LEAN FLOW TECHNOLOGY

MIXED-MODEL LINE DESIGN
TWO-BIN KANBAN SIZING

CALCULATION & ALGORITHMS

Lean Flow Consulting
►► *Creating World-Class Lean Enterprise*

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1. Lean Flow Technology Overview

Lean Flow Technology is a manufacturing methodology with the objective of building the highest quality product in the shortest possible time at the lower cost. To achieve this objective, Lean Flow Technology deploys the following principles :

- Building to daily customer demand rather than building to forecast,
    - ***To reduce finished goods inventory, reduce cost and increase customer satisfaction.***
- Continuous flow manufacturing rather than batch production,
    - ***To reduce work in process inventory, rework, scrap and increase quality. Quality problems are immediately addressed.***
- Mixed-Model production rather than process layout,
    - ***To build a mix of products on one line to respond to the customer demand and increase resources utilization.***
- In-Process quality rather than inspecting quality at the end of production,
    - ***To build quality into the product during the production process resulting in less waste and higher customer satisfaction.***
- Just-In-Time material replenishment rather than receipts of MRP forecasted demands,
    - ***To reduce the amount of component and material inventory and reduce cost.***
- Uses rate-based production rather than work orders,
    - ***To simplify shop floor activities and reduce costs.***
- Labor flexibility rather than labor specialization,
    - ***To increase productivity and reduce costs.***
- Backflush material and labor costs upon completion rather than at each operation,
    - ***To simplify shop floor activities and reduce costs.***

2. Mixed-Model Line Design

2.1. Line Design Concept

Line Design is the foundation of a Lean Flow production line. The objective of Lean Flow Technology is to balance lines and cells for mixed-model production at the expected customer daily demand that take the least possible time to execute.

Line Design includes groupings products into product families, defining processes and sequences of events required to produce each product, and re-grouping tasks into line operations at or below Takt-Time target.

Effective Lean Flow line design and balanced production smoothes production and eliminates bottlenecks. Lean Flow lines are designed to reduce flow process lead-time and resources costs by identifying to eliminate non-value added activities. Simplified processes are designed to reduce overhead costs by optimizing floor space utilization. This simplified design also helps increase material flow on production floor through visual management. Quality is improved by implementing quality criteria into processes and each operation, instead of final inspection.

2.2. Line Design Tools

2.2.1. Product Synchronization

Product Synchronization defines the processes used to build each product or product family and the sequence of events within each process. Events are chronologic tasks within the process that define the physical activities on the line. In addition flow routings can be used to define relationship of processes including feeder lines, rework paths, and both main and alternate processes required to make a product. This will help model the line as is to the system.

2.2.2. Mixed-Model Process Map

The Mixed-Model Process Map combines the information from the products assigned to a specific family into a line, including demand at capacity, all factors influencing demands, and labor and machine times. This information is displayed on the Mixed-Model Process Map (Time) in tabular form.

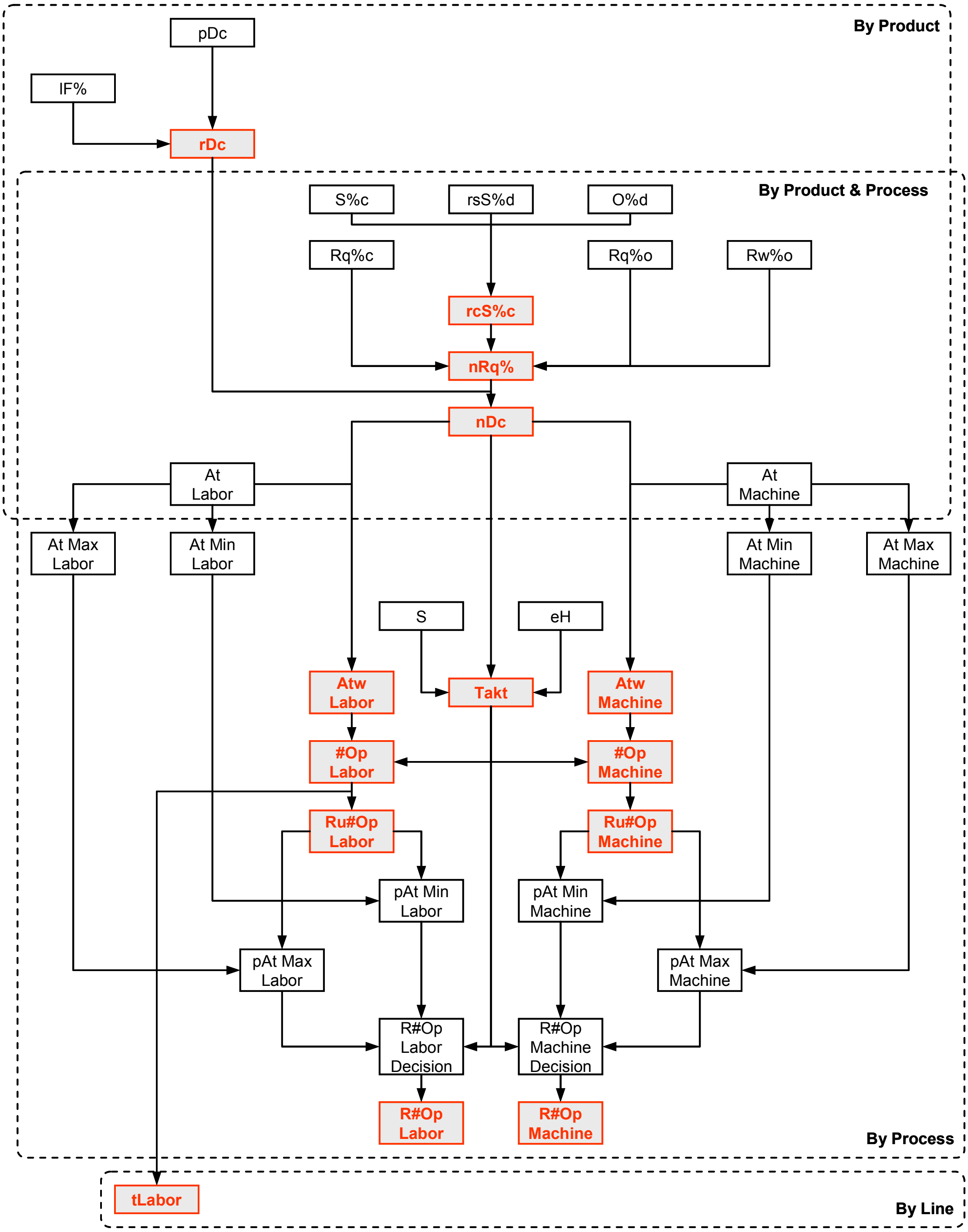
2.2.3. Sequence of Events

Sequences of Events are the fundamental Lean Flow Technology documents to define the one correct way to build products. Sequences of Events include tasks description with value added identification, required, setup or move times and quality criteria. These are the primary tools used to train employees and draw operational method sheets.

2.2.4. Mixed-Model Line Design Calculation

Mixed-Model Line Design Calculation is the module uses to achieve balanced flow lines. The Takt-Time is calculated from the daily demand at capacity and the available production hours in a day. The summary part of the Mixed-Model Line Design Calculation displays the labor and machine resources needed to meet the Takt-Time target. Since Takt-Time establishes the rhythm of the line, all the processes along the line are streamlined to complete within the Takt-Time. This ensures that each product moves from upstream to downstream process within the Takt-Time, which maintains the steady production rate necessary to meet customer demand.

2.3. Line Design Flowchart



2.4. Reverse Cumulative Scrap Percentage

Reverse Cumulative Scrap % is calculated for each process defined on product synchronization. This information is used in Net Required Percentage calculation.

$$rcS\%c = (1 - S\%c) * \Sigma (rcS\%d * O\%d)$$

Where :
S% = Scrap %
O% = Outgoing %
c = Current Process
d = Downstream Process

Note : All percentages are expressed in decimal format.

2.5. Net Required Percentage

Net Required % is calculated for each process defined on product synchronization. This information is used to define the Net Demand at Capacity for each parent part and process relationship.

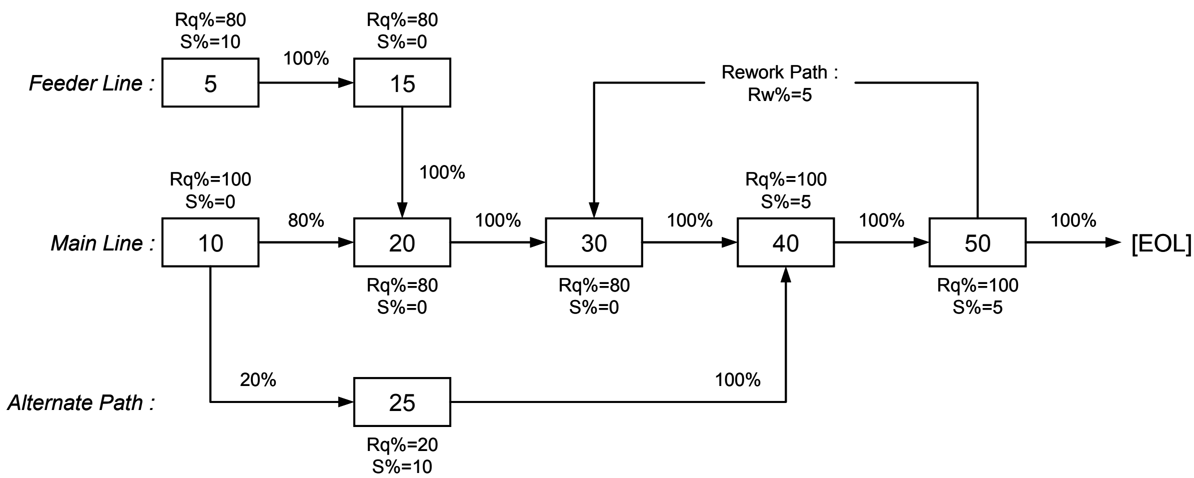
$$nRq\%c = Rq\%c * [(1 + Rw\%o) * Rq\%o] / rcS\%c$$

Where :
Rq% = Required Quantity of Products %
Rw% = Rework %
rcS% = Reverse Cumulative Scrap %
c = Current Process
o = Process Originating Rework

Notes : Rework impact calculation is equal to the Required % of the reworks originating process, times the Rework % coming from that Process.
Rework % impacts all processes within Rework path.
All percentages are expressed in decimal format.

In the below product synchronization, the main line path is processes 10 through 50. Percentages between processes represent the Outgoing percent defined to each path. Outgoing percent for the default [End of Line] is always 100%.

Product Synchronization



Example of Reverse Cumulative Scrap % Calculation :

Current Process		Consumed by Downstream Process			
Process ID	Scrap %	Process ID	Outgoing %	Process ID	Outgoing %
10	0.00	20	0.8	25	0.2
20	0.00	30	1.0		
25	0.10	40	1.0		
30	0.00	40	1.0		
40	0.05	50	1.0		
50	0.05	[EOL]	1.0		
5	0.10	15	1.0		
15	0.05	20	1.0		

Reverse Cumulative Scrap %		
Calculation	**Result**	**Order**
(1-0.00)*[(0.90*0.8)+(0.81*0.2)]	**0.88**	**6**
(1-0.00)*(0.90*1.0)	**0.90**	**4**
(1-0.10)*(0.90*1.0)	**0.81**	**5**
(1-0.00)*(0.90*1.0)	**0.90**	**3**
(1-0.05)*(0.95*1.0)	**0.90**	**2**
(1-0.05)	**0.95**	**1**
(1-0.10)*(0.90*1.0)	**0.81**	**8**
(1-0.00)*(0.90*1.0)	**0.90**	**7**

Example of Net Required % Calculation :

Current Process		With Rework	
Process ID	Required %	Rework %	Return Process ID
10	1.0		
20	0.8		
25	0.2		
30	0.8		
40	1.0		
50	1.0	0.05	30
5	0.8		
15	0.8		

Net Required %				
Rework Impact%	Rq%o	**rcS%**	Calculation	**Result**
		0.88	1.0 / 0.88	**1.13**
		0.90	0.8 / 0.90	**0.89**
		0.81	0.2 / 0.81	**0.25**
0.05	1.0	**0.90**	0.8*[(1+0.05)*1.0] / 0.90	**0.93**
0.05	1.0	**0.90**	1.0*[(1+0.05)*1.0] / 0.90	**1.16**
0.05	1.0	**0.95**	1.0*[(1+0.05)*1.0] / 0.95	**1.11**
		0.81	0.8 / 0.81	**0.98**
		0.90	0.8 / 0.90	**0.89**

2.6. Retained Demand at Capacity

Retained Demand at Capacity is calculated for each parent part.

rDc = pDc / IF%

Where : pDc = Projected Demand at Capacity
IF% = Line Design Factor %

Note : All percentages are expressed in decimal format.

Example of Retained Demand at Capacity Calculation :

Parent Part ID	pDc	IF%
A	20.20	0.85
B	12.40	0.85
C	8.32	0.80
D	14.23	0.85
E	15.45	0.85

Retained Demand at Capacity	
Calculation	**Result**
20.20 / 0.85	**23.76**
12.40 / 0.85	**14.59**
8.32 / 0.80	**10.40**
14.23 / 0.85	**16.74**
14.45 / 0.85	**18.18**

2.7. Net Demand at Capacity

Net Demand at Capacity is calculated for each process and each parent part. The sum of Net Demand at Capacity by process is used to define Takt-Time by process.

nDc = rDc * nRq%

Where : rDc = Retained Demand at Capacity
nRq% = Net Required %

Note : All percentages are expressed in decimal format.

Example of Net Demand at Capacity Calculation :

Parent Part ID	rDc	Net Required % Process					
		10	20	25	30	40	50
A	**23.76**	**1.13**	0.89	0.25	0.93	1.16	1.11
B	14.59	1.17	0.55	0.62	0.58	1.16	1.11
C	10.40				1.44	1.30	1.17
D	16.74	1.05	1.05		1.16	1.10	1.10
E	18.18	1.00		1.00	1.16	1.10	1.10

Net Demand at Capacity Process					
10	**20**	**25**	**30**	**40**	**50**
26.85	**21.15**	**5.94**	**22.10**	**27.56**	**26.37**
17.07	**8.02**	**9.05**	**8.46**	**16.92**	**16.19**
			14.98	**13.52**	**12.17**
17.58	**17.58**		**19.42**	**18.41**	**18.41**
18.18		**18.18**	**21.09**	**20.00**	**20.00**

Example with Parent Part A – Process 10 :
nDc = 23.76*1.13

2.8. Takt-Time

Takt-Time "Magic Number" is calculated by process in mixed-model line design. Each process can have a unique Takt-Time due to factors influencing Net Demand at Capacity.

Takt = (eH * S * 60) / Σ nDc

Where : eH = Effective Work Time per Shift, in hours
S = Number of Shifts per Day
nDc = Net Demand at Capacity

Note : Takt expressed in minutes.

Example of Takt-Time Calculation :

Parent Part ID	Net Demand at Capacity					
	Process					
	10	20	25	30	40	50
A	**26.85**	21.15	5.94	22.10	27.56	26.37
B	**17.07**	8.02	9.05	8.46	16.92	16.19
C				14.98	13.52	12.17
D	**17.58**	17.58		19.42	18.41	18.41
E	**18.18**		18.18	21.09	20.00	20.00
Σ nDc :	**79.68**	46.75	33.17	86.05	96.41	93.14
eH (h) :	**6.83**	6.83	6.83	6.83	6.83	6.83
S :	**2**	2	2	2	2	2
Takt (mn) :	**10.29**	**17.53**	**24.71**	**9.52**	**8.50**	**8.80**

Example with Process 10 :
Takt = (6.83*2*60) / (26.85+17.07+17.58+18.18)

2.9. Labor (or Machine) Actual Time Weighted

Labor and Machine Actual Time Weighted are calculated by process.

Atw = Σ (nDc * At) / Σ nDc

Where : nDc = Net Demand at Capacity
At = Actual Time, in minutes

Notes : Atw expressed in minutes.
At = Labor (or Machine) Total Actual Time from SOE.

2.9.1. Interpretation of Total Time from Sequence of Events :

Since different resources calculations are possible, Total Actual Time is defined for Labor and Machine, using following considerations :

- For Operational Definition :
  - Include Dynamic Setup and Move Times,
  - Include longest Overlapping Times,
  - Ignore Static Setup and Move Times.
- For Total Product Cycle Time (TPc/t) :
  - Include all Setup and Move Times to make one.
- For Daily Resources Planning :
  - Include all Overlapping Times, not only the longest,
  - Include all Setup Times.

Example of Labor and Machine Actual Time Weighted Calculation :

Parent Part ID	Net Demand at Capacity								
	Process								
	10		20	25	30		40		50
	Labor	Machine	Labor	Labor	Labor	Machine	Labor	Machine	Labor
A	**26.85**	26.85	21.15	5.94	22.10	22.10	27.56	27.56	26.37
B	**17.07**	17.07	8.02	9.05	8.46	8.46	16.92	16.92	16.19
C					14.98	14.98	13.52	13.52	12.17
D	**17.58**	17.58	17.58		19.42	19.42	18.41	18.41	18.41
E	**18.18**	18.18		18.18	21.09	21.09	20.00	20.00	20.00
Σ nDc :	**79.68**	79.68	46.75	33.17	86.05	86.05	96.41	96.41	93.14

Parent Part ID	Total Actual Time from Sequences of Events								
	Process								
	10		20	25	30		40		50
	Labor	Machine	Labor	Labor	Labor	Machine	Labor	Machine	Labor
A	**20.0**	5.6	42.0	23.0	9.0	9.0	62.0	8.0	23.0
B	**21.0**	5.6	45.0	26.0	7.0	7.0	67.0	8.0	45.5
C					8.0	8.0	50.0	8.0	12.0
D	**18.0**	7.8	52.0		6.0	6.0	46.0	9.0	12.0
E	**22.0**	5.6		25.0	8.0	8.0	48.0	9.0	49.0
Σ (nDc*At) :	**1611.9**	484.9	2163.4	826.4	663.2	663.2	5325.2	809.7	2682.0
Atw mn) :	**20.23**	**6.09**	**46.28**	**24.91**	**7.71**	**7.71**	**55.23**	**8.40**	**28.80**

Example with Process 10 – Labor :
Atw = [(26.85*20.0)+(17.07*21.0)+(17.58*18.0)+(18.18*22.0)] / (26.85+17.07+17.58+18.18)

2.10. Labor (or Machine) Operation Sizing

Labor and Machine Operation Sizing or Operational Definition is calculated by process.

#Op = Atw / Takt

Where : Atw = Labor (or Machine) Actual Time Weighted, in minutes
Takt = Takt-Time, in minutes

Example of Labor and Machine Actual Time Weighted Calculation :

	Process								
	10		20	25	30		40		50
	Labor	Machine	Labor	Labor	Labor	Machine	Labor	Machine	Labor
Atw (mn) :	20.23	6.09	46.28	24.91	7.71	7.71	55.23	8.40	28.80
Takt (mn) :	10.29	10.29	17.53	24.71	9.52	9.52	8.50	8.50	8.80
#Op :	**1.97**	**0.59**	**2.64**	**1.01**	**0.81**	**0.81**	**6.50**	**0.99**	**3.27**

2.11. Total Labor

Total Labor resource is calculated at capacity.

tLabor = Σ Labor #Op

Where : Labor #Op = Labor Operation Sizing

Note : Round up the nearest whole number to define Total Labor required, at capacity.

Example of Total Labor Calculation :

	Labor Process					
	10	20	25	30	40	50
#Op	1.97	2.64	1.01	0.81	6.50	3.27

tLabor
17

2.12. Projected Max (or Min) Actual Time

Projected Max and Min Actual Times are calculated by process, for labor and machine resources.

Projected Max and Min Actual Times are compared to Takt-Time target with the objective to define the Retained Operation Sizing for labor and machine resources at capacity.

pAt Max = At Max / ru#Op

pAt Min = At Min / ru#Op

Where : At Max = Max Labor (or Machine) Actual Time, in minutes
At Min = Min Labor (or Machine) Actual Time, in minutes
ru#Op = Rounding Up Labor (or Machine) Operation Sizing

Example of Projected Max and Min Actual Time Calculation :

Parent Part ID	Process								
	10		20	25	30		40		50
	Labor	Machine	Labor	Labor	Labor	Machine	Labor	Machine	Labor
A	20.0	5.6	42.0	23.0	9.0	9.0	62.0	8.0	23.0
B	21.0	5.6	45.0	26.0	7.0	7.0	67.0	8.0	45.0
C					8.0	8.0	50.0	8.0	12.0
D	18.0	7.8	52.0		6.0	6.0	46.0	9.0	12.0
E	22.0	5.6		25.0	8.0	8.0	48.0	9.0	49.0
At Max (mn) :	22.0	7.8	52.0	26.0	9.0	9.0	67.0	9.0	49.0
At Min (mn) :	18.0	5.6	22.0	23.0	6.0	6.0	46.0	8.0	12.0
ru#Op :	2	1	3	2	1	1	7	1	4
pAt Max :	**11.0**	**7.8**	**17.3**	**13.0**	**9.0**	**9.0**	**9.6**	**9.0**	**12.2**
pAt Min :	**9.0**	**5.6**	**7.3**	**11.5**	**6.0**	**6.0**	**6.6**	**8.0**	**3.0**

2.13. Retained Operation Sizing – Validation

Retained Operation Sizing can be modified for labor and machine resources to define flexible operations and resources.

R#Op = ru#Op Validation Where : ru#Op = Rounding Up Labor (or Machine) Operation Sizing

Example of Retained Operation Sizing Validation :

	Process								
	10		20	25	30		40		50
	Labor	Machine	Labor	Labor	Labor	Machine	Labor	Machine	Labor
pAt Max :	11.0	7.8	17.3	13.0	9.0	9.0	9.6	9.0	**12.2**
pAt Min :	9.0	5.6	7.3	11.5	6.0	6.0	6.6	8.0	**3.0**
Takt (mn) :	10.29	10.29	17.53	24.71	9.52	9.52	8.50	8.50	**8.80**
ru#Op :	2	1	3	2	1	1	7	1	**4**
R#Op :	**2**	**1**	**3**	**2**	**1**	**1**	**7**	**1**	**5**

Example with Process 50 – Labor :

- *Compare pAt Max (12.2) with Takt (8.80), High Imbalance between Work Content and the "Rhythm" of downstream process,*
- *Change ru#Op (4) to R#Op (5), to add Operation,*
- *Re-Calculate pAt Max (9.8),*
- *Compare last value of pAtMax (9.8) with Takt (8.80).*

At Max (mn) :	22.0	7.8	52.0	26.0	9.0	9.0	67.0	9.0	**49.0**
At Min (mn) :	18.0	5.6	22.0	23.0	6.0	6.0	46.0	8.0	**12.0**
pAt Max :	**11.0**	**7.8**	**17.3**	**13.0**	**9.0**	**9.0**	**9.6**	**9.0**	**12.2**
pAt Min :	**9.0**	**5.6**	**7.3**	**11.5**	**6.0**	**6.0**	**6.6**	**8.0**	**3.0**

3. Two-Bin Kanban Sizing

3.1. Kanban Design Concept

Key objective of Lean Flow manufacturing and Just-In-Time production is to minimize inventory and increase inventory turns. Raw material is pulled into production lines as needed to meet demand and the pulled material is replenished using kanban signal. The minimum amount of material possible, based on replenishment time is held at the line in kanban bins. As each bin is emptied, a visual signal is issued to replenish the bin and the next is used to pull material.

There are many kanban systems in use to replenish material, but the must commonly used is the single card two-bins system. Kanban Design supports this system for execution during production.

3.2. Kanban Design Tools

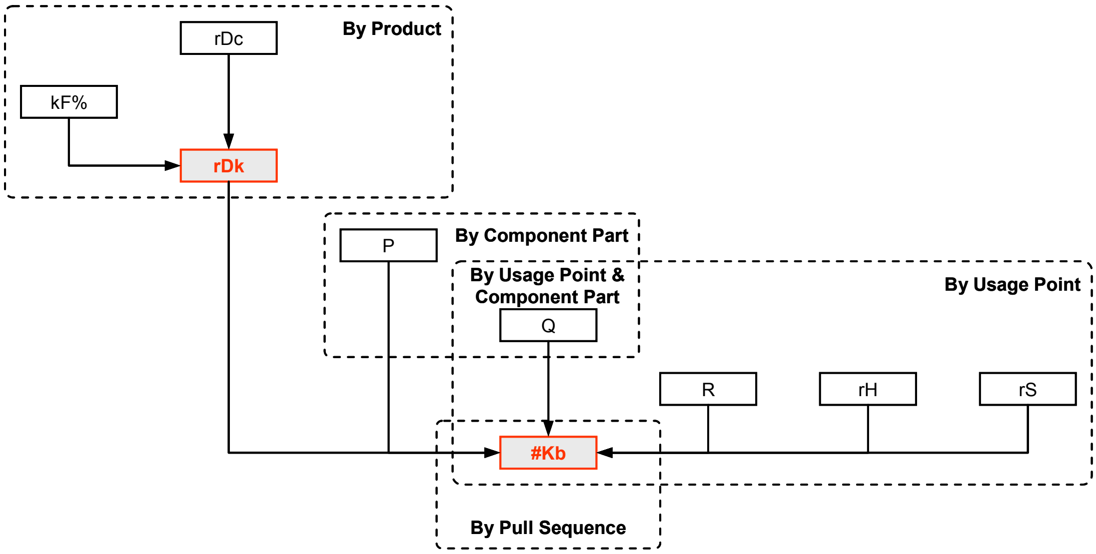
3.2.1. Calculation of Kanban Size

Lean Flow Technology calculates the optimal quantity per bin needed in each kanban location. Kanbans calculated can be compared and adjusted against kanban requirements for consistently varying demands. This process helps in both maintaining minimal material inventory and continuity of material flow from the supplier to the point of use into the production line.

3.2.2. Kanban Locations & Pull Sequences

Pull Sequence module helps you define the kanban locations for each component part along with the supply source information. The supply source can be internal or external suppliers, others production lines or un-attached feeder lines, RIP or supermarkets. A complete chain of demand-supply pull sequence can be defined.

3.3. Kanban Design Flowchart



3.4. Retained Daily Rate (for Kanban)

By kanban scenario defined, a Retained Daily Rate (for Kanban) is calculated for each parent part. This information is used in Kanban Sizing.

rDk = rDc * kF%

Where : rDc = Retained Demand at Capacity
kF% = Kanban Design Factor

Note : All percentages are expressed in decimal format.

Example of Retained Daily Rate for Kanban Calculation :

Parent Part ID	rDc	kF%
A	23.76	0.70
B	14.59	0.70
C	10.40	0.70
D	16.74	0.60
E	18.18	0.80

Retained Daily Rate	
Calculation	**Result**
23.76 * 0.70	**16.63**
14.59 * 0.70	**10.21**
10.40 * 0.70	**7.28**
16.74 * 0.60	**10.04**
18.18 * 0.80	**14.54**

3.5. Kanban Sizing

Kanban Sizing, defining the number of component parts in each Kanban containers, is calculated by consumption or usage point. Result can be adjusted to optimize material presentation after calculation.

#Kb = Σ (rDk * Q) * R / (rH * rS * P)

Where : rDk = Retained Daily Rate (for Kanban)
Q = Pull Usage Quantity
R = Replenishment Interval Time, in hours
rH = Work Replenishment Time per Shift, in hours
rS = Number of Replenishment Shifts per Day
P = Package Quantity (if available)

Example of Kanban Sizing Calculation :

Usage Point	Component Part ID	Pull Usage Qty by Parent Part ID			R	rH	rS	P
		A	B	C				
L1C1 OP10	Z123	2	2	4	6.83	6.83	2	1
	Y456	5	8		14	6.83	2	2
	X789	25	50	18	3	6.83	2	10
L1C1 OP20	Y456		6	6	6.83	6.83	2	2
	X789	6	3	6	3	6.83	2	10
		16.63	10.21	7.28				
		Retained Daily Rate						

Kanban Sizing	
Calculation	**Result**
[(16.63*2)+(10.21*2)+(7.28*4)]*6.83/(6.83*2*1)	**42**
[(16.63*5)+(10.21*8)]*14/(6.83*2*2)	**85**
[(16.63*25)+(10.21*50)+(7.28*18)]*3/(6.83*2*10)	**24**
[(10.21*6)+(7.28*6)]*6.83/(6.83*2*2)	**27**
[(16.63*6)+(10.31*3)+(7.28*6)]*3/(6.83*2*10)	**4**

4. Glossary

A

Actual Time Weighted – Atw

On a given process, Actual Time Weighted **(Atw)** is a weighted average of labor or machine total times estimates based upon mix at capacity.

C

Cascading Cumulative Scrap %

See : Reverse Cumulative Scrap %.

Component Part

Lean Flow Technology definition of a bill of material item, also called kanban component part.

D

Demand at Capacity – Dc

Demand at Capacity **(Dc)** is the daily quantity of products or finished goods, required by the customer.

Dynamic

Setup or move task performed every time a product required work.

E

Effective Work Time per Shift – eH

Effective Work Time per Shift **(eH)** is the work hours per shift that labor or machine resources are available to calculate line design.

Note : Not equal to Work Replenishment Time per Shift (rH) used in kanban sizing.

Synonyms : Effective Resource Available per Shift, Available Production Time per Shift.

K

Kanban

A method of Just-In-Time production that uses standard containers or lot sizes with a single card or label attached to each. It is a pull system in which work centers signal with a card that they withdraw parts or components from feeding operations or suppliers.

Kanban Component Part

An item or component part pulled through the Kanban system, via pull sequence.

Kanban Design Factor % – kF%

Defined by kanban scenario, the Kanban Design Factor **(kF%)** represents a factor used to adapt Kanban sizing, calculated from projected demand at capacity, to actual estimated daily demand.

Kanban Sizing – #Kb

Kanban Sizing **(#Kb)** defines the quantity of component parts in each Kanban containers.

L

Labor Time

Time during which a Labor resource performs a given task described on sequence of events.

Synonym : Labor Actual Time.

Line

Manufacturing work area consisted of one or several cells sharing common processes.

Line Design Factor % – IF%

Line Design Factor **(IF%)** represents a percentage used to integrate Overall Equipment Effectiveness on line design. Based on World-Class Manufacturing OEE Factor, Line Design Factor % is usually equal to 85%.

Synonym : OEE Factor %.

M

Machine Time

Time during which a Machine resource performs a given task described on sequence of events.

Synonym : Machine Actual Time.

N

Net Required (of Products) % – nRq%

Net Required of Products % **(nRq%)** represents the percentage of a given product that passes through a process, including all factors influencing demand.

O

Operation Sizing – #Op

Operation Sizing **(#Op)** defines the number of resources needed, on a given process, to support demand at capacity. Operation Sizing defines number of employees, machines, pieces in one machine, operations or work stations.

Operation Yield %

See : Yield %.

Operational Decision

Last step of line calculation, the Operational Decision permits to define and validate operation sizing, including projected work content for high, average, and low to the Takt-time target consideration. Operational Decision helps to define the number of flexible or additional operations used to perform high work content products.

Outgoing % – O%

Outgoing % **(O%)** represents the percentage of products completed on a current given process, before being consumed by one of downstream processes. Outgoing % is used when multiple paths exist between a current process and several downstream processes. At a given process, sum of all Outgoing % is always 100%.

P

Parent Part

Lean Flow Technology definition of a finished good product.

Point of Use – POU

Kanban location defines a specific position, rack or work station, on a cell or line, where the material will be used. Material is pulled from these locations via pull (chain) sequences.

Process

A physical work area inside which a group of tasks can be performed in a continuous flow, one product at a time.

Process Originating Rework

Process Originating Rework defines a process which the detected defective products will be sent through a rework path. On product synchronization, a Process Originating Rework is always linked with the upstream process of rework path.

Product Synchronization

The Product Synchronization defines the flow between processes, including rework paths used to produce a family of products.

Synonym : Value Stream Design.

Projected Demand at Capacity – pDc

Used to define the retained demand at capacity, the Projected Demand at Capacity **(pDc)** represents the quantity of products resulting from horizon forecasts analysis.

Projected Max (or Min) Actual Time – pAt Max or pAt Min

Projected Max (or Min) Actual Time **(pAt Max or pAt Min)** allows to compare Max and Min work content by process to the Takt-Time target, with the objective to define additional flexible resources.

Pull Usage Quantity – Q

Pull Usage Quantity **(Q)** represents the quantity of component parts pulled from a specific pull sequence consumption point to produce a given product.

Note : Not always equal to BOM Usage Quantity.

R

Required Quantity (of Products) % – Rq%

Required Quantity of Products % **(Rq%)** at one given process represents the required volume of a specific product, in percentage, that consume resources from that particular process.

Resource

Definition of an operator or a machine used in a given process.

Resource Definition

See : Operation Sizing.

Replenishment Interval Time – R

Replenishment Interval Time **(R)** represents the time required to restock a component part.

Replenishment Shift – rS

Replenishment Shift **(rS)** represents the number of shifts per day to replenish material.

Note : Not equal to Number of Shifts (S) used in line design.

Retained Demand at Capacity – rDc

Quantity of products used to calculate line design, the Retained Demand at Capacity **(rDc)** represents the projected demand at capacity to which adds a complementary quantity resulting from line design factor.

Retained Daily Rate (for Kanban) – rDk

Retained Daily Rate for Kanban **(rDk)** represents the quantity of products used to size kanbans. Retained Daily Rate is calculated from projected demand at capacity, including kanban design factor % to adjust quantity to the real customer demand.

Reverse Cumulative Scrap % – rcS%

Cascading upstream influence of all scrap %, on a base of 100, on the net volume for complete products scrapped. Reverse Cumulative Scrap % **(rcS%)** is calculated at each process on the product synchronization, starting with the End Of Line [EOL] process.

Synonym : Cascading Cumulative Scrap %.

Rework % – Rw%

As a recoverable yield, Rework % **(Rw%)** represents the percentage of defective, but repairable products, on a given process.

Rework Impact

Impact of Rework on the net required percentage. Rework Impact affects all processes within the rework path.

S

Sequence of Events

The Sequence of Events is a fundamental document of Lean Flow Technology to define the one correct way to build a given product or family of products at a designated process. This manufacturing engineering document includes, for each task, description, value added identification, labor and machine times dispatched in required, setup or move time and quality criteria. Sequences of Events can be used to complete Mixed-model process map time.

Scrap % – S%

Non-recoverable yield, Scrap % **(S%)** represents the percentage of defective and scrapped products on a given process.

Static

Setup or move task performed for a group of products or parts.

T

Takt-Time – Takt

Translation of the customer demand to a unit of time. Takt-Time **(Takt)** corresponds to the available production time per day divided by the total daily customer demand. Takt-Time sets the pace of production to match the daily demand at capacity based on customer demand and becomes the heartbeat of lean flow line. In Mixed-model production, Takt-Time is calculated for each process.

Total Product Cycle Time – TPc/t

The total time along the longest path of flow routing. Calculated per product by taking the sum of the process times along the longest primary or critical path defined on the product synchronization.

Note : Not equal to Flow Process Lead Time.

W

Work Replenishment Time per Shift – rH

Work Replenishment Time per Shift **(rH)** represents the work hours that the material handlers are available, per shift, to replenish material.

Note : Not equal to Effective Work Time per Shift (eH) used in line design.

Y

Yield % – Y%

Yield % **(Y%)** represents the percentage of products that passes through a process on a flow line without being scrapped or reworked.

5. Index

T

W

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If you have any questions, comments, or would like to learn more about Lean Flow Technology Education or Implementation Program, please contact us at : direction@leanflowconsulting.com