matriz de:
 - a) Remesas en efectivo
 - b) Materiales
 - c) Refacciones y Herramientas
 - d) Varios.

SE ADEBE:

- 1.- Por el importe de los materiales, refacciones y herramientas recibidos en efectivo, etc., recibidos de la Oficina Matriz.
- 2.- Por los sueldos y rayas que pague la Oficina Matriz por cuenta de la obra.
- 3.- Por las cuentas de maquinaria usada en la obra.
- 4.- Por los gastos que efectúe la Oficina Matriz por cuenta de - La Obra.

S. I. D. O.:

De naturaleza acreedora, representa el total de la inversión (excepto de maquinaria, mobiliario y equipo de oficina y e - quipo de transporte) que la Oficina Matriz tiene en la obra.

C A T A L O G O

802.- GASTOS GENERALES

- 01.- Sueldos Técnicos
- 02.- Sueldos Administrativos
- 03.- Gratificaciones
- 04.- Previsión Social
- 05.- 1% Para la Enseñanza
- 06.- Gastos de Viaje
- 07.- Gastos de Representación
- 08.- Pasajes y Autos de Alquiler
- 09.- Combustibles y Lubricantes
- 10.- Arrendamiento de Inmuebles
- 11.- Papelería y Artículos de Oficina
- 12.- Cuotas y Suscripciones
- 13.- Servicios Profesionales
- 14.- Fotostáticas, Heliográficas y Fotografía
- 15.- Depreciación de Bienes Muebles
- 16.- Conservación, Mantenimiento y Reparación de Mobiliario y Equipo de Oficina.
- 17.- Indemnizaciones
- 18.- Fletes y Acarreos
- 19.- Multas y Recargos
- 20.- Varios
- 21.- Amortización de Gastos de Organización e Instalación.
- 22.-
- 23.- Convenciones y Atención a Visitas.
- 24.- Correos, Telégrafos, Teléfonos
- 25.- Donativos
- 26.-
- 27.- Gastos Legales
- 28.-
- 29.- Luz y Fuerza
- 30.- Impuesto sobre Ingresos Mercantiles

508.- PERDIDAS Y GANANCIAS

SE DEBE:

(Inclusivamente en Papeles de Trabajo).

- 1.- Por el traspaso de las cuentas deudoras de resultados, como:
- a) Costo de Obras
 - b) Gastos Generales
 - c) Otros Gastos

SE HACE:

(Inclusivamente en Papeles de Trabajo).

- 1.- Por el traspaso de las cuentas acreedoras de resultados como:
- a) Ingresos exentos por Estimaciones
 - b) Ingresos Gravados por Estimaciones
 - c) Ingresos Exentos por Obras en Administración
 - d) Ingresos Gravados por Obras en Administración
 - e) Otros Ingresos.

S A B D O:

(Para efectos de presentación en Estados Financieros mensuales)

De acuerdo a su naturaleza deudora o acreedora, representa la utilidad o pérdida del ejercicio.

NOTA: Esta cuenta no se afectará en la obra y sólo se incluye en el catálogo de cuentas para tomarla en consideración al formular los estados financieros que mensualmente deben enviarse a la Oficina Matriz.

- 31.- Honorarios Profesionales (Externos)
- 32.- Seguros y Fianzas
- 33.- Otros impuestos, Derechos y Contribuciones
- 34.- Obsequios y Atenciones
- 35.- Artículos de Aseo y Limpieza.

701.- INGRESOS EXENTOS POR ESTIMACIONES

SE OAPCA:

El cargo no se opera contablemente, sino que sólo en valores de trabajo se traspasa a la cuenta 503.- PERDIDAS Y GANAN- - CIAS para determinar la pérdida o utilidad mensual e incluirla en los estados financieros que mensualmente deben enviarse a la Oficina Matriz.

SE ABOV:

- 1.- Por el importe semanal del avance de obra exento de Impue- - to Sobre Ingresos Mercantiles, ejecutado en la obra.
- 2.- Por el importe de las estimaciones aditivas aceptadas por - el cliente de la obra.
- 3.- En rojo, por el importe de las estimaciones deductivas he- - chas por el cliente de la obra.

SE I D O:

De naturaleza acreedora, representa el total de obra ejecu- - tado a precio de venta según contrato y cuenta por el Im - puesto Sobre Ingresos Mercantiles.

NOTA: Al finalizar el ejercicio, el saldo de esta cuenta - se traspasa a la cuenta 500.- OFICINA MATRIZ. Este - traspaso sí se hace contablemente.

702.- INGRESOS GRAVADOS POR ESTIMACIONES

SE CARGA:

El cargo no se opera contablemente, sino que sólo en papeles de trabajo se traspasa a la cuenta 508.- PERDIDAS Y GANANCIAS para determinar la pérdida o utilidad mensual e incluir la en los estados financieros que mensualmente deben enviarse a la Oficina Matriz.

SE ABONA:

- 1.- Por el importe semanal del avance de obra gravado por Impuesto sobre Ingresos Mercantiles.
- 2.- Por el importe de las estimaciones aditivas aceptadas por el cliente de la obra.
- 3.- En rojo, por el importe de las estimaciones deductivas, hechas por el cliente de la obra.

DEBE:

De naturaleza acreedora, representa el total de obra ejecutada a precio de venta, según contrato y gravada por el Impuesto Sobre Ingresos Mercantiles.

N O T A: Al finalizar el ejercicio, el saldo de esta cuenta se traspasa contablemente a la cuenta 500.- OFICINA MATRIZ.

703.- INGRESOS EXENTOS POR OBRAS EN
ADMINISTRACION

SE CARGA:

El cargo no se opera contablemente, sino que sólo en papeles de Trabajo se traspasa a la cuenta 503.- PERDIDAS Y GANANCIAS para determinar la pérdida o utilidad mensual e incluirla en los estados financieros que mensualmente deben enviarse a la Oficina Matriz.

SE ABONA:

- 1.- Por el importe de los recibos de honorarios expedidos por la empresa, por concepto del avance de la obra exenta para efectos del Impuesto Sobre Ingresos Mercantiles.
- 2.- Se abonan en rojo por el importe de las deducciones que haga el cliente a los recibos por honorarios aceptados.

SALDO:

De naturaleza acreedora, representa los ingresos exentos del Impuesto Sobre Ingresos Mercantiles, originados en la ejecución de obras en administración.

N O T A: Al finalizar el ejercicio, el saldo de esta cuenta se traspasa contablemente a la cuenta 500.- OFICINA MATRIZ.

704.- INGRESOS GRAVADOS POR OBRAS
EN ADMINISTRACION

SE CARGA:

El cargo no se opera contablemente, sino que sólo en papeles de trabajo se traspasa a la cuenta 503.- PERDIDAS Y GANANCIAS para determinar la pérdida o utilidad mensual e incluir la en los estados financieros que mensualmente deben enviarse a la Oficina Matriz.

DEBEN:

- 1.- Por el importe de los recibos de honorarios expedidos por la empresa, por concepto del avance de la obra gravada para efectos del Impuesto Sobre Ingresos Mercantiles.
- 2.- Se abona en rojo por el importe de las deducciones que haga el cliente a los recibos por honorarios aceptados.

SALDO:

De naturaleza acreedora, representa los ingresos gravados por el Impuesto Sobre Ingresos Mercantiles, originados en la ejecución de obras en administración.

N O T A: Al finalizar el ejercicio, el saldo de esta cuenta se traspasa contablemente a la cuenta 500.- OFICINA MATRIZ.

705.- OTROS INGRESOS

SE CARGA:

El cargo no se opera contablemente, sino que sólo en operales de trabajo se traspasa a la cuenta 503.- PERDIDAS Y GANANCIAS para determinar la pérdida o utilidad mensual e incluirla en los estados financieros que mensualmente deben enviarse a la Oficina Matriz.

SE DEBE:

- 1.- Por la percepción de ingresos que no sean el objeto principal de la obra.

SALDO:

De naturaleza acreedora, representa los ingresos por operaciones no propias de la Obra.

N O T A: Al finalizar elejercicio, el saldo de esta cuenta se traspasa contablemente a la cuenta 500.- OFICINA MATRIZ.

301.- COSTO DE OBRAS

SE CARGA:

- 1.- Por todos los costos en que se incurra, tales como, mano de Obra, materiales, rentas de maquinaria, etc., los que no aplicarán según el catálogo de costos formulado en la obra.

SE ABONA:

El abono no se opera contablemente, sino que sólo en case-
los de trabajo se traspasa a la cuenta 509.- PERDIDAS Y GA-
NANCIAS, para determinar la pérdida o utilidad mensual e in-
cluirlo en los estados financieros que mensualmente deben -
enviarse a la Oficina Matriz.

SALDO:

De naturaleza deudora, representa el costo de la obra, incu-
rrido durante el ejercicio.

N O T A: Al finalizar el ejercicio, el saldo de esta cuen-
ta, se traspasa contablemente a la cuenta 500.- -
OFICINA MATRIZ.

802.- GASTOS GENERALES

SE CARGA:

- 1.- Por los gastos de la obra especificados en el anexo respectivo.

SE ABONA:

El abono no se opera contablemente, sino que sólo en papeles de trabajo se traspasa a la cuenta 508.- PERDIDAS Y GANANCIAS para determinar la pérdida o utilidad mensual e incluirla en los estados financieros que mensualmente deben enviarse a la Oficina Matriz.

S A L D O:

De naturaleza deudora, representa el total de gastos efectuados por la obra durante el ejercicio.

N O T A: Al finalizar el ejercicio, el saldo de esta cuenta se traspasa contablemente a la cuenta 500.- OFICINA MATRIZ.

304.- OTROS GASTOS

SE CARGA:

1.- Por otros gastos no propios de la obra

SE ABONA:

El abono no se opera contablemente, sino que sólo en papeles de trabajo se traspasa a la cuenta 503.- PERDIDAS Y GANANCIAS para determinar la pérdida o utilidad mensual o incluiría en los estados financieros que mensualmente deben enviarse a la Oficina Matriz.

SALDO:

De naturaleza deudora, representa los gastos por operaciones no propias de la obra, efectuados durante el ejercicio.

N O T A: Al finalizar el ejercicio, el saldo de esta cuenta se traspasa contablemente a la cuenta 500.- OFICINA MATRIZ.



ESTADOS FINANCIEROS

Para considerarse totalmente informado de la posición de una empresa, es necesario entender los estados financieros y la información que contienen.

Una persona llega a dominar las habilidades financieras fundamentales y tomar decisiones políticas importantes con acierto si:

- Conoce el significado de cada renglón del activo y pasivo en su balance y el de los renglones principales de su estado de pérdidas y ganancias.
- Se familiariza con el análisis de relaciones de sus estados financieros, de manera que pueda conocer la posición de su empresa y obtener conclusiones acertadas al comparar los resultados de la misma con los de la industria en general a la que pertenece.

RENGLONES DEL ESTADO FINANCIERO.- Es conveniente recalcar y resumir los conceptos que integran el balance; aunque ya se analizaran anteriormente, a continuación se hace un enlistado de los mismos con aclaraciones convenientes:

Los activos se dividen en cuatro categorías que son:

-Activo Circulante.- Consiste en el efectivo, mercancías (almacén), cuentas por cobrar, cargos diferidos, etc., o sea lo que la empresa puede convertir en efectivo cuando le sea necesario.

-Activos Diversos.- Si el activo es tangible y no se pretende convertirlo en efectivo para la operación normal del negocio, cae en esta categoría, en este renglón caen los rescates en efectivo de seguros, inversiones en empresas subsidiarias, deudas de funcionarios y cargos diferidos.

-Pasivo Circulante.- Son aquellas obligaciones que vencen dentro de un año a partir de la fecha de cierre del estado financiero.

-Pasivo a Largo Plazo.- Son aquellas obligaciones que se vencen después del año de la fecha de cierre del estado financiero.

-Capital Neto.- es la diferencia entre el total de activos tangibles y la deuda total.

-Capital de trabajo.- Es la diferencia entre el activo circulante y el pasivo circulante.

INTERPRETACION DE ESTADOS FINANCIEROS.- La interpretación de un estado financiero será cuestión de emitir una opinión a través del enjuiciamiento cuidadoso de los resultados sometidos; sin embargo, para poder formarse ese juicio será necesaria una comparación que dependa de los objetivos perseguidos, esto es, de las metas perseguidas por los políticos generales de la empresa.

Las diferentes comparaciones que es posible definir son:

a) Con estudios financieros semejantes de periodos anteriores, si lo que interesa es analizar la evolución que ha tenido en el tiempo.

b) Con estados semejantes de otra empresa, si interesa analizar la situación competitiva en el mercado.

c) Con ciertos estándares establecidos, si la finalidad es juzgar la posición financiera respecto a normas generalmente aceptadas en la que se basan las modificaciones de carácter económico de la empresa.

Esto implica diferentes metodologías a seguir para poder obtener resultados satisfactorios de una interpretación. La primera consistirá en efectuar una serie de comparaciones en forma periódica, e ingerir conclusiones a partir de una serie cronológica de estados financieros.

El tercer método comunmente usado en la comparación de los estados financieros, consistirá en medir relaciones entre diferentes rubros, que serán comparados contra valores dados por la experiencia y aceptados en el medio.

El segundo método no siempre será factible de operar, ya que en ocasiones contadas podrá disponerse de información pertinente a otra empresa al nivel que puede interesar para efectuar una comparación.

El instrumental con que se cuenta para llevar a cabo dichas comparaciones varía también con el método, así que el más comúnmente usado es el de los "Coeficientes Comparativos Derivados de Relaciones"

La comparación con coeficientes establecidos sirve para juzgar la actuación de la empresa en diversos campos de actividad en el mercado, independientemente de que otras empresas esten o no en precios de competencia.

La empresa en cuestión deberá tener dichos coeficientes suficientemente cercanos a los obtenidos mediante un análisis teórico para poder considerarse en situación competitiva dentro del sector. En caso de diferir de los coeficientes teóricos, habrá necesidad de analizar a qué se debe dicha discrepancia, y de ser posible, tomar medidas correctivas en ese sentido.

RELACIONES FINANCIERAS SECUNDARIAS

$$\text{Relación Circulante} = \frac{\text{Activo Circulante}}{\text{Pasivo Circulante}}$$

Ofrece una imagen general de la suficiencia del capital de trabajo de una empresa para satisfacer sus obligaciones de pago cotidianas. Lo que nos indica, está condicionado por la calidad de los activos circulantes, así que esta relación comprueba cantidad y no calidad por lo que es necesario determinar la calidad del activo circulante, para que la relación no sea engañosa.

Al aumentar la relación circulante, se tendrá mayor liquidez y la empresa tendrá mayor posibilidad de satisfacer sus gastos cotidianos y enfrentarse a emergencias no previstas.

$$\frac{\text{Pasivo Circulante}}{\text{Capital Neto.}} \quad \text{y} \quad \frac{\text{Pasivo Total}}{\text{Capital Neto.}}$$

La libertad de operación de toda empresa está condicionada por el interés relativo de los acreedores tengan en dicho negocio - en contraste con el de los propietarios de éste.

Una empresa con una relación de deudas a capital neto menor del promedio, denota un fuerte interés ó posición de propiedad y goza de libertad en cuanto a que los acreedores exigen sus créditos ó traten de imponer su voluntad en cuanto a decisiones administrativas de la empresa.

Si las relaciones son altas, la administración puede verse sometida a presiones de acreedores, que la priven de valiosas - iniciativas ó renovaciones.

ALMACEN

CAPITAL DE TRABAJO

Como se sabe, capital de trabajo es la diferencia entre - el activo circulante y el pasivo circulante, por lo que el capital de trabajo representa una protección que la empresa establece para el caso de posibles reducciones en el valor de sus activos circulan- tes, la necesidad de adquirir activos fijos ó diversos.

El almacén es un elemento grande e importante en la compo- sición del capital de trabajo; si por cualquier causa, el valor de- las existencias se redujera, hay que tener previsto cómo afectaría- esa reducción la posición del capital de trabajo.

La relación de existencias a capital de trabajo es la que permite esa medición.

ESTIMACIONES POR COBRAR CAPITAL DE TRABAJO

Se basa en el mismo principio de la relación de almacenes a capital de trabajo.

En estimaciones por cobrar sólo interesan aquellas crea- das por la venta de productos ó servicios prestados por la Compañía. Esta relación es importante, pues una lentitud en los pagos a la - empresa le puede ocasionar fuertes problemas, así que es importante considerarla.

PASIVO A LARGO PLAZO.

CAPITAL DE TRABAJO

El pasivo a largo plazo generalmente se utiliza para agre- gar nuevos fondos a un capital de trabajo insuficiente.

Esta relación nos indica si los prestamos a largo plazo - han sido usados para cumplir su propósito principal ó sea robustecer el capital de trabajo.

También nos indica la posibilidad de futuros financiamientos a largo plazo.

UTILIDAD NETA
CAPITAL NETO.

Esta relación nos mide la utilidad sobre la inversión. - Esta relación es importante como un incentivo para los propietarios ya sean accionistas, socio, dueño individual y como medio para permitir el crecimiento de la compañía.

VOLUMEN DE OBRA.
ACTIVO FIJO.

Esta relación mide la eficiencia con la cual la empresa - está utilizando sus inversiones en terrenos, plantas, equipos, instalaciones, mobiliario, etc.

También nos indica si el volumen de obra es el adecuado.

Una buena relación de volumen de obra a activo fijo, refleja un buen uso de ese activo.

Una relación muy alta, indica que la empresa esta perdiendo su equipo y propiedades.

Una relación baja indica una mala inversión en activo fijo, teniendo como consecuencias fugas por depreciación y gastos fijos de ese equipo ó instalaciones, empobrecimiento del capital de trabajo y presión de deudas.

VOLUMEN DE OBRA.
CAPITAL DE TRABAJO.

Esta relación indica las demandas que pesan sobre el capital de trabajo para sostener un cierto volumen de obra. Un cierto volumen de obra requiere de cierto volumen de capital. Entre mayor sea esta relación mayor será la tensión en que la empresa se encontrará con sus obligaciones de pagos ya que si a la empresa le retrasan sus pagos, tendrá serios problemas para cumplir con sus compromisos.

RELACIONES CAUSALES.

Estas relaciones son la clave de los equilibrios financieros.

ACTIVO FIJO.
CAPITAL NETO.

Esta relación mide la extensión con la cual el capital está invertido en activos no liquidados, permanentes y sujetos a depreciación; también indica la cantidad de capital, que queda disponible para ser invertido en otros activos.

Una inversión muy alta en activos fijos limita el activo circulante de una empresa, aumenta su posición de pasivo y puede disminuir utilidades debido a depreciaciones y costos fijos.

Esta relación indica si se tiene un activo fijo muy alto ó un capital neto bajo.

La relación se obtiene previa depreciación del activo fijo.

Es muy importante estudiar como se debe distribuir el capital, cuanto en activo fijo, cuanto en circulante y que parte debe reservarse para el futuro crecimiento de la empresa.

Un activo fijo excesivo afectará las siguientes relaciones, que tienen que ver con el capital de trabajo:

$$\text{Relación circulante} = \frac{\text{Activo Circulante}}{\text{Pasivo Circulante}}; \quad \frac{\text{Volúmen de obra}}{\text{Capital de trabajo}}$$

$$\frac{\text{Almacén}}{\text{Capital de trabajo}}; \quad \frac{\text{Estimaciones}}{\text{Capital de trabajo}}; \quad \frac{\text{Pasivo a largo plazo}}{\text{Capital de trabajo}} .-$$

Cuando el activo fijo es alto, la relación circulante disminuye y las otras relaciones aumentan.

La disminución del capital de trabajo coloca a la empresa también en una situación dudosa de crédito, por lo que los proveedores le pueden ocasionar pérdidas de tiempo productivo.

Una relación anormalmente baja, indica que el grueso del activo fijo de la empresa es alquilado, esta condición de arrendamiento puede ser ó no una condición favorable para la empresa en función de los cargos y convenios que se tengan.

Periodo de Cobro.-

El programa y perspectiva de crédito y cobranzas de una empresa, la competencia del gerente de crédito y la naturaleza de su estructura en estimaciones a plazos, ejercen una influencia directa sobre ventas, utilidades y necesidad de obtener préstamos.

La relación del periodo de cobro es muy útil para analizar las estimaciones por cobrar de una empresa.

La relación del periodo de cobro se calcula de la siguiente manera:

$$\text{-Calcular } \frac{\text{Estimaciones en el año}}{365 \text{ días}} = \text{Volúmen de obra/día.}$$

-Sumar todas las demás estimaciones por cobrar.

$$\text{-Periodo de cobro(días)} = \frac{\text{Estimaciones por cobrar (\$)}}{\text{Volúmen de obra por día (\$/día)}}$$

Esta relación mide la eficiencia interna de la empresa en cuanto a crédito y cobranzas; determina la cancelación de estimaciones por malas pagas, en el total de estimaciones por cobrar y mide la relación de las estimaciones por cobrar de la empresa con relación a los logros observados en la industria.

OBRA EJECUTADA.

ALMACEN.

Mientras mayor es el ritmo del movimiento del almacén - mayor será la actuación desarrollada por la gerencia en los campos de compra bien programada y equilibrada de control de inventarios.

Una baja relación de obras ejecutadas a almacenes señala la probabilidad de que algún material invendible este incluido en libros de las existencias y la posibilidad que llegue a resultar alguna pérdida por lo mismo.

La falta de previsión en la compra de materiales o la incapacidad de proveedores para surtirlos, puede transformar en interrupción de la producción o bajas tasas de rotación.

La baja de existencias a un nivel inadecuado para soste-
ner el volúmen de obra es el resultado de otras causas más funda-
mentales, como insuficiencia del capital invertido, suspensión de
líneas de crédito debido a la disminución del capital de trabajo-
etc.

El almacén también está sujeto a depreciación, ya sea
por deterioro físico, baja en los precios de los materiales, -
obsolescencia por nuevos productos, etc.

Una disminución del ritmo de rotación del almacén pue-
de así mismo afectar la aptitud de la empresa para satisfacer -
sus obligaciones normales, así como sus costos; particularmente-
al incurrir en los costos de mantenimiento del lujo de unas exis-
tencias excesivas, por perder los descuentos de compra, que - -
podrían resultar de la disminución de flujo de efectivo.

Cuando es necesario pedir prestado para sostener las -
existencias, inmediatamente se ve afectado el capital de trabajo
y la utilidad.

Cuando se dan de baja existencias por obsoletas, tambié-
n disminuirá el capital neto.

Cualquiera disminución en la utilidad, capital de trabajo
ó capital neto, originará cambios adversos en las relaciones -
en que se incluyan a estos tres elementos principales.

VOLUMEN DE OBRA.
CAPITAL NETO.

Esta relación generalmente conocida como relación comer-
cial, mide hasta donde el volúmen de obra de una empresa está -
apoyado en el capital invertido.

Una relación muy alta, refleja que la empresa se encuen-
tra oprimida por deudas muy cuantiosas, y que la supervivencia de
la misma depende de la continuación por largo tiempo de condicio-
nes internas y externas optimas.

Lo contrario refleja que la empresa cuenta ó con recur-
sos de capital en exceso u obras inadecuadas para sostener el ne-
gocio.

Es necesario que exista un equilibrio entre esas dos -
situaciones, así que la relación volúmen de obra a capital neto -
mide el grado al cual la empresa ha alcanzado dicho equilibrio.

Sólo cierto volumen de obra puede derivarse de cada peso de capital social y para ampliar el negocio la empresa tendrá las siguientes alternativas:

-Pedir prestado ó depender de la confianza ó pasividad de sus acreedores, pero sólo es un alivio y no una solución.

-Reducir el periodo de cobros, reducir el riesgo de existencias y aumentar su rotación.

-Vender su planta y equipo y readquirirla por arrendamiento con el fin de reforzar su capital de trabajo.

-Atraer nuevo capital social lo cual puede ocasionar debilitación del control administrativo.

-Aumentar el capital neto por medio de retención de utilidades.

-La relación comercial en exceso ó en defecto es una situación desfavorable y coloca a la empresa en una situación vulnerable.

UTILIDAD NETA.
VOLUMEN DE OBRA.

Todas las empresas tienen como principal objetivo la obtención de utilidad.

Esta relación nos mide el éxito que una compañía ha tenido en alcanzar tal objetivo.

Este índice se obtiene dividiendo la utilidad neta anual una vez pagados los impuestos, entre el volumen de obra anuales.

Sólo cuando la empresa obtiene utilidad al vender su mercancía ó servicios tiene razón de existir y tener la oportunidad de progresar.

Una empresa, que pierde en cada obra que efectúa, tiende a desaparecer.

Las utilidades que se conservan en el negocio robustecen el capital de trabajo, aumentan el capital neto y ayudan a restablecer el equilibrio en cualquier relación que pudiera ser deficitaria.

En una empresa mientras mayor sea el volumen de obra, mayor será la posibilidad de incrementar sus utilidades sobre las mismas obras.

ACTIVOS DIVERSOS.
CAPITAL NETO.

Antes de analizar la relación, recordemos que son activos diversos; este termino incluye todos aquellos activos que no son - ni circulante, ni fijos, ni intangibles.

Entre estos activos se encuentran los siguientes:

- Deudas de funcionarios ó empleados (préstamos ó anticipos.
- Inversiones ó prestamos a compañías subsidiarias ó afiliadas.
- Gastos anticipados y cargos diferidos.
- Inversiones en valores poco negociables.
- Estimaciones por cobrar a largo plazo.
- Valores de rescate, Etc...

Si se compromete una proporción exagerada del capital en activos diversos, se limita el capital de trabajo y el activo fijo productivo y se puede aumentar la posición de pasivo de la empresa y también una relación circulante muy deficiente.

Los activos diversos son muy vulnerables a cancelaciones ó rebajas en las cifras acentadas en los libros contables, el dinero prestado a funcionarios muchas veces no se devuelve, otras veces los empleados se van y no pagan sus adeudos; así que el activo diverso está sujeto a disminuciones, lo cual afecta la utilidad neta así como a las relaciones que incluyen utilidades y utilidad neta.

I N D I C E .

- 1.- Balanza de comprobación.
- 2.- Balance general.
- 3.- Estado de pérdidas y ganancias.
- 4.- Estados de cambio de situación financiera.
- 5.- Concentración de almacenes.
- 6.- Conciliación de bancos.
- 7.- Arqueos de caja, fondos por justificar y otros valores.
- 8.- Clientes.
- 9.- Documentos por pagar.
- 10.- Deudores y acreedores.
- 11.- Inversiones amortizables.
- 12.- Informe de avance de obra.
- 13.- Gastos generales.
- 14.- Gastos por amortizar.
- 15.- Conciliación con , Oficina Matriz.
- 16.- Proveedores.
- 17.- Remesas en tránsito.
- 18.- Documentos por cobrar.
- 19.- Cuentas de orden.

Nota: Siempre deberá conservarse el número indicado para cada uno de los anexos.

1

BALANCE DE COMPROBACION AL 28 DE FEBRERO DE 1965.

C U E N T A S

	SALDO ANTERIOR		MOVIMIENTO DEL MES		SALDO ACTUAL	
	DEUDOR	ACREEDOR	D	H	DEUDOR	ACREEDOR
1.- Almacén.	\$ 84,446.25		\$ 468,356.60	\$ 465,077.16	\$ 87,725.69	
2.- Bancos.	19,956.47		780,228.05	788,399.36	11,785.16	
3.- Caja.	10,000.00				10,000.00	
4.- Clientes (Avances de Obra Atenciones por formular.)	5'129,015.21		1'256,114.87		6,385,130.08	
5.- Construcción (Costo.)	10'997,461.60		1'386,500.38		12'383,961.98	
7.- Proveedores y Acreedores Diversos.		\$ 351,707.21	1'823,306.28	1'700,675.71		\$ 229,076.64
8.- Documentos por Pagar.						
9.- Inversiones Amortizables (Cargos de instalación)	533,353.40		4,437.58	63,392.39	474,398.59	
10.- Otro Ejeccutal.		12'392,728.57		1'256,114.87		13'648,843.44
11.- Gastos Generales.	769,583.06		96,821.55		866,404.61	
12.- Gastos por Abastecer.	185,818.59			27,350.00	158,468.59	
13.- Oficina Matriz.		5'191,553.83	285,778.23	2'049,960.45		6'955,736.05
14.- Pérdidas y Ganancias.			398,476.85		398,476.85	
15.- Proveedores.	39,283.27		540,224.73	654,963.94		75,455.94
16.- Reservas en Tránsito.						
19.- Otros Gastos y Productos.		962.75	2,122.28	1,159.53		
25.- Mobiliario y Equipo de Oficina.	168,034.51		4,877.83	40,151.82	132,760.52	
29.- Cuentas de Orden Deudoras.	556,397.52			185,298.36	371,099.16	
30.- Cuentas de Orden Acreedoras.		556,397.52	185,298.36			371,099.16
SUMAS IGUALES	\$ 18'493,349.88	\$ 18'493,349.88	\$ 7'232,543.59	7'232,543.59	21'280,211.23	21'280,211.23

Vo. Bb.

R E V I S O

CONTABILIDAD

ING. IGNACIO TORRES MARZO

RUBEN KENDOZA SANCHEZ

COSME SASTRE PRIMO

10

ACTIVO:

RECORRIDOS:

Caja	\$ 10,000.00	
Bancos	11,785.16	
Clientes	6,385,130.08	
Deudores diversos	21,726.83	
Anticipos a Proveedores	61,850.22	
Almacén	<u>87,725.69</u>	\$ 6,578,217.98

I. J. O.:

Mobiliario y Equipo de Ofna.	132,760.52	
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GASTOS DIFERIDOS

Inversiones amortizables	\$ 474,398.59	
Gastos por amortizar	<u>158,468.59</u>	<u>632,867.18</u>

SUMA EL ACTIVO \$ 7,343,845.68

PASIVO Y CAPITAL:

CIRCULANTE: (a menos de un año)

Acreedores diversos	\$ 250,803.47	
Proveedores	<u>137,306.16</u>	\$ 388,109.63
Oficina Matriz		6,955,736.05
Resultado del 1° de Septiembre de 1964, al 28 de Febrero de 1965	\$ 398,476.85	
Traspaso a Oficina Matriz al 28 de febrero de 1965	<u>398,476.85R</u>	0.00

S U M A \$ 7,343,845.68

CUENTAS DE ORDEN

Materiales en custodia	\$ 271,099.16
Materiales en consignación	<u>100,000.00</u>
	\$ 371,099.16

Vo. Bo.

R e v i s ó

Contabilidad

ING. IGNACIO TORRES MANZO

RUBEN MENDOZA SANCHEZ

COSEME SASTEE PRIMO

12

3

ESTADO DE PERDIDAS Y GANANCIAS DEL 1º DE SEPTIEMBRE DE 1964 AL 28 DE FEBRERO DE 1965

CONCEPTO	MOVIMIENTO DEL MES:				%	ACUMULADO HASTA EL MES			
	COSTO PARCIAL	COSTO TOTAL	OBRA EJECUTADA	UTILIDAD		COSTO PARCIAL	COSTO TOTAL	OBRA EJECUTADA	UTILIDAD
RENTAS TERMINO-COLOCACION									
a).- Obra de Mano	\$ 217,497.14					\$ 2'461,210.21			
b).- Materiales	272,283.04					1'770,035.71			
c).- Destajos y Fletes	372,752.40					2'073,173.47			
d).- Maquinaria	359,400.04					2'131,412.65			
e).- Amortizaciones	27,350.00					867,350.00			
f).- Suellos Tec. y Admvo.	19,216.45					309,466.42			
g).- Varios	<u>28,638.96</u>	\$ 1'357,138.03	\$ 1'029,538.47	\$ 327,599.56-R	31.82-R	<u>345,262.11</u>	\$ 9'959,015.57	\$ 10'599,506.34	\$ 640,490.77 60.4
TRABAJOS POR ADMINISTRACION									
a).- Obra de Mano	\$ 13,079.51					\$ 287,139.43			
b).- Materiales	6,775.42					1'564,071.41			
c).- Destajos y Fletes	5,563.00					54,665.81			
d).- Maquinaria	94.90					94.90			
f).- Suellos Tec. y Admvo.	4,147.52					28,429.34			
g).- Varios	<u>- 0 -</u>	29,665.35	226,576.40	196,911.05	86.91	<u>527.89</u>	1'934,928.78	2'708,937.53	774,008.75 28.5
OBRAS TERMINADAS									
1.- Canal de Descarga	- 0 -					\$ 454,234.26			
2.- Adono Metálico	<u>\$ 303.00R</u>	303.00R	- 0 -	- 303.00	- 0 -	<u>35,783.37</u>	490,017.63	340,399.57	149,618.06R 43.5
COSTO DIRECTO		<u>\$ 1'386,500.38</u>	<u>\$ 1'256,114.87</u>	<u>\$ 130,385.51-R</u>	<u>10.38-R</u>	<u>\$ 12'383,961.98</u>	<u>\$ 13'648,843.44</u>	<u>\$ 1'264,881.46</u>	<u>9.2</u>
MENOS: GASTOS GENERALES DE LA OBRA				<u>15,997.55</u>	<u>1.27</u>			<u>400,756.61</u>	<u>2.9</u>
RESULTADO EN OBRA				<u>\$ 146,383.16-R</u>	<u>11.65-R</u>			<u>\$ 864,124.85</u>	<u>6.3</u>
MENOS: GASTOS GENERALES OFICINA MATRIZ				<u>80,824.00</u>	<u>6.43</u>			<u>465,648.00</u>	<u>3.4</u>
RESULTADO NETO				<u>\$ 227,207.16-R</u>	<u>18.09-R</u>			<u>\$ 398,476.85</u>	<u>2.5</u>
									<u>398,476.85</u>
									<u>\$ 0.00</u>

MENOS: TRASPASO A OFICINA MATRIZ DEL RESULTADO AL 28 DE FEBRERO DE 1965

, 28 DE FEBRERO DE 1965

Vo. Bo.

REVISO

CONTABILIDAD

ING. IGNACIO TOMAS MATO

RUBEN MENLOZA SANCHEZ

COSME SASTRE PRIMO

3

(4)

(4) ESTADO DE CAMBIO DE SITUACION FINANCIERA DEL 1° AL 28 DE FEBRERO DE 1965

CONCEPTO	ENERO	FEBRERO	RECURSOS	
			ORIGEN	APLICACION
<u>ACTIVO</u>				
<u>Excedente</u>				
Caja	10	10		
Bancos	20	12	8	
Clientes	5129	6385		1256
Deudores diversos	43	22	21	
Anticipos a proveedores	147	62	85	
Almacén	84	88		4
	5453	6579		
<u>Patrimonio</u>				
Mobiliario y Equipo de Oficina	168	133	35	
<u>Cargos Diferidos</u>				
Inversiones amortizables	533	474	59	
Gastos por amortizar	186	158	28	
	719	632		
Suma	6320	7344		
<u>PASIVO</u>				
Proveedores diversos	394	251		143
Proveedores	108	137	29	
	502	388		
Oficina Matriz	5191	6956	1756	
Resultados	627	398		229
Transferencia a Oficina Matriz del Resultado al 28 febrero 1965	0	398 R		398
Sumas	5818	6956		
	6320	7344	2030	2030

Vo. Bo.

Revisó

Contabilidad

(3)

ESTADO DE CAMBIO DE SITUACION FINANCIERA DEL 1o. DE SEPTIEMBRE DE 1964 AL
28 DE FEBRERO DE 1965.

CONCEPTO	SEPTIEMBRE <i>31/09/64</i>	FEBRERO <i>28/02/65</i>	RECURSOS	
			ORIGEN	APLICACION
<u>ACTIVO</u>				
<u>Circulante</u>				
Caja	10	10		
Bancos	5	12		7
Clientes	7839	6385	1454	
Deudores diversos	148	22	126	
Anticipos a proveedores	0	62		62
Almacén	368	88	280	
	<u>8370</u>	<u>6579</u>		
<u>Fijo</u>				
Mobiliario y equipo de oficina	0	133		133
<u>Cargos diferidos</u>				
Inversiones amortizables	0	474		474
Gastos por amortizar	763	158	605	
	<u>763</u>	<u>632</u>		
Suma	<u>9133</u>	<u>7344</u>		
<u>PASIVO</u>				
<u>Circulante</u>				
Acreedores diversos	293	251		42
Proveedores	317	137		180
	<u>610</u>	<u>388</u>		
Oficina Matriz	8523	6956		1567
Resultado	0	398	398	
Traspaso a Oficina Matriz del Resultado al 28 de febrero 1965	0	398R		398
	<u>8523</u>	<u>6956</u>		
Sumas	<u>9133</u>	<u>7344</u>	2863	2253

Vo. Do.

e v i s ó

Contabilidada.

Ing. Ignacio Torres

Rosé, Landoza Sánchez.

Cosme Sastré Primo.

(5)

(6)

INFORME GENERAL DE ALMACEN
AL 28 DE FEBRERO DE 1965

A L M A C E N .

MATERIALES	\$	56,405.14
RESGUARDO CONSULO		21,623.45
REFACCIONES		<u>9,967.10</u>
TOTAL	\$	<u>87,725.69</u>
ARTICULOS EN CUSTODIA		271,099.16
ARTICULOS EN CONSIGNACION		<u>100,000.00</u>

, 28 FEBRERO DE 1965.

Vo. Bo.

R E V I S O

CONTABILIDAD

ENC. IGNACIO TORRES MANZO

RUBEN LLENDOZA SANCHEZ

COSEL SASTRE PRIMO

CONCILIACION DEL BANCO DE LONDRES Y MEXICO, S. A. CON LA OBRA No.

1.- Saldo según nuestros libros	\$ 11,785.16
2.- Cargamos no Abonan
3.- Abonamos no Cargan	114,559.87
4.- Cargan no Abonamos
5.- Abonan no Cargamos	11,000.00

Saldo estado de cuenta de Banco de Londres y México, S.A. \$137,345.03

Vo. Bo.

R e v i s ó

Contabilidad

Ing. Ignacio Torres M.

Rubén Mendoza Sánchez

Cosme Sastré Primo

NOTA:- Si el saldo de nuestros libros que aparecen en el Renglón 1 es Doudor, se suman las partidas 3 y 5 y se restan las partidas 2 y 4 a dicho saldo.

Si el saldo de nuestros libros que aparece en el Renglón 1 es Acreo—
dor se restan las partidas 3 y 5 y se suman las partidas 2 y 4 a dicho saldo.

FECHA	REF.	C O N C E P T O	CARGAMOS NO ABONAR	ABONAMOS NO CARGAR	CARGAMOS NO ABONAMOS	ABONAMOS NO CARGAMOS
19-I-65	8652	Promotora Agricola Industrial, S.A.		\$ 3,657.00		
23-I-65	8695	Pablo Reyes Cruz		300.00		
16-II-65	9093	Alfonso González Aguado		510.00		
18-II-65	9101	Claudio Rolón Roldán		79.00		
19-II-65	9103	Samuel Domínguez Rodríguez		600.00		
19-II-65	9111	M. Enriqueta Lana de la O.		150.00		
19-II-65	9113	Aurelio Localona Ramírez		150.00		
19-II-65	9115	Inocencio Villogas Martínez		170.00		
19-II-65	9121	Petra Fonseca Lozano		600.00		
19-II-65	9126	Efrén Valdez Vega		445.93		
19-II-65	9127	Petra Fonseca Lozano		2,405.00		
19-II-65	9136	Fábrica de Artefactos de Híle		161.00		
26-II-65	9144	Petra Fonseca Lozano		2,618.75		
26-II-65	9145	Ester Quintero Sánchez		10,644.80		
26-II-65	9147	Pedro Oropeza Ramírez		207.48		
26-II-65	9148	Julio Cedillo Hernández		841.69		
26-II-65	9149	Jesús Sánchez Gómez		772.80		
26-II-65	9150	Horacio Mayorga Rodríguez		960.00		
26-II-65	9151	Petra Fonseca Lozano		528.00		
26-II-65	9152	Pedro Quintero Embarcadero		936.00		
26-II-65	9153	Felipe Castillo García		1,132.15		
26-II-65	9154	Saúl Rojas Hernández		4,784.00		
26-II-65	9155	Roberto Mayorga Leonardo		3,984.00		
26-II-65	9156	Efrén Valdez Vega		4,579.84		
26-II-65	9157	Julio Cedillo Hernández		13,852.53		
26-II-65	9158	Jesús Victor Crimaldi Zurcher		9,752.00		
26-II-65	9159	Zeferino Carmen Rodríguez		14,369.10		
26-II-65	9160	José Hernández Talonia		10,420.80		
26-II-65	9162	José Alvaro Cervantes		24,948.00		
26-II-65	S/n.	C r é d i t o .				11,000.00
				<u>\$114,559.87</u>		<u>\$11,000.00</u>

22

7

ARQUEO PRACTICADO A LA CAJA DE LA OBRA 603 TUNEL TEQUIXQUIAC
EL DIA 5 DE MARZO DE 1965.

Iniciado: 19:45 Es.
Terminado: 20:30 "

FECHA	CONCEPTO :	EFFECTIVO	DOCUMENTOS	PARCIAL	TOTAL
<u>BILLETES</u>					
29	de \$ 100.00	\$ 2,900.00			
12	de 50.00	600.00			
22	de 20.00	440.00			
53	de 10.00	530.00			
107	de 5.00	535.00			
226	de 1.00	226.00		\$ 5,231.00	
<u>MONEDAS</u>					
20	de 1.00	\$ 20.00			
117	de 0.50	58.50			
213	de 0.20	42.60			
126	de 0.05	6.30			
2	de 0.01	0.02		127.42	\$ 5,358.42
<u>DOCUMENTOS</u>					
<u>RECIBOS Y NOTAS VARIAS</u>					
II-5/65	Cirilo Romero R.- Fianzas		820.00		
II-5/65	Celso Viguera A. "		1,264.00		
II-5/65	Anastacio Escalona B."		878.00		
II-5/65	Lsteban Ruiz A. "		365.00		
II-5/65	José Ma. Cruz T. "		200.00		
II-5/65	José Ma. Cruz T.- Salarios no Cob.		94.43		
II-5/65	Ignacio Salvador R.- Trab. Eventuales		675.02		
II-5/65	Pago reembolso No. 2670		101.00		
II-5/65	Nota S/n. de Casa Bonfil		48.00		
II-5/65	Rbo. Telf. de Mex. 600654		10.60		
II-5/65	Juan Mendiota A.- Participación		70.34		
II-5/65	Aniceto Loya T.		115.24	4,641.63	4,641.63
		Importa el Arqueo:		\$ 10,000.05	
		Fondo Fijo de Caja:		10,000.00	
		Sobrante:		\$ 0.05	

HAGO CONSTAR QUE LOS VALORES RELACIONADOS EN ESTE ARQUEO POR \$ 10,000.05 (DIEZ MIL PESOS 05/100 M.N.) SON TODOS LOS QUE SE ENCUENTRAN BAJO MI CUSTODIA, PROPIEDAD DE INGENIEROS CIVILES ASOCIADOS, S. A., LOS CUALES FUERON CONTADOS EN MI PRESENCIA Y ENTREGADOS A MI ENTERA CONFORMIDAD.

COSME SASTRE PRIMO

UBALDO CALLEJA TOVAR

Nota:- Los comprobantes relacionados en el presente se encuentran debidamente autorizados por el Ing. Ignacio Torres Manzo y el Sr. Rubén Mendoza Sánchez.

DEUDORES Y ACREEDORES.

Relación al 28 de Febrero de 1965

N O M B R E :		SALDOS DEUDORES	SALDOS ACREEDORES
<u>RESUMEN</u>			
1.-	Diversos	\$ 9,469.70	\$ 30,520.73
2.-	Destajistas	319.20	809.41
3.-	Empleados	6,868.48	6.00
4.-	Fianzas destajistas		48,287.00
5.-	Fianzas trabajadores		168,580.61
6.-	Fleteros	309.96	2,158.27
7.-	Trabajadores	2,724.49	243.45
8.-	Entregas por justificar	35.00	
9.-	Comedor		198.00
10.-			
11.-			
12.-	Rayas (Saldo)	2,000.00	

\$ 21,726.83 \$ 250,803.47
 =====

Yo. Eo.

R e v i s ó

Contabilidad

DEUDORES Y ACREEDORES.

Relación al 28 de Febrero de 1965

N O M B R E	SALDOS DEUDORES	SALDOS ACREEDORES
<u>1.- Diversos:</u>		
Saldo acreedores menores de \$ 2,000.00		\$ 3,294.74
1/2 Imp. Educ. Patronal (II-26-65)		2,425.76
I. S. R. Cédula IV (II-26-65)		9,126.25
Sindicato (II-26-65)		9,502.37
Servicio Social (II-25-65)		6,171.61
Saldo deudores menores de \$ 2,000.00	\$ 2,221.70	
Depósito en Garantía.- Comi- sión Federal de Electricidad) (IV-30-64)	7,248.00	

S U M A S

\$ 9,469.70

\$ 30,520.73

El Sr.

Revisó

Contabilidad

M. TORRES M.

RUBEN LERDOZA SANCHEZ

COSME SASTRE PRIMO

Relación al 28 de Febrero de 1965

N O M B R E	SALDOS DEUDORES	SALDOS ACREEDORES
2.- <u>Destajistas:</u>		
Saldos acreedores menores de \$ 2,000.00		\$ 809.41
Saldos deudores menores de \$ 2,000.00	\$ 319.20	

\$ 319.20	\$ 809.41
=====	=====

Vo. Ec.

R e v i s ó

Contabilidad

ING. IGNACIO TORRES N.

RUBEN MENDOZA SANCHEZ

COSME SASTRE PRIMO

DEUDORES Y ACREEDORES.

Relación al 28 de Febrero de 1965

N O M B R E	SALDOS DEUDORES	SALDOS ACREEDORES
<u>3.- Empleados:</u>		
Saldos Acreedores menores de \$2,000.00		\$ 6.00
Saldos Deudores menores de \$2,000.00	\$ 1,130.48	
Ing. J. Guillermo Peña F. (II-25/65)	3,338.00	
Rubén Mendoza Sánchez (II-25/65)	2,400.00	

El saldo del Sr. Rubén Mendoza Sánchez fué autorizado por la Gerencia en memorandum 1° de - Octubre de 1964.

\$ 6,868.48
\$ 6.00

V. Bo.

R e v i s ó

Contabilidad

DR. ESTEBAN TORRES M.

RUBÉN MENDOZA SANCHEZ

COSME CASTAÑO PINERO

DEUDORES Y ACREEDORES.

Relación al 28 de Febrero de 1965

N O M B R E	SALDOS DEUDORES	SALDOS ACREEDORES
4.- <u>Fianzas Destajistas:</u>		
Zeferino Carmen Rguez.	(II-26/65)	\$ 16,767.00
José Alvaro Cervantes	(II-26/65)	13,453.00
J. Victor Crinaldi Zurcher	(II-26/65)	3,226.00
José Hdos. Talonia	(II-26/65)	14,841.00

\$ 48,287.00

Vo. Bo.

R e v i s ó

Contabilidad

DEUDORES Y ACREEDORES.

Relación al 28 de Febrero de 1965

N O M B R E

SALDOS
DEUDORES

SALDOS
ACREEDORES

6.- Fianzas Trabajadores:

Saldos Acreedores menores de
\$2,000.00

\$ 150,794.61

Bravo Díaz Alejandro (II-19-65)

2,423.00

Fabián Martínez Hermilo (II-19-65)

2,128.00

Morales Glez. Nexorio (II-26-65)

2,043.00

Pérez Ascención Rafael (II-12-65)

4,155.00

Quiñones Cuevas Gmo. (II-26-65)

2,092.00

Salgado Martagón Gabriel (II-19-65)

2,240.00

Uribe Calderón Wenceslao (II-19-65)

2,705.00

\$ 166,580.61
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Vo. Lo.

R o v i s ó

Contabilidad

DEUDORES Y ACREEDORES.

Relación al 28 de Febrero de 1965.

N O M B R E	SALDOS DEUDORES	SALDOS ACREEDORES
7.- <u>Plateros:</u>		
Saldo Acreedores menores de \$ 2,000.00		\$ 2,158.27
Saldo Deudores menores de \$ 2,000.00	\$ 309.96	

\$ 309.96	\$ 2,158.27
=====	

Vo. Bo.

R e v i s ó

Contabilidad

DEUDORES Y ACREEDORES.

Relación al 28 de Febrero de 1965

N O M B R E

SALDOS
DEUDORES

SALDOS
ACREEDORES

8.- Trabajadores:

Saldo Acreedores menores de

\$ 2,000.00

\$ 243.45

Saldo Deudores menores de

\$ 2,000.00

\$ 2,724.49

\$ 2,724.49

\$ 243.45

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Yo. Bo.

R e v i s ó

Contabilidad

DEUDORES Y ACREEDORES.

Relación al 28 de Febrero de 1965

N O M B R E

SALDOS
DEUDORES

SALDOS
ACREEDORES

9.- Deudas por Justificar:

Saldos Deudores menores de

\$ 2,000.00

\$ 35.00

\$ 35.00

Vc. Co.

R e v i s ó

Contabilidad

ING. MANUEL TORRES M.

RUBEN LLANDOZA SANCHEZ

COSME SASTRE GILLO

DEUDORES Y ACREEDORES

Relación al 28 de Febrero de 1965.

N O M B R E

SALDOS
DEUDORES

SALDOS
ACREEDORES

11.- Comedor:

Saldo Acreedores menores de

\$ 2,000.00

\$ 198.00

===== \$ 198.00 =====

Vc. Eo.

R e v i s ó

Contabilidad

DEUDORES Y ACREEDORES

N O M B R E	SALDOS DEUDORES	SALDOS ACREEDORES
12.- <u>Rayas:</u>		
Rayas por justificar		
Ubaldo Calleja Tovar (Sem. # 8) 26-II-65	\$ 54,253.80	
Rayas por pagar (Sem. # 8)		
Ubaldo Calleja Tovar 26-II-65		\$ 52,253.00
	\$ 54,253.80	\$ 52,253.00

SALDO: \$ 2,000.00

Vc. Bo.

R e v i s ó

Contabilidad

ING. IGNACIO TORRES M.

RUBEN MENDOZA SANCHEZ

COSME SASTRE PRIMO

INVERSIONES AMORTIZABLES AL 28 DE FEBRERO DE 1965.

C O N C E P T O		FEBRERO
I-A	Artículos para almacenamiento, transporte y conducción de líquidos y gases.	\$ 160,598.64
I-B	Artículos para conducción, transformación y medición de la energía eléctrica.	60,980.27
I-C	Artículos auxiliares para la construcción.	67,004.57
I-D	Artículos adquiridos o manufacturados especialmente para una obra.	29,605.51
II-A	Herramienta.	114,728.35
II-B	Equipo de Seguridad y Protección.	
III-A	Instrumental para trabajo técnico de ingenieros, de laboratorio y de dibujo y proyecto.	41,286.25
III-B	Equipo de Radio y campamento.	195.00
S U M A		\$ 474,398.59

Vó. Bo.

R E V I S O

CONTABILIDAD

ING. IGNACIO TORRES MAHZO

RUBEN MENDOZA SANCHEZ

COSME CASTRE PRIMO

INFORME DEL AVANCE DE OBRA

NOMBRES DE LAS CUENTAS	O B R A E J E C U T A D A Y E S T I M A D A			C L I E N T E S			O B R A E J E C U T A D A Y E S T I M A D A	O B R A E J E C U T A D A E N E L M E S
	H A S T A	H A S T A	E S T I M A C I O N	H A S T A	H A S T A	I N C R E M E N T O		
	F E B R E R O	E N E R O	D E L M E S	F E B R E R O	E N E R O			
	1	2	3=1-2	4	5	6=4-5	7, 8 y 9	10=3+6
5-III- <u>REVESTIMIENTO</u>								
CONCRETO COLOCADO	\$10'768,531.02	\$10'768,531.02		\$4'461,370.99	\$3'437,870.02	\$1'023,500.97		\$1'023,500.97
ACARREO DE CEMENTO	18,328.40	18,328.40		87,709.10	81,671.60	6,037.50		6,037.50
5-IV- <u>ADQUE METALICO</u>								
COLOCACION DE MARCOS	1'128,380.00	1'128,380.00		22,898.52-R	22,898.52-R			
FLETES DE MARCOS	3,983.47	3,983.47		19,130.65	19,130.65			
5-VII- <u>TRABAJOS POR ADMINISTRACION</u>	1'751,652.00	1'751,652.00		1'786,128.13	1'559,551.73	226,576.40		226,576.40
5-VIII- <u>CANAL DE DLS CARGA</u>								
1.- Excavación	2'199,540.18	2'199,540.18						
2.- Hierro de Refuerzo	356,047.16	356,047.16						
3.- Cimbra	113,459.95	113,459.95						
4.- Concreto	189,688.23	189,688.23						
5-IX- <u>ALCANFARILLA</u>				53,689.73	53,689.73			
	\$16'529,610.41	\$16'529,610.41		\$6,385,130.08	\$5'129,015.21	\$1'256,114.87		\$1'256,114.87

Vo. Bo.

R E V I S O

CONTABILIDAD

ING. IGNACIO TORRES MANZO

ING. MEDALDO SANCHEZ

COSME SASTRAS PRIMO



GASTOS GENERALES COMPARATIVOS
RELACION CORRESPONDIENTE AL MES DE FEBRERO DE 1965.

NOMBRE DE LAS SUB - CUENTAS		SALDO MES ANTERIOR	MOVIMIENTO DEL MES	SALDO MES ACTUAL
2.-	COMODORS	\$ 20,479.11	\$ 938.00	\$ 21,417.11
3.-	CARRAJENTO	18,593.45	1,338.85	19,932.30
4.-	CORREOS Y TELEGRAFOS	48.00		48.00
5.-	CONSERVACION Y REP. EQ. DE OF.		1,659.50	1,659.50
6.-	DONATIVOS	262.60		262.60
9.-	ESTUDIOS Y PROYECTOS	235.70		235.70
11.-	GASTOS DE VIAJE	663.65	651.71	1,315.36
12.-	GASTOS INDIRECTOS DE OF. MATRIZ	384,824.00	80,824.00	465,648.00
13.-	IMP. SOBRE INGRESOS MERCANTILES	1,478.54		1,478.54
14.-	INDICACIONES	14,180.95		14,180.95
15.-	LEGALES	199.27		199.27
17.-	LUZ Y TELEFONO	10,498.70	2,728.75	13,227.45
18.-	MULTAS Y RECARGOS	30.00		30.00
19.-	PAPALERIA Y ARTICULOS DE OF.	27,774.50	4,588.75	32,363.25
20.-	PREVISION SOCIAL	82,175.15	41,792.49-R	123,967.64
21.-	RADIO	662.50		662.50
22.-	RENTAS	19,268.07	1,800.00	21,068.07
23.-	SUELDOS b) AJENOS.	112,672.45	18,466.49	131,138.94
23.-	SUELDOS c) VIGILANCIA	9,613.21	1,753.36	11,366.57
24.-	TRANSPORTES a) (PROPIOS)	7,984.25	1,855.70	9,839.95
24.-	TRANSPORTES b) (AJENOS)	1,282.90	782.38-R	500.52
25.-	ENTRACCIONES	55,666.66	21,833.30	77,499.96
28.-	VARIOS	989.40	958.01	1,947.41

T O T A L E S

\$ 769,583.06 \$ 96,821.55 \$ 866,404.61

Vc. Do.

R e v i s ó

Contabilidad

ING. ENRIQUE LORAIN MANZO

RUBEN MENDOZA SANCHEZ

COSEME SASTRE PRILLO

ANALISIS DE GASTOS POR AMORTIZAR AL 28 DE FEBRERO DE 1965.

No.	NOMBRE	SALDOS ANTERIORES			MOVIMIENTO DEL MES			SALDOS ACTUALES		
		CARGOS	AMORTIZACION	SALDOS	CARGOS	AMORTIZACION	INCREMENTO	CARGOS	AMORTIZACION	SALDOS
1.-	INSTALACIONES	\$ 1'122,070.89	\$ 951,628.07	\$ 170,442.82		\$ 11,974.23	\$ 11,974.23-R	\$ 1'122,070.89	\$ 963,602.30	\$ 158,468.59
2.-	CANTONAJE	33,333.63	33,333.63					33,333.63	33,333.63	
3.-	SUMINOS	49,668.52	47,647.75	2,025.77		2,025.77	2,025.77-R	49,668.52	49,668.52	
4.-	TRANSPORTE, COMBUSTIBLES Y COMUNICACIONES	10,685.95	10,685.95					10,685.95	10,685.95	
5.-	GASTOS ANTICIPADOS - GRATIFICACIONES	47,350.00	34,000.00	13,350.00		13,350.00	13,350.00-R	47,350.00	47,350.00	
T O T A L E S :		\$ 1'263,108.99	\$ 1'077,290.40	\$ 185,818.59		\$ 27,350.00	\$ 27,350.00-R	\$ 1'263,108.99	\$ 1'104,640.40	\$ 158,468.59

CRITERIO PARA AMORTIZACIONES:- SE APLICAN \$ 140.00 (CIENTO CUARENTA PESOS 00/100) POR METRO LINEAL COLOCADO EN TUNEL

AVANCE REPORTADO AL 31 DE ENERO DE 1965	8,485.36 MTS.	\$ 1'077,290.40
AVANCE REPORTADO AL 28 DE FEBRERO DE 1965	100.00 "	14,000.00
MAS AMORTIZACION DE GASTOS ANTICIPADOS: GRATIFICACIONES		13,350.00
TOTAL AMORTIZADO AL 28 DE FEBRERO DE 1965	8,585.36 MTS.	\$ 1'104,640.40

NOTA: SE AMORTIZA EL SALDO DE GRATIFICACIONES POR TERMINACION DE OBRA.

Vo. Po.

R V I S O

CONTABILIDAD

ING. IGOR...

EDUARDO MEDINA SANJULI

COM. SASTRE PRIMO

CONCILIACION DE

OFICINA MATRIZ CON LA OBRA No.

28 DE FEBRERO DE 1965

1.- Saldo según nuestros libros	\$ 6'955,736.05
2.- Cargamos no Abonan	14,328.86
3.- Abonamos no Cargan	476,640.56
4.- Cargan no Abonamos	40,461.28
5.- Abonan no Cargamos	--
 Saldo estado de cuenta de Oficina Matriz	 6'533,885.63

Tequixquiac, Mex., a 28 de febrero de 1965.

Vo. Bo.

Revisó

Contabilidad

Ing. Ignacio Torres Manzo

Rubén Mendoza Sánchez

Cosme Sastré Primo.

NOTA: Si el saldo de nuestros libros que aparecen en el Renglón 1 es Deudor, se suman las partidas 3 y 5 y se restan las partidas 2 y 4 a dicho saldo.

Si el saldo de nuestros libros que aparece en el Renglón 1 es Acreedor se restan las partidas 3 y 5 y se suman las partidas 2 y 4 a dicho saldo.

FECHA	RMP.	CONCEPTO.	CARGAMOS NO ABONAR.	ABONAMOS NO CARGAMOS.	CARGAMOS NO- ABONAMOS.	ABONAMOS NO CARGAMOS.
11-9-64	320-CP	C/7865.- Aditivo Signit			\$35,028.00	
1-30-65	1-10-2	Reparación maquinaria, Enero 1965 (Diferencia)			5,135.15	
1-5-65	2-813	Gastos de traslado de José Rodríguez Estrada y Vicente Esquivel Trinidad a Orizaba	\$ 596.85			
1-5-65	2-835	50% Sueldo Domingo Fajardo Semana No. 5	282.80			
1-12-65	Ch/85027	Servicio Médico Ing. Manuel Barahona A.			75.00	
1-12-65	2-061	Importe aspas para compresor Vale 6313	3,210.00			
1-20-65	2-150	Vale 6320. Materiales proporcionados a Solum	2,933.52			
1-24-65	2-164	Saldo deudor de Vicente Esquivel	205.00			
1-25-65	2-183	Participaciones de Utilidades pagadas y Gastos de Viaje Víctor Hugo Vázquez Cortés	1,179.00			
1-26-65	524-CP	C/8092.- 2 Diafragmas			223.13	
1-26-65	2-185	50% Sueldo Domingo Fajardo Semana No. 8	282.80			
1-24-65	2-189	Vale 6919 Materiales proporcionados a Solum	1,088.89			
1-27-65	2-225	Traspaso Importe Venta de Chatarra		\$ 663.75		
1-27-65	2-229	Control 770 Artículos enviados a Orizaba	4,550.00			
1-27-65	2-230	Traspaso resultado ler. Período Ejercicio 1964-1965		398,476.85		
1-27-65	2-231	Traspaso Amortización extracciones al 28 de febrero de 1965		77,499.96		
Totales...			\$14,328.86	\$476,640.56	\$40,461.28	

22

PROVEEDORES:
RELACION AL 28 DE FEBRERO DE 1965.

NOMBRE		SALDOS DEUDORES	SALDOS ACREEDORES
15.- <u>Proveedores:</u>			
SOLEDAD RAMIREZ SOTO	26-II-65		\$ 2,121.35
. ALMACEN	(Central)	\$ 61,850.22	
E.N.S.A.	20-II-65		109,021.25
OBRA N. Z. T.	31-I -65		6,518.51
ESTHER QUINTERO SANCHEZ	28-II-65		6,280.90
S. R. H.	28-II-65		12,862.50
TRABAJADORES I.C.A.	24-II-65		.15
COMPRAS CONTADO	27-II-65		501.50

SUMAS \$ 61,850.22 227,306.10
=====

Yo. Ec. Revisó Contabilidad

RELACION DE PARTIDAS POR LIQUIDAR A PROVEEDORES:
 ALMACEN: CORRESPONDIENTE AL MES DE FEBRERO DE 1965.

FECHA	ENTRADA ALMACEN	Cantidad	C O N C E P T O .	REM.	IMPORTE.
I-	3-55	1	Tarrajás, enfriador, radios.	3	4,707.58
XII-	3-55	4	Adesógrafo		1,830.00 R
I-	3-55	5	Tubo Galvanizado		73.20 R
XII-	11-54	18	Radios, Guantes de Hule, Báscula,		1,852.62 R
XII-	17-54	38	Fotocopiadora, radios, Micrometros		8,962.56 R
XII-	18-54	41	Tubo Galvanizado, Manguera 6"		43,083.54 R
XII-	21-54	47	Enfriador, Escritorios, restirador		1,011.00 R
XII-	22-54	50	Mangueras de Alta Presión		8,003.68
XII-	24-54	607	Tambores vacíos cerrados		836.20 R
I-	7-55	632	Juntas		190.50
I-	7-55	655	Bobinas		385.50
I-	13-55	659	Tubo Galvanizado, conexiones		425.85 R
I-	16-55	683	Carretillas Tubulares, Radios		4,425.00 R
I-	18-55	683	Motores Eléctricos, Interruptores		5,327.70 R
I-	20-55	694	Caseta Metálica, Teléfonos Magneto		22,142.50 R
I-	20-55	696	Abrazaderas, codos, coples		1,048.75 R
I-	20-55	697-Bis	Llaves de Paso, Niples, Reduccio- nes Bushing		9.12 R
I-	20-55	698	Reducciones Campana, Tees, T.Unión		78.18 R
I-	20-55	699	Codos, Coples, Reducciones Bushing		44.42 R
I-	20-55	700	Niples, Coples, Llaves Check		93.95 R
I-	22-55	732	Aditivo "Sigunit"		28.00
I-	26-55	734	Refacciones Varias		25.26 R
I-	26-55	736	Refacciones Varias		39.25 R
I-	26-55	737	Refacciones Varias		1,482.38 R
I-	26-55	753	Elementos Filtro, Radios, Transito		167.80 R
I-	26-55	741	Tambores Aceite		1,052.59 R
I-	28-55	742	Mangueras Aeroquip, Fusibles, Bandas		1,822.54 R
I-	28-55	743	Refacciones Varias		895.81 R
I-	28-55	744	Refacciones Compresor		11,050.05 R
I-	28-55	745	Refacciones Varias		871.48 R
I-	28-55	746	Sillas Madera, Tarraja, Extractor		122.30 R
I-	28-55	751	Cascos, Guantes, Contactos, Cable		3,243.91 R
I-	28-55	752	Tafiletos, Fusibles, Reducciones		1,775.83 R
I-	28-55	753	Baleros, Fusibles "		972.92 R
I-	3-55	776	Bogues, Radio, Transformadores		7,425.00 R
I-	3-55	778	Cato Mecánico, Manual Malacate		125.00 R
I-	3-55	805	(Manual) Malacate Especial		206.33
I-	13-55	810	Motores Eléctricos, Interruptores		49.20 R
I-	16-55	813	Grilletes, dados, Extensión Proto		856.57 R
I-	18-55	819	Limas, Machuelos, Llaves, Manerales		493.69 R
I-	22-55	832	Aditivo "Rapidar"		18,000.00
I-	23-55	837	Tubo Galvanizado, Bogues, Coples		641.62 R
I-	23-55	839	Aditivo "Rapidar"		14,400.00
I-	24-55	841	Elemento Filtro		4,520.41 R
I-	24-55	842	Esmaril Eléctrico, Teléfono, Etc.		1,674.50 R
I-	24-55	843	Fusibles, Contactos, Grapas, etc.		536.28 R
I-	24-55	845	Opresores, Elementos Térmicos		638.94 R

FECHA	ENTRADA ALMACEN	Cantidad	C O N C E P T O .	REM.	IMPORTE.
II- 25-65	847		Tubo Galvanizado, Tambores Aceite	\$	10,292.94 R
II- 25-65	852		Aditivo "Rapidur"		10,800.00
III- 17-65	970		Refacciones Lanzadora		5,902.60
XII- 17-65	977		Refacciones Lanzadora		912.70
II- 1-65	983		Madera		8,954.60 R
X- 25-65	7522		Refacciones		191.75
II- 1-65	7570		Rines		544.00
X- 1-65	7577		Madera		13,418.90
II- 1-65	7593		Refacciones		584.80
X- 1-65	7599		Refacciones		39.75
X- 9-65	7600		Refacciones		392.25
XVI- 3-65	7604		Refacciones		422.55
XII- 3-65	7911		Hojas Lija Agua		51.20
II- 1-65	7977		Elementos Filtro		156.00
XII-10-65	7938		Horquilla		4.70
II- 1-65	8048		Estopa Blanca		312.50
II- 1-65	8049		Tambores Aceite		9,480.50
					<u>9,480.50</u>
T o t a l				\$	61,850.22 R

W. B.

R e v i s ó

Contabilidad

Hoy. Ignacio Torres Manzo.

Rubén Mendoza Sánchez

Cosme Sastré Primo.

CUENTAS DE ORDEN

NOMBRE DE LA CUENTA	SALDO ANTERIOR		MOVIMIENTO.		SALDOS	
	DEUDOR	ACREEDOR	DEUDOR	ACREEDOR	DEUDOR	ACREEDOR
Materiales en custodia	\$ 356,397.52			\$ 85,298.36	\$ 271,099.16	
Materiales en consignación	200,000.00			100,000.00	100,000.00	\$
Depositantes de materiales		\$ 356,397.52	\$ 85,298.36			\$ 271,099.
Consignatarios		200,000.00	100,000.00			100,000.
	<u>\$ 556,397.52</u>	<u>\$ 556,397.52</u>	<u>\$ 185,298.36</u>	<u>\$ 185,298.36</u>	<u>\$ 371,099.16</u>	<u>\$ 371,099.</u>

Vo. Bo.

Revisó

Contabilidad

ING. IGNACIO TORRES MANZO

RUBEN HENDEZA SANCHEZ

COSME SASTRE PRIMO

ANALISIS DE CUENTAS DE ORDEN

Al 28 de Febrero de 1965

MATERIALES EN CUSTODIA S. R. H. :

Cemento	\$ 212,401.25	
Material Ramset	<u>58,697.91</u>	\$ 271,099.16

MATERIALES EN CONSIGNACION:

Aceros Fagersta	\$ 80,000.00	
Atlas Copco	<u>20,000.00</u>	<u>100,000.00</u>
		\$ 371,099.16
		=====

CATALOGO DE CUENTAS CON SU INSTRUCTIVO

A C T I V O

CIRCULANTE

101.- Caja Chica

Cargar: Por la constitución
Por Aumentos

Abonar: Por Disminuciones
Por cancelaciones

102.- Bancos

112 Banco Nacional de México, S. A., cuenta de cheques

Cargar: Depósito en los Bancos
Cargos efectuados por el Banco
por...

Abonar: Cheques expedidos
Cargos efectuados por el Banco

103.- Clientes

113 Clientes por construcciones

Cargar: Por el Importe de las obras, según factura

Abonar: Por el anticipo de construcción
Por el pago intermedio
Por el pago final

Bonificaciones concedidas

123 Clientes por venta de refacciones

Cargar: Importe de la venta

Abonar: Por los pagos recibidos
Bonificaciones concedidas

104.- Deudores y Acreedores (Deudores)

Cargar: Adeudos a favor de la compañía por;
a) Préstamos al personal
b) Anticipo al personal sobre sueldos y comisiones
c) Anticipos para gastos de representación

NOTA: Todos estos adeudos deben ser diferentes a las ventas de la Cía.

Abonar: Por los pagos de los adeudos mencionados
Por la comprobación de gastos

105.- Materiales en Tránsito

Cargar: Precio de los materiales comprados fuera de la localidad,
importe de los derechos, fletes y acarreos
Abonar: Costo total de los materiales importados, con traspaso
al almacén

106.- Almacén de Materiales

Cargar: Por el importe de los materiales recibidos
Por la devolución de los materiales no usados en las cons-
trucciones.
Abonar: Por los materiales enviados a las construcciones para
consumo.
Por las devoluciones a Proveedores

107.- Almacén de refacciones

Cargar: Por el importe de los materiales recibidos
Por las devoluciones recibidas de clientes
Abonar: Por los materiales enviados a las construcciones para
consumo.
Por los materiales enviados a clientes
Por las devoluciones a Proveedores

108.- Obras en Proceso de Construcción

Cargar: Por los materiales consumidos en la construcción
Por los salarios devengados
Por los gastos que origine la construcción

Abonar: Por el Traspaso a costo de construcción de hornos

FIJO

121.- Mobiliario y Equipo

122.- Equipo de Transporte

123.- Maquinaria y Equipo de Taller

Cargar: Costo de las adquisiciones de activo
Costo de la instalación

Abonar: Costo de los activos cuando se venden o se dan de baja

124.- Depreciación acumulada de Mobiliario y Equipo

125.- Depreciación acumulada de Equipo de Transporte

126.- Depreciación acumulada de Maquinaria y Equipo de Taller

Cargar: Importe de la depreciación acumulada de los activos vendidos o dados de baja

4 Abonar: Provisión mensual o anual con cargo a las cuentas - de Resultados

127.- Maquinaria y Equipo en Tránsito

Cargar: Precios de las adquisiciones, importe de los derechos, fletes y acarreos.

Abonar: Costo total de la maquinaria importada y equipo de taller por traspaso a las cuentas 121,122 y 123

128.- Construcciones e instalaciones en proceso de maquinaria y Equipo de Taller (Propiedad de la compañía)

Cargar: Importe de los materiales, mano de obra y gastos erogados en las construcciones e instalaciones de activo.

Abonar: Costo total de las construcciones o instalaciones terminadas, con cargo a la cuenta respectiva. 121,122 o 123

129.- Edificios y Terrenos

Cargar: Costo de las adquisiciones de activo
Costo de la instalación
Aumentos por revaluación

Abonar: Costo de los activos cuando se den de baja o se vendan
Disminuciones por revaluación

130.- Depreciación acumulada de edificios

Cargar: Importe de la depreciación acumulada de los,activos vendidos o dados de baja

Abonar: Provisión mensual o anual con cargo a las cuentas de resultados

131.- Inversiones en valores

Cargar: Costo de adquisición de los valores

Abonar: Costo de los, valores vendidos

132.- Depósitos en Garantía

Cargar: Depósitos dados de baja

Abonar: Recuperación de los depósitos dados en garantía. Cancelación de los depósitos de garantía contra las cuentas - de resultados

133.- Herramientas

Cargar: Costo de adquisiciones de Herramientas

Abonar: Costo de las herramientas cuando se venden o se dan de baja

CARGOS DIFERIDOS

141.- Gastos por Amortizar

- 11 Gastos de Instalación
- 12 Gastos de organización

Cargar: Erogaciones durante la organización de la negociación o por instalación o adaptación de las oficinas

Abonar: Cancelación de los saldos cuando han sido totalmente amortizados

142.- Amortización acumulada

- 11 Gastos de Instalación
- 12 Gastos de Organización

Cargar: Cancelación de los saldos cuando han sido totalmente amortizados

Abonar: Importe de la amortización mensual o anual, con cargo a las cuentas de resultados

143.- Impuestos Pagados por Anticipado

- 11 Impuesto sobre la Renta

Cargar: Por la liquidación de los pagos provisionales

Abonar: Traspaso a la cuenta Impuesto sobre la Renta o a deudores diversos, impuestos por recuperar

PASIVOCirculante

201.- Documentos por Pagar a Bancos

202.- Documentos por pagar a Proveedores

203.- Documentos por Pagar a Varios (Otros documentos por Pagar)

Cargar: Pagos efectuados
Cancelación de documentos

Abonar: Documentos por Pagar aceptados

204.- Proveedores

Cargar: Anticipo para compras
Pagos efectuados
Cancelación de adeudos

Abonar: Adeudos a favor de Proveedores
Pagos de Proveedores hechos por cuenta de la negociación

205.- Deudores y Acreedores (Acreedores)

Cargar: Pagos efectuados
Cancelación de adeudos

Abonar: Adeudos a favor de personas diferentes a los Proveedores

206.- Cuotas e Impuestos por Pagar

- 11 Impuesto sobre Productos del Trabajo
- 12 5% Infonavit
- 13 1% sobre reenumeraciones pagadas
- 14 Impuesto sobre Ingresos Mercantiles
- 15 Cuotas al IMSB

Cargar: Por el Pago de Impuestos, cuotas y aportaciones

Abonar: Creación de Pasivo cada mes, o bimestre, según el caso

F I J O

211.- Documentos por Pagar a largo plazo

Cargar: Pago de Documentos
Traspasos a las cuentas 130, 131 y 132

Abonar: Documentos por Pagar aceptados a largo plazo

212.- Créditos Diferidos

Cargar: Aplicación de los créditos diferidos a las cuentas de Resultados

Abonar: Ingresos o cobros efectuados por anticipado (rentas, intereses, cuotas etc.)

CAPITAL

301.- Capital Social

Cargar: Disminuciones de Capital

Abonar: Impórtte del capital social
Aumentos de capital

302.- Reserva Legal

Cargar: Capitalización de la reserva
Absorción de las pérdidas

Abonar: 5% de la utilidad contable anual hasta igualar a la quinta parte del capital social

303.- Reserva de reinversión

Cargar: Capitalización de la reserva
Absorción de las Pérdidas

Abonar: Creación o incremento anual de dicha reserva

304.- Utilidades por repartir

Cargar: Reparto o aplicación de las utilidades por repartir

Abonar: Utilidades por repartir después de la aplicación de las utilidades

305.- Pérdidas por Aplicar

Cargar: Aplicación de la pérdida del Ejercicio

Abonar: Aplicación de Utilidades

306.- Utilidad (Pérdida) del ejercicio

Cargar: Saldos deudores de las cuentas de resultados al final de cada año
Aplicación de las utilidades

Abonar: Saldos Acreedores de las cuentas de resultados al final de cada año.
Aplicación de las Pérdidas

CUENTAS DE RESULTADOS

401.- Ingresos por construcción de Hornos

Cargar: Traspaso del saldo de esta cuenta a la cuenta 306 al -- final del Período

Abonar: Importe de los ingresos por construcciones, según facturas expedidas

402.- Ingresos por venta de Refacciones

Cargar: Traspaso del saldo de estas cuentas a la cuenta N° 306
al final del Período
Cancelación de ventas

Abonar: Importe de las ventas, según facturas expedidas

403.- Bonificaciones sobre ventas

Cargar: Bonificaciones otorgadas sobre las ventas

Abonar: Traspaso del saldo de esta cuenta a la cuenta N° 306 al
final del Período

404.- Productos Financieros

Cargar: Traspaso del saldo de esta cuenta a la cuenta N° 306 al
final del ejercicio

Abonar: Intereses cobrados
Desuentos por pronto pago
Utilidades en cambios

405.- Otros Productos

- 11 Utilidad en venta de activo fijo
- 12 Venta de desperdicios

Cargar: Traspaso del saldo de esta cuenta a la cuenta N° 306 al
final del Período

Abonar: Utilidades en venta de activo
Importe de la venta del desperdicio del taller
Ingresos diversos, diferentes a todos los mencionados

EGRSOS

501.- Costo de Ventas

- 11 refacciones

Cargar: Costo de los artículos vendidos

Abonar: Traspaso del saldo de esta cuenta a la cuenta N° 306 al
final del período

502.- Costo de construcciones de hornos

Cargar: Traspasos de la cuenta de costo de construcción de hornos,
por aquellos que ya han sido entregados

Abonar: Traspaso del saldo de esta cuenta a la cuenta N° 306 al -
final del Período

503.- Gastos de Administración (ver sub-cuentas)

Cargar: Gastos propios de la,operación de la negociación

Abonar: Traspaso del saldo de esta cuenta a la cuenta N° 306 al final del período

504.- Gastos Financieros

Cargar: Intereses y descuentos pagados
Comisiones bancarias
Pérdidas en cambios

Abonar: Traspaso del saldo de esta cuenta a la cuenta N° 306 al final del período

505.- Otros Gastos

Cargar: Pérdida en venta de activos
Gastos extraordinarios

Abonar: Traspaso del saldo de esta cuenta a la cuenta N° 306 al final del período

506.- Impuesto sobre la Renta

Cargar:Provisión para el pago del impuesto e impuesto definitivo

Abonar: Traspaso del saldo de esta cuenta a la 306 al final del período

507.- Participación de los trabajadores en las utilidades

Cargar: Por el Pago de estas participaciones

Abonar: Traspaso del saldo de esta cuenta a la cuenta N° 306 al final del Período

CUENTAS DE ORDEN

601.-Contratos de obraspor ejercer

Cargar: Importe de contratos concertados

Abonar: Cobros efectuados

602.- Obras contratadas por ejercitar

Cargar: Cobros efectuados

Abonar: Importe de contratos concertados

SUB-CUENTAS DE GASTOS DE ADMINISTRACION

503.- Gastos de Admnsitración

- 11.- Sueldos y salarios
- 12.- Comisiones de agentes
- 13.- Sueldos fuera de nómina
- 14.- Seguro Social
- 15.- Infonavit
- 16.- 1% sobre reenumeraciones pagadas
- 17.- Aguinaldos y gratificaciones de fin de año
- 18.- Vacaciones
- 19.- Honorarios
- 20.- Gratificaciones
- 21.- Comidas y Representaciones
- 22.- Impuestos y Cuotas
- 23.- Pasajes y Transportes
- 24.- Fletes
- 25.- Combustibles y Lubricantes
- 26.- Gastos aduanales
- 27.- Teléfonos
- 28.- Correos y Telégrafos
- 29.- Publicidad
- 30.- Gastos de Viaje
- 31.- Conservación y Mantenimiento
- 32.- Depreciación
- 33.- Amortización
- 34.- Diversos
- 35.- No deducibles
- 36.- Papelería y Utiles de Escritorio
- 37.- Seguros y Fianzas
- 38.- Conservación de Vehículos
- 39.- Mantenimiento del Taller
- 40.- Cuotas y Suscripciones
- 41.- Impuesto sobre Ingresos Mercantiles

GUIA DE CONTABILIDAD

<u>OPERACION</u>	<u>COMPROBANTE</u>	<u>DOCUMENTO DE REGISTRO</u>	<u>C U E N T A S</u>	
			<u>CARGOS</u>	<u>ABONOS</u>
1.- Compras a) De materiales y refacciones en la localidad (concentración mensual, que se hará con base en las cuentas por pagar expedidas y en las entradas del almacén)	Registro de compras	Póliza de diario	106.- Almacén de Materiales 107.- Almacén de Refacciones	204.- Proveedores
b) De Activo Fijo	Factura, recibo etc.	Póliza-cheque	129.- Edificios y Terrenos 131.- Inversiones en valores 121.- Mobiliario y Equipo 122.- Equipo de Transporte 123.- Maquinaria y equipo de Taller	102.- Bancos 104.- Deudores y Acreedores
2.- Pago a Proveedores	Factura	Póliza-cheque	204.- Proveedores	102.- Bancos
3.- Anticipos a Proveedores	Recibo o remisión	Póliza-cheque	204.- Proveedores	102.- Bancos
4.- Pago de Impuestos y Cuotas	Declaraciones delladas por la dependencia a - que corresponda	Póliza-cheque	143.- Impuestos pagados por anticipado 206.- Cuotas e Impuestos por Pagar	102.- Bancos
5.- Pago de gastos de instalación y/o organización	Factura, recibo etc.	Póliza-cheque	141.- Gastos por amortizar	102.- Bancos
6.- Entregas por préstamos y gastos a comprobar	Recibos	póliza-cheques	104.- Deudores y Acreedores	102.- Bancos
7.- Materiales comprados fuera de la localidad	Aviso de envío de mercancía, remisión, etc.	Póliza	105.- Materiales en tránsito	204.- Proveedores
8.- Consumo de materiales en las construcciones	Recibos	Póliza	108.- Obras en Proceso de Construcción	106.- Almacén de Materiales 107.- Almacén de refacciones
9.- Gastos directos de las construcciones	Fact. recibos, notas, etc.	Póliza o cheque	108.- Obras en proceso de construcción	102.- Bancos 104.- Deudores y Acreedores
10.- Gastos de Administración, gastos financieros y otros gastos	Facturas, recibos, - notas, etc.	Póliza o cheque	503.- Gastos de Administración 504.- Gastos Financieros 505.- Otros Gastos	102.- Bancos 203.- Documentos por Pagar a varios 104.- Deudores y Acreedores

<u>OPERACION</u>	<u>COMPROBANTE</u>	<u>DOCUMENTOS DE REGISTRO</u>	<u>CARGOS</u>	<u>C U E N T A S</u>	<u>ABONOS</u>
11.- Pago de Documentos	Copia del Documento	Póliza-cheque	201.- Documentos por Pagar a Bancos 202.- Documentos por Pagar a Proveedores 203.- Documentos por Pagar a Varías		102.- Bancos
12.- Pago a Acreedores	Recibos, notas, etc.	Póliza-cheque	104.- Deudores y Acreedores		102.- Bancos
13.- Ingresos por construcción de hornos	Factura (registro de ingresos)	Póliza	103.- Clientes 11.- Clientes por Construcciones		401.- Ingresos por construcción de Hornos
14.- Ingresos por venta de refacciones	Factura (registro de Ingresos)	Póliza	103.- Clientes 12.- Por venta de refacciones		402.- Ingresos por venta de refaccio
15.- Entradas de dinero por préstamos	Letras, Pagfres, documentos y fichas de depósito al Banco	Póliza	102.- Bancos		201.- Doctos. por Pagar a Bancos 203.- Doctos. por Pagar a Varías
16.- Cobros a clientes por venta de refacciones	Ficha de depósito y - reporte de cobranzas	Póliza	102.- Bancos		103.- Clientes 12.- Por venta de refacciones
17.- Cobro a Clientes por el anticipo, avance y pago final de la construcción de hornos	Fichas de depósito y recibo	Póliza	102.- Bancos		103.- Clientes 11.- Clientes por Construcción
18.- Cobro a Deudores Diveros	Ficha de depósito y - recibos	Póliza	102.- Bancos		104.- Deudores y Acreedores
19.- Venta de Activo Fijo	Factura y ficha de - depósito	Póliza	102.- Bancos 104.- Deudores y Acreedores 124 a 126, 130.- Depreciación acumulada 1161.- Otros Gastos		121 a 123.- Equipos y Mobiliarios 129.- Edificios y Terrenos 405.- Otros Productos
20.- Ingresos por venta de desperdicios	Ficha de depósito y - o recibos, notas etc.	102.- Póliza	102.- Bancos		405.- Otros Productos
21.- Documentación de Deudas a Proveedores	Letras, Pagfres, Doctos. aceptados por la Cia.	Póliza	204.- Proveedores		202.- Documentos por Pagar a Proveedores
22.- Creación de Pasivo de Impuestos y Cuotas a cargo de la Cia.	Declaraciones por Pagar	Póliza	303.- Gastos de Administración		206.- Cuotas e Impuestos por Pagar

<u>OPERACION</u>	<u>COMPROBANTE</u>	<u>DOCUMENTOS DE REGISTRO</u>	<u>CARGOS</u>	<u>G U E N T A S</u>	<u>ABONOS</u>
23.- Depreciación de Activos Fijos	Cédula correspondiente	Póliza	503.- Gastos de Administración 108.- Obras en Proceso de Construcción		124 a 126, 130.- Depreciación Acumulada
24.- Amortización de Gastos	Cédula correspondiente	Póliza	503.- Gastos de Administración 108.- Obras en Proceso de Construcción		142.- Amortización Acumulada
25.- Recepción de los materiales en Tránsito	Facturas y comprobantes de gastos de transporte y aduanales	Póliza	106.- Almacén de Materiales 107.- Almacén de Refacciones 503.- Gastos de Administración 108.- Obras en Proceso de Construcción		105.- Materiales en Tránsito 204.- Proveedores 204.-
26.- Registro del Costo de venta de Refacciones	Salida de Almacén	501.- Gastos Póliza	501.- Costo de Ventas		107.- Almacén de Refacciones
27.- Registro del Costo de Construcción de Hornos	Salidas de Almacén	Póliza	502.- Costo de Construcción de Hornos		108.- Obras en Proceso de Construcción.

9.5

REGLAS PARA LA AUTORIZACION DE LINEAS DE CREDITO

- 1.- El total de los créditos autorizados a un cliente no deben exceder en un conjunto del 50% de su Capital Real Ajustado.
- 2.- El importe de las líneas de crédito para Descuentos Mercantiles no -- podrá exceder del 30% del Capital Real Ajustado del cliente.
- 3.- El total de los giros documentarios; no podrá exceder del 20% del Capital Real Ajustado del cedente. Cuando se trate de letras que no estén acompañadas de documento de embarque o que el conocimiento de embarque esté consignado a favor del propio girado, el importe máximo -- tomado a un cedente no excederá del 10% del C.R.A.
- 4.- El total de Préstamos Directos concedidos a un cliente no debe exce-- der del 20% de su C.R.A.
- 5.- El total de Préstamos Prendarios que se otorguen a un cliente no será superior al 30% del C.R.A. El importe de éstos préstamos no excederá del 70% del valor de la prenda.
- 6.- El monto de los Préstamos de Habilitación o Avío concedidos a un clien-- te no excederá del 30% de su C.R.A.
- 7.- El monto total de los Préstamos Refaccionarios concedidos a un clien-- te no podrá exceder del 30% del C.R.A. del mismo.
- 8.- El monto total de los Créditos Comerciales sin Refinanciamiento y sin Control de Mercancías concedido a un cliente, sumado al de los Créditos Comerciales con Refinanciamiento y Préstamos Directos no excederá del 20% del C.R.A.
- 9.- El monto total de los Créditos con Refinanciamiento o Contra - Acepta-- ción concedidos a un cliente sumados a los riesgos en Préstamos Direc-- tos no excederá del 20% del C.R.A. del mismo.
- 10.- El importe de los Créditos Comerciales Revolventes concedidos a un -- cliente no podrá exceder del 20% de su C.R.A.
- 11.- El importe de las Cartas de Crédito que se extienden a favor del - -- cliente sin que su importe sea liquidado previamente, no podrá exce-- der del 5% del C.R.A. y se requiere la autorización del Gerente General de Zona, u Organismo superior facultado.

- 12.- El importe de los pagos autorizados concedidos a determinado cliente no excederá del 10% de su C.R.A.
- 13.- El importe de los Créditos en Cuenta Corriente no podrá exceder del 20% del C.R.A. su monto más el importe del crédito concedido en Préstamos Directos no podrán exceder en conjunto del 20% del C.R.A. y se requiere aprobación del Subdirector Regional.
- 14.- AVALES O ACEPTACIONES POR CUENTA DE CLIENTES, estas operaciones sólo pueden ser autorizadas por el Comité de Crédito de la Dirección General u Organismo superior, dependiendo de la clase de operación para la cual se solicita el aval del Banco, y del plazo de la misma, se tendrán en cuenta los porcentajes autorizados para las operaciones que la originen.
- 15.- El 20% del importe sumado de las líneas de crédito concedidas a un cliente en Descuentos y Préstamos Directos podrá utilizarse para Remesas en Camino, siempre que no exceda del 50% de su Saldo Promedio en cuenta de cheques. Sin embargo el Subdirector Regional podrá autorizar hasta el 100% de las líneas normales establecidas.

BALANCE GENERAL

Documento en que se describen las inversiones de la empresa y los nombres de quienes las aportaron.

ACTIVO

Conjunto de bienes en los que se encuentra invertido el capital reunido por los dueños y acreedores.

PASIVO

La parte de la riqueza proporcionada por los acreedores.

CAPITAL

La parte de la riqueza aportada por los dueños del negocio.

Circulante:

Inversiones destinadas al tráfico del negocio. Producen utilidades o pérdidas y su recuperación se hace en una sola operación, ya sea de venta, ya de cobro.

Fijo:

Inversiones destinadas al uso de la empresa. Su recuperación se hace en proporción al tiempo durante el cual los bienes que representan estas inversiones son capaces de rendir un servicio eficaz.

Otros Activos:

Inversiones que no participan de las características del circulante y del fijo.

Cargos Diferidos:

Anticipos por servicios que deberán recibirse después de la fecha del balance.

Circulante:

Acreedores a plazo relativamente corto. (no mayor de un año).

Fijo:

Acreedores a plazo mayor del asignado para el pasivo circulante. (Más de un año).

Créditos Diferidos:

Cantidades percibidas a cuenta de servicios que deberán proporcionarse después de la fecha del balance.

Capital Inicial:

Aportaciones del, o de los dueños al establecerse el negocio.

Utilidad:

Las obtenidas y no retiradas hasta la fecha del balance.

Pérdidas:

Las sufridas hasta la fecha del balance.

Inventario de mercancías.
Adeudos a favor de la empresa.
Dinero en efectivo.

Muebles, enseres, equipo, maquinaria, etc.

Cuentas por cobrar a largo plazo.
Depósitos en garantía de contratos.
Patentes, derechos de propiedad literaria, etc.

Pagos por conceptos de renta, seguros, etc.
Instalaciones y adaptaciones de locales.
Costo de papelería, efectos de escritorio, etc.

Adeudos a favor de proveedores de mercancías, o acreedores en general.

Adeudos a favor de proveedores o acreedores a plazo largo.

Rentas o cuotas por servicios, cobradas anticipadamente.

De un solo propietario: Comerciante.
De varios propietarios: Sociedad mercantil.

Ilustración 1.—Clasificación del balance.

PRINCIPALES RAZONES SIMPLES

<u>RAZON</u>	<u>COMO SE LEE</u>	<u>QUE SIGNIFICA</u>	<u>OBSERVACIONES</u>
<u>Activo Circulante</u> o <u>Pasivo Circulante</u>	El número de pesos de efectivo y de otros bienes que en el -- curso normal de las operacio-- nes se convierten en efectivo, por cada peso de obligaciones a corto plazo.	El índice de solvencia o capaci-- dad del negocio para hacer -- frente a sus obligaciones a -- corto plazo.	Muy útil para la determinación y análisis del capital de trabajo y la rotación del mismo.
<u>Capital de Trabajo</u> o <u>Pasivo Circulante</u>	El número de pesos invertidos-- en Activo Circulante de Propie-- tarios y Acreedores de corto -- plazo en comparación con la in-- versión de los acreedores a -- corto plazo.	La importancia relativa de las 2 clases de inversiones en el Activo Circulante.	Es la base para determinar el límite de crédito a corto plazo.
<u>Act. Circ. Inventarios</u> <u>Pasivo Circulante</u>	Número de pesos razonablemente disponibles por cada peso de -- obligaciones a corto plazo.	Índice de solvencia inmediata-- Prueba más estricta de la cap-- cidad de pago a corto plazo.	La resta del Act. Circ. menos los inventarios se llama Activo Disponible y se apoya en el supuesto de que en el curso -- normal de las operaciones, los Inventarios disponibles para su conversión inmediata a efectivo.
<u>Capital Contable</u> <u>Pasivo Total</u>	Número de pesos propiedad de -- los dueños por cada peso de -- los acreedores.	La solidez del patrimonio de-- termina hasta qué grado el negocio, está en manos de los -- propietarios o de los acreedo-- res.	Es el margen de seguridad del conjunto de acreedores desde el punto de vista de la capacidad de pago.
<u>Capital Contable</u> <u>Pasivo Circulante</u>	El número de pesos invertidos-- por los propietarios del negocio por cada peso de los acree-- dores a corto plazo.	Ratifica la solidez del patri-- monio comparando el total de fondos que constituyen permanente-- mente el negocio que continua-- mente ingresan y salen.	Esta razón complementa a la del capital de trabajo y a la del margen de seguridad por el antecedente representa los activos libres de obligación.

Superavit
Capital Parado

El número de pesos que el negocio ha logrado aportar al patrimonio de los propietarios - por cada peso que han aportado ellos mismos.

La protección de que se ha rodeado al pasivo en general y al capital aportado en particular.

Debe estudiarse a la luz del número de años que ha operado el negocio.

Utilidad Neta a Capital Contable

El número de pesos de beneficio por cada peso de inversión propia.

Indice de productividad determinado en forma de porcentaje, - el rendimiento obtenido por los propietarios cada año.

También se determina con base en el Capital Parado. También hay productividad del negocio en general.

Utilidad Neta a No. de Acciones

El número de veces que se han cobrado las cuentas por cobrar medios en el plazo a que se refieren las ventas.

La rapidez de cobro, y por lo tanto, la eficiencia de créditos (dividiendo 360 entre la rotación se determina el plazo medio de cobro)

El plazo medio de cobro también se obtiene dividiendo el promedio de cuentas y documentos por cobrar a clientes, entre el promedio diario de ventas.

Ventas Netas a Promedio de Cuentas y Documentos por Cobrar a Clientes.

Costo de Ventas a Promedio de Inventarios

El número de veces que se han vendido los inventarios medios, en el plazo a que se refiere - el costo de ventas.

La rapidez de ventas y por lo tanto la eficiencia de las mismas así como la planeación de compras y producción (dividiendo 360 entre la rotación se determina el plazo medio de ventas).

El plazo medio de ventas, también se determina dividiendo el promedio de Inventarios entre el promedio diario de costo de ventas.

Ventas Netas a Promedio de Activo no Circulante

El número de veces que se han obtenido ingresos equivalentes a la inversión permanente en el plazo a que se refieren las ventas.

La rapidez de las ventas, en función de la inversión realizada para lograrlos. Es muy importante su empleo como índice de sobre inversión en el Activo no Circulante.

No se debe deducir depreciación.

6

INTEGRACION DEL EXIEDIENTE DE CREDITO

DOCUMENTACION QUE DEBE CONTENER

1.- Balance General y Estado de Pérdidas y Ganancias.

El requisito de recabar estos documentos está reglamentado por los párrafos primero y segundo del Artículo 13 de la Ley General de -- Instituciones de Crédito y Organizaciones Auxiliares; así como la Circular Núm. 579 de la Comisión Nacional Bancaria; y así como las políticas internas de nuestra Institución. En caso necesario ésta información puede recabarse en la "Manifestación Confidencial" - - (1:153.11).

2.- Balance General Ajustado - Comparativo (Análisis de Estados Financieros).

3.- Informes de Crédito abarcando:

Instituciones de Crédito
Proveedores
Clientes
Competidores

Quando el solicitante tenga negocios o propiedades en otro lugar - del País, será necesario que se obtenga un informe de crédito rendido por el corresponsal o sucursal de la Plaza donde también opera nuestro cliente.

4.- Verificación en el Registro Público de la Propiedad, de los bienes raíces declarados en el Balance del cliente.

5.- Cuando se nos proponga la firma de un aval, el expediente de éste debe contener toda la documentación planteada para el solicitante del crédito.

6.- Cuadro de Promedios y Riesgos (datos por los últimos 6 meses o 12- si es negocio cíclico).

7.- Solicitud de línea de crédito, sólo en las oficinas que tengan establecido Departamento de Análisis de Crédito.

8.- Declaraciones del cliente sobre:

- a) Los seguros que tiene contratados para cubrir su negocio.
- b) De encontrarse al corriente en el pago de los impuestos fiscales y de las cuotas al I.M.S.S.

9.- Carta Fianza

10.- Autorización para cargar en cuenta los créditos no liquidados.

ADEMAS EN CASO DE LAS SOCIEDADES MERCANTILES, DEBERA RECABARSE:

- a) Copias de la Escritura Constitutiva, reformas a la misma y de los poderes, con los datos de inscripción en el Registro Público de la Propiedad.
- b) En todos los casos de Sociedad Anónima, se obtendrá copia del Acta de la última Asamblea de Accionistas.
- c) Sobre los documentos expuestos en los dos puntos anteriores, se solicitará un dictamen del abogado del Banco en la localidad, sobre su correcta emisión, igualmente deberá verificarse en el Registro Público de la Propiedad.

BALANCE GENERAL AL 31 DE DICIEMBRE DE 1970

2

ACTIVO

PASIVO

CIRCULANTE:

Caja y Bancos		\$	
Documentos por Cobrar	\$		
Cuentas por Cobrar	"	\$	
Menos: Rebaja por Cuentas Incobrables	"	\$	
Inventario de Mercancías Terminadas	\$		
Productos en Proceso	"		
Materia Prima	"		
Inversiones en Valores	"		\$

FIJO:

Terrenos		\$	
Edificios	\$		
Menos: Rebaja por Depreciación Maquinaria y Equipo	"		
Menos: Rebaja por Depreciación Mobiliario	"		
Menos: Rebaja por Depreciación	"		"

OTROS ACTIVOS:

Patentes y Otros Activos Intangibles		\$	
Inversiones cotizadas en Bolsa		"	
Otras Inversiones		"	\$

CARGOS DIFERIDOS:

Seguros Pagados por Adelantado		\$	
Material de Propaganda y Papelería		"	
Gastos de Instalación	\$		
Menos: Rebaja por Amortización	"		\$

Suma el Activo: 7 =====

CIRCULANTE:

Banco Comercial Mexicano, S.A.	\$	
Otros Bancos	"	
Proveedores	"	
Otros Documentos por Pagar	"	
Impuestos por Pagar	"	
Pasivo a favor de Socios	"	
Otras Acumulaciones por pagar	"	\$

FIJO:

Con Instituciones de Crédito	\$	
Con Proveedores	"	
Otros	"	"

CREDITOS DIFERIDOS:

Renta Cobrada por Adelantado	"	
------------------------------	---	--

Suma el Pasivo \$

CAPITAL CONTABLE:

Capital Social	\$	
Superavit:		
Reserva Legal	\$	
Resultados Anteriores.	"	
Utilidad Neta del Ejercicio	"	"

Suma Pasivo y Capital \$ =====

CUENTAS DE ORDEN:

Documentos Descontados	\$	\$
Fianzas y Garantías	"	"
Mercancías Recibidas en Consignación		

ESTADO DE PERDIDAS Y GANANCIAS POR EL AÑO QUE TERMINA
EL 31 DE DICIEMBRE DE 197__

Ventas Totales		\$	
Menos: Rebajas sobre Ventas	\$		
Devoluciones sobre Ventas	"		"
Ventas Netas			\$
 Costo de la Mercancía Vendida:			
Inventario Inicial		\$	
Compras Totales	\$		
Menos: Rebajas sobre Compras	\$		
Devoluciones sobre --			
Compras.....	" "		
Compras Netas		\$	
Menos: Inventario Actual		"	"
Utilidad Bruta			\$
 Gastos de Operación:			
Gastos de Venta			
Propaganda.....	\$		
Sueldos y Comisiones de Vendedores.....	"		
Gastos de Embarque y Entrega de Mercancías	" "	\$	
Gastos de Administración			
Sueldos de Empleados	\$		
Rentas de Oficina	"		
Papelería y Efectos de Escritorio	"		
Depreciación de Equipo	"		
Luz y Calefacción	"		
Teléfonos, Telégrafos y Correos	"		
Diversos Gastos	" "	\$	
Gastos y Productos Financieros			
Descuentos Sobre Ventas	\$		
Descuentos y Cambios	"		
Cuentas Incobrables	" "	\$	
Descuentos sobre Compras	\$		
Intereses Percibidos	" "	\$	\$
Utilidad de Operación			\$
 Otros Gastos y Productos:			
Pérdidas en la Venta de Bonos "N".....		\$	
Dividendo del Cupón No. 10 de Acciones "R"		"	
Utilidad Neta			\$
			=====

BALANCE GENERAL

Al 31 de Diciembre de 1968
(En miles de pesos)

10

A C T I V O

CIRCULANTE:

Efectivo en Caja y Bancos		\$	53	
Documentos por Cobrar	\$ 5,023			
Clientes	554			
Deudores Diversos	48	5,625		
Almacén		1,882		
Pagos Anticipados		8	\$ 7,568	

INVERSIONES:

Acciones, Bonos y Valores 150

FIJO:

Edificio	\$ 640			
Depreciación Acumulada	120	\$ 520		
Equipo de Reparto	\$ 240			
Depreciación Acumulada	80	160		
Muebles y Enseres	\$ 120			
Depreciación Acumulada	50	70		
Terrenos		545	1,295	

SUMA EL ACTIVO: \$ 9,013

P A S I V O

CIRCULANTE:

Préstamos Bancarios	\$ 1,955		
Proveedores	1,204		
Acreedores Diversos	67		
Impuesto sobre la Renta	124	(1)	
Participación a los Trabajadores	59		

SUMA EL PASIVO: \$ 3,409

CAPITAL CONTABLE

Capital Social	\$ 4,000		
Superávit:			
Reserva Legal	\$ 251		
Resultados de Ejercicios Anteriores	675		
Utilidad neta del ejercicio del 1o. de enero al 31 de diciembre de 1968	678	1,604	5,604

SUMAN PASIVO Y CAPITAL: \$ 9,013

NOTA:

(1) El impuesto sobre la renta causado durante el ejercicio asciende a \$ 504, de los cuales se han anticipado \$ 380.

EL HOGAR MODERNO, S. A.

ESTADO DE PERDIDAS Y GANANCIAS

Por el ejercicio del 1o. de enero al 31 de diciembre de 1968.

(En miles de pesos)

<u>VENTAS NETAS</u>		\$ 10,332
<u>COSTO DE VENTAS</u>		<u>6,843</u>
UTILIDAD BRUTA		\$ 3,489
<u>GASTOS DE OPERACION</u>		
Gastos de Venta	\$ 1,378	
Gastos de Administración	<u>870</u>	<u>2,248</u>
UTILIDAD ANTES DE IMPUESTO SOBRE LA RENTA Y DE PARTICIPACION A LOS TRABAJADORES EN LAS UTILIDADES		\$ 1,241
<u>IMPUESTO SOBRE LA RENTA</u>		<u>504</u>
UTILIDAD ANTES DE PARTICIPACION A LOS TRABAJADORES EN LAS UTILIDADES		\$ 737
<u>PARTICIPACION A LOS TRABAJADORES EN LAS UTILIDADES</u>		<u>59</u>
UTILIDAD NETA		\$ 678
		<u><u> </u></u>

ARTICULO 20.—De los ingresos acumulables podrán hacerse únicamente las siguientes deducciones:

I. Las devoluciones, descuentos, rebajas y bonificaciones, efectuadas durante el ejercicio;

II. El costo de las mercancías o de los productos vendidos, determinado de acuerdo con las disposiciones reglamentarias respectivas. Cuando el precio de compra declarado por el causante respecto de mercancías importadas, no corresponda a los reales del mercado, la Secretaría de Hacienda y Crédito Público fijará el precio tomando en cuenta los de factura, los oficiales o los corrientes en el mercado interior o exterior;

III. La depreciación de activos fijos tangibles y la amortización de activos fijos intangibles y de gastos y cargos diferidos;

IV. La amortización de pérdidas de operación ocurridas en ejercicios anteriores;

V. Las pérdidas de bienes del causante por caso fortuito o fuerza mayor;

VI. Las pérdidas por créditos incobrables;

VII. La creación e incremento de reservas para pensiones o jubilaciones del personal;

VIII. Los gastos normales y propios del negocio, y

IX. La diferencia entre los inventarios inicial y final de un ejercicio, cuando el inventario inicial fuere el mayor, tratándose de causantes dedicados a la ganadería.

Se reformaron las fracciones I, II, y III del artículo 21 por Decreto de 29 de diciembre de 1970, publicado en el "Diario Oficial" de la Federación del 30 del mismo mes y año, en vigor el 1o. de enero de 1971 para quedar como sigue:

ARTICULO 21. La depreciación de los activos fijos tangibles y la amortización de los intangibles y de los cargos diferidos, se sujetarán a las siguientes reglas:

I. No excederán de los siguientes por cientos anuales, sobre el monto original de la inversión respectiva:

a) Activos fijos intangibles y cargos diferidos. 5%

Se reformó y adicionó el inciso b) de la fracción I, por Decreto de 23 de diciembre de 1971 y luego por Decreto de 29 de diciembre de 1972, publicado éste en el "Diario Oficial" de la Federación de 30 del mismo mes y año, en vigor el 1o. de enero de 1973, para quedar como sigue:

b).—Bienes de activo fijo.

1.—Edificios y construcciones 3%

2.—Viviendas que las empresas proporcionen a sus trabajadores en cumplimiento de la Ley Federal del Trabajo 5%

Se reformó el subinciso 3 por Decreto de 29 de diciembre de 1972, publicado en el "Diario Oficial" de la Federación de 30 del mismo mes y año, en vigor el 1o. de enero de 1973, para quedar como sigue:

3.—Ferrocarriles, carros de ferrocarril, locomotoras y embarcaciones (excepto los comprendidos en el inciso c) No. 8) 6%

4.—Mobiliario y equipo de oficina 10%

5.—Automóviles, camiones de carga, tralicamiones, remolques y maquinaria y equipo para la industria de la construcción 20%

6.—Autobuses. 11%

Se reformó el subinciso 7 por Decreto de 29 de diciembre de 1972, publicado en el "Diario Oficial" de la Federación de 30 del mismo mes y año, en vigor el 1o. de enero de 1973, para quedar como sigue:

7.—Equipo periférico del contenido en el subinciso 9): perforadoras de tarjetas, verificadoras, tabuladoras, clasifica-

doras, intercaladoras y demás que no queden comprendidas en dicho subinciso 12%

Se reformó el subinciso 8 por Decreto de 29 de diciembre de 1972, publicado en el "Diario Oficial" de la Federación de 30 del mismo mes y año, en vigor el 1o. de enero de 1973, para quedar como sigue:

8.—Aviones (excepto los comprendidos en el inciso ~~8~~ No. 9) 17%

Se reformó el subinciso 9 por Decreto de 29 de diciembre de 1972, publicado en el "Diario Oficial" de la Federación de 30 del mismo mes y año, en vigor el 1o. de enero de 1973, para quedar como sigue:

9.—Equipo de cómputo electrónico consistente en una máquina o grupo de máquinas interconectadas conteniendo unidades de entrada, almacenamiento, computación, control y unidades de salida, usando circuitos electrónicos en los elementos principales para ejecutar operaciones aritméticas o lógicas en forma automática por medio de instrucciones programadas, almacenadas internamente o controladas externamente 25%

Se adicionó el subinciso 10, por Decreto de 29 de diciembre de 1972, publicado en el "Diario Oficial" de la Federación de 30 del mismo mes y año, en vigor el 1o. de enero de 1973, como sigue:

10.—Dados, troques, moldes, matrices y herramental . 35%

Se adicionó el subinciso 11, por Decreto de 29 de diciembre de 1972, publicado en el "Diario Oficial" de la Federación de 30 del mismo mes y año, en vigor el 1o. de enero de 1973, como sigue:

11.—Equipo destinado a prevenir y controlar la contaminación ambiental en cumplimiento de las disposiciones legales respectivas 35%

Se adicionó el subinciso 12, por Decreto de 29 de diciembre de 1972, publicado en el "Diario Oficial" de la Federación de 30 del mismo mes y año, en vigor el 1o. de enero de 1973, como sigue:

12.—Equipo destinado directamente a la investigación de nuevos productos o desarrollo de tecnología en el país ... 35%

Se reformó el inciso c) de la fracción I, por Decreto de 23 de diciembre de 1971, publicado en el "Diario Oficial" de la Federación del 29 del mismo mes y año, en vigor el 1o. de enero de 1972, para quedar como sigue:

c).—Maquinaria y equipo distintos de los mencionados en el inciso anterior, utilizados por empresas dedicadas a:

1.—Producción de energía eléctrica; transportes eléctricos 3%

2.—Molienda de granos; producción de azúcar y derivados; de aceites comestibles; transportación marítima, fluvial y lacustre 5%

3.—Producción de metal (obtenido en primer proceso); productos de tabaco y derivados del carbón natural 6%

4.—Fabricación de pulpa, papel y productos similares; productos de caucho; petróleo y gas natural 7%

5.—Fabricación de vehículos de motor y sus partes; construcción de ferrocarriles y navíos; fabricación de productos de metal, de maquinaria y de instrumentos profesionales y científicos; producción de alimentos y bebidas (excepto granos, azúcar, aceites comestibles y derivados) 8%

6.—Curtido de piel y fabricación de artículos de piel; de productos químicos, petroquímicos y farmacobiológicos; de productos plásticos; impresión y publicación 9%

7.—Fabricación de ropa; fabricación de productos textiles, acabado, teñido y estampado 11%

8.—Construcción de aeronaves; compañías de transporte terrestre, de carga y de pasajeros 12%

9.—Compañías de transporte aéreo; transmisión por radio y televisión 16%

Se reformó el inciso d) de la fracción I, por Decreto de 23 de diciembre de 1971, publicado en el "Diario Oficial" de la Federación del 29 del mismo mes y año, en vigor el 1o. de enero de 1972, para quedar como sigue:

d).—Actividades agropecuarias:

- | | |
|---|-----|
| 1.—Agricultura (incluyendo maquinaria y equipo) | 20% |
| 2.—Cría de ganado mayor | 11% |
| 3.—Cría de ganado menor | 25% |

Se adicionó el segundo párrafo del inciso e) de la fracción I, por Decreto de 23 de diciembre de 1971, publicado en el "Diario Oficial" de la Federación del 29 del mismo mes y año, en vigor el 1o. de enero de 1972, como sigue:

e) Otras actividades no especificadas en la enumeración anterior 10%;

En caso contrario de que una empresa se dedique a dos o más actividades de las señaladas, aplicará el por ciento que le corresponda a la actividad preponderante según el monto de sus ventas.

II. Los por cientos elegidos por el causante serán fijos, constantes y obligatorios, pero cuando el causante hubiere utilizado factores de depreciación menores que los señalados en este precepto, la Secretaría de Hacienda y Crédito Público podrá autorizar su modificación siempre y cuando no excedan de los por cientos señalados por la Ley;

III. Las deducciones respectivas podrán hacerse sólo para fines fiscales aún cuando no se efectúen contablemente. También podrán ser diferentes los por cientos utilizados para uno y otro fin.

Se reformó la fracción IV e inciso a), por Decreto de 23 de diciembre de 1971, publicado en el "Diario Oficial" de la Federación del 29 del mismo mes y año, en vigor el 1o. de enero de 1972, para quedar como sigue:

IV.—La Secretaría de Hacienda y Crédito Público con fines de fomento económico, podrá autorizar que se efectúe depreciación acelerada con arreglo a las siguientes bases:

a) —La autorización se hará mediante acuerdos de carácter general, que señalen las regiones o ramas de actividad y los activos que podrán gozar del beneficio, los métodos aplicables, el plazo de su vigencia y los requisitos que deban cumplir los interesados.

b) La autorización señalará el porcentaje máximo del valor

del activo que podrá depreciarse en forma acelerada y el período durante el cual debe efectuarse dicha depreciación;

Se reformó el inciso c) de la fracción IV, por Decreto de 23 de diciembre de 1971, publicado en el "Diario Oficial" de la Federación del 29 del mismo mes y año, en vigor el 1o. de enero de 1972, para quedar como sigue:

c).—Los interesados deberán obtener el acuerdo concreto de las autoridades fiscales, para aplicar el método de depreciación acelerada.

d).—Derogado por Decreto de 23 de diciembre de 1971, publicado en el "Diario Oficial" de la Federación del 29 del mismo mes y año, en vigor el 1o. de enero de 1972.

Se reformó la fracción V, por Decreto de 29 de diciembre de 1972, publicado en el "Diario Oficial" de la Federación de 30 del mismo mes y año, en vigor el 1o. de enero de 1973, para quedar como sigue:

V.—Los descuentos, primas, comisiones y demás gastos relacionados con la emisión de obligaciones incluyendo las emitidas por instituciones de crédito, se amortizarán anualmente en proporción a las obligaciones pagadas durante cada ejercicio.

VI. Las construcciones, instalaciones o mejoras permanentes en activos fijos tangibles, propiedad de terceros que, de conformidad con los contratos de arrendamiento o de concesión respectivos, queden a beneficio del propietario, se amortizarán durante el período de vigencia del contrato de arrendamiento o de la concesión. Si el contrato o la concesión fueren por tiempo indefinido, la amortización se hará en cinco anualidades salvo modificación autorizada por la Secretaría de Hacienda y Crédito Público;

VII. Las indemnizaciones pagadas a trabajadores en caso de separación, sólo son amortizables cuando la separación sea consecuencia de reajuste necesario para la reorganización de la empresa, y la amortización se hará por partes iguales de un plazo hasta de cinco años a partir del ejercicio en que se efectúe el pago;

VIII. La depreciación y amortización empezará a deducirse, a elección del causante, a partir del ejercicio en que se inicie la utilización de los bienes o desde el ejercicio siguiente. El causante podrá no iniciar la depreciación o la amortización para efectos fiscales. En este caso podrá hacerlo con posterioridad; pero perderá el derecho a deducir las cantidades correspondientes a los ejercicios transcuridos, calculadas aplicando los porcentajes indicados en la fracción I;

IX. Las operaciones con activos fijos y los gastos y cargos diferidos, en moneda extranjera, se registrarán en moneda nacional al tipo de cambio oficial vigente en la fecha en que se efectúe la operación, aunque el de la época de pago sea diferente;

siones, corrigiéndolas en caso necesario, pero siempre con un año de anticipación

Hemos encontrado que es un método ideal para comparar la actuación de diferentes departamentos o de empresas dedicadas a la misma actividad. Para nosotros, la mayor utilidad que nos presta es la de hacer resaltar de inmediato las fallas más importantes y poder dictar acciones correctivas ipso-facto; la forma de presentación tiene la grandísima ventaja de ahorrar considerablemente el tiempo tan valioso de los altos ejecutivos.

Adicionalmente empleamos el método de relaciones entre los diferentes renglones del balance, y en forma rutinaria, mensualmente, se analizan las siguientes, llevándose un registro gráfico y numérico de todas y cada una de ellas.

I.—LIQUIDEZ: *relaciones financieras*

- 1.—Activo Circulante \div Pasivo Circulante
- 2.—(Activo Circulante — inventarios) — Pasivo Circulante
- 3.—(Caja — Bancos) \div Pasivo Circulante
- 3a.—Efectivo y equivalentes \div Pasivo Circulante
- 4.—Ventas anuales \div (Caja + Bancos)
- 4a.—Ventas anuales \div Efectivo y equivalentes
- 5.—Inventarios — (Activo Circulante — Pasivo Circulante)

II.—NIVELADORAS.

- 6.—Pasivo total \div Capital
- 7.—Pasivo Circulante \div Capital
- 8.—Activo Fijo \div Capital
- 9.—(Activo fijo + Activo diferido) \div Capital

13.—Ventas \div Activo total

IV.—PRODUCTIVIDAD.

- 14.—Beneficios \div Ventas
- 15.—Beneficios \div Activo total
- 16.—Beneficios — Capital
- 17.—Ventas \div Capital

V.—ESTRUCTURA

- 18.—(Pasivo Circulante \div Pasivo fijo) \div (Activo Circulante — Activo Fijo)
- 19.—Pasivo fijo — Activo fijo
- 20.—Créditos a largo plazo — Activo total
- 21.—Beneficios \div Pasivo total
- 22.—Activo fijo — Activo total.

La división de las relaciones en 5 grupos ha obedecido a un criterio más o menos lógico, y aunque para cualquier contador el significado de cada una de las relaciones es perfectamente claro y preciso, me permitiré hacer un recordatorio breve de cada relación.

I.—LIQUIDEZ.

Las relaciones de liquidez pretenden ser una medida de la habilidad de la empresa para hacer frente a sus compromisos financieros, éste es sólo un aspecto de la liquidez, puesto que sólo trata con datos históricos. Un verdadero análisis de ellas debería comprender no sólo el pasado sino el futuro también, en otras palabras, deberían analizarse los presupuestos, en particular las previsiones de necesidades de efectivo.

La liquidez ha sido empleada en el sentido de tratar de expresar la posición financiera total de las empresas. Usada en esta forma, la

liquidez debía incluir las relaciones de actividad y de capital.

1.—Activo Circulante ÷ Pasivo Circulante.

Esta relación es la generalmente aceptada para medir la solvencia de las empresas a corto plazo. El valor de esta relación generalmente aceptado es de 2.

2.—(Activo Circulante — Inventarios) ÷ Pasivo Circulante.

Mide la capacidad de la empresa para liquidar sus deudas a corto plazo, sin necesidad de recurrir a la venta de los productos terminados, y almacenados. Generalmente se acepta una relación de 1 : 1.

3.—(Caja + Bancos) ÷ Pasivo Circulante

En realidad debía haber considerado efectivo y equivalentes, sin embargo preferí dividir la relación conocida como prueba del ácido (Efectivo y equivalente ÷ Pasivo Circulante) en las relaciones 3 = (Caja + Bancos) ÷ Pasivo Circulante y la 3a.—Efectivo y equivalentes ÷ Pasivo Circulante, para obtener la relación 3 una medida de la habilidad de la gerencia para, por una parte, obtener créditos a corto plazo, (fundamentalmente de proveedores), y por otra, tener una idea de manera incorrecta, del manejo del efectivo.

3a.—Efectivo y equivalentes ÷ Pasivo Circulante.

Esta relación, que en mi opinión es una medida mucho más aproximada a la realidad, de la prueba ácida, puesto que se puede afirmar que para las empresas constructoras no hay problema alguno en obtener rápidamente un alto porcentaje del valor de las estimaciones formuladas y de los deudores diversos.

4.—Ventas anuales ÷ (Caja + Bancos).

Efectivo y equivalentes

Esta relación, que se llama también, velocidad o rotación del efectivo, nos mide la habilidad de la gerencia para manejar el efectivo.

He seguido el mismo criterio que para la relación 3, descomponiendo la rotación de efectivo en dos relaciones, la 4 y la 4a.

5.—Inventarios ÷ (Activo Circulante — Pasivo Circulante).

El activo circulante menos el pasivo circulante o sea el capital de trabajo, al relacionarlo con el valor de los inventarios, nos indicará la pérdida potencial de la empresa por la inevitable disminución de los valores de los inventarios.

II.—NIVELADORAS.

Estas relaciones miden la contribución de los propietarios del capital de la empresa al financiamiento de las operaciones, comparándolo con el financiamiento conseguido u otorgado por los acreedores. La obtención de fondos, contrayendo deudas, proporciona a los propietarios la ventaja de mantener el control de la firma con una inversión pequeña.

6.—Pasivo total ÷ Capital.

Mide las obligaciones de la empresa para con los acreedores, relacionándolas con las aportaciones de los propietarios. Es obvio que los acreedores prefieren que esta relación sea lo menor posible con objeto de disminuir al máximo el riesgo que corren en caso de liquidación de la empresa, y cuando mucho están dispuestos a conceder un crédito cuyo valor no exceda al del capital. Por otra parte los propietarios desean lo contrario, es decir, quieren que la relación sea lo más grande posible.

Si la relación es demasiado grande existe

el peligro de alentar la irresponsabilidad de los propietarios al emplear prácticas indeseables de carácter meramente especulativo.

7.—Pasivo Circulante ÷ Capital.

De esta relación se desprende que si los propietarios no han aportado el capital suficiente, las fuentes de préstamos a largo plazo no estarán dispuestas a correr riesgos concediendo préstamos, por lo que la empresa se verá obligada a recurrir forzosamente a los créditos a corto plazo, por lo que la relación Pasivo-Circulante — Capital será grande y la compañía se verá obligada a pagar sus cuentas muy lentamente.

8.—Activo fijo ÷ Capital.

Esta relación nos muestra hasta dónde los fondos de los propietarios están invertidos en activos fijos, los que en general tienen una baja productividad. Si la relación tiene un valor tan alto que se considere poco satisfactorio, el gerente financiero quizá considere indispensable la venta de acciones comunes para poder hacer frente a las necesidades futuras de capital.

9.—(Activo fijo + Activo diferido) ÷ Capital.

De significado muy semejante al de la relación anterior, nos servirá para tener una idea más precisa de la distribución del capital entre los activos.

III.—ACTIVIDAD.

Todas estas relaciones miden la efectividad del empleo de los recursos para el financiamiento de la empresa. El análisis de la actividad tomando en consideración el grado de "inversión" empleado por la empresa, son los factores determinantes de la productividad.

10.—Ventas anuales ÷ inventario.

Es la rotación de los inventarios, relación que debía calcularse, en mi opinión, tomando como precio para obtener los valores de las ventas y del inventario, el precio de venta.

11.—Ventas ÷ Activo fijo.

La rotación del activo fijo no debe tener un valor superior a dos veces el de la media de la industria que se trate; si así ocurriese la relación es demasiado alta y se requiere adquirir más activo fijo. Si es demasiado baja estará indicando que la empresa tiene una inversión excesiva en activos fijos a menos que se le demuestre sin lugar a dudas que las ventas aumentarán notablemente.

12.—Estimaciones por cobrar X 360 ÷ Ventas. O cuentas X Cobrar X 360 ÷ Ventas.

Esta relación, a la cual podemos llamar velocidad de cobro, nos determina el número de días que en promedio se tarda el cobro de una estimación.

13.—Ventas ÷ Activo total.

La rotación del activo total nos da un índice que pone de manifiesto si los recursos se están utilizando adecuadamente, si se está abusando de ellos o si hay capacidad ociosa. Una relación baja nos está señalando inversiones excesivas, lo que equivale a tener capacidad ociosa. Lo contrario indicará que se requiere una mayor inversión.

IV.—PRODUCTIVIDAD.

La productividad es sólo el resultado de un gran número de políticas practicadas por la empresa. Se emplean varias medidas de productividad, ya que en ella influyen notable-

mente las características de la industria y las prácticas contables de la empresa

14.—Beneficios ÷ Ventas.

Nos mide la utilidad obtenida al vender.

15.—Beneficios ÷ Activo total.

Nos mide la productividad de los recursos empleados en la operación de la empresa. Es la medida empleada por Du Pont para medir y calificar a sus empresas. Se le llama rédito de la inversión.

16.—Beneficios ÷ Capital.

Nos proporciona la medida de la utilidad producida por el capital.

17.—Ventas ÷ Capital.

La rotación del capital, que en realidad es una relación de activos más que de productividad, la incluimos como medida de los esfuerzos promocionales de las empresas.

V.—ESTRUCTURA.

Se han llamado así por reflejar la estructura de los balances de las empresas.

18.— $(\text{Pasivo Circulante} \div \text{Pasivo Fijo}) \div (\text{Activo Circulante} \div \text{Activo Fijo})$.

Es la relación entre las estructuras del Pasivo y del Activo.

19.—Pasivo Fijo ÷ Activo Fijo.

Nos proporciona una idea muy clara de la garantía que tiene el pasivo fijo.

20.—Créditos a largo plazo ÷ Activo total.

Es una relación que complementa la in-

formación proporcionada por la relación 19.

21.—Beneficios ÷ Pasivo total.

Permite al gerente financiero cuantificar la capacidad de la empresa para aumentar sus pasivos a corto o a largo plazo sin poner en peligro la estabilidad financiera de la compañía.

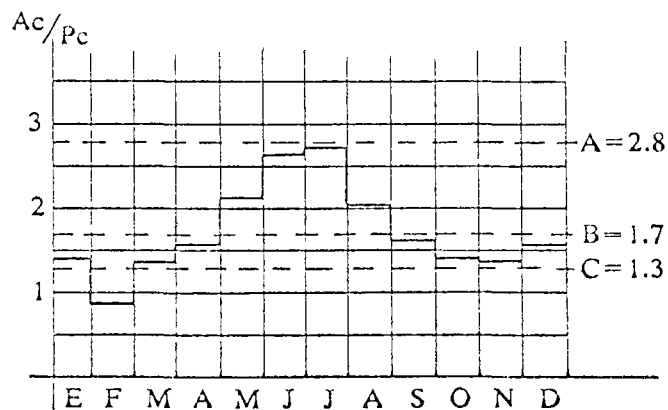
22.—Activo fijo ÷ Activo total.

Nos da una idea clara de la estructura del activo. Esta información complementada con la proporcionada por las relaciones 8, 9 y 11; [Activo fijo ÷ capital, (Activo fijo + diferido) ÷ Capital y Ventas ÷ Activo fijo], nos permitirá definir mejor los límites aconsejables para el activo fijo y conocer si contamos o no con capacidad ociosa o si se requiere una mayor inversión en activos fijos.

Con la experiencia de varios años hemos fijado los límites para cada una de las relaciones, así que la gerencia financiera al contemplar la gráfica correspondiente sabe inmediatamente si algo anda mal, analiza la situación y dicta las medidas necesarias para corregir la irregularidad.

La lámina 16 es la representación gráfica de la relación Activo Circulante entre Pasivo Circulante

LAMINA 16



A New Approach to the Breakeven Chart*

WILLIAM E. ARNSTEIN and EDGAR A. MACK

This article introduces a flexible breakeven chart, one useful in profit planning and control.

Breakeven analysis is not new. Its goal is to focus attention on the relationship among volume, price, and profit. Experience shows, however, that the classic breakeven chart often fails as a working tool for executives. A more helpful technique is therefore needed. But first let us take a close and critical look at the classic chart

We are all familiar with the straight-line breakeven graph. Period costs, variable costs, and sales revenue are charted in relation to volume expressed in units, percent of plant capacity, or sales dollars. Exhibit I is an example of the straight-line breakeven chart.

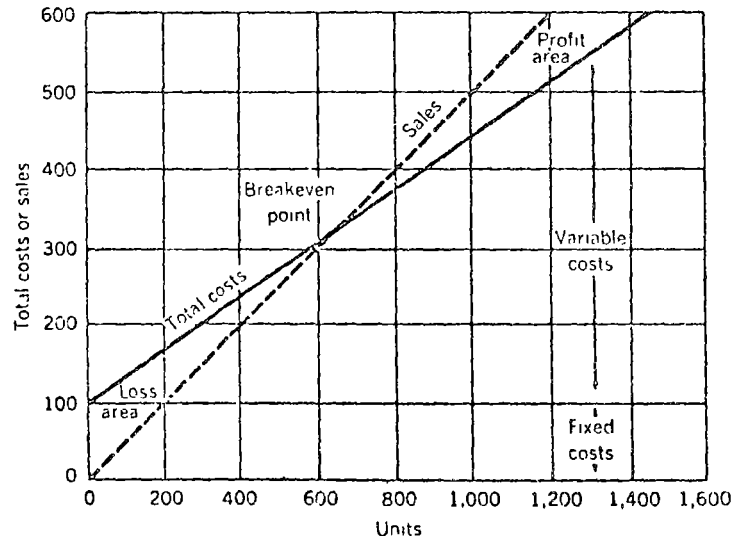
* Reprinted by permission of the publisher from *Management Services*, vol 1, no 1, pp. 60-62, March-April, 1964. Mr. Arnstein is partner in charge of management services, Main Lafrentz & Co., and Mr. Mack is assistant controller of Arwood Corporation, New Jersey office.

A chart of this type necessarily assumes a fixed set of conditions: a given product mix, unit selling prices, and a rate (or level) of marketing expenses. Unfortunately, the classic breakeven chart lends itself to *misuse*, particularly when management fails to clearly understand the underlying assumptions, or fails to remember them.

DANGERS OF CHART

Here is how this chart might be misused—unintentionally—in decision making. A greater and *seemingly* profitable volume is planned, but by means differing from the fixed conditions of the chart—by changing the product mix and emphasizing lines with low profit margins, or by shaving sales prices; or by increasing promotion and advertising expenses. The volume goal is reached, but profits fall far short of the expectations appearing on the chart. The writers are familiar with instances in which the increased volume actually showed lower profits than the original volume.

EXHIBIT I



What should have been done, of course, was to prepare a new breakeven chart reflecting the new assumptions. This only points up another disadvantage of the classic chart—*inflexibility*.

A novel but useful approach to breakeven analysis considers the breakeven point as the percentage markup on *variable* costs required to recover all costs. Note the markup percentage refers to the markup on variable costs, not that related to selling price.

To construct a breakeven chart based on this concept entails four relatively easy steps. The analyst determines period costs, selects several likely levels of variable costs, and computes the relationship of period costs to each variable cost selected. These percentages are the breakeven points, that is, they show the markup on variable costs required to break even. The last step is plotting the percentages on a chart.

Exhibit II illustrates a breakeven chart of this type. In Exhibit II, period costs are \$100,000, and the variable costs range from \$100,000 to \$500,000, in steps of \$20,000. As was to be expected, the breakeven points line up as a curve.

The chart in Exhibit II attains flexibility without danger of unintentional misuse, because it does not assume a fixed set of conditions.

Suppose a company contemplates a different product mix, or buying rather than manufacturing finished products—the breakeven point, and the profitability of a particular level of volume, fluctuates with each contemplated change in conditions. To denote the new breakeven point, etc., a new chart is normally

needed. If more than one change in condition is being considered, several charts are needed. By using the markup on variable costs approach, each new breakeven point can be quickly calculated once the new total of variable costs is known.

The breakeven calculation in Exhibit II has the advantage of not being coupled to sales. It is not necessary to project unit selling price, product mix, and total sales to compute breakeven points. Under the markup approach the total sales required to break even is found afterwards—by applying the markup percentage to forecasted variable costs.

OTHER CAPABILITIES

Exhibit III illustrates a chart showing the markup on variable costs required to earn a *specific* profit. In this example, the planned profit is \$10,000 and the period costs are \$100,000 (as in Exhibit II). The desired profit is built into the required markup by adding profit to period costs before computing percentages.

A chart of this type is not limited to a single profit plan. By simply having several curves on a chart, one chart can show the required markup for *several* profit plans—\$10,000, \$20,000, \$30,000, etc. Similarly, one chart can indicate the required markup for breaking even at several levels of fixed costs. This is especially useful if a rise in fixed costs is anticipated. It is evident then that a single chart can display the required markup for several combinations of profit plans and period costs—and all in

EXHIBIT II

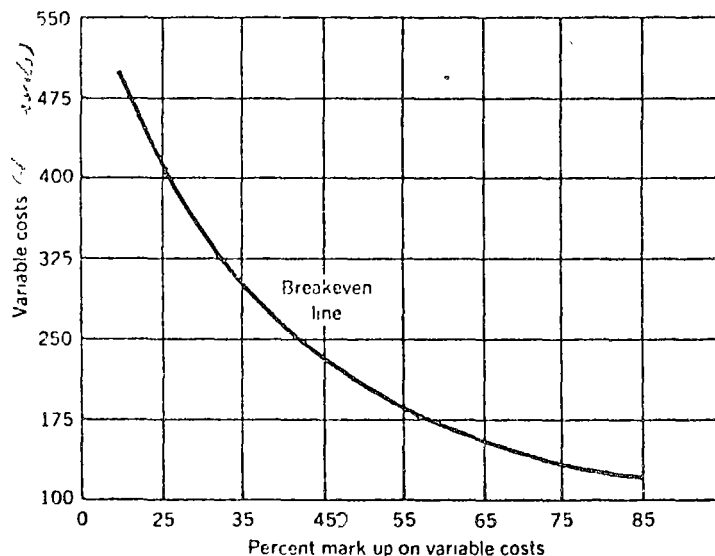
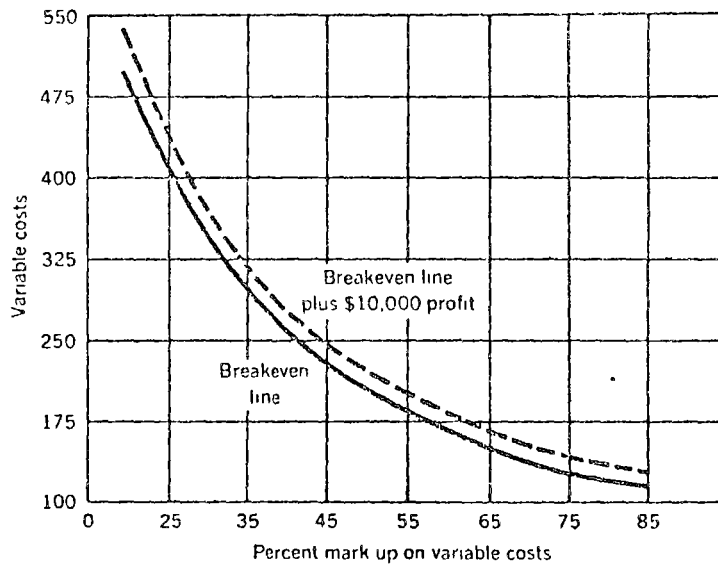


EXHIBIT III



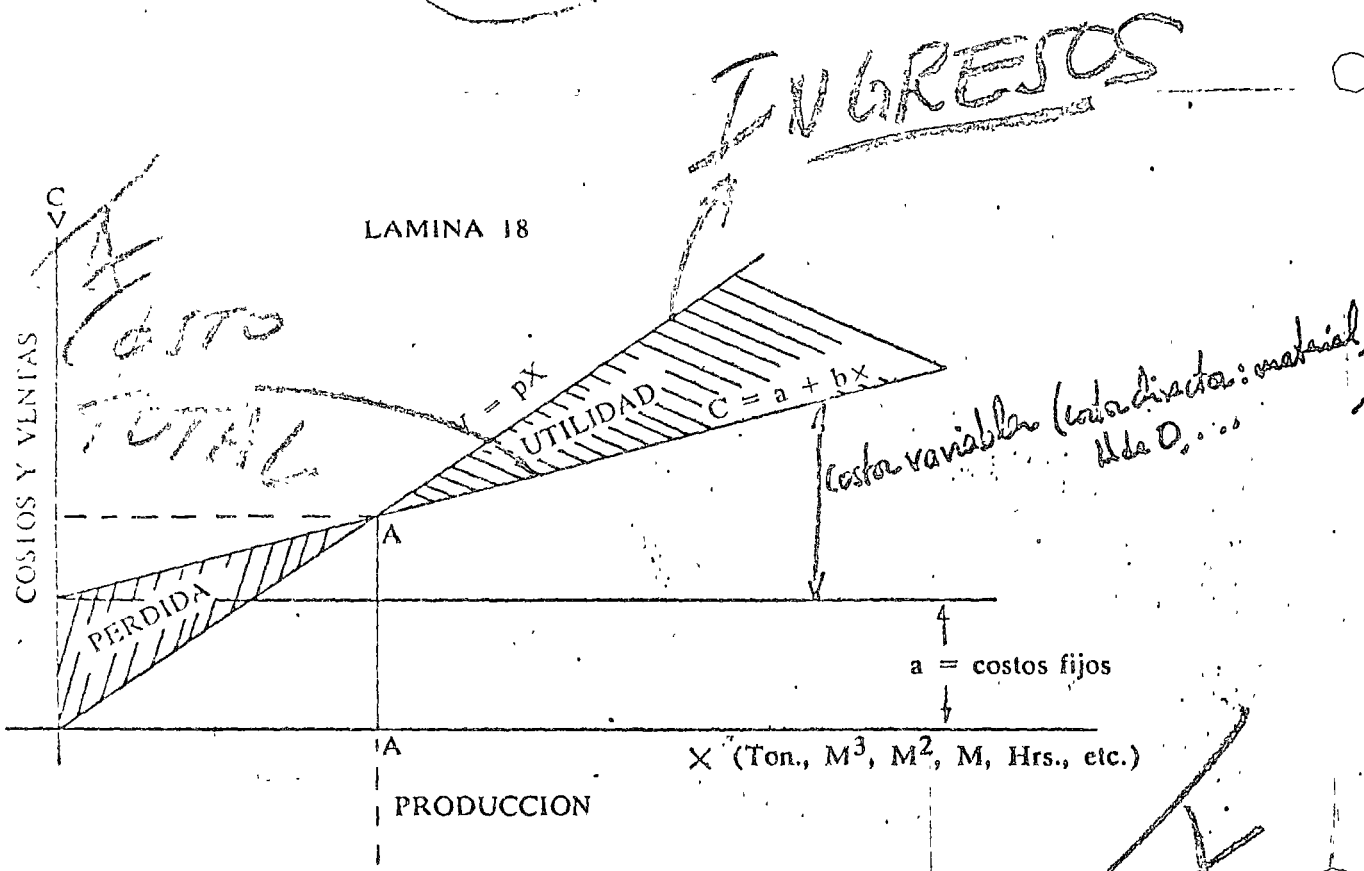
relation to any level of variable costs.

A desirable feature of a multicurve chart is its ability to give information not specifically plotted in it. For example, a chart which shows several profit plans can be used to quickly approximate by interpolation, the required markup for a profit plan not drawn on the chart. Another example is seen in Exhibit III. If fixed costs were to unexpectedly rise 10 percent (the exact relation of projected profit, \$10,000, to fixed costs, \$100,000), then the profit plan curve can be used to determine the markup to break even. If fixed costs were to rise 5 percent, the markup to breakeven can be estimated by interpolation.

The typical breakeven chart is seldom used by executives, either because they don't fully understand it or because they recognize its inherent limitations. With meager control tools for guidance, especially in smaller companies, managers make decisions on experience, on an indefinable "feel" of the business. Sometimes this is enough. More often, however, it is not, and a breakeven chart would help, providing it is easy to use, but not to misuse.

In contrast to the classic breakeven chart—which summarizes a fixed set of assumptions or reports past results—the chart recommended here is a working tool. It is a *reliable* device designed for *continual* use.

LAMINA 18



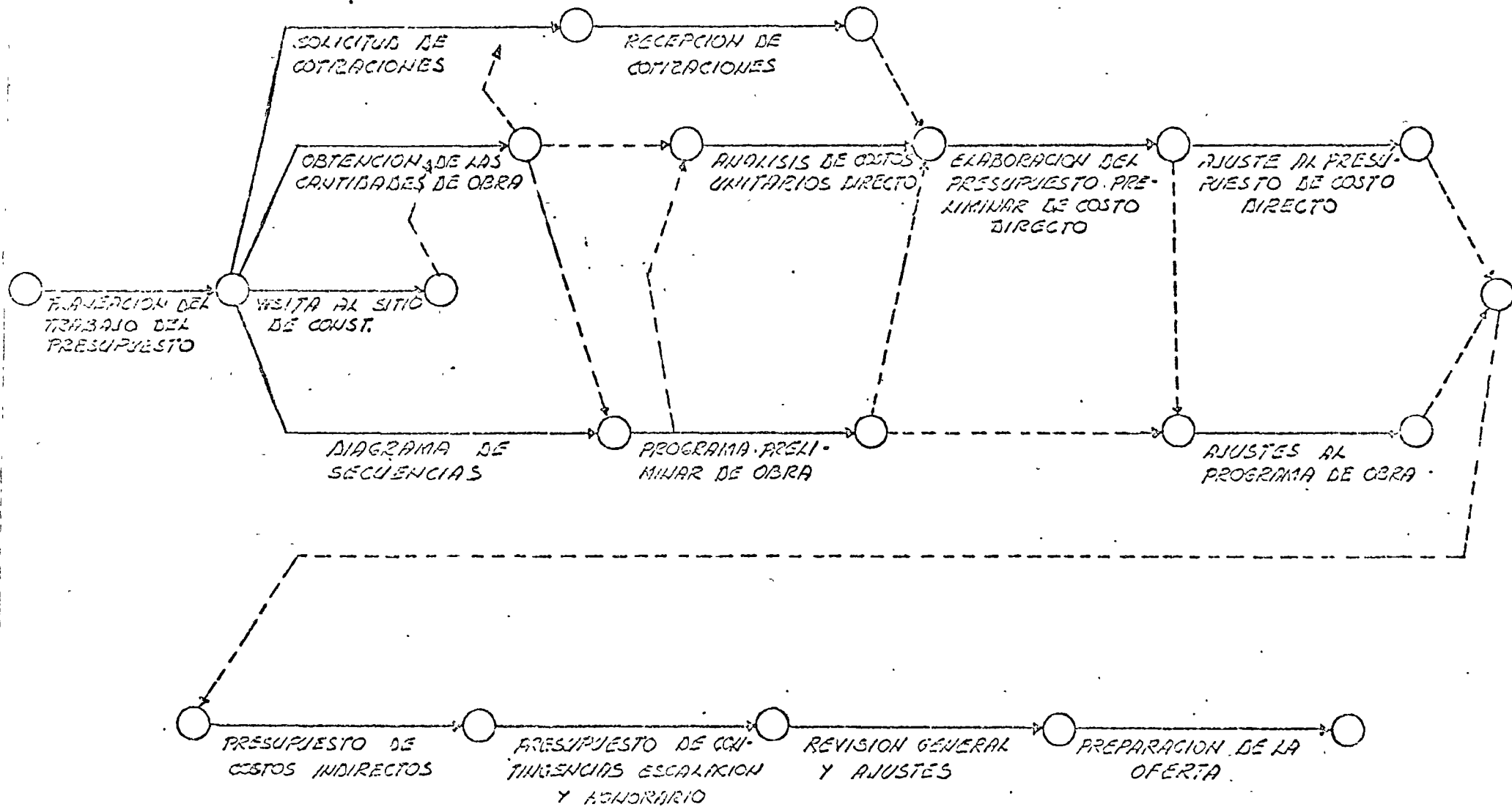


DIAGRAMA DE SECUENCIAS PARA EL CALCULO DE PRESUPUESTOS DE CONSTRUCCION.



IV.- PRESUPUESTOS.

Tanto la exactitud como el alcance de un presupuesto, dependerá fundamentalmente de contar con:

1. El proyecto y las especificaciones respectivas.

Los resultados serán distintos:

a) Si se cuenta con un proyecto completo, con especificaciones claras y precisas, que si sólo se dispone de un anteproyecto.

b) Si se tiene información sobre la forma en que se llevarán a cabo el control de calidad y los sistemas de seguridad.

2. Información del lugar en donde se llevará a cabo la obra acerca de:

a) Condiciones físicas del sitio de la obra: topografía, lugares disponibles para instalaciones provisionales, servicios existentes de electricidad, agua, etc.

b) Materiales: precio, calidad y volumen disponible,

c) Mano de obra: tabulador de salarios, destajos, sindicatos, seguro social, prestaciones varias, etc.

d) Obligaciones fiscales.

e) Condiciones específicas de comunicaciones disponibles, servicios existentes de bancos, alojamiento, talleres mecánicos y refaccionarias, reglamentos locales, etc.

f) Clima: temperatura, lluvias, etc. en las diversas épocas del año.

3. Banco de información de experiencias pasadas.

Resultados obtenidos, identificando los métodos constructivos usados y las condiciones particulares en que se obtuvieron.

4. Tipo de contrato.

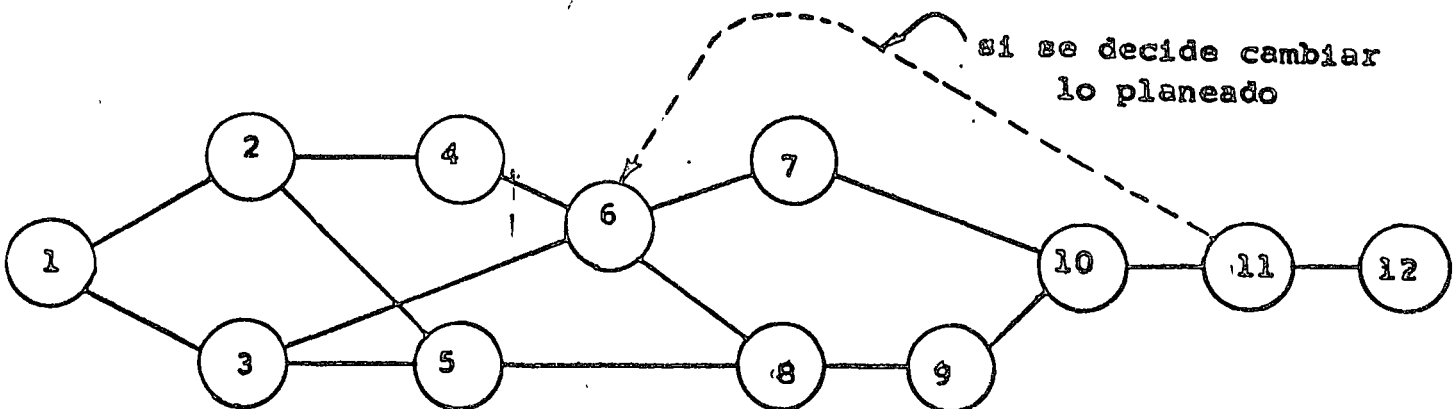
a) Precio alzado

b) Precios unitarios

c) Administración con honorarios fijos

- d) Administración con porcentaje
 - e) Máximo garantizado.
5. Manera de formular, tramitar y pagar estimaciones.
 6. Planeación y programación adecuadas.
Habiendo seleccionado las alternativas de posible ejecución de la obra en forma realista, con respecto a - disponibilidad de recursos, tiempos de ejecución, --- etc.
 7. Tiempo disponible para la elaboración del presupuesto.
 8. Personal calificado con suficiente criterio y expe---riencia profesional.
 9. Publicaciones de tipo estadístico que contengan datos básicos de rendimientos, costos, experiencias, fluc---tuaciones de mercado, etc.
 10. Listados de conceptos de obra, para evitar omisiones y lograr unificación en las especificaciones de los - conceptos que integrarán el presupuesto.
(Estos listados deben estar visualizados en los catá---logos de cuentas).

Los pasos necesarios a dar, recomendables en la elaboración de todo presupuesto, se expresan en el si---guiente diagrama:



1. Estudio del proyecto y especificaciones.
2. Visita al lugar de la obra.
3. Obtención de conceptos y cantidades de obra.
4. Fase I de la ruta crítica.
5. Solicitud y recepción de cotizaciones.
6. Planteamiento y selección de alternativas de métodos de construcción.
7. Obtención de fase II.
8. Análisis de precios unitarios.
9. Obtención de presupuesto preliminar de costos directos.
10. Determinación de gastos indirectos, imprevistos y utilidad.
11. Uso de la fase III ruta crítica.
12. Elaboración de la proposición definitiva.

En general es muy conveniente contar con formatos previamente diseñados para cada una de las etapas que aparecen en el diagrama anterior, con el objeto de facilitar y uniformizar el trabajo, evitar omisiones, etc.

Con el objeto de ilustrar lo anterior se muestran algunos usados por alguna empresa constructora.

Existen ciertos conceptos que tienen una interpretación generalizada aunque cada institución, los debe fijar según convenga a sus intereses y a sus políticas. Tales conceptos son:

Costos directos: Los constituyen todas las erogaciones que se ocasionan por la realización física de la obra: materiales, mano de obra, equipo y herramienta, instalaciones, etc.

Costos indirectos: Los constituyen los gastos generales que se efectúan en la obra y que no se incluyen en los costos directos por la imposibilidad de rela-

cionarlos directamente con algún concepto de obra en particular.

Imprevistos: Son las erogaciones que son imposibles prever. Generalmente se expresan como un tanto por ciento de los costos directos.

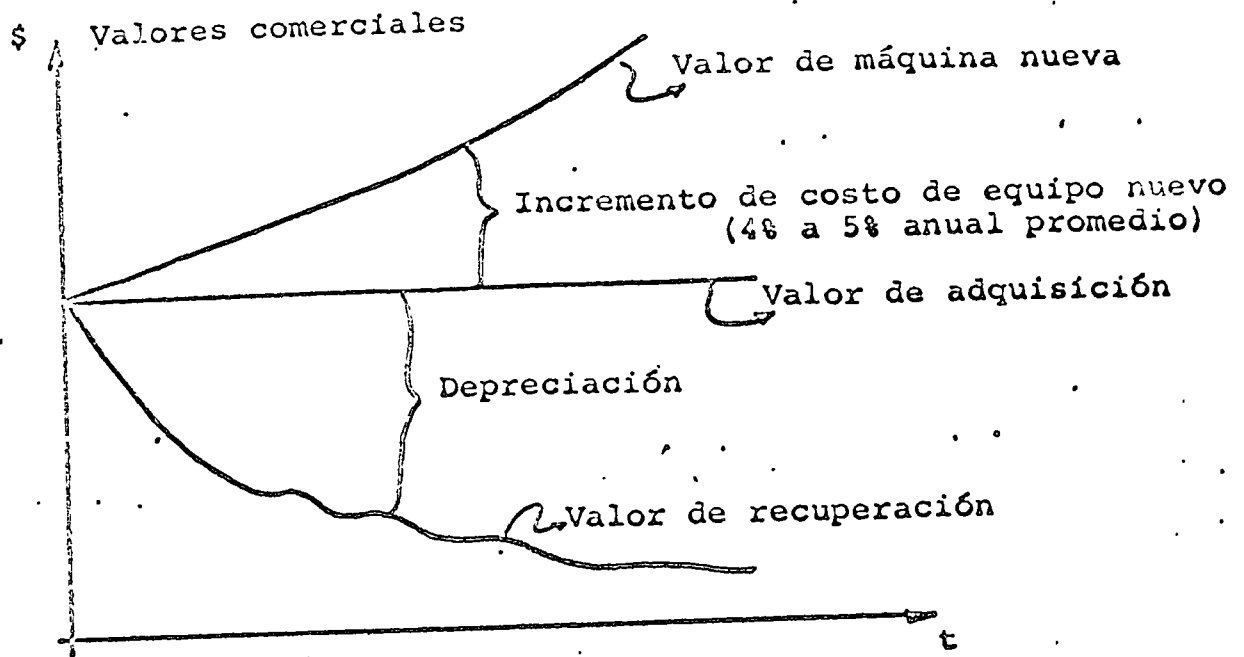
Utilidad: Es la ganancia que se percibe por la ejecución de la obra.

Es conveniente en el cálculo de los costos directos seguir ciertos lineamientos como los que se enlistan a continuación:

1. El análisis del costo unitario deberá siempre referirse a la unidad en que se expresa el concepto de obra respectivo.
2. Incluir los desperdicios de materiales que se crea se tendrán en la obra.
3. Tener muy presente el método de construcción, las condiciones de trabajo y el tiempo previsto para la realización de lo que se está analizando.
4. Cuando se tiene urgencia de la entrega de la propuesta, es aconsejable jerarquizar las partidas y conceptos de obra, en función de su volumen, su costo, su conocimiento o incertidumbre de ejecución, etc. con el objeto de distribuir el tiempo disponible de la manera más convenientemente posible.
5. Calcular desde un principio el costo de conceptos básicos que intervienen en diversos análisis, como son morteros, acarreos, etc., con el objeto de evitar duplicidad de trabajo.

Para el cálculo de los costos indirectos es necesario contar, al igual que para los directos, con un listado de conceptos, que desde luego también debe estar visualizado en el catálogo de cuentas.

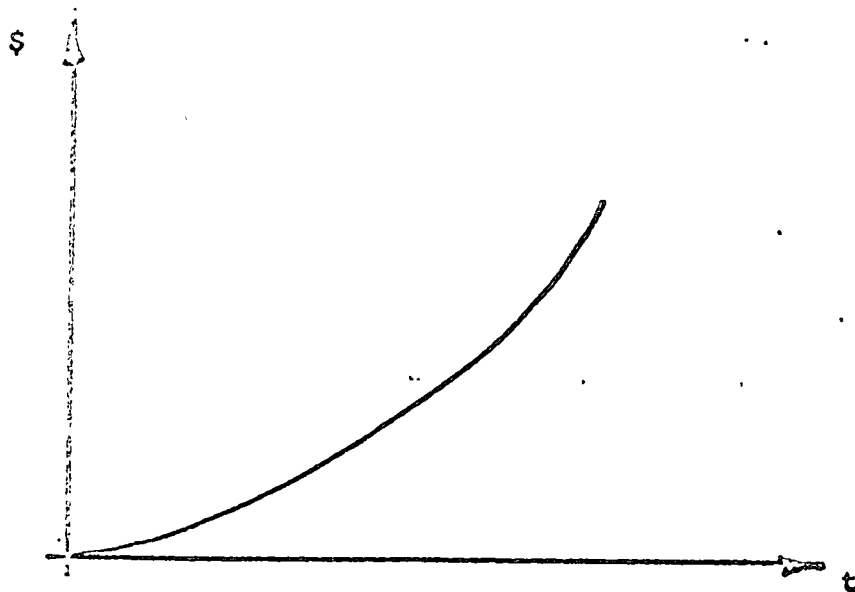
En caso de que la oferta sea aceptada, toda la información que se ha descrito, junto con el contrato correspondiente, deberá facilitarse al responsable de la realización de la obra para que éste se entere de los compromisos adquiridos y aproveche todo el trabajo reali-



1. Depreciación: Es importante no confundir la depreciación comercial con la depreciación fiscal o contable

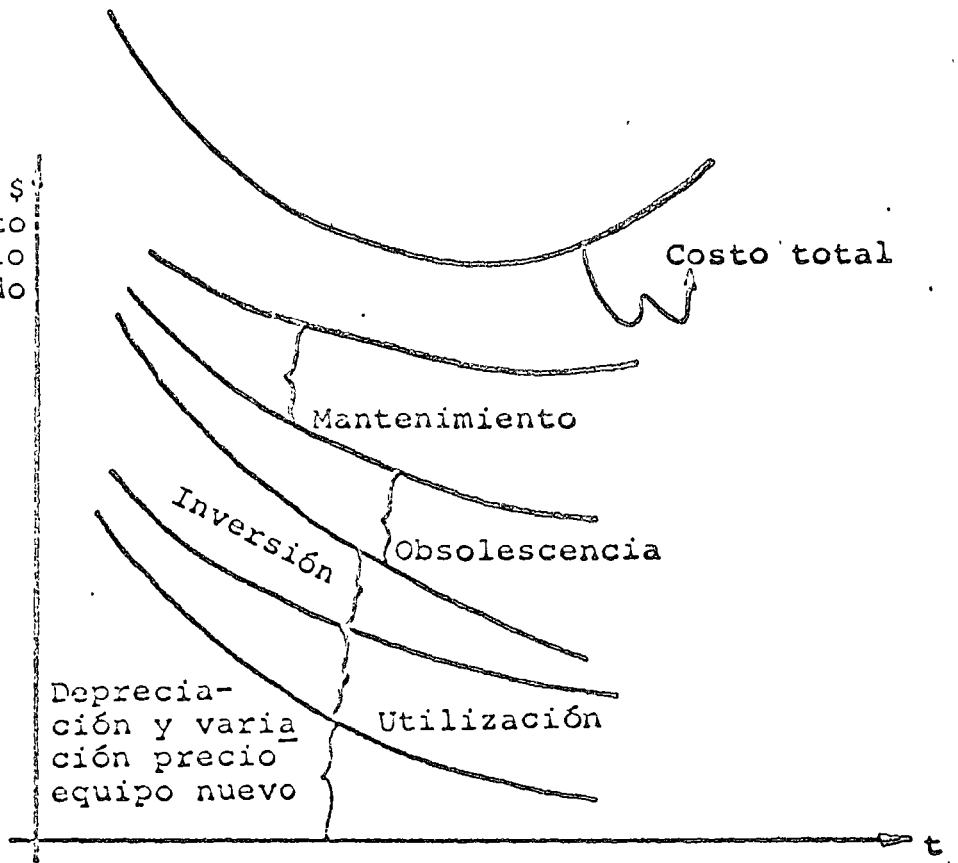
2. Variación en el precio del equipo

3. Utilización: En este punto se involucra la vida de la máquina, horas paradas, etc.

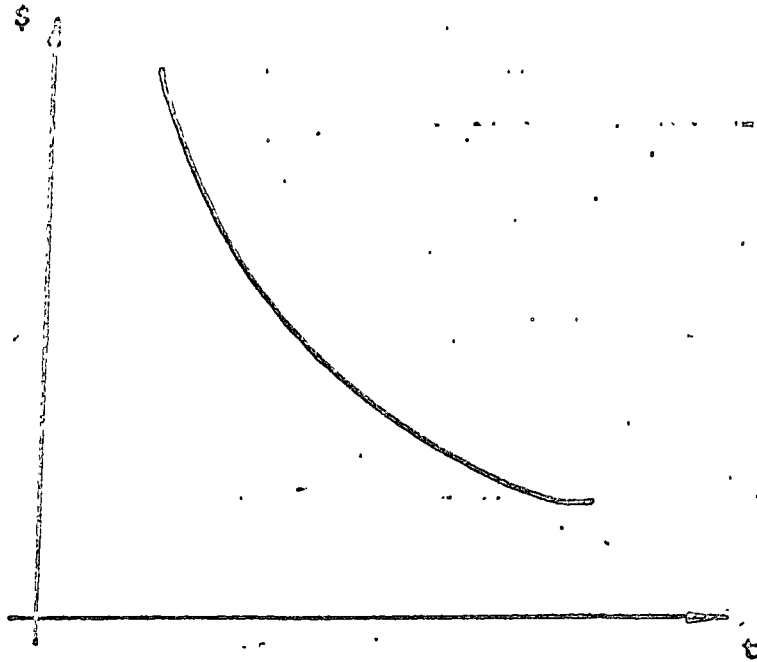


Resumen

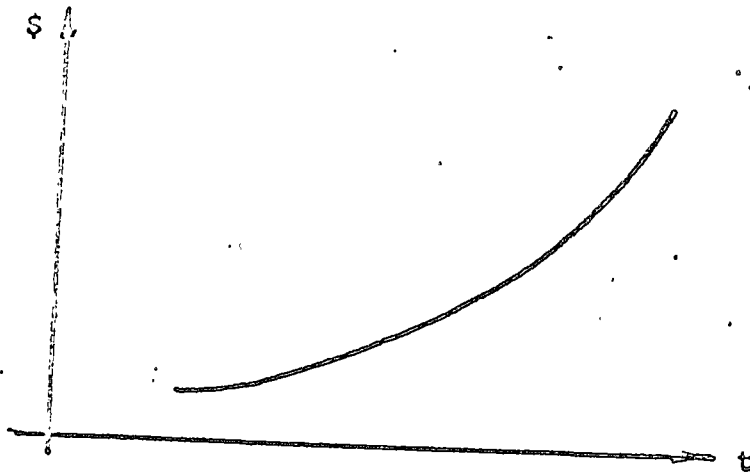
\$
Costo
Promedio
Acumulado



4. Inversión: Es función del capital invertido y la tasa de interés



5. Obsolescencia: Debido a la mejoría continua del equipo nuevo $\approx 5\%$ anual



6. Mantenimiento



Dado: Se quiere proyectar una carretera de dos carriles con un tránsito diario inicial (TDI) = 1000 vehículos, cuya distribución se muestra en los ejemplos de tránsito vistos en el capítulo 2. de estas rutas, se espera un crecimiento anual del tránsito de 10%. La carga legal límite por eje sencillo es de 13500 lb (97kn.). Se quiere ejecutar el NTD para un periodo de diseño de 20 años.

De acuerdo al análisis de tránsito, considerando para el carril de diseño el 50% del tránsito total, se usara 259 vehículos pesados en el carril de diseño y un peso promedio de estos vehículos de 34000 lb., con estos datos hemos subido hasta el paso 6) de la secuencia de cálculo continuaremos en el paso 7).

En la gráfica de análisis de tránsito se localiza en la escala C el punto correspondiente a 259 vehículos pesados y en la D el correspondiente a 34000 lb. A continuación se unen esos dos puntos con una recta, la que se prolonga hasta la escala B, donde se localiza el punto pivote. En seguida, se localiza en la escala E, el punto correspondiente a 13500 lb., y uniendo este punto con el pivote, con una recta la que se prolonga hasta la escala A, se lee el NTI de 180.

3. Como el NTI > 10, no requiere concesión por automoviles o vehículos ligeros.

3. Periodo de diseño = 20 años

4. Crecimiento anual esperado = 10%

11. Factor de ajuste del NTI.

$$\text{Factor} = \frac{(1+0.10)^{19}}{20 \times 0.10} = 2.86$$


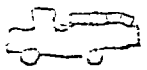


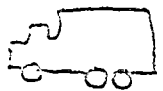

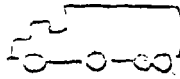
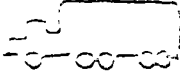
3. El número de tránsito de diseño sera: $\text{NTD} = 180 \times 2.86 = 515$

Comparando los dos procedimientos: para $m = 20$ años y $r = 10\%$
El tránsito acumulado es:

análisis detallado = $C \times T_0 = 20.000 \times 220^* = 4.420.000$ ejes de 18000.

análisis rápido = $515 \times 20 \times 365 = 3.760.000$ ejes de 18000

La diferencia se debe a la diferencia de precisión de cada procedimiento.

TIPO DE VEHICULO		DISTRIBUCION DEL TRANSITO		PESO POR VEHICULO		VEHICULOS	A+B
				TON	LB	MAYORES DE 15000	
A _p		VACIOS	-	-	-	-	-
		CARGADOS	275	2.0	4400	-	-
A _c		VACIOS	88	2.4	5290	-	-
		CARGADOS	38	4.9	10790	-	-
B		VACIOS	-	-	-	-	-
		CARGADOS	105	12.5	27530	105	2'890650
C ₂		VACIOS	82	4.2	9250	-	-
		CARGADOS	140	9.3	20480	140	2'867200
C ₃		VACIOS	22	6.9	15200	22	354400
		CARGADOS	85	16.6	36560	85	3'107.600
T2S1		VACIOS	5	9.1	20,040	5	100,200
		CARGADOS	20	18.8	41,410	20	828200
T2S2		VACIOS	15	11.3	24890	15	373350
		CARGADOS	55	24.6	54190	35	2'980450
T3S2		VACIOS	15	13.9	30620	15	459300
		CARGADOS	55	29.9	65860	55	3'622300

$\Sigma = 517 \quad \Sigma = 17'563'650 \text{ lb.}$

NUMERO DE VEHICULOS PESADOS EN EL CARRIL DE DISEÑO = $\frac{517}{2} = 259$

PESO PROMEDIO DE VEHICULOS PESADOS = $\frac{17'563'650}{517} = 33972 \approx 34000$

517

zado en la planeación, programación y elaboración de presupuestos.

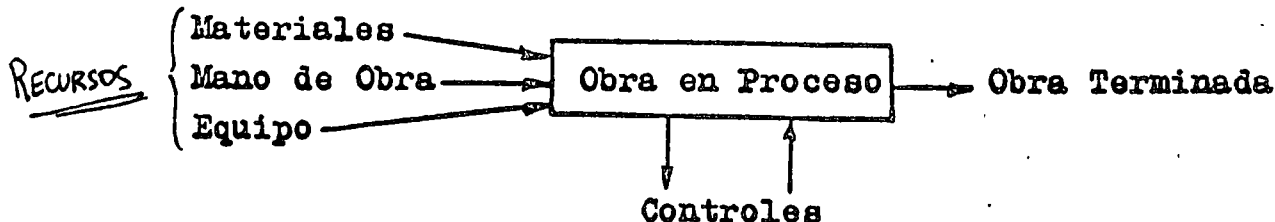
V.- CONTROL.

Dada la complejidad intrínseca de la construcción, la cantidad de imponderables, el monto de dinero que se maneja, etc., se considera que la etapa de control es vital para este tipo de actividad, ya que no es posible esperar algún tiempo después del término de una obra, para saber si se lograron o no los objetivos previstos, sino que será indispensable revisar a todo lo largo del desarrollo de la obra si lo que inicialmente planeamos, programamos y presupuestamos fue correcto o se está cumpliendo, con el objeto de hacer oportunamente las correcciones, cambios de política, etc., que sean pertinentes. En otras palabras, el control no es más que un sistema de alarma que permite detectar cuando algo no funciona según lo previsto.

En general existen tres tipos de control:

1. Administrativo (presupuesto)
2. De avance de obra (programa)
3. De calidad (especificaciones)

Los tres constituyen propiamente un sistema de retroalimentación, ya que los resultados que se van obteniendo en el proceso de la obra, se comparan con el "estándar" previsto. (Es obvio que la calidad del control será función de los "estándares" de comparación que son presupuesto, programa y especificaciones).



Como fuente de información básica para los dos primeros controles será necesario contar con el avance - de obra a determinada fecha, expresado en por ciento del volumen total para cada partida de obra pre-establecida.

Es recomendable determinar con cuidado el grado de control que se quiera establecer para cada obra, ya - que un control exageradamente detallado será innecesario y costoso, y viceversa, un control exageradamente superficial no cumplirá con los objetivos propios para los - que se establecen los sistemas de control.

CONSTRUCORA "X"

Balance General al 31 de diciembre de 1967

ACTIVO

PASIVO

ACTIVO CIRCULANTE:

Caja	\$ 10,144.78	
Bancos	<u>76,430.75</u>	\$ 86,575.53
Clientes	154,441.35	
Documentos por cobrar	50,000.00	
Obras y terrenos	32,950.00	
Inventarios	7,850.00	
Deudores diversos	12,049.30	
Bonos y valores	5,000.00	
Menos:		
Cuentas incobrables	<u>19,350.00</u>	\$ 242,440.65

ACTIVO FIJO:

Terranos	\$ 45,000.00	
Edificio	150,000.00	
Maquinaria y equipo	261,700.00	
Equipo de transporte	26,000.00	
Muebles y enseres	20,418.50	
Otros activos	<u>45,000.00</u>	548,118.50
Menos:		
Depreciación acumulada	<u>119,280.44</u>	\$ 428,838.06

ACTIVO DIFERIDO O CARGOS DIFERIDOS:

Gastos anticipados	\$ 6,149.29	
Gastos de instalación	<u>9,459.15</u>	\$ 15,608.44

Suma el Activo: \$ 773,462.68

PASIVO CIRCULANTE:

Proveedores	\$ 37,544.11	
Documentos por pagar (corto plazo)	5,000.00	
Acreedores diversos	154,424.18	
Otros pasivos	<u>8,558.00</u>	\$ 205,526.29

PASIVO FIJO:

Documentos por pagar (largo plazo)	\$ 94,460.00	
Otros pasivos	<u>3,000.00</u>	\$ 97,460.00

CAPITAL

Capital	{ Acciones: 300,000.00 Utilidades retenidas: <u>110,870.00</u>	\$ 410,870.00
Utilidad del Ejercicio		<u>59,606.39</u> \$ 470,476.39

Suma el Pasivo y Capital:

\$ 773,462.68

Cuentas de orden.



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TECHNICAL REPORT # 51, STANFORD UNIVERSITY.



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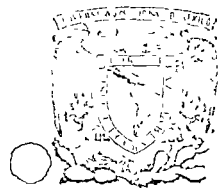
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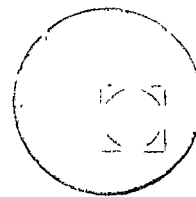
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facultad de ingeniería, unam



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ING. EDGAR FERNANDEZ GOMEZ
BUFETE INDUSTRIAL
SUB-DIRECTOR DE PROGRAMACION
ESTIMACION Y COSTOS
Tolstoi No. 22
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ING. JOSE CASTRO ORVAÑANOS
INVESTIGADOR DEL INSTITUTO DE INGENIERIA
U. N. A. M.



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 5. ING. JOSE BONILLA RAMIREZ
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<u>NOMBRE Y DIRECCION</u>	<u>EMPRESA Y DIRECCION</u>
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9. ING. CARLOS LUIS COUCHONNAL MIRANDA FF. CC. de Cuernavada 208-Depto. 8 Col. Polanco México 5, D. F.	CONSTRUCCIONES, CONDUCCIONES Y PAVI- MENTOS, S. A. Minería No. 145 Col. Escandón México 18, D. F. Tel: 5-40-32-53
10. ING. RAUL CUEVAS BUITRON Joaquín Clausel No. 27 México, D. F. Tel: 5-62-78-56	DE LA BORRA INGENIEROS CIVILES, A.P. Rio Mixcoac No. 25-6o. Piso México, D. F. Tel: 5-24-87-83 y 5-24-88-06
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NOMBRE Y DIRECCION

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24. ING. FRANCISCO JOSE GUZMAN CAMPUZANO
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25. ING. EVANGELINA SARA HURTADO DE MENDOZA
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<u>NOMBRE Y DIRECCION</u>	<u>EMPRESA Y DIRECCION</u>
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30. ING. JUAN MERIDA DOMINGUEZ Norte 72-A No. 5814-4 México 14, D. F.	PETROLEOS MEXICANOS Av. Marina Nacional No. 329 México, D. F. Tel: 5-31-63-20
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DIRECTORIO DE ASISTENTES AL CURSO DE PROGRAMACION, PRESUPUESTO Y CONTROL DE OBRAS (DEL 14 DE ENERO AL 27 DE FEBRERO DE 1974)

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<u>NOMBRE Y DIRECCION</u>	<u>EMPRESA Y DIRECCION</u>
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46. ING. RAUL ZOLA GOMEZ Retorno 5 de Av. Taller No. 23 México 8, D. F. Tel: 5-52-17-86	SECRETARIA DE RECURSOS HIDRAULICOS Paseo de la Reforma No. 69-8o. P. México, D. F. Tel: 5-35-28-15

L SUB CONTRATOS	TOTAL	DESCRIPCION	T O T A L			TOTAL
			LABOR	MATERIAL	SUB CONTRATOS	
	39,000	9643 MAT. DE DIBUJO		500		500
	15,000	9644 COPIAS			1500	1,500
	6,000	9645 RENTA INMUEBLES			-	--
	--	9646 INST. PROVISION.			14410	14,410
	--	9648 RTA. EQ. Y MAQ. (BI)			7000	7,000
	--	9649 RTAS. EQ. OFNA. BI			5300	5,300
	10,000	9651 REP. MEN. Y REFAC.			420	420
	11,600	9652 REP. MAY. Y REFAC.				
		9653 LUZ, FUERZA Y AGUA			5000	5,000
	5,000	9654 EFECTOS, UTILES -				
	--	DE ESCRITORIO		1200		1,200
	--	9655 COMUNICACIONES			200	200
	--	9656 GTOS. DE VIAJE			1500	1,500
	--	9657 HIGIENE Y SEGUR.		1000	300	1,300
	--	9658 CUOTAS SINDICALES			2000	2,000
3 883	3,883	9659 FLETES Y ACARREOS				--
11 364	11,364	9660 RELAC. PJB. Y AT.			1000	1,000
		9661 C. DE CALIDAD Y				
	947	PRUEBAS.				--
	-	9662 HERR. CONSUMIBLE				--
3 883	3,883	9663 HERR. MENORES				--
		9664 MAT. DE CONSUMO		1300		1,300
		9666 OTR. IMPTOS. DER.	Incluidos	por separado		-
	8,600	9667 SEG. DE DAÑOS				
10 000	10,000	9668 SEG. Y FIANZAS	No incluidos			-
	-					
30 077	125,277	SUB-TOTAL 9643 - 9668		4000	33 630	37,630
		T O T A L	94 700	4500	68 707	167,907

BUFETE INDUSTRIAL

HOJA DE ESTIMADO
GASTOS INDIRECTOS

PROYECTO Nº _____ REVISION Nº _____
ESTIMADO POR _____ REV. POR _____
Nº DE CUENTA _____ HOJA 1 DE 1

REV. 1 AL CATALOGO DE CUENTAS - MAYO 26, 1972



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