

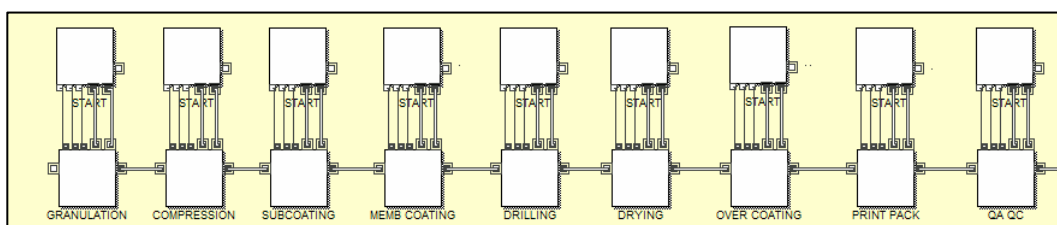
Lean Manufacturing Model

A New Use of Simulation Technology in Pharmaceuticals

Achieving sustainable manufacturing improvement for pharmaceutical and biological products has been difficult in the past due to the complexity of processing and the lack of tools. OpStat's lean model can be used to make improvements in existing operations, analyze capacity in new and existing installations, and plan for the future based on demand scenarios. The model is like a dynamic value stream map so analysts and engineers can see material moving through all work centers/equipment in the process.

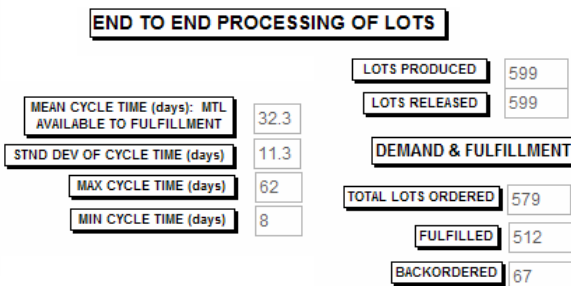
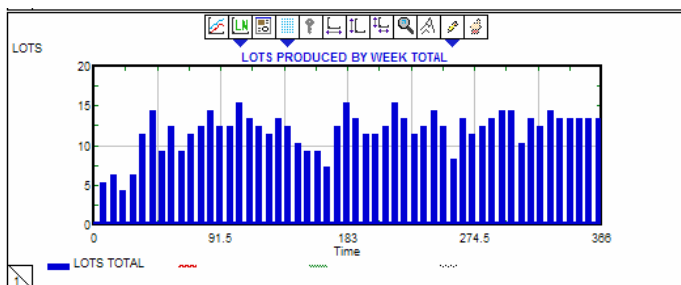
Material, Information & Financial Flows are Visible

Flows and accompanying spreadsheets may be configured using standard modules.



Flexible graphical summaries on performance

Statistics on throughput, cycle time, yield & service levels



Chemistry and protein based product forms – e.g., API, tablets, capsules, liquids, lyophilized vials & syringes, inhalers, transdermal patches - may be configured by your own employees after training and benchmarking to actual metrics.

Validated Equipment & Rules

Current and proposed validations as well as all cleanout and sterilization rules by product are maintained in Excel spreadsheets for ease of use.

Product Equip - Multiple Equipment Paths Allowed					Path 1		All times in hours				
Product ID	Product Name	Product Code	Operation Nbr	Operation Name	Nbr of Paths	1 Equip Select	2 Process Time	3 Recon Time	4 Full Clean Time	5 BB Clean Time	
50	LIGHT 80	1021	7	Pouching	3	1	15.25	0	6	3	
53	LEIJ 80	1121	7	Pouching	2	1	15.25	0	6	3	



Detailed Processing Through Equipment

Models are configured hierarchically for supply chains and manufacturing streams down to work centers and individual sets of equipment as required.

Test scheduling & replenishment mechanisms for each work center.

START SIGNAL SOURCE AFTER 1st OP:
 0 = When Batch is Received (Not w/BOM)
 1 = Signal to Replenish Kanban
 2 = Schedule or Takt Releases Lots
 3 = Schedule with Kanban Check

START SIGNAL SOURCE: FOR 1st OPERATION
 4 = Schedule Generates Lots
 5 = Kanban Generates Lots

Equip Select Switch Options
 0 - Chooses 1st available path not busy, in priority order
 1 - Uses pre-selected set of equipment (in schedule)
 2 - Chooses a path that had the same product preceding
 3 - Chooses a path that had the same or lighter color product preceding
 4 - Uses pre-selected set of equipment from Master Matrix
 5 - Chooses path with lowest nbr waiting

Lots per Camp	Priority	Prod Code
5	1	7918
3	1	4883
5	1	7918
1	1	4228

Variability and planned/unplanned downtimes in all processes, as well as in demand, is incorporated in the *monte carlo simulation* employed.

THESE ARE GLOBAL VARIABILITY & DOWNTIME SETTINGS FOR THE MODEL.

OPERATIONS MAY BE INDIVIDUALLY TURNED ON. IF SO, LEAVE THESE GLOBAL SWITCHES OFF.

TURN VARIABILITY ON/OFF

SET CONTROLS

UNSCHEDULED DOWNTIME:
 OFF = WEEKLY AMT PER EQUIP SCHED SPREADSHEET;
 ON = STATISTICAL MTF/MTR

Resource Utilization: People & Equipment in both Manufacturing & Labs

The utilization of critical skilled personnel and of individual sets of equipment in each is tracked, as well as confidence intervals of results. Overall Equipment Effectiveness (OEE) is also calculated for each set of equipment.

Manufacturing Equipment & Product

LOTS Completed	LOTS WAITING			EQUIP UTILIZATION			OEE
	NBR	DAYS		IN USE	CLEANOUT	DOWN	
203	0.159	0.283	1	0.62546	0.14714	0.10422	0.622
196	0.092	0.171	2	0.56717	0.15756	0.10314	0.5638
57	0	0	3	0.10929	0.03552	0.10861	0.1093

People Schedules

Days per Week: 7 Hours per Shift: 8

Shifts per Day: 2

Lab Equipment

Equipment	Total Available	Utilization
BALANCE	1	61.2%
CENTRIFUGE	1	16.2%
CIRCULATING BATH	10	0.8%
DEGASSER	1	1.0%
GC	2	13.9%
HEADSPACE AUTO	3	0.1%
HPLC 1	12	18.5%
HPLC 2	10	50.1%
HPLC 3	8	26.8%
LIQ VOLDISP	1	9.0%
LOAD CELL	1	15.6%

OpStat Group Inc. has a proven track record with pharmaceutical and biological companies. Founded in 1986, our staff is expert in operational improvement, and uses simulation tools for analysis of operations. We have adapted our simulation models to be licensed to companies focused on lean operations.



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