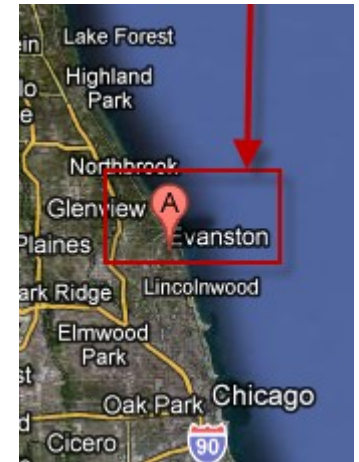


CONWIP

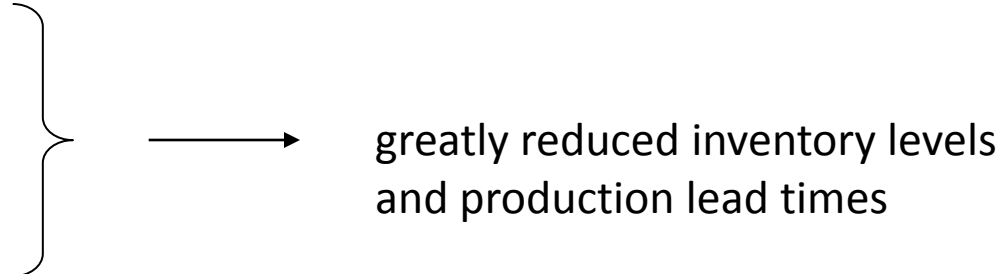
(A pull alternative to kanban principle)



Main resources : Mark Spearman, David Woodruff and Wallace Hopp
Northwestern University,
Evanston, Illinois, USA

Diagrams, modifications, structures and editing (J.Skorkovský,KPH)

Methodologies used for effective production control

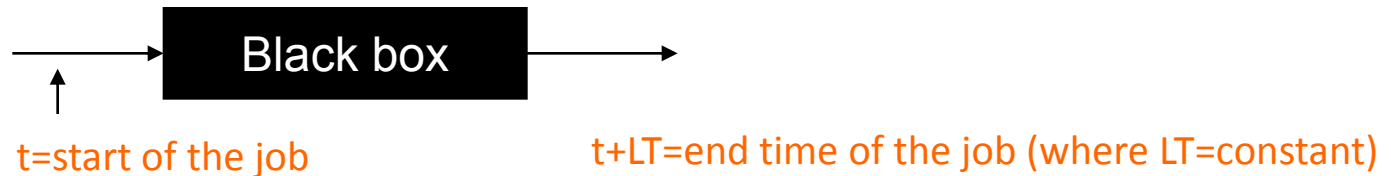
- Based on **PULL** principle
 - JIT
 - kanban
 - zero inventory

greatly reduced inventory levels and production lead times

 - kanban (mostly used for repetitive manufacturing)
- Based on **PUSH** principle
 - MRP (MRP-II)
- Based on both principles (**push** and **pull**)
 - CONWIP (Constant Work In Progress)

PUSH and PULL

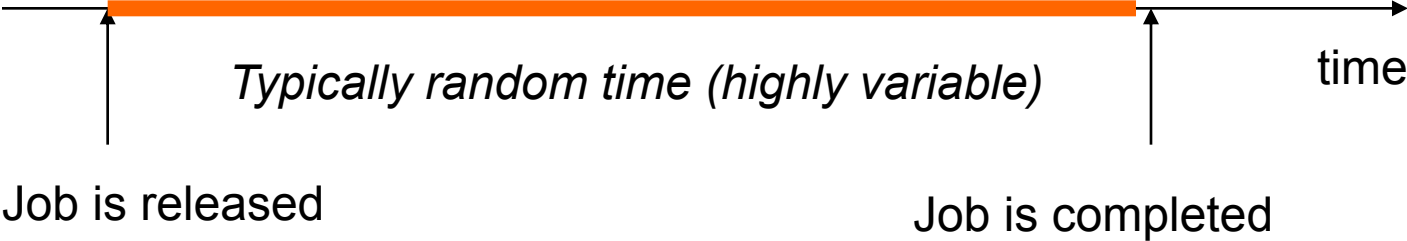
- **PUSH** : production jobs (production orders) are scheduled (MRP nad MRP-II)
 - often not feasible plans are generated and problems are often detected too late
 - used fixed lead times=LT (see next slide) do not depend on capacity utilization
 - Having in mind , that production is random process, LT is very pessimistic



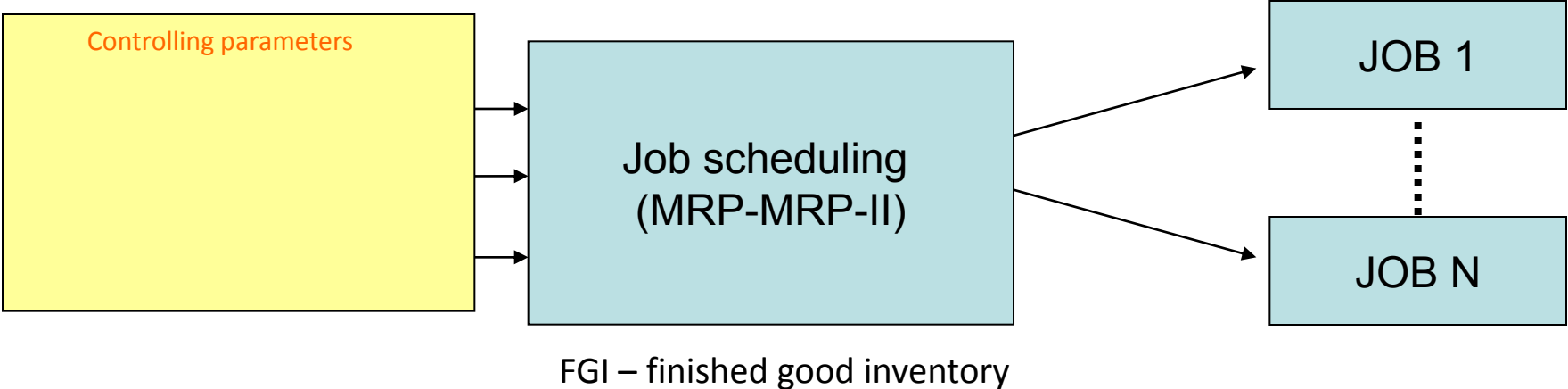
- **PULL** : production jobs (production orders) starts are triggered by completion of another job

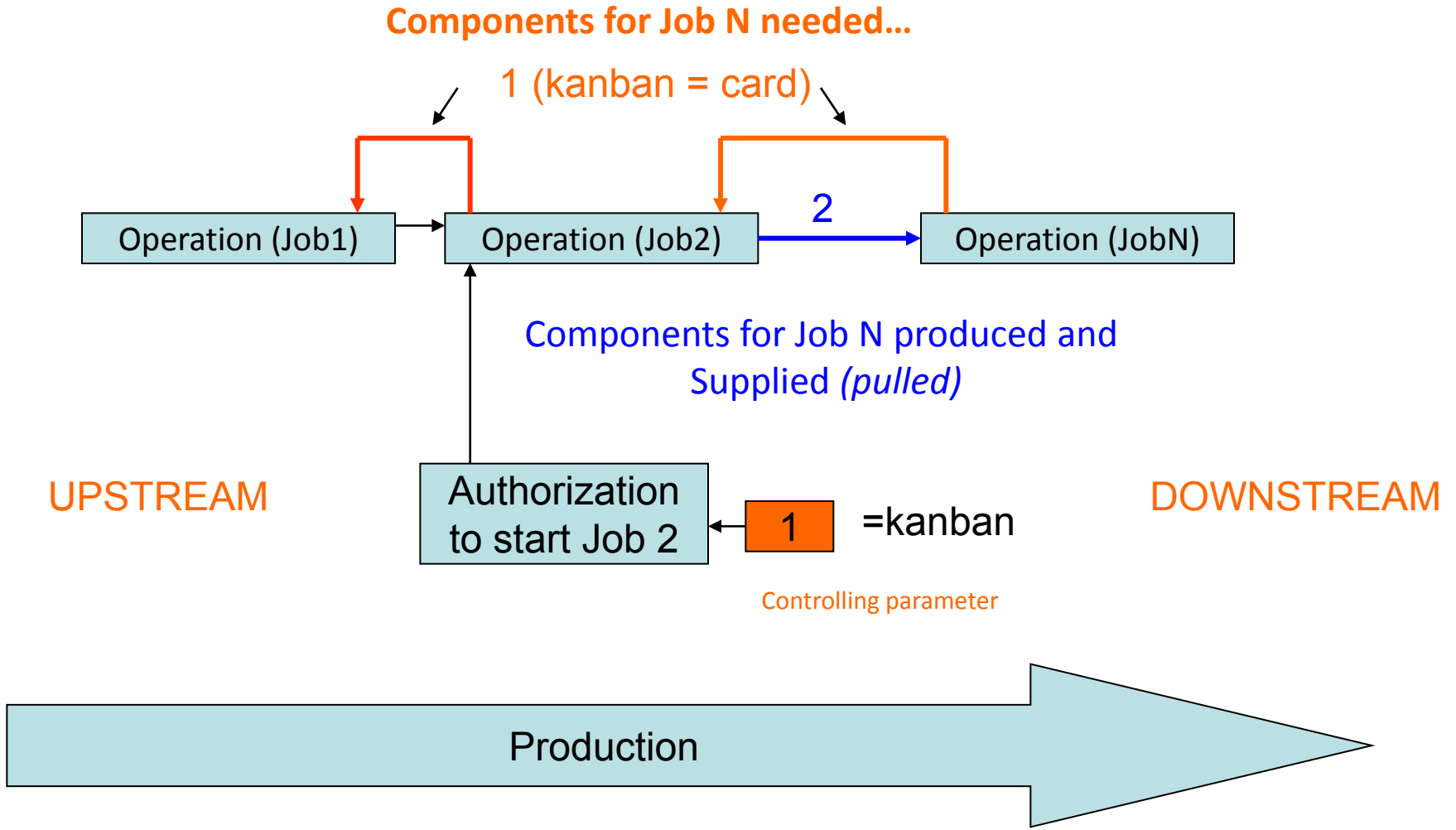
Flow time and Lead time

- **Flow time** (known also as a „cycle time“)



- **Lead time** (constant used for planning)





The number of cards in the system determines the WIP levels in the plant

JIT

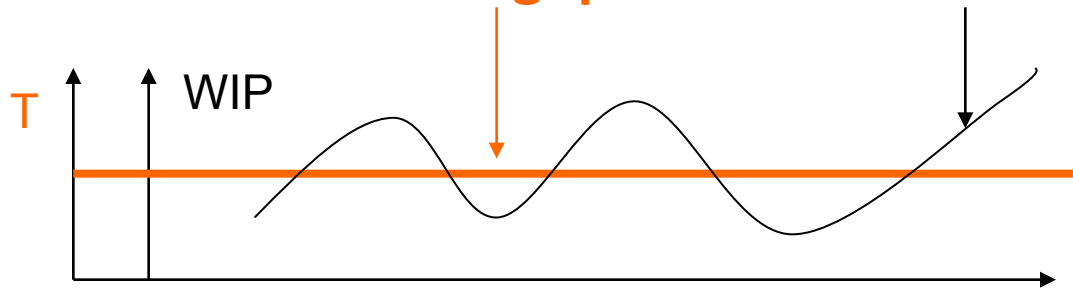
- Kanban is not JIT (manufacturing philosophy)
- JIT encompasses :
 - kanban
 - total quality control (TQM) – e.g. scrap loss not tolerated....
 - setup **time** reduction
 - worker participation
- Advantages of JIT philosophy :
 - reduced WIP
 - shorter flow times
 - lower production costs
 - greater customer responsiveness

PUSH and **PULL** are not mutually exclusive (vzájemně se nevylučují) approaches and other statements...

- **Push** and **Pull** can be combined !
- MRP is considered to be more applicable than kanban
- MRP is in almost any discrete part production
- Kanban(JIT,**pull**) – superior results if applicable
- Kanban(JIT,**pull**) – is difficult to use if :
 - Jobs with short production runs
 - Significant setup times
 - Remarkable Scrap losses
 - Unpredictable fluctuation in demand

PUSH and **PULL** and the types of the queuing networks

- **Push** : open queuing network
- **Pull** : closed queuing network
- **Push** : schedule **Throughput** and measure WIP



- **PULL** : setup WIP and measure Throughput

Advantage of **PULL** over **PUSH**

- **PUSH** : WIP and **Throughput** fluctuations – result in violation of the assumption, that Flow Times (**FT**) and therefore Lead Times (**LT**) are constant ! **Push is more difficult to manage than Pull**
- WIP is easier to optimize than Throughput (**T**)

- **Little's law** :

Average **FT**=Average **WIP**/Average **T** – meaning that **FT** cannot be constant but vary with **WIP** and **T**

- **Pull is easy to manage** : why ? -> **WIP** is easier to control than an estimation of the capacities needed to appropriately release work in **Push** system

CONstant Work In Process = CONWIP

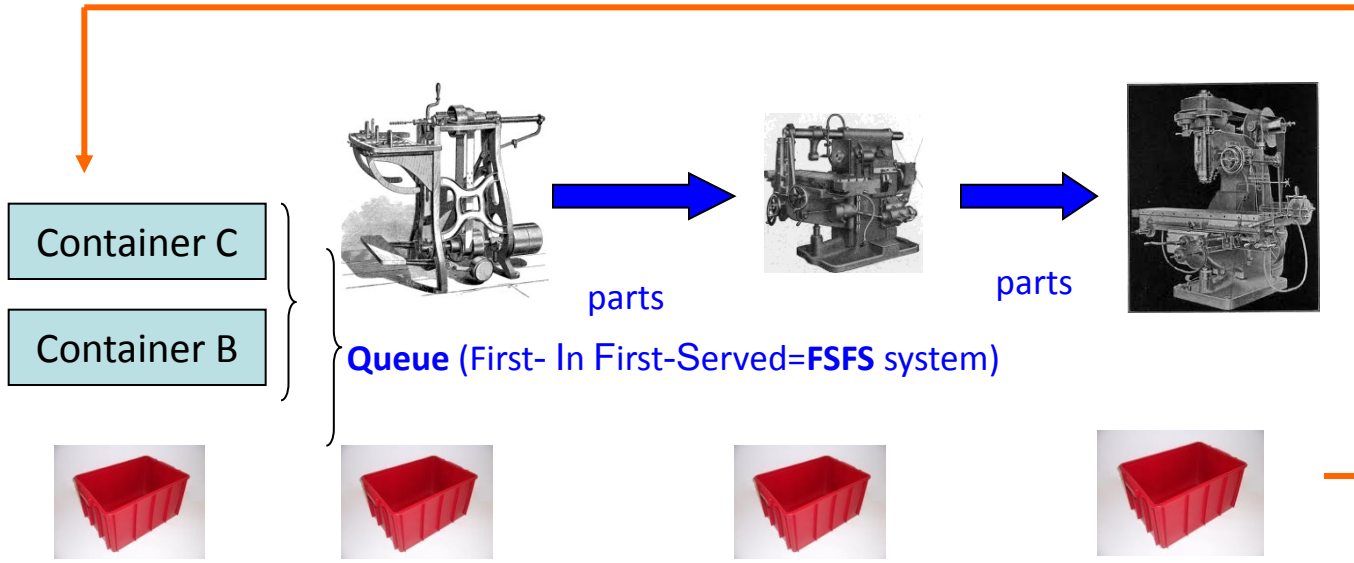
- System having benefits of a PULL and can be used in variety of manufacturing environment
- CONWIP : generalized form of Kanban
- CONWIP relies on signals (electronic, paper cards, semaphores,...)

CONstant Work In Process = CONWIP

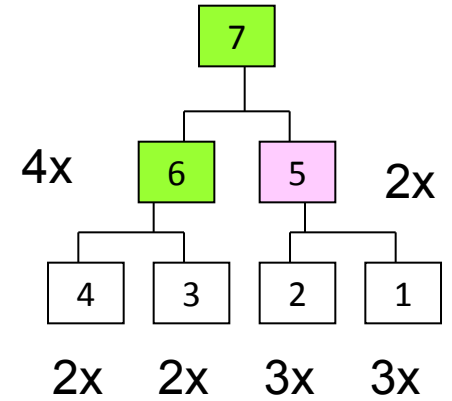
- **Kanban:** card is used to signal production of a specific part
- **CONWIP :** card is assigned to production line and are not part number specific

CONWIP

cards



BOM of the final product (7)



Container A	Container A	Container A	Container A
Bag log list	Bag log list	Bag log list	Bag log list
1 : 6 pc	1 : 6 pc	1 : 0 pc	1 : 0 pc
2 : 6 pc	2 : 6 pc	2 : 0 pc	2 : 0 pc
3 : 8 pc	3 : 0 pc	3 : 0 pc	3 : 0 pc
4 : 8 pc	4 : 0 pc	4 : 0 pc	4 : 0 pc
6 : 0 pc	6 : 4 pc	6 : 4 pc	6 : 0 pc
5 : 0 pc	5 : 0 pc	5 : 2 ks	5 : 0 ks
7 : 0 pc	7 : 0 pc	7 : 0 ks	7 : 1 ks

SET=8:00

SET=10:00

SET=12:00

SET=14:00

System Entry Time=SET

maintaining of BLL
(bag log list) is
responsibility of
inventory control staff

CONWIP parameters

- The card count (it determines the max WIP level for the line) =**m**
- Production quota (target production quantity/period) =**q**
- Maximum work ahead amount =**n** (if **q+n** is produced during a period, the line is stopped until the start of the next period)

CONWIP-air traffic control



Originating airport



Destination airport
(air above airport)

If heavy air traffic, departing planes should be held on the ground at the originating airport rather than control flying aircrafts in the air above destination airport as a holding pattern

The results : greater safety and lower fuel consumption

CONWIP-Theory of Constraints

- Balance the flow and not the capacity
- Operation of the **CONWIP** line is regulated by the **bottleneck resource**
- If we have sufficient demand, the correct number of the cards will maintain just enough WIP to keep bottleneck busy

Thanks a lot for Your Attention

Skorkovský