UNIT III

Chapter 2

Risk Management

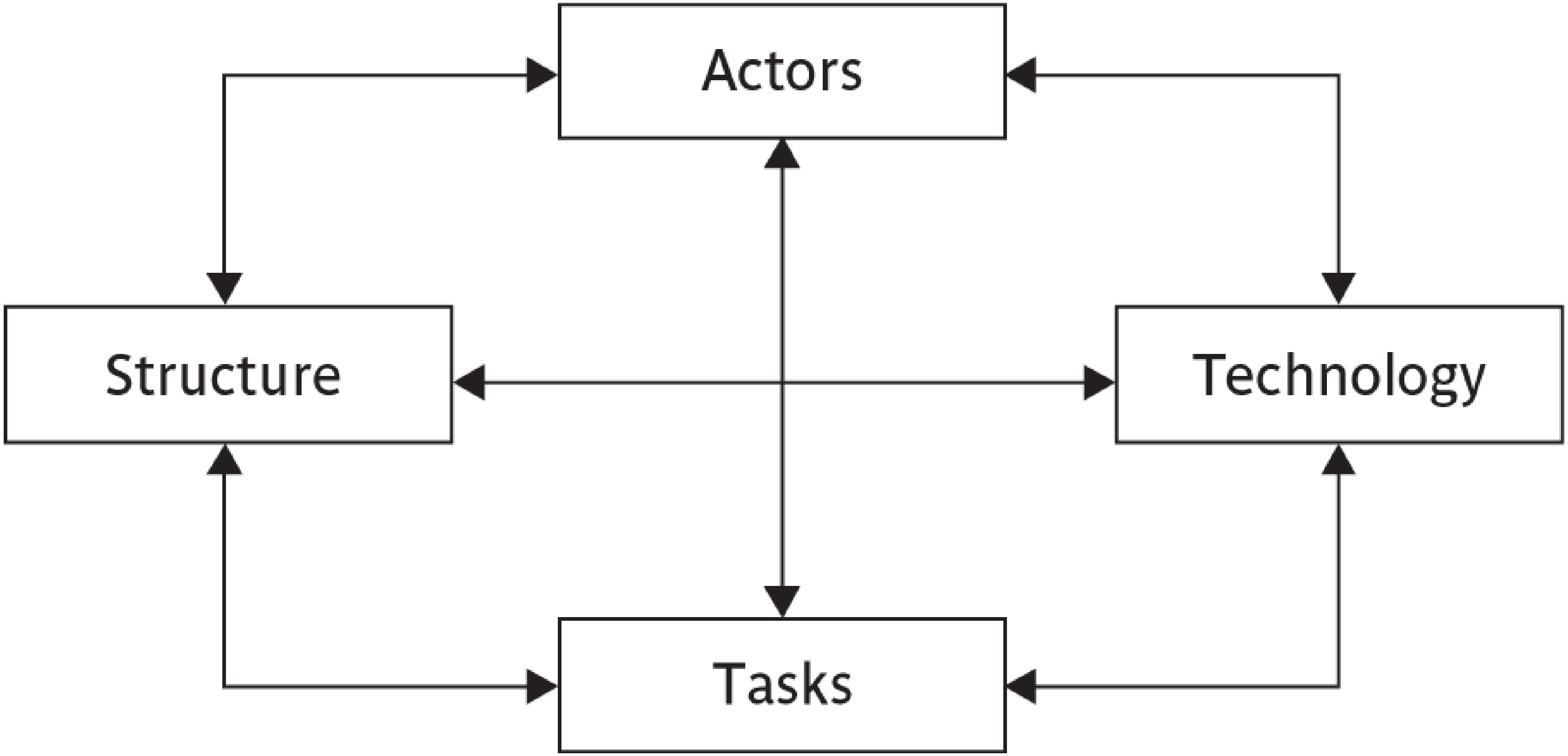
Introduction

'the chance of exposure to the adverse consequences of future events' PRINCE2

'an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives' PM-BOK

- Risks relate to **possible future** problems, not current ones
- They involve a possible cause and its effect(s) e.g. developer leaves > task delayed

Categories of risk



❑ Risk Management Approaches

- Reactive:
  - Reactive approaches take no action until an unfavourable event occurs.
  - Once an unfavourable event occurs, these approaches try to contain the adverse effects associated with the risk and take steps to prevent future occurrence of the same risk events.
- Proactive:
  - The proactive approaches try to anticipate the possible risks that the project is susceptible to.
  - After identifying the possible risks, actions are taken to eliminate the risks.

❑ A framework for dealing with risk

The planning for risk includes these steps:

- Risk identification – what risks might there be?
- Risk analysis and prioritization – which are the most serious risks?
- Risk planning – what are we going to do about them?
- Risk monitoring – what is the current state of the risk?

❑ Risk identification

Approaches to identifying risks include:

- Use of checklists – usually based on the experience of past projects
- Brainstorming – getting knowledgeable stakeholders together to pool concerns
- Causal mapping – identifying possible chains of cause and effect

❑ Boehm's top 10 development risks

Risk	Risk reduction techniques
1. Personnel shortfalls	Staffing with top talent; job matching; teambuilding; training and career development; early scheduling of key personnel
2. Unrealistic time and cost estimates	Multiple estimation techniques; design to cost; incremental development; recording and analysis of past projects; standardization of methods
3. Developing the wrong software functions	Improved software evaluation; formal specification methods; user surveys; prototyping; early user manuals
4. Developing the wrong user interface	Prototyping; task analysis; user involvement

5. Gold plating	Requirements scrubbing, prototyping, design to cost
6. Late changes to requirements	Change control, incremental development
7. Shortfalls in externally supplied components	Benchmarking, inspections, formal specifications, contractual agreements, quality controls
8. Shortfalls in externally performed tasks	Quality assurance procedures, competitive design etc.
9. Real time performance problems	Simulation, prototyping, tuning
10. Development technically too difficult	Technical analysis, cost-benefit analysis, prototyping , training

❑ Risk Assessment

Risk exposure (RE)

= (potential damage) x (probability of occurrence)

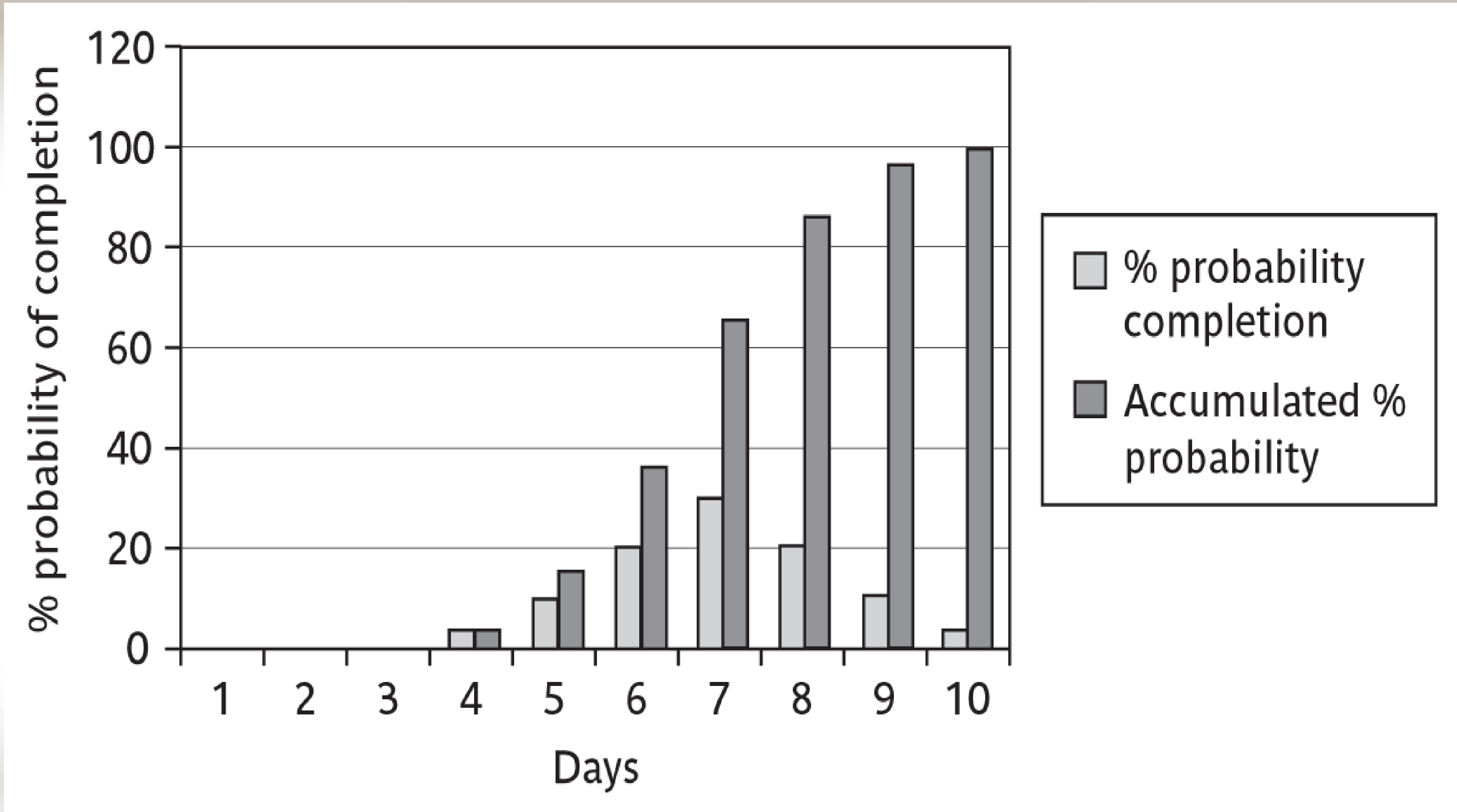
Ideally

Potential damage: a money value e.g. a flood would cause £0.5 millions of damage

Probability 0.00 (absolutely no chance) to 1.00 (absolutely certain) e.g. 0.01 (one in hundred chance)

RE = £0.5m x 0.01 = £5,000

Crudely analogous to the amount needed for an insurance premium


% probability of completion
120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
Days
% probability completion
Accumulated % probability

Risk probability: qualitative descriptors

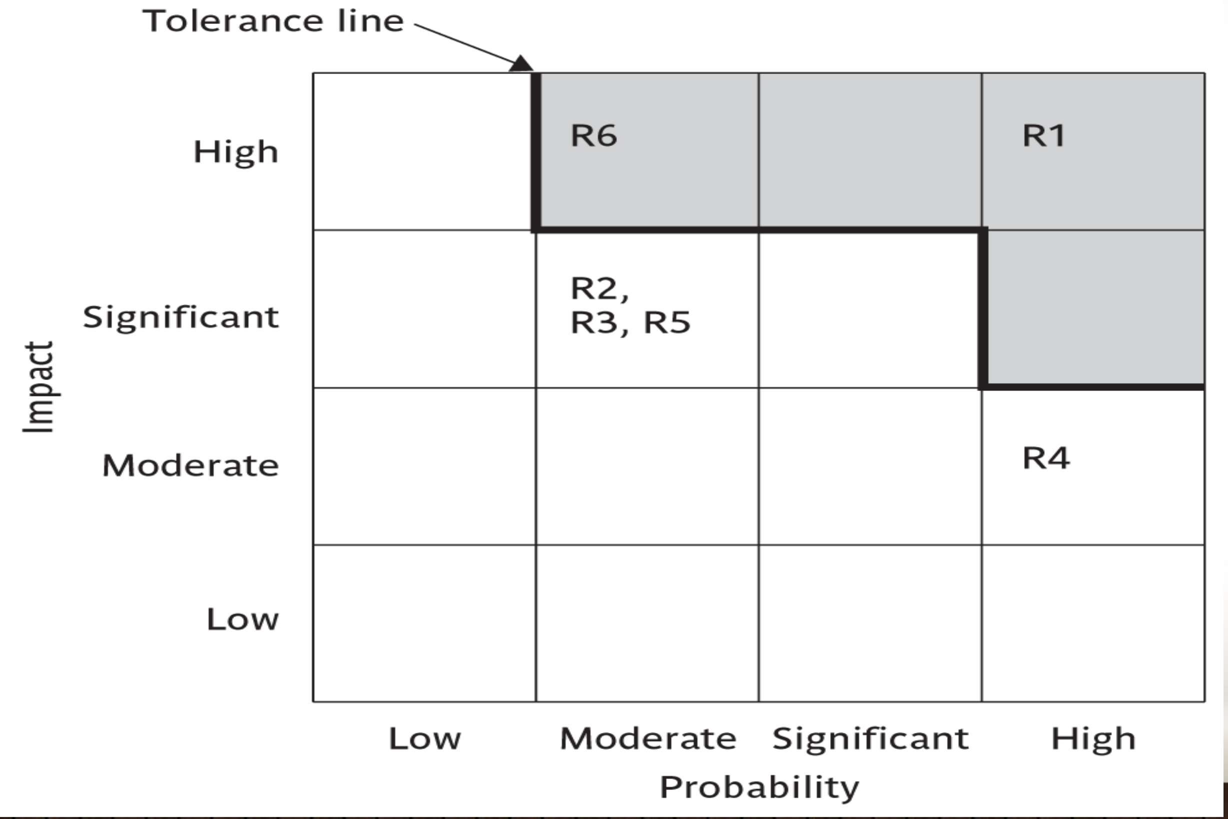
Probability level	Range
High	Greater than 50% chance of happening
Significant	30-50% chance of happening
Moderate	10-29% chance of happening
Low	Less than 10% chance of happening

Qualitative descriptors of impact on cost and associated range values

Impact level	Range
High	Greater than 30% above budgeted expenditure
Significant	20 to 29% above budgeted expenditure
Moderate	10 to 19% above budgeted expenditure
Low	Within 10% of budgeted expenditure.

Probability impact matrix

- Risk that appear within this zone have a degree of seriousness that calls for particular attention .



Risk planning

Risks can be dealt with by:

- Risk acceptance
- Risk avoidance
- Risk reduction
- Risk transfer
- Risk mitigation/contingency measures

Risk reduction leverage

Risk reduction leverage =

$$(RE_{before} - RE_{after}) / \text{(cost of risk reduction)}$$

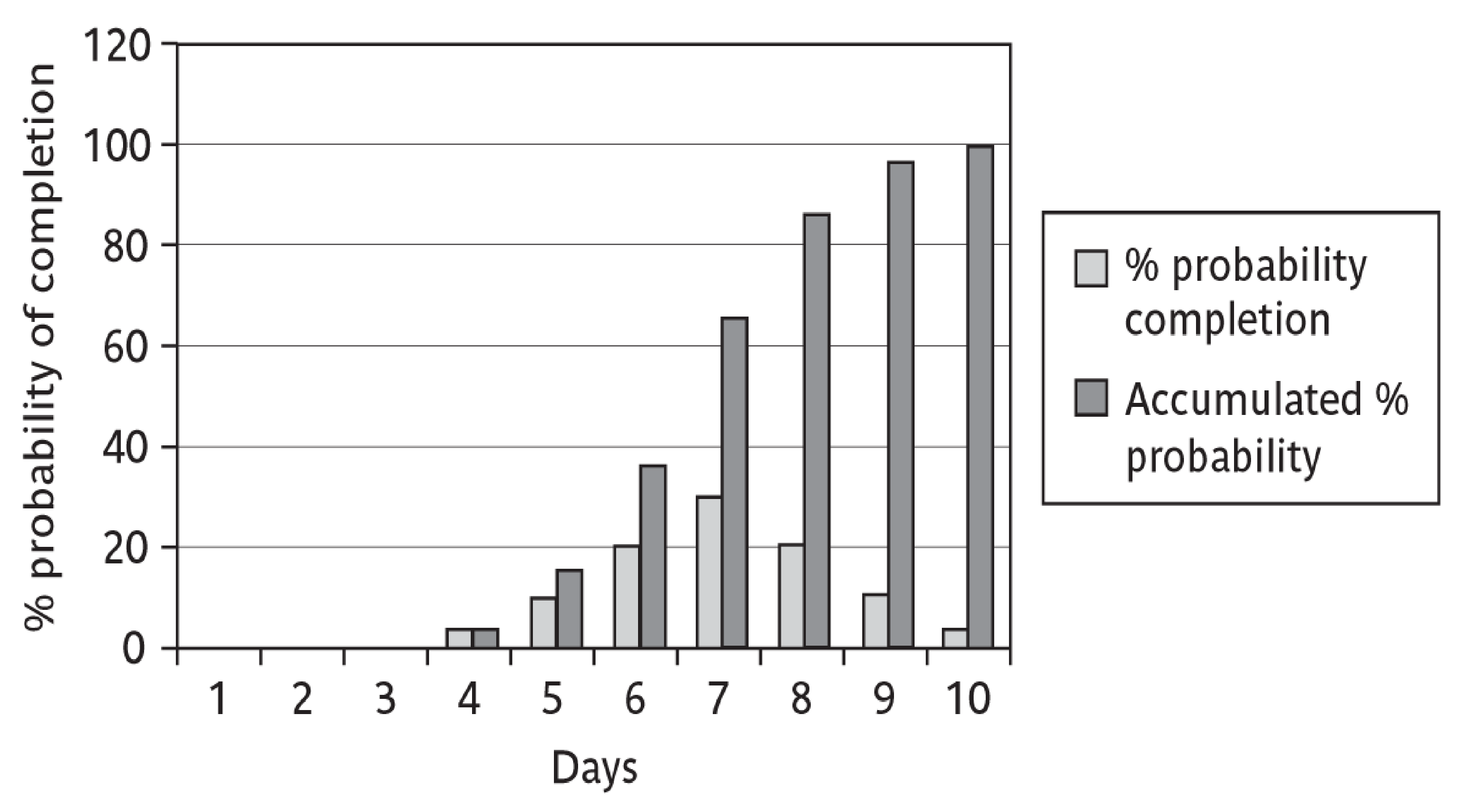
RE_{before} is risk exposure before risk reduction e.g. 1% chance of a fire causing £200k damage

RE_{after} is risk exposure after risk reduction e.g. fire alarm costing £500 reduces probability of fire damage to 0.5%

RRL = (1% of £200k)-(0.5% of £200k)/£500 = 2

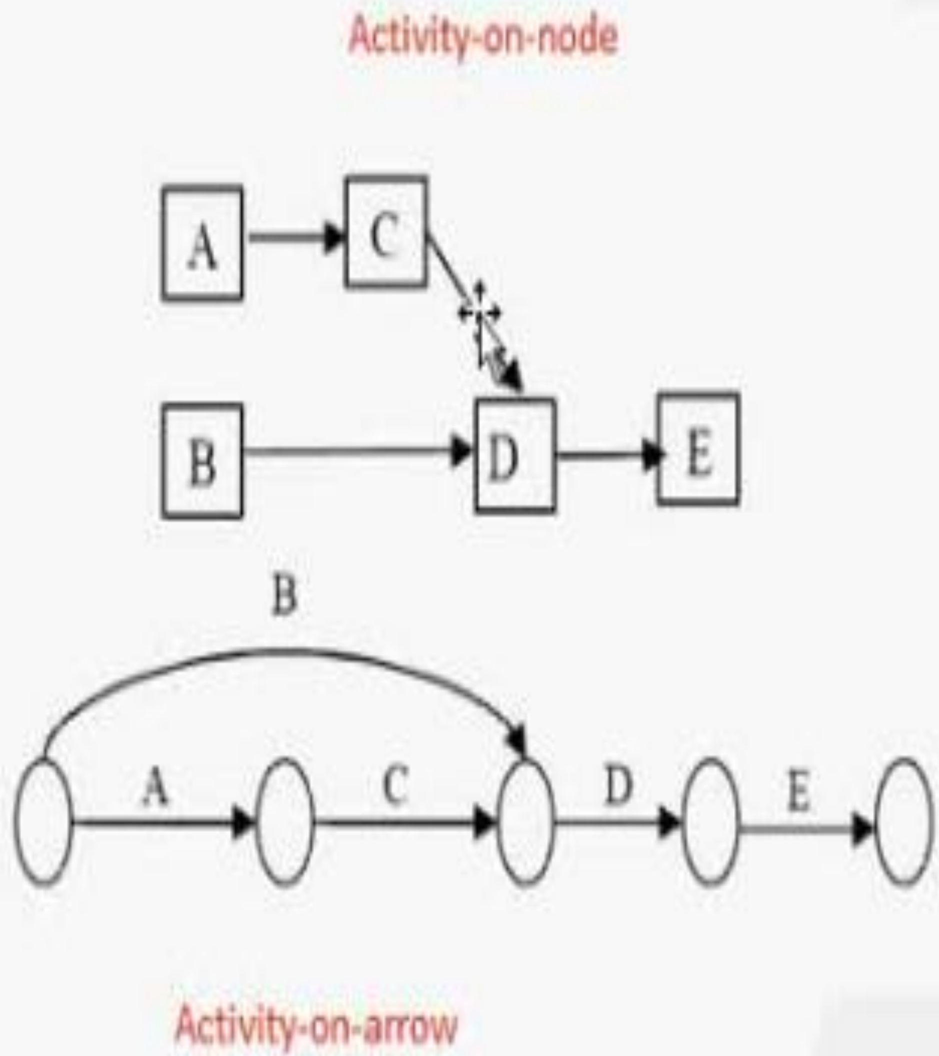
RRL > 1.00 therefore worth doing

Evaluating Risk to Schedule



Example of PERT diagrams:

Task	Precedence
A	
B	
C	A
D	B,C
E	D

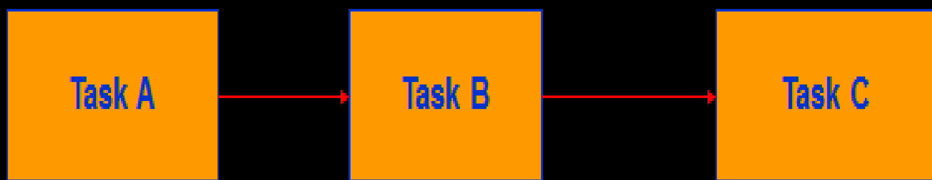


Apply : : Using PERT to evaluate the effects of uncertainty

Three estimates are produced for each activity

- Most likely time (m)
- Optimistic time (a) – task to undertake in normal circumstances
- Pessimistic (b) -worst possible time
- ‘expected time’ t_e Or Mean = (a + 4m +b) / 6
- ‘activity standard deviation’ S or Variation = (b-a)/6

A chain of activities



Task	a	m	b	t_e	s
A	10	12	16	?	?
B	8	10	14	?	?
C	20	24	38	?	?

Question :

1. What would be the expected duration of the chain A + B + C?

Answer:

12.66 + 10.33 + 25.66

i.e. 48.65

2. What would be the standard deviation for A + B+ C?

Answer:

square root of $(1^2 + 1^2 + 3^2)$

i.e. 3.32

TABLE 7.6 PERT activity time estimates

Activity	Optimistic (*a*)	Activity durations (weeks). Most likely (*m*)	Pessimistic (*b*)
A	5	6	8
B	3	4	5
C	2	3	3
D	3.5	4	5
E	1	3	4
F	8	10	15
G	2	3	4
H	2	2	2.5

t_e $(a + 4m + b) / 6$

s $(b - a)/6$

Table 7.7 Expected times and standard deviations

Activity	Activity durations (weeks)				
	Optimistic (a)	Most likely (m)	Pessimistic (b)	Expected (t_e)	Standard deviation (s)
A	5	6	8	6.17	0.50
B	3	4	5	4.00	0.33
C	2	3	3	2.83	0.17
D	3.5	4	5	4.08	0.25
E	1	3	4	2.83	0.50
F	8	10	15	10.50	1.17
G	2	3	4	3.00	0.33
H	2	2	2.5	2.08	0.08

PERT event Labelling →

Even number	Target date
Expected date	Standard deviation

Activity		Duration (weeks)	Precedents
A	Hardware selection	6	
B	System configuration	4	
C	Install hardware	3	A
D	Data migration	4	B
E	Draft office procedures	3	B
F	Recruit staff	10	
G	User training	3	E, F
H	Install and test system	2	C, D

1. Calculate Expected Duration

t_e $(a + 4m + b) / 6$

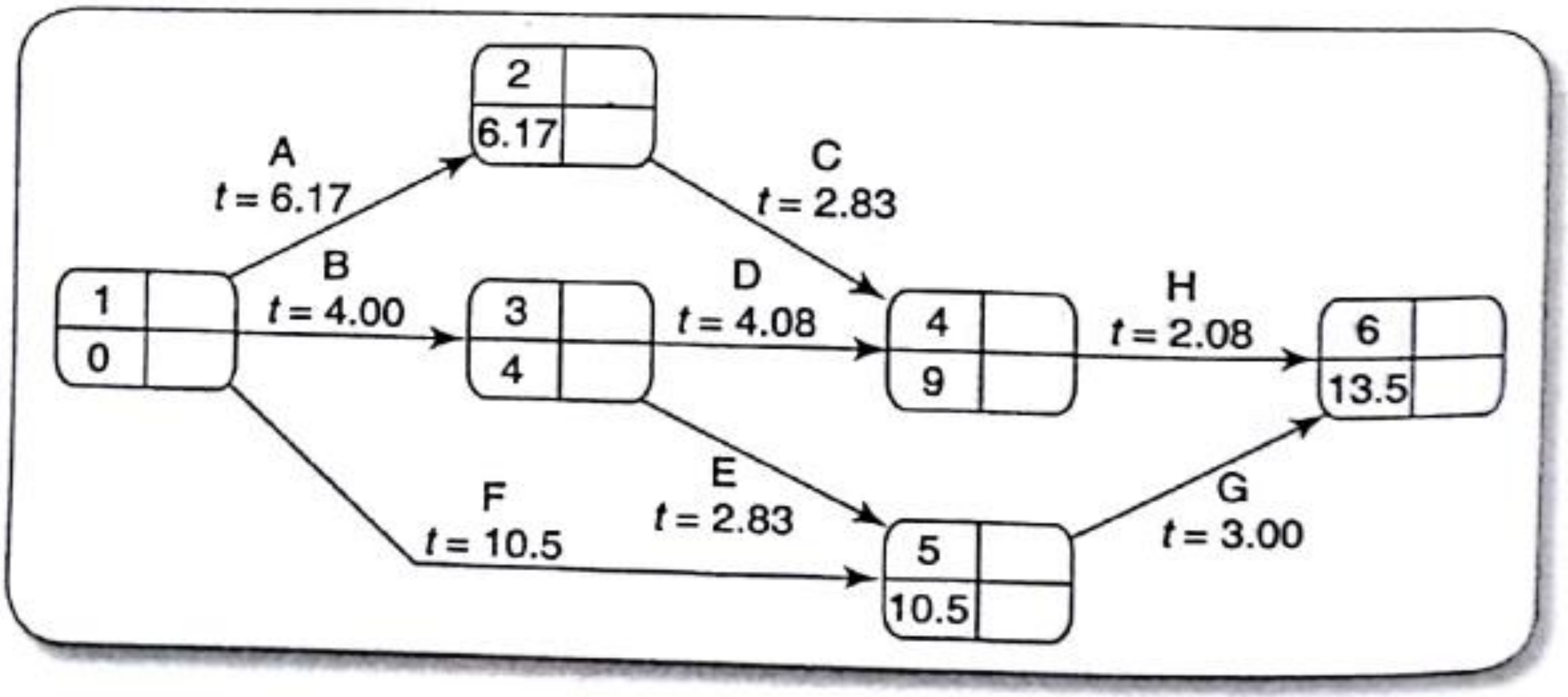
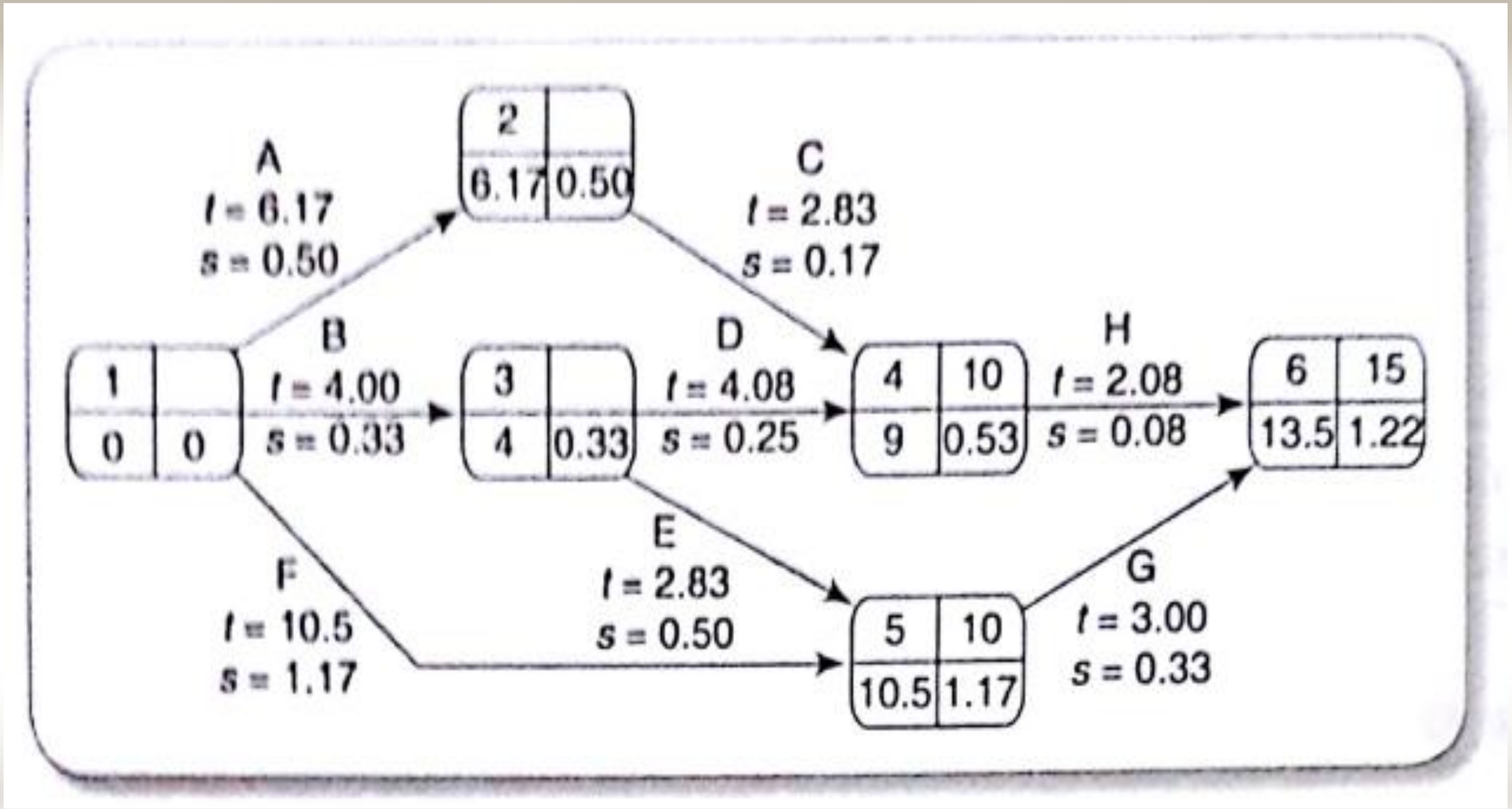


Figure 7.6 The PERT network after the forward pass

2. Calculate Standard Deviation

S (b-a)/6



Calculating the z values

The z value is calculated for each node that has a target date. It is equivalent to the number of standard deviations between the node's expected and target dates. It is calculated using the formula

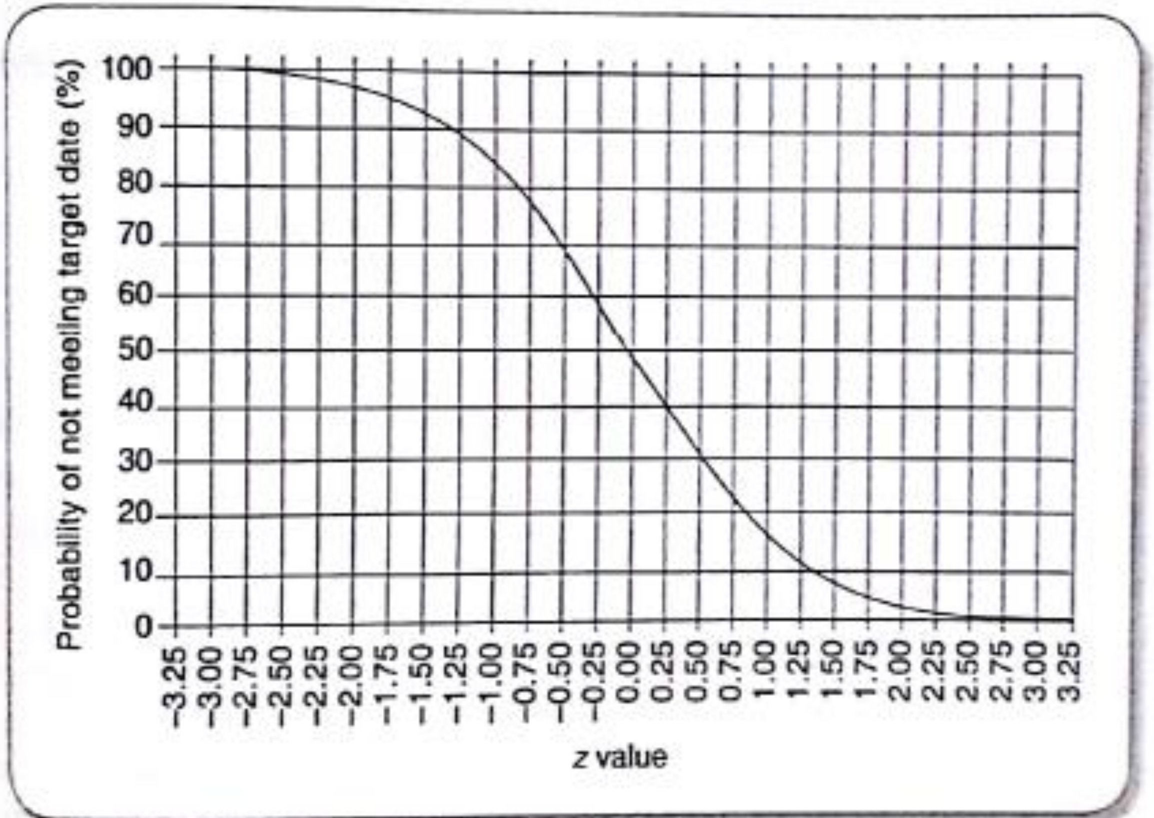
$$z = \frac{T - t_e}{s}$$

where t_e is the expected date and T the target date.

The z value for event 4 is $(10 - 9.00)/0.53 = 1.8867$.

Converting z values to probabilities

A z value may be converted to the probability of not meeting the target date by using the graph in Figure 7.8.



This graph is the equivalent of tables of z values, also known as standard normal deviates, which may be found in most statistics textbooks.

FIGURE 7.8 The probability of obtaining a value within z standard deviations of the mean for a normal distribution

Advantages of PERT

PERT (Program Evaluation and Review Technique) compels managers to plan, which helps them see how the pieces fit together.

Each subordinate manger has to plan the events for which her or she is responsible.

It concentrates on critical elements that may need correction.

It makes possible a kind of forward-looking control.

The network system with its subsystems enables managers to aim reports and pressure for action at the right spot and level in the organization structure at the right time.

Disadvantages of PERT

Because of its emphasis on "activity-time" to its operation, PERT is not useful when no reasonable estimates of time schedule can be made.

Another disadvantage has been its emphasis on time only but not on costs.


MONTE CARLO
SIMULATION

- If you are involved in risk management.
- Is a quantitative risk analysis technique which is used to identify the risk level of completing the project.

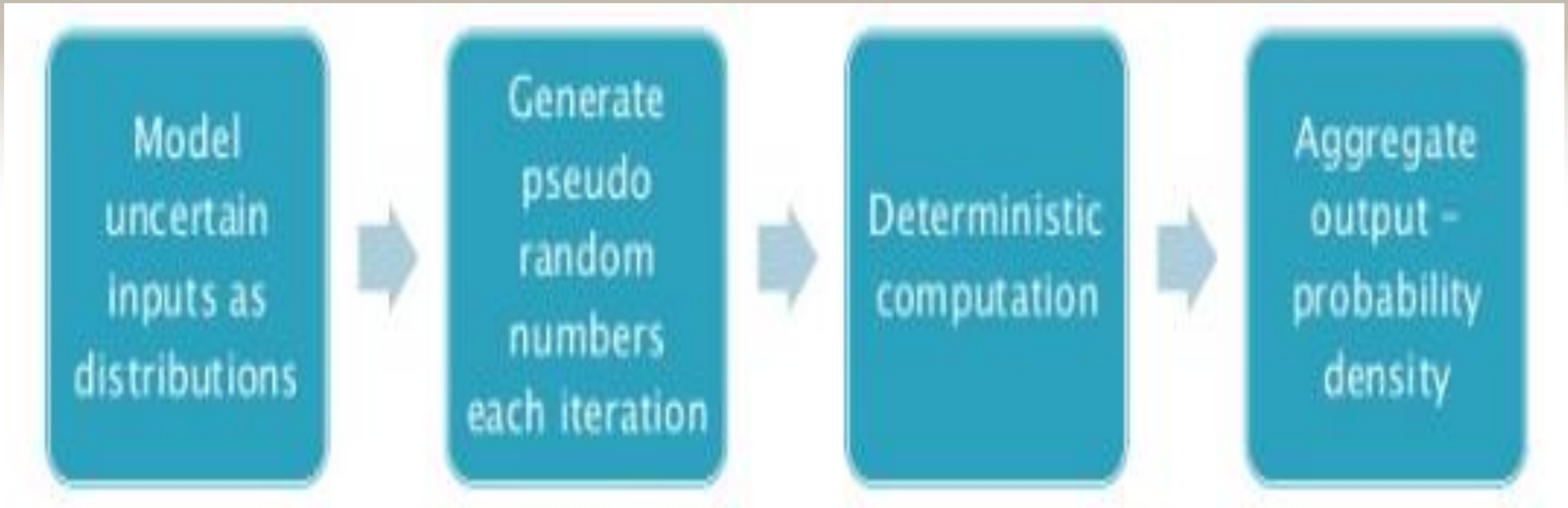
Monte Carlo Simulation

- An alternative to PERT.
- A class of general analysis techniques:
  - Valuable to solve any problem that is complex, nonlinear, or involves more than just a couple of uncertain parameters.
- Monte Carlo simulations involve repeated random sampling to compute the results.
- Gives more realistic results as compared to manual approaches.

Steps of a Monte Carlo Analysis

1. Assess the range for the variables being considered.
2. Determine the probability distribution of each variable.
3. For each variable, select a random value based on the probability distribution.
4. Run a deterministic analysis or one pass through the model.
5. Repeat steps 3 and 4 many times to obtain the probability distribution of the model's results.

Process



Model uncertain inputs as distributions
Generate pseudo random numbers each iteration
Deterministic computation
Aggregate output - probability density

Example

- To perform the Monte Carlo simulation to determine the schedule, you must have duration estimates for each activity.

Let's say that you have three activities with the following estimates (in months):

Activity	Optimistic	Most Likely	Pessimistic	PERT Estimate
A	5	4	6	4.5
B	5	6	7	6
C	6	7	8	7
Total	16	17	21	17.5

However, in the best case, it will be finished in 16 months, and in the worst case it will be finished in 21 months.

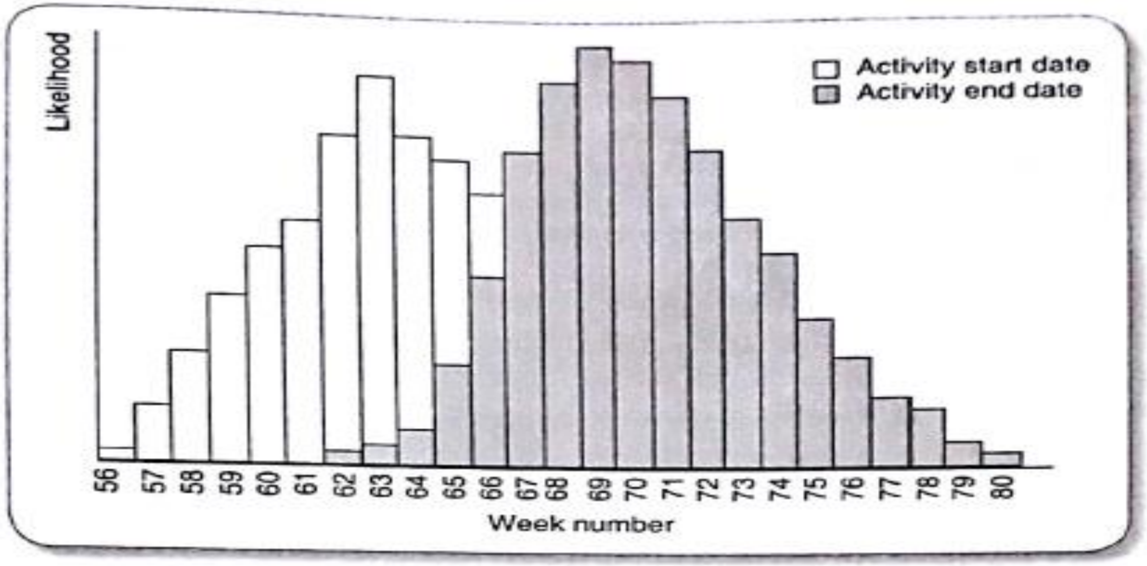
Now, if we run the Monte Carlo simulation for these tasks five hundred times, it will show us results such as:

Duration (in months)	Chances of Completion
16	2%
17	8%
18	55%
19	70%
20	95%
21	100%

n- activities

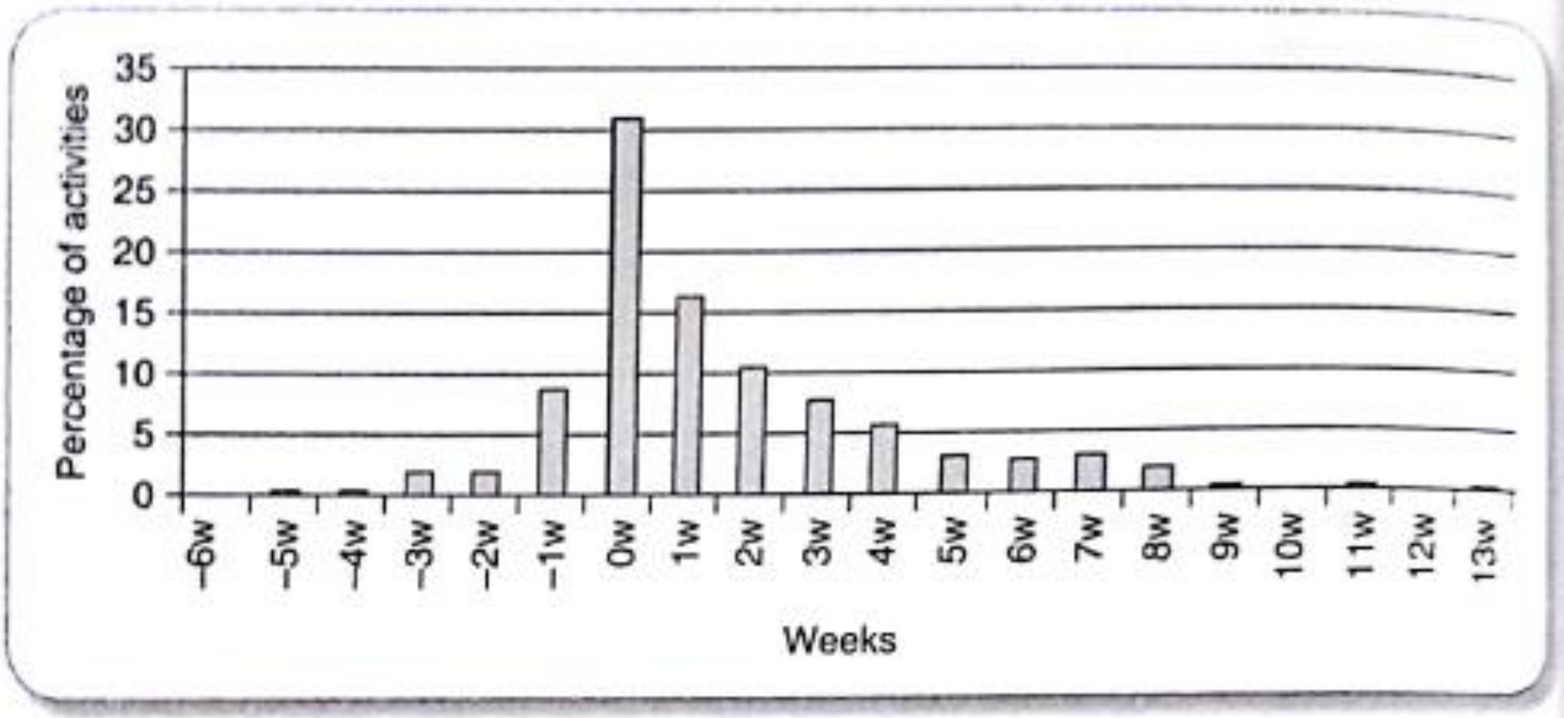
...for a project consisting of n activities are as follows:

- *Step 1:* Express the project completion time in terms of the duration of the n activities ($x_{i,\ i=1,\ n}$ and their dependences as a precedence graph, $d = f(x_1, x_2, \ldots, x_n)$.
- *Step 2:* Generate a set of random inputs, $x_{i1}, x_{i2}, \ldots, x_{in}$ using specified probability distributions.
- Step 3: Evaluate the project completion time expression and store the result in d_i.
- *Step 4:* Repeat Steps 2 and 3 for the specified number of times.
- *Step 5:* Analyze the results $d_{i,\ i=1,n}$; summarize and display using a histogram as the one shown in Figure 7.9.



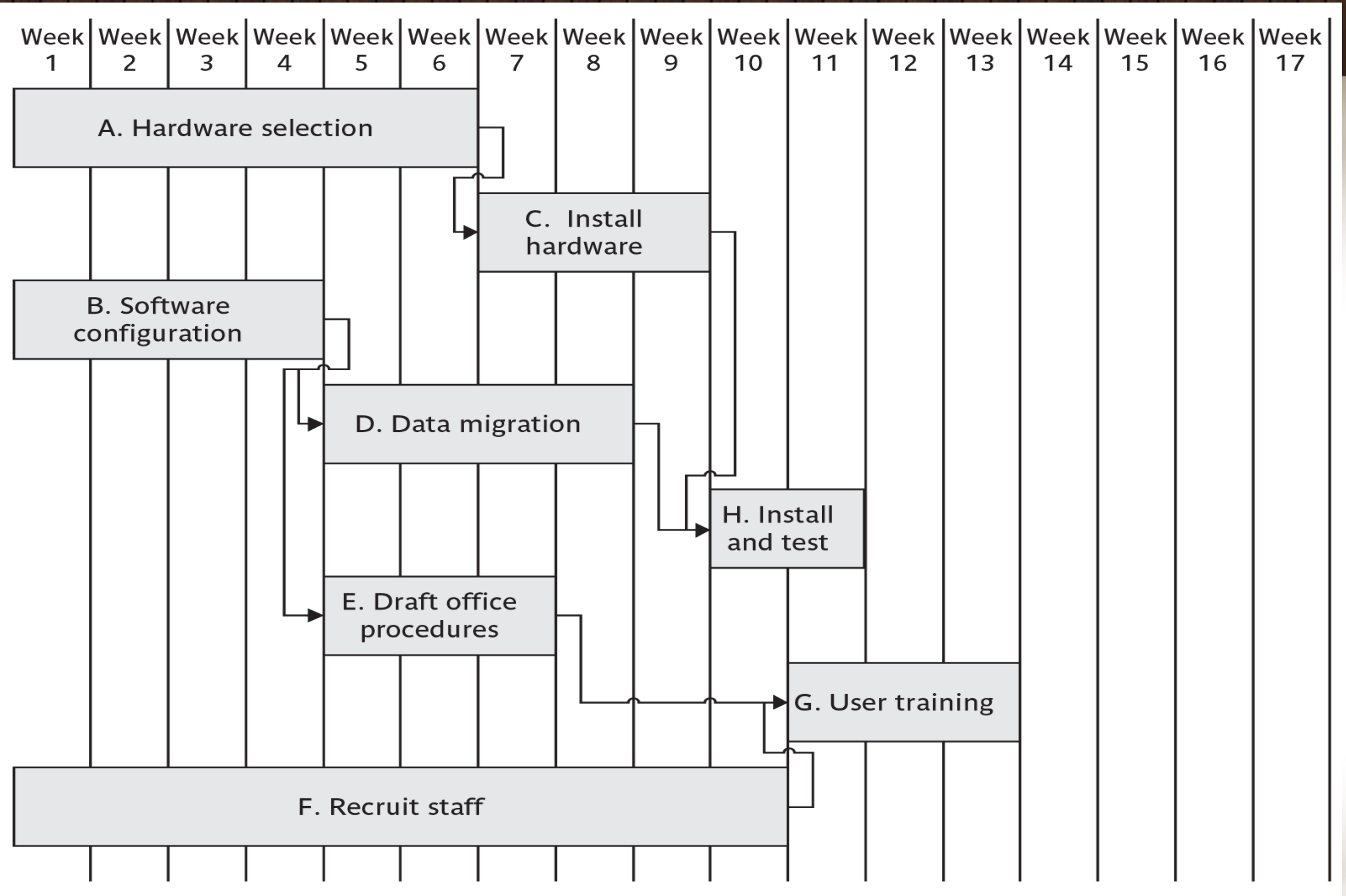
URE 7.9 Risk profile for an activity generated using Monte Carlo simulation

CRITICAL CHAIN CONCEPTS



10 Percentage of activities early or late (after van Genuchten, 1991)

Traditional planning approach



Critical chain approach

One problem with estimates of task duration:

- Estimators add a safety zone to estimate to take account of possible difficulties
- Developers work to the estimate + safety zone, so time is lost
- No advantage is taken of opportunities where tasks can finish early – and provide a buffer for later activities

One answer to this:

1. Ask the estimators for two estimates
   1. Most likely duration: 50% chance of meeting this
   2. Comfort zone: additional time needed to have 95% chance
2. Schedule all activities using most likely values and starting all activities on latest start dates

Most likely and comfort zone estimates

Activity	Most likely	Plus comfort zone	Comfort zone
A	6	8	2
B	4	5	1
C	3	3	0
D	4	5	1
E	3	4	1
F	10	15	5
G	3	4	1
H	2	2.5	0.5

TABLE 7.8 Most likely and comfort zone estimates (days)

Executing the critical chain-based plan

- No **chain** of tasks is started earlier than scheduled, but once it has started is finished as soon as possible
- This means the activity following the current one starts as soon as the current one is completed, even if this is early – the relay race principle

Buffers are divided into three zones:

- Green: the first 33%. No action required
- Amber : the next 33%. Plan is formulated
- Red : last 33%. Plan is executed.