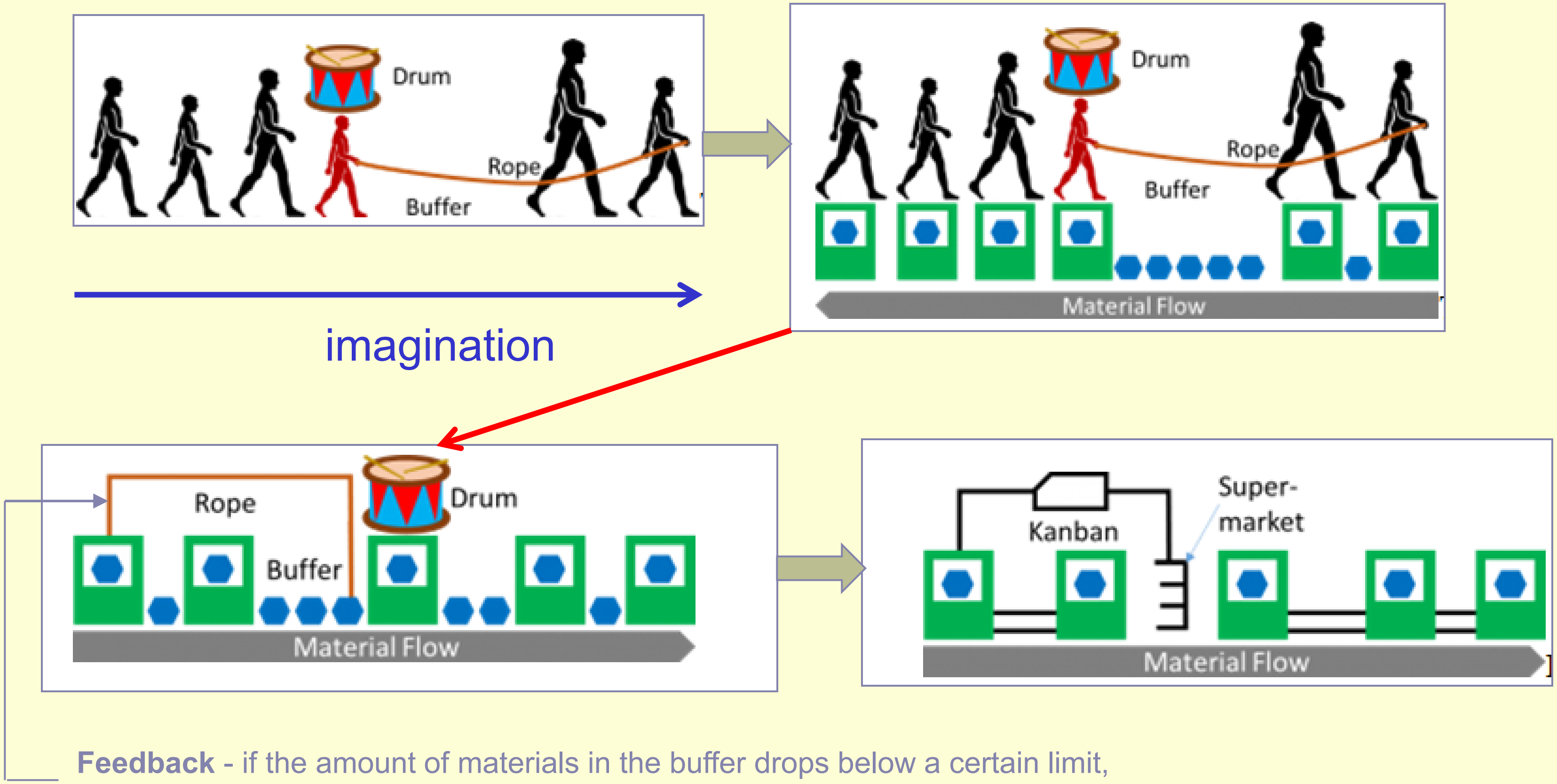
Drum –Buffer-Rope

Based on : R. Holt, Ph.D., PE

Principles

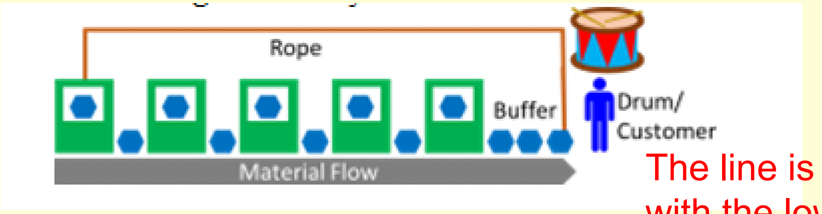


Feedback - if the amount of materials in the buffer drops below a certain limit, the input of components to the line is released

Resource : http://www.allaboutlean.com/drum-buffer-rope/

Simplified Drum Buffer Rope (S-DBR)

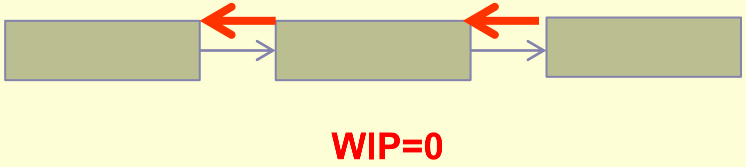
Principles



The line is not controlled by the source with the lowest flow (throughput), but by the requirements of the Customers

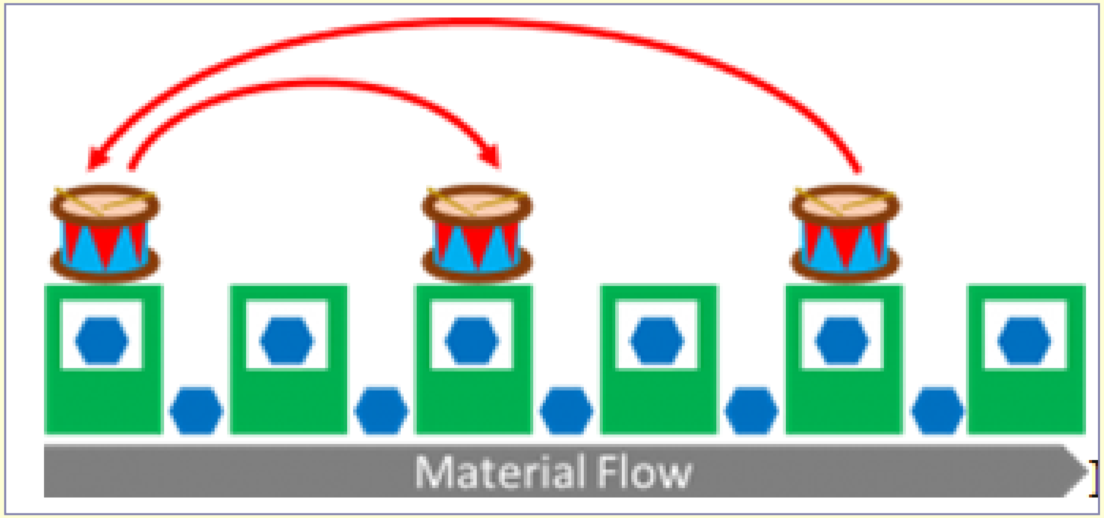
Most importantly, it does try to constrain the Work-In-Progress (WIP) and aims to **prevent an overloading** of the system. As such it can be considered sort of a pull system like Kanban or CONWIP (Constant Work in Progress), and hence **Drum-Buffer-Rope** is superior to the traditional **push systems**.

Push – MRP-II

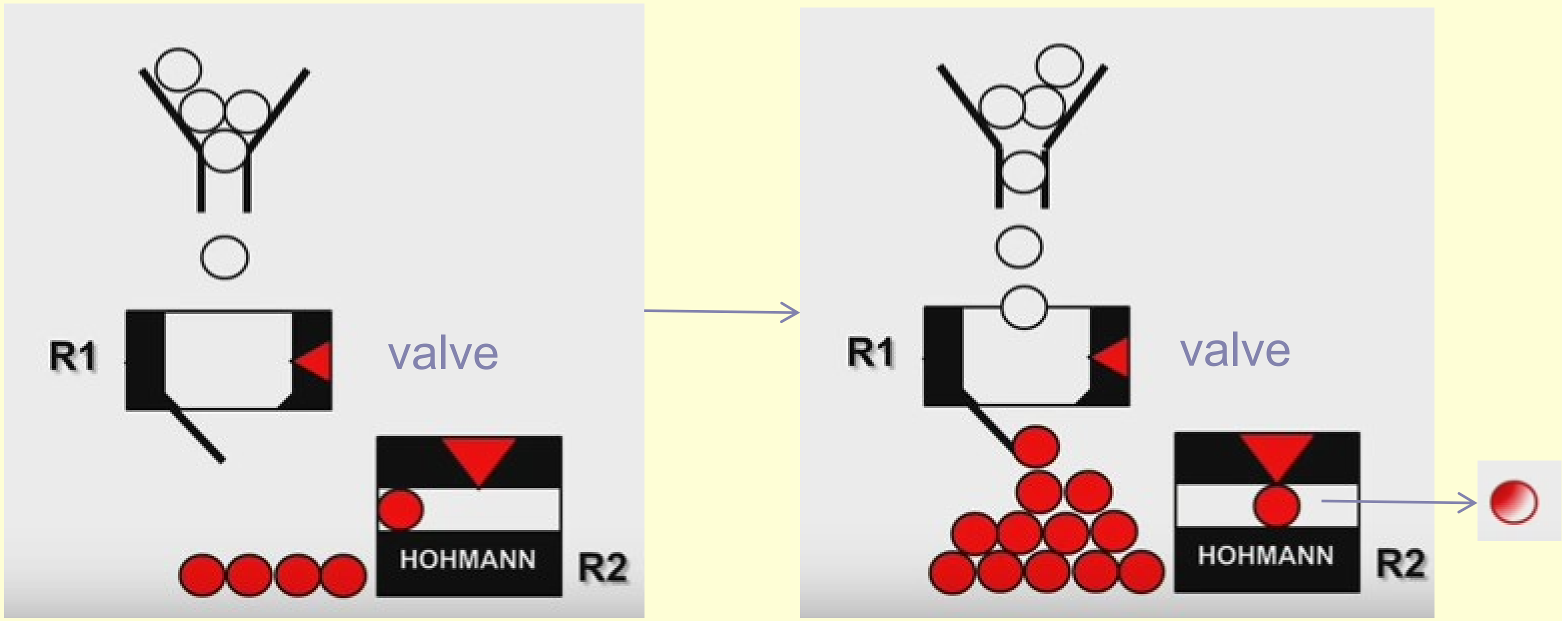


Pull – JIT- kanban = ←

DBR disadvantage : No Consideration for Shifting Bottlenecks

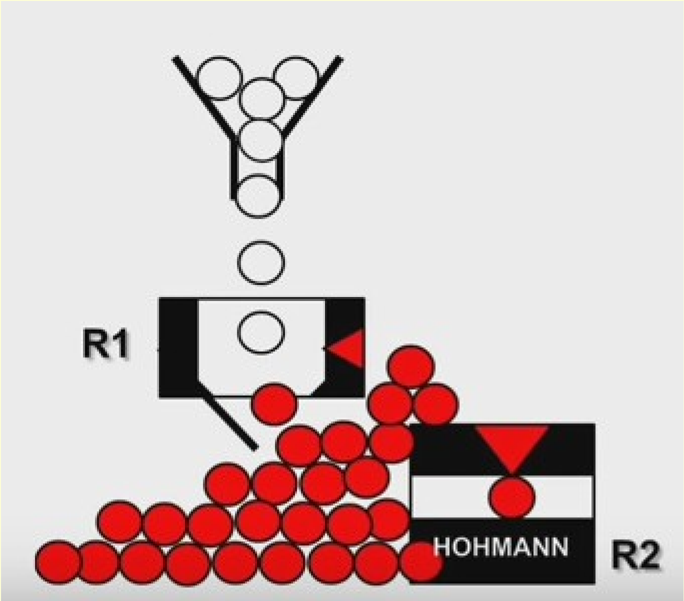


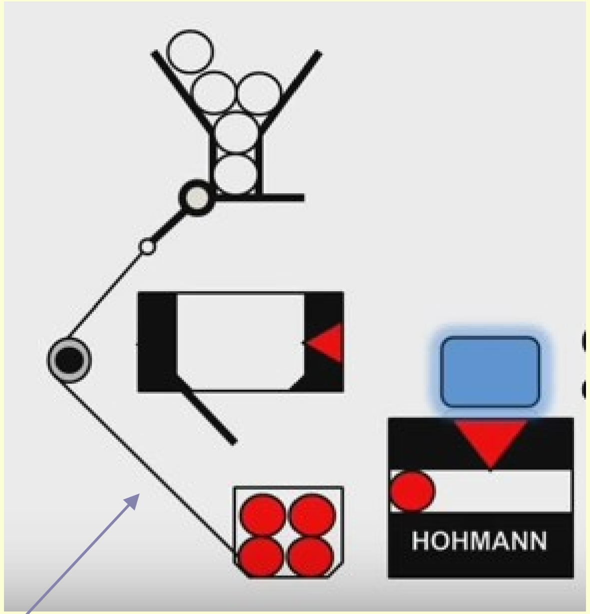
This system is not controlled



Based on pictures taken from CH.Hohman show

First part is not controlled ->so it has to be modified (DBR)

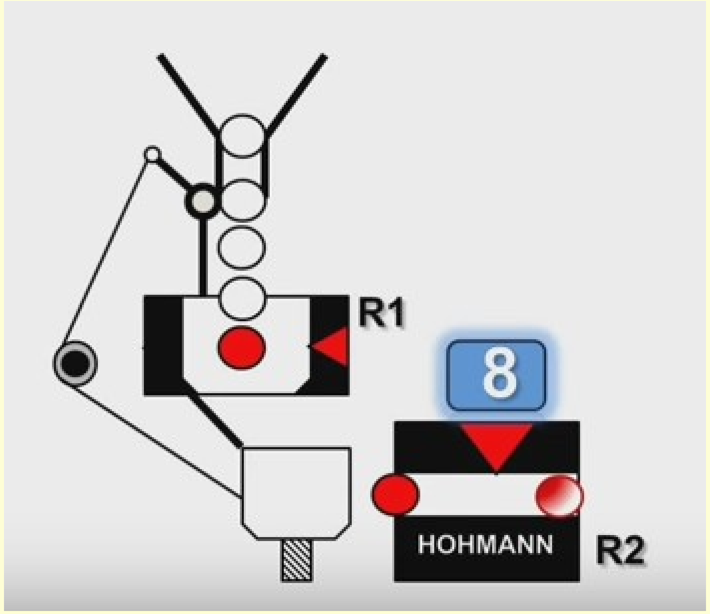


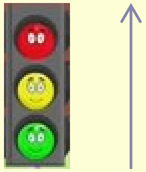


ROPE= feedback

Based on pictures taken from CH.Hohman show

Rope opened raw material valve R1





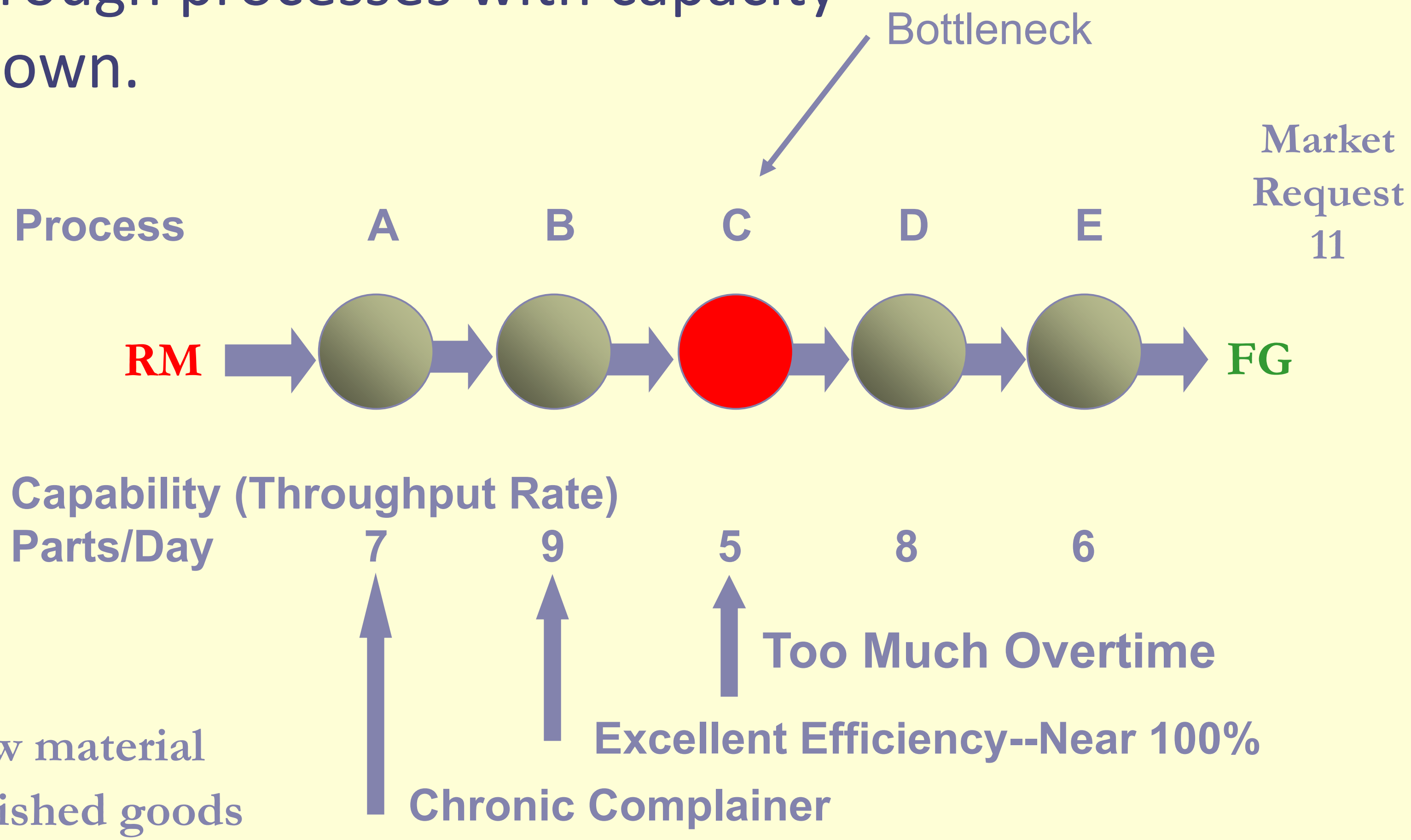
Based on pictures taken from CH.Hohman show

DBR example

- Imagine a hospital waiting room. If the time the doctor takes to see each patient is the Drum, then the Buffer can be the receptionist scheduling appointments so there are always two or three patients in the waiting room. The Rope is the nurse calling in each patient once the doctor is ready to see them.

We Measure Operational Efficiency

- Workflow from left to right through processes with capacity shown.



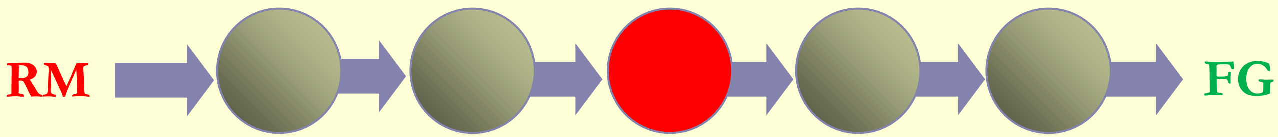
RM = raw material

FG = finished goods

Reward Based on Efficiency

- Workflow from left to right.

Process	A	B	C	D	E



Capability(Throughput Rate)

Parts/Day	7	9	5	8	6

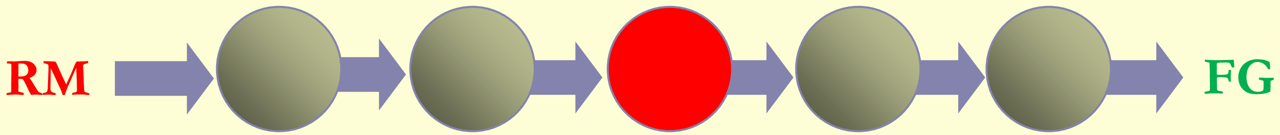
Both (D and E) found ways to look busy and appear to have a capacity of 5 parts/day.

„upper stream“

„down stream“

In reality…

- Processes A and B won’t produce more than Process C for long.



Process	A	B	C	D	E
Potential Part/Day	7	9	5	8	6
Reality	5	5	5	5	5

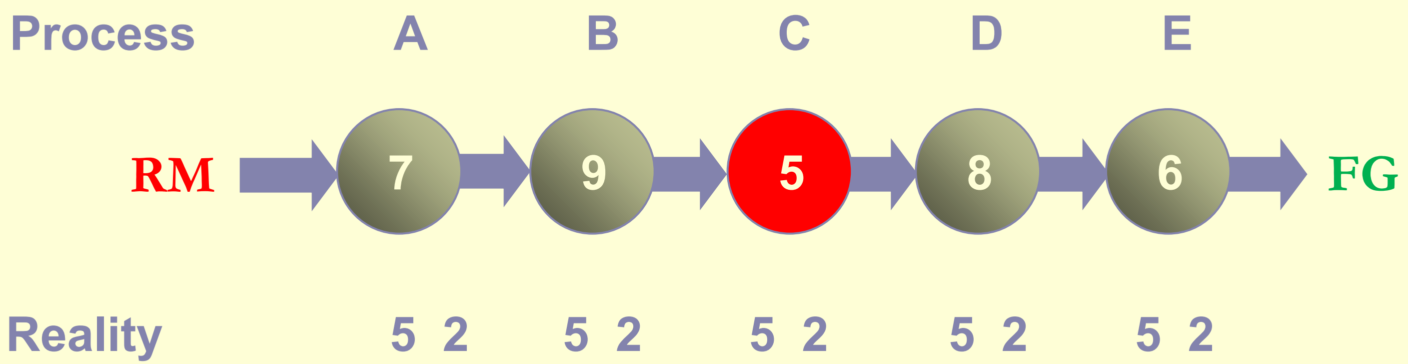
P/D=parts/day

RM = raw material

FG = finished goods

Then Variability Sets In

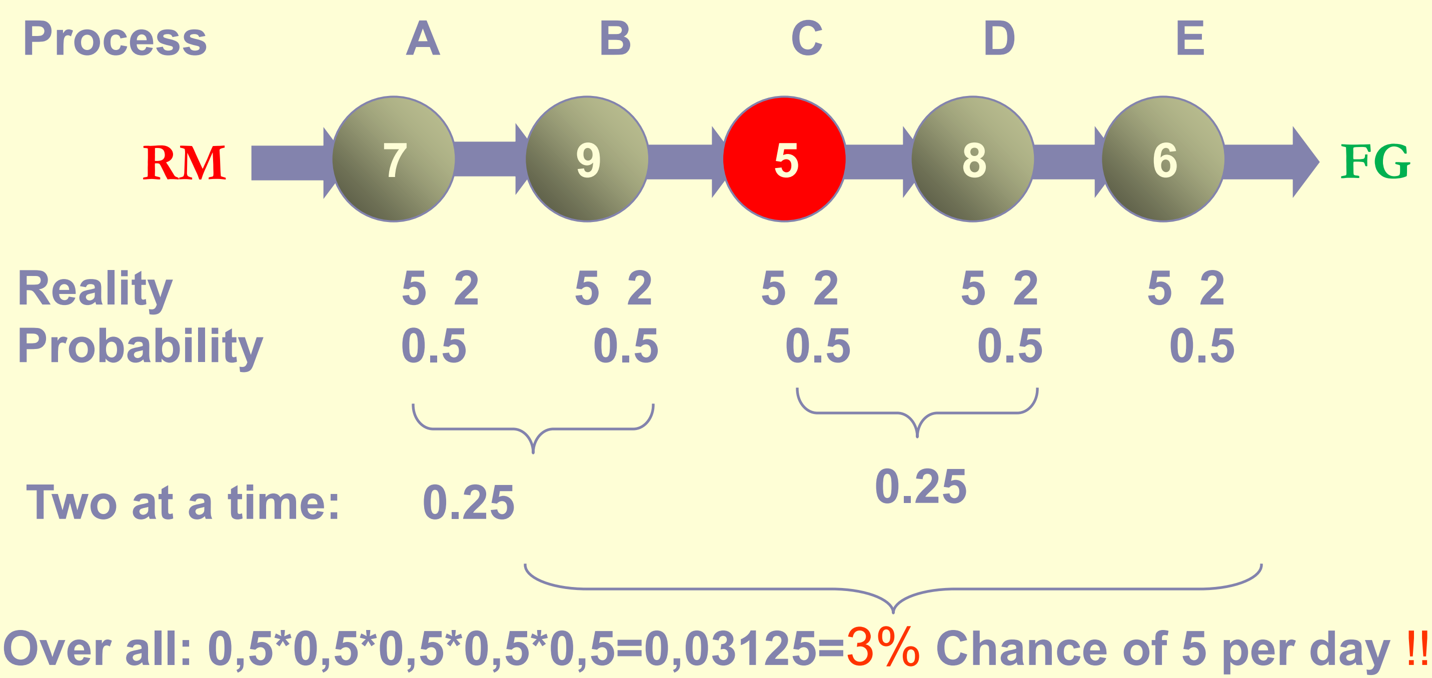
- Processing times are just AVERAGE Estimates



It can be a value between 3 and 7 (3,4,5,6 or 7)

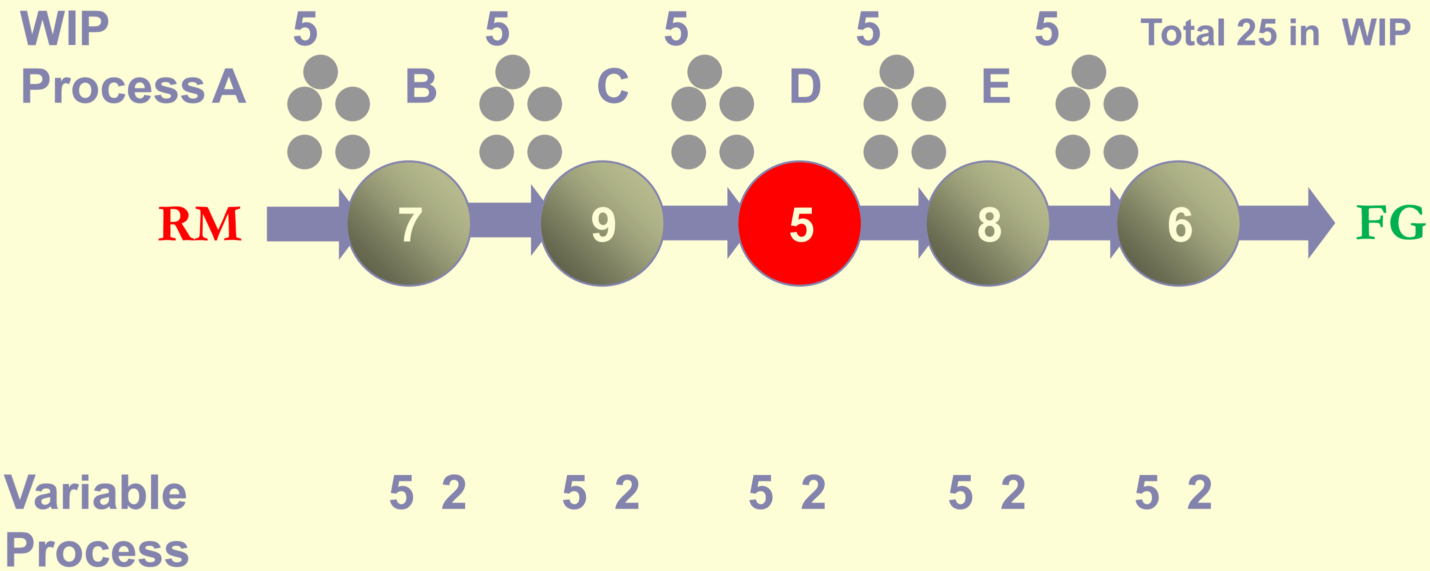
What's an Average? 50%

- Half the time there are 5 or more per day at each process and half the time less



One solution -not a good attempt!

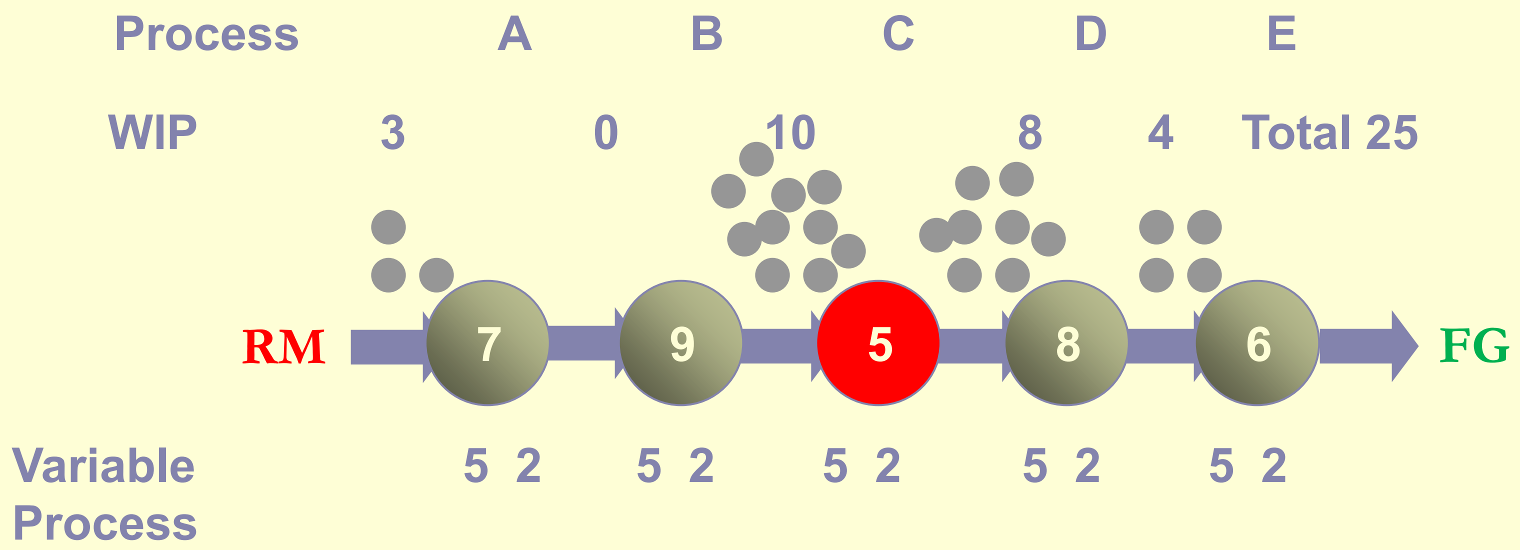
- At the beginning of the process you put a day of inventory (WIP) before each process



WIP= Work in Progress

System Variability Takes Over → Chaos

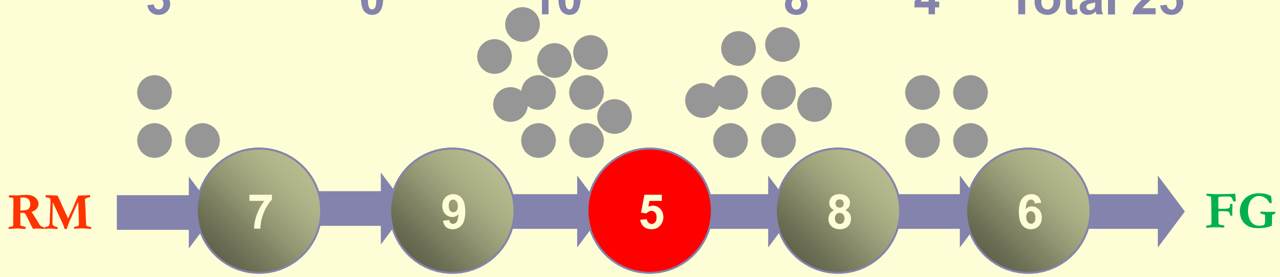
Inventory (WIP) quickly shifts position. The Inventory manager tries to smooth it out. Distribution problems result. And costs go up !!!



System Variability Takes Over->Chaos

An Average of 5 means sometimes 3 and sometime 7

Process	A	B	C	D	E	
WIP	3	0	10	8	4	Total 25



Variable	5 2	5 2	5 2	5 2	5 2

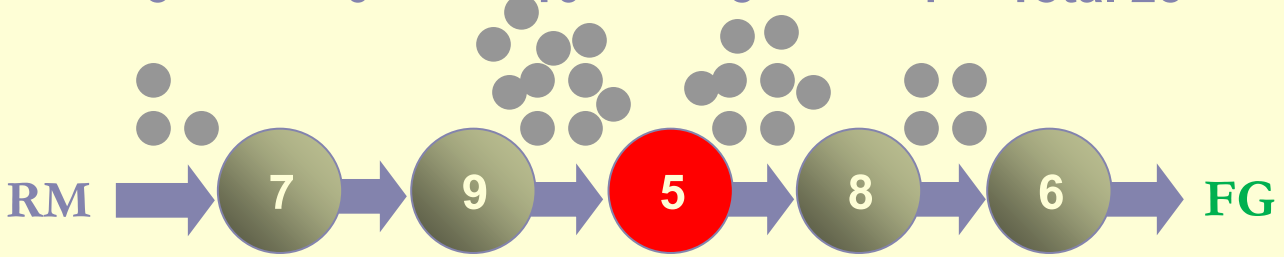
Process

Shifting work-in-progress (WIP) creates large queues at some locations. This makes work wait longer to be processed.
(based on Little s law ->WIP=TH x CT)
TH= průtok
CT = Cycle Time=CT=average time from when the job is released into station (machine or line) to when it exits.

System Variability Takes Over->Chaos

Process A B C D E

WIP 3 0 10 8 4 Total 25



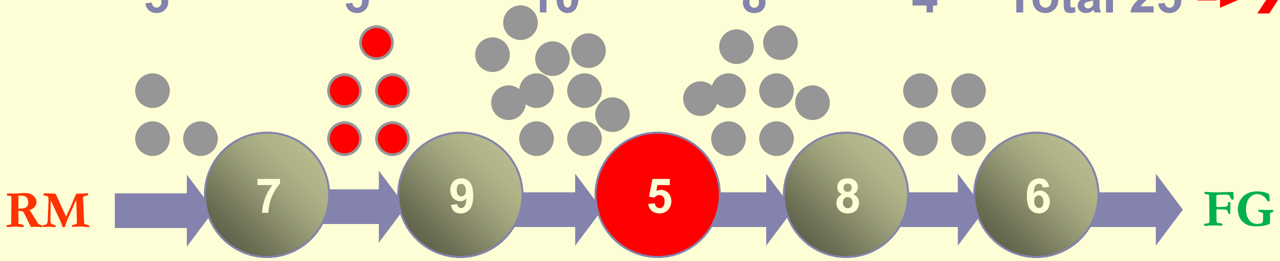
Variable Process 5 2 5 2 5 2 5 2 5 2

Shifting work-in-process creates **large queues** at some locations. This makes work wait longer to be processed.

Other workstations are starving for work (B). The work they could do is delayed because they have no input material. They can't take advantage of their extra capability. So what to do?

System Variability Takes Over--Chaos

Process	A	B	C	D	E	
WIP	3	5	10	8	4	Total 25 **->X 30**



Variable Process	5 2	5 2	5 2	5 2	5 2

So… **Management Helps!** Management puts in more work (Inventory) (rate of input **RM**) to give everyone something to do (**Cost World Approach-see TOC**) !

Result: It takes longer and longer from time of release until final shipping. **More and more delay!!!!!!!!!!!**

TOC Steps to Continuous Improvement

Step 1. ***Identify*** **the system's constraint.**

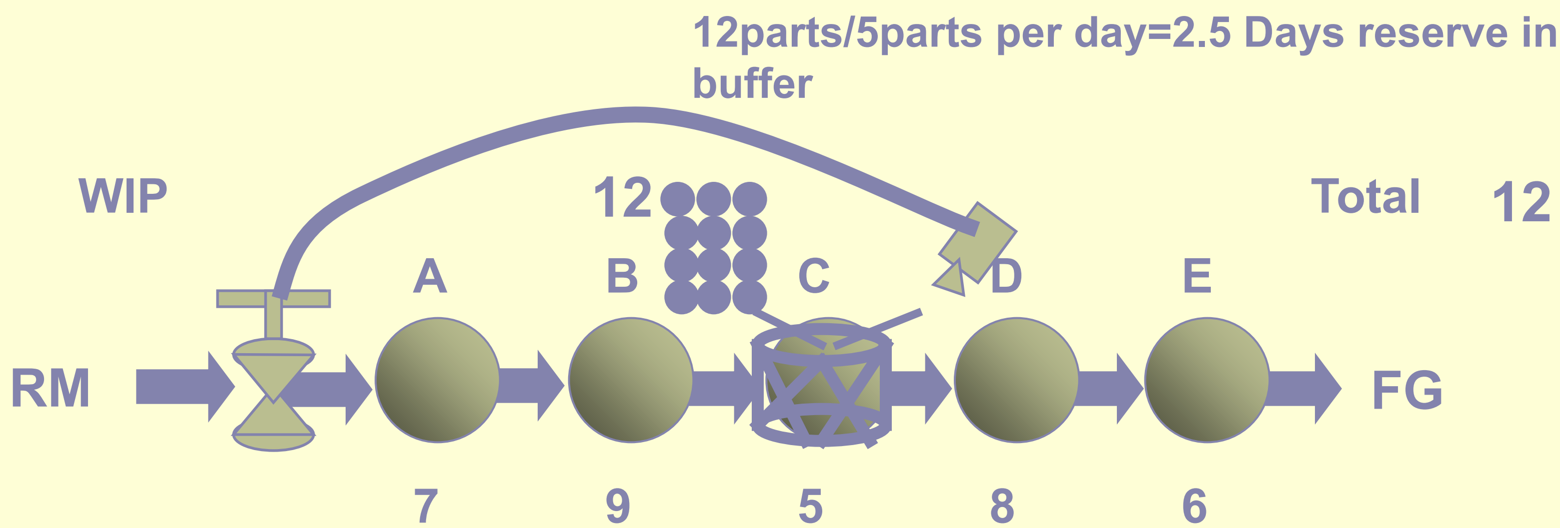
Step 2. ***Exploit*** **the system's constraint.**

Step 3. ***Subordinate*** **everything else to the above decision.**

Step 4. ***Elevate*** **the system's constraint.**

Step 5. **If a constraint is broken (that is, relieved or improved), go back to Step 1. But don't allow** ***inertia*** **to become a constraint.**

Five Steps Applied to Flow Operations



<u>Five Focusing Steps</u>

Step 1. Identify the Constraint (The Drum) – CRT

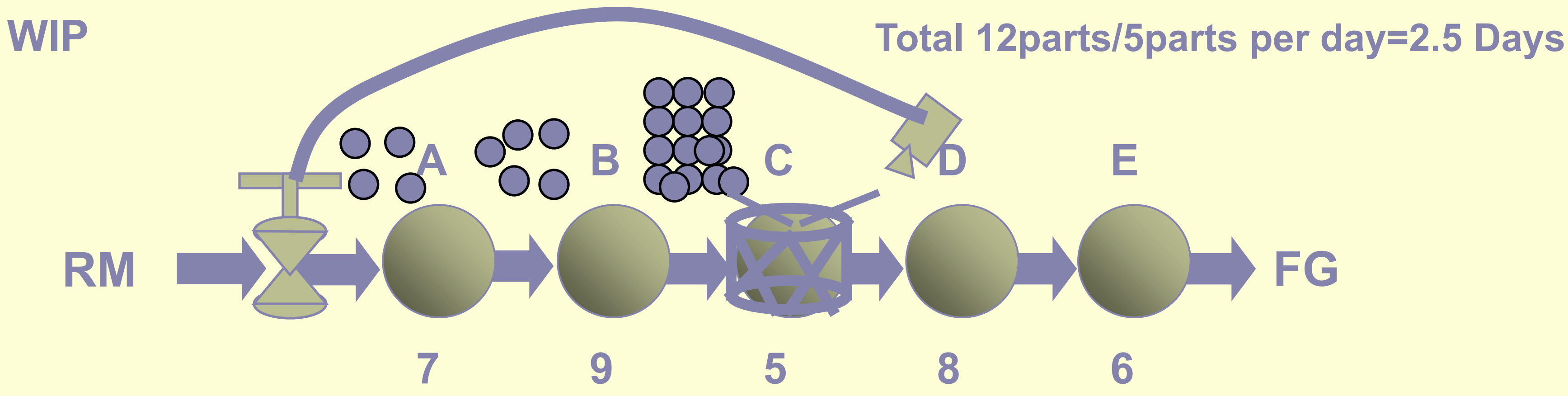
Step 2. Exploit the Constraint (Buffer the Drum) – time reserve

Step 3. Subordinate Everything Else (Rope) – feedback

Step 4. Elevate the Constraint ($?) - related to additional cost

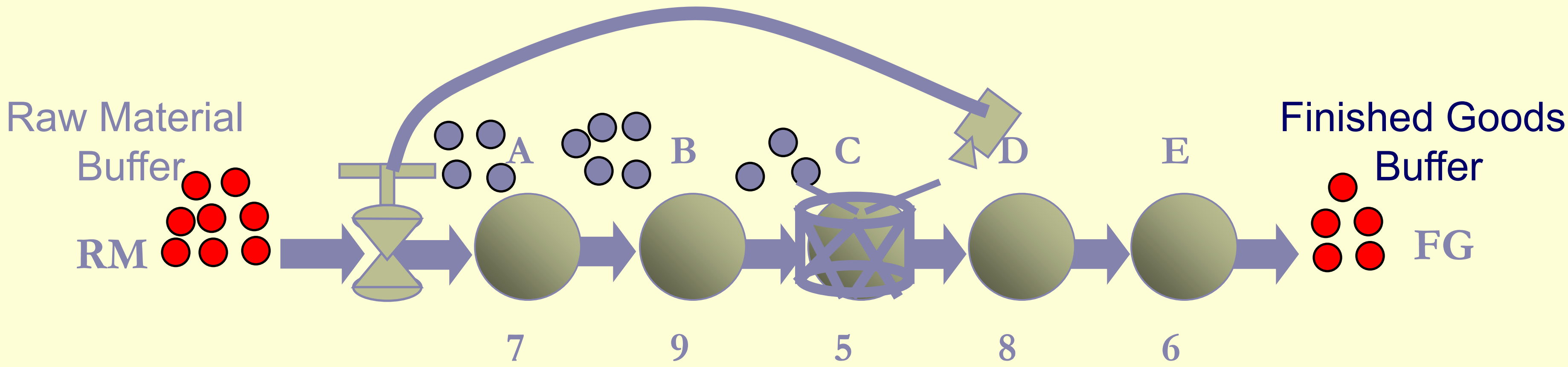
Step 5. If the Constraint Moves, Start Over

Understanding Buffers



- The "Buffer" is Time!
- In general, the buffer is the total time from work release until the work arrives at the constraint.
- Contents of the buffer alters (see below)
- If different items spend different time at the constraint, then number of items in the buffer changes
- but **Time in the buffer remains constant**.

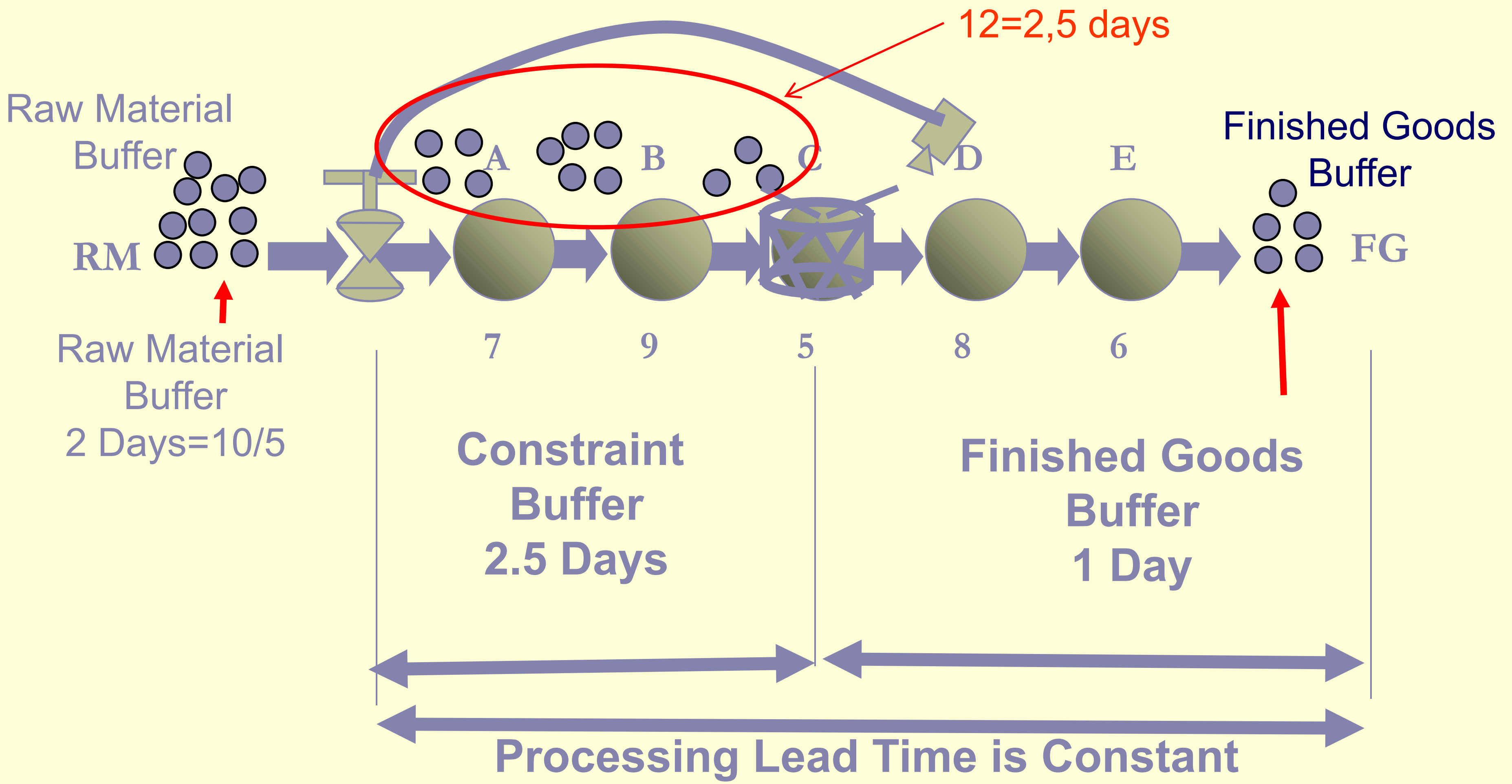
We need more than one Buffer



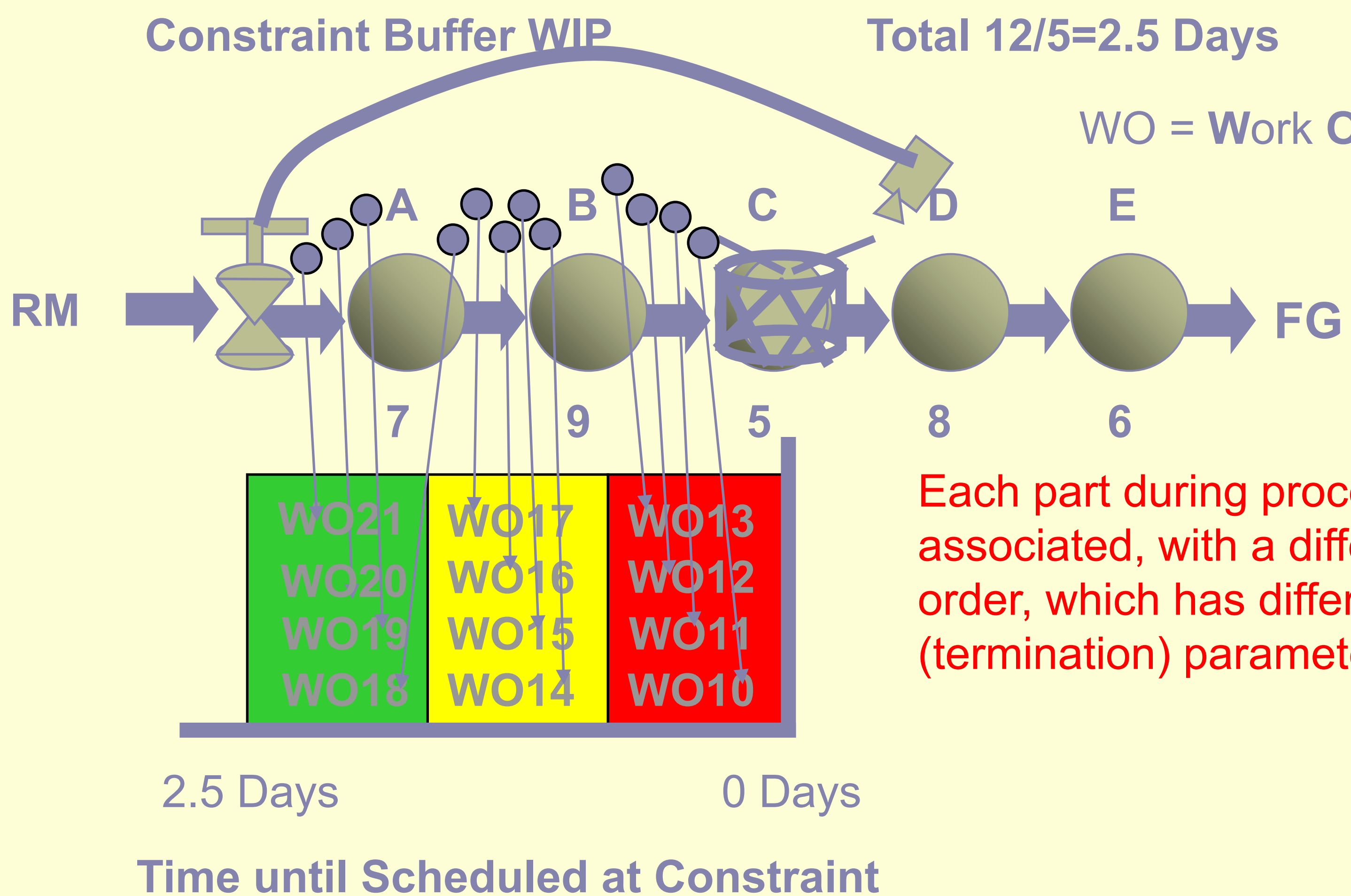
There is variability in the Constraint.
To protect our delivery to our customer we need a finished goods buffer.

- **There is variability in our suppliers.**
  We need to protect ourselves from unreliable delivery.

Buffer Time is Constant-Predictable

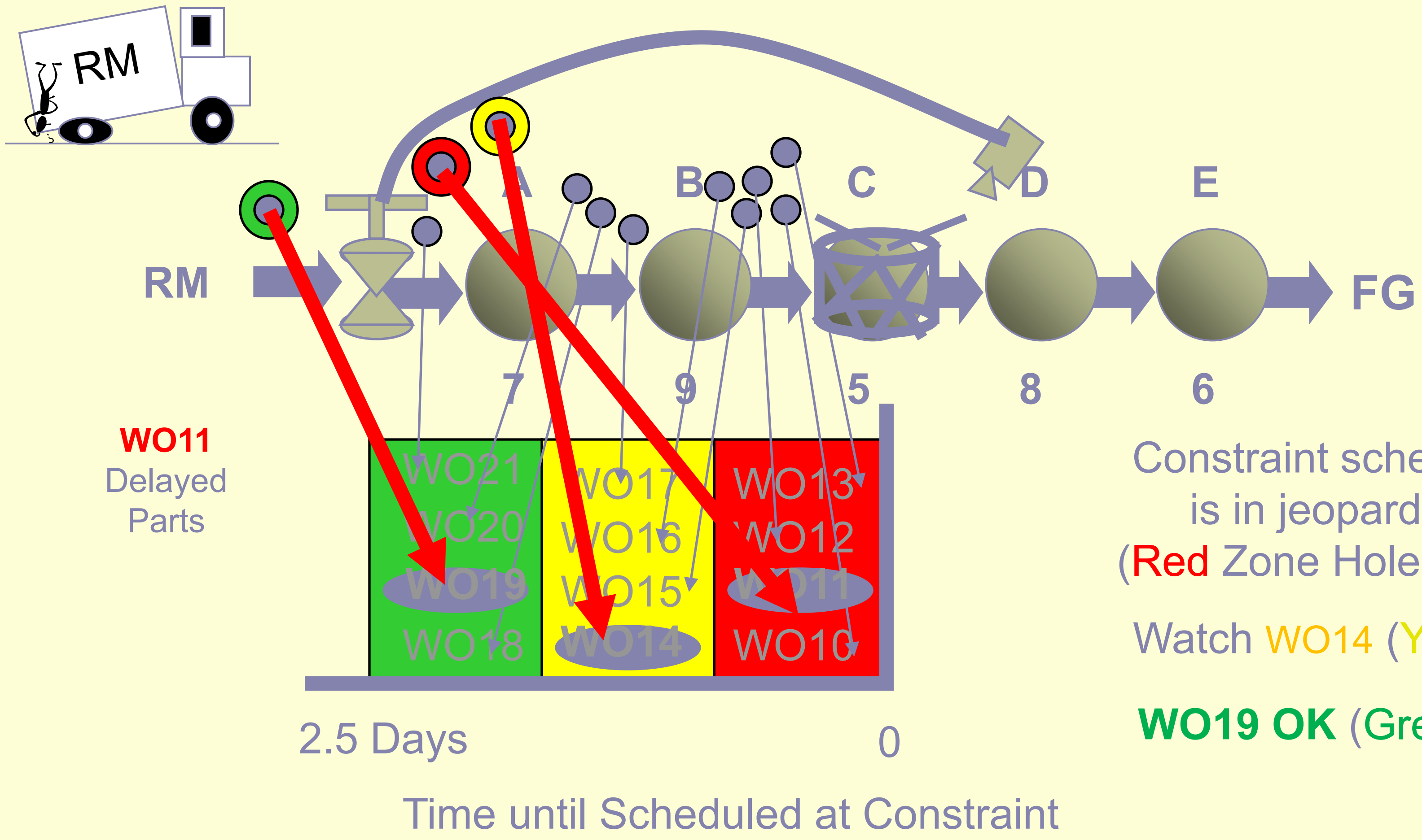


Buffer Management



Each part during processing is associated, with a different work order, which has different delivery (termination) parameters, etc.

Problem Identification

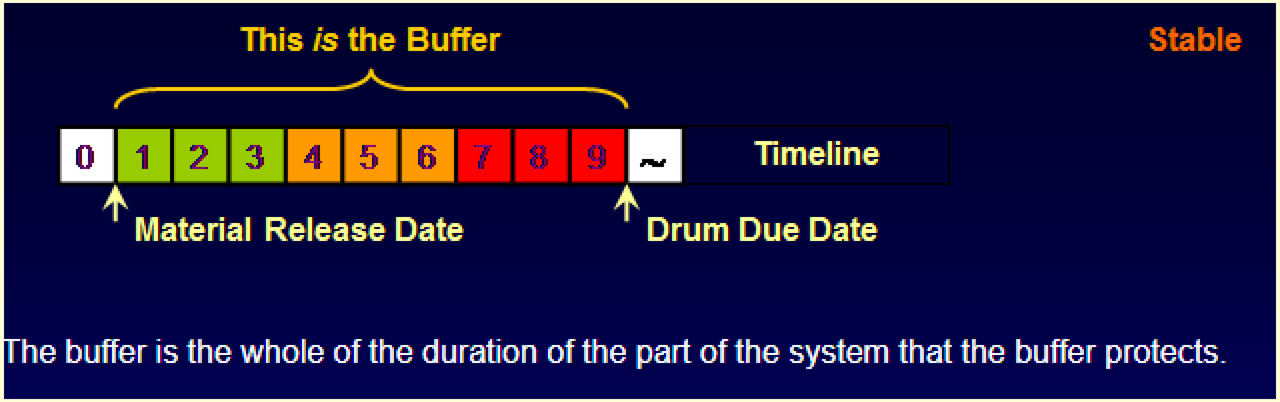


Constraint schedule
is in jeopardy!
(Red Zone Hole **WO11**)

Watch WO14 (Yellow)

WO19 OK (Green)

Buffer



The order of priority for processing parts assigned to different Work Orders is determined by color (as in traffic lights)

Additional Buffers

- Constraint Buffer (as we discussed)
  - Protects the Constraint from running out of work
- Finished Goods Buffer
  - Protects customer delivery from Constraint variation
- Raw Material Buffer
  - Protects the Release of material from suppliers
- Assembly Buffer
  - Facilitates speedy flow of products

See interesting video

https://www.youtube.com/watch?v=8yehd2ZsKH0

DBR additional information

- https://www.dbrmfg.co.nz/Production%20DBR.htm

DBF postulates (home study)

- Drum-Buffer-Rope (DBR) is a theory-based resource **planning** and **scheduling** solution restriction.

- The basic assumption of DBR is that there is one or a limited number of capacities in each company limited resources that are key to the performance (efficiency) of the company.
- We call this limited resource the "drum" (DRUM) because it sets the pace for every other resource.
- To achieve the maximum output of the system, we must first manage our limited system source (so called DRUM), meaning its use and priority planning which work orders will be realized on it
- Ensuring that the DRUM operates continuously (see steps 2-3 of the five TOC steps) is a must
- Failure of any source inputs (material or failure of sources before our limitation) is provided by time reserve (BUFFER).
- A feedback element ensure synchronization with other sources before DRUM is called ROPE.

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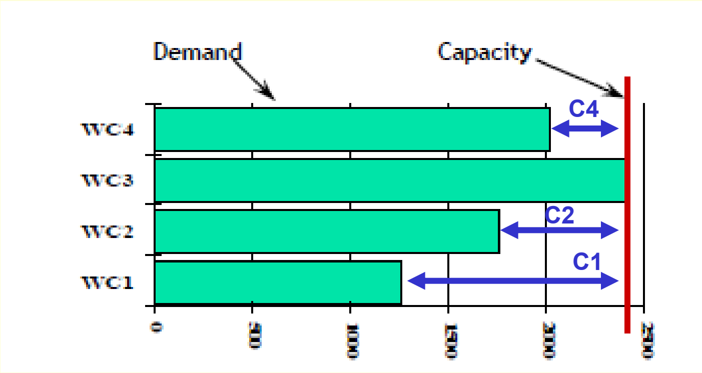
- A feedback element ensure synchronization with other sources befire |called a rope (ROPE)

Scheduling

- Each source must be in terms of its load, and available capacity must be assessed individually
- For example, let's have **1000** hours available and demand **880** hours for that capacity.
- However, this demand does not describe the indicated situation with sufficient precision.
- In the picture, we see that most work centers (WC) still have sufficient capacity while WC3 is fully loaded, and it is not possible to use it for a possible work order specified by time requirement
- The actual situation is that the capacity of the company is limited because **we can not increase** the number of orders because we are already determined by the fully used capacity of WC3



C4 +C1+C2=1000-880=120 → our time reserve

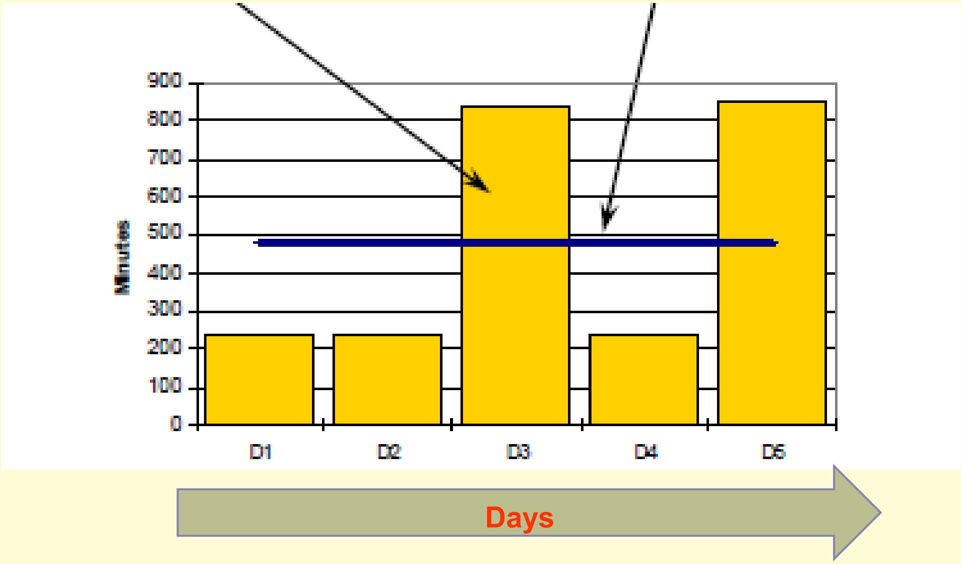
Reserve capacity remaining

What we have at our disposal and what are the requirements

We need to consider the **time frame** in which demand occurs. A monthly or weekly demand plan may not be enough to take action to meet the requirements over time.

Requirement : what we need

Capacity: what is available



TOC Approach

- To improve the system, we must optimize the weakest link (restriction) called **DRUM**. All other sources are subject to this decision. The scheduling is as follows :
- 1.Develop a detailed **drum work** assignment plan (DRUM)
- 2. BUFFER is added to protect performance of our limited resource
- 3. The work schedule of other resources is synchronized according to the schedule drum (**DRUM**)

Scheduling means that we determine what will be done by which resource at given times.

Resource utilization (drum) to the maximum

Capacity: what is available

Requirement : what we need

40 hours/week

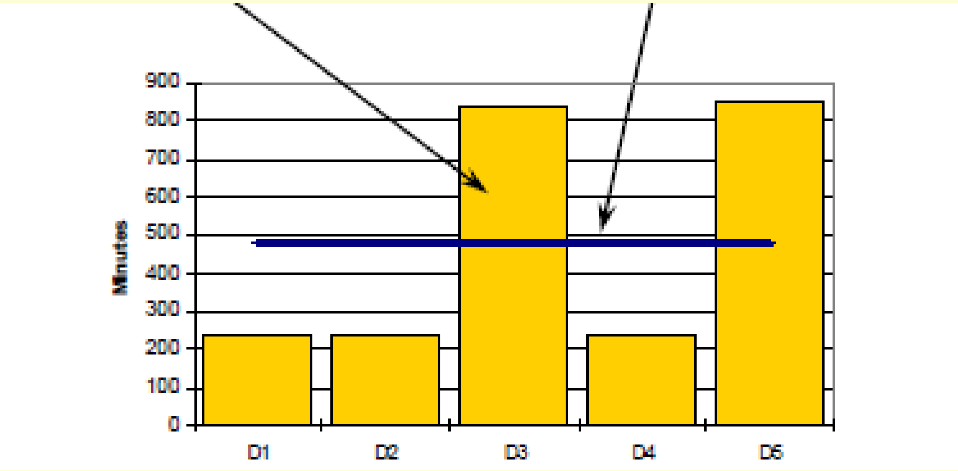
P1 requirement

Requirements
51 pcs per day 5
50 pcs per day 3

P2 requirement

10 pcs per days 1-5

Requirements
(every day 10 pcs of P2)



P1 and **P2** are the products we will produce in the company.

Scheduling on CCR (drum) – home study

40 hours/week

P1 requirement

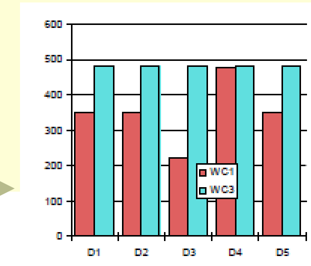
51 pcs per day 5

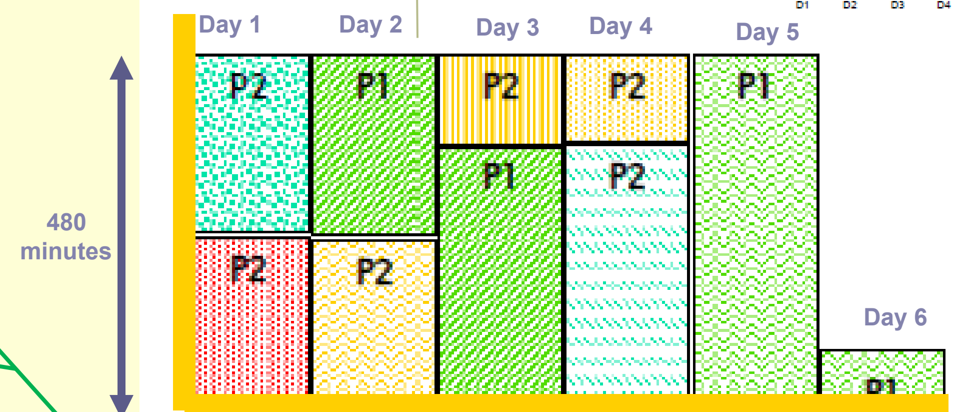
50 pcs per day 3

P2 requirement

10 pcs per days 1-5

Day	Productk	Qty	Minutes
1	P2	10	240
1	P2	10	240
2	P2	10	240
2	P1	20	240
3	P1	30	360
3	P2	5	120
4	P2	15	360
4	P2	5	120
5	P1	40	480
6	P1	11	132





P1 50 pcs day 3

P2 10 pcs day 1-5 (prodution time 1pc//24 minutes)

480/20 = 24

10 pcs per 240 minutes

P1 51 pcs day 5 (production time 1pc/12 minutes)

CCR =Capacity-Constrained Resource, Qty=Quantity

Thank you for your attention