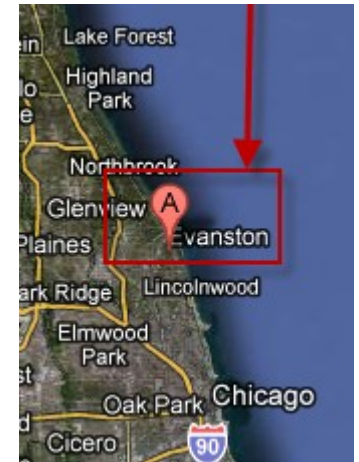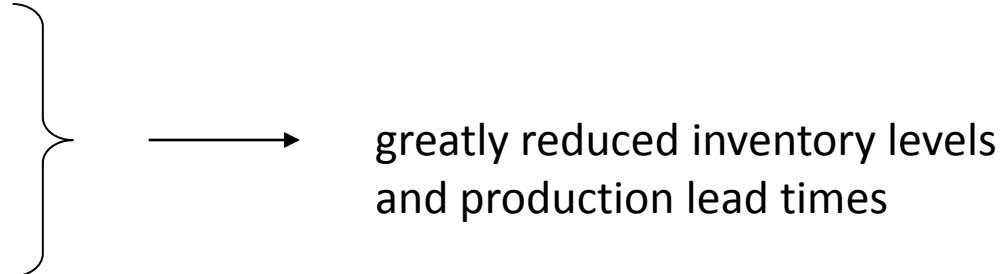# CONWIP

(A pull alternative to kanban principle)

Main resources : Mark Spearman, David Woodruff and Wallace Hopp
Northwestern University,
Evanson, 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)
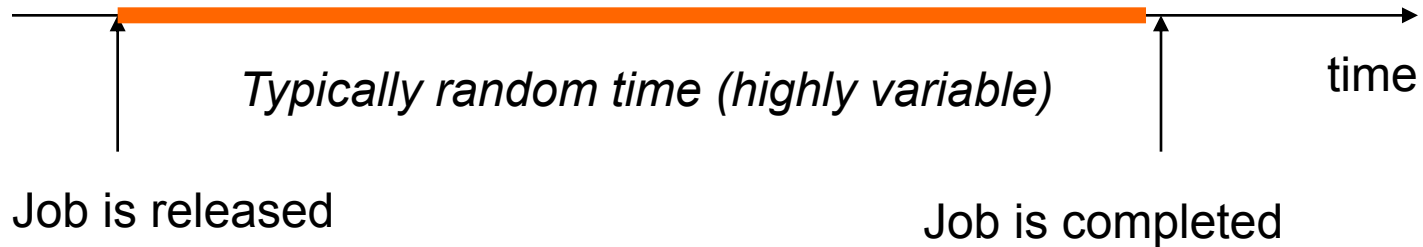   - CONWIP (Constant Work In Progress)

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
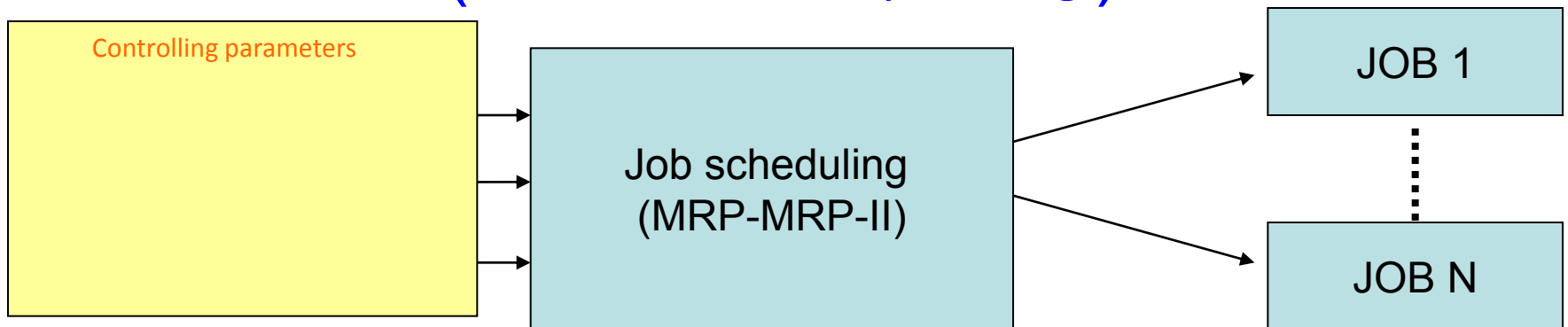 - Having in mind , that production is random process, LT is very pessimistic

t=start of the job

t+LT=end time of the job (where LT=constant)
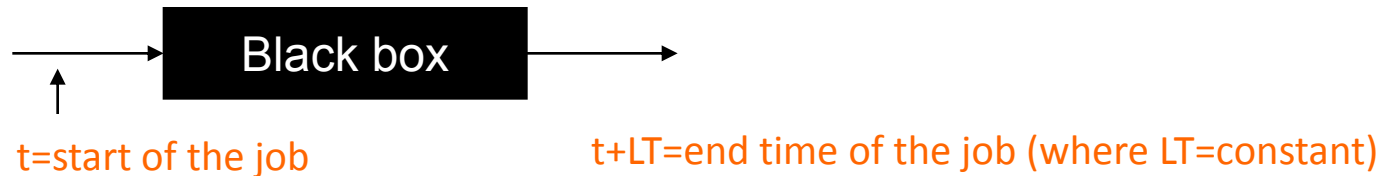
- **PULL :** production jobs (production orders) starts are triggered by completion of another job

Flow time and Lead time (FT<>LT)

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

Typically random time (highly variable)

time

Job is released

Job is completed

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

Controlling parameters

Job scheduling
(MRP-MRP-II)

JOB 1

JOB N

FGI – finished good inventory ; WIP = Work in Progress

Components for Job N needed…

1 (kanban = card)

| Operation (Job1) | 2 | Operation (Job2) | 2 | Operation (JobN) |

Components for Job N produced and
Supplied *(pulled)*

UPSTREAM

Authorization
to start Job 2 ← 1 =kanban

Controlling parameter

DOWNSTREAM

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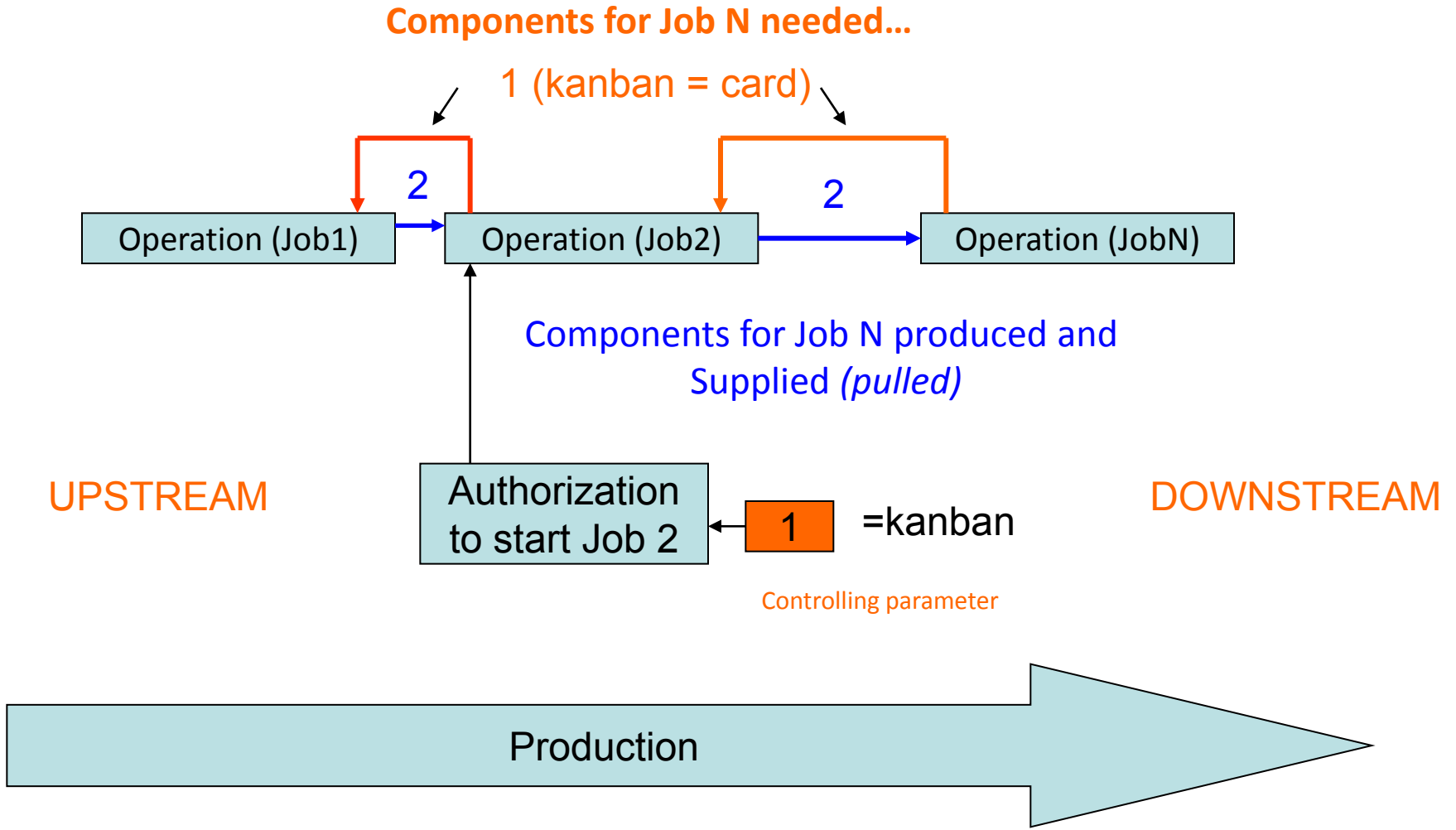
The number of kanban cards in the system determines the WIP levels in the plant

JIT

- Kanban is not JIT , where JIT=manufacturing philosophy
- JIT encompasses (includes):
  - Kanban card system
  - Total Quality Control (TQM) – e.g. scrap loss not tolerated….
  - Setup time reduction
  - worker participation
- Advantages of JIT philosophy :
  - reduced WIP (work in progress)
  - shorter flow times (shorter production
  - lower production costs
  - greater customer responsiveness
  - Lower inventory levels and lover stocking costs

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 (long ones)- if Make-To-Order is applied
  - Remarkable Scrap losses (bad quality)
  - Unpredictable fluctuation in demand

PUSH and PULL and the types of the queuing networks

- **Push :** open queuing network

- **Pull** : closed queuing network (feed back)

- **Push :** schedule **Throughput** and measure **WIP**
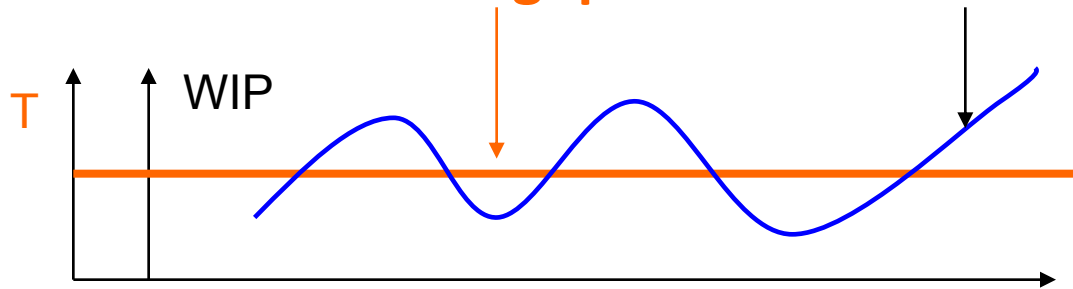
- **PULL :** setup **WIP** level and measure **Throughput**

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 low :**

  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 Progress = 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,…)
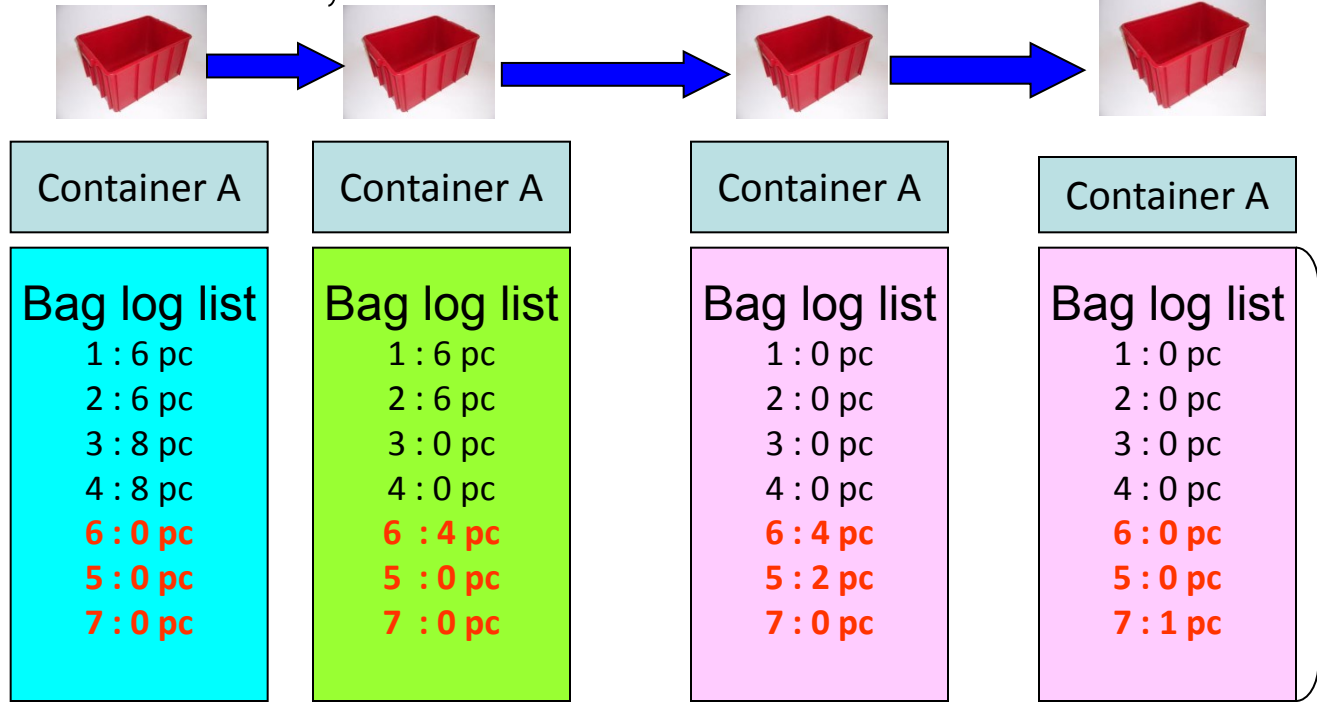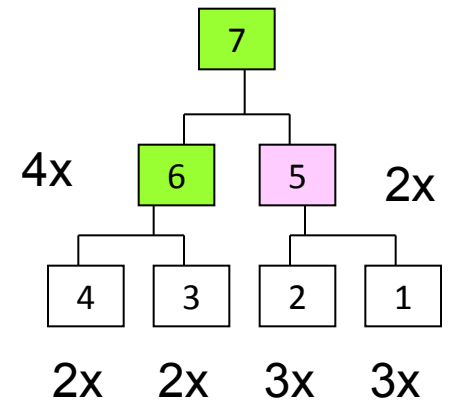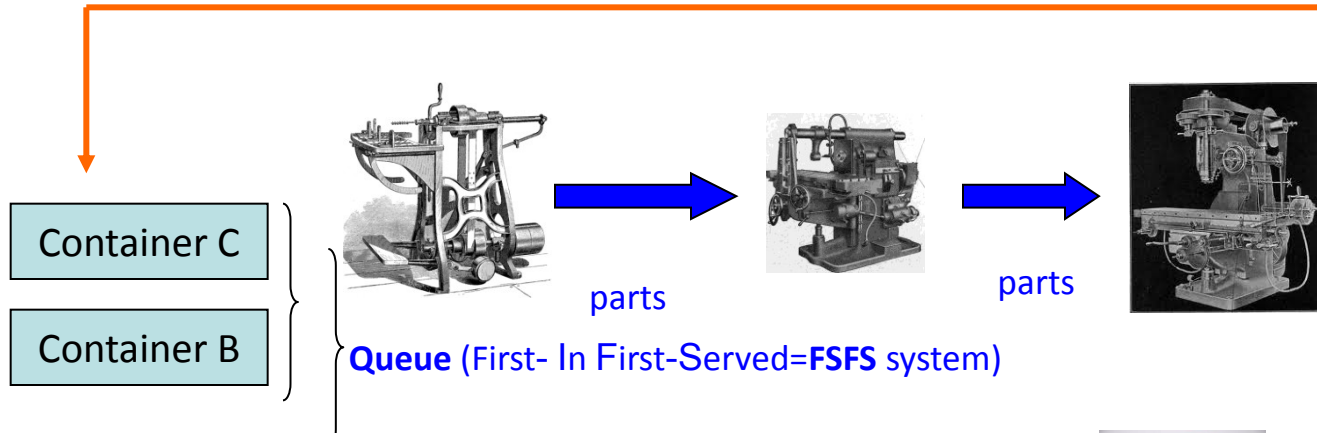
CONstant Work In Process = CONWIP

- **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 C

Container B

parts

parts

Queue (First- In First-Served=**FSFS** system)

4x   6   5   2x

4   3   2   1

2x   2x   3x   3x

Container A

Container A

Container A

Container A

BOM=Bill of material

System Entry Time=SET

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 pc	5 : 0 pc
7 : 0 pc	7 : 0 pc	7 : 0 pc	7 : 1 pc

maintaining of **BLL** (Bag Log List) is responsibility of inventory control staff

SET=8:00   SET=10:00   SET=12:00   SET=14:00

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