Software Project Management

Chapter Seven

Risk management (Step 3 & 6)

Risk management

This lecture will touch upon:

- Definition of ‘risk’ and ‘risk management’
- Some ways of categorizing risk
- Risk management
  - Risk identification – what are the risks to a project?
  - Risk analysis – which ones are really serious?
  - Risk planning – what shall we do?
  - Risk monitoring – has the planning worked?
- We will also look at PERT risk and critical chains

Some definitions of risk

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

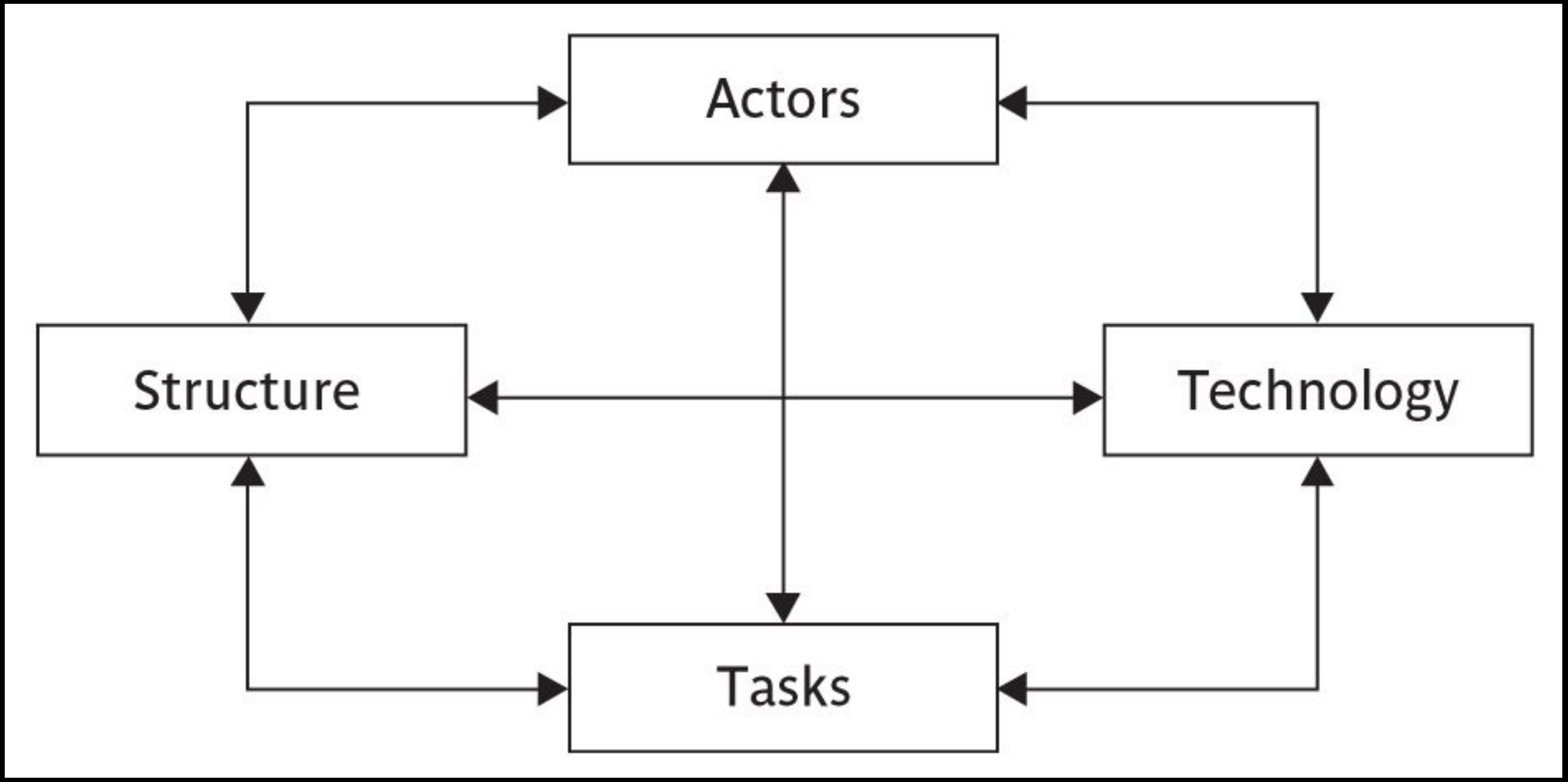
'an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives' PM-BOK

Risks relate to **possible future** problems, not current ones

They involve a possible cause and its effect(s) e.g. developer leaves > task delayed

https://www.youtube.com/watch?v=H5p_gu_WKE0

Categories of risk



Risk Management Approaches

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.

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.

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

Boehm's top ten risk - continued

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

Risk Assessment & Prioritization

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

POTENTIAL DAMAGE = RS. 15,50,000

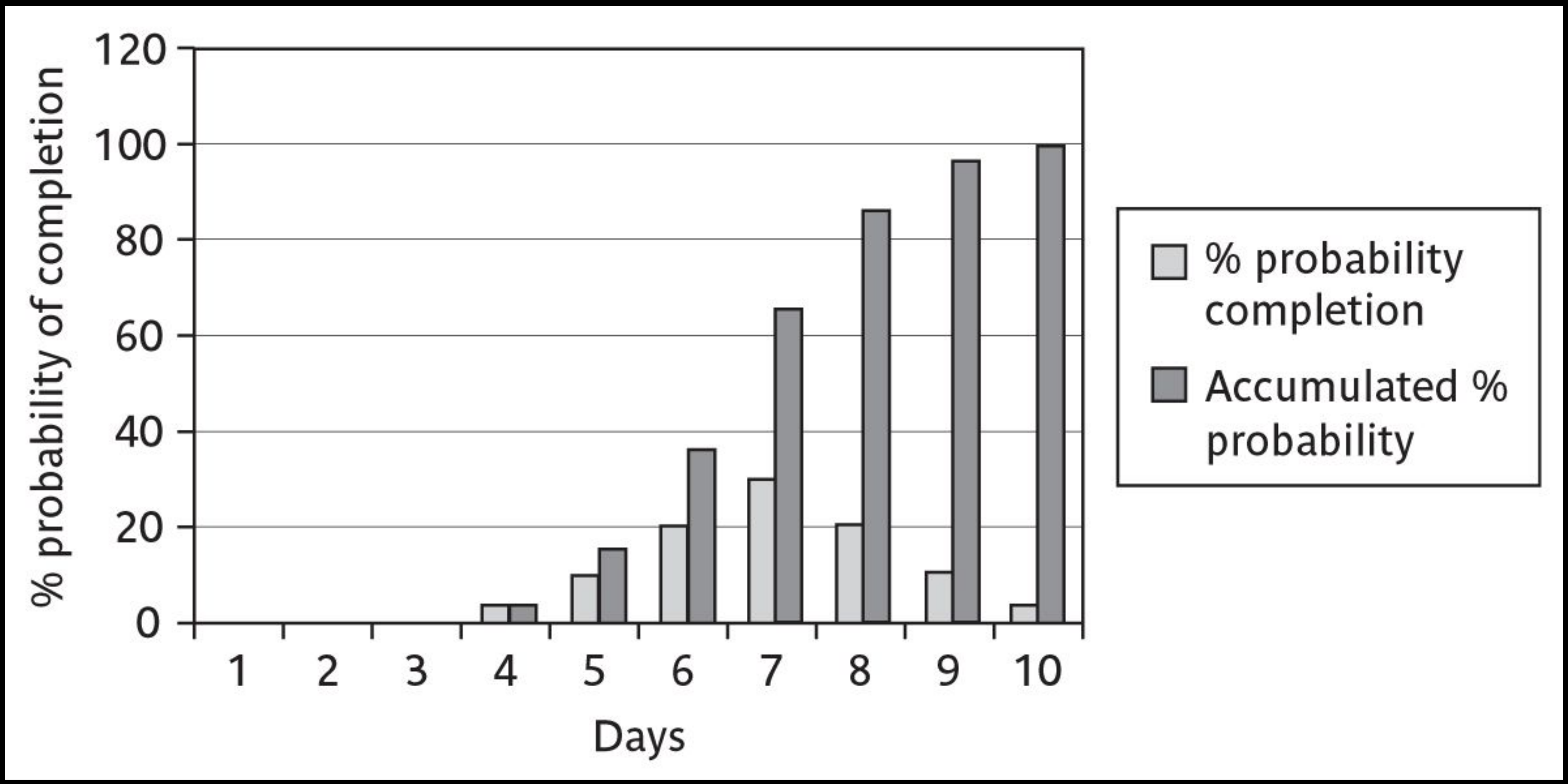
PROBABILITY OF OCCURRENCE IS 2 IN 1000

Risk Assessment & Prioritization

- RE assumes that amount of Damage will always be the same (actually it may differ)
- RE assumes risk always leads to Damage (it can be profitable too)
- Team Leader might associate different Probability at different point in time
-

McGraw Hill Education

Probability chart



Ref	Hazard	Likelihood	Impact	Risk
R1	Changes to requirements specification during coding	8	8	64
R2	Specification takes longer than expected	3	7	21
R3	Significant staff sickness affecting critical path activities	5	7	35
R4	Significant staff sickness affecting non-critical activities	10	3	30
R5	Module coding takes longer than expected	4	5	20
R6	Module testing demonstrates errors or deficiencies in design	4	8	32

Qualitative Description

- Probability level and Impact level is assigned to each risk
- Level can be defined as
  - HIGH
  - SIGNIFICANT
  - MODERATE
  - LOW
- Using Probability and Impact we make PROBABILITY IMPACT MATRIX
- This Matrix has a Tolerance Line. Risks that appear in this Zone are extremely high in their impact

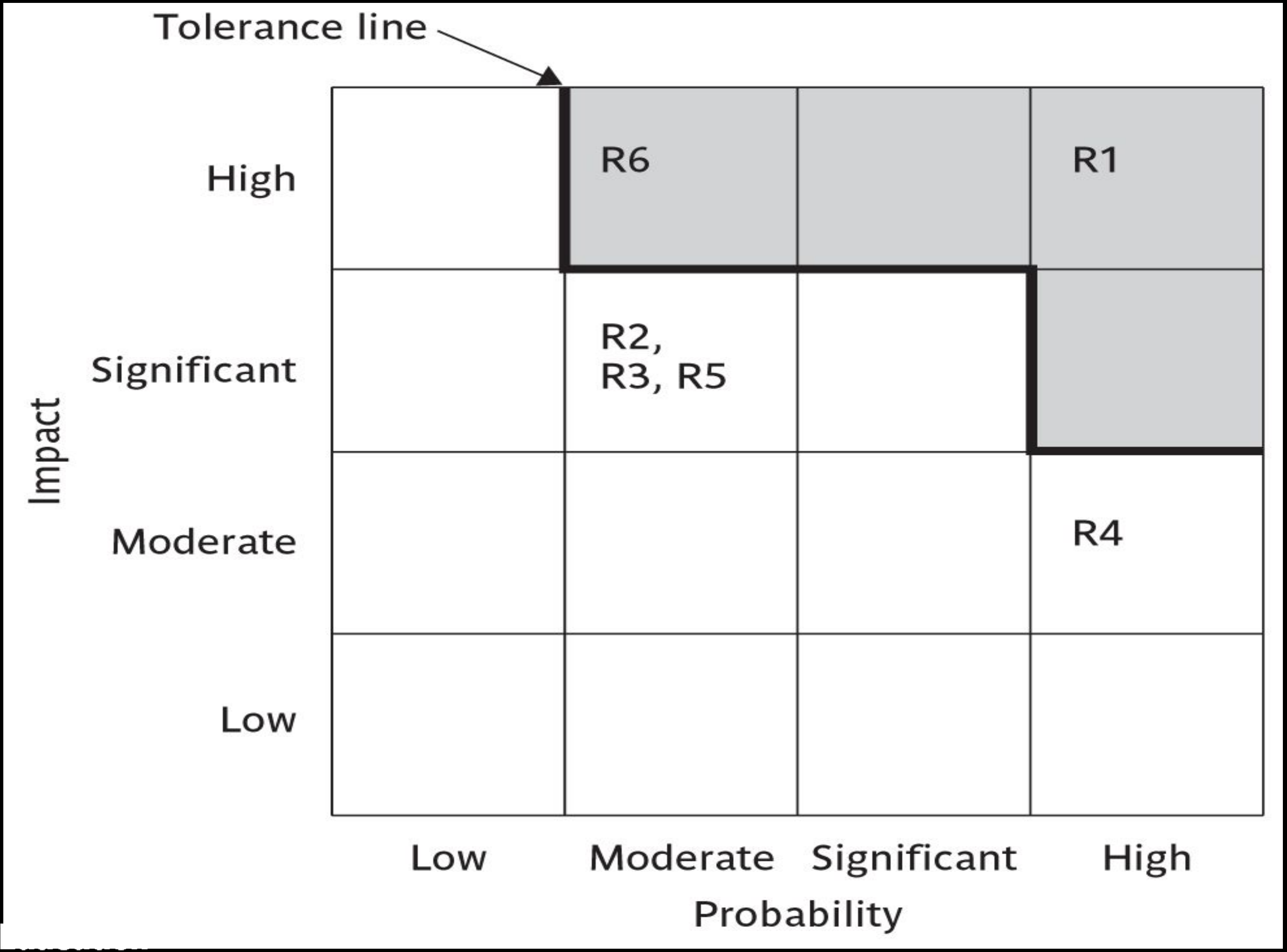
Risk probability: qualitative descriptors

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



		Probability (Likelihood)		
		Low	Medium	High
Impact (Consequence)	High	0	2	1
	Medium	3	1	1
	Low	4	2	2

https://www.youtube.com/watch?v=LfUTAzS73J8

https://www.youtube.com/watch?v=TBX6azJb0ps

https://www.youtube.com/watch?v=xXV_gjtXMSk

Risk planning

Risks can be dealt with by:

- Risk acceptance
- Risk avoidance
- Risk reduction - reduces the probability
- Risk transfer
- Risk mitigation/contingency measures - reduces the impact
- https://www.youtube.com/watch?v=EUQVL3xiI44

McGraw Hill Education

Risk reduction leverage

- Once the Risk materializes, decided Contingency Plan is followed
- Whatever countermeasures have been decided they must be cost effective
- Cost effectiveness of a risk reduction action can be assessed by calculating - RRL (Risk Reduction Leverage)

Risk reduction leverage

Risk reduction leverage =

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

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

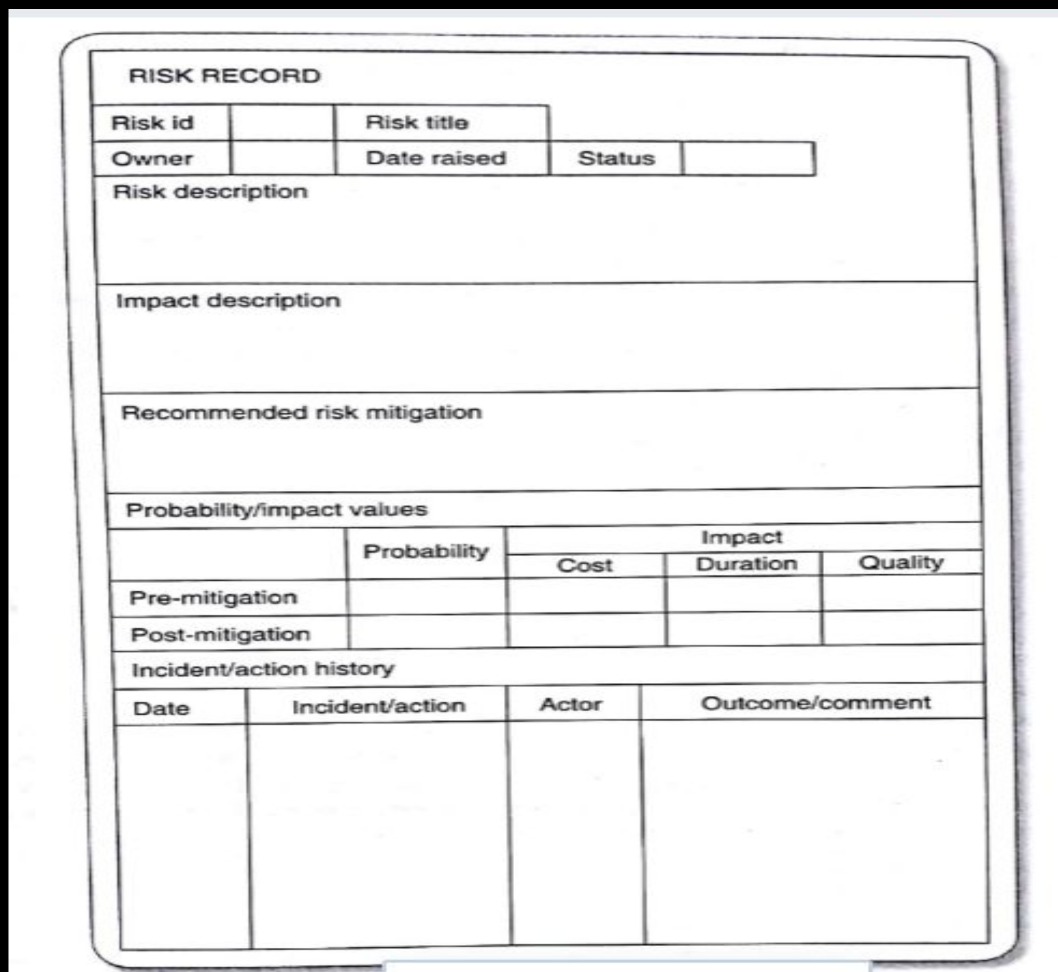
RE_{after} is risk exposure after risk reduction e.g. fire alarm costing £500 reduces probability of fire damage to 0.5%

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

RRL > 1.00 therefore worth doing

Risk Register

- Risk findings are recorded in RISK REGISTER
- It is reviewed and amended at regular intervals
- Risks are closed once they are no longer relevant



RISK RECORD

Risk id		Risk title		
Owner		Date raised	Status	

Risk description

Impact description

Recommended risk mitigation

Probability/impact values

	Probability	Impact		
		Cost	Duration	Quality
Pre-mitigation				
Post-mitigation				

Incident/action history

Date	Incident/action	Actor	Outcome/comment

Using PERT to evaluate the effects of uncertainty

** Uncertainties Related to estimates of Task duration**

Three estimates are produced for each activity

Most likely time (m)

Optimistic time (a)

Pessimistic (b)

'expected time' $t_e = (a + 4m + b) / 6$

'activity standard deviation' $S = (b-a)/6$

A chain of activities

Task	a _ O	m	b_P	t_e	s= (p-o)/6
A	10	12	16	? 12.33	? 16-10 =6/6 =1
B	8	10	14	? 10.33	? 1
C	20	24	38	? 25.33	? 3

A chain of activities

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

Answer: 12.66 + 10.33 + 25.66 i.e. 48.65

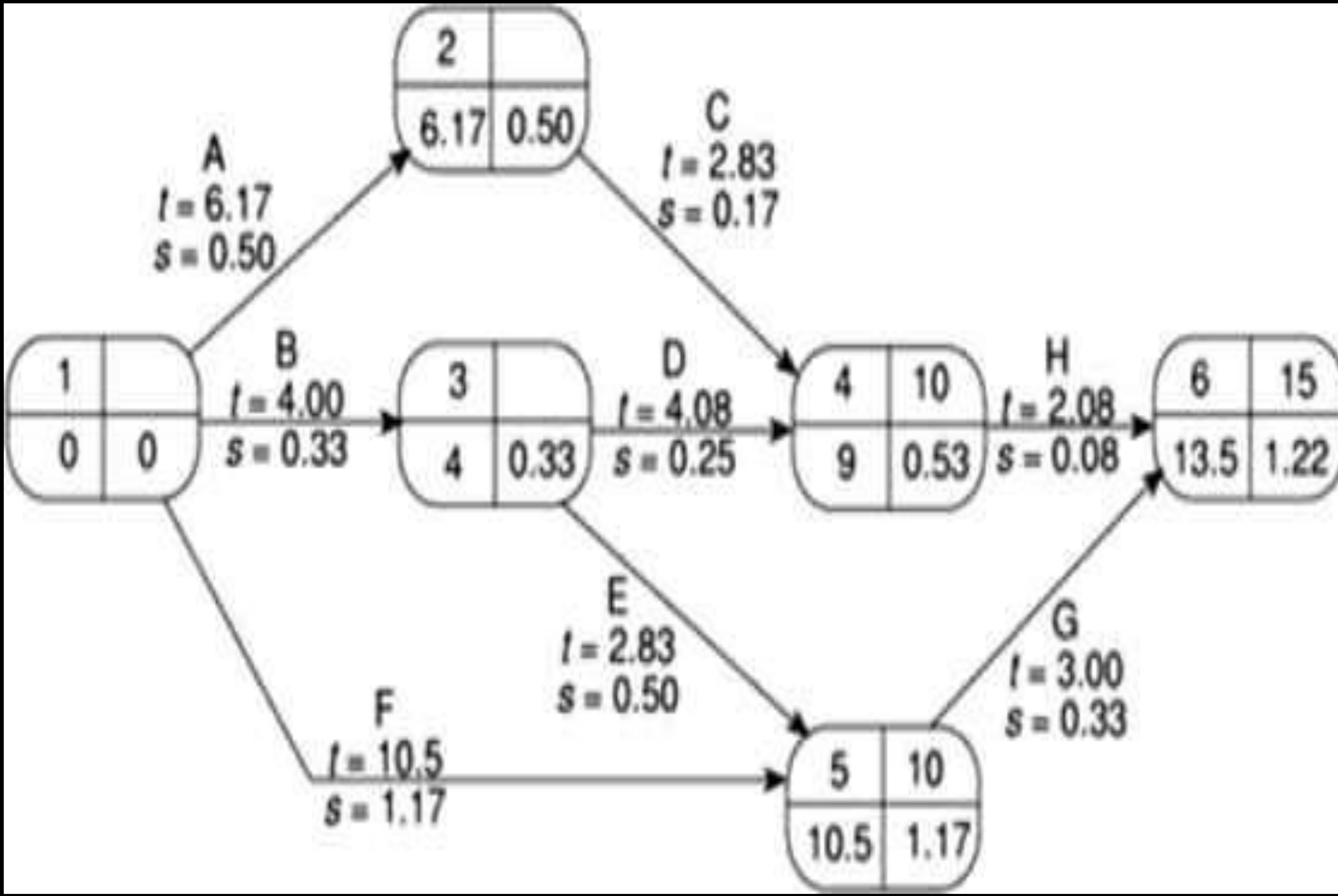
What would be the standard deviation for A + B+ C?

Answer: square root of ($1^2 + 1^2 + 3^2$) i.e. 3.32

https://www.youtube.com/watch?v=V5FmgNCD5Rw

Expected Times and Standard Deviation

Activity	Optimistic	Most likely	Pessimistic	Expected	Standard deviation
	(a)	(m)	(b)	(te)	(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


2
6.17
0.50
A
t = 6.17
s = 0.50
C
t = 2.83
s = 0.17
1
0
0
B
t = 4.00
s = 0.33
3
4
0.33
D
t = 4.08
s = 0.25
4
10
9
0.53
H
t = 2.08
s = 0.08
6
15
13.5
1.22
E
t = 2.83
s = 0.50
G
t = 3.00
s = 0.33
F
t = 10.5
s = 1.17
5
10
10.5
1.17

SD(4) = SQRT(SQR(SD(C) + SQR(SD(2))

= SQRT (SQR(0.17) + SQR(0.50))

= SQRT (0.0289 + 0.25)

= SQRT(0.2789)

= 0.528 = 0.53

SD(4) = SQRT(SQR(SD(3) + SQR(SD(D))

= SQRT (SQR(0.33) + SQR(0.25))

= 0.41

Assessing the likelihood of meeting a target

Say the target for completing A+B+C was 52 days (T)

Calculate the z value thus

$z = (T - t_e)/s$

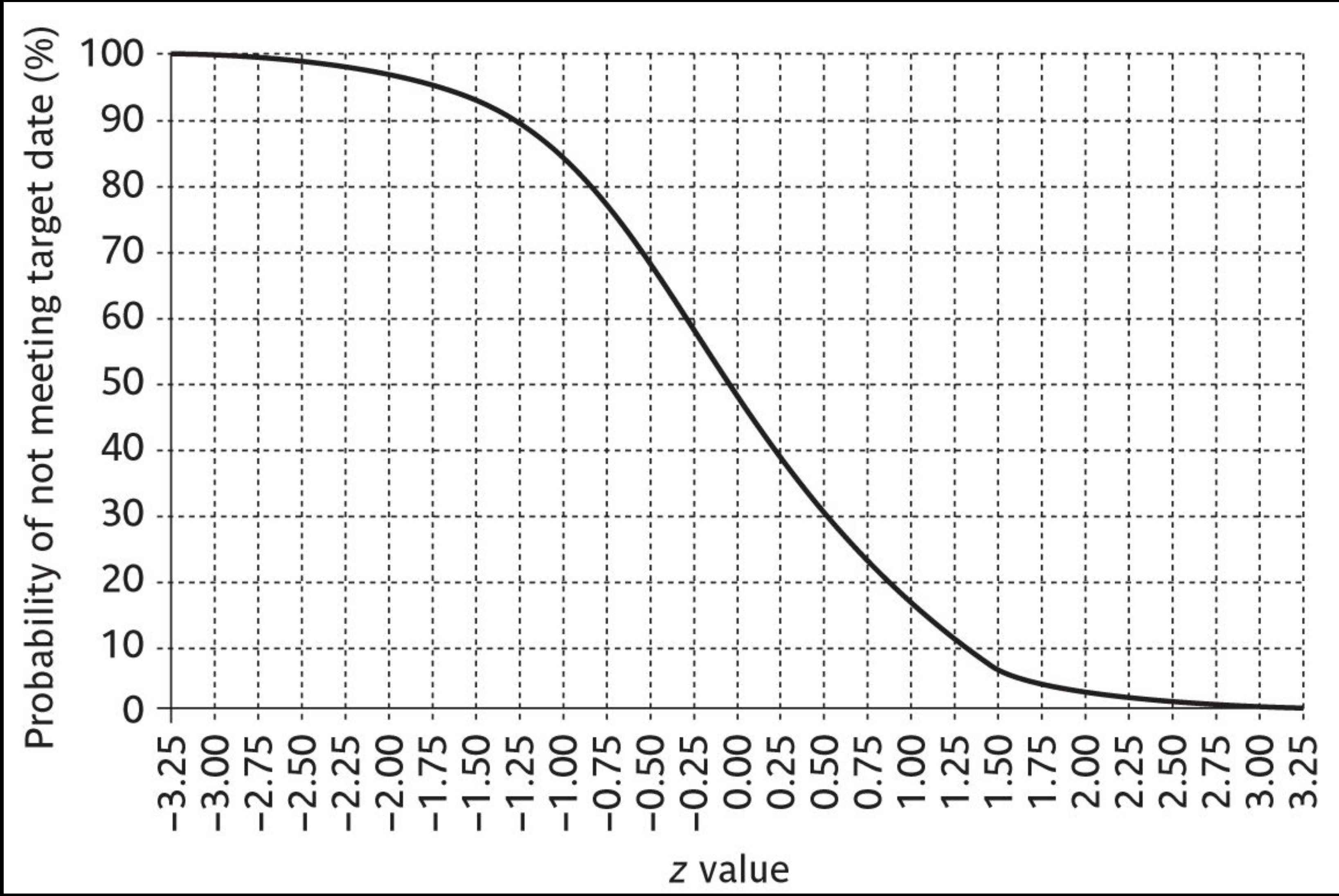
In this example $z = (52-48.33)/3.32$ i.e. 1.01

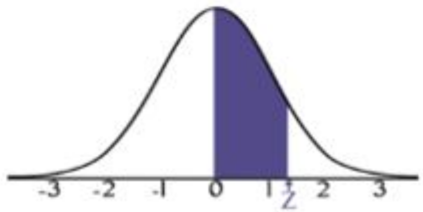
Look up in table of z values – see next overhead

Te = 39.52 ; s = 1.28 ; T = 45

$z = (45-39.52)/1.28 = 4.28$

Graph of z values





STANDARD NORMAL TABLE (Z)

Entries in the table give the area under the curve between the mean and z standard deviations above the mean. For example, for $z = 1.25$ the area under the curve between the mean (0) and z is 0.3944.

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0190	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2969	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3513	0.3554	0.3577	0.3529	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998

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.

https://www.youtube.com/watch?v=DbaaUlhm5kg

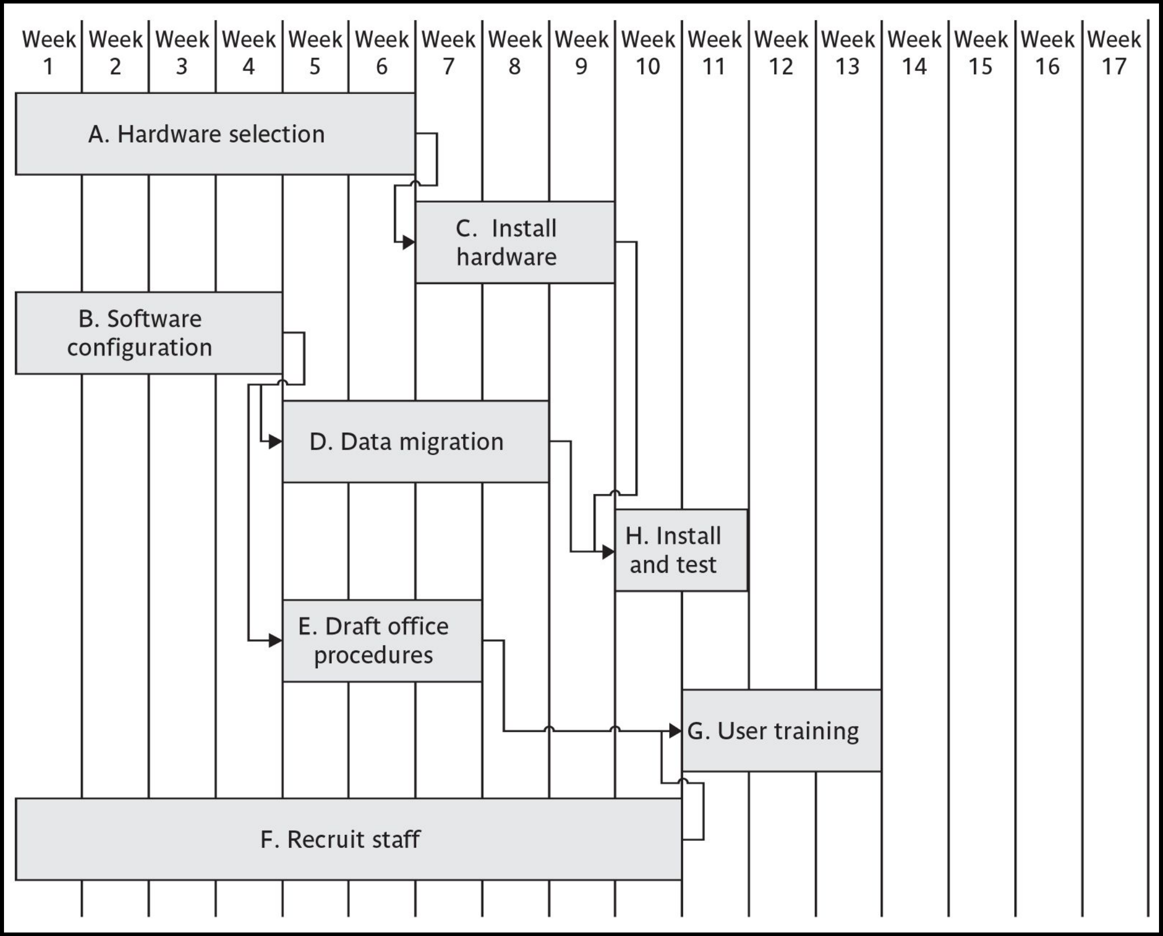
Steps of a Monte Carlo Analysis

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.

Critical chain concept

https://www.youtube.com/watch?v=rq0HG6sWc8s

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

Critical chain approach

One answer to this:

1. Ask the estimators for two estimates

   Most likely duration: 50% chance of meeting this

   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)

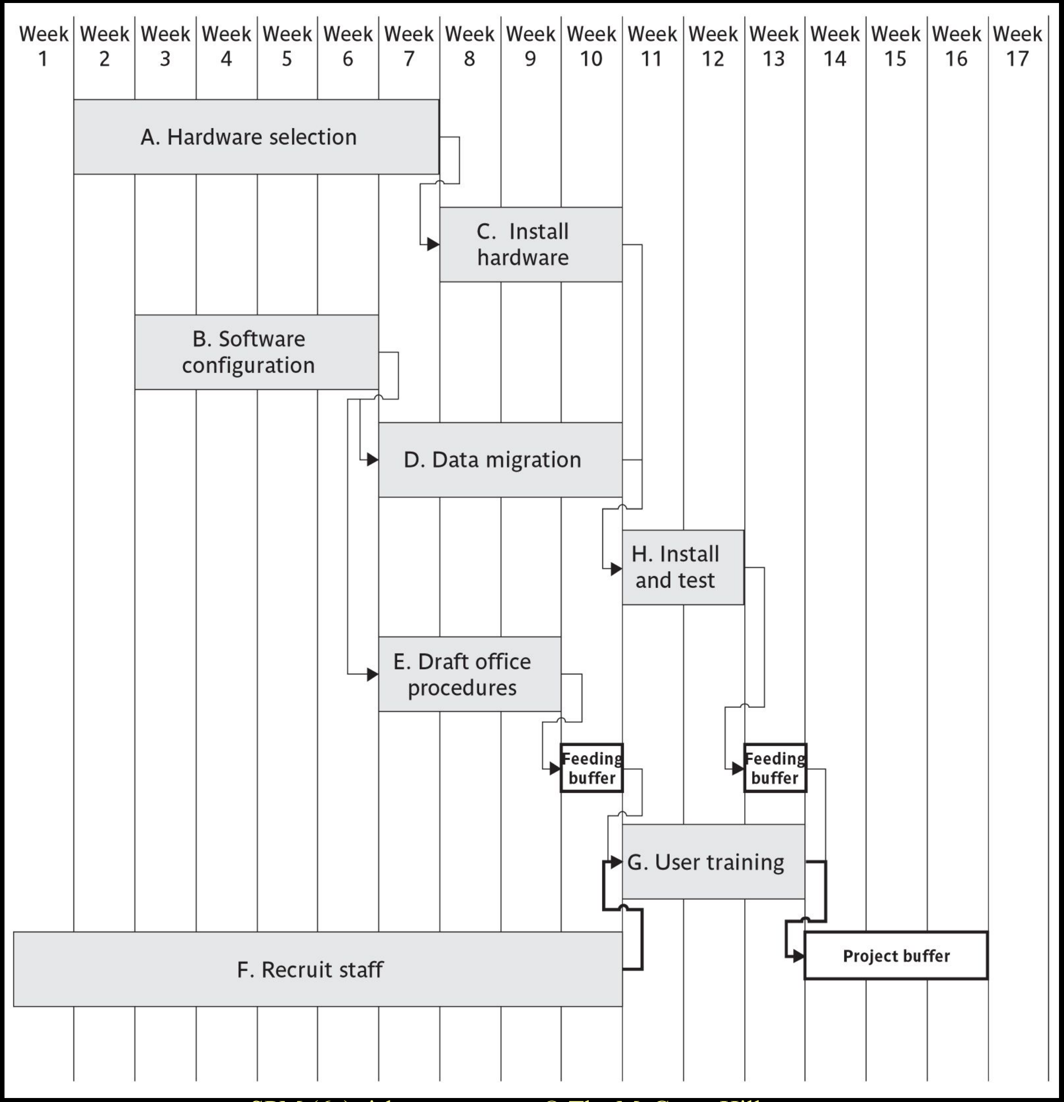
Critical chain - continued

3. Identify the critical chain – same a critical path but resource constraints also taken into account
4. Put a project buffer at the end of the critical chain with duration 50% of sum of comfort zones of the activities on the critical chain.

Critical chain -continued

5. Where subsidiary chains of activities feed into critical chain, add feeding buffer
6. Duration of feeding buffer 50% of sum of comfort zones of activities in the feeding chain
7. Where there are parallel chains, take the longest and sum those activities

Plan employing critical chain concepts



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

Executing the critical chain-based plan

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.