Drum –Buffer-Rope

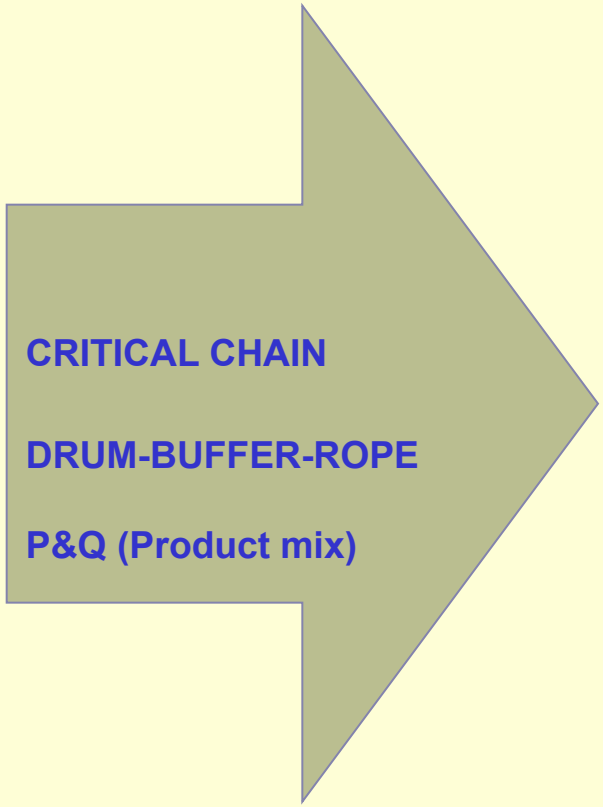
Based on : R. Holt, Ph.D., PE

http://www.dbrmfg.co.nz/Production%20Implementation%20Details.htm

TOC-fundamental knowledge and its applications

- Simplicity
- Bottlenecks
- Cost world
- Throughput world
- Five focusing steps
- Three questions

- **Thinking tool**
  - **CRT**
  - **Evaporating cloud**
  - **FRT**
  - **Transition tree**
  - **Prerequisite tree**



DBR basics

Components releasing

7 → 9 → 5 → 8 → 6 → FG

Throughput

Rope

Buffer

7 9 = non-constraints; 2=7-5 and 4=9-5 = protective capacities

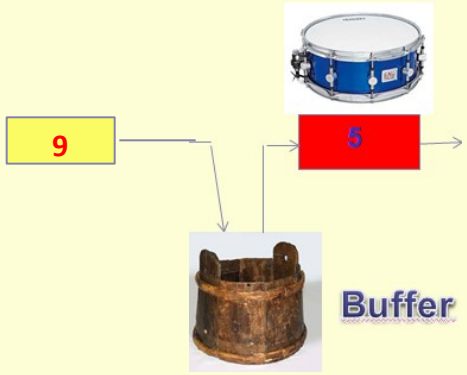
Red numbers= parts/time unit

See Excel file after few slides !!!!!

FG = finished goods

DBR basics

We must protect **the constraint** to make sure the correct material is always ready and waiting for processing in time. We can achieve this by ensuring that we release material by use of rope communication device in time prior to the scheduled consumption on the constraint.



&

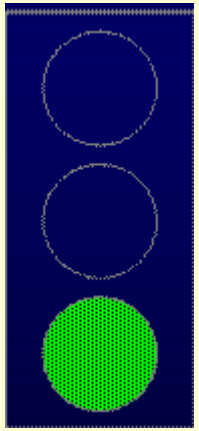
When there **is work**, **complete it promptly !!!**
When there **is no work**, **find something else** to do !!!

Non-constraints rules

7 9

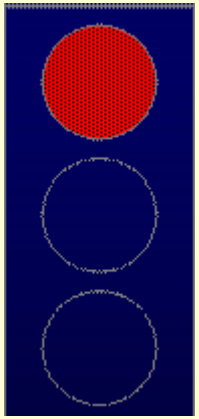
DBR basics

Fully on



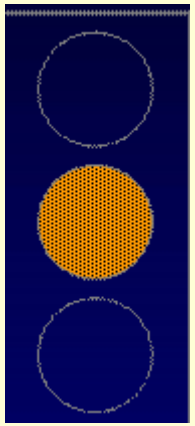
Throughput creation

Fully off



Throughput protection

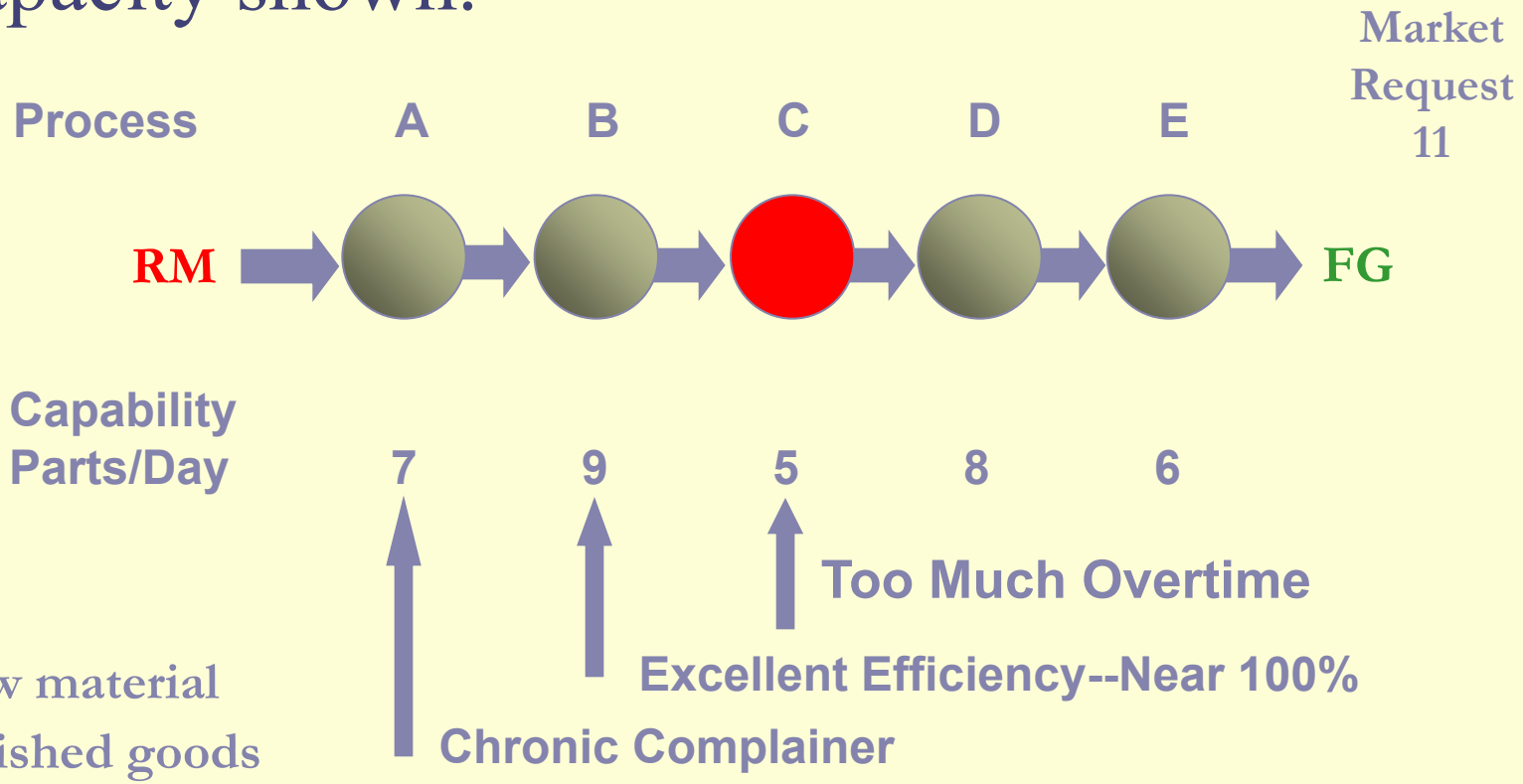
Slowing down



Throughput destruction

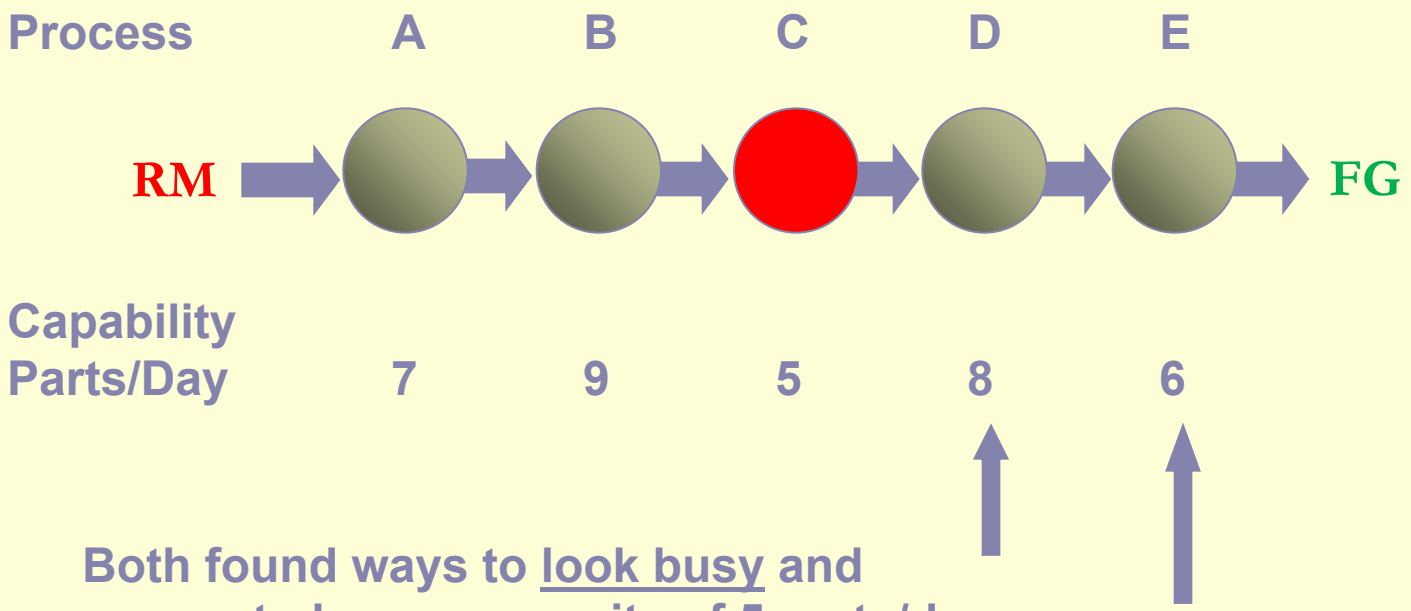
We Measure Operational Efficiency

- Work flows from left to right through processes with capacity shown.



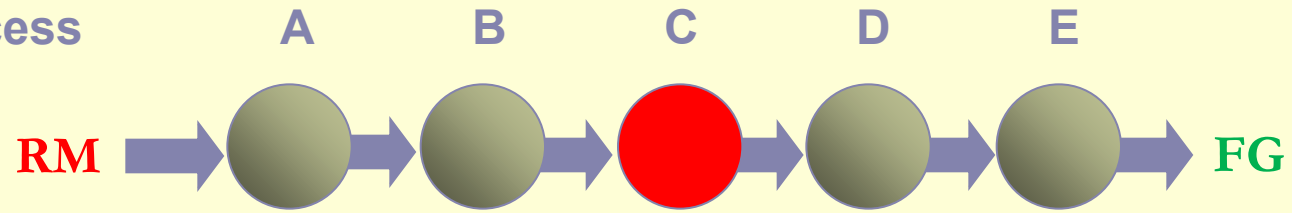
Reward Based on Efficiency

- Work flows from left to right.



In reality...

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

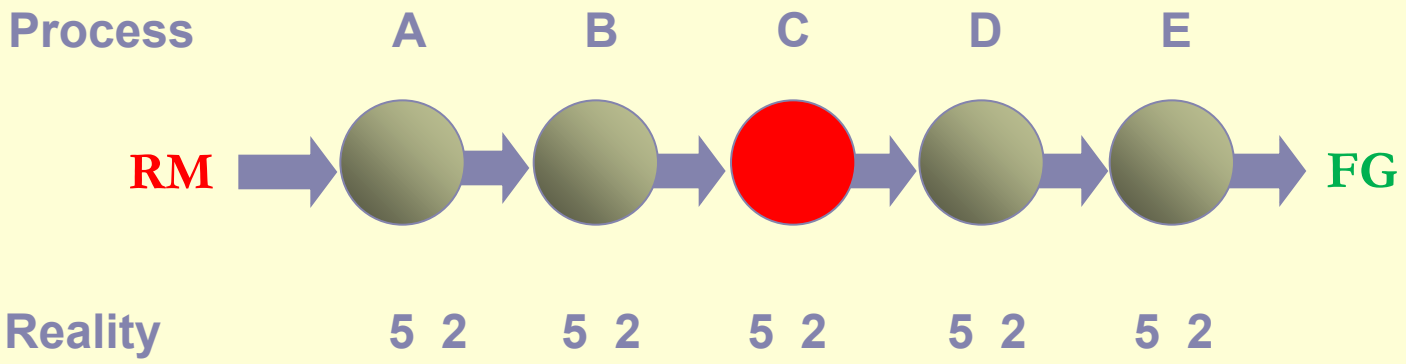


	A	B	C	D	E
Potential P/D	7	9	5	8	6
Reality	5	5	5	5	5

P/D=parts/day

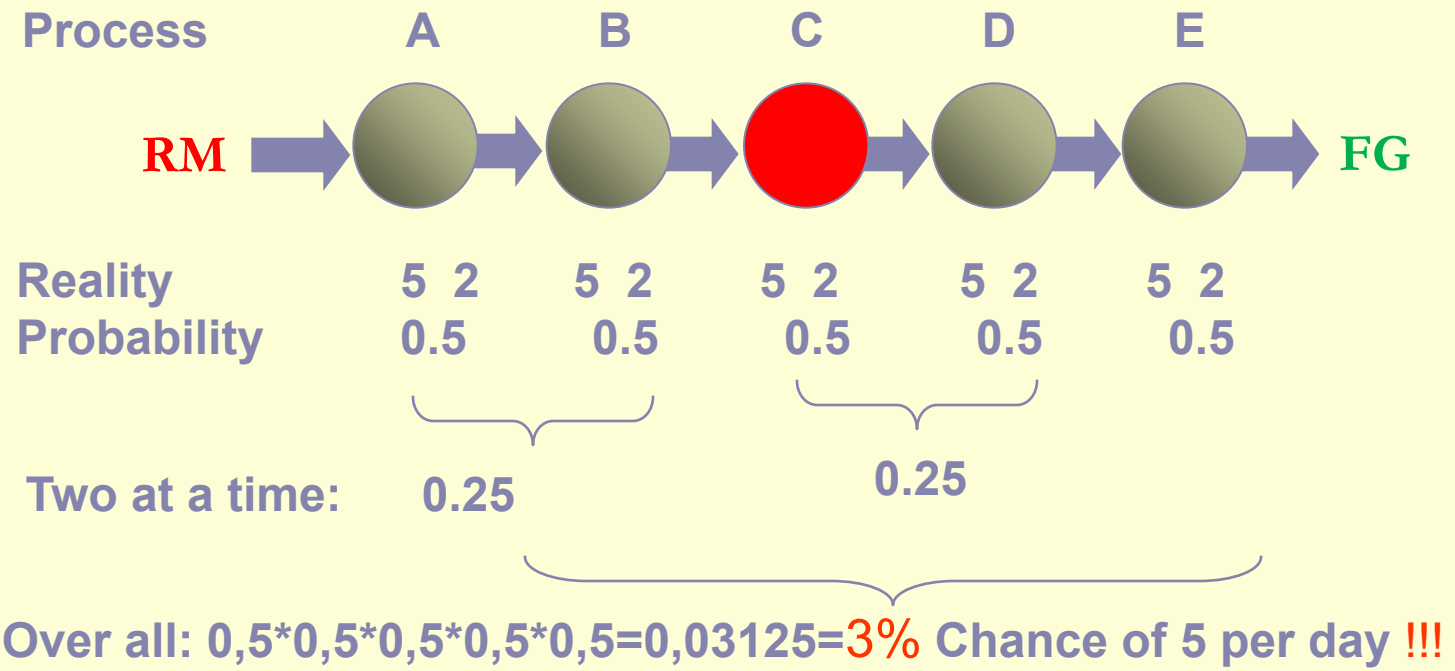
Then Variability Sets In

- Processing times are just AVERAGE Estimates



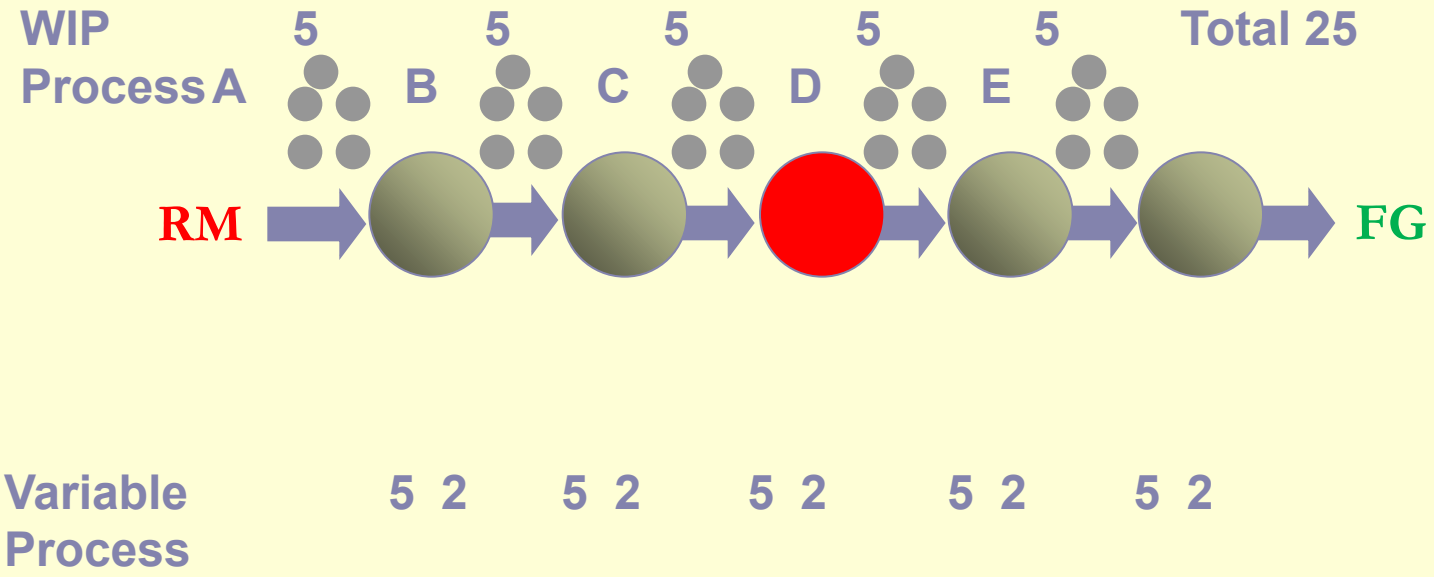
What's an Average? 50%

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



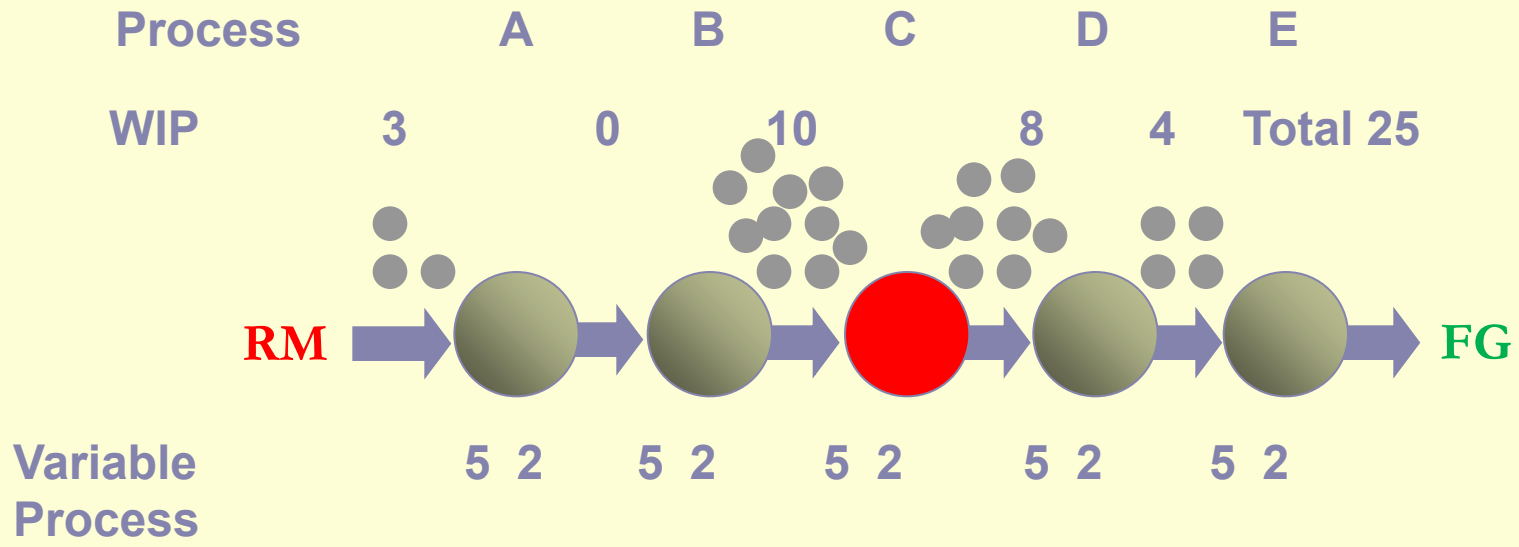
Previous Solution: Inventory

- Put a day of inventory (WIP) at each process!



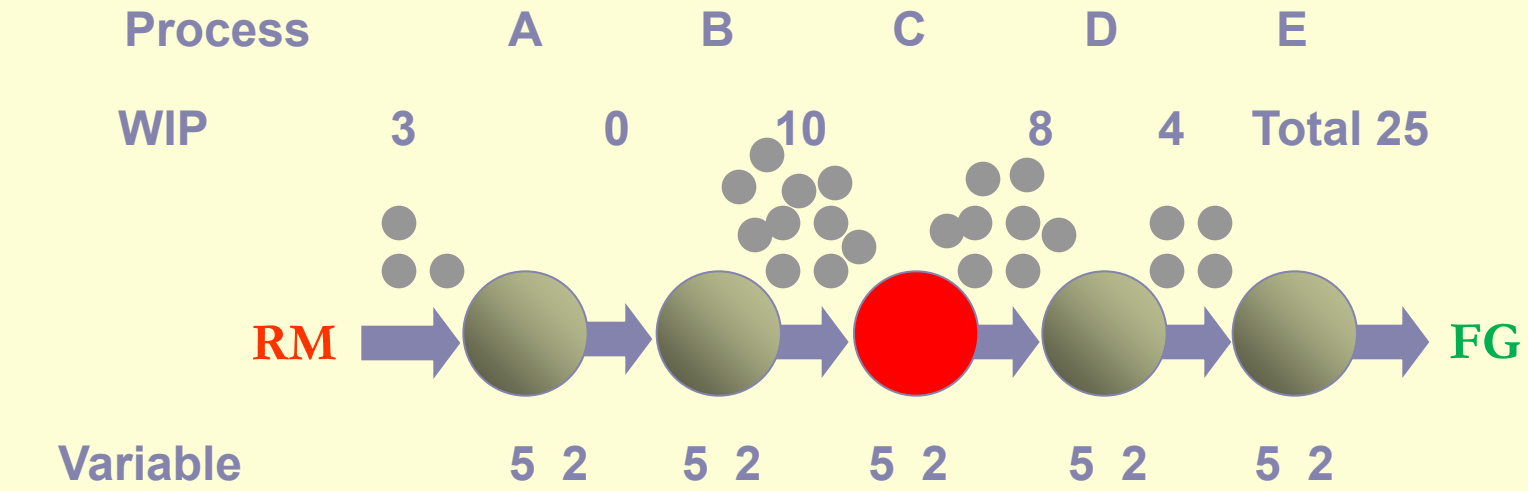
System Variability Takes Over--Chaos

Inventory (WIP) quickly shifts position.
Inventory manager/expediter tries to smooth it out.
Distribution problems result. Costs go up !!!



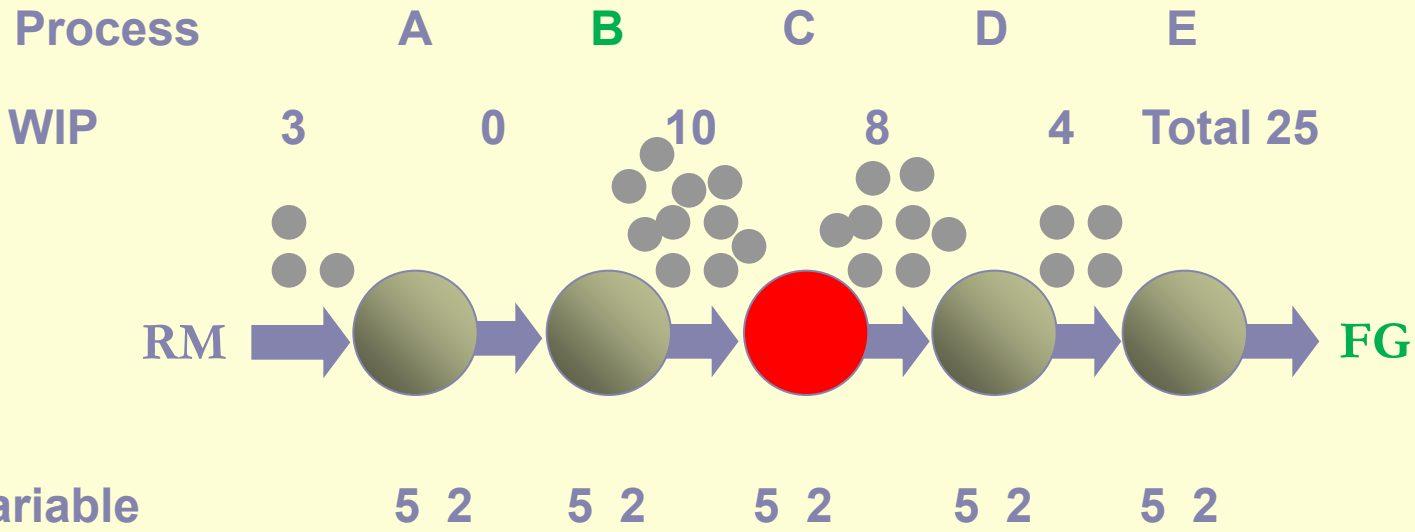
System Variability Takes Over--Chaos

An Average of 5 means sometimes 3 and some times 7



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

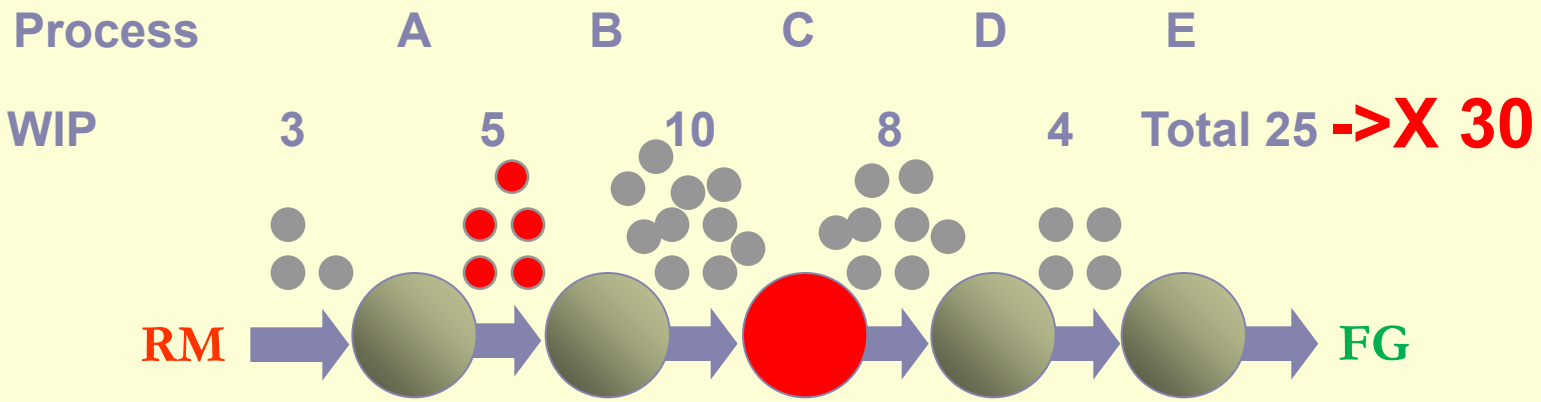
System Variability Takes Over--Chaos



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..... ?

System Variability Takes Over--Chaos



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

So… **Management Helps!** Management puts in more work (Inventory) (rate of RM) to give everyone something to do!
Result: It takes longer and longer from time of release until final shipping. **More and more delay!!!!!!!!!!**

Little s law - definition (formula)

- Fundamental relationships among :
  - WIP (Work In Process)
  - Cycle Time (CT)
  - Throughput (T or sometimes TH)
- Formula

$$WIP = TH \times CT$$

- Can be applied to :
  - Single machine station
  - Complex production line
  - Entire plant

Relationships among these variables will serve to se clearly precise (quantitative) description of behaviour of the single production line . It helps user to use a given scale to benchmark actual production systems

Definition of basic parameters

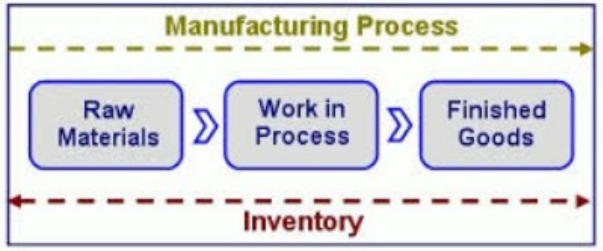
- **Throughput (Throughput rate, TH)** : production per unit time that is sold (see TOC definition)
- If **TH** is measured in cost dollars rather than in prices it is typically called :

Cost of good sold (COGS)

- **Upper limit** of TH in production process is **capacity**
- If you release more raw material above capacity of the line (machine),system become unstable –> **WIP goes up !!**

Definition of basic parameters

- **WIP (Work In Process)** : inventory between start and end points of the product routing
- **WIP** can be used as one parameter to calculate (measure) an **efficiency**
- **Efficiency** can be defined as **Turnover Ratio** = TH/FGI for warehouses or TH/(FGI+WIP) for production plants where **FGI**=Finished goods inventory
- **WIP** : **inventory still in line**
- **FGI** : inventory waiting for dispatch (shipping)



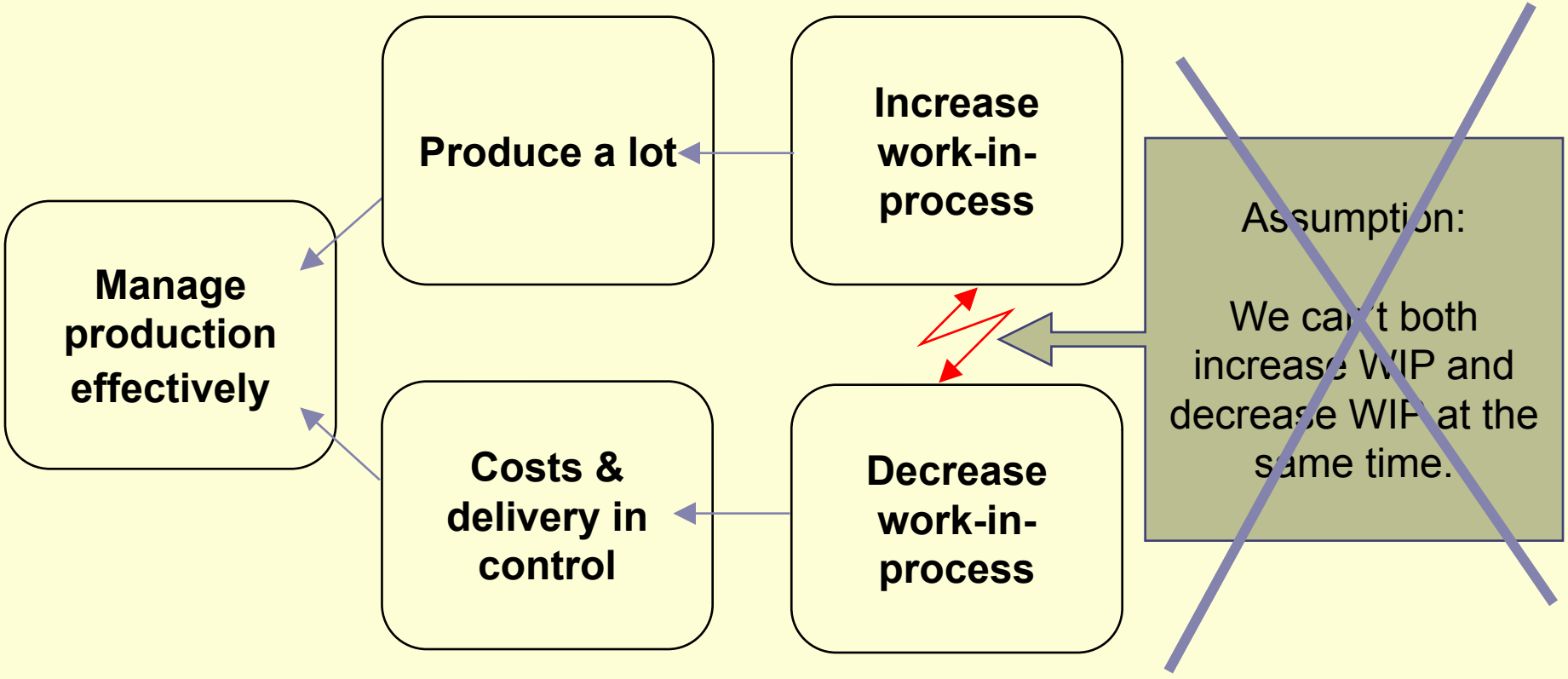
Definition of basic parameters

- **CT (Cycle Time, Flow Time or Throughput Time)** : average time from release of the job of the beginning of the routing until it reaches an inventory point at the end of the routing or time that part spends as a WIP.

- **LT (Lead Time)** : managerial constant used for planning of production

Service level P{Cycle time=<Lead Time}

Operation's Dilemma



Injection: Put a large inventory where its needed and low everywhere else!

TOC Steps to Continuous Improvement

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

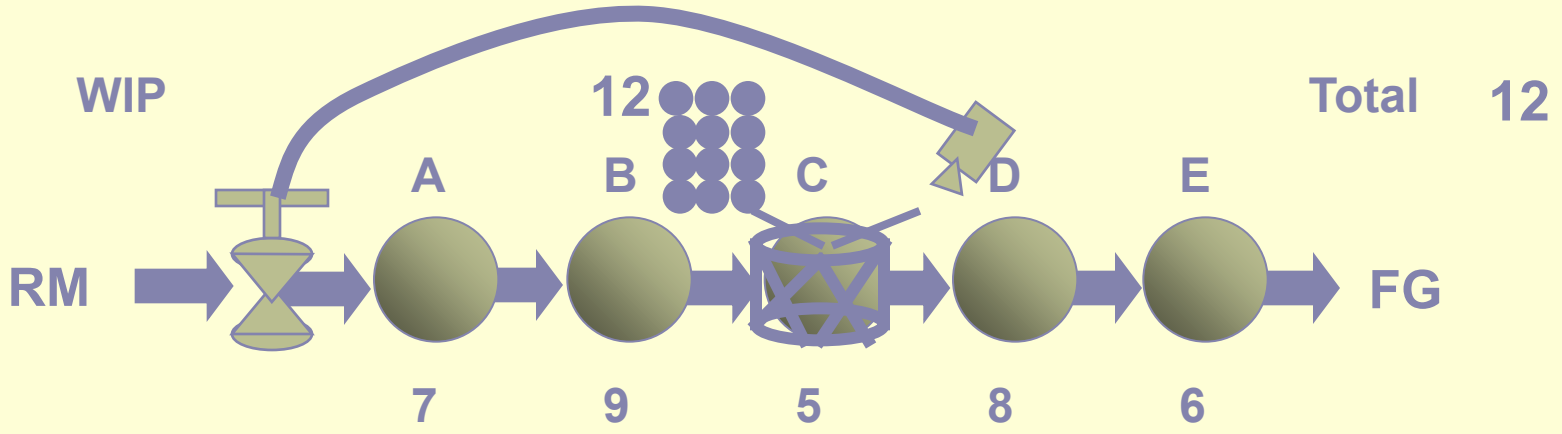
Step 2. ***Exploit*** **the system's constraint.**

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



Five Focusing Steps

Step 1. Identify the Constraint (The Drum)

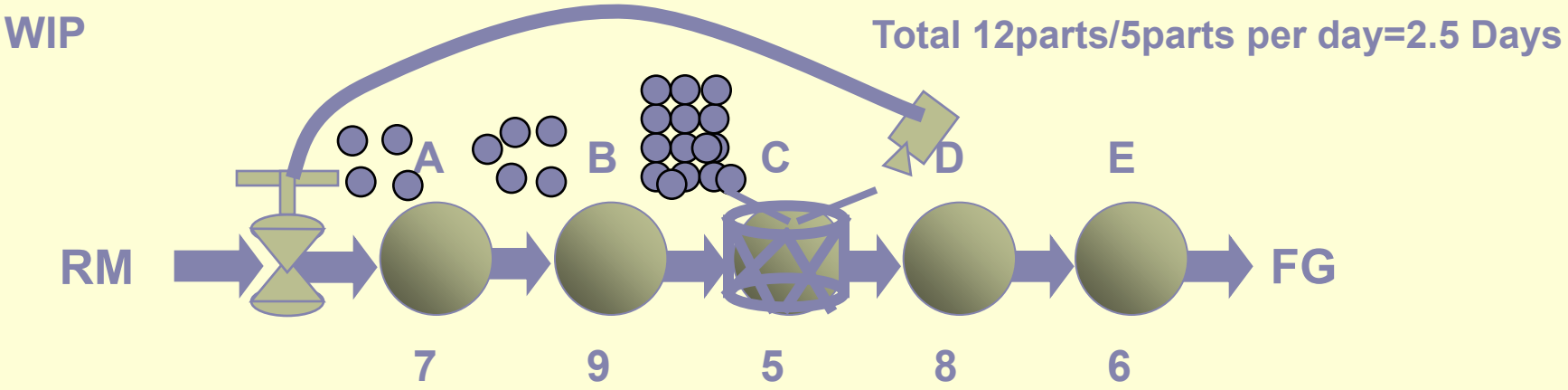
Step 2. Exploit the Constraint (Buffer the Drum)

Step 3. Subordinate Everything Else (Rope)

Step 4. Elevate the Constraint ($?)

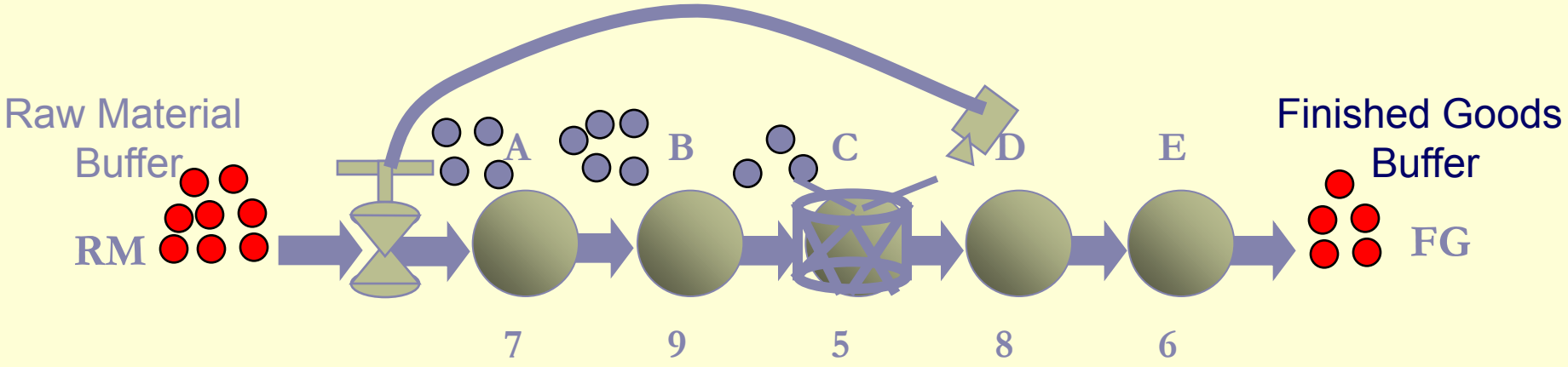
Step 5. If the Constraint Moves, Start Over

Understanding Buffers



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

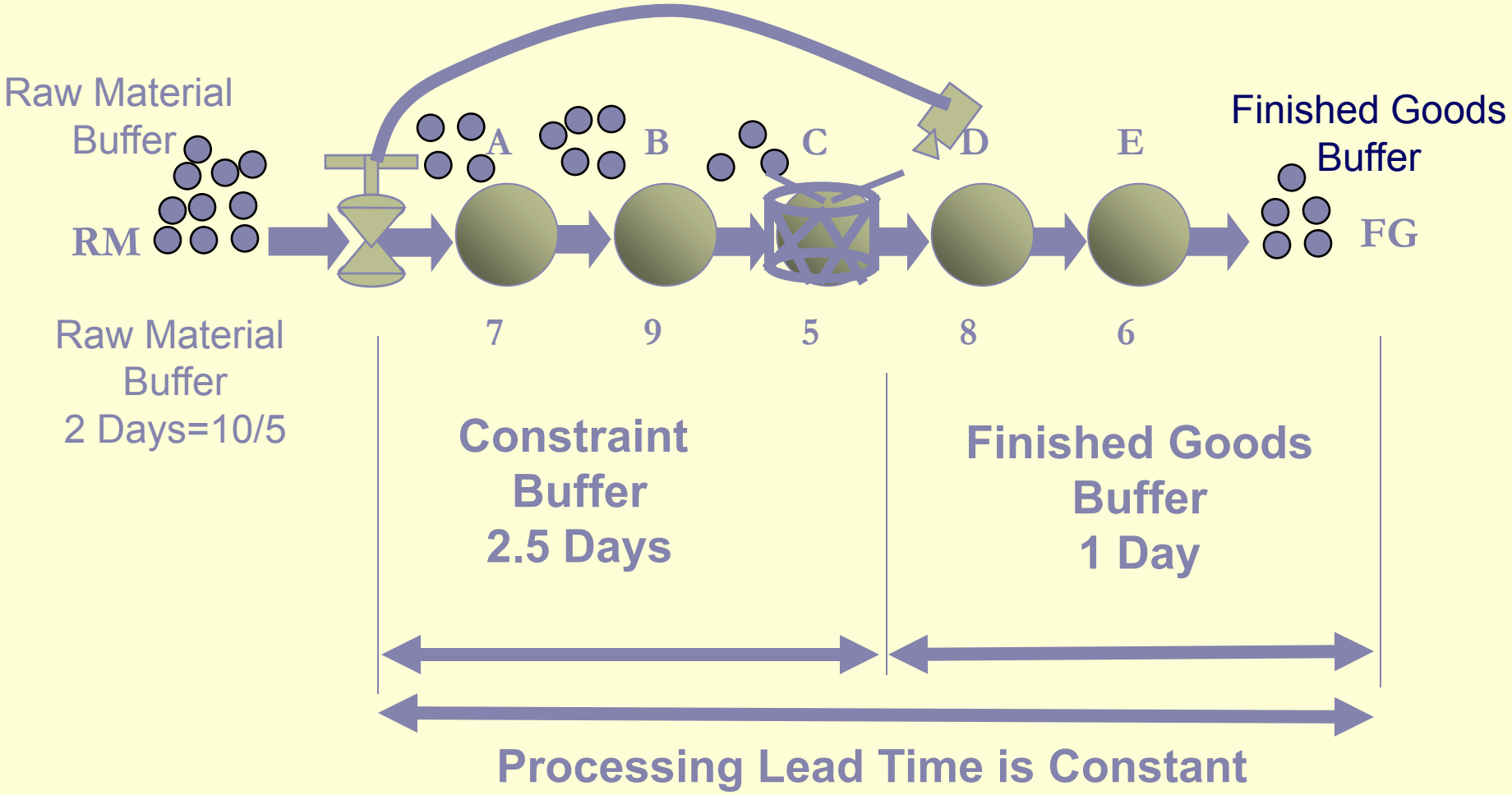
We need more than one Buffer



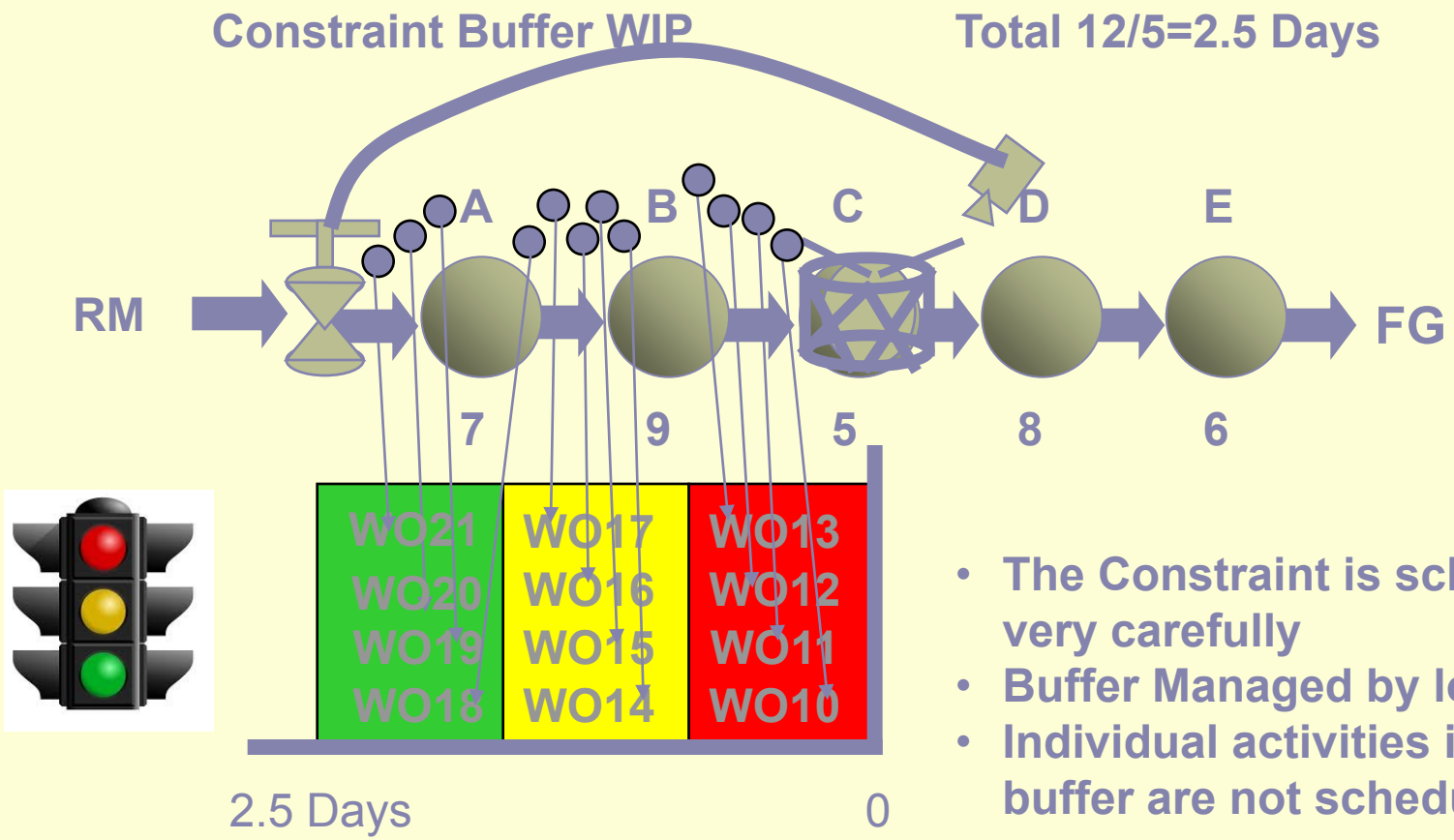
There is variability in the Constraint.
To protect our delivery to our customer we need a finished goods buffer.

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

Buffer Time is Constant-Predictable

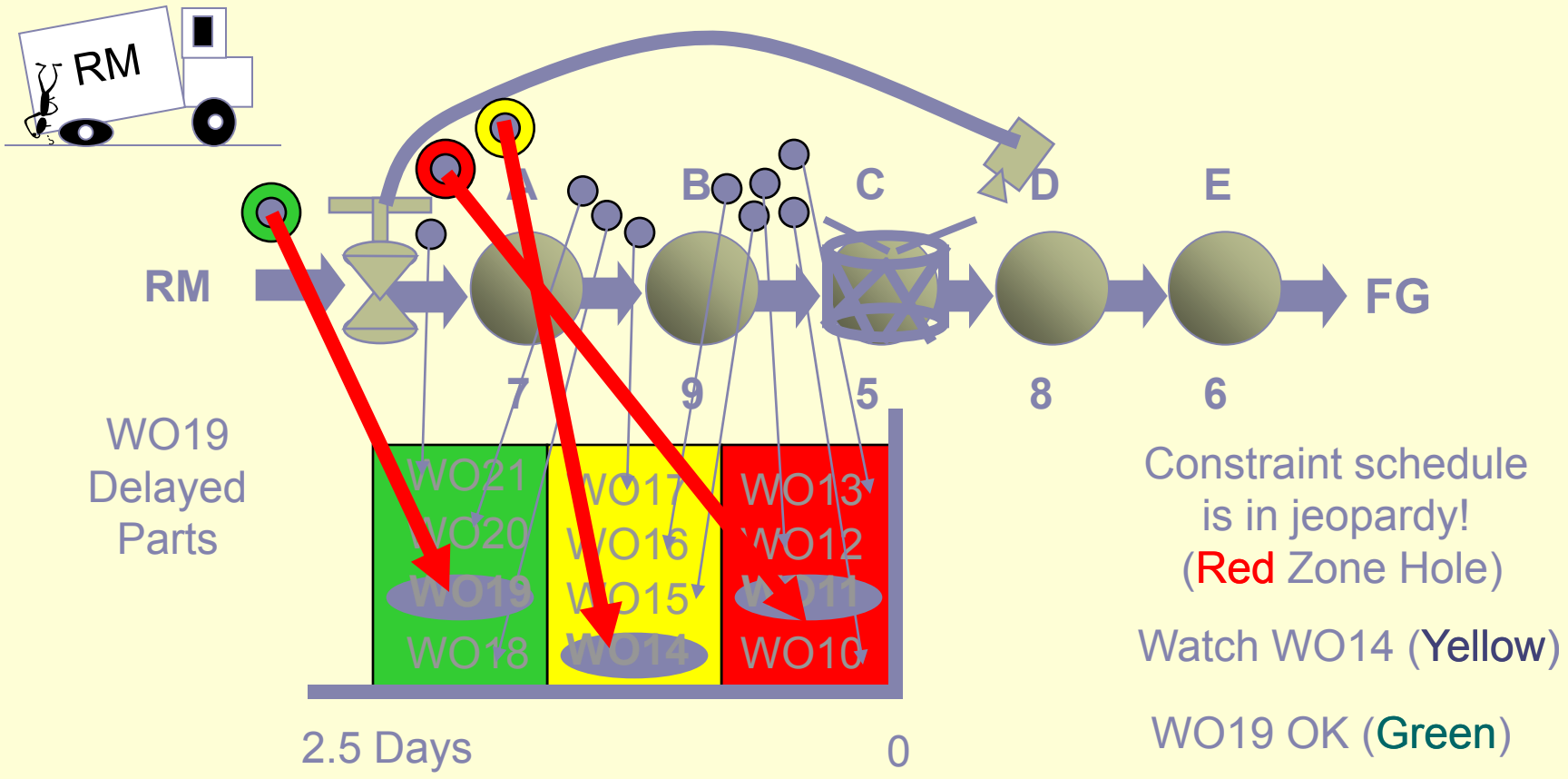


Buffer Management



- The Constraint is scheduled very carefully
- Buffer Managed by location
- Individual activities in the buffer are not scheduled

Problem Identification



Additional Buffers

- **Constraint Buffer** (as we discussed)
  - Protects the Constraint from running out of work
- **Finished Goods Buffer** =Shipping buffer
  - Protects customer delivery from Constraint variation
- **Raw Material Buffer**
  - Protects the Release of material from suppliers

Some resources

http://www.dbrmfg.co.nz/Production%20Implementation%20Details.htm