Charting and Diagramming Techniques for Operations Analysis

Chapter 9

Sections:

1. Overview of Charting and Diagramming Techniques
2. Network Diagram
3. Traditional Engineering Charting and Diagramming Techniques

- Operation Charts
- Process Charts
- Flow Diagram
- Activity Charts

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Objectives of Charts and Diagrams

1. To permit work processes to be communicated and comprehended more readily
2. To use algorithms specifically designed for the particular diagramming technique
3. To divide a give work process into its constituent elements for analysis purposes
4. To provide a structure in the search for improvements
5. To represent a proposed new work process or method

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How to Analyze the Chart or Diagram

- Algorithmic analysis
  - Line balancing (e.g., calculation of the minimum number of workstations and cycle time), critical path methods (e.g., calculation the longest path time in network diagram)
- Checklists
  - General questions applied to the particular process to assess whether they can be applied to the problem of interest
- Brainstorming
  - Team activity in which participants contribute recommendations
- Separating value-added and non-value-added operations

- value-added are operations that: (1) the customer considers important
(2) Physically change the product or service

- Non-value-added operations are such as : rework, delays, unnecessary inspections and unnecessary moves.

Categories of Charts and Diagrams

1. **Network diagrams**
2. **Traditional industrial engineering charts and diagrams**
   - Operation charts
   - Process charts
   - Flow diagrams
   - Activity charts
3. Block diagrams and process maps

1. Network Diagrams (Precedence diagram)

- Consist of:
  - **Nodes** representing operations, work elements, activities or other entities
  - **Arrows** connecting the nodes indicate relationships among the nodes
    - Direction of work flow between nodes
    - Precedence among nodes
  - Used to represent
    - Work elements in assembly line balancing
    - Sequences of processing operations
    - Work activities in Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT).
- Two-way flows (movement of materials):
  Maximum number of arrows = $n(n-1)$
- One-way arrows (precedence):
  Maximum number of arrows = $\frac{n(n-1)}{2}$

n is the number of nodes in the diagram

Example Network Diagrams Applications

Sequential Operations in Industry OR services:

- Manufacturing (e.g., sequences of assembly process for the products between the workstations in a factory).
- Medical services (e.g., a surgery patient is first admitted and then move to a waiting room before arriving the operation room).
- Transportation (e.g., unloading the products from truck before transport them to the warehouse and then move the products to the shops)

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Network Digrams Patterns

- **Pure sequential –** all work units follow the same exact sequence of operations and workstations
  - Work flow is identical for all work units

- **Mixed sequential –** different work units are processed through different operations
  - Different work flows for different types of work units

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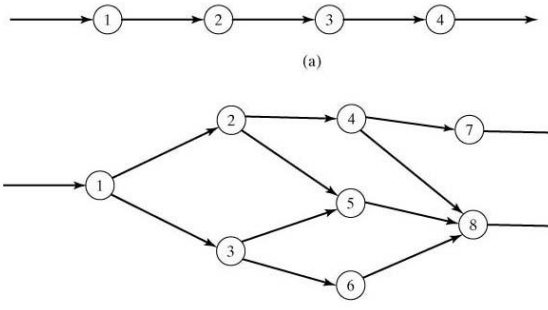
Work Flow Patterns

Network diagrams representing (a) pure sequential work flow and (b) mixed sequential work flow



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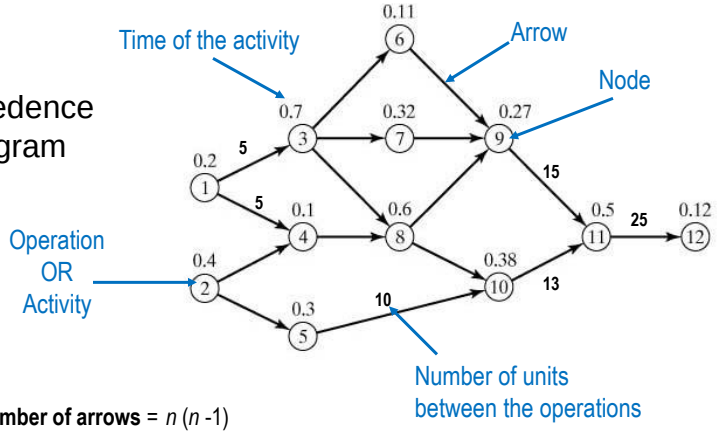
Network Diagram - Precedence Constraints

- Restrictions on the order in which work elements can be performed

Precedence diagram



Maximum number of arrows = $n(n-1)$
$= 12(12-1) = 132$ arrows

2.Traditional IE Charts and Diagrams

- Operation charts
- Process charts
- Flow diagrams
- Activity charts

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Operation Charts

Graphical and symbolic representation of the operations used to produce a product

- Two types of operations:
  1. Processing and assembly operations (Symbol, ○ OR Letter O)
     - Changing the shape, properties or surface of a material or workpart
     - Joining two or more parts to form an assembly
  2. Inspection operations (Symbol, □ OR Letter I)
     - Checking the material, workpart, or assembly for quality or quantity

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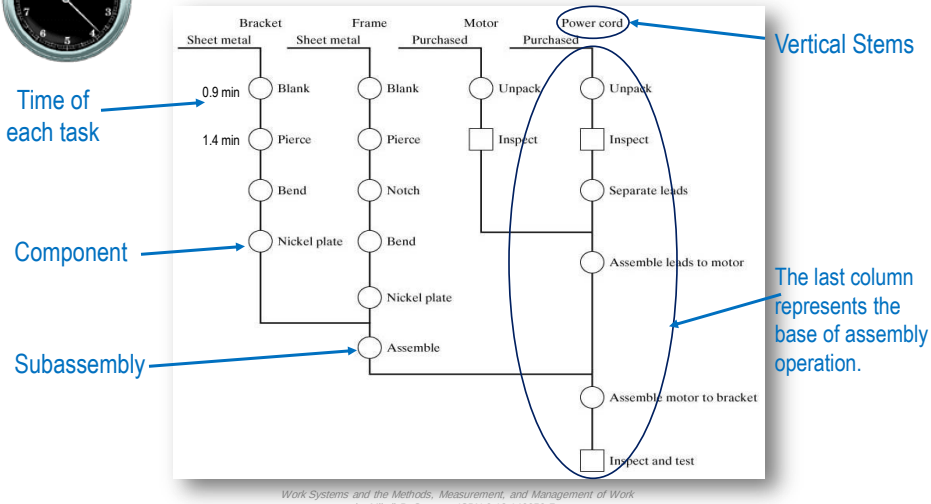
Operation Chart for Subassembly of a Product



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Checklist of Questions Used to Analyze an Operation Chart

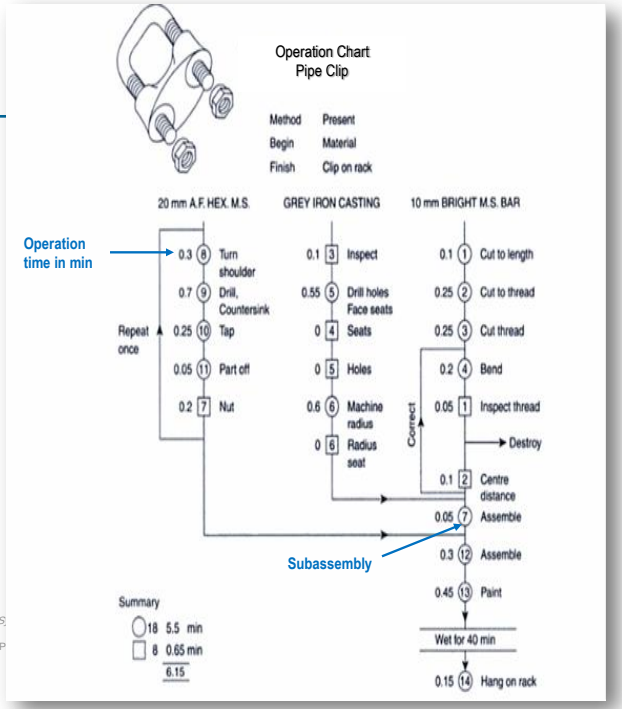
- The focus of the operation chart is on the materials of a product and the operations on them

- **Questions related to material**
  - What alternative starting material could be used?
  - Make or buy decision: should the part be produced in the factory or purchased?

- **Questions related to operations**
  - Is this processing operation necessary?
  - Can this operation be eliminated, combined, or simplified?
  - Could a different joining method be used?

- **Questions related to inspection**
  - Is this inspection necessary?
  - Could the inspection task be automated?

Example: Operation Chart for a Pipe Clip manufacturing



Wild R., (2003) "Work & work methods". Operation Management , (Thomson Learning Ltd, Oxford), pp. 188-209.

Process Charts

- Graphical and symbolic representation of the processing activities performed on something or by somebody
- The chart using various symbols to represent operations, inspections, moves, delays and other activities.

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Process Charts (Cont.)

- **Principal types of process charts:**

1. **Flow process chart** – analysis of a material or workpiece being processed
2. **Worker process chart** – analysis of a worker performing a task
3. **Form process chart** – analysis of the processing of paperwork forms

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Flow Process Chart

Uses five symbols to detail the work performed on a material or workpart as it is processed through a sequence of operations and activities (see table 9.3, textbook page:238):

- **Operation** – processing of a material
- **Inspection** – check for quality or quantity
- **Move** – transport of material to new location
- **Delay** – material waiting to be processed or moved
- **Storage** – material kept in protected location

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Flow Process Chart

1- Flow Process Chart: The chart uses 5 symbols to analysis and detail the work performed on a material or work part through a sequence of operations and other activities.

TABLE 9.3 Symbols Used in the Flow Process Chart

Symbol[a]	Letter	Description
○	O	***Operation***, usually a processing operation performed on the material at one location or workstation in which the physical shape or chemical characteristics of the material are changed. Assembly operations are unusual in a flow process chart.
□	I	***Inspection***, either to check for quality or quantity, performed at a single location or workstation.
→	M	***Move*** that involves transport of the material from one location to another, but not including moves within an operation at a workstation.
D	D	***Delay*** that occurs when the material does not or cannot proceed to the next activity—for example, a material waiting to be processed at a workstation, but other materials are ahead of it.
▽	S	***Storage*** in which the material is kept in a protected location to prevent unauthorized removal. Storage usually involves the use of a requisition to withdraw from storage, whereas a delay does not involve such a transaction.

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(see Textbook, Table 9.3, Page:238)

Flow Process Chart (Cont.)

- If the processing **operation** combined with an **inspection** at the same workstation: combine symbols - a circle inside a square ◯

- The chart also indicates **distances** for move activities and **time** values for other activities

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Example: Type of flow process chart: Material flow process chart

Type of task or name of operation: Forging processed (metal manufacturing processing)

Flow Process Chart

Part No. 459011	Material: Steel C1045 forging	Description: Forgings processed in batches of 20			
Seq.	Activity Description	Symbol	Time	Distance	Analysis Notes
1	Forgings transported from forge shop	→		300 m	Forklift truck
2	Inspection of incoming forgings	□	1 hr		
3	Forgings moved and placed in storage	→		75 m	Hand truck
4	Storage	∇	7 days		Factory warehouse
5	Forgings retrieved from storage	→		75 m	Hand truck
6	Transport to machine shop	→		180 m	Forklift truck
7	Move to milling machine	→		20 m	Hand truck
8	Delay in queue for milling machine	D	5 hr		
9	Milling operation (roughing and finishing)	○	8 min/pc		Milling Machine No. 573
10	Move to drill press	→		20 m	Hand truck
11	Delay in queue for drill press	D	2 hr		
12	Drilling and tapping operations (6 holes)	○	3 min/pc		CNC Drill Press No. 226
13	Delay waiting for inspection	D	4 hr		
14	Inspection for machining operations	□	0.2 hr		
15	Delay waiting for transport to cleaning	D	3 hr		
16	Transport to finishing department	→		75 m	Forklift truck
17	Move to cleaning operation	→		10 m	Hand truck
18	Delay in queue for cleaning operation	D	30 min		
19	Cleaning operation (all parts in batch)	○	10 min		Solvent clean tank
20	Move to nickel plate operation	→		15 m	Hand truck
21	Delay in queue for nickel plate operation	D	45 min		
22	Nickel plate operation (all parts in batch)	○	20 min		Electroplating tank
23	Delay waiting for transport to storage	D	30 min		
24	Transport to storage	→		200 m	Forklift truck
25	Storage awaiting assembly	∇			Factory warehouse

Flow Process Chart

2- Worker Process Chart: The chart is used to analysis the activities of a human worker as he or she performs a task that requires movement around a facility.

TABLE 9.5 Symbols Used in the Worker Process Chart

Symbol	Letter	Description
○	O	***Operation*** performed by a worker at a single location or workstation. The operation may involve movements of materials within the workstation.
□	I	***Inspection***, either to check for quality or quantity, performed by a worker at a single location or workstation.
→	M	***Move*** in which the worker moves from one location to another as a regular element required in the task. It does not include moves within a workstation.
D	D	***Delay*** of the worker. Worker is forced by the situation to wait (e.g., waiting for an elevator). The waiting may involve moving, but the move is not a regular element required in the task (e.g., worker goes to the coffee machine while waiting for the elevator).

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(see Table 9.5, Page:242)

Flow Process Chart

3- Form Process Chart: The chart is used to analyze the flow of paper-work and office procedures that normally involve the processing of documents .

TABLE 9.6 Symbols Used in the Form Process Chart

Symbol	Letter	Description
◎	C	***Creation*** of the form (circle in a circle). This symbol is used for the origination of the form, when the form is first initiated.
○	O	***Operation*** performed on the form at a single location or workstation. The operation may involve calculations, data entries, filling out forms, folding, photocopying, stapling, assembling multiple forms into one document, etc.
□	I	***Inspection*** to read information from the form or check for correctness performed at a single location or workstation.
→	M	***Movement*** of the form from one location to another by mail or human carrier.
D	D	***Delay*** of the form. Form is waiting to be worked on, located in an in-basket or similar location other than a storage file.
▽	S	***Storage*** in a file, normally in a file cabinet or other organized filing system. This usually involves storage for a considerable time period, rather than a temporary delay.
X	X	***Disposal*** of the form. The form or a copy is destroyed.

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(see textbook, Table 9.6, Page:242)

Standard Form for Flow Process Chart

Date:	Flow Process Chart				Page ___ of ___
Analyst:	Approval:	Summary of Activities			
Job:	Part No:	Activity (symbols)	Count	Time	Distances
Material:		Operations (○, O)			
Description:		Inspections (□ , I)			
		Moves (→, M)			
		Delays (D, D)			
		Storages (∇, S)			

Seq.	Activity Description	Symbol	Time	Distance	Analysis Notes
1					
2					
3					
4					
5					
6					

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Standard Form for Flow Process Chart (Other form)

Flow Process Chart				Worker/Material/Equipment Type			
Chart No. 2	Sheet No.						
Subject charted:		Activity		Present	Proposed	Saving	
		Operation	○				
Activity:		Transportation	⇨				
Method: Present/Proposed		Delay	D				
Location: *Receiving Dept.*		Inspection	□				
Operative(s):	Clock No.	Storage	▽				
See *Remarks column*		Distance (m)					
		Time (work-h)					
Charted by:	Date:	Cost					
		Labor					
Approved by:	Date:	Material					
		Total					

Description	Qty. 1 Case	Dist-ance (m)	Time (min)	Symbol ○	⇨	D	□	▽	Remarks
Total									

Checklist of Questions Used to Analyze a Flow Process Chart

- **Questions Related to Material**
  - Make or buy decisions: Should the part be produced in the factory or purchased from an outside vendor?
- **Questions Related to Operations and Inspections**
  - Is the operation time too high?
  - Is the inspection operation necessary?
- **Questions Related to Moves**
  - How can moves be shortened or eliminated by combining or eliminating operations?
  - Can the level of mechanization in material handling be increased?
- **Questions Related to Delays**
  - Is the delay avoidable?
  - What is the reason for the delay? Can the reason be eliminated?
- **Questions Related to Storage**
  - Is the storage necessary?
  - Why can't the material be move immediately to the next operation?

Example of Flow Process Chart (Material Process Chart)

Flow process chart — ~~Worker~~ /Material/~~Equipment~~ type

Chart No. 1 Sheet No. 1 of 1

Subject charted: *Used bus engines*

Activity: *Stripping, cleaning and degreasing prior to inspection*

Method: Present/~~Proposed~~

Location: *Degreasing shop*

Operative(s): Clock Nos. *1234, 571*

Charted by: Date:

Approved by: Date:

Summary	Present	Proposed	Saving
Operation ○	4		
Transport ⇨	21		
Delay D	3		
Inspection □	1		
Storage ▽	1		
Distance (m)	237.5		
Time (work-min.)	—	—	—
Cost	—		
Labour	—		
Material	—		
Total	—	—	—

Description	Qty.	Distance (m)	Time (min.)	Symbol ○ ⇨ D □ ▽	Remarks
Stored in old-engine store					
Engine picked up					*Electric crane*
Transported to next crane		*24*			*Electric crane*
Unloaded to floor					
Picked up					*Electric crane*
Transported to stripping bay		*30*			*Electric crane*
Unloaded to floor					
Engine stripped					
Main components cleaned and laid out					
Components inspected for wear; inspection report written					
Parts carried to degreasing basket		*3*			
Loaded for degreasing					
Transported to degreaser		*1.5*			*Hand crane*
Unloaded into degreaser					
Degreased					
Lifted out of degreaser					*Hand crane*
Transported away from degreaser		*6*			*Hand crane*
Unloaded to ground					
To cool					
Transported to cleaning benches		*12*			*By hand*
All parts cleaned completely					
All cleaned parts placed in one box		*9*			*By hand*
Awaiting transport					
All parts except cylinder block and heads loaded on trolley					
Transported to engine inspection section		*78*			*Trolley*
Parts unloaded and arranged on inspection table					
Cylinder block and head loaded on trolley					
Transported to engine inspection section		*78*			*Trolley*
Unloaded to ground					
Stored temporarily awaiting inspection					
Total		*237.5*		*4 21 3 1 1*	

Flow Diagram

Drawing of the facility layout with the addition of lines representing movement of materials or workers within the facility

- Arrows on the lines represent direction of movement
- Often used in conjunction with a process chart
- Can be used to detect excessive backtracking, which might be missed in a process chart

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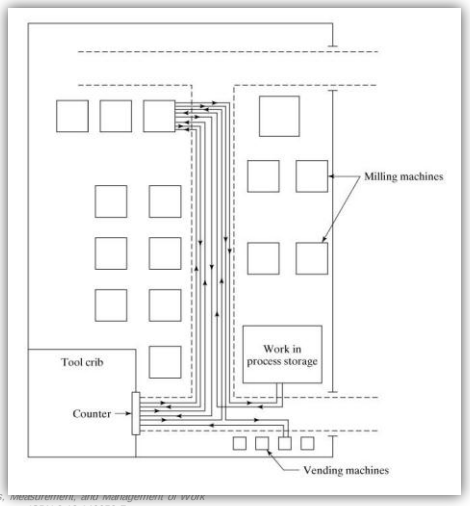
Example: Flow Diagram

Flow diagram for worker setting up a milling machine

Note the large number of trips back and forth between the milling machine and the tool crib



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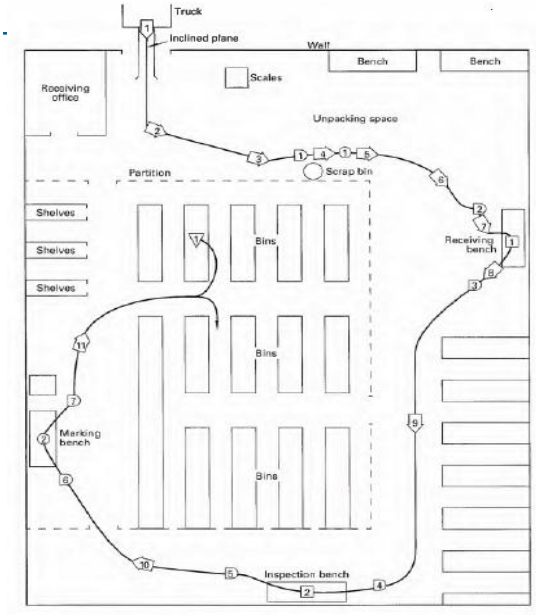
Description	Qty. 1 case	Distance (m)	Time (min.)	Symbol	Remarks
Lifted from truck: placed on inclined plane		1.2			2 labourers
Slid on inclined plane		6	10		2 labourers
Slid to storage and stacked		6			2 labourers
Await unpacking		–	30		
Case unstacked		–			
Lid removed: delivery note taken out		–	5		2 labourers
Placed on hand truck		1			
Trucked to reception bench		9	5		2 labourers
Await discharge from truck		–	10		
Case placed on bench		1	2		2 labourers
Cartons taken from case: opened:					
checked replaced contents		–	–15		Storekeeper
Case loaded on hand truck		1	2		2 labourers
Delay awaiting transport		–	5		
Trucked to inspection bench		16.5	10		1 labourer
Await inspection		–	10		Case on truck
Tee-pieces removed from case and cartons:		1	20		Inspector
inspected to drawing: replaced					
Await transport labourer		–	5		Case on truck
Trucked to numbering bench		9	5		1 labourer
Await numbering		–	15		Case on truck
Tee-pieces withdrawn from case and		–	15		Stores labourer
cartons: numbered on bench and replaced					
Await transport labourer		–	5		Case on truck
Transported to distribution point		4.5	5		1 labourer
Stored					
Total		56.2	174	2 11 7 2 1	

1. **Lifted from truck: placed on inclined plane**
2. **Slid on inclined plane**
3. **Slid to storage and stacked**
4. **Await unpacking**
5. **Case unstacked**
6. **Lid removed: delivery note taken out**
7. **Placed on hand truck**
8. **Trucked to reception bench**
9. **Await discharge from truck**
10. **Case placed on bench**
11. **Cartons taken from case: opened: checked replaced contents**
12. **Case loaded on hand truck**
13. **Delay awaiting transport**
14. **Trucked to inspection bench**
15. **Await inspection**
16. **Tee-pieces removed from case and cartons: inspected to drawing: replaced**
17. **Await transport laborer**
18. **Trucked to numbering bench**
19. **Await numbering**
20. **Tee-pieces withdrawn from case and cartons: numbered on bench and replaced**
21. **Await transport laborer**
22. **Transported to distribution point**
23. **Stored**

Example Material Process Chart:
Receiving and inspecting aircraft parts



Flow process chart — ~~Worker~~/Material/~~Equipment~~ type

Chart No. 4 Sheet No. 1 of 1

Subject charted: *Case of BX 487 tee-pieces (10 per case in cartons)*

Activity: *Receive, check, inspect and number tee-pieces and store in case*

Method: ~~Present~~/Proposed

Location: *Receiving Dept.*

Operative(s): Clock No. *See Remarks column*

Charted by: Date:

Approved by: Date:

Summary

Activity	Present	Proposed	Saving
Operation ○	2	2	–
Transport ⇨	11	6	5
Delay D	7	2	5
Inspection □	2	1	1
Storage ▽	1	1	–
Distance (m)	56.2	32.2	24
Time (work-h)	1.96	1.16	0.80
Cost per case			
Labour	$10.19	$6.03	$4.16
Material	–	–	–
Total	$10.19	$6.03	$4.16

Description	Qty. 1 case	Distance (m)	Time (min.)	Symbol ○	⇨	D	□	▽	Remarks
Crate lifted from truck; placed on inclined plane		1.2							2 labourers
Slid on inclined plane		6	5						2 labourers
Placed on hand truck		1							2 labourers
Trucked to unpacking space		6	5						1 labourer
Lid taken off case		–	5						1 labourer
Trucked to receiving bench		9	5						1 labourer
Await unloading		–	5						
Cartons taken from case; opened and tee-pieces placed on bench; counted and inspected to drawing		–	20						Inspector
Numbered and replaced in case									Stores labourer
Await transport labourer		–	5						
Trucked to distribution point		9	5						1 labourer
Stored		–	–						
Total		32.2	55	2	6	2	1	1	

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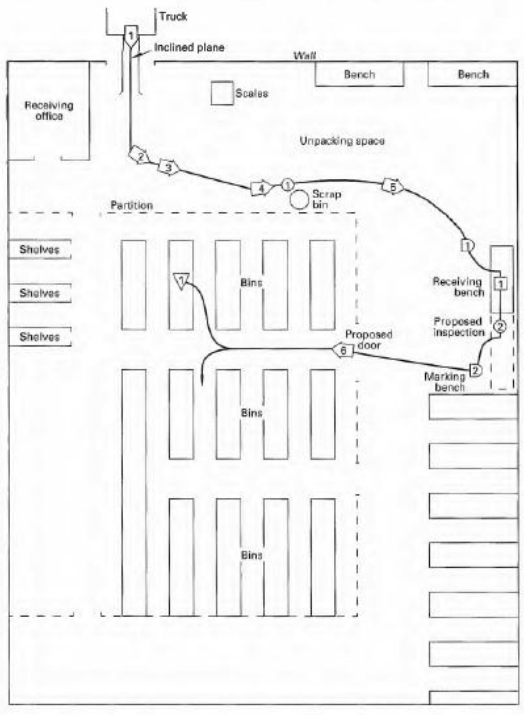
1. **Case lifted from truck: placed on inclined plane**
2. **Slid on inclined plane**
3. **Placed on hand truck**
4. **Trucked to unpacking space**
5. **Lid taken off case**
6. **Trucked to reception bench**
7. **Await unloading**
8. **Cartons taken from case: opened and tee-pieces placed on bench: counted and inspected to drawing**
9. **Numbered and replaced in case**
10. **Await transport laborers**
11. **Trucked to distribution point**
12. **Stored**



Activity Charts

A listing of the activities of one or more subjects (e.g., workers, machines) plotted against a time scale to indicate graphically how much time is spent on each activity

- Types of activity charts:
  - Right-hand/left-hand activity chart (a.k.a. workplace activity chart)
  - Worker-machine activity chart
  - Worker-multimachine activity chart
  - Gang activity chart (a.k.a. multiworker activity chart)

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Activity Charts (cont.)

- The usual format of ***activity chart*** is to provide a brief descriptions of the activities against a vertical scale for a single worker perfuming a repetitive work cycle.
- In activity chart is used a ***vertical lines*** or ***bars*** instead of using ***symbols*** for the work activities.
- The lines or bars are ***shaded*** or ***colored*** to indicate the kind of activity.

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Activity Chart

Activity chart for a worker performing a repetitive task

Activity Description	Chart	Activity Time (min)	Cumulative time (min)
Pick up plate from tote pan.		0.05	0.05
Carry plate to drill press and load.		0.07	0.10
Activate press.		0.03	0.15
Semiautomatic machine cycle.		0.20	0.20
			0.25
			0.30
			0.35
Remove plate.		0.03	
Carry to pallet container.		0.05	0.40
Place in pallet container.		0.02	0.45
Walk to tote pan.		0.05	0.50

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Shading Formats for Activity Charts

Shading	Color	Activity
Black	Blue	***Operation***: Performing an operation. Worker operating on or handling material at workplace. Machine performing an operation on automatic or mechanized cycle.
Gray	Yellow	***Inspection***: Worker performing an inspection, to check for either quantity or quality.
White (blank)	White (blank)	***Idle time***: Worker or machine is idle, waiting, or stopped.
Diagonal lines	Green	***Moving***: Worker walking outside immediate workplace (e.g., to fetch tools or materials).
Horizontal lines	Red	***Holding***: Worker holding an object in fixed position without performing any work on it.

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Activity Charts (Cont.)

1- Right-hand/left-hand activity chart (workplace activity chart):

- This chart details the contribution of the right and left hands of one worker performing a task that is highly repetitive.
- The task usually performed at a single workplace so this chart is called also, ***workplace activity chart***

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Example: Right-Hand/Left-Hand Activity Chart

Task involves placing pegs into a peg board

Note that left hand is used as a workholder

Left Hand	Time (min)	Right Hand	Cumulative time (min)
Pick up board	0.08		0.08
Hold board	0.06	Pick up peg and insert	0.14
Hold board	0.06	Pick up peg and insert	0.20
Hold board	0.06	Pick up peg and insert	0.26
Hold board	0.06	Pick up peg and insert	0.32
Hold board	0.06	Pick up peg and insert	0.38
Hold board	0.06	Pick up peg and insert	0.44
Hold board	0.06	Pick up peg and insert	0.50
Hold board	0.06	Pick up peg and insert	0.56
Put assembly in tote pan	0.06		0.62

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Activity Charts (Cont.)

2- Worker-machine activity chart *(Only one machine)*:

- This chart shows how the work elements and associated times are allocated between a worker and machine for the repetitive cycle of worker-machine system.
- The chart consists of ***two main columns***, one for the worker and the other for the machine.

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Example: Worker-Machine Activity Chart

- Finish small mill casting on a vertical miller machine
- Original method

Worker		Time	Machine 1		Time	Cum. Time (min)
Walk to tote pan		0.13		idle		0.13
Pick up raw workpart and transport to machine		0.23				0.36
Load workpart and engage automatic cycle		0.12				0.48
			Machine cycle		0.75	1.23
Unload finished part from machine		0.10				1.33
Transport part and deposit in tote pan		0.15				1.48

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Example: Worker-Machine Activity Chart

- Finish small mill casting on a vertical miller
- Proposed method

Worker		Time	Machine 1		Time	Cum. time
Unload finished part from machine		0.10				0.10
Load raw part, engage auto cycle		0.12				0.22
Transport finished part, deposit in tote pan, walk to raw parts tote pan, pick up and transport to machine		0.51	Machine cycle		0.75	**0.97**

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Activity Charts (Cont.)

3- Worker-multimachine activity chart:

- This chart is similar to the Worker-machine activity chart expect that the worker is responsible for more than one machine.
- The work cycle must be developed that minimize or eliminates the ***machine interference***.

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Example: Worker-Multimachine Activity Chart

Can be used to indicate *machine interference* (when a machine must wait for service because worker is currently servicing another machine)

Worker	Time (min)	Machine 1	Time	Machine 2	Time	Cumulative time (min)
Walks to machine 1	0.2					
Services machine 1	0.3	Idle	0.3			0.5
Walks to machine 2	0.2	Automatic cycle				
Services machine 2	0.3			Idle	0.3	1.0
				Automatic cycle		
	0.5					1.5
Walks to machine 1	0.2		1.2			
Services machine 1	0.3	Idle	0.3			2.0
Walks to machine 2	0.2	Automatic cycle			1.2	
Services machine 2	0.3			Idle	0.3	2.5
Idle				Automatic cycle		
	0.5					3.0
Walks to machine 1	0.2		1.2			
Services machine 1	0.3	Idle	0.3			3.5
Walks to machine 2	0.2	Automatic cycle			1.2	
Services machine 2	0.3			Idle	0.3	4.0

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Activity Charts (Cont.)

4- Gang activity chart (multiworker activity chart):

- This chart tracks the activities of two or more workers performing together as a team.
- The purpose of the activity chart analysis is to better coordinate the activities and balance the workload among the workers.

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String Diagram

- Movement of workers and material

- **Examples in manufacturing:**
  - Material fed to/removed from continuous process, and is stored around the process.
  - An operative is looking after two or more machines.
  - Laborers are delivering materials to or removing work from a series of machines or workplaces.
- **Examples Outside manufacturing operations:**
  - In stores/shops where materials are being removed from or put away into racks or bins.
  - In restaurant/canteen kitchens during preparation of meals.
  - In control laboratories where routine tests are carried out.

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String Diagram (Cont.)

- The **string diagram** is a scale plan or model on which a thread is used to trace and measure the path of workers, material or equipment during a specified sequence of events
- The string diagram is mostly used for studying workers' movement.
- The work study person observes the movement of a worker over enough period of time. The observations may be recorded in a simple movement study sheet. Then, the string diagram can be constructed.

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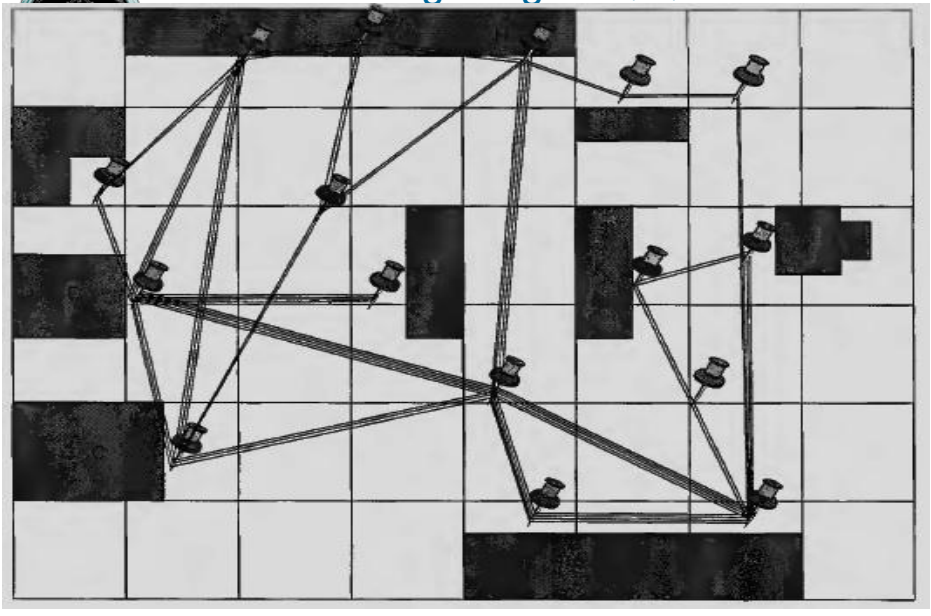
String Diagram (Cont.)

A simple movement study sheet

Movement study sheet

Chart No. *1* Sheet No. *1 of 2*			Operative(s):	
Operation: *Transport biscuit tiles*				
from inspection to storage			Charted by:	
bins and unload into bins			Date:	
Location: *Biscuit warehouse*			Cross-reference: *String diagrams*	
				1 and 2
1 Time dep.	2 Time arr.	3 Time elapsed	4 Move to	5 Notes
			Inspection bench (I) *to Bin 4* *I 13* *I 5* *I 32* *I 18*	

String Diagram (Cont.)



String Diagram (Cont.)

- The **examination** of the diagram and the **development** of the new layout can now proceed with templates being used and the pins and templates being moved around until an arrangement is found by which the same operations can be performed with a minimum movement between them.

- The string diagram is a useful aid in explaining proposed changes to management, supervisors and workers.

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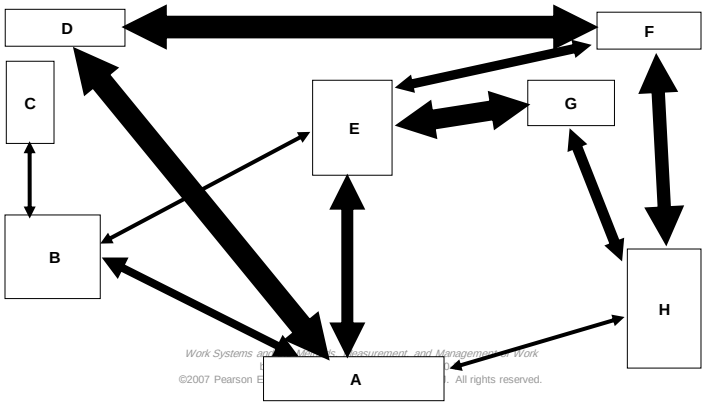
String Diagram (Cont.)

Example of a string diagram:
Moving through several locations
(Original Method)



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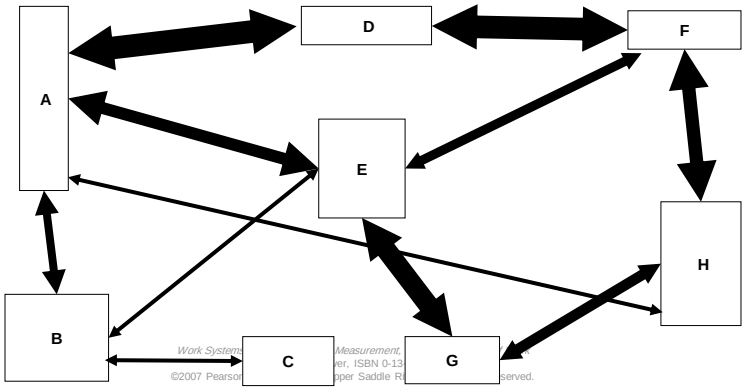
String Diagram (Cont.)

Example of a string diagram:
Moving through several locations
(Improved Method)



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