Production Planning & Control

ME 483

Presented by:

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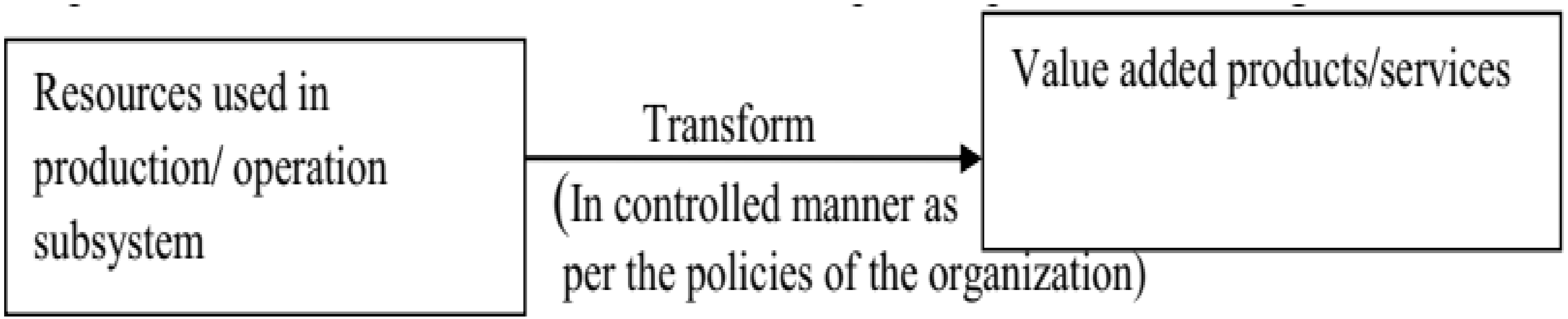
https://github.com/tanmoyie/operations-Management

Ref book: Operations Management 12th edition by Stevension

Introduction to PPC

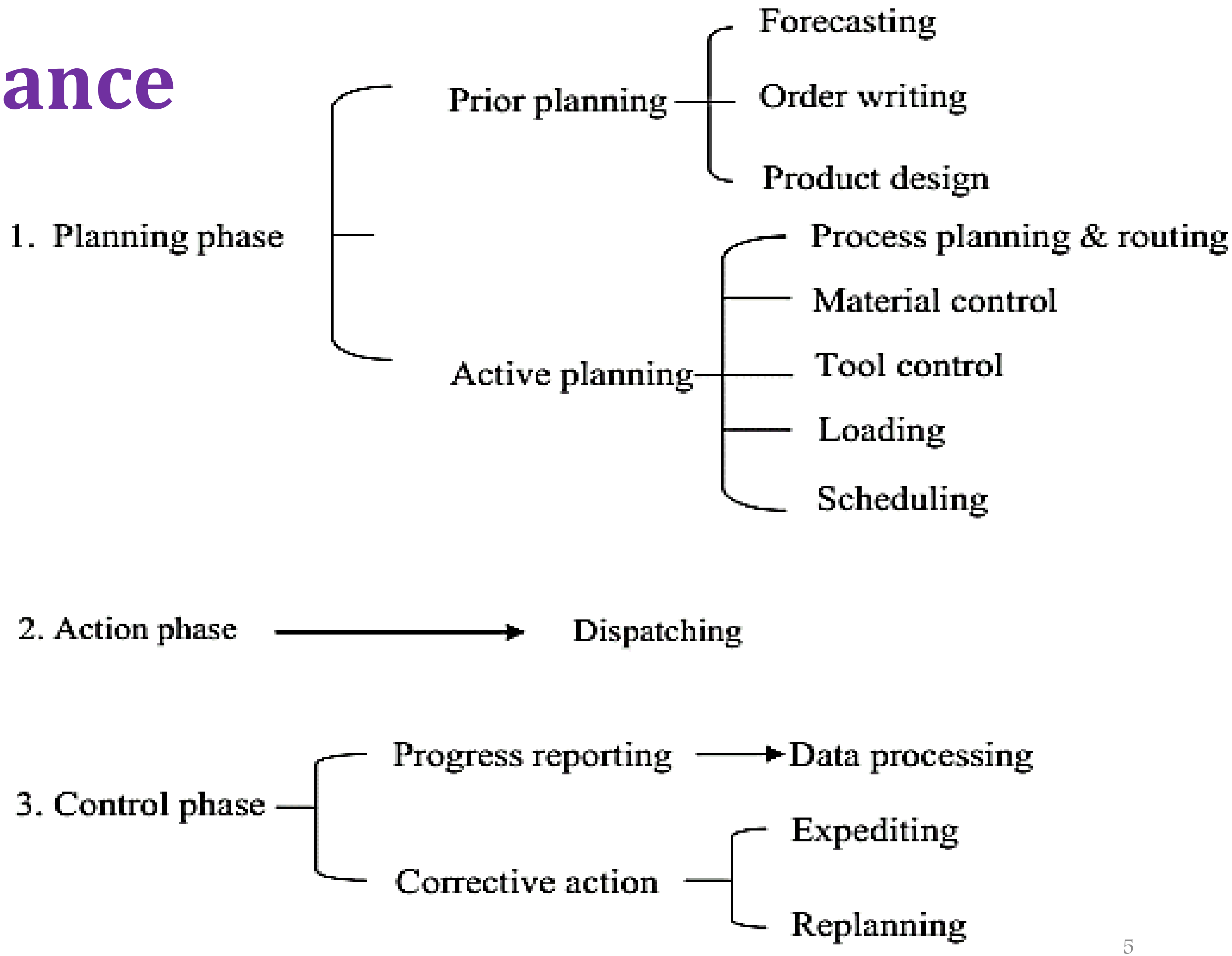
Input – Process - Output



Definition

- **PRODUCTION:** that transformation of raw materials to finished goods.
- **PLANNING:** looks ahead, anticipates possible difficulties and decides in advance as to how the production, best, be carried out.
- **CONTROL:** phase makes sure that the programmed production is constantly maintained

PPC at a glance



Efficiency & Effectiveness

Efficient – Performing or functioning in the best possible manner with the least waste of time and effort.

Effective - successful in producing a desired or intended result.

Being **effective** is about doing the right things, while being **efficient** is about doing things right.

Pursuit of Appropriate Goals / Doing Right Things		Inefficient	Efficient
	Effective	Pursuing right goals, but inefficient (costs are high)	Pursuing right goals and efficient (high-ROI, cost-efficient)
	Ineffective	Pursuing wrong goals and inefficient (not producing enough and are expensive)	Pursuing wrong goals but is efficient (not producing enough but low-cost)

Use of Resources / Doing Things Right

Productivity

- Production/Operation management is the process which combines and transforms various resources used in the production/operation subsystem of the organization into value added products/services
- **Productivity:**

Productivity is the quantitative relation between what we produce and what we use as a resource to produce them. Productivity can be expressed as:

$$Productivity = \frac{Output}{Input}$$

PDCA cycle

- Plan~Do~Check~Act

80-20 rules

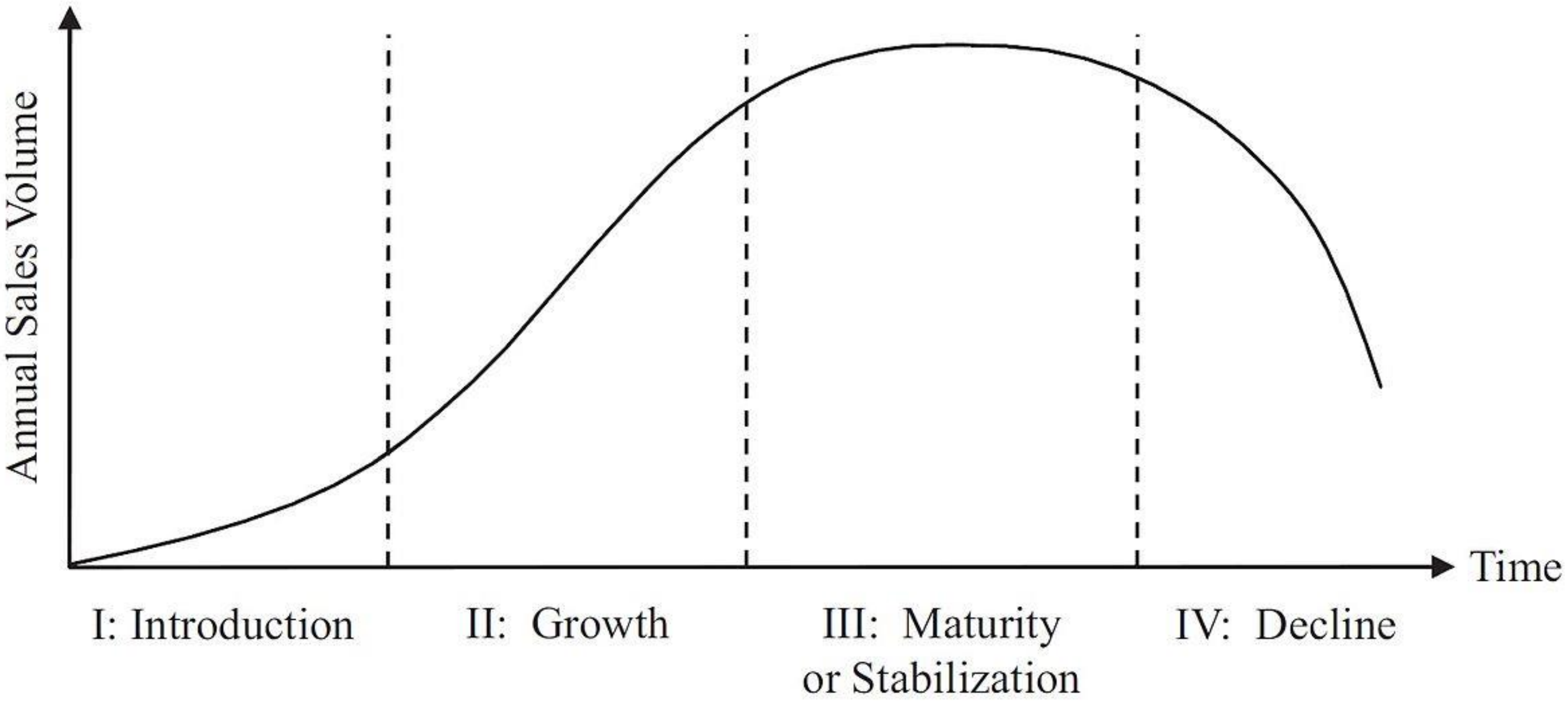
- 20% of the causes contributes to 80% of the effects

How SolidWorks can assist during Planning Stage?

BoM

- A bill of materials (BOM) describes the components that are required in order to produce a product. The components can be raw materials, semi-finished products, or ingredients.

Product Life Cycle



Time Dimension in Planning

 Long Range Planning; is done annually and focus on a planning horizon greater than one year.
 Medium Range Planning; usually covers a period from 6 months to 18 months, with monthly or sometimes quarterly time increments.
 Short Range Planning; covers a period from one day or less to six months, with weekly time increment usually

Production Planning

PLANNING

 That may be defined as the technique of foreseeing every step in a long series of separate operations., Each step to be taken at the **right time**, and in the **right place** and each operation to be performed in maximum efficiency.

ROUTING

 Under this operations , their path and sequence are established

SCHEDULING

 It mainly concerns with time element and priorities of a job.
 The pattern of scheduling differs from one job to another which is explained as below:
Production Schedule, Master Schedule, Manufacturing Schedule

LOADING

 Defined as the relationship between load and capacity, so as to assign the work for the production

- MRP – Material Requirement Planning
- MPS – Master Production Scheduling
- CPM – Critical Path Method
- PERT – Program Evaluation & Review Technique
- MRP-II – Manufacturing Resource Planning
- JIT – Just in Time

Further resources

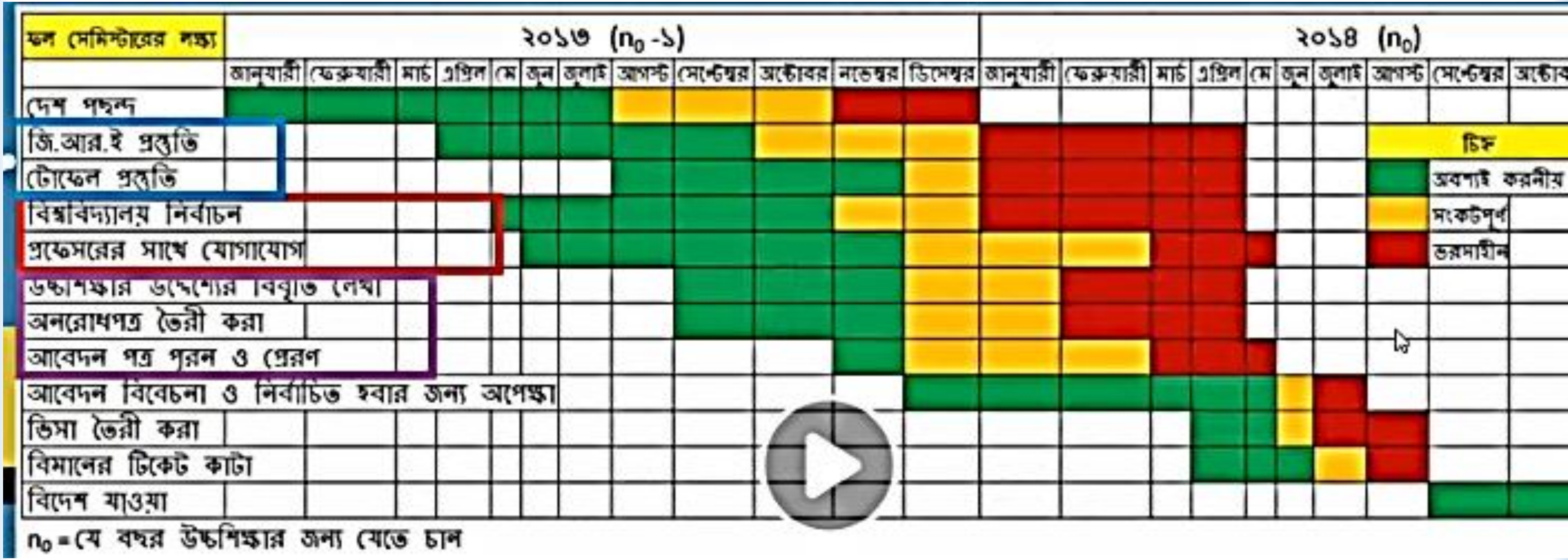
1. PPC intro.pdf
2. Efficiency, Production Systems, Plant layout.ppt
3. JIT, PDCA, TOC.ppt

CPM & PERT

The objective of CPM & PERT

1. A graphical display of project activities.
2. An estimate of how long the project will take.
3. An indication of which activities are the most critical to timely project completion.
4. An indication of how long any activity can be delayed without delaying the project

Gantt Chart

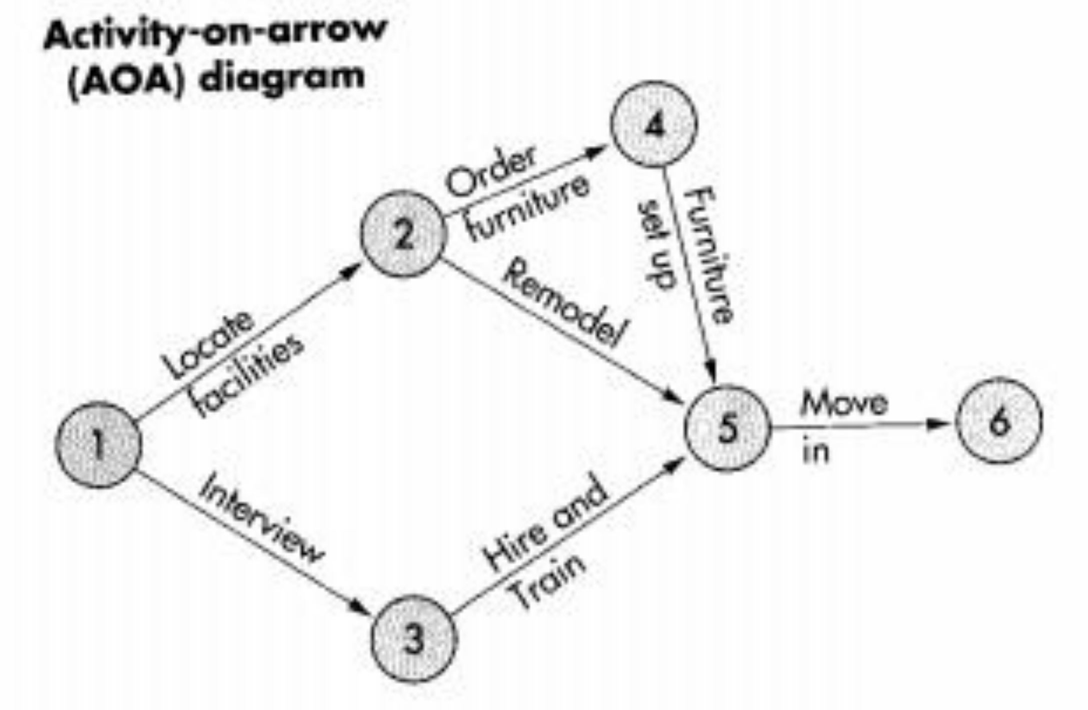


মূল সেমিস্টারের লক্ষ্য
২০১৩ (n_0 -১)
২০১৪ (n_0)
জানুয়ারী
ফেব্রুয়ারী
মার্চ
এপ্রিল
মে
জুন
জুলাই
আগস্ট
সেপ্টেম্বর
অক্টোবর
নভেম্বর
ডিসেম্বর
দেশ পছন্দ
জি.আর.ই প্রস্তুতি
টোফেল প্রস্তুতি
বিশ্ববিদ্যালয় নির্বাচন
প্রফেসরের সাথে যোগাযোগ
উচ্চশিক্ষার উদ্দেশ্যের বিবৃতি লেখা
অনুরোধপত্র তৈরী করা
আবেদন পত্র পূরন ও প্রেরণ
আবেদন বিবেচনা ও নির্বাচিত হবার জন্য অপেক্ষা
ভিসা তৈরী করা
বিমানের টিকেট কাটা
বিদেশ যাওয়া
চিহ্ন
অবশ্যই করনীয়
সংকটপূর্ণ
n_0 = যে বছর উচ্চশিক্ষার জন্য যেতে চান

Time estimates include:

1) Total time for completion.
2) ES- Earliest start time: the earliest time at which the activity can start given that its precedent activities must be completed first.
3) EF-Earliest finish time: equals to the earliest start time for the activity plus the time required to complete the activity.
4) LF- Latest finish time: the latest time in which the activity can be completed without delaying the project.
5) LS- Latest start time: equal to the latest finish time minus the time required to complete the activity.

Network Diagram



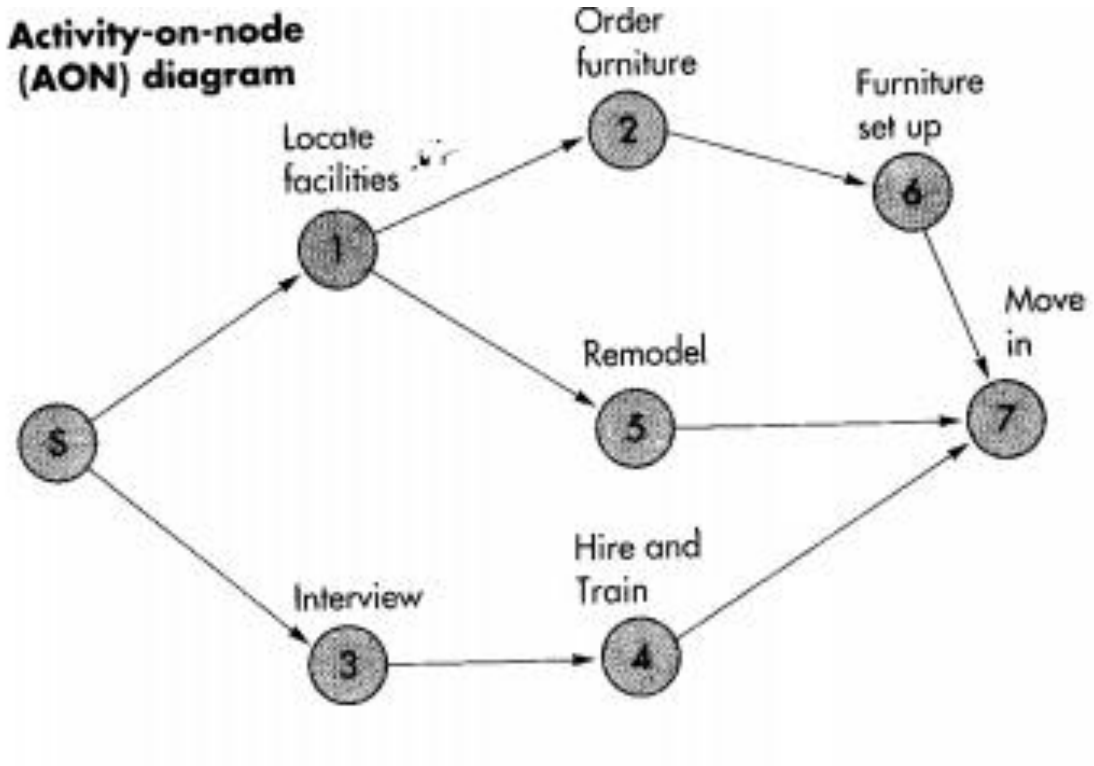
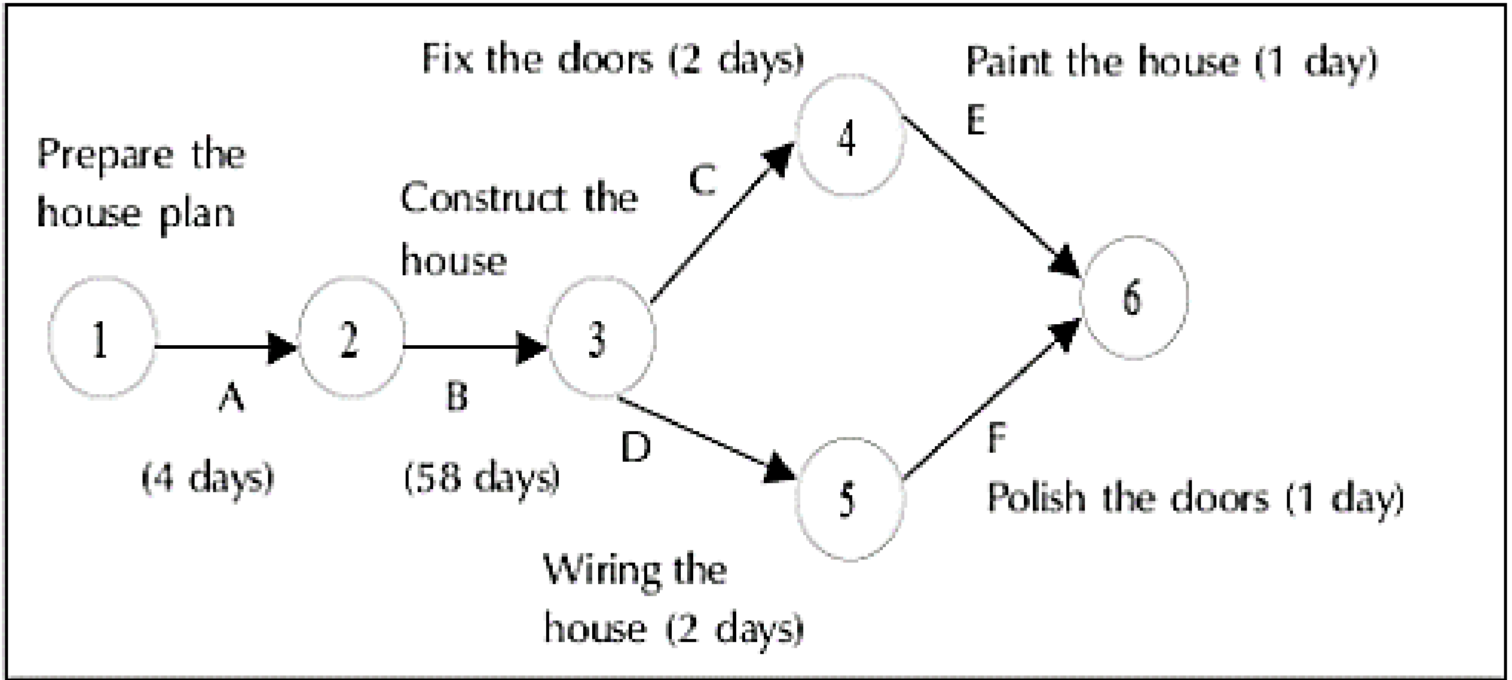


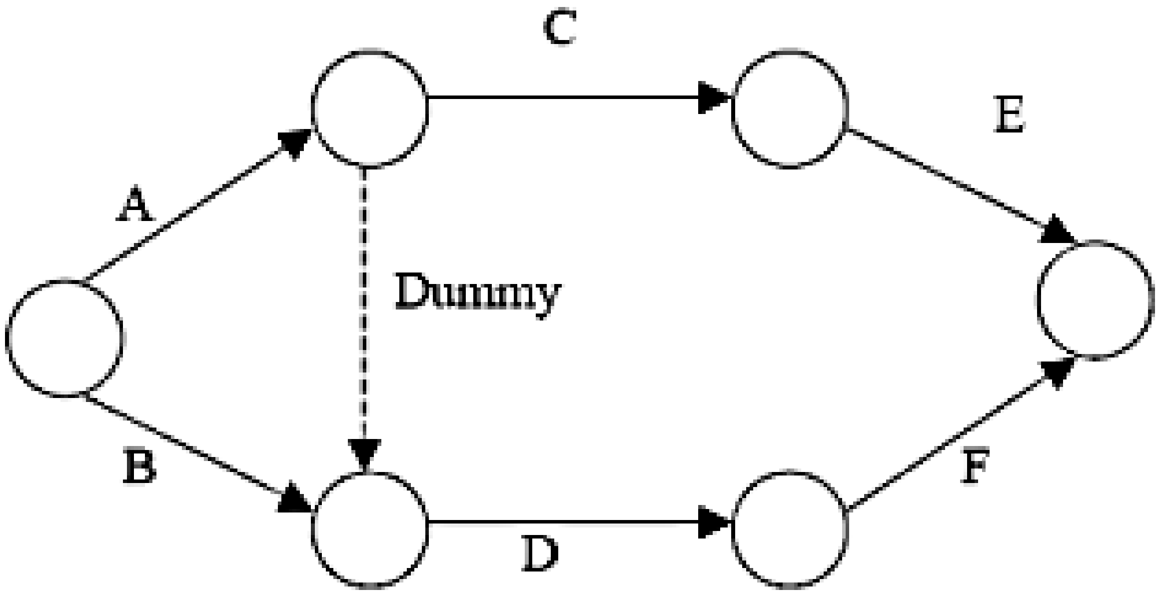
Table 8.1: Sequence of Activities for House Construction Project

Name of the activity	Starting and finishing event	Description of activity	Predecessor	Time duration (days)
A	(1,2)	Prepare the house plan	--	4
B	(2,3)	Construct the house	A	58
C	(3,4)	Fix the door / windows	B	2
D	(3,5)	Wiring the house	B	2
E	(4,6)	Paint the house	C	1
F	(5,6)	Polish the doors / windows	D	1



Network diagram with dummy activities

Activity	Description	Predecessor
A	Purchase of Land	-
B	Preparation of building plan	-
C	Level or clean the land	A
D	Register and get approval	A, B
E	Construct the building	C
F	Paint the building	D



CPM

- Critical path: the longest path; determine the expected project duration
- The (estimated) project duration equals the length of the longest path through the project network. This longest path is called the critical path. (If more than one path tie for the longest, they all are critical paths.)

- The earliest start time of an activity is equal to the largest of the earliest finish times of its immediate predecessors (ES is used in Forward pass). In symbols,

$$EF = \textit{largest EF of the immediate predecessors}.$$

- The latest finish time of an activity is equal to the smallest of the latest start times of its immediate successors. (LF is used in Backward pass). In symbols,

$$LF = \textit{smallest LS of the immediate successors}.$$

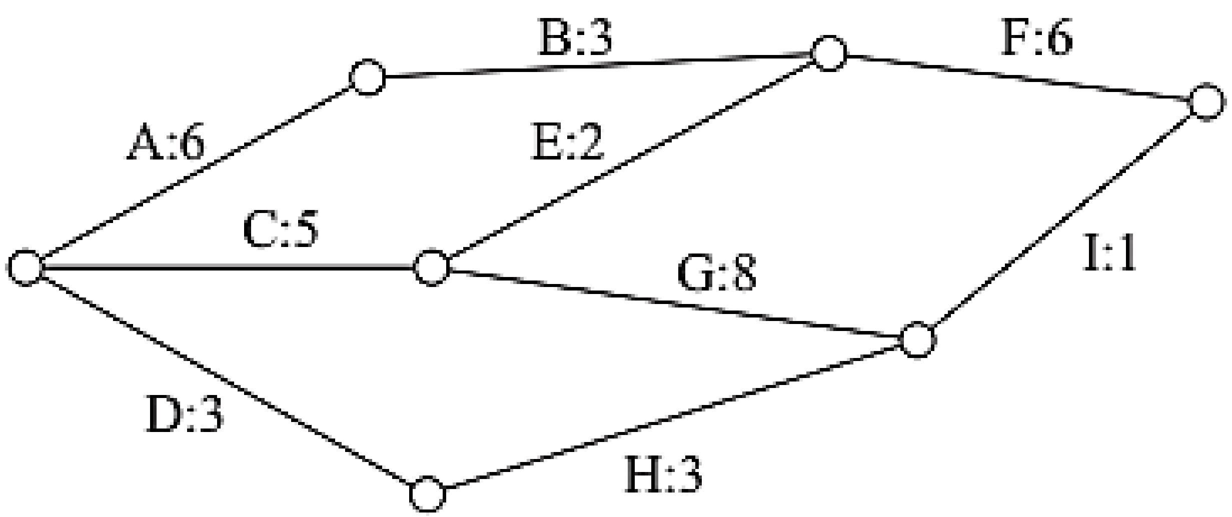
The project network below shows activity durations in weeks. There is a likelihood that Activity D cannot start until the end of Week 3. In this context, the earliest that the project can be completed is the end of Week:

A. 15

B. 17

C. 18

D. 43



The diagram with early start, late start, early finish, and late finish times is as follows:

Activity:

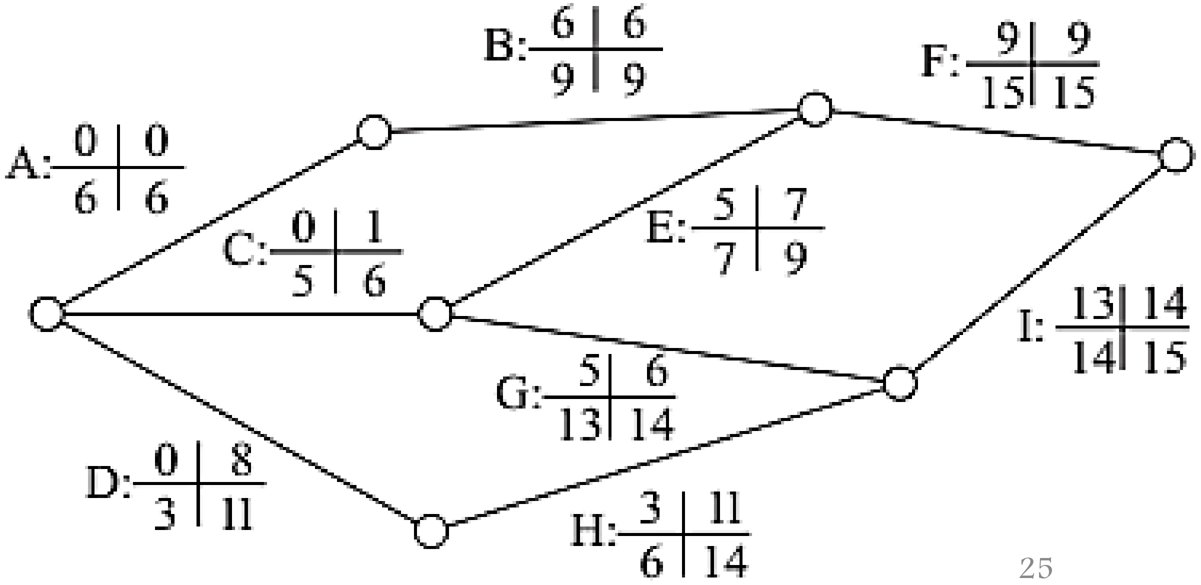
ES: earliest start

EF: earliest finish

LS: latest start

LF: latest finish

ES LS
EF LF



The critical path is A–B–F. Activity D has slack of 8 weeks, so starting Activity D at the end of Week 3 will not affect the completion date. Therefore, A–B–F will still be the critical path with a time of 15 weeks.

PERT

- Optimistic time (to) – It is the shortest time in which the activity can be completed.
- Most likely time (tm) – It is the probable time required to perform the activity.
- Pessimistic time (tp) – It is the longest estimated time required to perform an activity.
- Expected time

$$t_e = \frac{(t_o + 4t_m + t_p)}{6}$$

PERT

(a_{ij}, b_{ij}, c_{ij}) = (optimistic, most likely, pessimistic) durations for activity (i, j)

μ_{ij} = mean duration of activity (i, j)

σ_{ij} = standard deviation of the duration of activity (i, j)

μ = project mean duration

σ = standard deviation of project duration

$$\mu_{ij} = \frac{a_{ij} + 4b_{ij} + c_{ij}}{6}$$

$$\sigma_{ij} = \frac{c_{ij} - a_{ij}}{6}$$

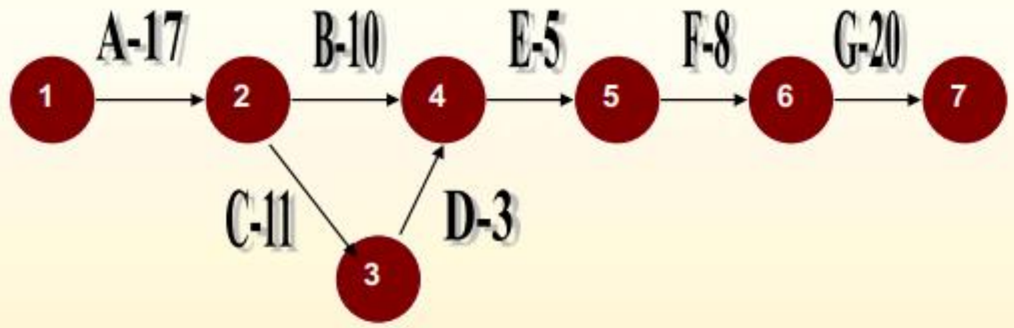
$$\mu = \sum_{(i,j)\in CP} \mu_{ij}$$

$$\sigma^2 = \sum_{(i,j)\in CP} \sigma_{ij}^2$$

Math problem in PERT

- Construct the network diagram
- Determine the CP as well
- Find the project duration

Activity	Description	Precedence	Optimistic time	Most Likely time	Pessimistic time
A	Initial design	-	12	16	26
B	Survey market	A	6	9	18
C	Build prototype	A	8	10	18
D	Test prototype	C	2	3	4
E	Redesigning	B,D	3	4	11
F	Market testing	E	6	8	10
G	Set up production	F	15	20	25



A-B-E-F-G = 60

A-C-D-E-F-G = 64 (CRITICAL PATH)

Line Balancing

Line Balancing

- Line Balancing: the process of assigning tasks to workstations in such a way that the workstations have approximately equal time requirements
- Cycle time: The maximum time allowed at each workstation to perform assigned tasks before the work moves on. The cycle time also establishes the output rate of a line.

Line Balancing

$$N_{\min} = \left(OR \times \sum_i t_i \Big/ OT \right)$$

$$= \text{theoretical minimum number of stations}$$

$$\text{Idle Time/Station} = CT - ST$$

$$\text{Idle Time/Cycle} = \sum (CT - ST)$$

$$\text{Percent Idle Time} = \frac{\text{Idle Time/Cycle}}{N_{\text{actual}} \times CT} \times 100, \text{ where}$$

CT = cycle time (time between units)

OT = operating time/period

OR = output rate/period

ST = station time (time to complete task at each station)

t_i = individual task times

N = number of stations

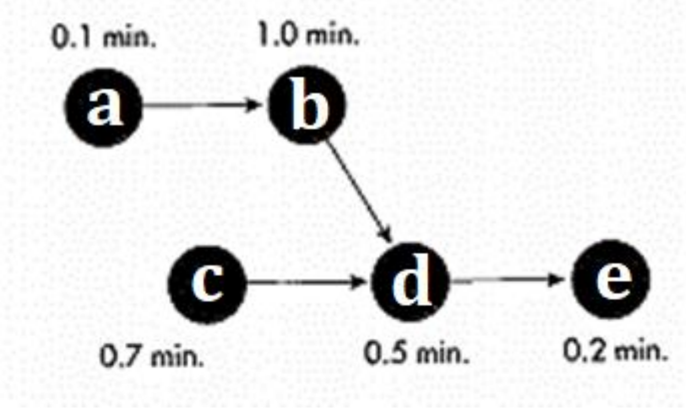
Line Balancing

- $Output = \frac{OT}{CT}$
  - OT = Operating time
  - CT = Cycle time

- The minimum number of workstations needed,

$$N_{min} = \frac{\sum t}{CT}$$

Math problem: Given, CT = 1



Solution:
N_min = (.1+1+.7+.5+.2)/1 = 2.5 stations = 3 stations

The *percentage of idle time* of the line. This is sometimes referred to as the **balance delay.** It can be computed as follows:

$$\text{Percentage of idle time} = \frac{\text{Idle time per cycle}}{N_{\text{actual}} \times \text{cycle time}} \times 100$$

where N_{actual} = Actual number of stations.

Workstation	Time Remaining	Eligible	Assign Task	Station Idle Time
1	1.0	a, c	a	
	0.9	c	c	
	0.2	none	—	0.2
2	1.0	b	b	0.0
3	1.0	d	d	
	0.5	e	e	
	0.3	—	—	0.3
				0.5

Forecasting

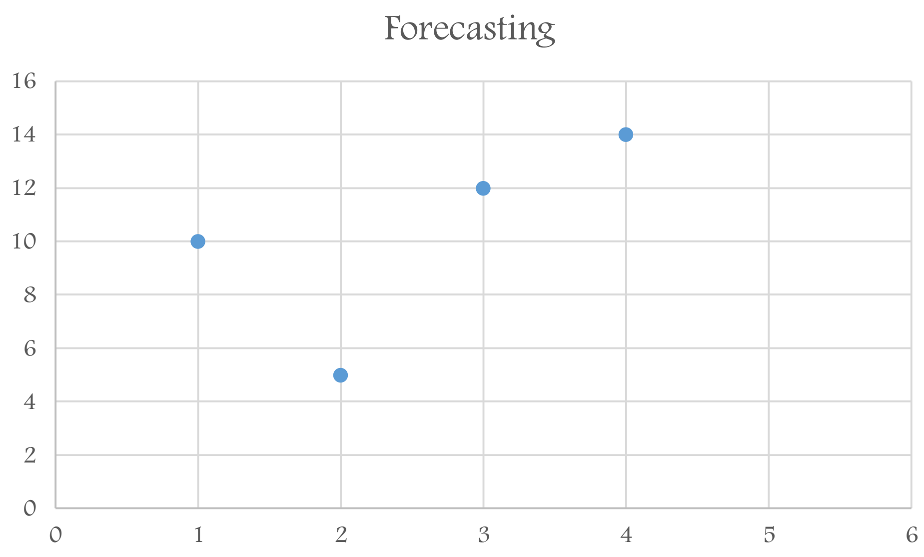
Reference: Chapter 03, Operations Management 12th edition by Stevension

Please refer to Chapter 03 & Forecasting slides

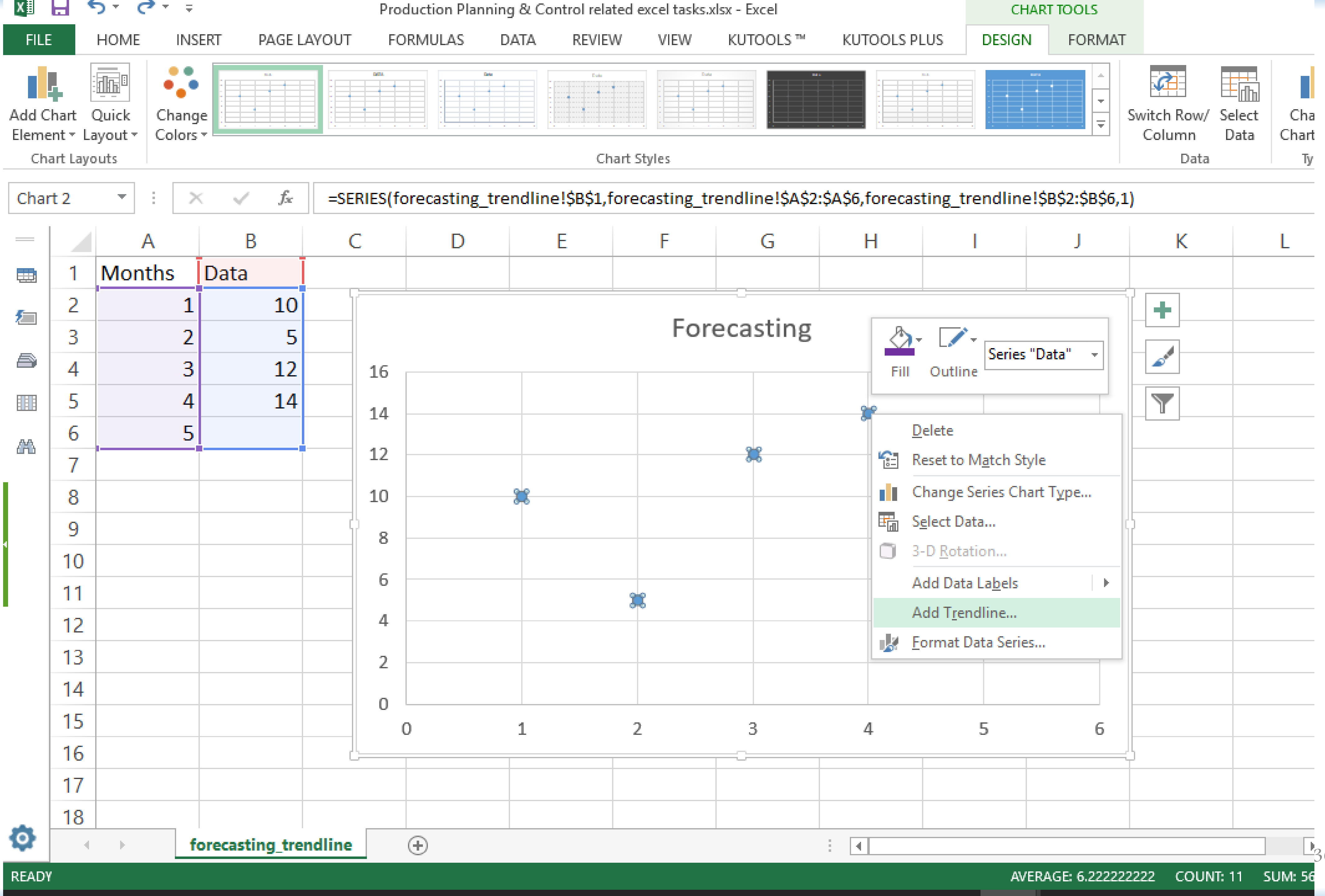
Forecasting in MS Excel

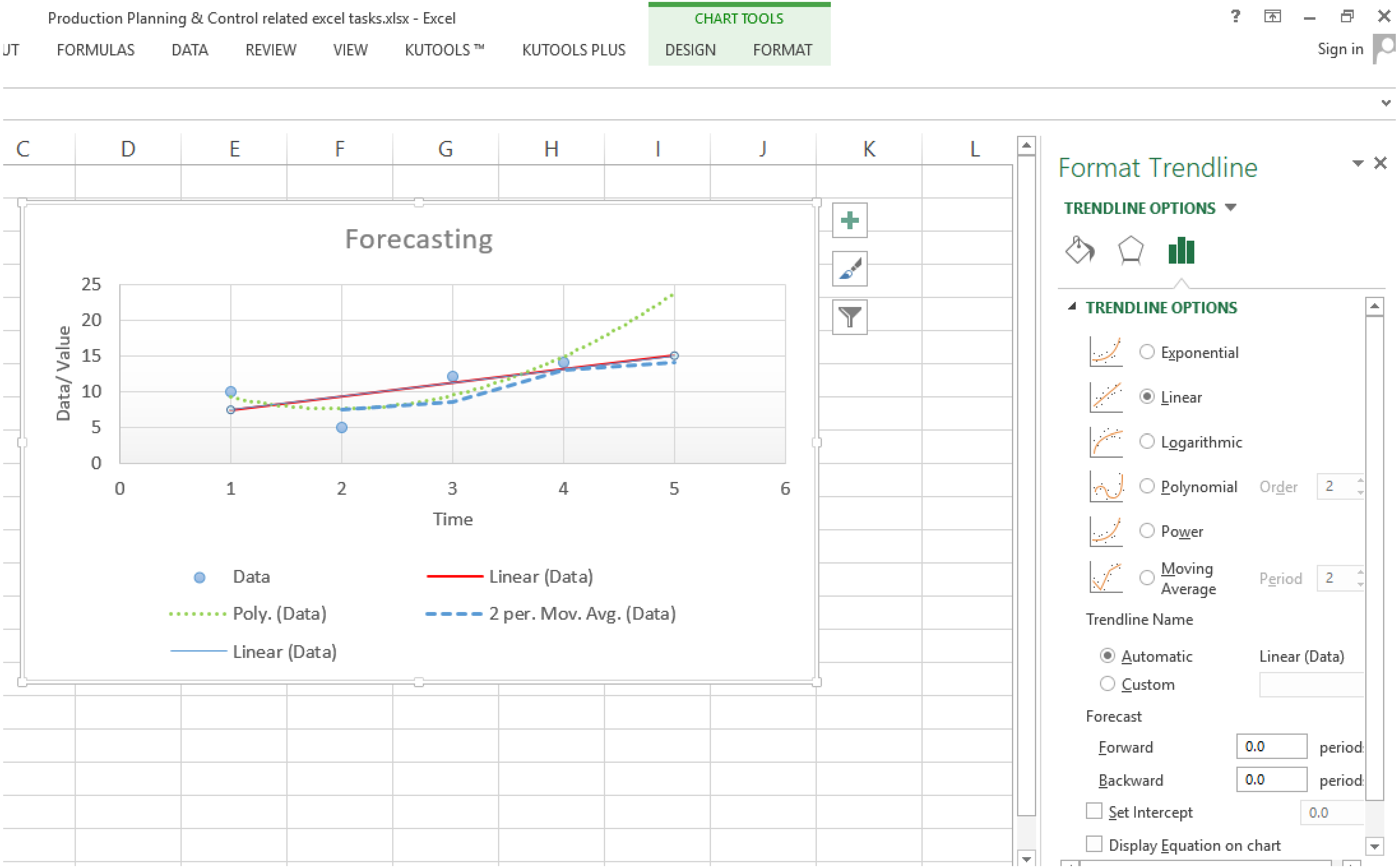
- We have our data. We want to predict future values in MS Excel using **Trendline.**

Months	Data
1	10
2	5
3	12
4	14
5	



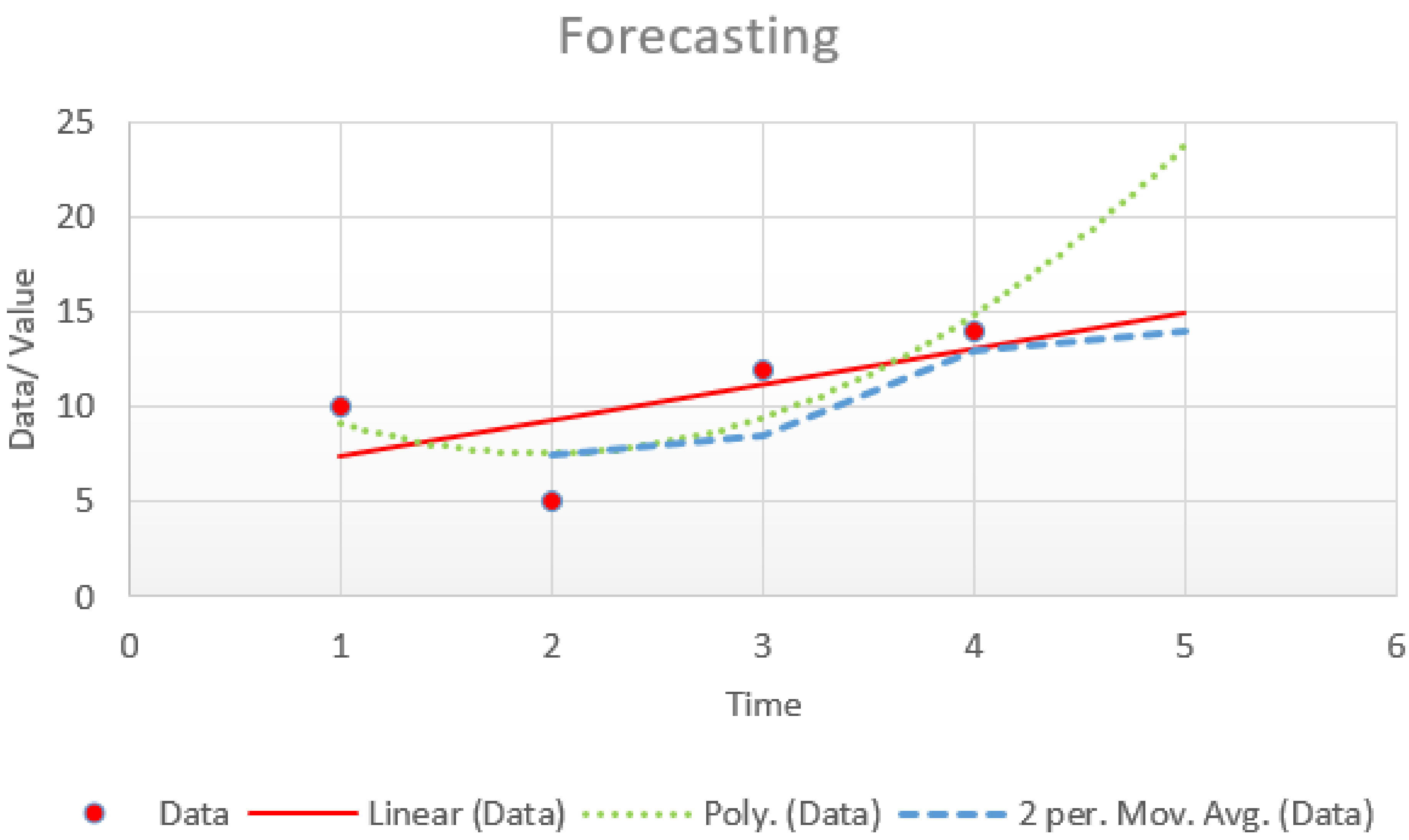
Scatter plot in Excel


Production Planning & Control related excel tasks.xlsx - Excel
CHART TOOLS
FILE
HOME
INSERT
PAGE LAYOUT
FORMULAS
DATA
REVIEW
VIEW
KUTOOLS ™
KUTOOLS PLUS
DESIGN
FORMAT
Add Chart Element
Quick Layout
Change Colors
Chart Layouts
Chart Styles
Switch Row/ Column
Select Data
Data
Chart 2
=SERIES(forecasting_trendline!$B$1,forecasting_trendline!$A$2:$A$6,forecasting_trendline!$B$2:$B$6,1)
Months
Data
1
10
2
5
3
12
4
14
5
Forecasting
Fill
Outline
Series "Data"
Delete
Reset to Match Style
Change Series Chart Type...
Select Data...
3-D Rotation...
Add Data Labels
Add Trendline...
Format Data Series...
forecasting_trendline
READY
AVERAGE: 6.222222222
COUNT: 11
SUM: 56



Production Planning & Control related excel tasks.xlsx - Excel
CHART TOOLS
UT FORMULAS DATA REVIEW VIEW KUTOOLS ™ KUTOOLS PLUS DESIGN FORMAT
Sign in
C D E F G H I J K L
Forecasting
Data/ Value
25 20 15 10 5 0
0 1 2 3 4 5 6
Time
Data
Linear (Data)
Poly. (Data)
2 per. Mov. Avg. (Data)
Linear (Data)
Format Trendline
TRENDLINE OPTIONS
TRENDLINE OPTIONS
Exponential
Linear
Logarithmic
Polynomial
Order 2
Power
Moving Average
Period 2
Trendline Name
Automatic
Linear (Data)
Custom
Forecast
Forward 0.0 periods
Backward 0.0 periods
Set Intercept 0.0
Display Equation on chart

Months	Data
1	10
2	5
3	12
4	14
5	??



Further resources

1. Forecasting.ppt
2. Chapter 03, Operations_Management_Stevension_2015.pdf
3. Production Planning & Control related excel tasks (forecasting).xlsx

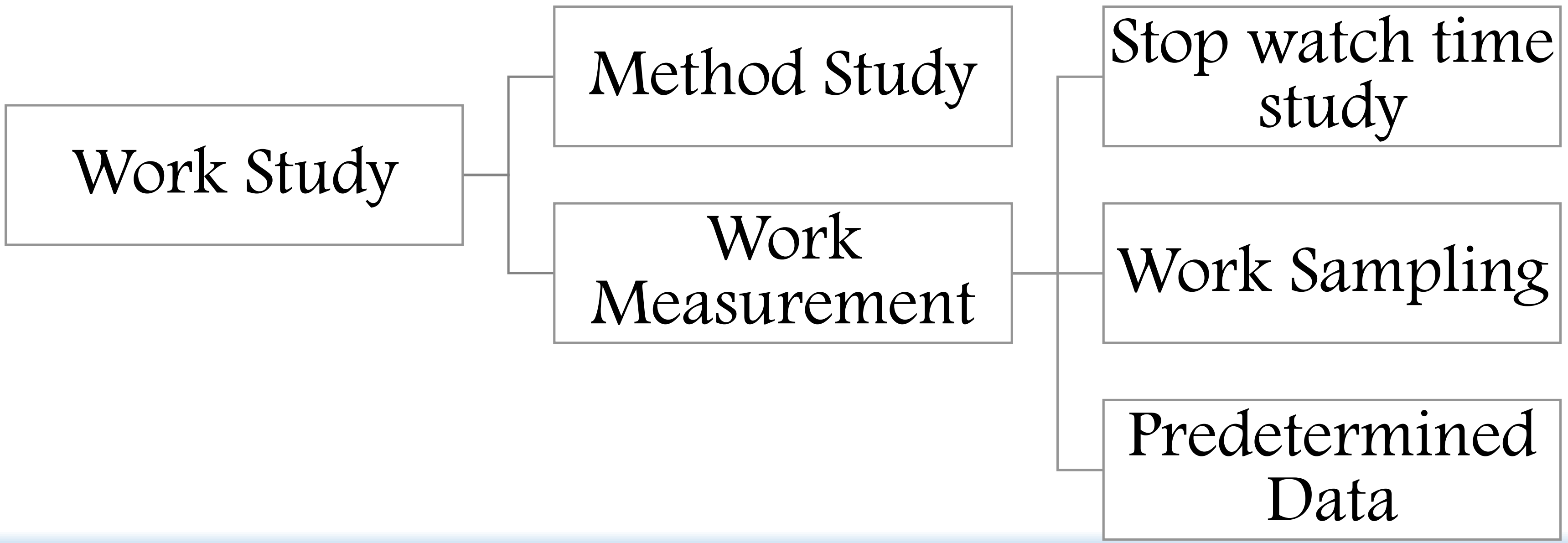
Work Study

Outline of Work Study

A. Methods analysis (e.g., charting, workstation design, motion economy)
B. Time study (e.g., time standards, allowances)
C. Predetermined time standard systems (e.g., MOST, MTM)
D. Work sampling
E. Learning curves

Work study

- Work study may be defined as the analysis of a job for the purpose of finding the preferred method of doing it and also determining the standard time to perform it by the preferred (or given) method. Work study, therefore, comprises of two areas of study: method study (motion study) and time study (work measurement).



A. Methods analysis (e.g., charting)

A. Methods analysis (e.g. workstation design)

A. Methods analysis (e.g. motion economy)

- **motion study:** Systematic study of the human motions used to perform an operation.

B. Time study (e.g., time standards, allowances)

- Work measurement: determining how long it ought to take to perform a job
- A **standard time** is the amount of time it should take a qualified worker to complete a specified task, working at a sustainable rate, using given methods, tools and equipment, raw material inputs, and workplace arrangement

The basic steps in a time study are:

1. Define the task to be studied, and inform the worker who will be studied.
2. Determine the number of cycles to observe.
3. Time the job, and rate the worker's performance.
4. Compute the standard time

B. Time study (e.g., time standards, allowances)

- Observed Time: The average of recorded time

$$OT = \frac{\sum x_i}{n}$$

OT = Observed time, $\sum x_i$ = Sum of recorded time, n = number of observation

- Normal Time: OT adjusted for worker performance

$$NT = OT * PR$$

NT = normal time, OT = Observed time, PR = Performance rating

- Standard Time: NT plus an allowance

$$ST = NT * AF$$

B. Time study (e.g., time standards, allowances)

An industrial engineer conducted a time study of an assembly operation with the times given. The engineer gave a performance rating of 115. The allowance factor is 10% of job time. The standard time for this operation is most nearly:

A. 2.96
B. 3.20
C. 3.56
D. 3.92

Observation	Time
1	3.10
2	3.05
3	3.10
4	3.08
5	3.12
6	3.15
7	3.12
8	3.08
9	3.05
10	3.10

$OT = \frac{\sum x_i}{n}$ => 30.95/10 = 3.095
$NT = OT * PR$ => 3.095*1.15 = 3.559
$ST = NT * AF$ => 3.559*1.10 = 3.915

A time study analyst timed an assembly operation for 30 cycles, and computed the time per cycle, which was 18.75 minutes. The analyst assigned a performance rating of .96,<11;'(& decided that an appropriate allowance was 15 percent~ Assume the allowance factor is based on the *workday*. *De*termine the following: the observed time, the normal time (NT), and the standard time (ST).

$$OT = \text{Average time} = 18.75 \text{ minutes}$$

$$NT = OT \times \text{Performance rating} = 18.75 \text{ minutes} \times .96 = 18 \text{ minutes}$$

$$AF = \frac{1}{1 - A} = \frac{1}{1 - .15} = 1.176$$

$$ST = NT \times AF = 18 \times 1.176 = 21.17 \text{ minutes}$$

C. Predetermined time standard systems (e.g., MOST)

- **MOST** stands for Maynard operation Sequence technique. It is one of the important work measurement technique used for decisions making.

C. Predetermined time standard systems (e.g. MTM - Method time measurement)

- the analyst must divide the job into its basic elements (reach, move, turn, disengage), measure the distances involved (if applicable), rate the difficulty of the element, and then refer to the appropriate table of data to obtain the time for that element.
- The standard time for the job is obtained by adding the times for all of the basic elements. Times of the basic elements are measured in time measurement units (TMUs); one TMU equals .0006 minute.

- **Standard Time Determination**
  $ST = NT \times AF$
  where NT = normal time, AF = allowance factor

- *Case 1:* Allowances are based on the *job time*.

$$AF_{job} = 1 + A_{job}$$

  A_{job} = allowance fraction (percentage/100) based on *job time*.

- *Case 2:* Allowances are based on *workday*.
  $AF_{time} = 1/(1 - A\_day)$
  A_{day} = allowance fraction (percentage/100) based on *workday*

1. Predetermined time systems are useful in cases where either (1) the task does not yet exist or (2) changes to a task are being designed and normal times have not yet been established for all elements of the new task or changed task. In such cases no opportunity exists to measure the element time.
2. Unfortunately, there is no scientific basis for predicting element times without breaking them down into motion-level parts. A task consists of elements. An organization may develop its own database of normal element durations, and normal times for new or changed tasks may be predicted if the tasks consist entirely of elements whose normal times are already in the database.
3. But new elements can be decomposed into motions, for which scientifcally predetermined times exist in databases called MTM-1, MTM-2, and MTM-3. These databases and software to manipulate them are commercially available. To use one of them effectively requires about 50 hours of training

D. Work sampling

The technique for estimating the proportion of time that a worker or machine spends on various activities and the idle time

$$n = \left(\frac{z}{e}\right)^2 \hat{p}(1 - \hat{p})$$

The manager of a small supermarket chain wants to estimate the proportion of time stock clerks spend making price changes on previously marked merchandise. The manager wants a 98 percent confidence that the resulting estimate will be within 5 percent of the true value. What sample size should she use?

The procedure of work sampling

1. Clearly identify the worker(s) or machine(s) to be studied.
2. Notify the workers and supervisors of the purpose of the study to avoid arousing suspicions.
3. Compute an initial estimate of sample size using a preliminary estimate of p, if available (e.g., from analyst experience or past data). Otherwise, use $p = .50$.
4. Develop a random observation schedule.
5. Begin taking observations. Re-compute the required sample size several times during the study.
6. Determine the estimated proportion of time spent on the specified activity

WORK SAMPLING FORMULAS

$$D = Z_{\alpha/2}\sqrt{\frac{p(1-p)}{n}} \text{ and } R = Z_{\alpha/2}\sqrt{\frac{1-p}{pn}}, \text{ where}$$

p = proportion of observed time in an activity

D = absolute error

R = relative error ($R = D/p$)

n = sample size

Source: FE – Industrial Specific

Work sampling. An analyst has been asked to prepare an estimate of the proportion of time that a turret lathe operator spends adjusting the machine, with a 90 percent confidence level. Based on previous experience, the analyst believes the proportion will be approximately 30 percent.

a. If the analyst uses a sample size of 400 observations, what is the maximum possible error that will be associated with the estimate?

b. What sample size would the analyst need in order to have the maximum error be no more than ±5 percent?

$\hat{p} = .30 \qquad z = 1.65$ (for 90 percent confidence)

a. $e = z\sqrt{\dfrac{\hat{p}(1-\hat{p})}{n}} = 1.65\sqrt{\dfrac{.3(.7)}{400}} = .038$

b. $n = \left(\dfrac{z}{e}\right)^2 \hat{p}(1-\hat{p}) = \left(\dfrac{1.65}{.05}\right)^2 (.3)(.7) = 228.69$, or 229

Time Study	Work Sampling

Time Study

A. Sample size

$$n = \left(\frac{zs}{a\bar{x}}\right)^2 \qquad (7\text{–}1)$$

$$n = \left(\frac{zs}{e}\right)^2 \qquad (7\text{–}2)$$

B. Observed time

$$\text{OT} = \frac{\sum x_i}{n} \qquad (7\text{–}3)$$

C. Normal time

$$\text{NT} = \text{OT} \times \text{PR} \qquad (7\text{–}4)$$

$$\text{NT} = \sum(\bar{x}_j \times \text{PR}_j) \qquad (7\text{–}5)$$

D. Standard time

$$\text{ST} = \text{NT} \times \text{AF} \qquad (7\text{–}6)$$

E. Allowance factor

$$\text{AF}_{job} = 1 + A \qquad (7\text{–}7)$$

$$\text{AF}_{day} = \frac{1}{1 - A} \qquad (7\text{–}8)$$

Work Sampling

A. Maximum error

$$e = z\sqrt{\frac{\hat{p}(1 - \hat{p})}{n}} \qquad (7\text{–}9)$$

B. Sample size

$$n = \left(\frac{z}{e}\right)^2 \hat{p}(1 - \hat{p}) \qquad (7\text{–}10)$$

Symbols:

a = Allowable error as percentage of average time

A = Allowance percentage

e = Maximum acceptable error

n = Number of observations needed

NT = Normal time

OT = Observed, or average, time

PR = Performance rating

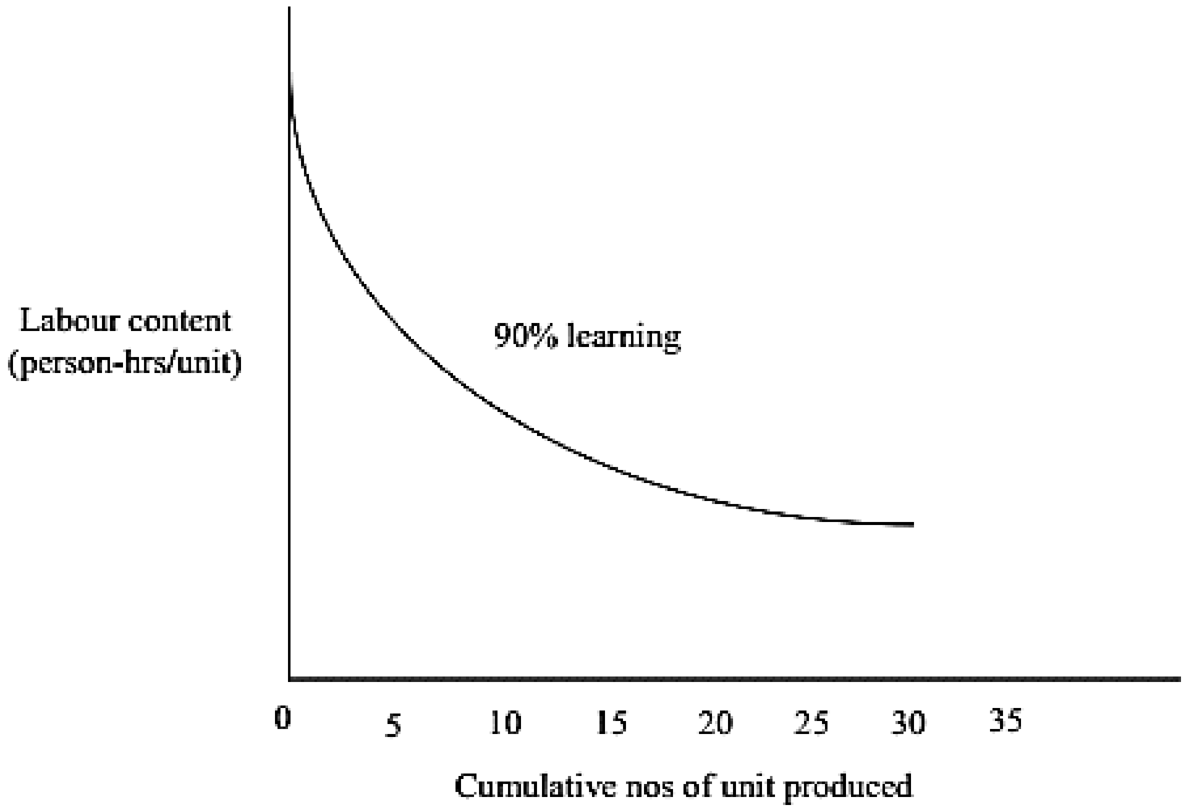
s = Standard deviation of observed times

ST = Standard time

x_i = Time for ith observation (i = 1, 2, 3, . . . , n)

E. Learning curves

- Human performance of activities typically shows improvement when the activities are done on a repetitive basis: The time required to perform a task decreases with increasing repetitions. *Learning curves* summarize this phenomenon



Learning Curve

- The labour content (in person-hrs per unit) requires to make a product, expressed as a function of the cumulative number of units made is called Learning Curve
- the amount of time required to make the nth unit of the product will be

$$T_n = T_1 \times n^a$$

where T_n = Time to make the nth unit.
T_1 = Time to make 1st unit.
a = (ln x/ln 2)
x = learning rate (expressed as decimal)

- **Given, 80% curve, T_1 = 10 hours, how much it would take to produce 3rd product?**

Applications of Learning Curves

Learning curve theory has found useful applications in a number of areas

1. Manpower planning and scheduling.
2. Negotiated purchasing.
3. Pricing new products.
4. Budgeting, purchasing, and inventory planning.
5. Capacity planning.

LEARNING CURVES

The time to do the repetition N of a task is given by

$$T_N = KN^s, \text{ where}$$

K = constant

s = ln (learning rate, as a decimal)/ln 2; or, learning rate = 2^s

If N units are to be produced, the average time per unit is given by

$$T_{avg} = \frac{K}{N(1+s)}\left[(N+0.5)^{(1+s)} - 0.5^{(1+s)}\right]$$

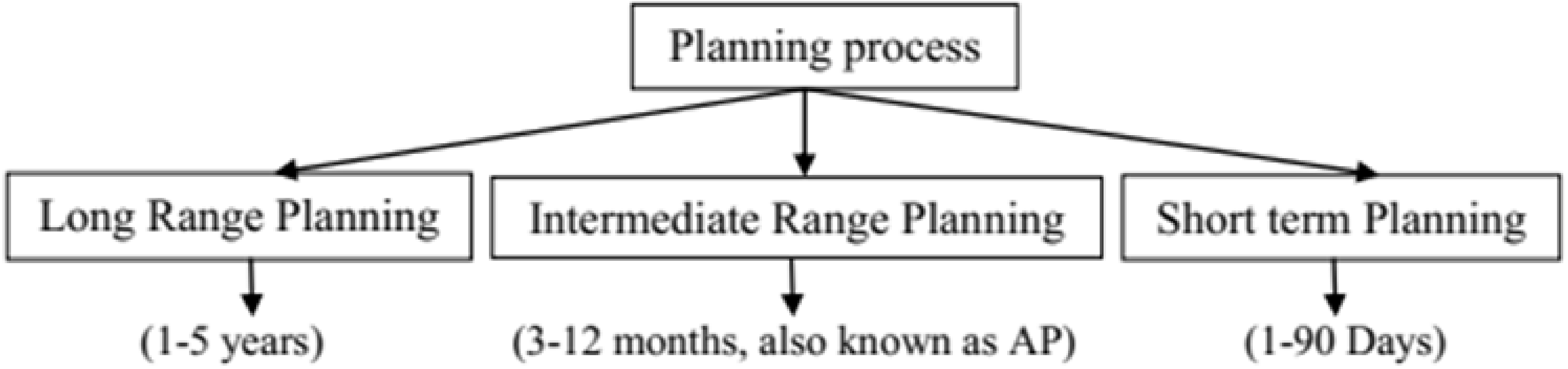
Source: Fundamental Engineering – Industrial Specific

Aggregate Planning

Aggregate Planning definition

- The aggregate planning concentrates on scheduling production, personnel and inventory levels during intermediate term planning horizon such as 3-12 months.
- Aggregate plans act as an interface between strategic decision (which fixes the operating environment) and short term scheduling and control decision which guides firm's day-to-day operations.

Aggregate planning (AP)



Planning hierarchy

AP: Production planning in the intermediate range of time is termed as Aggregate planning.

MRP and ERP

Learning Objectives

- Describe the conditions under which MRP is most appropriate.
- Describe the inputs, outputs, and nature of MRP processing.
- Explain how requirements in a master production schedule are translated into material requirements for lower-level items.
- Discuss the benefits and requirements of MRP.

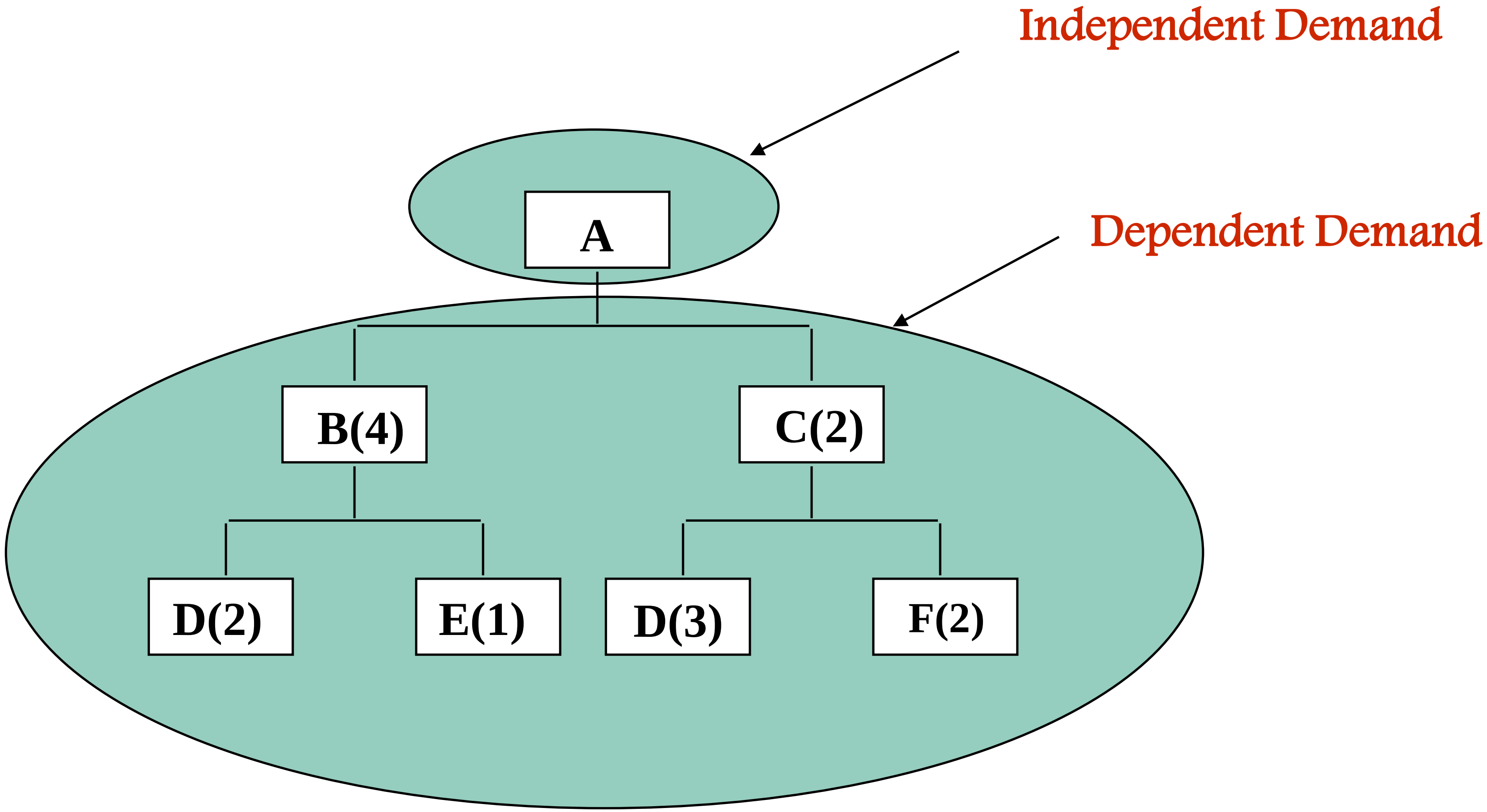
Learning Objectives

- Explain how an MRP system is useful in capacity requirements planning.
- Outline the potential benefits and some of the difficulties users have encountered with MRP.
- Describe MRP II and its benefits.
- Describe ERP, what it provides, and its hidden costs.

MRP

- *Material requirements planning (MRP):* Computer-based information system that translates master schedule requirements for end items into time-phased requirements for subassemblies, components, and raw materials.

Independent and Dependent Demand



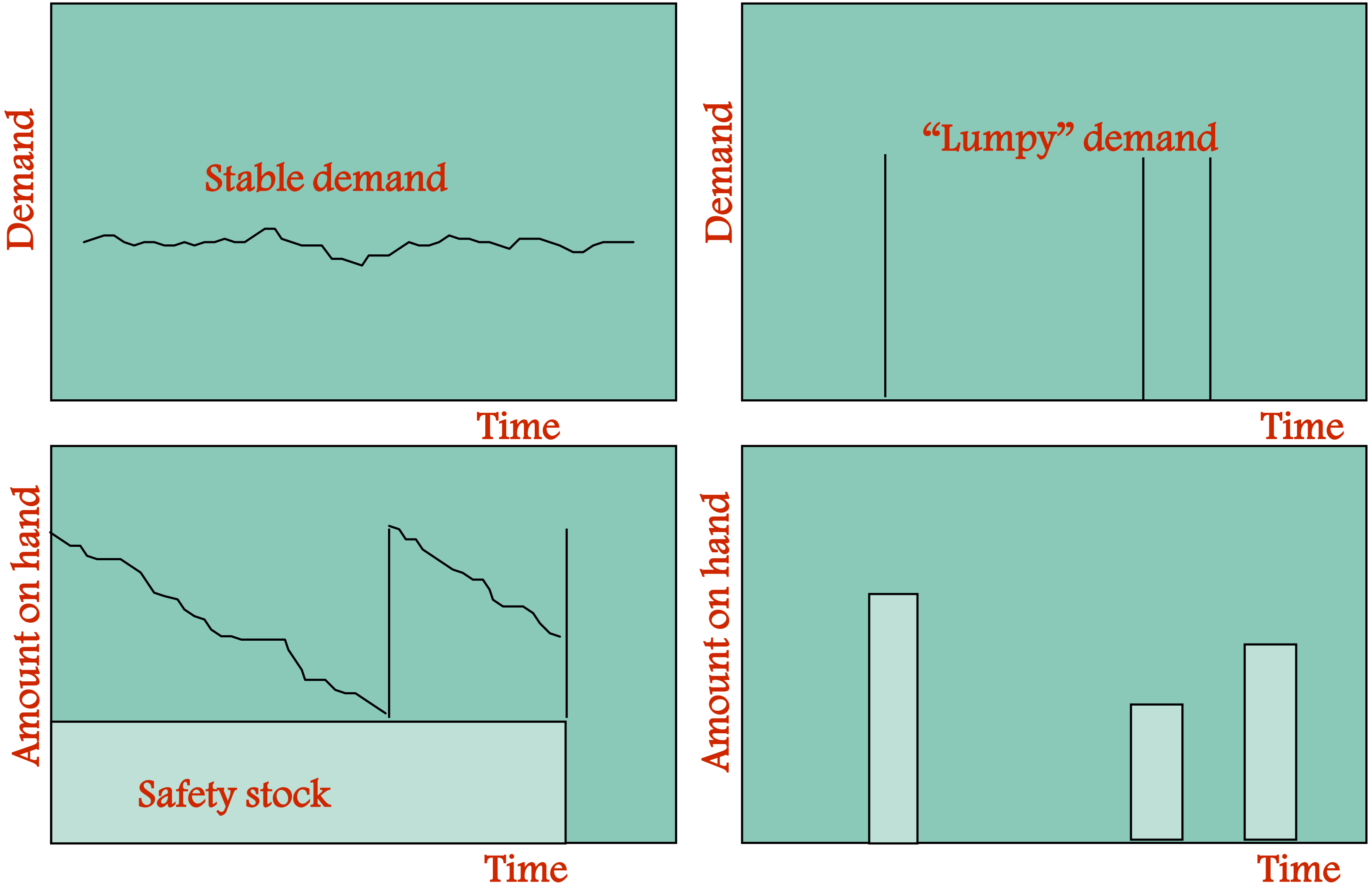
Independent demand is uncertain.
Dependent demand is certain.

Dependant Demand

- *Dependent demand*: Demand for items that are subassemblies or component parts to be used in production of finished goods.
- Once the independent demand is known, the dependent demand can be determined.

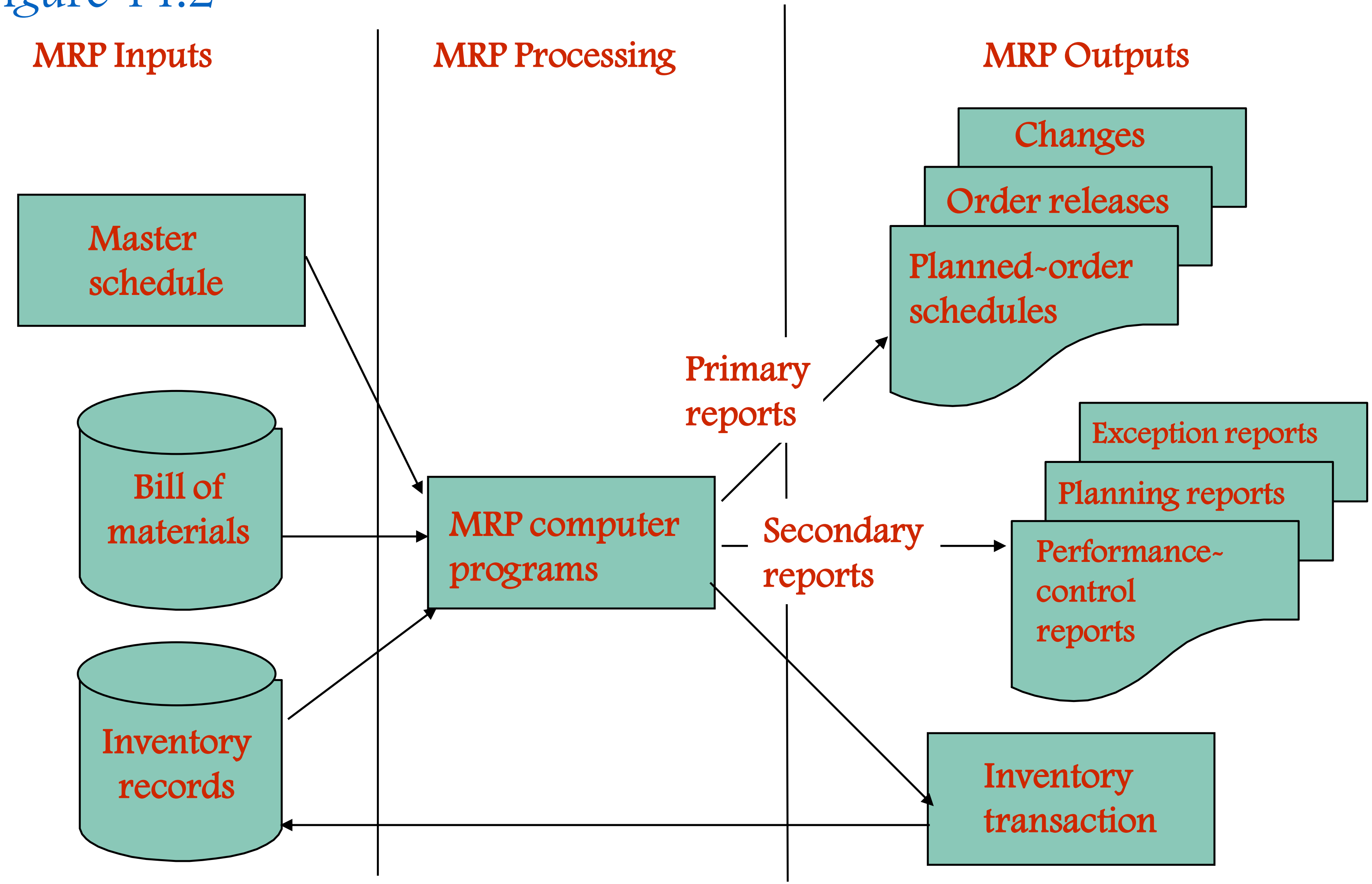
Dependent vs Independent Demand

Figure 14.1



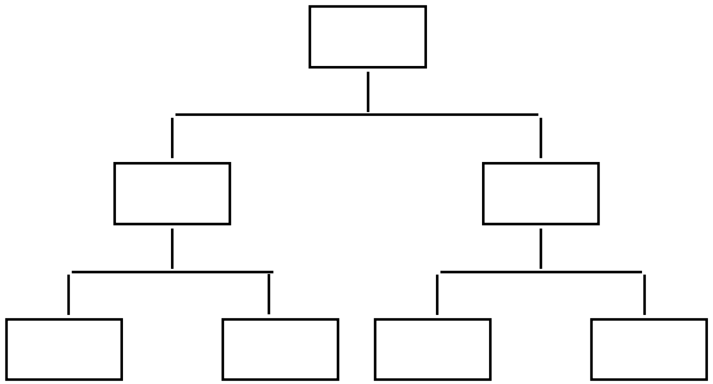
Overview of MRP

Figure 14.2



MPR Inputs

- Master Production Schedule
- Time-phased plan specifying timing and quantity of production for each end item.
- Material Requirement Planning Process



Product Structure Tree

Lead Times

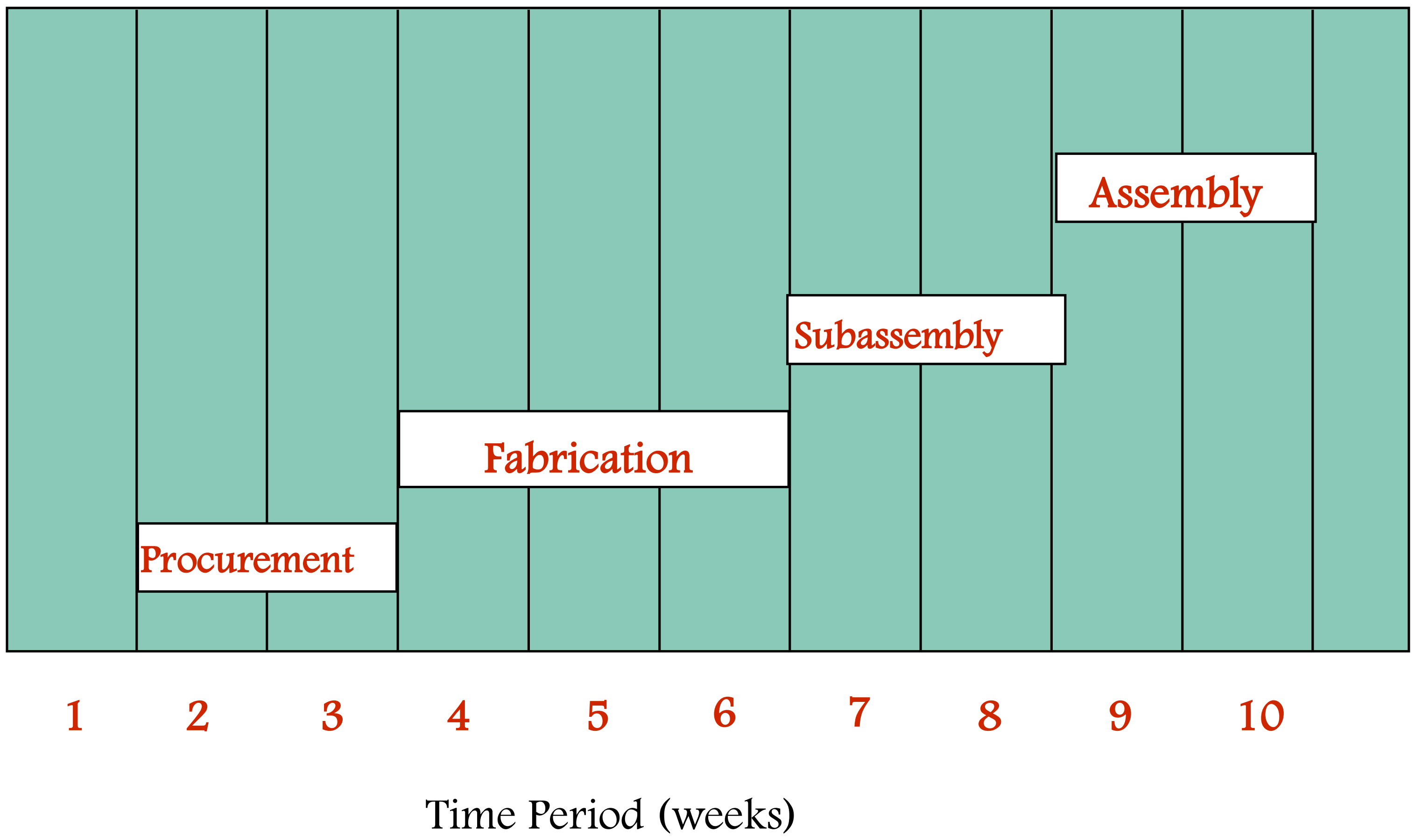
Master Schedule

Master schedule: One of three primary inputs in MRP; states which end items are to be produced, when these are needed, and in what quantities.

Cumulative lead time: The sum of the lead times that sequential phases of a process require, from ordering of parts or raw materials to completion of final assembly.

Planning Horizon

Figure 14.4



Bill-of-Materials

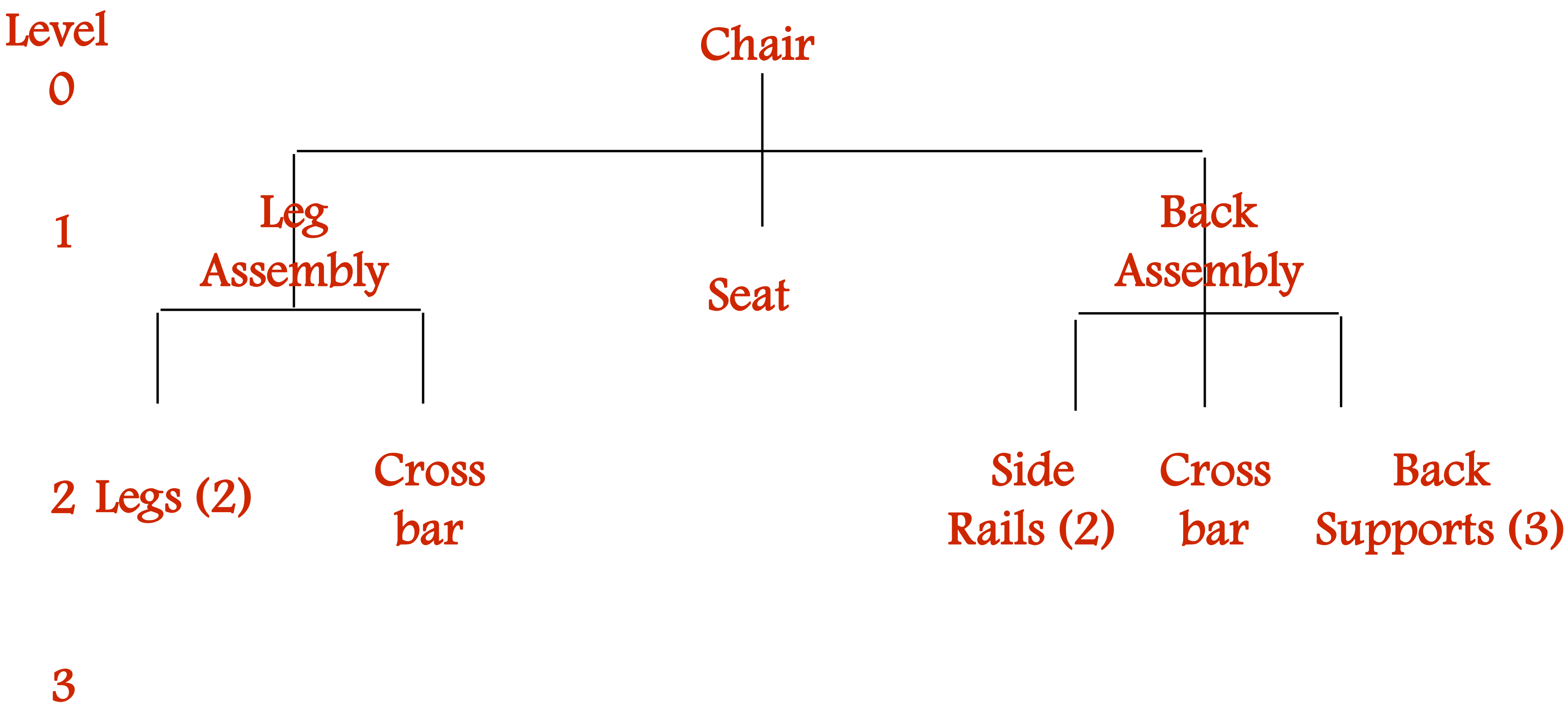
Bill of materials (BOM): One of the three primary inputs of MRP; a listing of all of the raw materials, parts, subassemblies, and assemblies needed to produce one unit of a product.

Product structure tree: Visual depiction of the requirements in a bill of materials, where all components are listed by levels.

Low-level coding: Restructuring the bill of materials so that multiple occurrences of a component all coincide with the lowest level the component occurs

Product Structure Tree

Figure 14.5



Inventory Records

- One of the three primary inputs in MRP
- Includes information on the status of each item by time period
  - Gross requirements
  - Scheduled receipts
  - Amount on hand
  - Lead times
  - Lot sizes
  - And more …

Inventory Requirements

- Net requirements:

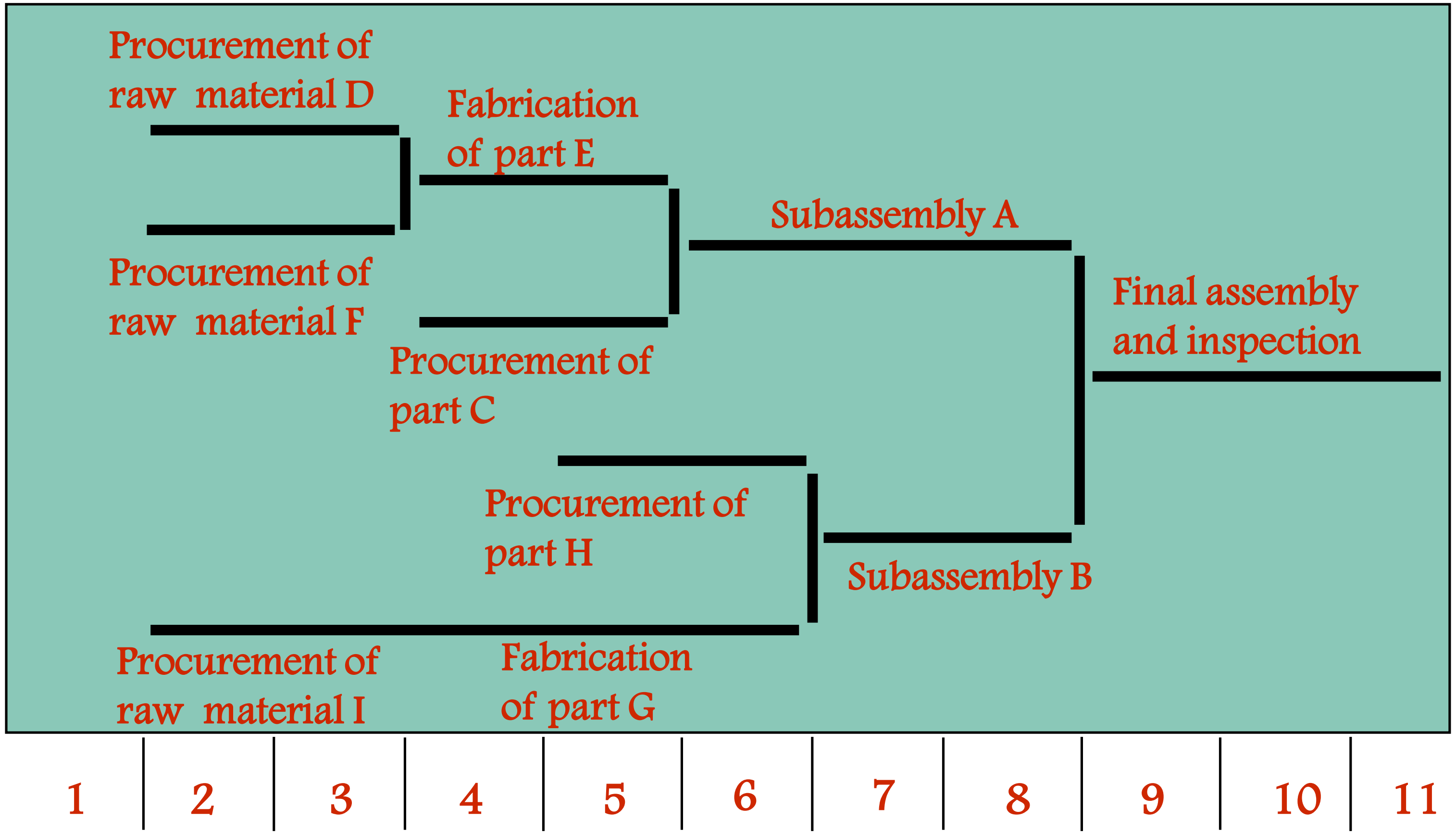
Net Requirements =
Gross Requirements
– Available Inventory

- Available Inventory:

Available Inventory =
Projected on hand
– Safety stock
– Inventory allocated to other items

Assembly Time Chart

Figure 14.7



MRP Processing

- Gross requirements
- Schedule receipts
- Projected on hand
- Net requirements
- Planned-order receipts
- Planned-order releases

MPR Processing

- Gross requirements
  - Total expected demand
- Scheduled receipts
  - Open orders scheduled to arrive
- Planned on hand
  - Expected inventory on hand at the beginning of each time period

MPR Processing

- Net requirements
  - Actual amount needed in each time period
- Planned-order receipts
  - Quantity expected to received at the beginning of the period
  - Offset by lead time
- Planned-order releases
  - Planned amount to order in each time period

Updating the System

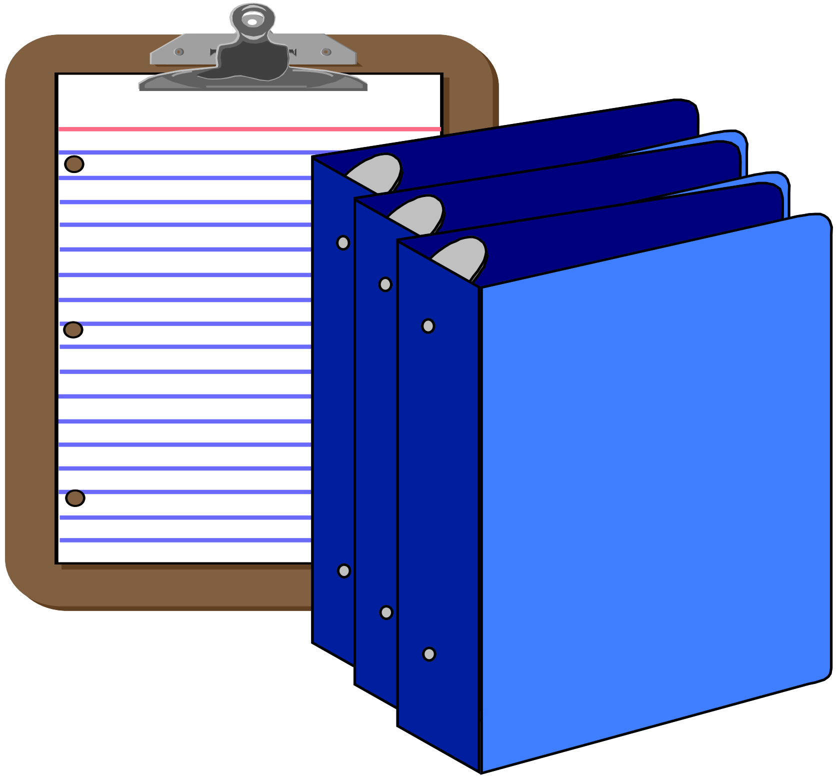
- Regenerative system
  - Updates MRP records periodically
- Net-change system
  - Updates MPR records continuously

MRP Primary Reports

- Planned orders - schedule indicating the amount and timing of future orders.
- Order releases - Authorization for the execution of planned orders.
- Changes - revisions of due dates or order quantities, or cancellations of orders.

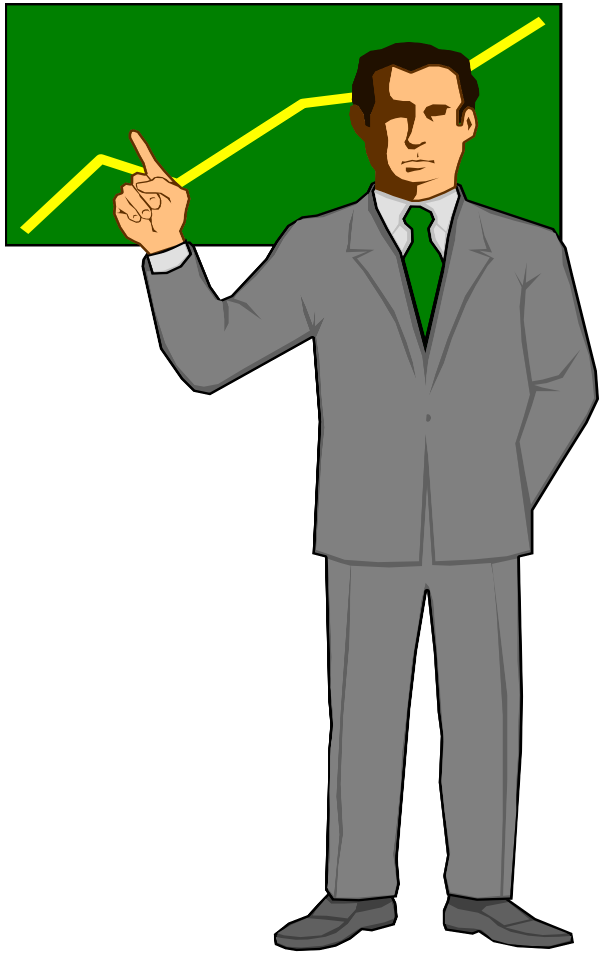
MRP Secondary Reports

- Performance-control reports
- Planning reports
- Exception reports



Other Considerations

- Safety Stock
- Lot sizing
  - Lot-for-lot ordering
  - Economic order quantity
  - Fixed-period ordering



MRP in Services

- Food catering service
  - End item => catered food
  - Dependent demand => ingredients for each recipe, i.e. bill of materials
- Hotel renovation
  - Activities and materials "exploded" into component parts for cost estimation and scheduling

Benefits of MRP

- Low levels of in-process inventories
- Ability to track material requirements
- Ability to evaluate capacity requirements
- Means of allocating production time
- Ability to easily determine inventory usage by backflushing
- *Backflushing*: Exploding an end item's bill of materials to determine the quantities of the components that were used to make the item.

Requirements of MRP

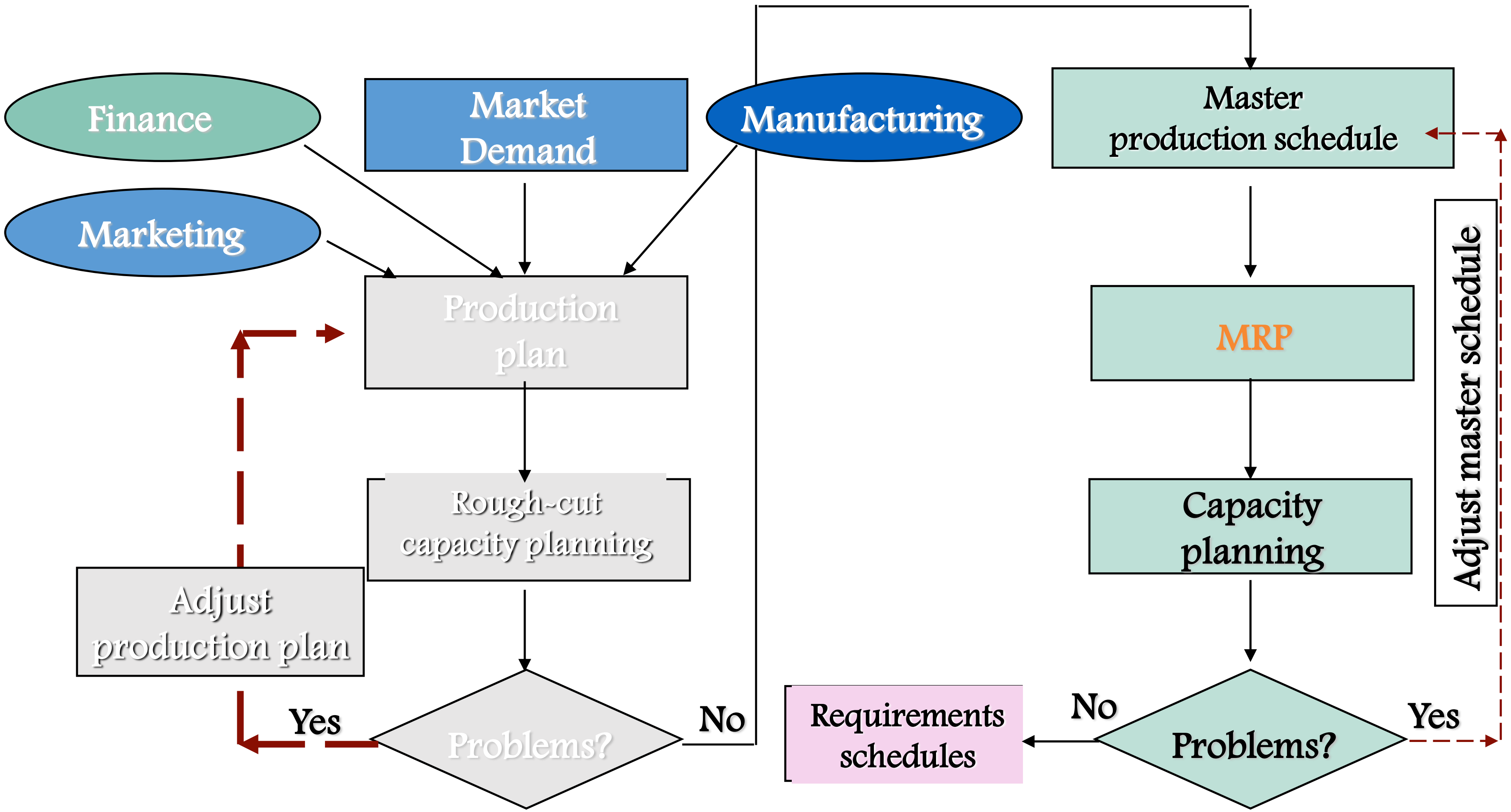
- Computer and necessary software
- Accurate and up-to-date
  - Master schedules
  - Bills of materials
  - Inventory records
- Integrity of data

MRP II

- Expanded MRP with emphasis placed on integration
  - Financial planning
  - Marketing
  - Engineering
  - Purchasing
  - Manufacturing

MRP II

Figure 14.14



Capacity Planning

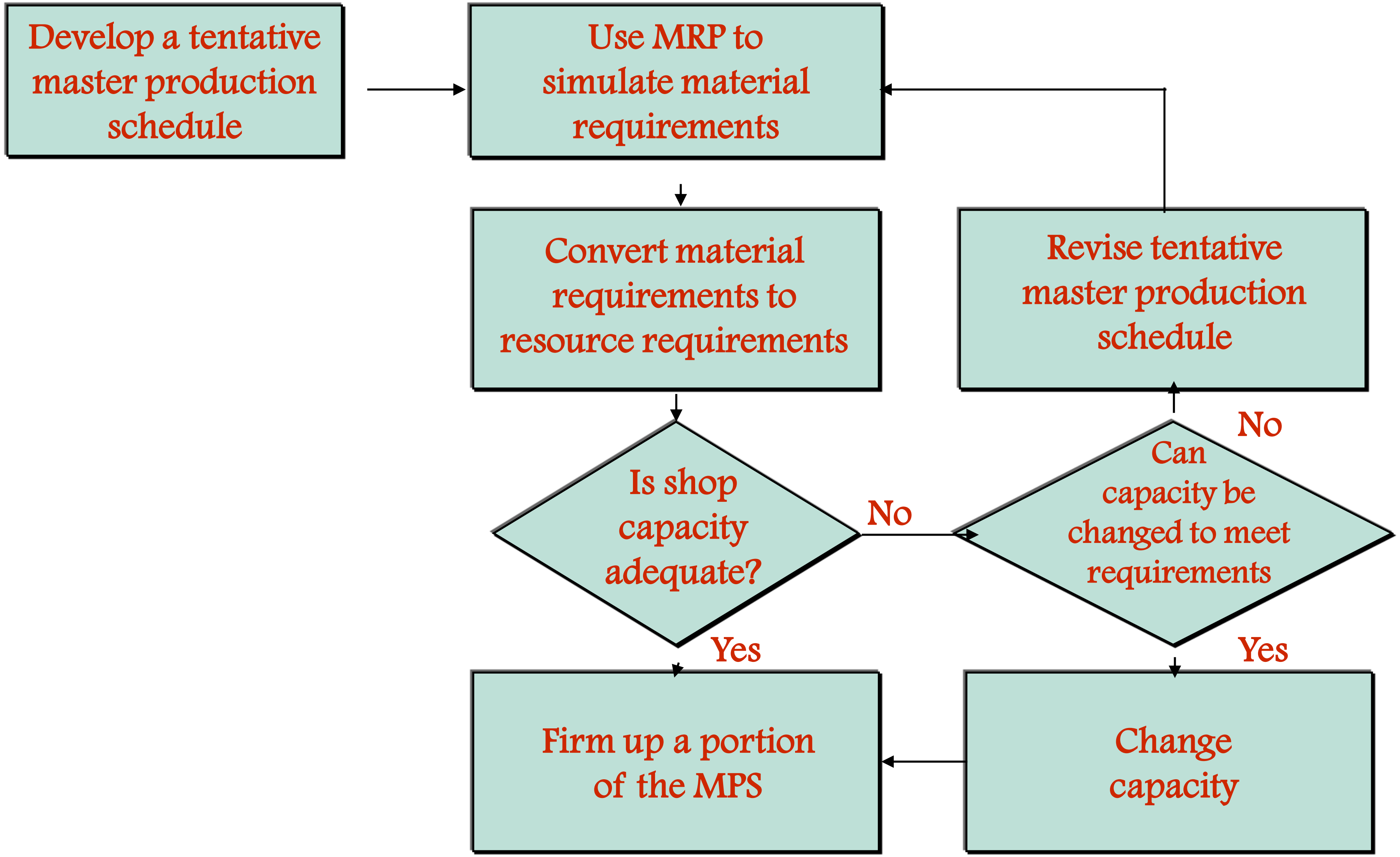
Capacity requirements planning: The process of determining short-range capacity requirements.

Load reports: Department or work center reports that compare known and expected future capacity requirements with projected capacity availability.

Time fences: Series of time intervals during which order changes are allowed or restricted.

Capacity Planning

Figure 14.15



ERP

- *Enterprise resource planning (ERP):*
  - Next step in an evolution that began with MPR and evolved into MRPII
  - Integration of financial, manufacturing, and human resources on a single computer system.

ERP Software

- ERP software provides a system to capture and make data available in real time to decision makers and other users in the organization
- Provides tools for planning and monitoring various business processes
- Includes
  - Production planning and scheduling
  - Inventory management
  - Product costing
  - Distribution

MRP in Services

- Service applications such as:
  - Professional services
  - Postal services
  - Retail
  - Banking
  - Healthcare
  - Higher education
  - Engineering
  - Logistical services
  - Real estate

ERP Strategy Considerations

- High initial cost
- High cost to maintain
- Future upgrades
- Training

Further Resources

- Aggreagate Planning.ppt
- MRP & ERP.ppt
- Chapter 11,12; Operations_Management_Stevension_2015.pdf

Journal Paper: Computer in PPC

- Computer Applications in Production Management and Their Impact on Company performance