Simulation-Aided Production and Operations Scheduling for Food and Beverage Plants

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Industrial Engineering and Operations Management

On the Complexity of Typical Dairy Plants

The front-end challenge: optimization of a production schedule

- The never-ending story that comes back every week!

The next step: increase or re-schedule volumes

- How to ensure resources utilization optimality?
- What additional volumes can be accommodated?

Planning the future: replace or add machines, design a new plant

- What will be the plant capacity?
- What equipment will be sufficient to accommodate the capacity?

On the Complexity of Dairy Plants

Why is it complicated?

- High number of possible production lots permutations
- Different and variable lot/batch sizes must be used
- Product incompatibilities need to be managed
- Allocation and priority to use share resources (CIP…)

What is it all about?

- Eliminate undesired waiting times
- Shorten run lengths and avoid over-time
- Manage limited holding tanks/silos properly

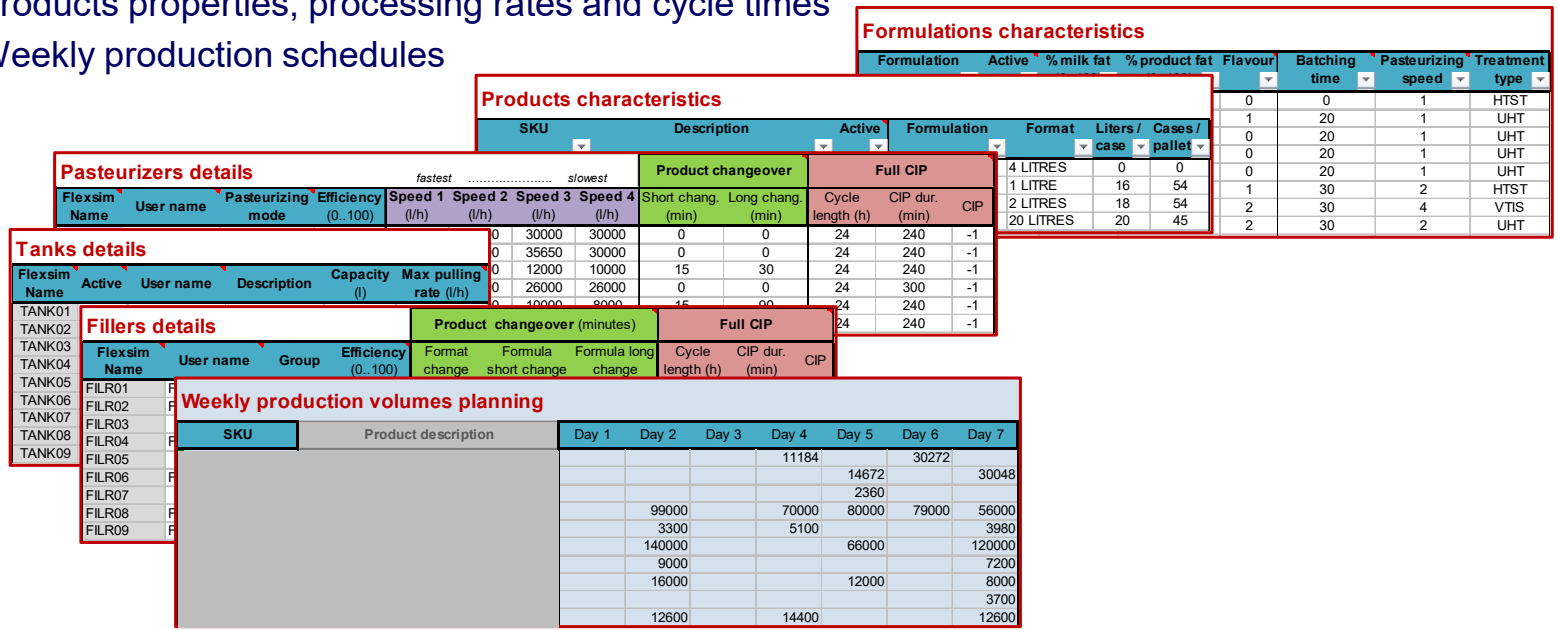
Too many variables exceeding a normal human brain capacity!

But state-of-the-art simulation tools can help.

Using Simulation to Make Better Decisions

An Excel file stores all parameters describing:

- Plant equipment, cleaning rules and times
- Products properties, processing rates and cycle times
- Weekly production schedules



Formulations characteristics

Formulation	Active	% milk fat	% product fat	Flavour	Batching time	Pasteurizing speed	Treatment type
				0	0	1	HTST
				1	20	1	UHT
				0	20	1	UHT
				0	20	1	UHT
				0	20	1	UHT
				1	30	2	HTST
				2	30	4	VTIS
				2	30	2	UHT

Products characteristics

SKU	Description	Active	Formulation	Format	Liters / case	Cases / pallet
				4 LITRES	0	0
				1 LITRE	16	54
				2 LITRES	18	54
				20 LITRES	20	45

Pasteurizers details

Flexsim Name	User name	Pasteurizing mode	Efficiency (0..100)	Speed 1 (l/h)	Speed 2 (l/h)	Speed 3 (l/h)	Speed 4 (l/h)	Product changeover: Short chang. (min)	Product changeover: Long chang. (min)	Full CIP: Cycle length (h)	Full CIP: CIP dur. (min)	Full CIP: CIP
				fastest			slowest					
				0	30000	30000		0	0	24	240	-1
				0	35650	30000		0	0	24	240	-1
				0	12000	10000		15	30	24	240	-1
				0	26000	26000		0	0	24	300	-1
				0	10000	8000		15	90	24	240	-1
										24	240	-1

Tanks details

Flexsim Name	Active	User name	Description	Capacity (l)	Max pulling rate (l/h)
TANK01					
TANK02					
TANK03					
TANK04					
TANK05					
TANK06					
TANK07					
TANK08					
TANK09					

Fillers details

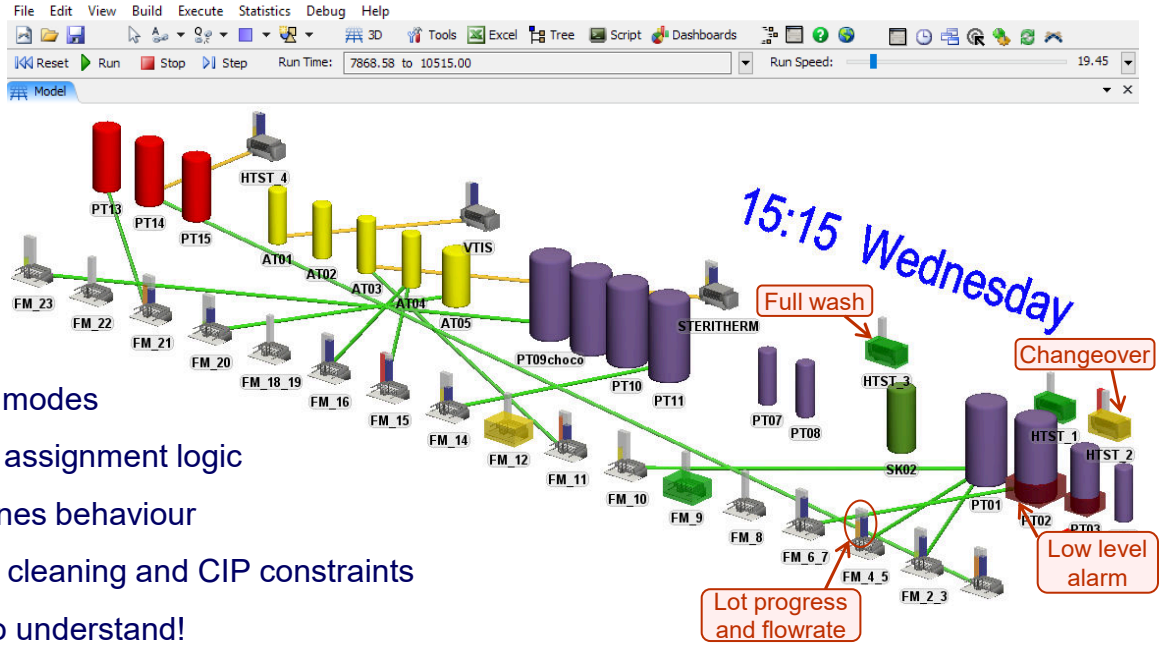
Flexsim Name	User name	Group	Efficiency (0..100)	Product changeover (minutes): Format change	Product changeover (minutes): Formula short change	Product changeover (minutes): Formula long change	Full CIP: Cycle length (h)	Full CIP: CIP dur. (min)	Full CIP: CIP
FILR01									
FILR02									
FILR03									
FILR04									
FILR05									
FILR06									
FILR07									
FILR08									
FILR09									

Weekly production volumes planning

SKU	Product description	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
					11184		30272	
						14672		30048
						2360		
			99000		70000	80000	79000	56000
			3300		5100			3980
			140000			66000		120000
			9000					7200
			16000			12000		8000
								3700
			12600		14400			12600

Using Simulation to Make Better Decisions

A powerful software simulates the production plan:



- Pasteurizing modes
- Holding tank assignment logic
- Filling machines behaviour
- Changeover, cleaning and CIP constraints
- Visual aids to understand!

Using Simulation to Make Better Decisions

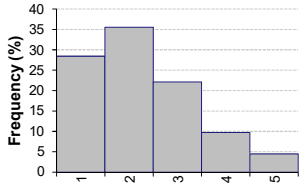
Enriched results are exported to Excel:

- On-time schedule completion and equipment utilization rates
- Effective and feasible Gantt-style production schedule
- Utilities, cases, pallets, and ingredients balances

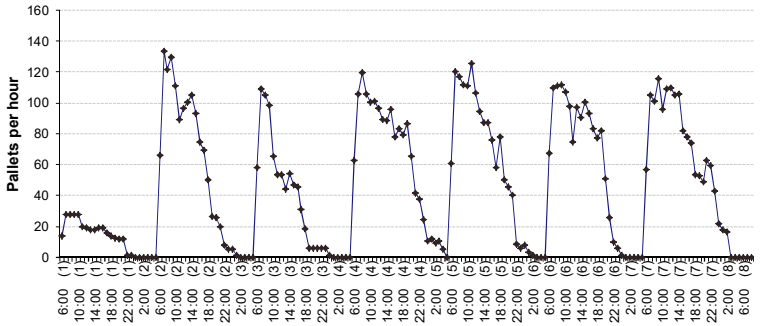
Daily utilized time (h)

Day:	1	2	3	4	5	6	7
HTST_1	8.4	9.9	8.2	9.4	7.9	10.5	9.9
HTST_2	5.1	13.7	11.6	13.9	16.0	15.0	12.1
HTST_3	4.4	9.6	12.4	13.5	12.8	10.1	7.3
HTST_4	6.9	12.9	3.9	12.3	10.9	9.0	10.1
STERITHERM	17.2	13.6	18.8	18.0	16.3	18.0	8.5
VTIS	6.5	16.0	5.7	15.9	13.5	14.7	9.1
FM_0_1	0.0	15.9	7.8	17.2	12.6	14.5	15.6
FM_2_3	0.0	15.9	16.0	17.5	19.0	17.7	19.8
FM_4_5	0.0	13.2	14.6	17.0	19.3	17.7	20.0
FM_6_7	0.0	12.7	7.0	12.9	12.4	15.3	19.5
FM_9	0.0	11.5	8.9	10.2	14.5	8.6	14.7
FM_10	0.0	19.2	0.0	15.3	11.2	13.4	15.4
FM_11	22.4	14.7	8.2	22.1	18.7	16.4	24.0
FM_12	0.0	16.3	5.8	13.9	14.0	11.0	12.5
FM_14	0.0	18.0	14.2	20.6	16.4	17.3	19.0
FM_15	0.0	6.8	0.0	6.2	6.5	5.7	0.0
FM_16	0.0	11.5	0.0	11.6	10.4	11.3	0.0
FM_20	16.6	20.6	15.5	22.6	19.8	18.8	23.7
FM_21	9.7	14.8	13.6	21.7	16.7	18.0	13.5
FM_22	0.0	7.5	0.0	6.5	6.5	8.4	4.1
FM_23	20.4	20.4	22.7	21.1	23.8	22.9	19.3

In-use batchers



Released pallets per hour



Using Simulation to Make Better Decisions

The most useful output: detailed Gantt-style production schedule

Using Simulation to Make Better Decisions

Example: Improving an historically hand-made refined schedule:

Day:	1	2	3	4	5	6	7	GLOBAL
R1		100	100	100	50	50		90
R2	100	100	100	80	80	80		96
R3		100	100	67	67	67		91
R4		100	100	100	80	100		100
R5		100	100	100	80	100		100
R6		100		80	43	86		96
R8		100	100	100	50	100		100
R9		100						100
R20	83	100	100	100	75	100		100
R21		100	100	100	100	100		100
R23								
R24		100	100	100	100			100

	Before	After	Gain
Total waiting time (h)	254	60	-76%
Total available time (h)	890	1,021	+15%
Orders fulfilment	94.8%	100%	

After 1 hour of simulation work

Day:	1	2	3	4	5	6	7	GLOBAL
R1		100	100	100	100	100		100
R2	100	100	100	100	100	100		100
R3		100	100	100	100	100		100
R4		100	100	100	100	100		100
R5		100	100	100	100	100		100
R6		100		100	100	100		100
R8		100	100	100	100	100		100
R9		100		100	100	100		100
R20	83	100	100	100	100	100		100
R21		100	100	100	100	100		100
R23								
R24		100	100	100	100			100

What Our Clients Do With This?

Simulation can answer to…

- Try different equipment priorities for a CIP?
- Evaluate the necessity of adding/enlarging a tank?
- Validate the additional capacity an extra filler could provide?
- Eliminate overtime using a more efficient schedule?

… in hours instead of days, with 1 person instead of a team!

Some harder challenges addressed with this simulation:

- Deliver additional volumes to support promotions
- Introduce new products in the normal schedule
- Balance workload between several plants
- Validate new plant design for an expected demand

And guess what? With training, our Clients do all of this without us!

Thank you
for
your attention!

FOR MORE INFORMATION:

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