Chapter 20

IMPROVING PRODUCTIVITY AND PERFORMANCE

State of the Industry

- The serious decline in U.S. construction industry productivity during the 1960s and 1970s led the Business Roundtable to conduct its Construction Industry Cost Effectiveness (CICE) study.
- This study, completed in 1982, was probably the most comprehensive study ever made of the U.S. construction industry.

State of the Industry

- Although the study found that the U.S. construction industry faced a number of problems in remaining competitive in the international construction market, it concluded that the majority of problems could be overcome by improved management of the construction effort.

- At the project management level, the study discovered inadequate management performance in a number of areas which include:
  - construction safety,
  - control of the use of overtime,
  - training and education,
  - worker motivation and
  - failure to adopt modern management systems.

What is Productivity?
"Productivity" means the output of construction goods and services per unit of labor input.

Tools for Better Management

- A number of studies, including the CICE study, have shown that most on-site delays and inefficiencies lie within the control of management.
- Management is responsible for planning, organizing, and controlling the work.
- If these management responsibilities were properly carried out, there would be few cases of workers standing idle waiting for job assignment, tools, or instructions.
- One of the major tools for improving construction productivity is work improvement; that is, the scientific study and optimization of work methods.

- Workers' physical capacity, site working conditions, morale, and motivation are important elements in determining the most effective work methods and the resulting productivity for a particular task.
- Other techniques available to assist the construction manager in improving construction productivity and cost-effectiveness include:
  - network planning methods,
  - economic analyses,
  - safety programs,
  - quantitative management methods (linear programming),
  - simulation, and the use of computers.

WORK IMPROVEMENT

- An important component of work improvement is preplanning, that is, detailed planning of work equipment and procedures prior to the start of work.
- 1. Physical models and traditional work improvement techniques may be used in the preplanning process.
- Traditional work improvement techniques include:
  - 2. Time studies,
  - 3. Flow process charts,
  - 4. Layout diagrams,
  - 5. Flow diagrams, and
  - 6. Crew balance charts

1. Physical models

- Models are often used for large and complex projects such as power plants, dams, and petrochemical process plants to check physical dimensions, clearance between components, and general layout.
- Computer graphics and computer-aided design (CAD) can perform similar functions faster and at lower cost than can physical models or other manual techniques.

1. Physical Models

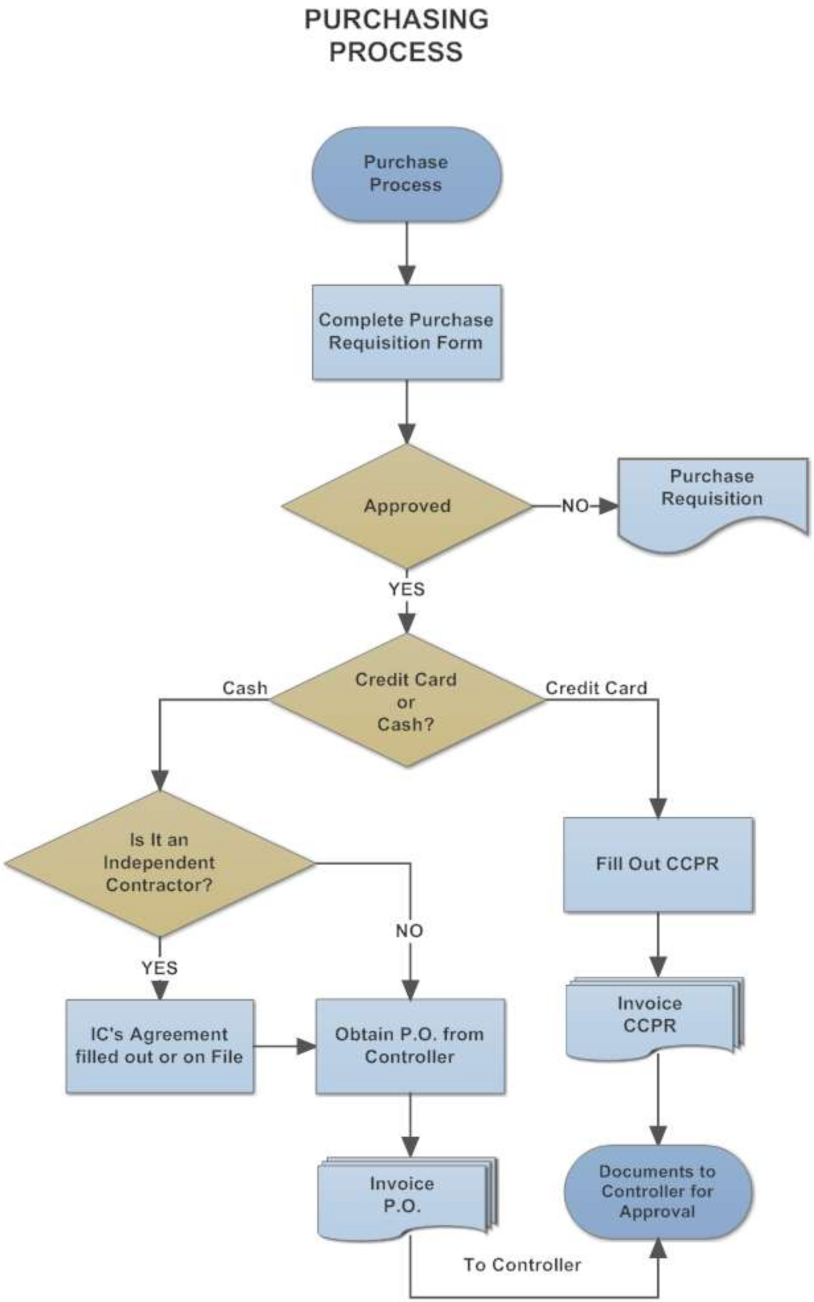
2. Time Studies

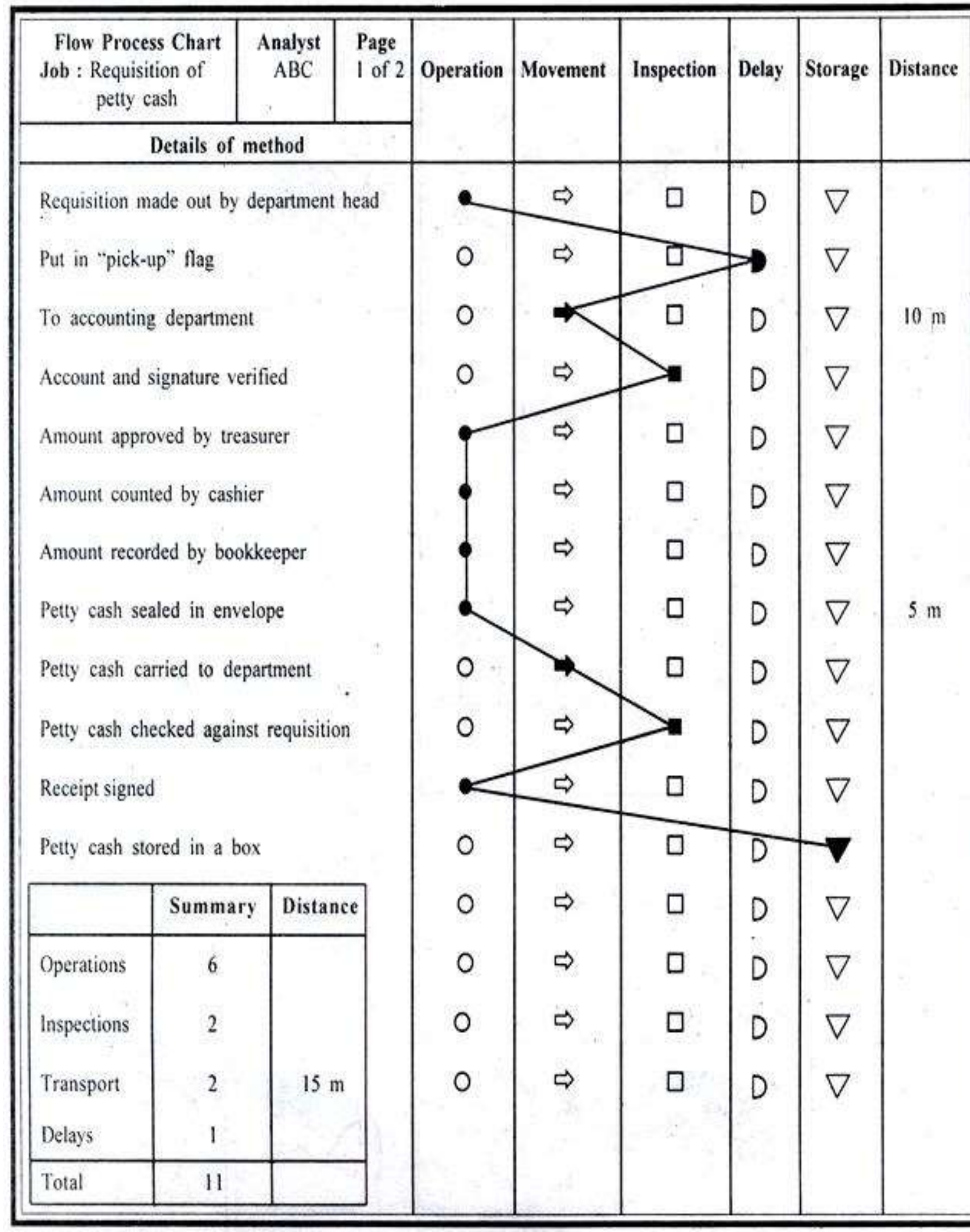
- Time studies are used to collect time data relating to a construction activity for the purpose of either statistical analysis or of determining the level of work activity.
- It is important that the data collected be statistically valid.
- Work sampling is the name for a time study conducted for the purpose of determining the level of activity of an operation.
- A study of a construction equipment operation, for example, may classify work activity into a number of categories, each designated as either active or nonworking.

- Sampling for labor effectiveness may also divide observations into categories such as effective work, essential contributory work, ineffective work, and nonworking.
- Analysis of work by category will again assist management in determining how labor time is being utilized and provide clues to increasing labor effectiveness.
- Although time studies are traditionally made using stopwatches and data sheets, there is growing use of time-lapse equipment for conducting work improvement studies on construction projects provides several advantages over stopwatch studies.
- Modified super-8mm cameras and projectors provide a relatively inexpensive method of recording and analyzing time-lapse film.

3. A flow process chart

- A flow process chart for a construction operation serves the same purpose as does a flowchart for a computer program.
- That is, it traces the flow of material or work through a series of processing steps (classified as operations, transportation, inspections, delays, or storage).
- Depending on the level of detail, it usually indicates the distance and time required for each transportation and the time required for each operation, inspection, or delay.
- From the chart the manager should be able to
  - visualize the entire process and
  - to tabulate the number of operations, transportation, inspections, delays, and storage involved, and
  - the time required for each category.

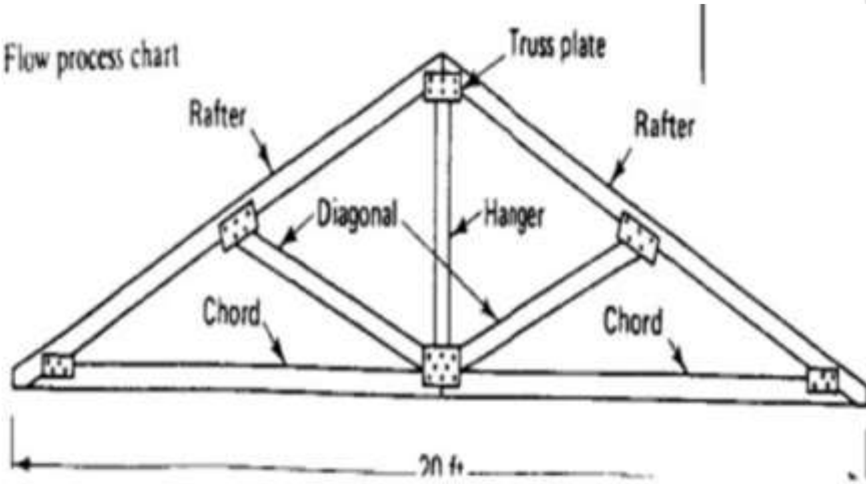




Flow Process Chart Job : Requisition of petty cash	Analyst ABC	Page 1 of 2	Operation	Movement	Inspection	Delay	Storage	Distance
Details of method								
Requisition made out by department head			●					
Put in "pick-up" flag						●		
To accounting department				➡				10 m
Account and signature verified					■			
Amount approved by treasurer			●					
Amount counted by cashier			●					
Amount recorded by bookkeeper			●					
Petty cash sealed in envelope			●					5 m
Petty cash carried to department				➡				
Petty cash checked against requisition					■			
Receipt signed			●					
Petty cash stored in a box							▼	

	Summary	Distance
Operations	6	
Inspections	2	
Transport	2	15 m
Delays	1	
Total	11	

Flow process chart



FLOW PROCESS CHART

NUMBER	101
PAGE NO.	1
NO. OF PAGES	1
PROCESS	Assemble Truss
MAN OR MATERIAL	
CHART BEGINS	Parts stack
CHART ENDS	Parts stack
CHARTED BY	J. Doe
DATE	7/13
ORGANIZATION	E Z Construction

SUMMARY

ACTIONS	PRESENT NO.	PRESENT TIME	PROPOSED NO.	PROPOSED TIME	DIFFERENCE NO.	DIFFERENCE TIME
OPERATIONS	10	137				
TRANSPORTATIONS	9	90				
INSPECTIONS	0					
DELAYS	0					
STORAGES	0					
DISTANCE TRAVELLED (Feet)	300					

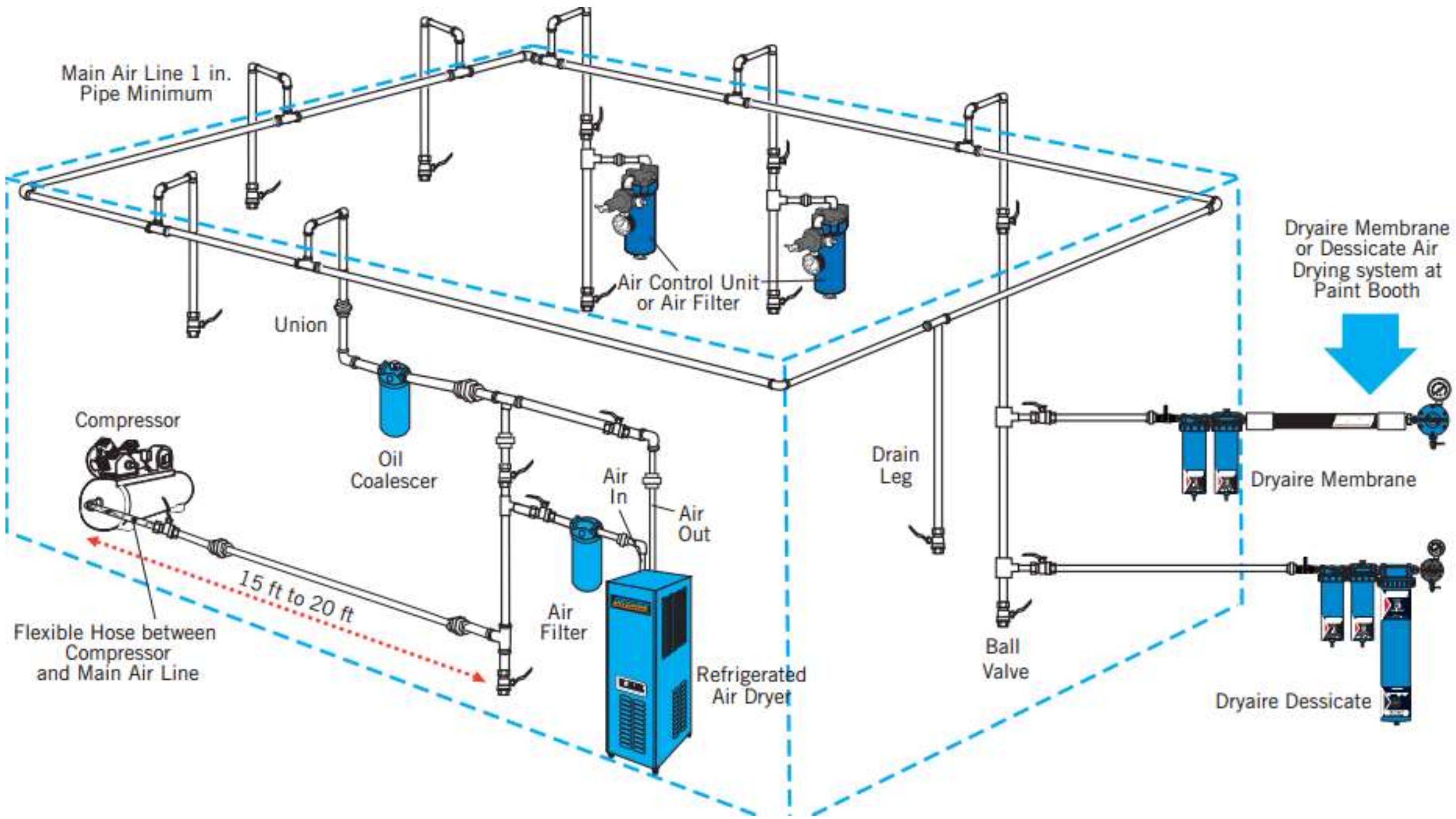
No.	DETAILS OF PRESENT / PROPOSED METHOD	OPERATION TRANSPORTATION INSPECTION DELAY STORAGE	DISTANCE IN FEET	QUANTITY	TIME (sec)	NOTES
1	Remove chords from stack	○⇨□D▽		2	3	
2	Transport chord to jig	○⇨□D▽	25	2	10	
3	Position chords in jig	○⇨□D▽		2	5	
4	Return to parts stack	○⇨□D▽	25		6	
5	Remove rafters from stack	○⇨□D▽		2	3	
6	Transport rafters to jig	○⇨□D▽	25	2	10	
7	Position rafters in jig	○⇨□D▽		2	5	
8	Return to parts stack	○⇨□D▽	25		6	
9	Remove diagonals	○⇨□D▽		2	3	
10	Transport diagonals	○⇨□D▽	25	2	10	
11	Position diagonals in jig	○⇨□D▽		2	5	
12	Return to parts stack	○⇨□D▽	25		6	
13	Remove hanger from stack	○⇨□D▽		1	3	
14	Transport hanger to jig	○⇨□D▽	25	1	10	
15	Position hanger in jig	○⇨□D▽		1	5	
16	Fasten truss plates	○⇨□D▽		12	85	
17	Remove truss from jig	○⇨□D▽		1	20	
18	Trans & stack truss	○⇨□D▽	50	1	15	Using forklift
19	Return to parts stack	○⇨□D▽	75		17	
20		○⇨□D▽				Cycle time = 227 sec
21		○⇨□D▽				

Figure 20–1 Flow process chart.

4. Layout Diagrams

- A layout diagram is a scaled diagram that shows the location of all physical facilities, machines, and material involved in a process.
- Since the objective of a work improvement study is to minimize processing time and effort, use a layout diagram to assist in reducing the number of material movements and the distance between operations.

Layout Diagrams



5. A flow diagram

- A flow diagram is similar to a layout diagram but also shows the path followed by the worker or material being recorded on a flows process chart.
- The flow diagram should indicate the direction of movement and the locations where delays occur.
- Step numbers on a flow diagram should corresponded to the sequence number used on the corresponding flow process chart.

- flow process charts, flow diagrams, and layout diagrams must be studied together for maximum benefit and must be consistent with each other.
- Since layout diagrams and flow diagrams help us to visualize the operation described by a flow process chart, these diagrams should suggest
  - jobs that might be combined,
  - storage that might be eliminated, or
  - transportation that might be shortened.

5. Crew Balance Charts

- A crew balance chart uses a graphical format to document the activities of each member of a group of workers during one complete cycle of an operation.
- A vertical bar is drawn to represent the time of each crew member during the cycle.
- The bar is then divided into time blocks showing the time spent by that crew member on each activity which occurs during the cycle.
- The crew balance chart enables us easily to compare the level of activity of each worker during an operation cycle.

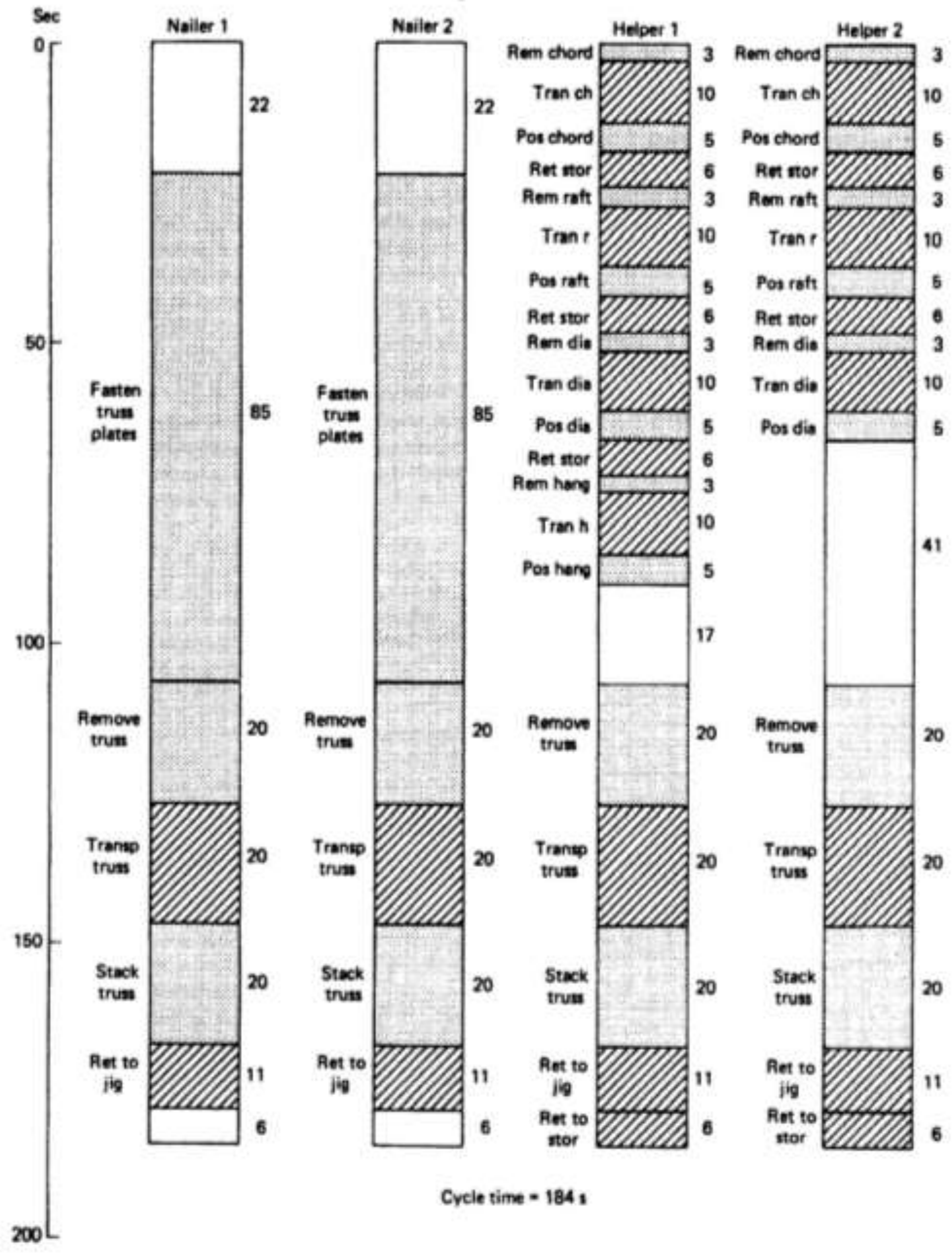


Figure 20-3 Crew balance chart.

Human Factors

- Workers who are fatigued, bored, or hostile will never perform at an optimum level of effectiveness.
- Some major human factors to be considered include environmental conditions, safety conditions, physical effort requirements, work hours, and worker morale and motivation.
- Attempts at sustained higher levels of effort will only result in physical fatigue and lower performance.
- Physical work requirements should be adjusted to match worker capability.

- Studies have shown that worker productivity is seriously reduced by sustained periods of overtime work.
- When the premium cost of overtime is considered, it is apparent that the labor cost per unit of production will always be higher for overtime work than for normal work.
- Worker morale and motivation have also been found to be important factors in construction worker productivity.
- Factors inhibiting craft productivity , nonavailability of material was the most Significant, followed by nonavailability of tools, and the need to redo work.

Some of the worker demotivators identified by the study.

- Disrespectful treatment of workers.
- Lack of sense of accomplishment.
- Nonavailability of materials and tools.
- Necessity to redo work.
- Discontinuity in crew makeup.
- Confusion on the project.
- Lack of recognition for accomplishments.
- Failure to utilize worker skills.
- Incompetent personnel.
- Lack of cooperation between crafts.
- Overcrowded work areas.
- Poor inspection programs.
- Inadequate communication between project elements.
- Unsafe working conditions.
- Workers not involved in decision making.

Some of the worker motivators identified in the study

- Good relations between crafts.
- Good worker orientation programs.
- Good safety programs.
- Enjoyable work.
- Good pay.
- Recognition for accomplishments.
- Well-defined goals.
- Well-planned projects.