Critical Resources & Critical Path

Training for the Critical Chain

John Warren
Updated 6th August 2015
with new learning – It's a learning process

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How long does it to take to drive from Here to Heathrow?

- It depends on the time of day & the traffic?
- Give me an estimate:
- 2 hours?
- Or as long as 5 hours?

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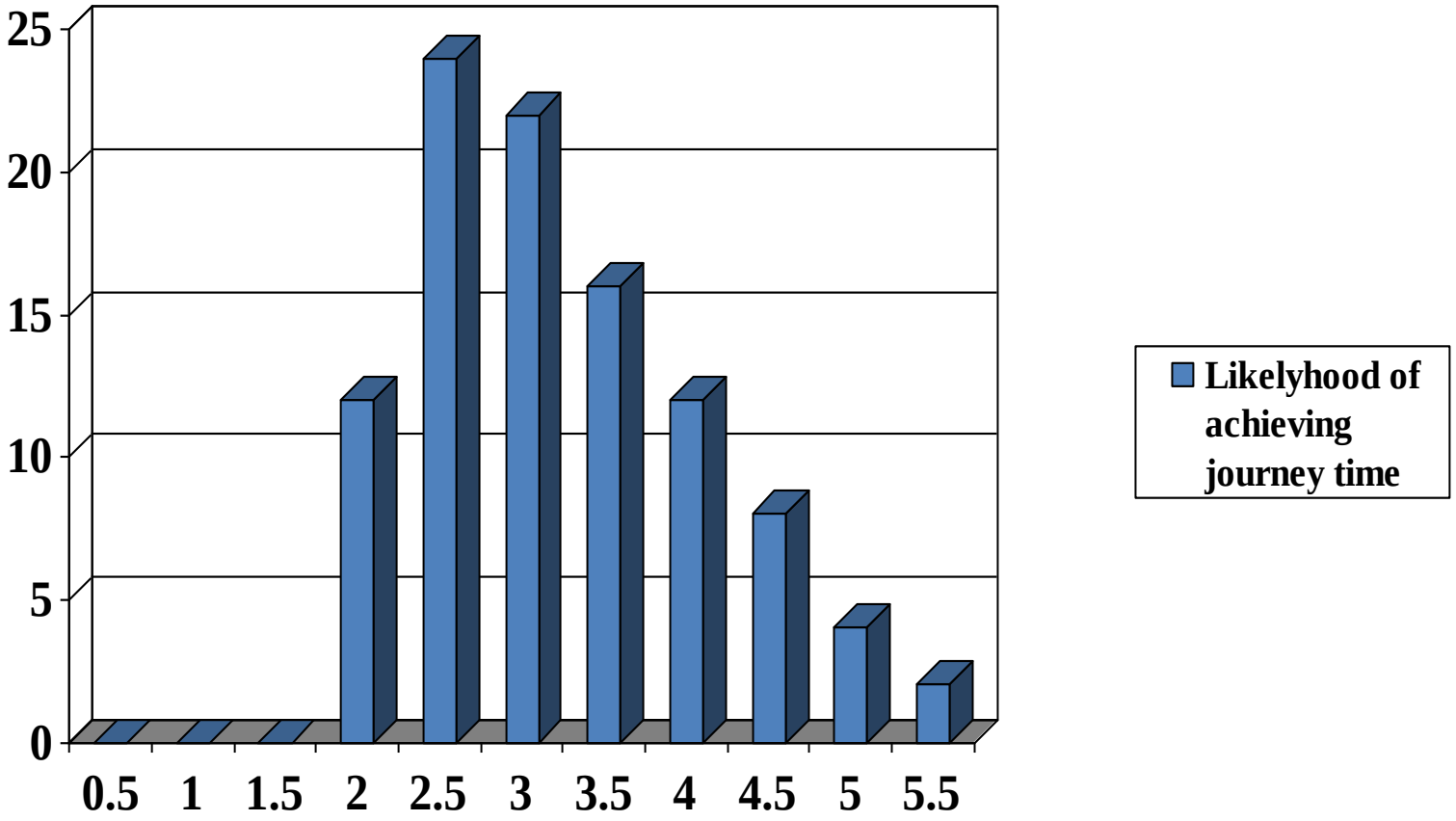
What would your estimates look like if they were plotted?



…….. A normal distribution curve with a tail?

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So if you had to catch a plane, or advise a visitor, how much time would you allow?

- When you give an estimate to someone, do you give an estimate that you stand a chance of achieving?
- What chance?
- 80% - 90%

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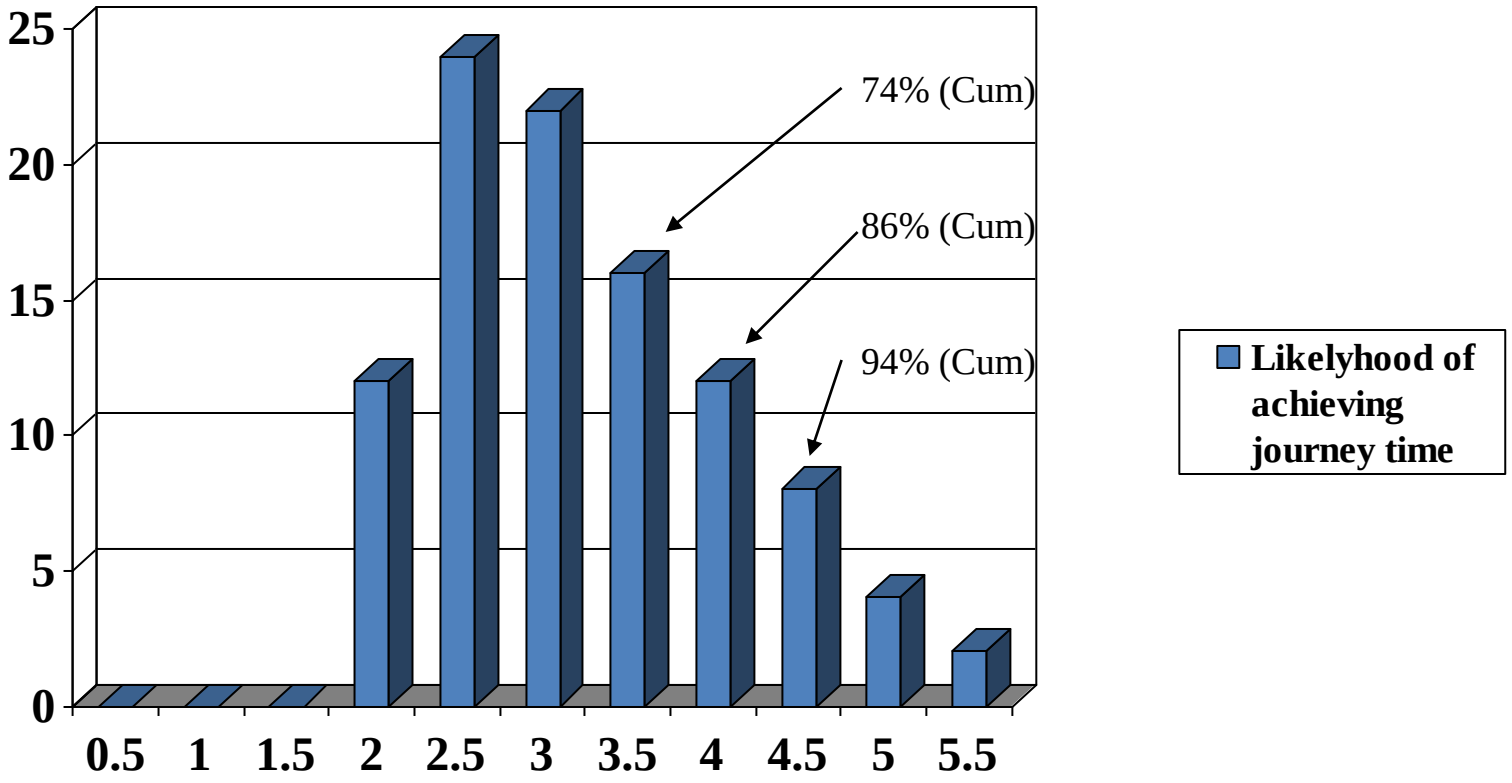
Based on this, what estimate would you give to be assured of an 80% to 90% probability of achieving it?



So in general, when giving a promise we will circa double the likely time allowed by adding safety. This is based on our past (pessimistic) experience.

How do the estimates for the completion of our projects compare with this analogy? Do we and our people add safety into their estimates?

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Why and how do our people add safety?

1. In general, when giving a promise we circa double the likely time allowed by adding safety, based on our past (pessimistic) experience.

Consider two tasks under the same manager

Is the manager likely to trust the estimates?

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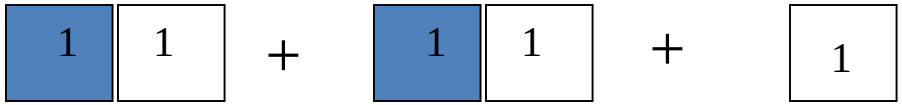

Is the manager likely to trust the estimates?

No, sometimes they will add their own safety

3. Senior Management Budget Cut

- Does your senior management ever allow the time that you ask for or do they cut it?
- Do you or your people allow for this cut in their estimates?
- Do they allow even more safety?

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Three ways in which we add safety

We put safety in

- based on our past pessimistic experience
- Management safety
- Senior Management Budget Cut

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Having got the safety, how do we use it or waste it?

We must waste the safety because we are typically late on our programmes

1. Starting on Time

- Do you start on time?
- Why not?
  - Because you have other things to do and
  - you know this task will not take as long as you have estimated
  - you have plenty of time!
- So assuming a person has added their safety,
  - do they start on time or
  - do they leave it for a while?
  - After all they know they have some spare safety margin built in as well.
- Now knowing that Murphy will strike, when does it invariably strike?
- Murphy was allowed for in the safety which has probably been wasted by starting late.
- This is sometimes called the student syndrome :
  - I have a week so I will start at the last possible moment, then
  - I find a problem and
  - I have no time to solve it.
  - Hence the project runs even later.

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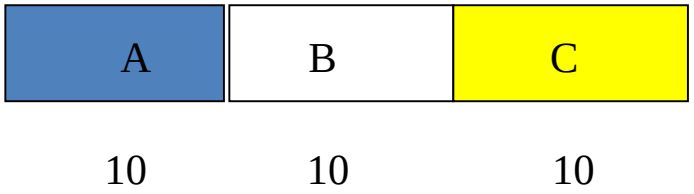
2. The effects of multi tasking?

- Consider 3 tasks green, white and yellow, that each take 10 days.
- If done sequentially, with no multi-tasking, each task would have a lead-time of 10 days



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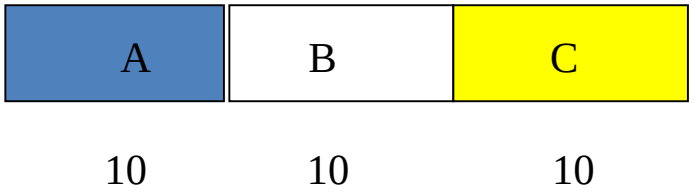

- However, in the real world, people know that they will have to multi-task. In this case the schedule could look like this:-

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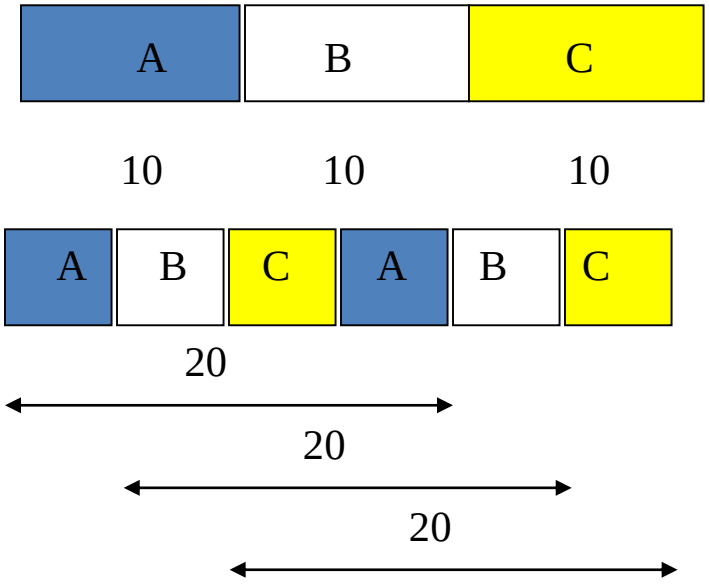

- Multi-tasking on just this simple 3-task example has the effect of doubling the lead-time for each task
- We effectively just doubled that first estimate
- What happened to the safety?
- Consider the effect when multiple resources are multi-tasking on several projects

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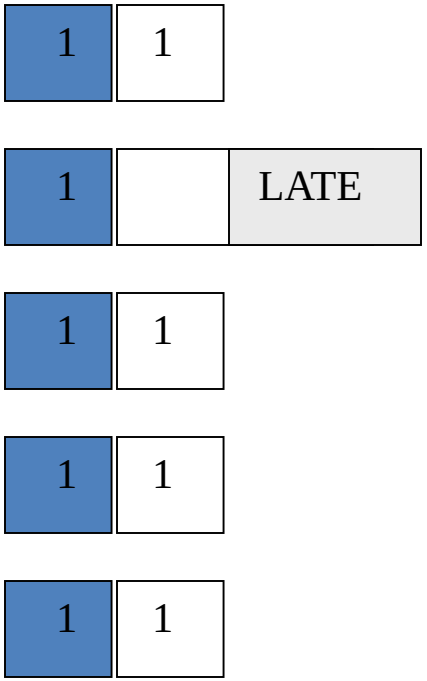
3. Misunderstanding the effects of delays and early finishes

3a. Consider the effects of a delay of one step on the whole programme



If we have 5 parallel steps and 1 runs late,

what is the net effect on the next step?

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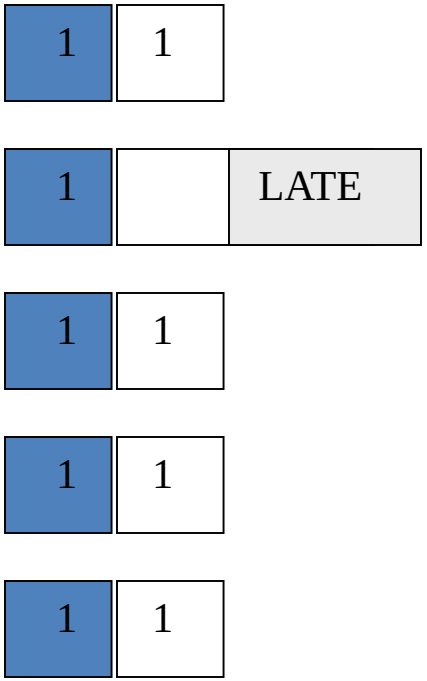

If we have 5 parallel steps and 1 runs late,

what is the net effect on the next step?

The delay is passed on in full to the next step

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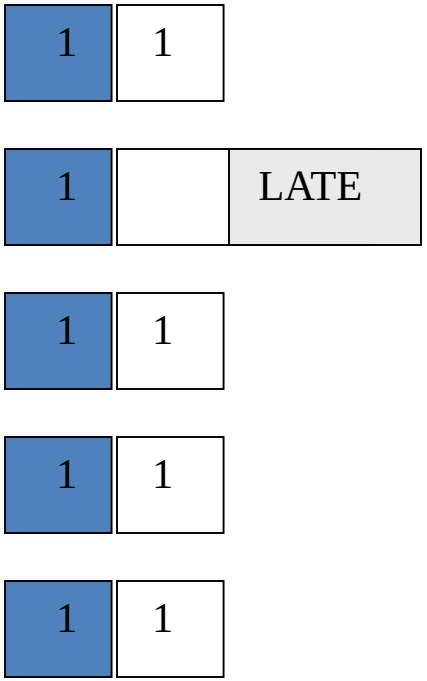
3b. Also consider whether on average, it will work out?



If we have 5 parallel steps and 1 runs late,

- 5 steps of 2 weeks each = Average of 2 weeks

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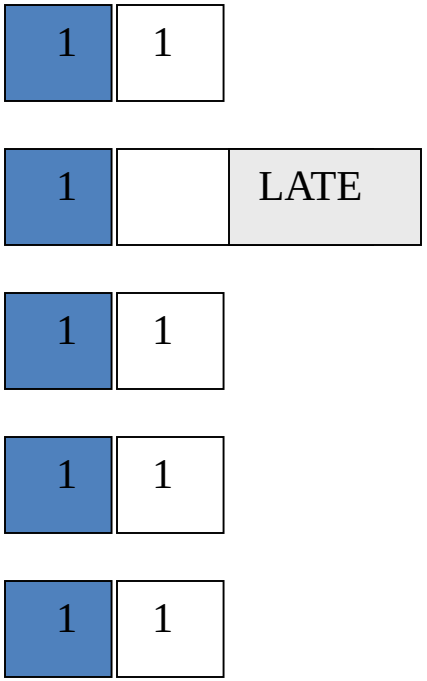


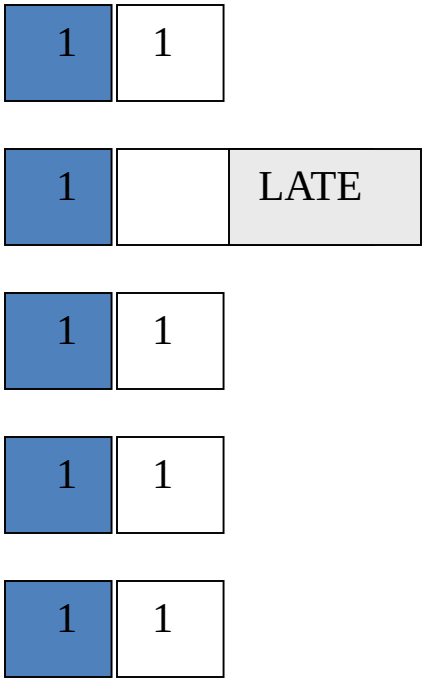
If we have 5 parallel steps and 1 runs late,

- 5 steps of 2 weeks each = Average of 2 weeks
- Becomes

  5 steps total of 12 weeks = Average of 2.4 weeks
- or, if we consider the duration delay:-

  5 steps total of 20 weeks = Average of 4 weeks

3b. Also consider whether on average, it will work out?



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- Becomes

  5 steps total of 12 weeks = Average of 2.4 weeks
- or, if we consider the duration delay:-

  5 steps total of 20 weeks = Average of 4 weeks

Averages do not work in this case.

And remember, for all their good points, some "Earned Value Systems" average things out

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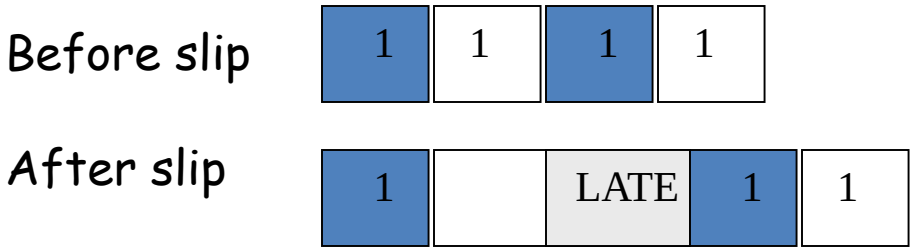
3c. Now consider the effects of a delay of one step on the whole programme

What about Serial steps in a programme



If 1 step runs late, what is the net effect on the next step?

It gets delayed by 100% of the slip

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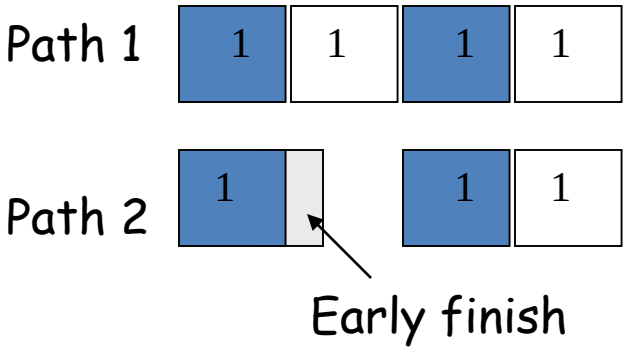
3d. Now consider the effects of a early finish in one step on the whole programme



If you have serial or parallel steps and 1 step runs early,

what is the net effect on the next step or the other path?

- Is it likely to start on time?
- Why won't it start early?
  - Not reported as complete
  - Adding "bells and whistles"
  - Labour not available
  - "I am not due to start the next task yet"

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Three ways in which waste safety

- Student syndrome - starting late
- Multi Tasking
- Misunderstanding the effects of delays and early finishes
  - In parallel steps, the worst is passed on and the safety on the other steps disappear
  - In parallel steps, “averages” do not work.
  - In serial steps, a delay in one step is passed on in full to the next step and the safety on the other steps disappear
  - Early finishes are not passed on - they are lost along with the safety that could have been released

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What's the difference between Critical Path and Critical Chain

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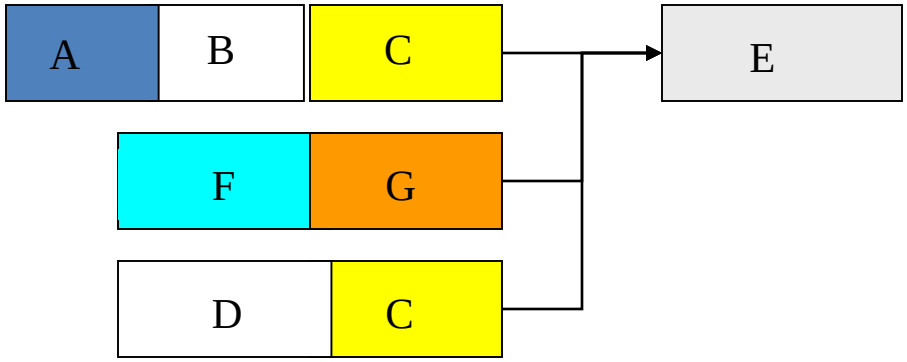
What's the difference between Critical Path and Critical Chain

Consider the following programme :-



Tasks = coloured blocks

Resources = A B C D E F G

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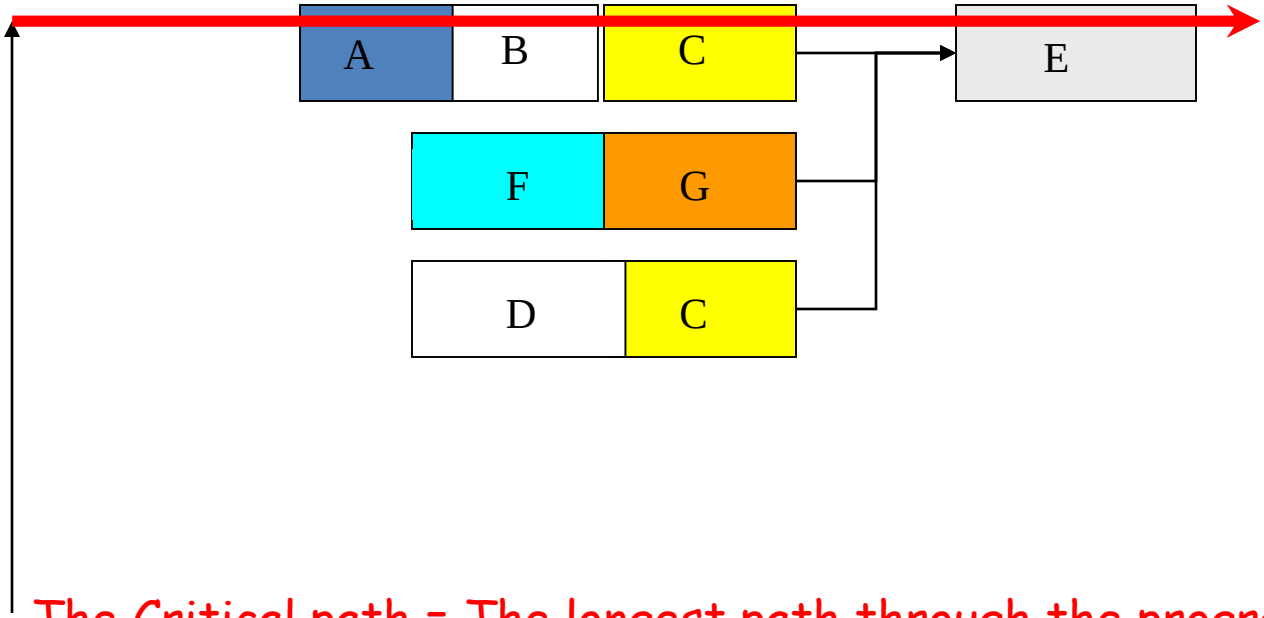

The Critical path = The longest path through the programme

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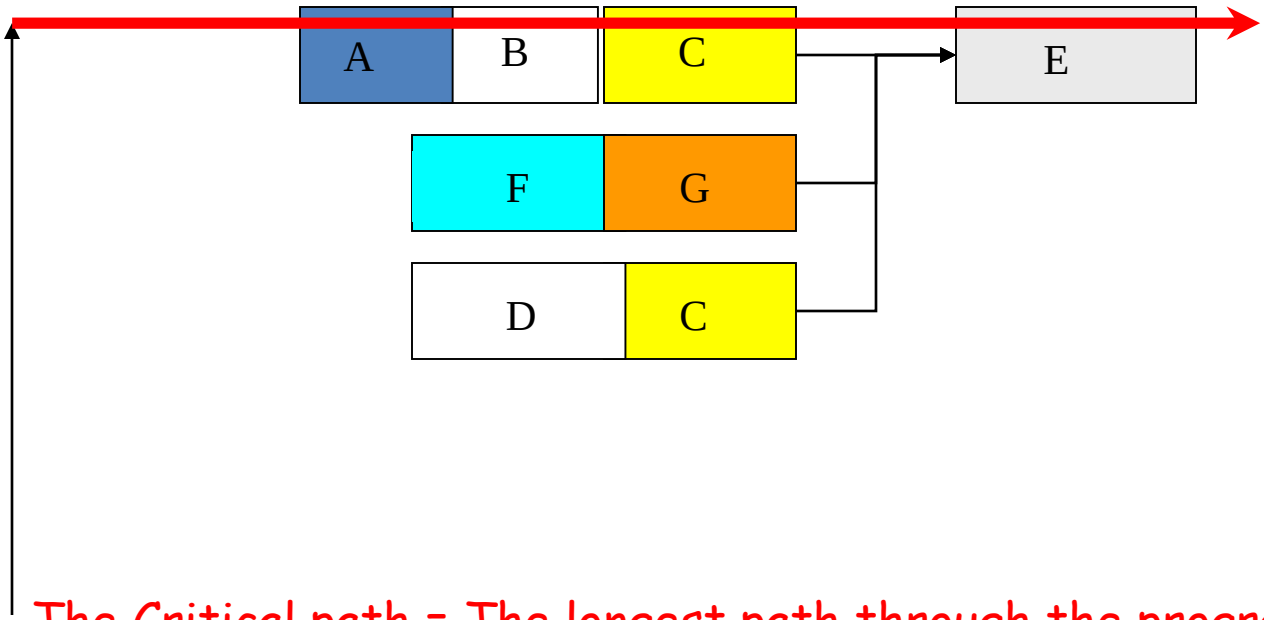

The Critical path = The longest path through the programme

But if the yellow task uses the same single resource C, one of the tasks will have to be rescheduled

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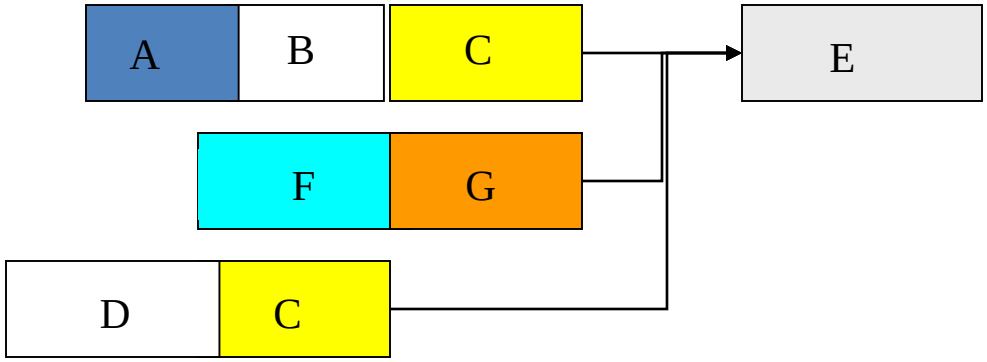
What's the difference between Critical Path and Critical Chain

When one of the tasks is rescheduled :-



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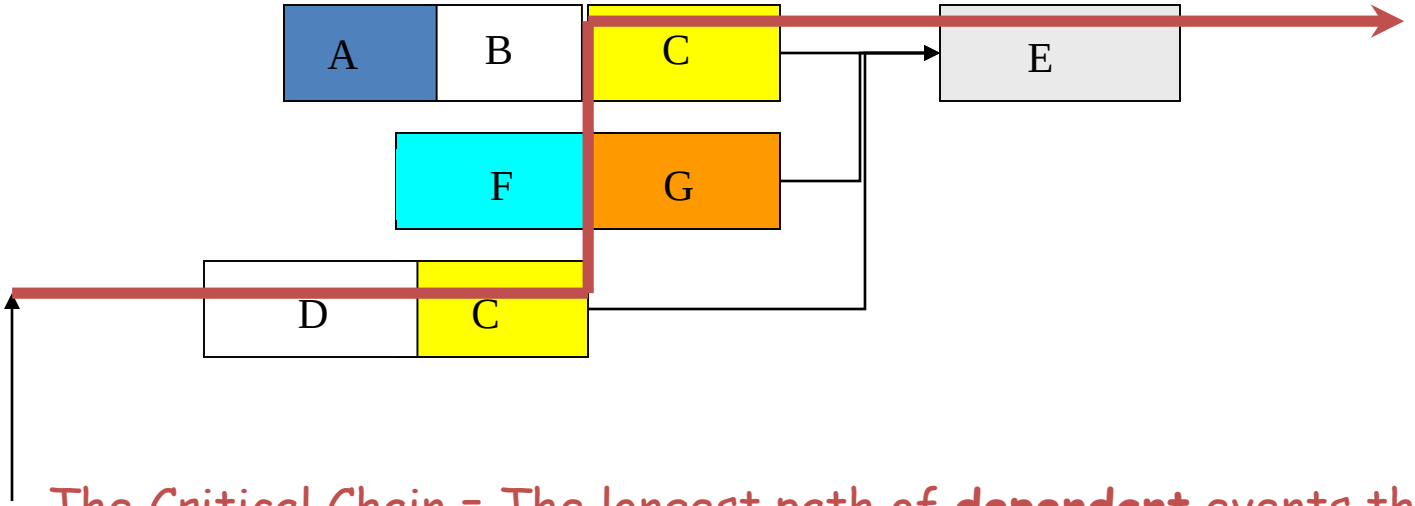

The Critical Chain = The longest path of **dependant** events through the programme, either because of:-
path dependency or
resource dependency

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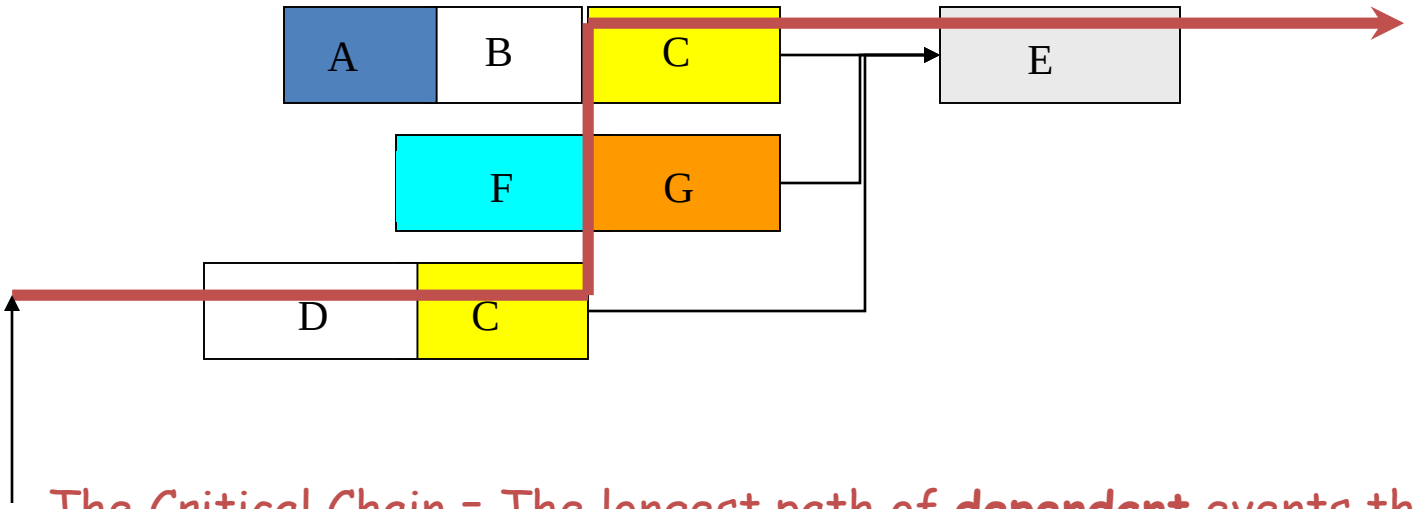

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And note the programme just got longer.
Consider also the effect of multiple programmes.

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So what can be done?

The full Critical Chain methodology (described in Goldratt's business novel of the same name) addresses the problems in the previous slides.

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So what can be done?

The full Critical Chain methodology (described in Goldratt's business novel of the same name) addresses the problems in the previous slides.

The first challenge is to get people bought in :-

- to give up their safety (in duration terms)
- to realise that they only have a 50% chance of completing the task
- but to work on the critical chain tasks immediately

but there's more

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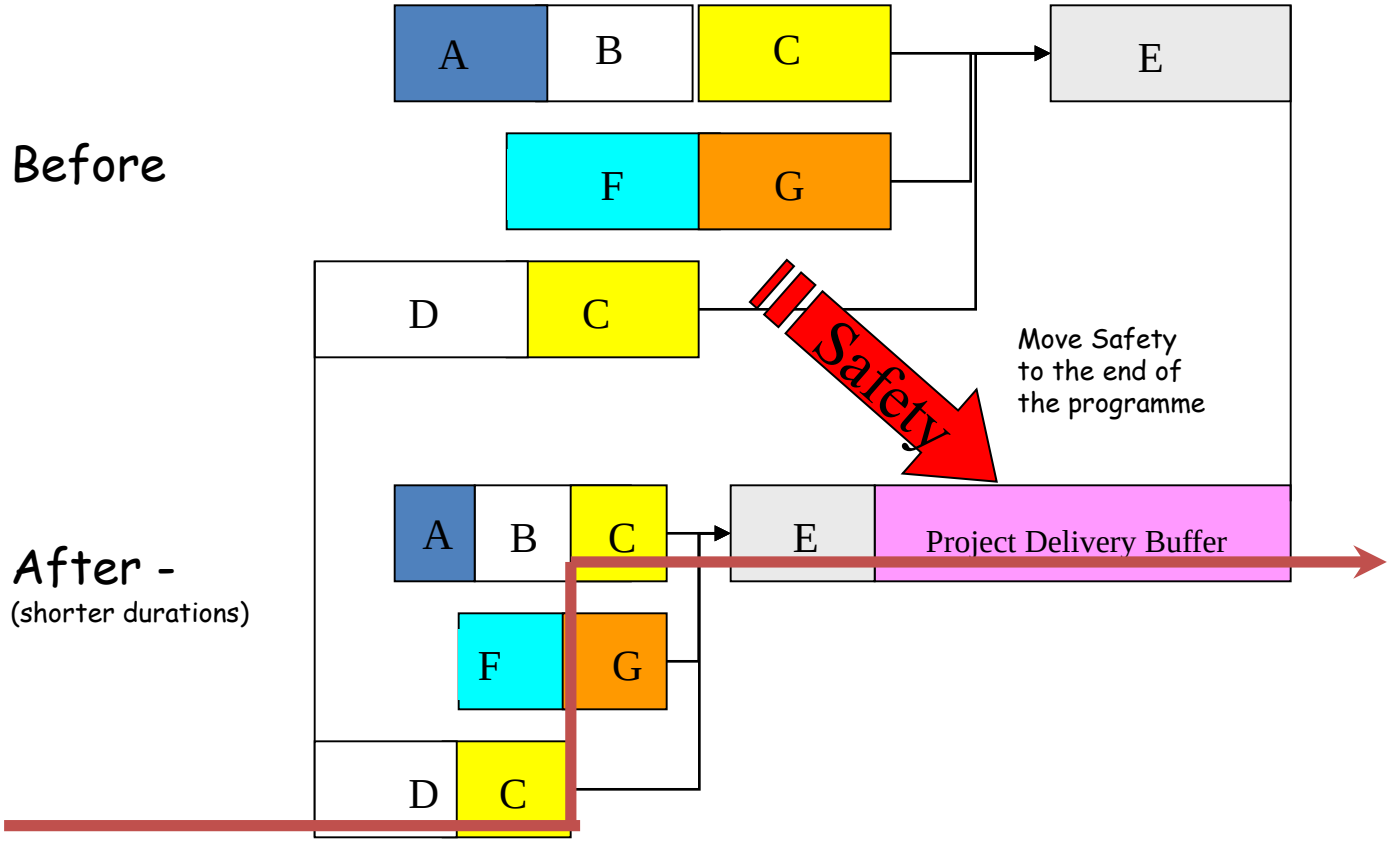
We learnt that every step has safety built into it, effectively doubling the steps lead-time duration

- Remove the safety and put it where it is needed most:-
  - protecting the end delivery



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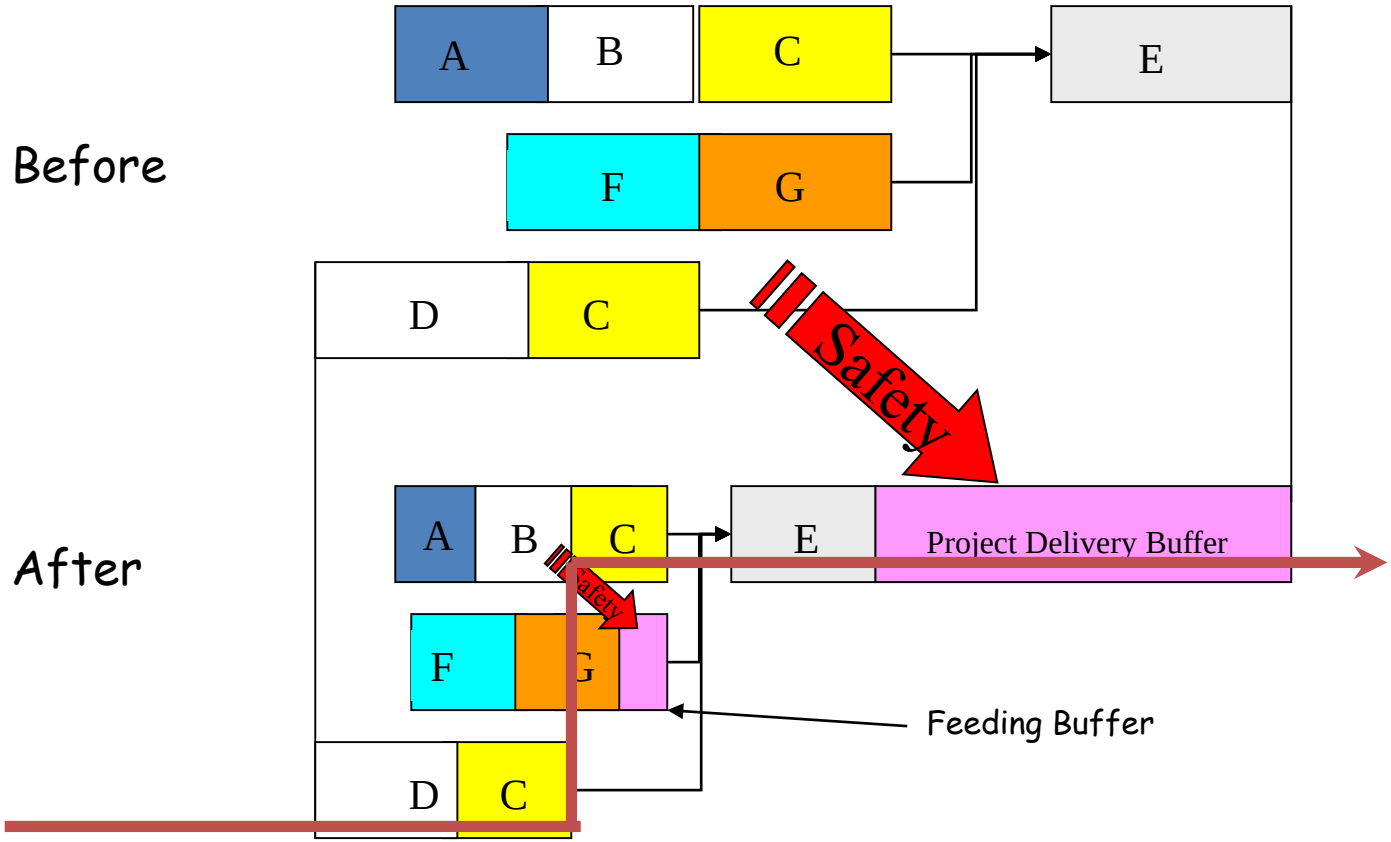

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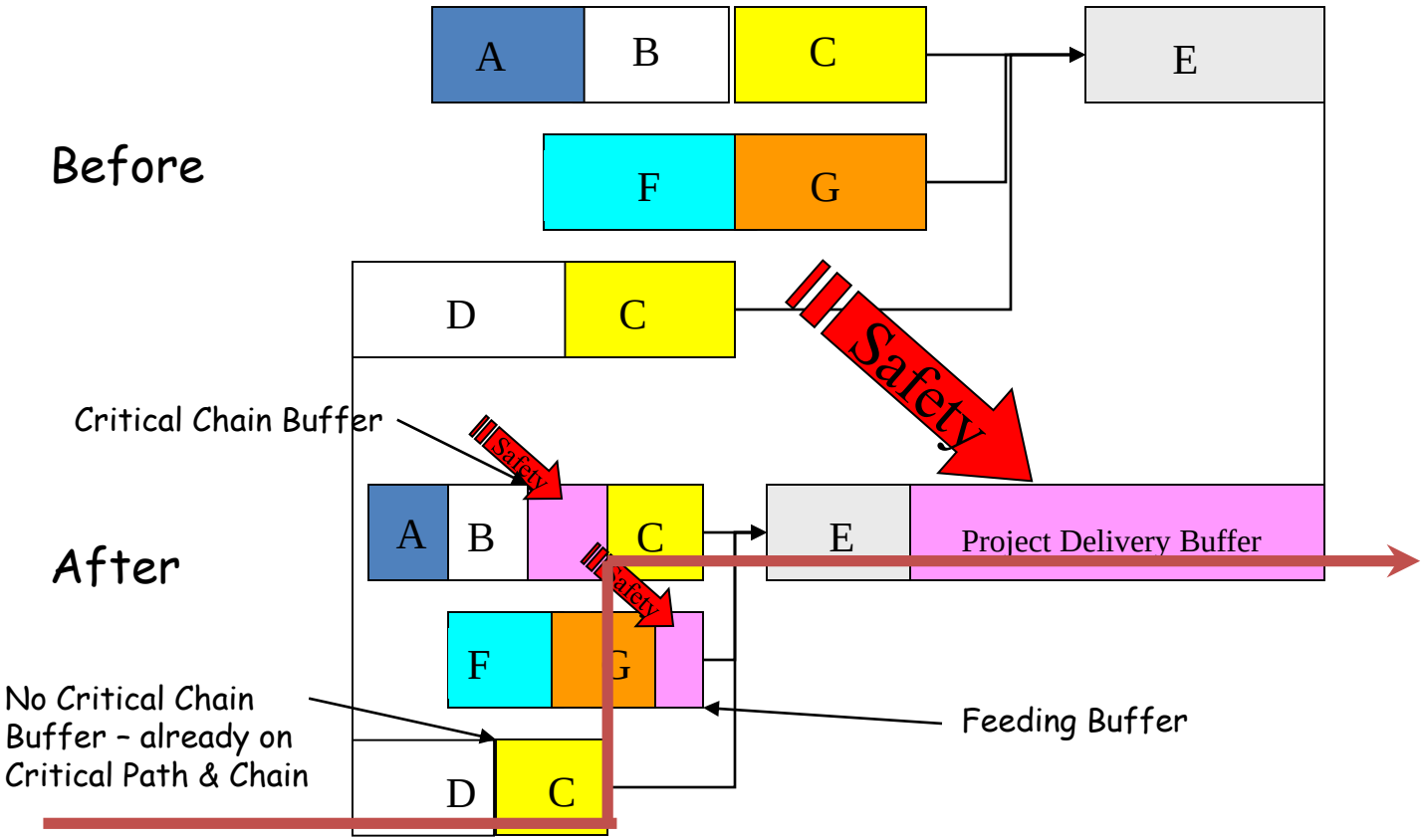
  - protecting the critical path from tasks that feed it
  - protecting the critical chain



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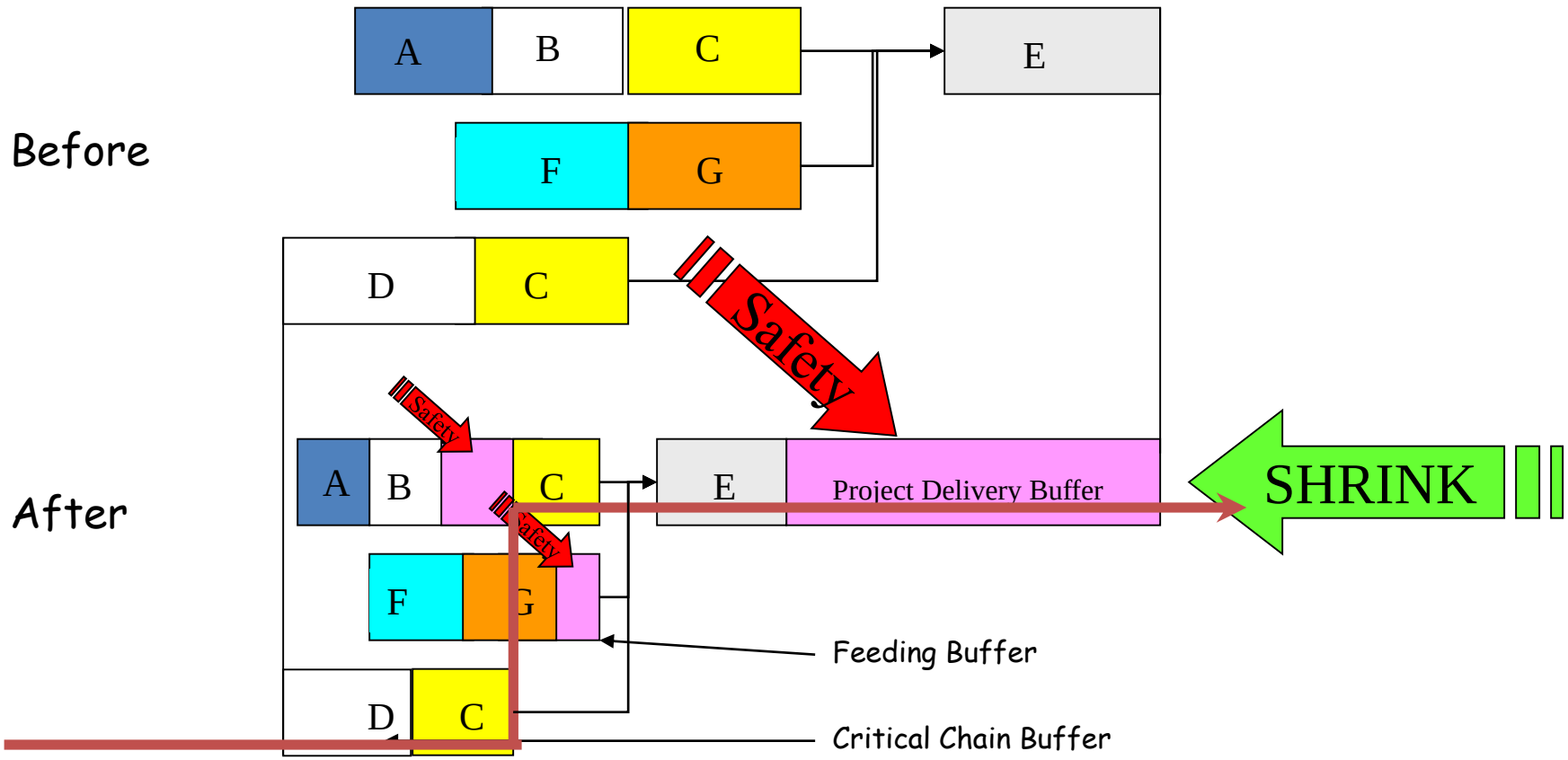
Knowing that we have too much safety built in to our estimates, it should be possible, with the new behaviour that this method of working creates to shrink the cumulative amount of safety in the delivery buffer



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Focusing – “Early Starts” versus “Late Starts”

Using PERT Networks and Microsoft Project, when there is float on the non-critical tasks we can choose “Early Starts” or “Late Starts”

Early starts –

- Starting all tasks as early as possible, can cause a lack of focus on the project, too many tasks to manage and away from those tasks that are really on the critical path / chain, causing the overall programme to run late.
- Particularly, when Murphy strikes on the Critical path / chain, if we do not focus on it, choosing to focus on getting work done that is not on the critical path, then we will further delay the overall programme.

Late Starts –

- Starting all tasks as late as possible, perhaps to delay the expenditure or financial commitment, will mean that there is no float in those tasks / path.
- When Murphy strikes here, it will then delay the critical path.

FOCUS

- Its all about FOCUS and to that end lets turn our attention to how we manage and measure performance of our programme

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Typically, programmes measure

Cost World

- Percentage Completion (Hours or Financial) and / or
- Milestone achievement

Throughput World

- However, neither have a direct correlation against progress through the Critical Path or Critical Chain:
  - you may have spent all of the money or time or a differing combination, but we do not know how much further the task has to go until it is completed.
  - Unless we ask for an estimate to completion in both
    - The cost world on CSR or
    - In the Throughput World, an estimate of when the task will be completed and a % probability of achieving it

- Indeed, it can drive a lack of focus on the activities and Murphy's on the Critical Path / Chain, causing delays to the Programme and the inevitable overrun in timescales and costs

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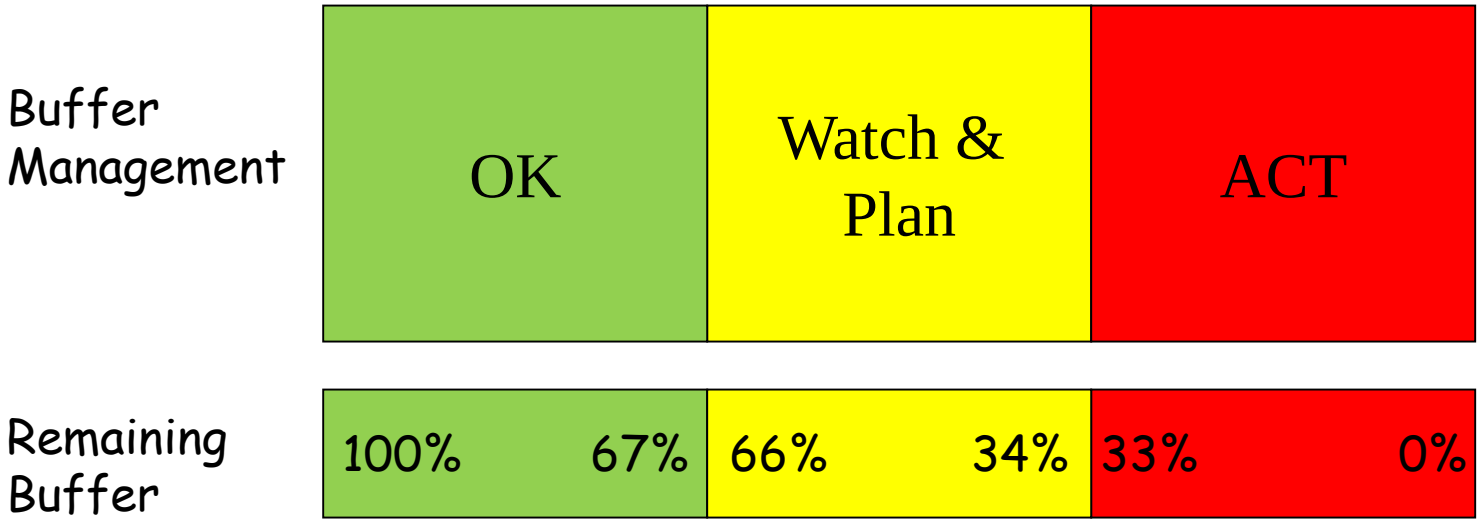
Manage / focus on the Critical Chain / Path and the buffers, not every step of the programme

FOCUS –

- Manage / focus on the Critical Chain / Path and the buffers, not every step of the programme



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So what is available?

- Several companies have implemented this methodology with tremendous results
- It does require commitment from everyone involved in programmes, in managing programmes and in managing the programme managers
- When this presentation was first created in Nov 2000, software was available such as “Prochain” which is a bolt on product to “Microsoft Project” to de-conflict resources @ $900 per seat, or “Scitor?” @1100 per seat which interfaces with SAP
- The Critical Chain is based on the “Theory of Constraints” by Eliyahu Goldratt who wrote the novel “The Goal” for Manufacturing. The Critical Chain is the application of the same “Theory of Constraints” but applied to Projects. For example, the bottleneck in projects is the “Critical Path”. It’s a novel and I will not spoil it for you as it is a great read. But, as you maybe considering implementing Critical Chain, you may benefit from the attached. Happy to discuss further.
- For ease of reference, please be advised that copies of the Critical Chain are available from Amazon or…
  - here is my Amazon affiliate link directly to the book The Critical Chain is also available as an audio book)
  - We have also talked about The Goal, also written Eliyahu Goldratt

Just right click on the underlined titles and open the hyperlink

Disclosure: An amazon Affiliate link apparently costs the buyer the same price, but the promoter may get a small %. I have never received any money yet, I just wanted an easy way of pointing people to this and similar products, but maybe one day it will pay me something – This is not why I do it – I believe it is a good book and have personally bought 100’s of copies for previous companies, but I just wanted you to be aware of my potential “conflict of interest”

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Implementation Plans for one of John's factories, that were attempting to manage 100 programmes with 4000 line Microsoft Project Plans whilst using constrained, multi- tasking and busy resources

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The Cost World v The Throughput World

- We must distinguish in everything we do and discuss, between the Cost World and the Throughput World

For example, the work content is 5 hours and I will get it done in the next few days (say two days)

There are circa 8 hours in a single shift, working day

In the Throughput World, my estimate is 2 days or 16 hours

In the Cost World, my estimate is 5 hours

For whatever reason, we have added a lot of safety 1-((16-5) / 5) = +120% safety.

This maybe because we are doing something else, or we will have to multi task, or we will not get the inputs that we need in a timely manner, or we are bound to get problems or be interrupted.

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Work Package Management & Critical Path at Your Site

- Identify and engage with Stakeholders to design and develop the solution
- If you are drowning in Microsoft schedules with 1000's of lines, implement Work Package Management to reduce the number of lines in a programme
  - Choose a selection of programmes by some means
  - Implement WPM,
  - Taking care to retain sufficient detail to manage the resources and the Critical Path
  - Use Microsoft Project to identify Critical Path
  - Ensure Critical Path and it's importance is visible through EPM to all personnel
  - Ensure Critical Path awareness is progressed by PMO and Project Managers

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Identify Company Bottlenecks

- Determine Types of programmes, their high level process map and the bottlenecks they face, through
  - the complete order intake process
  - through Design, Manufacture and Test,
  - to shipment, invoice and after sales support.
- Identify resource constraints per type of programme, either through Brainstorm or Microsoft / Excel Analysis
- Train people and raise awareness on the effects and impacts of multi-tasking. Take action to reduce multi- tasking
- Office moves to create co located teams versus functional nodes where there is insufficient resource to put into teams of projects
- Reconfirm bottlenecks

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Apply the 5 focusing steps at your site and on your programmes

- Identify and engage with Stakeholders to design and develop the solution
- Roll out training and general awareness
- As WPM is introduced to each programmes, apply the 5 focusing steps:-
  - Identify the Critical bottleneck or the critical constraint to the company's Throughput
    - If you care about the performance of a chain, strengthening any link apart from the weakest is a sheer waste of time and energy.
    - Similarly, the vast majority of efforts to "improve" something in the organization rarely results in any increased profits for shareholders, delight for customers, or satisfaction for employees. This is because most initiatives are not focused on the constraint of the organization
  - Exploit the constraint – squeeze everything possible from it, ensuring that it is efficiently used and maximised, it never stops etc
    - Gather the underlying data and analyse it using Pareto techniques. Once the primary causes are identified, use fishbone diagrams and Five Why analysis to drill down to the root cause for underperformance.
    - When the root causes are clear, eliminate them on a permanent basis. Quality and productivity tools such as Six Sigma, Poka-Yoke, design of experiments, SMED, etc. often provide the answer, depending upon the nature of the problem.
  - Subordinate everything else to it
    - By definition, any non-constraint has more capacity to produce than the constraint itself. Left unchecked, this results in bloated WIP inventory, elongated lead times, and frequent expediting/firefighting
    - ensuring that the rest of the system supports the work of the constraint at all times. It must never ever be starved for inputs, or fed poor quality materials. This can be achieved by maintaining a reasonable buffer of safety stock.
  - Elevate the constraint by increasing it's capacity or by moving non essential work to other resources or times (earlier or later)
    - Once the capacity of the system is exhausted, it must be expanded by investing in additional equipment/land, hiring people, or the like.
    - Warning! We tend to instinctual gloss over the first 3 steps and jump straight to elevation. Implementing the first 3 steps properly typically expose a minimum of 30% hidden capacity within the first few months! This capacity is available free of cost, without any investment. Investing too soon raises risk unnecessarily. Only elevate once exploitation & subordination (Steps 2 & 3) is fully complete, if at all
  - Prevent Inertia from becoming the constraint
    - Once elevated, the weak link may not remain weakest. Consider elevating other resources to retain the old constraint, depending on where you wish to have the constraint in the long-term. A new constraint demands a whole new way of managing the system. We therefore return to Step 1, and thus begins our journey of continuous improvement

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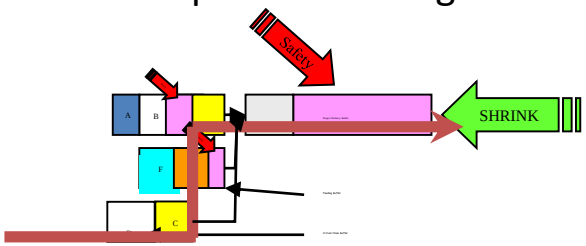
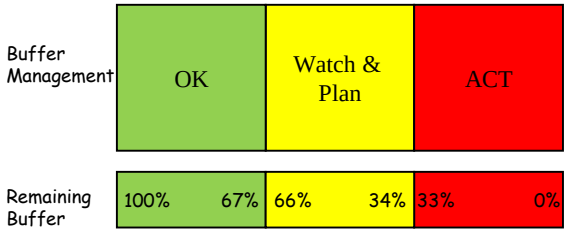
Apply Concerto (Critical Chain) on **individual** programmes on your site

- Identify and engage with Stakeholders to design and develop the solution
- Roll out training and general awareness
- Use Concerto (automatic process?) or some other process to adjust task **durations** on each programme individually
  - Creating
    - project buffers,
    - buffers to protect the Critical Path where non Critical paths meet the critical path
    - Scheduling resource constraints so that they do not call for the same constraint at the same time
    - Buffers to protect the critical constraints when they are not on the Critical Path (when they are on the Critical path they need to work on it immediately so there is no need for a buffer)
- This is a critical phase for training to ensure the activity is understood
- Ask for estimates of when a task will be completed, or
- The likely duration of the task and the % probability that the task will be completed on time and adjust the estimate accordingly
- Measure the performance along the critical chain
- Set up buffer management and buffer reporting (Throughput World)





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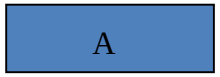
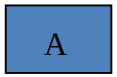
The Impact of Reducing the Duration of a Task

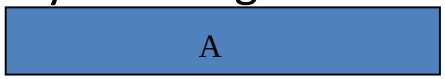
- There are two possibilities of how people may react to unilateral reduction in the duration of the task on future estimates the following week or on the following programme
- From this 

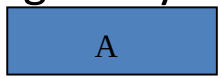
to this 

- If through training and understanding, they know what you are trying to achieve, next time they may reduce their estimate.



- In this case, we need to be careful not to reduce it again 

- Alternatively they may react by doubling the estimate, knowing that you are going to half it, from this 

to this 

- Either way, the effect is undesirable, especially if we do not understand which route has been taken.
- To overcome this…..

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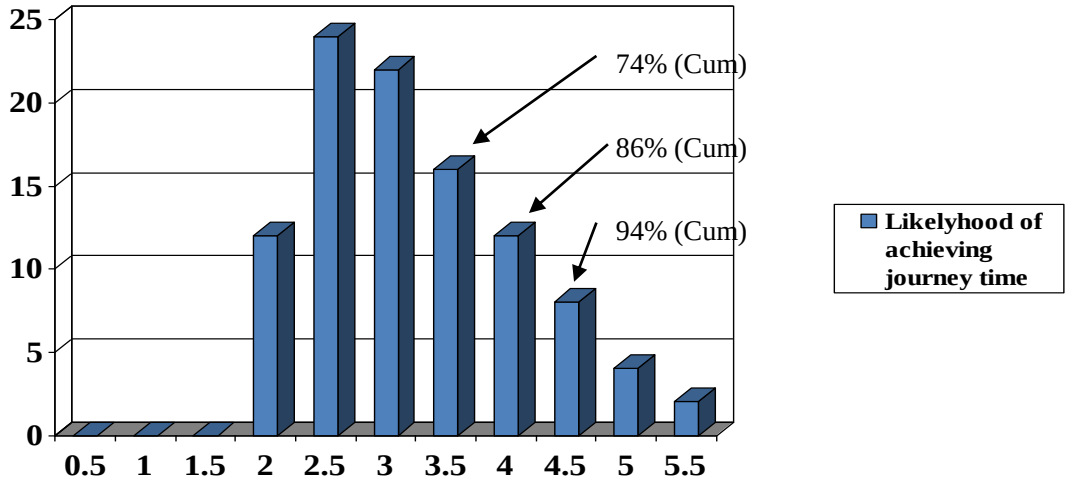
Understand the duration estimated and the % probability of achieving it

To overcome this, we need to

- Ask for estimates of when a task will be completed, or preferably
- The likely duration of the task and the % probability that the task will be completed on time and adjust the estimate accordingly.
    - For example, if we know that there is a 95% probability of completing the task then we can assume that the task has been circa doubled in duration to allow for safety



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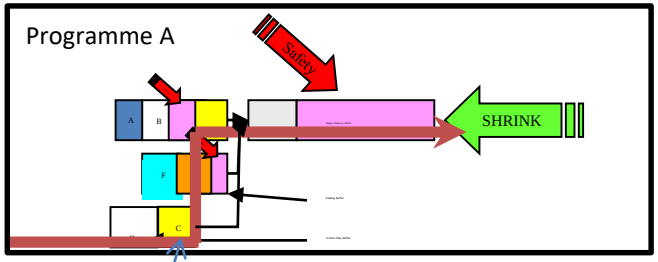
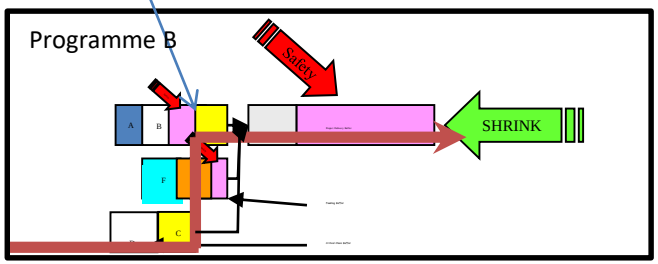
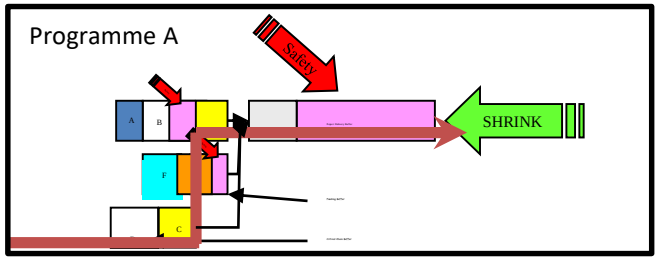
Reconfirm Company Bottlenecks and schedule them moving programmes accordingly

- Identify and engage with Stakeholders to design and develop the solution
- Roll out training and general awareness
- Reconfirm the Critical Bottleneck and Resources that impact the programmes through the company
- Schedule programmes through those bottleneck by moving programmes to the left or right depending on a selected priority

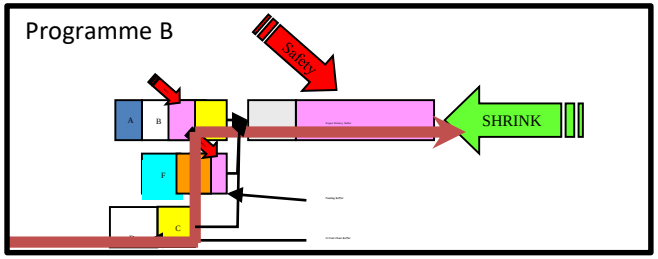


Critical Resource C conflict between 2 or more programmes leading to multi-tasking and likely other resources as well





Move whole programme to the left or right - scheduling critical resource so that it is not multi-tasked. Other resources will also move, but those conflicts can be covered by use of the float in the buffers.



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Revisit

- Determine Types of programmes, their high level process map and the bottlenecks they face
- Office moves to create co located teams versus functional nodes where there is insufficient resource to put into teams of projects
- Reconfirm bottlenecks

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