PLANNING AND SCHEDULING OF PROJECTS

Prepared by:
Dr. Husein Ali Husein
husein.ali@su.edu.krd
dr.arch.huseinali@gmail.com

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With my thanks to Professor Dr. Nuri

"Well begun is half done"

Critical Path Method (CPM)

The critical path method (CPM) is a project modeling technique developed in the late 1950s.

CPM is commonly used with all forms of projects, including construction, aerospace and defense, software development, research projects, product development, engineering, and plant maintenance, among others.

Any project with interdependent activities can apply this method of mathematical analysis.

Basic technique:

1. A list of all activities required to complete the project (typically categorized within a work breakdown structure).

2. Quantity of the activity, the rate of performance, and then the time (duration) that each activity will take to complete.

3. The dependencies between the activities and,

4. Logical endpoints such as milestones or deliverable items.

Methods of Scheduling

- Bar (Gantt) Chart Method
- Critical Path Method

1) The Activity-On-Arrow (AOA) Method
2) The Activity-On-Node (AON) Method
3) The Program Evaluation and Review Technique (PERT) Method

Bar (Gantt) Chart Method

The bar graph or bar chart schedule is a graphical schedule relating progress of items of work to a schedule.

A Gantt chart is a horizontal bar chart showing the start and end dates of each task within a project.

It shows the tasks on the vertical axis and time on the horizontal axis.

The bar schedule traces its origin to a chart developed by Henry L. Gantt, a pioneer in application of scientific management methods to industrial production.

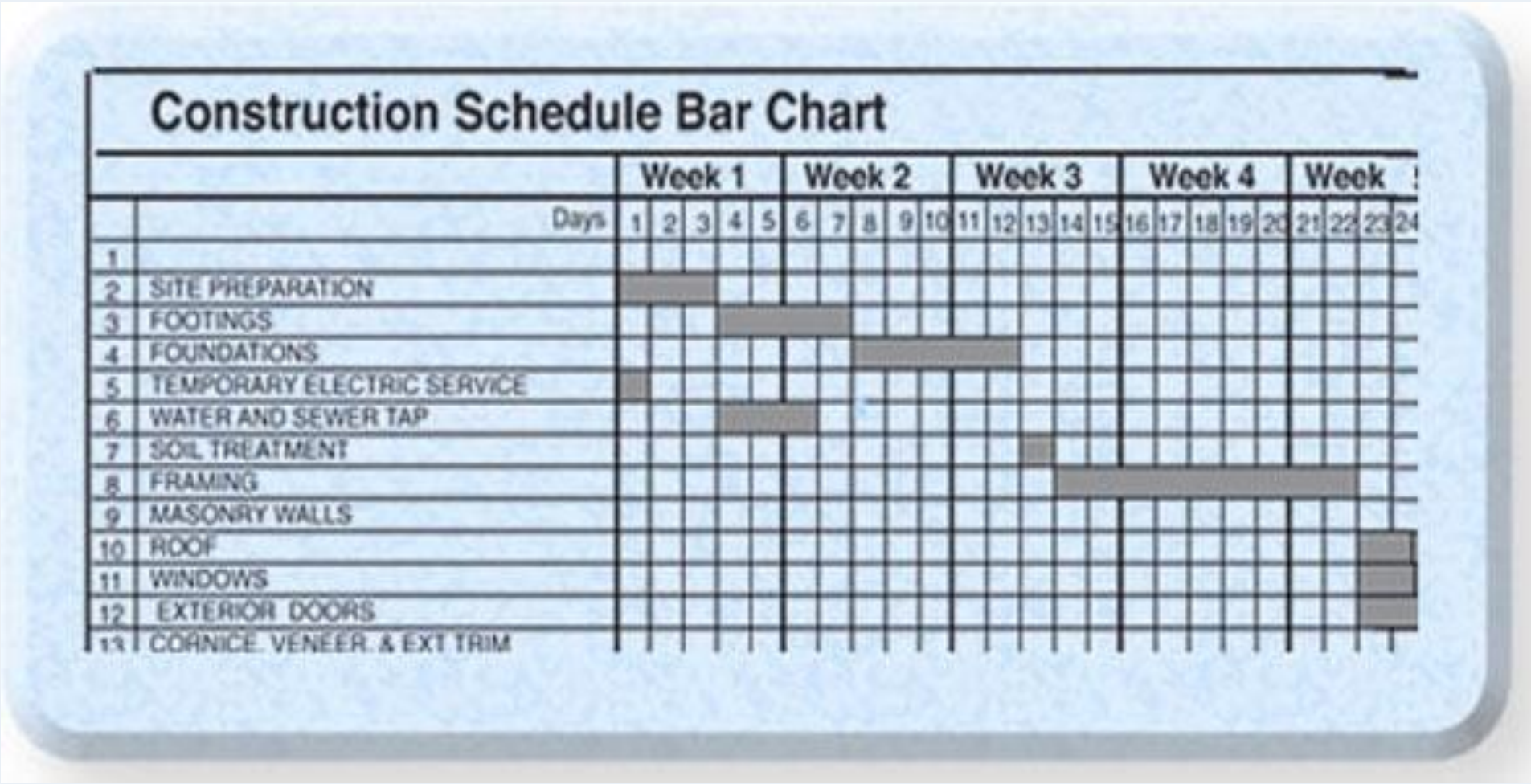
In spite of the advent of network planning methods, the bar graph schedule is still the most widely used schedule form found in construction work.

Its continued popularity in the face of significant deficiencies is undoubtedly due to its graphic and easily understood format.

Procedure of bar chart scheduling

1. Define the activities of work,
2. Determine the quantity of the work involved in each activity,
3. Estimate the probable rate, at which the work will be performed.
4. Calculate the probable time required to complete each activity,
5. Arrange the activities properly (sequencing) and
6. Draw each activity against time required.

A small building bar chart schedule.

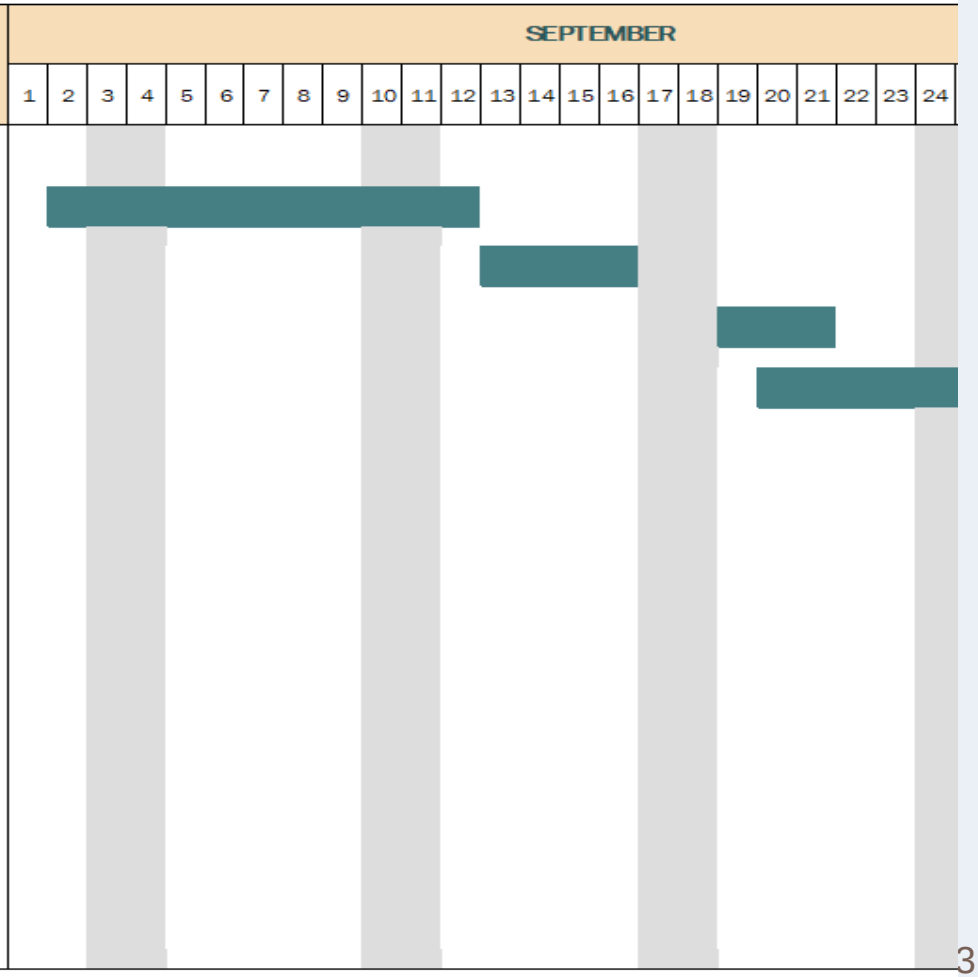


Build a house bar chart schedule.

www.projectengineer.net

Build a House

ACTIVITY	START DATE	DURATION	END DATE
Excavation			
Excavation	02-Sep-18	7	12-Sep-18
Pour Concrete	13-Sep-18	4	16-Sep-18
Backfill	19-Sep-18	3	21-Sep-18
Framing	20-Sep-18	14	7-Oct-18
Mechanical/Electrical			
HVAC	10-Oct-18	10	21-Oct-18
Plumbing	13-Oct-18	10	26-Oct-18
Electrical	18-Oct-18	9	28-Oct-18
Finishing			
Drywall	28-Sep-18	2	28-Sep-18
Painting	10-Nov-18	9	22-Nov-18
Flooring	23-Nov-18	9	5-Dec-18
Landscaping	21-Nov-18	23	21-Dec-18

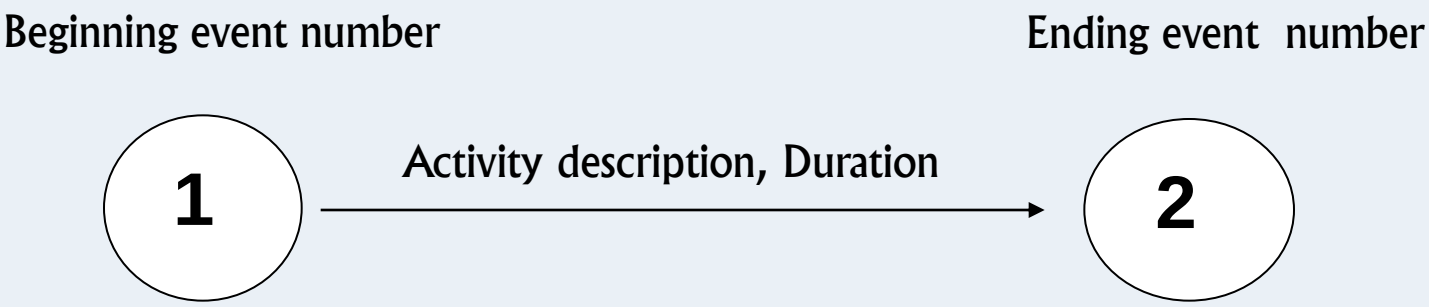


Advantage of Bar Chart Schedule

Bar charts are the easiest to understand and the most widely used form of planning tool.
Even when a more sophisticated technique like network analysis is used, the eventual work schedule is usually presented in the bar-chart form.

The Activity- On – Arrow (AOA)- Method

Activity: A specific job or task that has to be performed. Normally time is required to complete an activity. For example, placing concrete is an activity.



Event: The start or completion of an activity.
It requires no time in itself and is usually indicated on the AOA diagram by a number enclosed in a circle (square, rectangular, or oval).

Arrow:

A line drawn to represent each activity in a network, joining two events (the start and the finish of an activity).

The arrow is usually designated by two numbers, one at the tail (the "from" event) and one at the head (the "to" event).

The "from" number should always be less than the "to" number.

AOA network:

This is the arrow diagram drawn to portray the proper relationship between the activities in a project.

It is common practice to start time with zero and to start the first arrow or arrows at the left end of the network and proceed to the right.

Dummy:

This is an artificial activity, usually represented on the diagram by a dotted line, to **describe the proper relationship between activities**. For example, X is a dummy activity and indicates that activity E cannot be started until activities A and B are completed. (Used only on AOA- diagrams).

Earliest Start (ES):

This is the earliest time an activity can start.

Duration: The estimated time to perform an activity.

For example, it is estimated that the concrete must be cured for 7 days.

Units such as days, weeks, and months are generally used.

Once the units are selected, the usual practice is to use integer quantities only, rounding off all duration to the next higher value.

Early Finish (EF):

This is the earliest time an activity can be finished.

$$EF = ES + D$$

Late Start (LS):

This is the latest time an activity can be started without delaying the completion of a project.

$$LS = LF - D$$

Late Finish (LF):

This is the latest time an activity can be finished without delaying the completion of a project.

$$LF = LS + D$$ (from the network)

Total Float (TF):

This is the amount of time that an activity may be delayed without delaying the completion of the project.

$$TF = LS - ES \qquad TF = LF - EF$$

Free Float (FF):

This is the time that the finish of an activity can be delayed without delaying the early start time of any following activity.

FF = ES of following activity (the smallest ES) - EF

Critical Path:

This is the longest interconnected path of activities through the network. Its length determines the overall duration of the project.

All activities on the critical path have zero float (TF, FF) times.

A project may have more than one critical path.

Critical Activity:
This is an activity on the critical path. It has zero float time.

Ordering Activities
The order of activities is based on the timing of some activities relative to the occurrence of other activities.
For each identified activity, the following must be determined:

1. Which activities must precede it?
2. Which activities must be following it?
3. Which activities can be concurrent with it?

Steps in critical path scheduling:

1. Separate the project into discrete activities, each with a definite starting point and ending point.
2. Estimate the duration of each activity.
3. Determine the proper sequencing of each activity, including which activities must precede or follow other activities.
4. Draw an AOA network with the activities and events properly interconnected, where necessary, including dummy activities to clarify the network and avoid redundancy in activity event numbers.
5. Examine the network and optimize, if possible, to eliminate unnecessary dummy activities.
6. Assign numbers to all events, being sure that the "from" number is always less than the "to" number. This establishes the proper direction of the activities.
7. Make a forward pass and a backward pass through the network to establish early start, late start, early finish, and late finish times for all activities.
8. Determine the critical path, or paths, and critical activities.
9. Prepare a table listing all activities, their designations, durations, and ES, LS, EF, and LF times, and their total float.

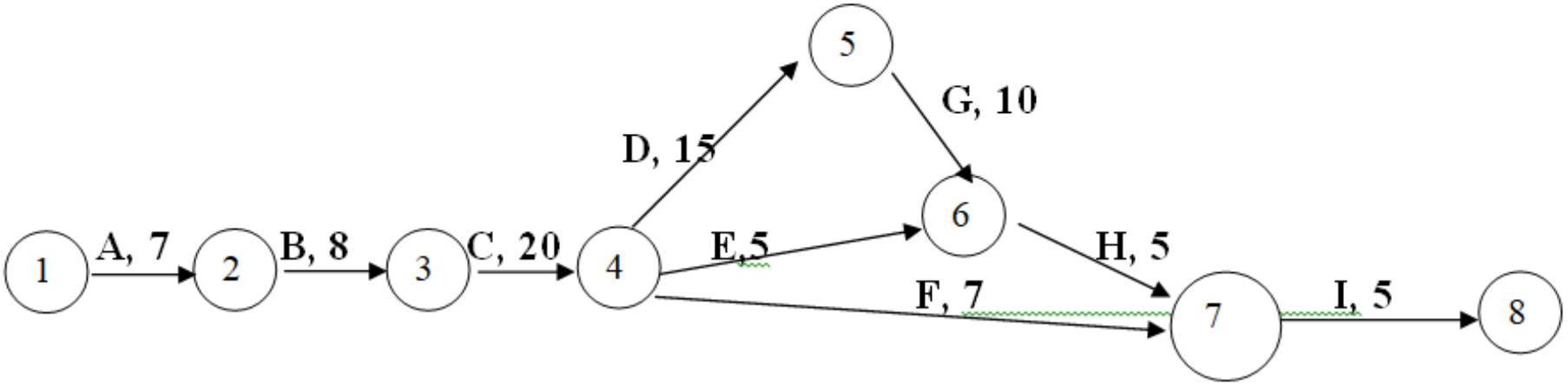
Their free float can also be listed if desired.

Example 1. (Building a house)

Prepare an (**AOA**) diagram showing critical path and calculate **ES, EF, LS, LF, TF and FF** for a project involving following activities and durations.

Activity	Code	Duration (days)	Activity	
			Precedence	following
Foundation works	A	7	-	B
Brickwork above DPC	B	8	A	C
Roofing	C	20	B	D,E,F
Plastering	D	15	C	G
Electrical	E	5	C	H
Plumbing	F	7	C	I
Glass tiling	G	10	D	H
Gypsum works	H	5	G,E	I
Doors and window fixing	I	5	H,F	-

Solution



Activity	Duration	ES	EF=ES+D	LS=LF-D	LF(from fig.)	TF=LS-ES = LF-EF	FF=ES(folw.)-EF
A	7	0	7	0	7	0	0*
B	8	7	15	7	15	0	0*
C	20	15	35	15	35	0	0*
D	15	35	50	35	50	0	0*
E	5	35	40	55	60	20	20
F	7	35	42	58	65	23	23
G	10	50	60	50	60	0	0*
H	5	60	65	60	65	0	0*
I	5	65	70	65	70	0	0*

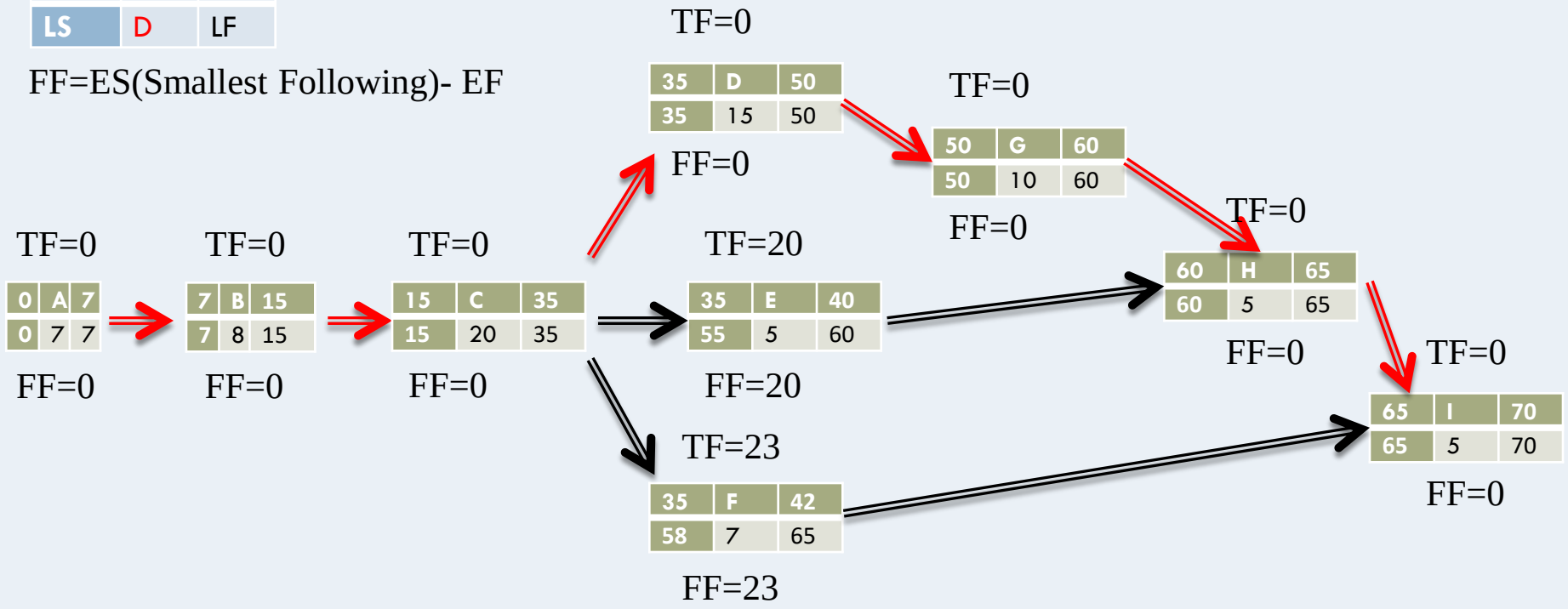
* critical activity; Critical path= A-B-C-D-G-H-I; Duration of project = 70 days

AON (Activity on Nod)

TF=LS-ES, TF= LF-EF

ES	AC	EF
LS	D	LF

FF=ES(Smallest Following)- EF



Quiz (10 Minutes)

Following Table represents the activities of the placement of a mobile home on a permanent site; prepare an **AOA diagram** showing critical activities, ES, EF, LS, LF, TF, and FF times.

Activity	Description	Event (From-to)	Duration, days	Activities which Precede	Follow
A	Site layout	1-2	1	---	B, D
B	Excavation	2-3	4	A	C
C	Slab forms	3-5	1	B	G
D	Place blocks	2-4	1	A	E, F
E	Rough plumbing	4-6	2	D	H
F	Rough electrical	4-8	2	D	K
G	Place concrete	5-7	1	C	I, J
H	Place home	6-8	1	E	K
I	Remove forms	7-9	2	G	L
J	Cure concrete	7-10	7	G	L
K	Hookup home	8-10	4	F, H	L
L	Cleanup	10-11	2	I, J, K	-----
X	Dummy	9-10	0	I	L

THANKS

QUESTIONS ?