LEAN FLOW TECHNOLOGY

- MODULE LFT106 -

BALANCE AND FLOW

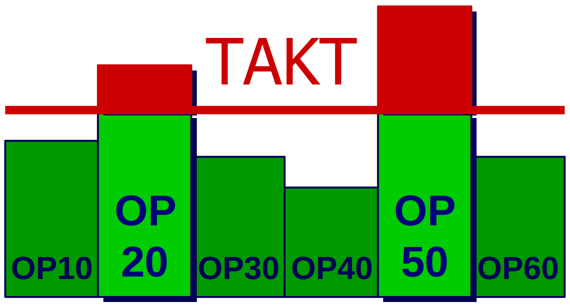
LEAN FLOW TECHNOLOGY
BALANCE AND FLOW

PURPOSE

- Operational Definition.
  - "At, or Below" TAKT Time Targets to create Balance.
- Resolve Imbalances.
- In-Process Kanban.
- Balance and Flexibility.
  - U-Cell Design.
- Physical Implementation.

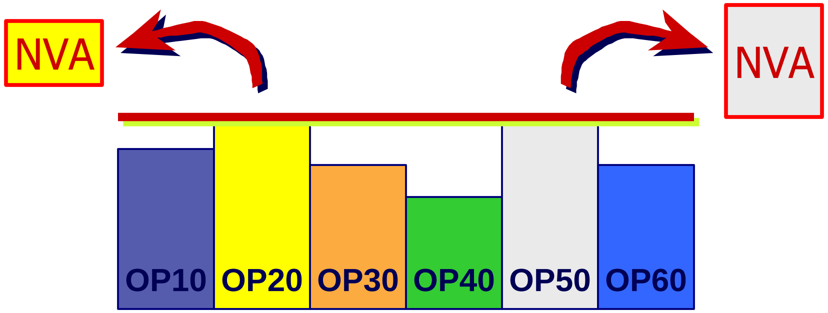
BALANCE AND FLOW OVERVIEW

- OPERATIONAL DEFINITION.
  - Optimum Flow is achieved by Grouping Tasks "At, or Below" TAKT Time.
  - When Actual Work Content cannot be Grouped "At or Below" TAKT Time Targets to create Balance = **IMBALANCE**.
  - Resolve Imbalances :

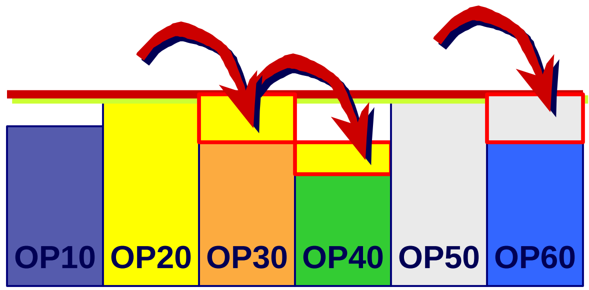


1. Eliminate Work Content. – NVA.
2. Move Work from one Operation to the Next.
3. Inventory Investment. – IPK's.
4. Additional Resources. – $$$$$.

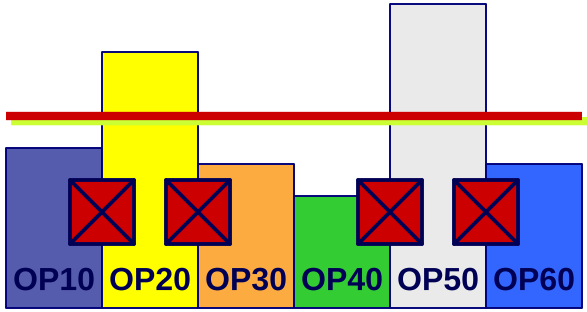
BALANCE AND FLOW
RESOLVE IMBALANCES



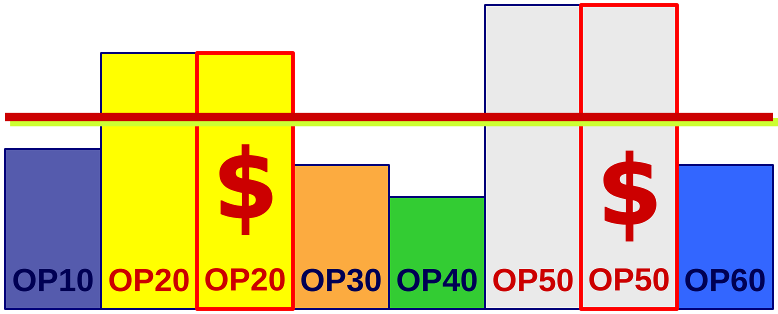
1 – Eliminate Work Content



2 – Move Work Elements



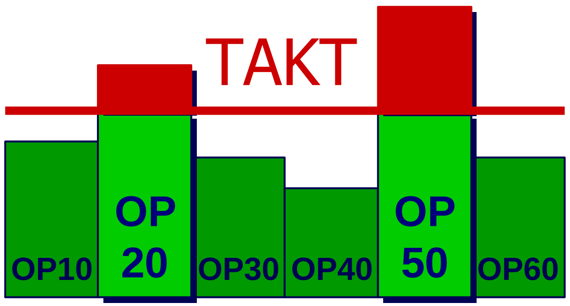
3 - IPK's Implementation

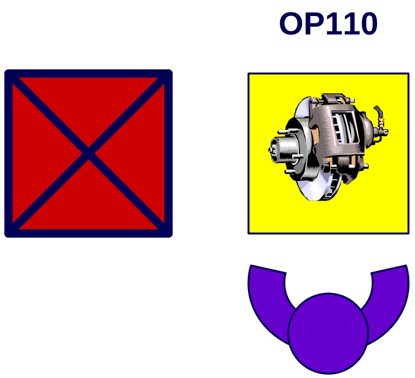


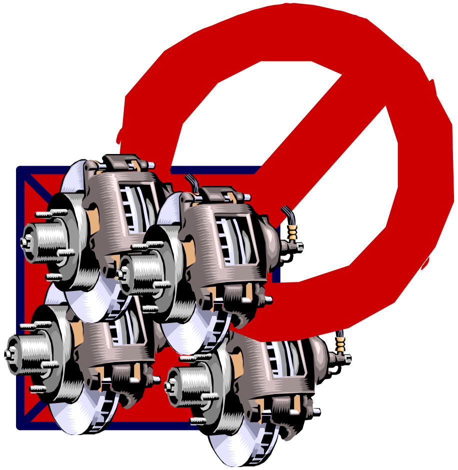
4 - Additional Resources

IN-PROCESS KANBAN – IPK's OVERVIEW

- Resolving Imbalance.
- ... **Inventory Investment.**
- Supported with Calculations.
- Visual Signal to Work or Move.
- First In – First Out Management.







#IPK = 1 !...

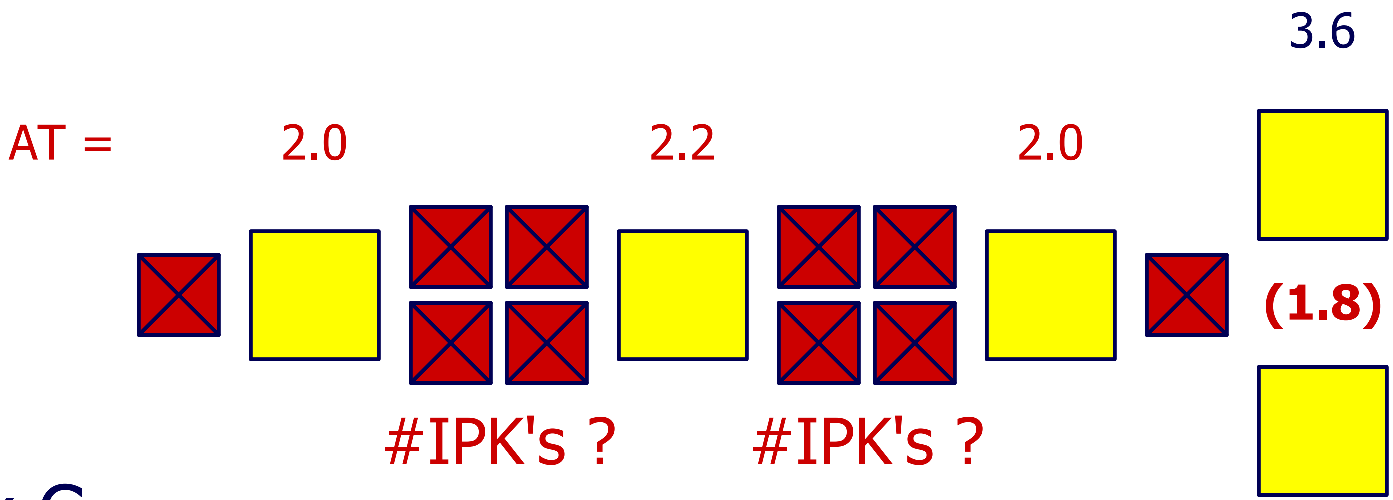
IN-PROCESS KANBAN FORMULA

$$\#IPK = \frac{I \times C}{TAKT}$$

I : Imbalance : I=AT-TAKT.
C : Cycle of Imbalance : C=H/AT.
H : Effective Work Time per Shift.

IN-PROCESS KANBAN
A TYPICAL CASE OF … CALCULATION

TAKT = 2 mn.



$$\#IPK = \frac{I \times C}{TAKT}$$

$I = AT - TAKT = 2.2 - 2.0 = 0.2$

$C = H/AT = 440/2.2 = 200$

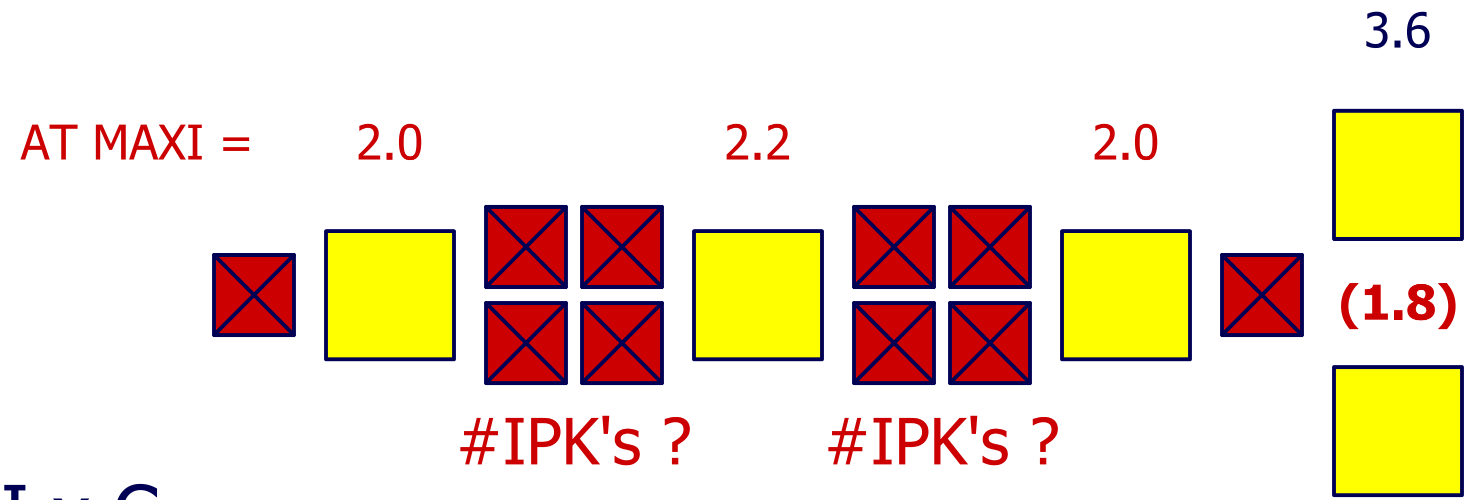
$$\#IPK = \frac{I \times C}{TAKT} = \frac{0.2 \times 200}{2}$$

#IPK = 20

$$?

IN-PROCESS KANBAN CALCULATION IN MIXED-MODEL

TAKT = 2 mn.



3.6

$$\#IPK = \frac{I \times C}{TAKT}$$

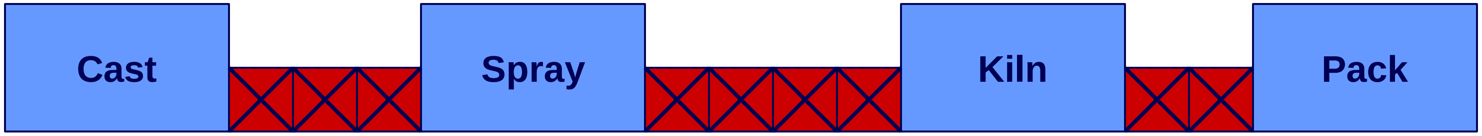
I=AT-TAKT=3.8-2.0=1.8

C=1 (Mixed-Model)

$$\#IPK = \frac{I \times C}{TAKT} = \frac{1.8 \times \underline{1}}{2}$$

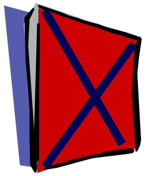
#IPK = 1

IN-PROCESS KANBAN
BETWEEN PROCESSES FORMULA



#IPK = A x B

Between Processes :

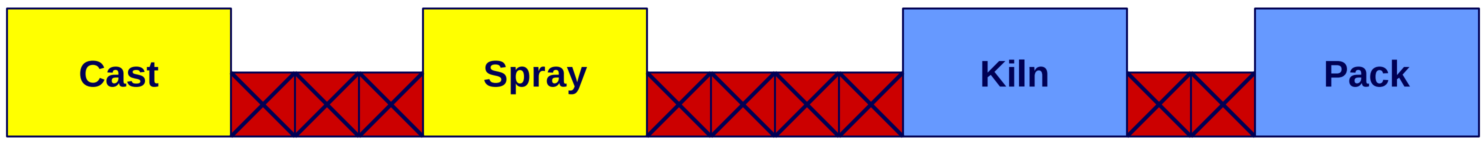


A : Shift Difference.

B : D_c per Shift Longer Process.

IN-PROCESS KANBAN
A TYPICAL CASE OF … CALCULATION

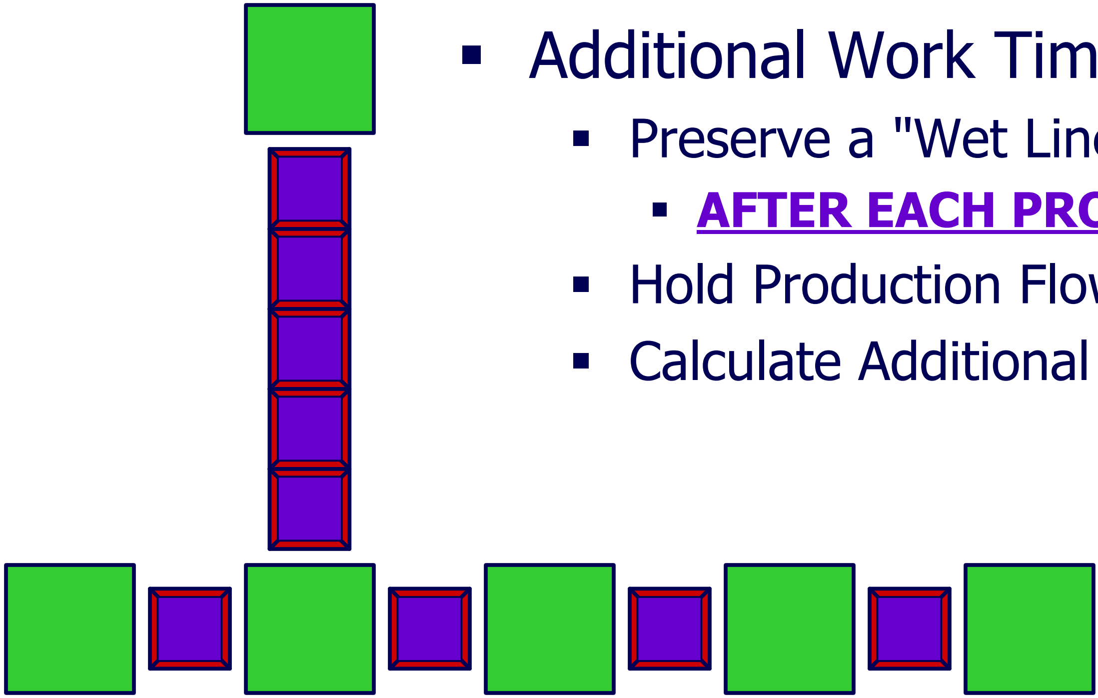
#IPK's ?



	Cast	Spray	Kiln	Pack
D_c :	**300**	**300**	300	300
Shifts :	**2**	**1**	3	2
D_c per Shift :	**150**	**300**	100	150

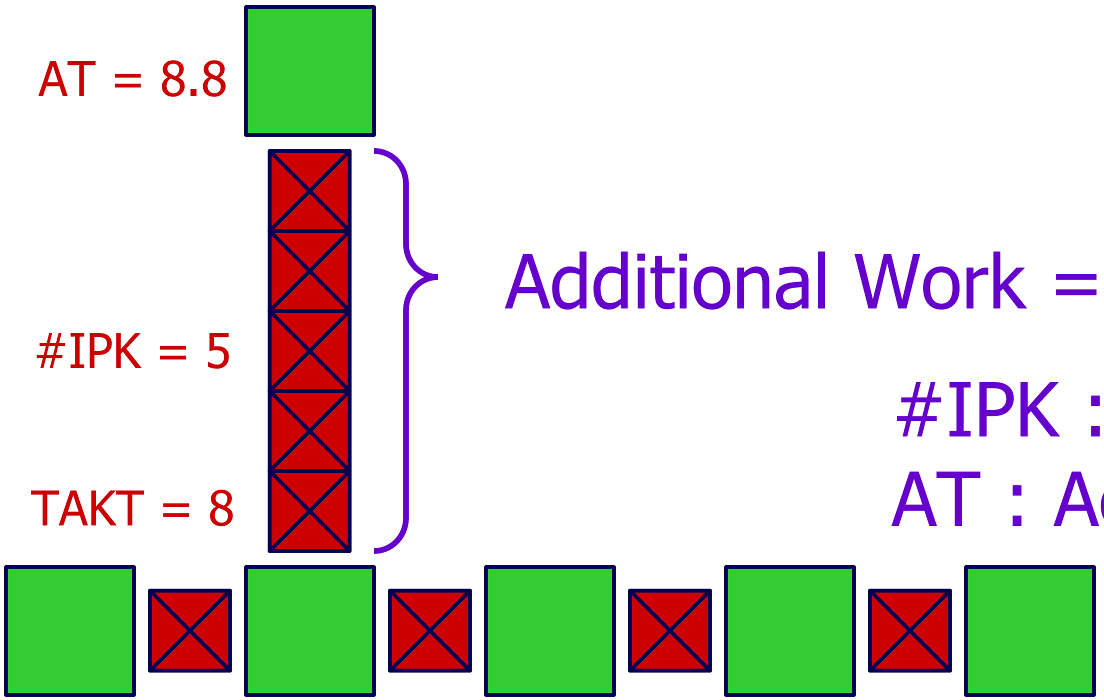
- Compare Side by Side Processes.
  - **Example between Cast and Spray Processes :**
  - Calculate the Shift Difference between Processes.
    - 2 – 1 = **1**
  - Select the D_c for Process with Greater Number of Shifts.
    - Cast Process : D_c per Shift = **150**
  - #IPK's = A (Shift Difference) x B (D_c per Shift Longer Process)
  - **#IPK's = 1 x 150 = 150**

IN-PROCESS KANBAN WET LINE



- Additional Work Time to :
  - Preserve a "Wet Line" :
    - **AFTER EACH PRODUCTION DAY.**
  - Hold Production Flow in Balanced.
  - Calculate Additional Resources.

ADDITIONAL WORK AROUND IPK's
A TYPICAL CASE OF ...



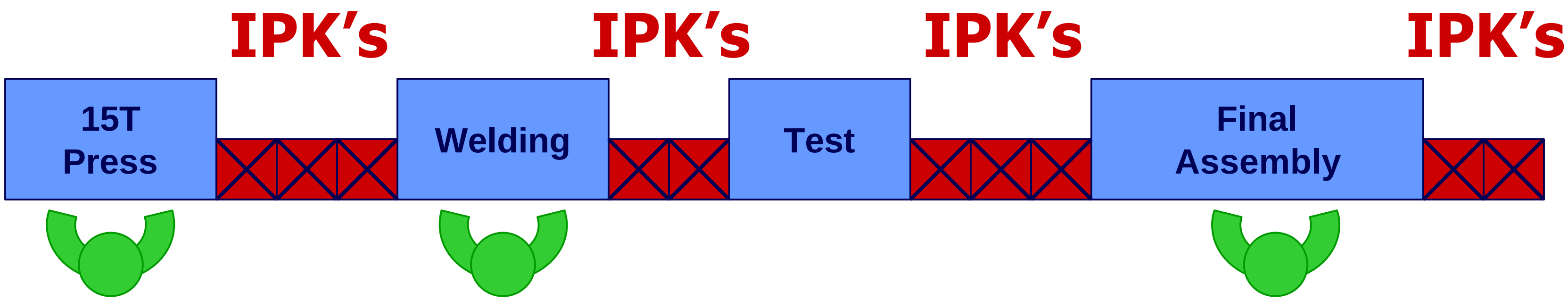
Additional Work = #IPK x AT

#IPK : Size of IPK's.
AT : Actual Time.

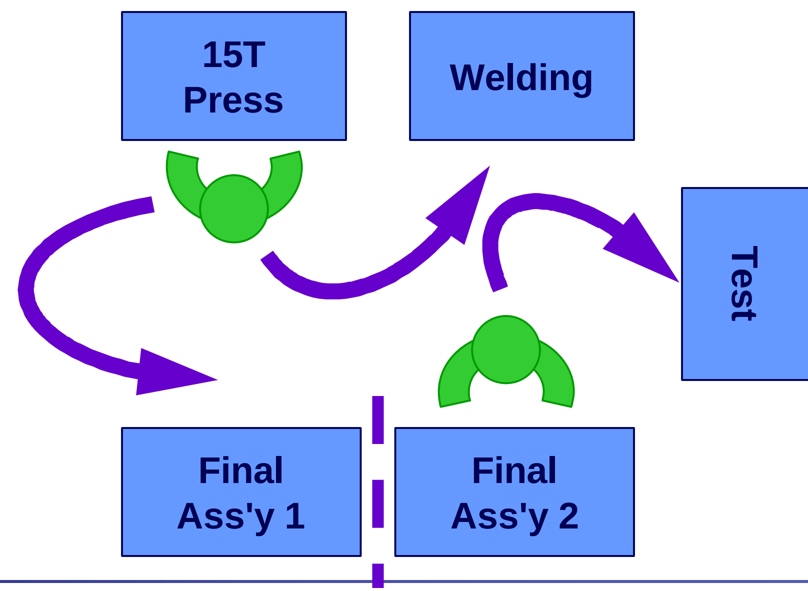
Additional Work = 5 x 8.8

RESOURCES FOR ADDITIONAL WORK = **44 min.**

BALANCE AND FLOW
U-SHAPED CELLS



- First Step of Improvement : **U-SHAPED CELLS.**
  - Several Operations by Employee.
  - Space Floor Saving.
  - Create Balance.
  - Cells designed for Flexibility.
  - **Improve :**
    - **Machine Utilization.**
    - **Labor Productivity.**
    - **Operational Cycle Time.**



BALANCE AND FLEXIBILITY
TAKT TIME

Wished Flexibility :	-20%	Nominal	+20%
Demand at Capacity - D_c :	22	28	34
TAKT Time (mn) :	**19.1**	**15**	**12.4**

Effective Work Time per Shift (mn) : 420

Number of Shift(s) : 1

Nominal D_c : 28 → TAKT Time (mn) = 15

Low D_c : 22 → TAKT Time (mn) = 19.1

High D_c : 34 → TAKT Time (mn) = 12.4

BALANCE AND FLEXIBILITY RESOURCES CALCULATION

Wished Flexibility :	-20%	Nominal	+20%
Demand at Capacity - D_c :	22	28	34
TAKT Time (mn) :	19.1	15	12.4
#OP – Theoretical :	2.84	3.61	4.37
#OP – Effective :	**3**	**4**	**5**

Total Time from SOE's (mn) : 54.2

Operations : #OP (Dc) = 54.2 / 15 = 3.61 ???

#OP (Dc-20%) = 54.2 / 19.1 = 2.84

#OP (Dc+20%) = 54.2 / 12.4 = 4.37

BALANCE AND FLEXIBILITY CORRECTED CAPACITY

Wished Flexibility :	-20%	Nominal	+20%
Demand at Capacity - D_c :	22	28	34
TAKT Time (mn) :	19.1	15	12.4
#OP – Theoretical :	2.84	3.61	4.37
#OP – Effective :	3	4	5
Corrected Capacity :	**23**	**30**	**38**

Total Time from SOE's (mn) : 54.2

Effective Work Time per Shift (mn) : 420

#OP – Theoretical : 4 → Capacity / Day = 420 x 4 / 54.2 = 30

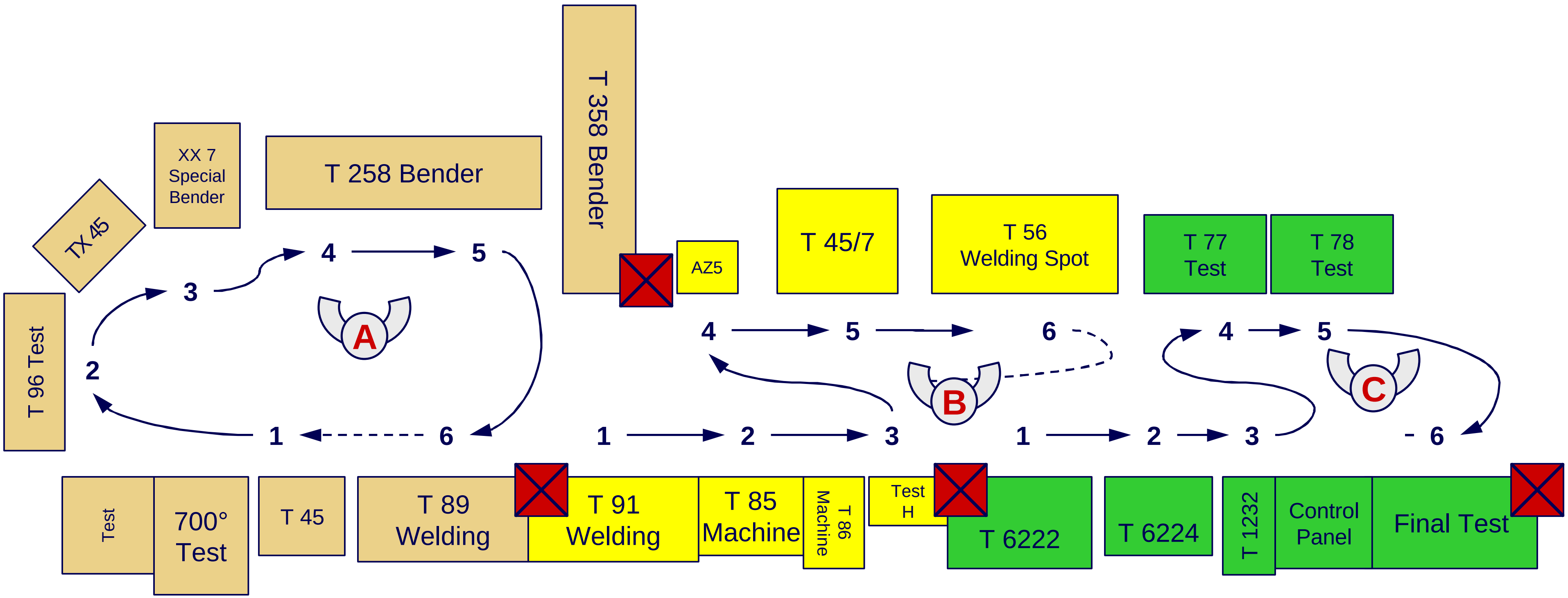
#OP – Theoretical : 3 → Capacity / Day = 420 x 3 / 54.2 = 23

#OP – Theoretical : 5 → Capacity / Day = 420 x 5 / 54.2 = 38

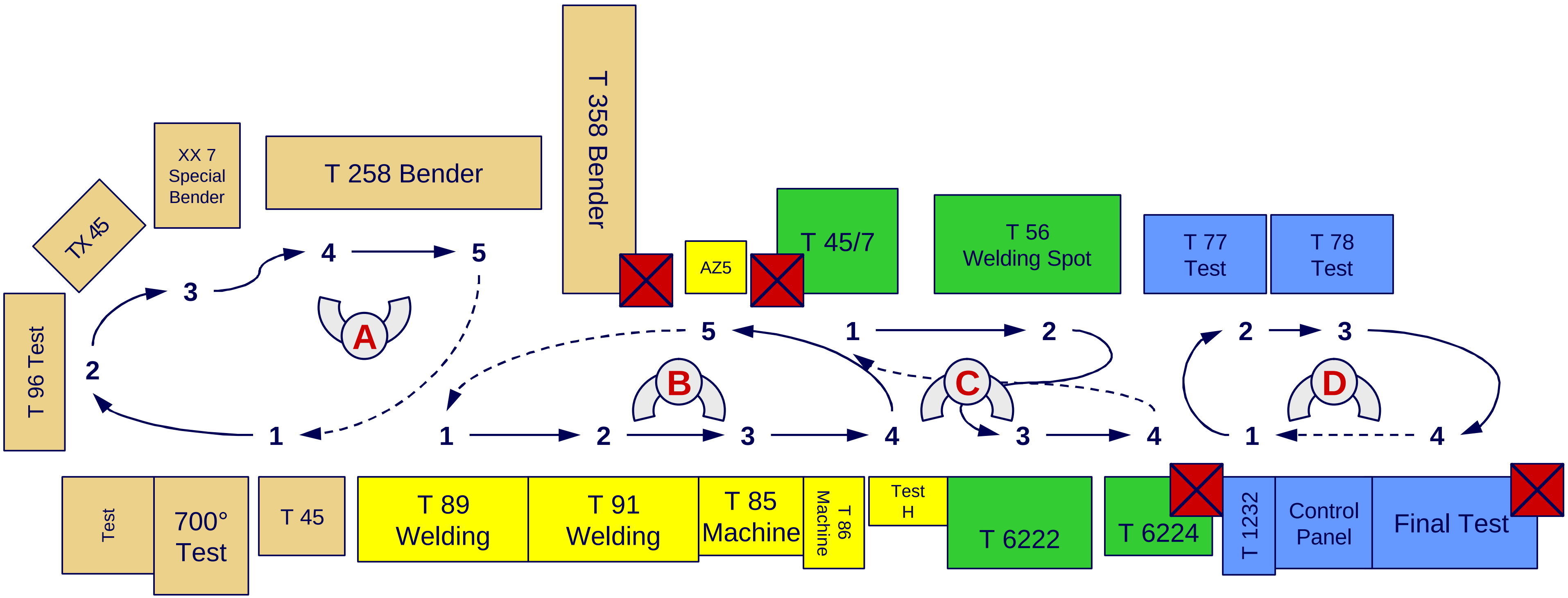
BALANCE AND FLEXIBILITY
CORRECTED FLEXIBILITY

Wished Flexibility :	-20%	Nominal	+20%
Demand at Capacity - D_c :	22	28	34
TAKT Time (mn) :	19.1	15	12.4
#OP – Theoretical :	2.84	3.61	4.37
#OP – Effective :	3	4	5
Corrected Capacity :	23	30	38
Corrected TAKT Time (mn) :	18.3	14	11
	-23%	**Nominal**	**+26%**

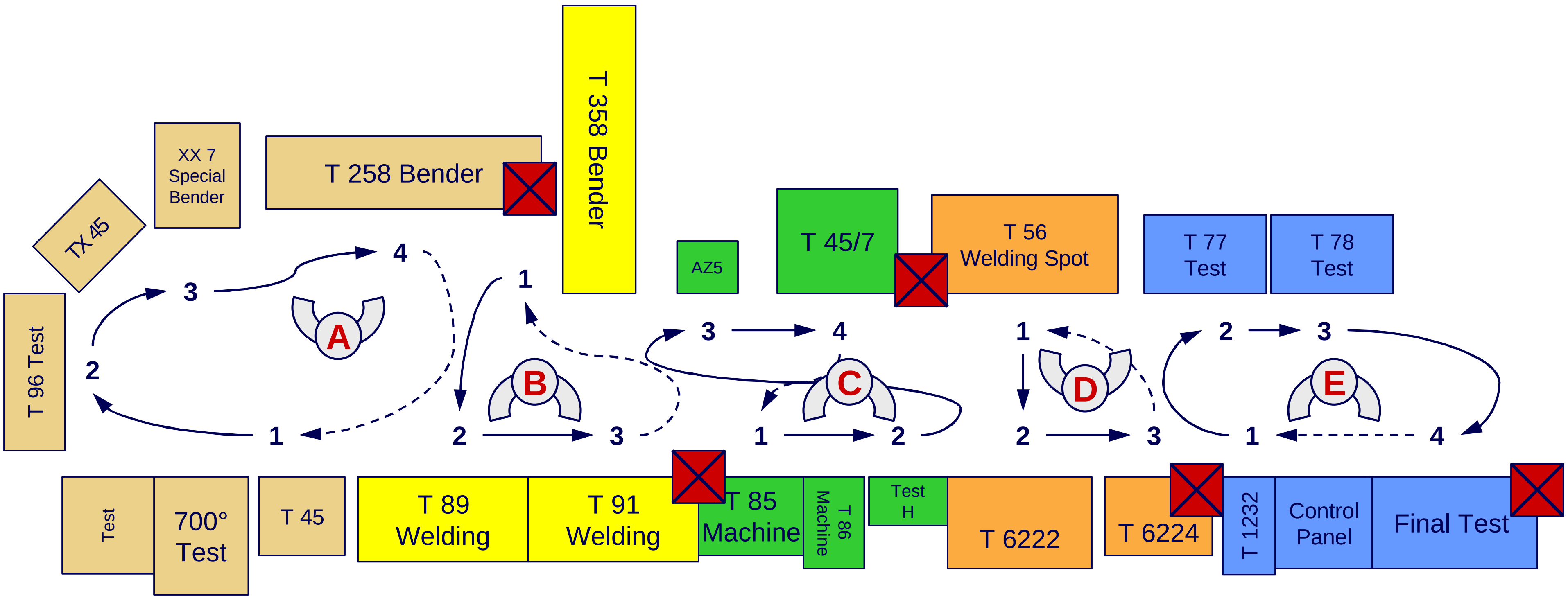
BALANCE AND FLEXIBILITY
LOW CAPACITY DEFINITION



BALANCE AND FLEXIBILITY
NOMINAL CAPACITY DEFINITION

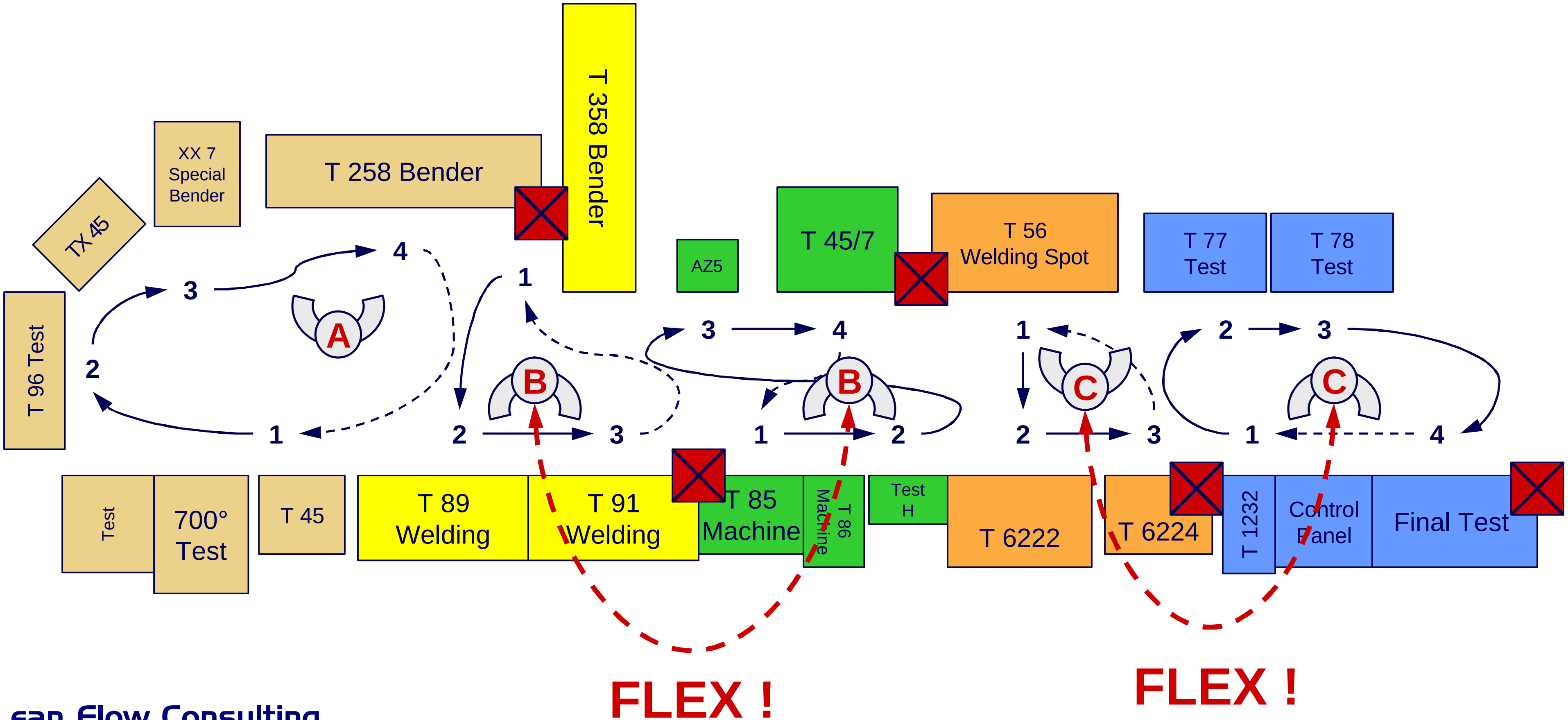


BALANCE AND FLEXIBILITY
HIGH CAPACITY DEFINITION



BALANCE AND FLEXIBILITY FLEXIBLE PRODUCTION SYSTEM

- #OP based on Customer Demands.



LEAN FLOW TECHNOLOGY
TIMES IN LFT

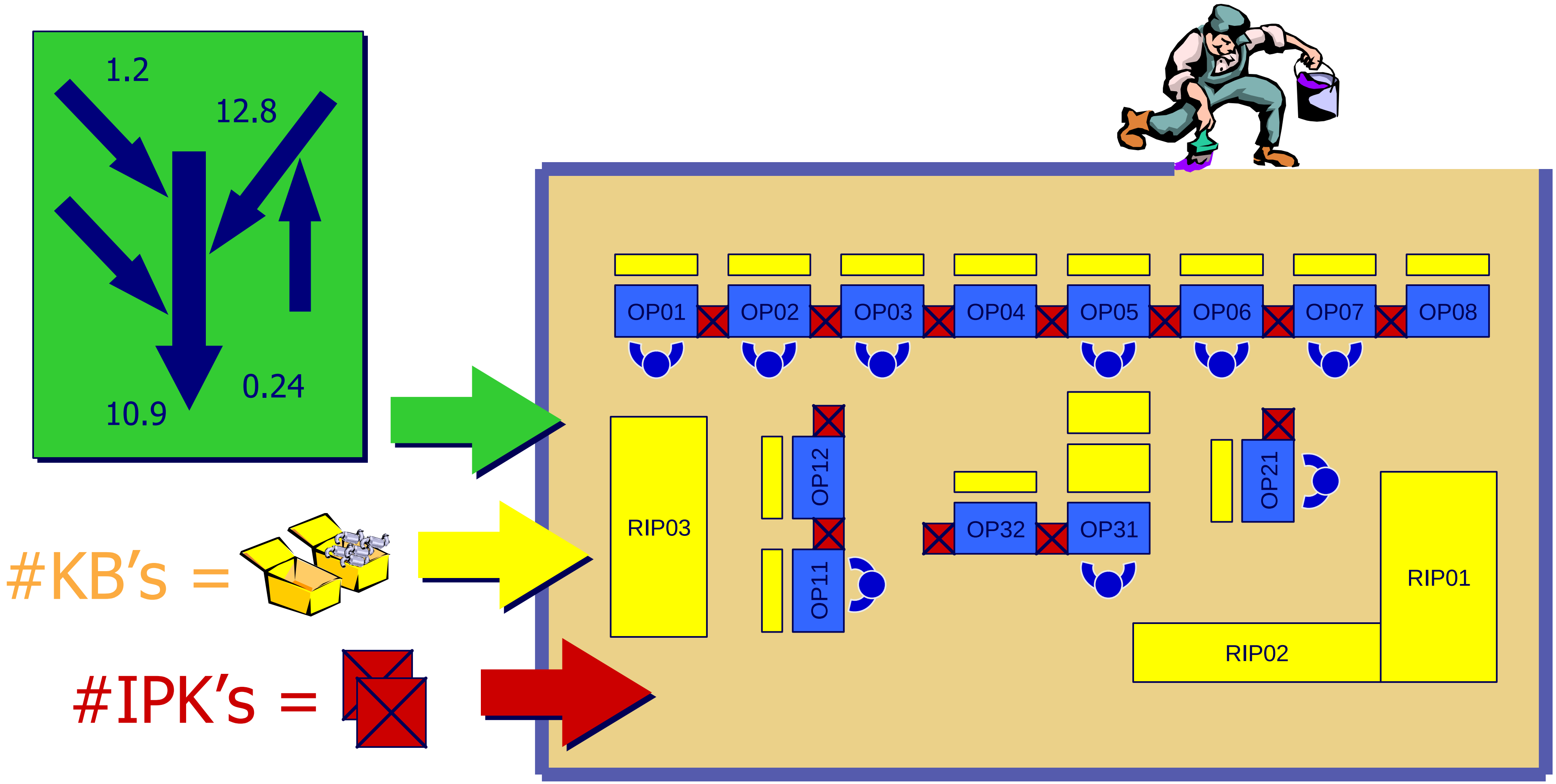
- TAKT Time.
  - Volume driven Time Targets. – By Process.
- Actual Times. – AT.
  - From the Sequences of Events. – SOE's.
- Operations.
  - Work Grouped **within a TAKT Time Target.**
- Balance.
  - Between **Actual Time at Operation (AT) and TAKT Time, Not Between Operations.**

MIXED-MODEL LINE DESIGN PHYSICAL IMPLEMENTATION

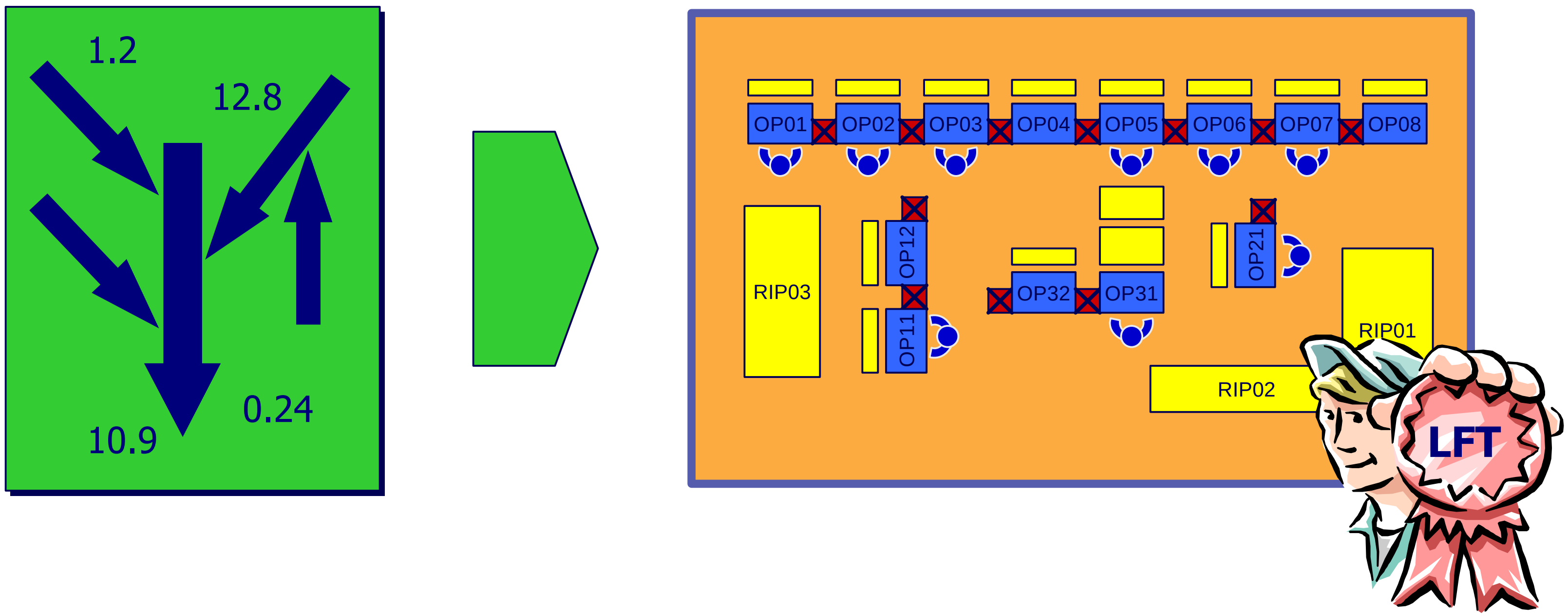
- Demand at Capacity.
- TAKT Time.
- Daily Rate.
- Kanban Sizes.
- Method Sheets.
- Sequence of Events.
- Sequence Lists.
- Operational Definition.
- Staffing.
- Effective Work Hours.
- Number of Shifts.
- Replenishment Intervals.
- IPK's Sizes.

Which Should Change Every Day ?

MIXED-MODEL LINE DESIGN PHYSICAL IMPLEMENTATION



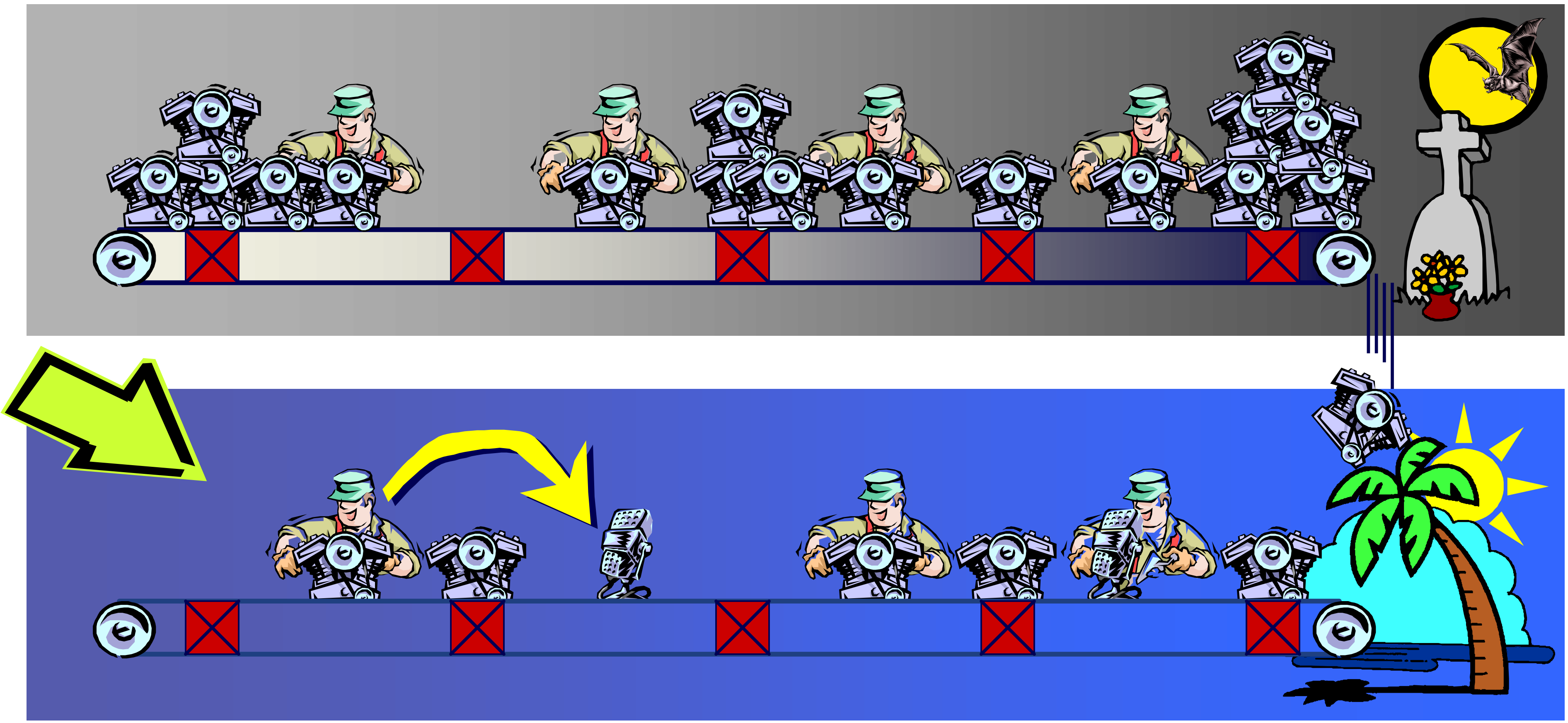
MIXED-MODEL LINE DESIGN
… VISUALIZE THE END RESULT



“ Imagination is More Important than Knowledge ”

Albert Einstein

MIXED-MODEL LINE DESIGN
WHAT IS THE TRUE FLOW ?



LEAN FLOW TECHNOLOGY
BALANCE AND FLOW

SUMMARY

- Operational Definition.
  - "At, or Below" TAKT Time Targets to create Balance.
- Resolve Imbalances.
- In-Process Kanban.
  - Formulae and Calculation.
  - … Typical Case in Mixed-Model Concept.
  - Additional Work.
- Balance and Flexibility.
  - U-Cell Design.
- Physical Implementation.

LEAN FLOW TECHNOLOGY QUESTIONS

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